Crane Valley Hydroelectric Project, FERC No. 1354

Crane Valley Water Temperature Monitoring Results – 2007

Addressing License Article 405 and U.S. Forest Service Condition No. 5

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Crane Valley Hydroelectric Project, FERC No. 1354
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1. INTRODUCTION

1.1 Objective

The Crane Valley Water Temperature Monitoring Program was initiated in 2005 to determine the water temperature conditions in the Crane Valley Project Area under operating conditions and ambient hydrological and meteorological conditions. Data collected during 2007 represent the third year of water temperature monitoring for the Crane Valley Project.

1.2 FERC License Article 405 and U.S. Forest Service 4(e) Condition No. 5

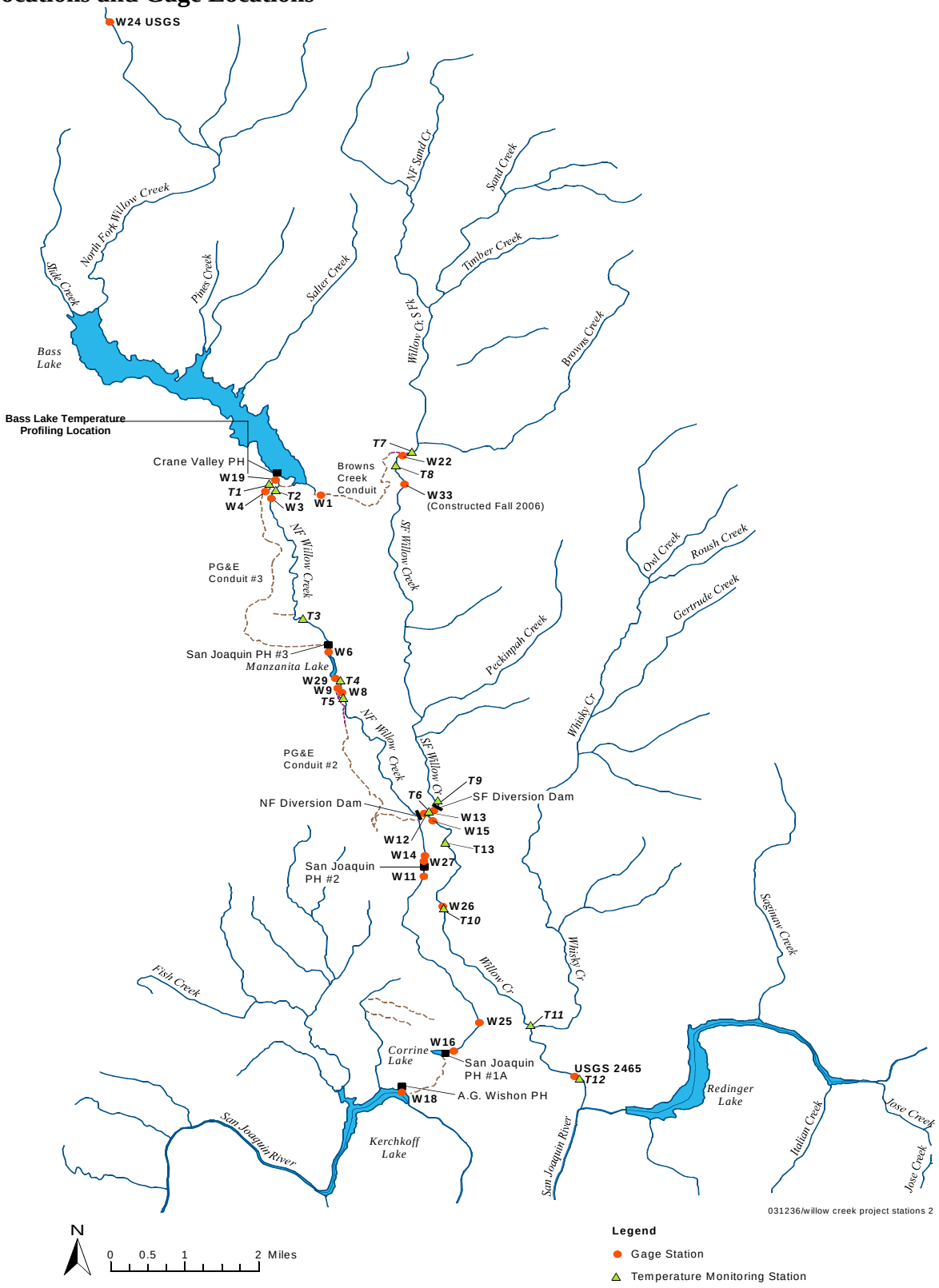
Pacific Gas and Electric Company (PG&E) filed with the Federal Energy Regulatory Commission (FERC) a water temperature monitoring plan on September 24, 2004 that was prepared in consultation with the California Department of Fish and Game, the U.S. Fish and Wildlife Service, the U.S. Forest Service (USFS), and the State Water Resources Control Board (PG&E 2004). The water temperature monitoring plan was verbally approved by the USFS on September 17, 2004 pursuant to USFS 4(e) Condition No. 5. An Order was issued by FERC on January 18, 2005, approving the water temperature monitoring plan pursuant to Article 405 and subject to the modifications outlined in the Order (FERC 2005).

1.3 Project Area

The Crane Valley Hydroelectric Project (Project), FERC No. 1354 in Madera County, includes the North Fork Willow Creek (NFWC), the South Fork Willow Creek (SFWC), mainstem Willow Creek, two major tributaries (Peckinpah Creek and Whiskey Creek), and four lakes (Bass Lake, Manzanita Lake, Chilkoot Lake, and Corrine Lake) (Figure 1.1-1). The Project was constructed between 1895 and 1920 by the San Joaquin Electric Company and later the San Joaquin Power and Light Corporation (Studley et al. 1995). FERC issued a new license to PG&E for the continued operation of the Project on September 16, 2003 (FERC 2003). Project elevations range from 966 feet at Wishon Powerhouse on the San Joaquin River to 7,497 feet at Chilkoot Lake.

Bass Lake is the main storage reservoir for the Project and has a drainage area of 50.4 square miles and a maximum water surface elevation of 3,377 feet. Bass Lake is formed by the Crane Valley Dam and is approximately 4 miles long. Bass Lake receives inflow from the NFWC, the SFWC (through the 2-mile long Browns Creek conduit), and other small streams.

Figure 1.1-1 Crane Valley Project Area, Including Water Temperature Monitoring Station Locations and Gage Locations



Upstream of Bass Lake, Chilkoot Dam is located on Chilkoot Creek and creates Chilkoot Lake. The Chilkoot Lake Pick-up ditch collects water, primarily spring runoff, and delivers it to Chilkoot Lake. When the water stored in Chilkoot Lake is released, it flows down Chilkoot Creek to the NFWC and then into Bass Lake.

Operational Flows including Releases to Tunnels, Canals and Bypass Flows

Water from Bass Lake enters a tunnel beneath the lake and passes through the dam to the Crane Valley Powerhouse. Outflow from the powerhouse travels approximately 3.5 miles through the No. 3 Conduit to a forebay upstream of the San Joaquin No. 3 Powerhouse. Outflow from that powerhouse enters the NFWC at the upper end of Manzanita Lake and is diverted again at Manzanita Lake Dam into the No. 2 Conduit, which carries water approximately 3 miles to the No. 2 Forebay. Water then travels approximately 0.75 miles through a penstock to the San Joaquin No. 2 Powerhouse.

Water from the San Joaquin No. 2 Powerhouse combined with water diverted from NFWC (including water diverted from the SFWC into NFWC) travels to the San Joaquin No. 1A Powerhouse via approximately 5 miles of conduit. Water released from the powerhouse flows into Corrine Lake, which is the forebay for the A.G. Wishon Powerhouse. Water is released from the A.G. Wishon Powerhouse into Kerckhoff Lake.

Instream Flow Release Points that Support Fish and Riparian Vegetation habitats along NFWC, SFWC and Willow Creek

Water is released into NFWC below Bass Lake and supplemented with flows from a spill channel below Crane Valley Powerhouse via a 6 inch diameter pipe. The flows in NFWC below Bass Lake are measured at stream gage W3 and are required[1] to be a minimum of 2 cubic feet per second (cfs), all water year (WY) types, year round. Water is diverted into Manzanita Lake from San Joaquin Powerhouse No. 3. Water is released from Manzanita Lake into the NFWC. The License requires PG&E to release a minimum of 2 cfs, all WY types, year round from Manzanita Lake, as measured at stream gage W29. Below Manzanita Lake water from NFWC flows into the North Fork Diversion Dam and is released to its confluence with SFWC. With respect to the SFWC, flows are released into the SFWC via Browns Creek Diversion Dam with a 4.5 cfs to 10 cfs minimum flow requirement that is month dependent (June through January 4.5 cfs, February and May 8.0 cfs, and March and April 10 cfs). The required flows are measured at stream gage W33. Below the confluence of the NFWC and SFWC (Willow Creek) no water is diverted into the system. Nominal water flows are returned to Willow Creek from the San Joaquin No. 1 Conduit when the project is in operation to ensure that flow as measured at stream gage W26 is no less than 0.5 cfs, all WY types, year round.

[1] Instream flows are required by the license, but at the present time PG&E does not have an approved flow management plan. This plan is pending completion of all necessary gages and the Rex Ranch Flow Study. Approximate releases are being made with the intent of meeting the required flows until the final flow management plan is approved.

2.0 METHODS

2.1 Sample Locations

Water temperature was measured at 13 stream locations from May 1 to October 31, 2007 (Figure 1.1-1). These water temperature monitoring stations are listed below, and photos of each station are included in Appendix E.

T1 NFWC below Bass Lake at the Crane Valley Powerhouse tailrace

T2 NFWC below Bass Lake at river mile 7.13

T3 NFWC upstream of Manzanita Lake at river mile 4.39

T4 NFWC at the Manzanita Lake Diversion Dam

T5 NFWC downstream of Manzanita Lake at river mile 3.00

T6 NFWC upstream of the North Fork Diversion Dam at river mile 0.25

T7 SFWC upstream of the Browns Creek Diversion Dam at river mile 6.59

T8 SFWC downstream of the Browns Creek Diversion Dam at river mile 6.5

T9 SFWC above the South Fork Diversion Dam at river mile 0.1

T10 Willow Creek at Gage W-26, river mile 4.3

T11 Willow Creek at Whiskey Creek, river mile 1.8

T12 Willow Creek at USGS Gage 2465, river mile 0.37

T13 Willow Creek downstream of the Sand Trap Spill Channel confluence, river mile 6.1

The rationale for selection of each sample location is provided in Table 2.1-1.

In addition to the thirteen stream water temperature monitoring stations, water temperature profiles were collected on a monthly basis (April 26 – November 1, 2007) from Bass Lake near the outlet structure (Figure 1.1-1).

2.2 Water Temperature Data Collection

Stream water temperatures were automatically measured *in situ* at 20-minute intervals from May 1 through October 31, 2007 with VEMCO MiniLog 12 TR digital temperature loggers. The MiniLog 12 TR is a miniature microprocessor controlled water temperature logger that stores data in non-volatile memory. The MiniLog 12 TR has an accuracy of ± 0.1°C between 5 and 40°C. Data were downloaded monthly to a laboratory computer and stored. Monthly downloads from the water temperature recorders occurred on May 31, June 28, August 2, September 6, October 4 and 5, and November 1, 2007. These data are provided in Appendix A.

In addition to the 13 stream water temperature stations, Bass Lake water temperature profiles were collected on a monthly basis using a YSI 600XL multiparameter water quality measurement system coupled with a YSI 610 DM Display/Logger. The YSI 600XL instrument has an accuracy of approximately ±0.15°C between -5 and 50°C. Water temperature was recorded in 0.1 meter intervals for the profiling of Bass Lake. Reservoir temperature data are also provided in Appendix A.

Water temperature monitoring equipment quality assurance/quality control (QA/QC) calibration is ongoing and certification of calibration is included as Appendix D. Other quality assurance procedures consisted of employing redundant loggers and a thorough post-collection data review (Section 2.5). Following application of the QA/QC procedures, the hourly average water temperatures recorded during each day were calculated in an Excel spreadsheet for both tabular and graphical presentation.

2.3 Stream Flows (Preliminary and Provisional)

In addition to water temperature, stream flow was measured continuously at 21 existing PG&E maintained gaging stations and two U.S. Geological Survey (USGS) gaging stations during the monitoring period (one of the USGS stations, USGS 2465, is maintained by the Southern California Edison Company [SCE]). Reservoir elevations were also collected at two locations (Bass Lake and Corrine Lake). A list of the instream flow monitoring stations, operational flow monitoring stations and reservoir storage monitoring stations is below. Locations of the stream flow monitoring stations are presented in Figure 1.1-1. All data associated with preliminary and provisional stream flow and reservoir storage within the Project are located in Appendix B (on CD) along with plots of daily average flows.

<u>Instream Flow Monitoring Stations</u>

WC3 North Fork Willow Creek near Bass Lake – Total Flow

W24 North Fork Willow Creek near Sugar Pine (USGS maintained gage)

W3 North Fork Willow Creek near Bass Lake

W33 SFWC below the Brown's Creek Diversion Dam

W29 Instream Flow on North Fork Willow Creek below Manzanita Lake Dam

W26 Willow Creek below Confluence of North and South Forks

2465 Willow Creek at Mouth (USGS-SCE gage)

<u>Operational Flow Monitoring Stations</u>

W1 Browns Creek Canal at Bass Lake

W19 Crane Valley Powerhouse

W4 Conduit No. 3 near Bass Lake

W6 San Joaquin No. 3 Powerhouse

W9 No. 2 conduit

W11 San Joaquin Powerhouse No. 2

W8 North Fork Willow Creek Spill below Manzanita Lake

W15 North Fork Willow Creek Spill below North Fork Diversion Dam

W13 South Fork Willow Creek Spill below South Fork Diversion Dam

W12 South Fork Willow Creek Canal above North Fork Willow Creek

W14 Willow Creek Diversion to No. 1 Conduit

W27 No. 1 Conduit Spillway at San Joaquin No. 2 Powerhouse

W25 No. 1 Conduit below Bass Lake

W16 San Joaquin No. 1A Powerhouse

W18 A.G. Wishon Powerhouse

Reservoir Storage Monitoring Stations

W2 Bass Lake Storage

W17 Corrine Lake Storage

All stream flow data are presented as daily average flow data in cfs and storage data are presented in acre feet (AF). All flow and storage data are considered preliminary and subject to revision until a final review of the data has been completed.

2.4 Meteorological Stations

To collect data on ambient weather conditions during the sampling period, two PG&E meteorological stations were monitored within the Project area. The meteorological stations were located near the Crane Valley Powerhouse (at an elevation of 3,400 feet) and at the A.G. Wishon Powerhouse (at an elevation of 990 feet). Date, time, and hourly average air temperatures were recorded at the meteorological stations. Relative humidity and solar radiation were also measured in order to supplement the water temperature monitoring data, and will be useful if a modeling effort is conducted in the future.

The raw data for air temperature is provided in Appendix C (on CD) for both meteorological stations during the 2007 monitoring program period (May – October). Raw data were extracted into Excel spreadsheets, and daily average and daily maximum air temperatures were calculated, by month, for use in both tabular and graphical presentations.

2.5 Quality Assurance/Quality Control

The 2006 Quality Assurance Program Plan (QAPP) prepared by PG&E was developed to provide guidance and quality assurance for water temperature and water quality monitoring studies that are required for various PG&E projects, including FERC relicensing and compliance monitoring activities (PG&E 2006). This QAPP was utilized during data acquisition and synthesis to provide quality assurance and quality control guidance.

During the 2007 Crane Valley water temperature monitoring study, some data were lost at T4, T5, and T9 due to changes in flows or vandalism. Data loss at T4 was due to vandalism and was limited to 16 days. The location of this recorder was at the project diversion dam at Manzanita Lake, which is behind a locked gate. Both of the water temperature loggers had been removed from the water, and were sitting on the dam face when they were checked on May 31. Data at T5 was lost due to a change in flows between monitoring periods. Data loss was limited to 23 days. During the September 6 visit, the flows were high and both loggers were moved to a more safely accessible location. However, flows receded and both of the loggers were found out of the water on the October 5 visit. At T9, data loss occurred during three periods over the course of the monitoring year. Data loss at T9 resulted from reductions in flow. To help prevent additional loss of data both water temperature loggers at T9 were relocated downstream on September 6; however, additional data losses still occurred. Data were lost from July 9 through July 18, from September 13 through September 22, and October 26 through October 31.

The datasets for both the primary and redundant water temperature loggers at each site were compared against each other and the instantaneous water temperature measured during each monthly visit to ensure the loggers were calibrated. At each site the water temperature recorded between the primary and redundant logger never varied by more than 1°C. The difference between the two loggers can be attributed to logger placement at each site which was generally no more than 5 meters apart (the spacing between loggers was to minimize data loss due to vandalism). If the loggers were placed in different locations at each site, field staff tried to ensure that placement of both loggers was in similar stream settings (deeper channel, with the most flow available resulting in a representative water temperature of the stream reach).

During the course of the monitoring period, the redundant logger was reassigned to the role of primary logger at three locations: 1) T11B was reassigned to the role of primary logger and T11A was reassigned the role of secondary logger in August. During August download, T11A had not reinitialized properly. 2) T12B was reassigned to the role of primary logger and T12A was reassigned the role of secondary logger in May. T12A was found out of the water during the May download. 3) T13B was reassigned to the role of primary logger and T13A was reassigned the role of secondary logger in August. During August download, T13A had not reinitialized properly

After water temperature data were downloaded, graphs were created with the daily mean, maximum, and minimum temperatures. These graphs were then used to visually represent the data at each monitoring site. Outlying data points were looked at and removed if they occurred during a period when the temperature logger was out of water. These graphs containing the synthesized data were used to produce Figures 3.1-1, 3.1-2 and 3.1-4 through 3.1-27.

3.0 RESULTS

Temperature data are presented in Section 3.1. A summary of flow data throughout the project area is included in Section 3.2. A discussion of the 2007 temperature monitoring study results is presented in Section 3.3.

3.1 Water Temperatures and Meteorological Conditions

Water temperature recorders were deployed at all 13 sites (T1 through T13) on April 26, 2007. Temperature data collected for this project are summarized in Table 3.1-1. All daily maximum, mean and minimum water temperatures have been plotted and are presented in Figures 3.1-1, 3.1-2 and 3.1-4 through 3.1-14. Bass Lake water temperature profiles are presented in Figure 3.1-3. Because water temperature monitoring sites T2, T3, T5, T8, T9, T10 and T12 are located at or in close proximity to stream gaging stations W3, W3, W29, W33, W13, W26, and USGS 2465 respectively, the flow data collected at the gages are also presented with the water temperature data in Figures 3.1-2, 5, 6, 8, 10, 12, and 14.

Ambient air temperature data were collected at the A.G. Wishon and Crane Valley Powerhouse weather stations. A comparison between daily average water temperature, daily average air temperature and daily flow (if available) is provided in Figures 3.1-15 through 3.1-27 for each water temperature monitoring site.

A station-by-station discussion, from the upper elevation stations to the lower elevation downstream stations, is provided below.

<u>Water Temperature Monitoring Sites T7 and T8: SFWC upstream of the Browns Creek Diversion Dam at river mile 6.59 and SFWC downstream of the Browns Creek Diversion Dam at river mile 6.5 respectively</u>

Water temperature monitoring sites T7 and T8 are located in close proximity to each other. T7 is located upstream of the Browns Creek Diversion Dam, while T8 is located downstream of the diversion dam. The minimum, maximum and average daily water temperatures recorded at both sites are nearly identical (Figures 3.1-1; 3.1-2; 3.1-15; and 3.1-16). The average daily water temperature did not exceed 19.1°C at both sites during the monitoring period. On August 2, both water temperature recorders at T8 were moved upstream and placed closer to the stream bank to allow for easier access during high flows. As the stream flow at W33 decreased, the average daily water temperatures increased. This relationship is represented in Figure 3.1-2.

<u>Bass Lake Temperature Profile</u>

Seven water temperature profiles of Bass Lake were collected between April 26 and November 1. All seven profiles are graphically shown in Figure 3.1-3. The water temperature profile taken in late April shows a warming trend in Bass Lake with a thermocline forming within the first three meters of depth. Bass Lake became more stratified after the April profile and shows a thermocline at about four meters on May 31, 2007. The thermocline remains through September but drops to a depth of approximately five meters. The October and November water

temperature profiles both show the reservoir water temperature as orthograde indicating that fall turnover had recently occurred.

Water Temperature Monitoring Site T1: NFWC below Bass Lake at the Crane Valley Powerhouse Tailrace Overflow Spillway

The water temperature recorders at T1 recorded the outflow from Bass Lake via the overflow spillway channel from the No. 3 Conduit below the Crane Valley Powerhouse. Between May 1 and August 28, the average daily water temperature in the spill channel remained fairly constant, between 6.9 and 8.0°C. From September 4 through October 5, water temperatures increased to a high of 16.6°C and subsequently decreased until the recorders were removed.

The average daily water temperature at T1 remained below 10°C from May 1 through September 3 (Figure 3.1-17). Water temperature began to rise on September 4, which appears to be correlated with an increase in flow through the No. 3 Conduit to 71.2 cfs which occurred on the same day. The average daily water temperature never exceeded 16.6°C for the entire monitoring period. However, because of its proximity to Bass Lake (immediately below the dam), the water temperature at T1 is likely most affected by the water temperature released from Bass Lake. The warmest water temperatures recorded at T1 were from September 4 through October 5 and coincided with the fall turnover of Bass Lake (Figure 3.1-17). The warmer July air temperatures did not demonstrate a noticeable increase in water temperatures at this location.

Water Temperature Monitoring Site T2: NFWC below Bass Lake at river mile 7.13

Water temperature monitoring station T2 is located downstream of Bass Lake on the NFWC near gage W3. Between May 1 through September 23, water temperatures fluctuated between an average daily water temperature of 10.9°C up to an average daily water temperature of 14.9°C (Figure 3.1-5; 3.1-18). From September 24 to October 3, the average daily water temperature increased to 16.1°C. After October 3, the temperatures slowly decreased until the temperature loggers were removed. The average daily water temperature never exceeded 16.1°C for the entire duration of the monitoring period.

Water Temperature Monitoring Site T3: NFWC upstream of Manzanita Lake at river mile 4.39

T3 showed an overall increase in average daily water temperature from May 1 through July 7 when the average daily temperature peaked at 19.4°C (Figure 3.1-6; 3.1-19). After July 7, the average daily temperature showed an overall decrease until the recorders were removed. The average daily water temperature never exceeded 19.4°C for the entire monitoring period. The average daily water temperature resembled the same trend as the average daily air temperatures throughout the monitoring period (Figure 3.1-19).

Water Temperature Monitoring Sites T4 and T5: NFWC at the Manzanita Lake Diversion Dam and NFWC downstream of Manzanita Lake at river mile 3.00 respectively

Sites T4 and T5 are located within 150 feet of each other. T4 is located on the upstream side of Manzanita Dam, while T5 is located downstream of the dam just below a weir and gage. During

the September 6 visit, both loggers at T5 were completely submerged by high flows and were subsequently relocated closer to the bank for safer and easier access. During the October 5 visit, both loggers were found out of the water due to decreased flow (the high flows were short-lived) (Figure 3.1-8). The average daily water temperatures at T5 never exceeded 25.4°C throughout the monitoring period.

During the May 31 visit at site T4, both temperature loggers were found out of the water. Water temperature data were subsequently removed for the period between May 15 and 31. For the available 15 days of data, all of the average daily water temperatures were below 17.3°C. For the remainder of the monitoring period, the average daily water temperatures at T4 did not exceed 24.5°C.

Overall, both T4 and T5 demonstrated the same trends with respect to average daily water temperatures. Also, both of these sites appeared to show a correlation between average daily water temperatures and average daily air temperatures (Figure 3.1-20 and Figure 3.1-21, respectively). The values at gage W29, which is located below Manzanita Lake, were mostly constant except for short peaks at 50 cfs on September 6 and 63 cfs on October 1. Before and after these increases, the flow values were around 4 cfs for the duration of the monitoring period.

<u>Water Temperature Monitoring Site T6: NFWC upstream of the North Fork Diversion Dam at river mile 0.25</u>

T6 is located at the upstream face of the North Fork Diversion Dam. In May, the average daily water temperature never exceeded 18.1°C. In June, the maximum daily average water temperature increased to 20.6°C (Figure 3.1-9). In July, the maximum daily average water temperature continued to increase to 22.9°C. In August and September, the average daily water temperature never exceeded 22.3°C. The average daily water temperature continued to decrease in October and all 31 days in October remained below 15.9°C. The flow value at spill gage W15 below North Fork Diversion Dam remained at zero for the entire monitoring period with the exception of July 8, when the value was 2 cfs. The average daily water temperature values demonstrate the same overall trend as the daily average air temperatures (Figure 3.1-22).

<u>Water Temperature Monitoring Site T9: SFWC above the South Fork Diversion Dam at river mile 0.1</u>

Water temperature monitoring site T9 is located upstream of the South Fork Diversion Dam. The average daily water temperatures in May and June never exceeded 17.0°C and 19.1°C, respectively. Data from July 8 at 1:00 p.m. through July 18 were removed due to indications that both recorders were displaced from the water (Figure 3.1-10; 3.1-23). Although the recorders were found submerged in the water, the data for these dates contained values that exceeded the maximum and fell below the minimum daily stream temperatures of the remaining July data (this spiky data closely follows air temperature trends and is indicative of a recorder that has become stranded). In July, the average daily water temperatures did not exceed 20.5°C. In August, the average daily water temperatures did not exceed 21.2°C. During the September 6 visit, both of the recorders were moved downstream approximately 75 yards in an effort to decrease the likelihood of stranding due to fluctuating water levels and for continued safe access.

Unfortunately, the recorders were stranded, thus resulting in the removal of data (between September 12 at 2:00 p.m. and September 22). The average daily water temperatures during September, for the available data days, were below 21.3°C. During the November 1 visit, both of the recorders were found out of the water. As a result, data were removed between October 26 and October 31. The remaining 25 days of data for October showed that the daily average water temperatures were below 12.6°C.

Water Temperature Monitoring Site T13: Willow Creek downstream of the Sand Trap Spill Channel confluence, river mile 6.1

Site T13 is located below the spill channel of the No.1 Conduit Sand Trap, downstream of the confluence of the NFWC and SFWC. The average daily water temperature values in May did not exceed 18.0°C for the entire month. In June, the average daily water temperatures increased to a maximum daily average of 20.5°C. In July, the maximum daily average water temperature increased to 22.7°C. The average daily water temperature was below 22.5°C for the entire month of August. In September, the average daily water temperature decreased to a maximum daily average of 22.4°C. The average daily water temperatures continued to decline in October and resulted in the temperatures for the entire month of October being below 16.0°C (Figure 3.1-11). The overall warming and cooling trend of water temperatures followed the overall air temperature fluctuations throughout the monitoring period (Figure 3.1-24).

Water Temperature Monitoring Site T10: Willow Creek at Gage W-26, river mile 4.3

Site T10 is located below the confluence of NFWC and SFWC downstream of gage W26. The average daily water temperature at T10 never exceeded 20.4°C in May. In June, the daily average water temperature did not exceed 22.0°C. In July, the daily average water temperature increased to a maximum daily temperature of 23.8°C. Daily average water temperatures in August decreased to a maximum of 23.1°C. In September, the daily average water temperature continued to decrease to a maximum of 22.6°C (Figure 3.1-12). The lowest daily maximum average water temperature occurred in October with a value of 15.1°C. All of the elevated water temperatures noted at T10 correspond to elevated air temperatures (Figure 3.1-25).

Water Temperature Monitoring Site T11: Willow Creek at Whiskey Creek, river mile 1.8

Site T11 is located on the main stem of Willow Creek just below its confluence with Whiskey Creek. The water temperature at T11 is influenced by the inflow from Whiskey Creek. In May, the daily average water temperature did not exceed 19.3°C. The average daily water temperature at T11 never exceeded 22.6°C in June. In July, the daily average maximum water temperature increased to 26.1°C and was the same value in August. The daily average maximum water temperature in September decreased to 25.6°C. The lowest daily maximum average water temperature occurred in October with a value of 16.1°C. Also, the increases and decreases in average daily water temperature at T11 follow the increases and decreases in average daily air temperature (Figure 3.1-26).

Water Temperature Monitoring Site T12: Willow Creek at USGS Gage 2465, river mile 0.37

Site T12 is the lowest on the Project (elevation 1,196 feet) and is located upstream of the confluence of Willow Creek and the San Joaquin River at the USGS/SCE gage 2465. The average daily water temperature at site T12 exceeded 20.3°C for 96 consecutive days between June 11 and September 14, 2007. However, the highest average daily water temperature was not recorded at T12 (25.6°C), but rather at T11 (26.1°C). The increases and decreases in average daily water temperature at T12 follow the increases and decreases in average daily air temperature (Figure 3.1-27). Figure 3.1-14 depicts the reduction in flow from a high of 13 cfs (May 5) to a low of 1.6 cfs (June 26) and corresponds to the overall increase in average daily water temperature of 11.5 (May 5) to 25.3°C (July 7). Water flowing through T12 spent a greater amount of time being heated prior to it flowing through the station when compared to the other stations within the Project. Again, water temperature monitoring station T12 is the lowest in elevation and is therefore the most likely to experience the highest ambient air temperatures thus resulting in higher average daily water temperature.

3.2 Stream Gage and Reservoir Storage Measurements

Preliminary and provisional stream flow data from 22 gaging stations and storage data from Bass Lake and Corrine Lake are presented as a summary of monthly average flows in Table 3.2-1. These data encompass May 1 through October 31, 2007.

Stream Flow (Preliminary and Provisional)

The majority of the highest average, maximum and minimum stream flow values recorded at each gaging station were observed during September and October (Table 3.2-1). The highest flows within the NFWC, SFWC or Willow Creek were recorded at gage W16 (located at San Joaquin Powerhouse No. 1A) with a maximum flow of 148.9 cfs. The highest monthly average flows were recorded at gage W4 and averaged 113.7 cfs for the month of October. Of the eight gages located within NFWC, SFWC and Willow Creek (this does not include flows through Project canals), two recorded the spill over Project diversion dams and not actual stream flow. The two gages are W15 and W13. Gage W15 recorded zero spills for the entire monitoring period other than July 8 when it recorded 2 cfs and gage W13 recorded zero spills throughout the entire monitoring period. It must be noted that while the spill gages recorded zero spill the actual flow within the NFWC, SFWC and Willow Creek was not zero and minimum stream flow requirements were being met and measured at other locations throughout the project.

As described in Section 1.3 (Project Description) the Crane Valley Hydroelectric Project License specifies minimum flow requirements within the NFWC, SFWC and Willow Creek. Within NFWC a minimum flow of 2 cfs are to be measured at gages W3 and W29 year round. According to the preliminary and provisional stream flow data for the NFWC during the 2007 Crane Valley Water Temperature Monitoring Project (as measured at W3 and W29), the minimum flow requirements were generally met. Only on one day, August 17, flows measured at W29 fell below the minimum stream flow requirement (preliminary data). At stream gage W3 the minimum stream flow requirement (2.0 cfs) was met for the duration of the 2007 Crane Valley Water Temperature Monitoring Project.

Within the SFWC the minimum stream flow requirements during the course of the Crane Valley Water Temperature Monitoring Project are set at 8 cfs for May and 4.5 cfs through October or natural flow, whichever is less. During dry or critically dry water years, flows can be reduced to 3 cfs year round, if necessary, to achieve the lake level requirements specified in Condition 10 (Lake Levels) of the license. The required flows are measured at stream gage W33, downstream of the Browns Creek Diversion Dam and water temperature monitoring sites T7 and T8. Flows greater than 3 cfs were measured at W33 in May, June, and the beginning of July. The flows fell below 3 cfs between July 6 and October 29, and increased above 3 cfs on October 30. During periods of low flow, the flows were not being diverted and were equivalent to upstream, natural flows.

For the mainstem of Willow Creek, flows (as reported at W26) met or exceeded the 0.5 cfs minimum requirement from May 3 through May 19, May 27 through June 3, and June 7 through October 31. Between May 1 and May 2, May 20 and May 26 and from June 4 through June 6 (for a total of 12 days) minimum stream flow requirements were not met.

With respect to the conduits, water was diverted for storage through some Project conduits during periods of snowmelt and rain that occurred in the spring. This resulted in flows through conduits W1, W12 and W14. After Labor Day, flows increased through a different set of conduits to begin drawing on the stored water for power generation. This resulted in flows through conduits W4, W9 and W25.

Reservoir Storage

Reservoir storage was measured at Bass Lake and Corrine Lake. Bass Lake is the main storage reservoir for the Crane Valley Project while Corrine Lake (A.G. Wishon Forebay) is located outside of the Willow Creek Drainage and receives much of its water from the Willow Creek drainage.

From May 1 through June 15, storage increased in Bass Lake from 35,500 to 37,500 AF of water. After June 15, storage in Bass Lake was no longer increasing. By October 31, storage had been reduced to 22,900 AF.

Water storage levels varied in Corrine Lake between a low of 32.9 AF (on June 4) and a high of 67.8 AF (on July 8) between May 1 and October 31.

3.3 Discussion of Results

2007 was the third year of the Crane Valley Water Temperature Monitoring Program. In general, the water temperature increased as water flowed from the upper elevations of the Project to the lower elevations of the Project. Additionally, water temperatures within the system increased with the onset of summer, peaked near the end of July/early August, and decreased throughout the remainder of the study period.

2007 was a Critically Dry Water Year according to the San Joaquin Valley Water Year Type Index (information obtained from the Department of Water Resources California Data Exchange Center [CDEC] at http://cdec.water.ca.gov/cgi-progs/iodir/WSI). Critically Dry water years represent extremely dry conditions, which understandably result in increased occurrences of stranding of temperature recorders and warmer stream temperature conditions due to the decreased volume and velocity of the stream flows.

In general, July was, on average the warmest month with a monthly average air temperature of 26.5°C at the A.G. Wishon Powerhouse and a monthly average air temperature of 24.8°C at the Crane Valley Powerhouse. The high air temperatures and extended periods of daylight combined with the low flow conditions increased the water temperatures in NFWC, SFWC and Willow Creek.

4.0 REFERENCES

Federal Energy Regulatory Commission (FERC) 2002. Supplemental Environmental Assessment for Hydropower License, Crane Valley Project, FERC No. 1354.

FERC 2003. Pacific Gas and Electric Company Project No. 1354-005, Order Issuing New License.

FERC 2005. Pacific Gas and Electric Company Project No. 1354-041, Order Approving Water Temperature Monitoring Plan, January 18.

Pacific Gas and Electric Company (PG&E) 2002. Crane Valley Hydroelectric Project (FERC No. 1354, Amended Application for new License. PG&E. San Francisco, California.

PG&E 2004. Crane Valley Project, FERC No. 1354, Article 405 and Condition No. 5, Water Temperature Monitoring Plan. PG&E. San Ramon, California.

PG&E Environmental Services, Water Resources. 2006. Quality Assurance Program Plan (QAPP) for Projects Requiring Water Quality and/or Water Temperature Monitoring. February 23, 2006. San Ramon, CA.

Studley et al., 1995. Response of Fish Populations to Altered Flows Project, volume 1: Predicting Trout Populations from Streamflow and Habitat Variables.

Table 2.1-1 Sample locations and the rationale for selection.

Station ID	Station Location	Monitoring Activity*	Rationale
Profiles	Bass Lake	TP	Determine water temperature changes in the water column of Bass Lake
Meteorology	Crane Valley Powerhouse	Met	Characterize ambient conditions within the Project near Crane Valley PH
T1	NFWC downstream of Bass Lake at the Crane Valley PH Tailrace	TR	Determine water temperature of water released through Crane Valley PH
T2	NFWC River Mile 7.13, below Bass Lake	TR	Determine stream water temperature at the start of the stream reach
T3	NFWC River Mile 4.39, upstream of Manzanita Lake	TR	Determine stream water temperature entering a Project reservoir
T4	Manzanita Lake at the Project Diversion	TR	Determine the water temperature of water in Manzanita Lake
T5	NFWC River Mile 3.0, downstream of Manzanita Lake	TR	Determine water temperature of water released from Manzanita Lake
T6	NFWC River Mile 0.25, upstream of the NFWC Diversion Dam	TR	Determine water temperature of stream above Project diversion
T7	SFWC River Mile 6.59, upstream of Browns Creek Diversion Dam	TR	Determine water temperature of stream above Project Diversion
T8	SFWC River Mile 6.5, downstream of the Browns Creek Diversion Dam	TR	Determine water temperature of stream below Project diversion at the start of the stream reach
T9	SFWC River Mile 0.1, upstream of the SFWC Diversion Dam	TR	Determine water temperature of stream above Project Diversion
T10	Willow Creek River Mile 4.3, at Gage W-26	TR	Determine water temperature below the confluence of NFWC and SFWC
T11	Willow Creek River Mile 1.8, at the mouth of Whiskey Creek	TR	Determine water temperature at the confluence of a major tributary
T12	Willow Creek River Mile 0.37, at USGS Gage 2465	TR	Determine water temperature at the end of the Project Reach
T13	Willow Creek downstream of the sand trap spill channel confluence	TR	Determine water temperature below the confluence of NFWC and SFWC
Meteorology	A.G. Wishon Powerhouse	Met	Characterize ambient conditions within the Project near A.G. Wishon PH

* TP = Water temperature profile of Bass Lake
Met = Meteorology monitoring (Air Temperature)
TR = Continuous recording of water temperature

Table 3.1-1 Monthly average, minimum and maximum water temperatures observed during the monitoring program (May 1 to October 31, 2007) by station.

Station ID	Month during 2007	Data Days	Water Temperature (°C)		
			Min	Mean	Max
T1	May	31	6.9	7.4	8.0
	June	30	7.6	7.9	8.0
	July	31	7.6	7.8	8.1
	August	31	7.6	7.9	8.7
	September	30	8.8	12.3	16.3
	October	31	14.4	15.4	16.6
T2	May	31	10.9	11.7	12.9
	June	30	11.3	12.3	12.8
	July	31	12.4	12.7	13.2
	August	31	11.5	11.9	12.5
	September	30	12.1	13.7	15.8
	October	31	14.5	15.2	16.1
T3	May	31	10.2	14.7	16.2
	June	30	12.9	16.5	18.2
	July	31	17.4	18.3	19.4
	August	31	15.5	16.8	18.4
	September	30	12.6	14.8	17.5
	October	31	10.5	12.3	13.6
T4	May	15	12.8	15.1	17.2
	June	30	17.2	20.2	22.1
	July	31	22.0	23.5	24.5
	August	31	19.2	21.3	23.7
	September	30	11.9	14.2	20.1
	October	31	14.4	15.3	16.4
T5	May	31	14.3	19.3	21.8
	June	30	18.9	22.0	23.8
	July	31	23.1	24.6	25.4
	August	31	21.2	22.9	24.7
	September	6	12.1	18.6	23.0
	October	31	14.3	15.1	16.1
T6	May	31	10.0	15.7	18.1
	June	30	14.5	18.7	20.6
	July	31	19.8	21.7	22.9
	August	31	19.6	20.8	22.3
	September	30	12.9	15.8	22.2
	October	31	11.5	13.0	15.8
T7	May	31	7.5	12.4	15.0
	June	30	11.4	15.0	16.6
	July	31	15.8	17.3	18.3
	August	31	16.4	17.5	18.9
	September	30	12.4	15.4	19.1
	October	31	9.8	11.5	13.0
T8	May	31	6.8	11.9	14.5
	June	30	10.8	14.7	16.3
	July	31	15.5	17.2	18.2
	August	31	16.3	17.5	18.9
	September	30	11.9	15.1	19.1
	October	31	9.1	10.9	12.5

Table 3.1-1 (continued)

Station ID	Month during 2007	Data Days	Water Temperature (°C)		
			Min	Mean	Max
T9	May	31	9.3	14.8	17.0
	June	30	13.6	17.3	19.1
	July	21	18.3	19.5	20.5
	August	31	18.9	19.9	21.2
	September	20	12.7	17.1	21.2
	October	25	9.7	10.8	12.5
T10	May	31	13.0	18.1	20.4
	June	30	16.0	20.1	22.0
	July	31	21.0	22.3	23.8
	August	31	20.0	21.4	23.1
	September	30	14.1	17.1	22.6
	October	31	11.6	12.9	15.1
T11	May	31	10.0	15.7	19.3
	June	30	15.0	20.4	22.6
	July	31	22.4	24.4	26.1
	August	31	22.4	24.3	26.1
	September	30	15.7	19.7	25.6
	October	31	12.2	13.9	16.1
T12	May	31	11.5	17.4	20.6
	June	30	17.4	21.6	23.5
	July	31	23.0	24.3	25.6
	August	31	21.8	23.1	24.6
	September	30	16.2	19.8	24.3
	October	31	12.5	14.2	16.2
T13	May	31	10.4	15.8	18.0
	June	30	14.4	18.5	20.5
	July	31	19.6	21.4	22.7
	August	31	19.6	20.9	22.4
	September	30	13.6	16.4	22.4
	October	31	11.9	13.3	15.9

Monthly values are based on daily average data, and represent the maximum, minimum and mean of the daily average water temperatures recorded in each month. The daily average is based on hourly average water temperatures recorded during each day.

Table 3.2-1 Summary of 2007 stream flow (cfs) monitoring and reservoir storage (AF) at PG&E and USGS-SCE maintained stations. All flow data are preliminary and provisional.

Station ID	Month during 2007	Data Days	Daily Average Flow (cfs) or Storage (AF)		
			Min	Mean	Max
W24	May	31	11.0	23.3	39.0
	June	30	3.7	6.5	10.0
	July	31	2.7	3.2	3.8
	August	31	1.1	1.8	2.5
	September	30	1.1	1.4	2.3
	October	31	1.8	2.3	3.4
W33	May	31	4.2	9.0	12.0
	June	30	3.9	6.7	10.0
	July	31	1.0	2.1	3.7
	August	31	0.4	0.6	1.0
	September	30	0.4	0.8	2.0
	October	31	0.9	1.6	5.0
W1	May	31	0.0	9.0	21.0
	June	30	0.0	0.0	0.0
	July	31	0.0	0.0	0.0
	August	31	0.0	0.0	0.0
	September	30	0.0	0.0	0.0
	October	31	0.0	0.0	0.0
W2 Bass Lake Storage	May	31	35,500	36,774	37,400
	June	30	37,400	37,430	37,500
	July	31	36,600	37,003	37,300
	August	31	35,800	36,200	36,600
	September	30	29,500	32,746	35,800
	October	31	23,100	26,136	29,300
W19	May	31	0.0	0.0	0.0
	June	30	0.0	0.0	0.0
	July	31	0.0	0.0	0.0
	August	31	0.0	0.0	0.0
	September	30	0.0	99.4	132.7
	October	31	82.8	99.2	105.9
W3	May	31	2.6	3.1	3.5
	June	30	3.1	3.5	3.5
	July	31	3.5	3.7	3.8
	August	31	3.5	3.9	4.7
	September	30	3.1	3.2	3.5
	October	31	3.1	3.4	3.5
W4	May	31	0.9	1.2	2.9
	June	30	1.5	1.7	2.0
	July	31	0.0	0.4	1.5
	August	31	0.0	0.2	2.5
	September	30	3.1	107.2	137.0
	October	31	94.0	113.7	122.0
W6	May	31	0.0	0.0	0.0
	June	30	0.0	0.0	0.0
	July	31	0.0	0.0	0.0
	August	31	0.0	0.0	0.0
	September	30	0.0	81.8	114.4
	October	31	0.0	79.2	95.3

Table 3.2-1 (continued)

Station ID	Month during 2007	Data Days	Daily Average Flow (cfs) or Storage (AF)		
			Min	Mean	Max
W8	May	31	3.3	3.8	4.8
	June	30	2.4	3.3	4.5
	July	31	2.2	2.8	5.9
	August	31	1.8	2.5	6.4
	September	30	2.0	7.0	115.0
	October	31	3.0	7.5	115.0
W29	May	31	4.3	4.9	6.2
	June	30	3.4	4.4	5.7
	July	31	3.2	3.8	7.5
	August	31	1.8	2.9	6.4
	September	30	2.5	5.5	50.0
	October	31	3.0	6.7	63.0
W9	May	31	0.0	0.0	0.0
	June	30	0.0	0.0	0.0
	July	31	0.0	0.0	0.0
	August	31	0.0	0.0	0.0
	September	30	0.0	104.5	135.0
	October	31	0.0	101.8	115.0
WC3	May	31	8.4	117.2	140.1
	June	30	79.5	115.1	125.5
	July	31	6.6	29.3	78.9
	August	29	7.5	67.9	148.0
	September	30	89.4	102.3	115.4
	October	31	120.9	140.5	153.4
W11	May	31	0.0	0.0	0.0
	June	30	0.0	0.0	0.0
	July	31	0.0	0.2	7.1
	August	31	0.0	0.2	5.0
	September	30	0.0	90.6	130.1
	October	31	0.0	86.9	105.2
W12	May	31	8.0	13.5	22.0
	June	30	3.0	6.3	10.0
	July	31	0.0	1.6	4.0
	August	31	1.0	1.1	2.0
	September	30	0.0	0.9	2.0
	October	31	0.0	0.9	2.0
W15	May	31	0.0	0.0	0.0
	June	30	0.0	0.0	0.0
	July	31	0.0	0.1	2.0
	August	31	0.0	0.0	0.0
	September	30	0.0	0.0	0.0
	October	31	0.0	0.0	0.0
W13	May	31	0.0	0.0	0.0
	June	30	0.0	0.0	0.0
	July	31	0.0	0.0	0.0
	August	31	0.0	0.0	0.0
	September	30	0.0	0.0	0.0
	October	31	0.0	0.0	0.0

Table 3.2-1 (continued)

Station ID	Month during 2007	Data Days	Daily Average Flow (cfs) or Storage (AF)		
			Min	Mean	Max
W14	May	31	12.0	17.9	25.0
	June	30	6.0	11.1	16.0
	July	31	3.0	5.9	8.0
	August	31	2.0	3.2	4.0
	September	30	2.0	7.4	115.0
	October	31	4.0	7.0	59.5
W27	May	31	0.0	0.0	0.0
	June	30	0.0	0.0	0.0
	July	31	0.0	0.0	0.0
	August	31	0.0	0.0	0.0
	September	30	0.0	0.0	0.0
	October	31	0.0	0.0	0.0
W26	May	31	0.2	0.6	1.4
	June	30	0.2	1.3	2.1
	July	31	1.2	2.5	5.6
	August	31	0.8	1.3	9.5
	September	30	1.2	2.5	8.4
	October	31	1.9	2.8	8.3
USGS Gage 2465	May	31	4.3	6.7	13.0
	June	30	1.6	3.1	4.9
	July	31	0.61	2.5	4.4
	August	31	0.39	0.79	5.2
	September	30	0.51	3.1	8.9
	October	*	*	*	*
W25	May	31	0.0	0.0	0.0
	June	30	0.0	0.0	0.0
	July	31	0.0	0.0	0.0
	August	31	0.0	0.0	0.0
	September	30	0.0	106.9	140.0
	October	31	74.6	109.4	118.0
W16	May	31	0.0	0.0	0.0
	June	30	0.0	0.0	0.0
	July	31	0.0	0.0	0.0
	August	31	0.0	0.0	0.0
	September	30	0.0	104.6	148.9
	October	31	0.0	103.6	138.1
W17 Corrine Lake Storage	May	31	0.037	0.044	0.049
	June	30	0.033	0.047	0.062
	July	31	0.046	0.058	0.068
	August	31	0.045	0.055	0.063
	September	30	0.041	0.048	0.052
	October	31	0.047	0.049	0.064
W18	May	31	37.4	43.9	48.5
	June	30	32.9	46.9	61.5
	July	31	45.6	57.7	67.8
	August	31	44.7	54.8	63.1
	September	30	40.7	48.1	52.0
	October	31	47.0	48.9	64.4

* No flow values are available at this time. They will be incorporated into the report if they become available.

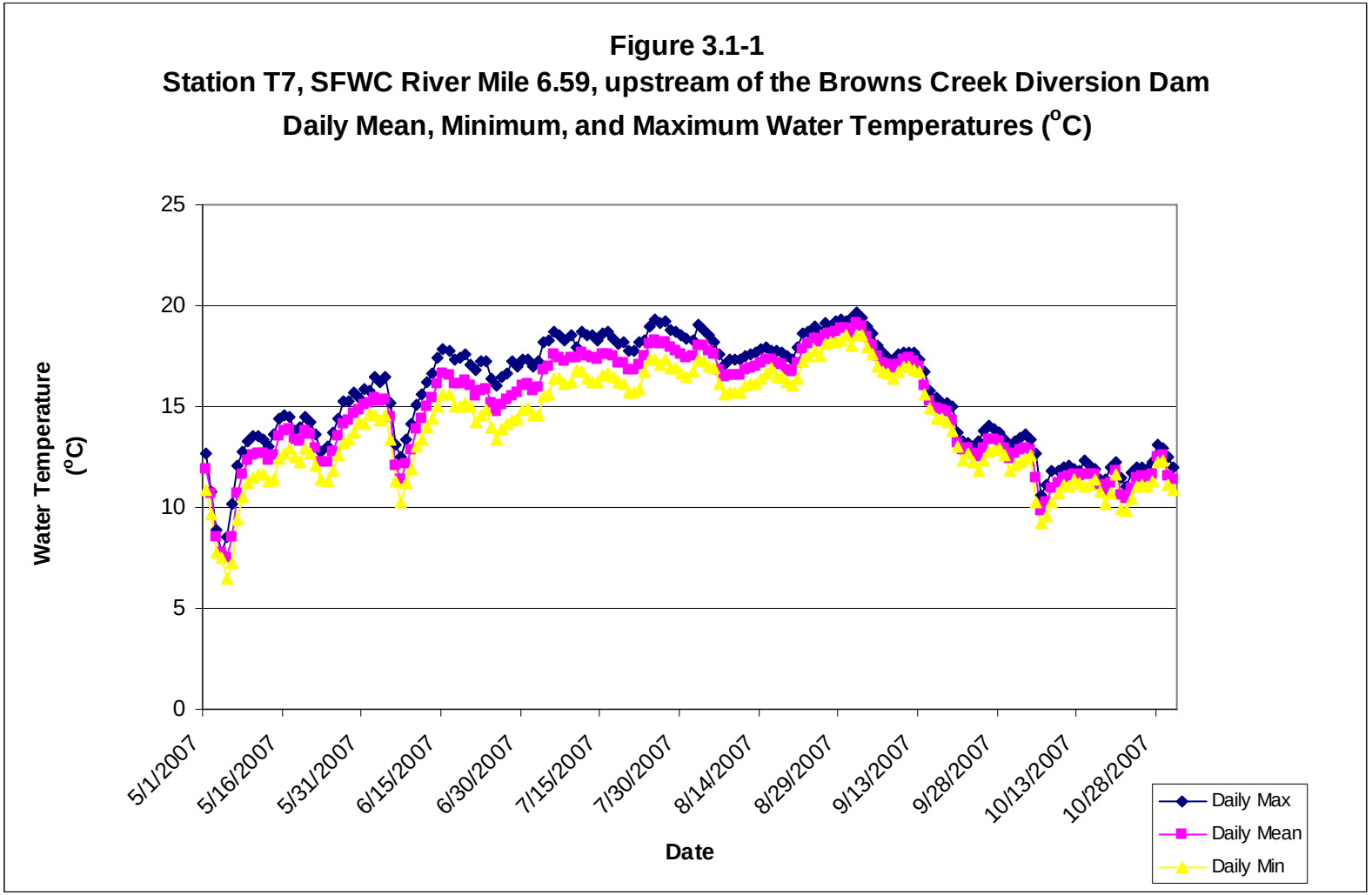


Figure 3.1-1
Station T7, SFWC River Mile 6.59, upstream of the Browns Creek Diversion Dam
Daily Mean, Minimum, and Maximum Water Temperatures (°C)
Water Temperature (°C)
25
20
15
10
5
0
5/1/2007
5/16/2007
5/31/2007
6/15/2007
6/30/2007
7/15/2007
7/30/2007
8/14/2007
8/29/2007
9/13/2007
9/28/2007
10/13/2007
10/28/2007
Date
Daily Max
Daily Mean
Daily Min

Figure 3.1-2
Station T8, SFWC River Mile 6.5, downstream of the Browns Creek Diversion Dam
Daily Mean, Minimum, and Maximum Water Temperatures (^{o}C) and stream flow at gage W33 (cfs)

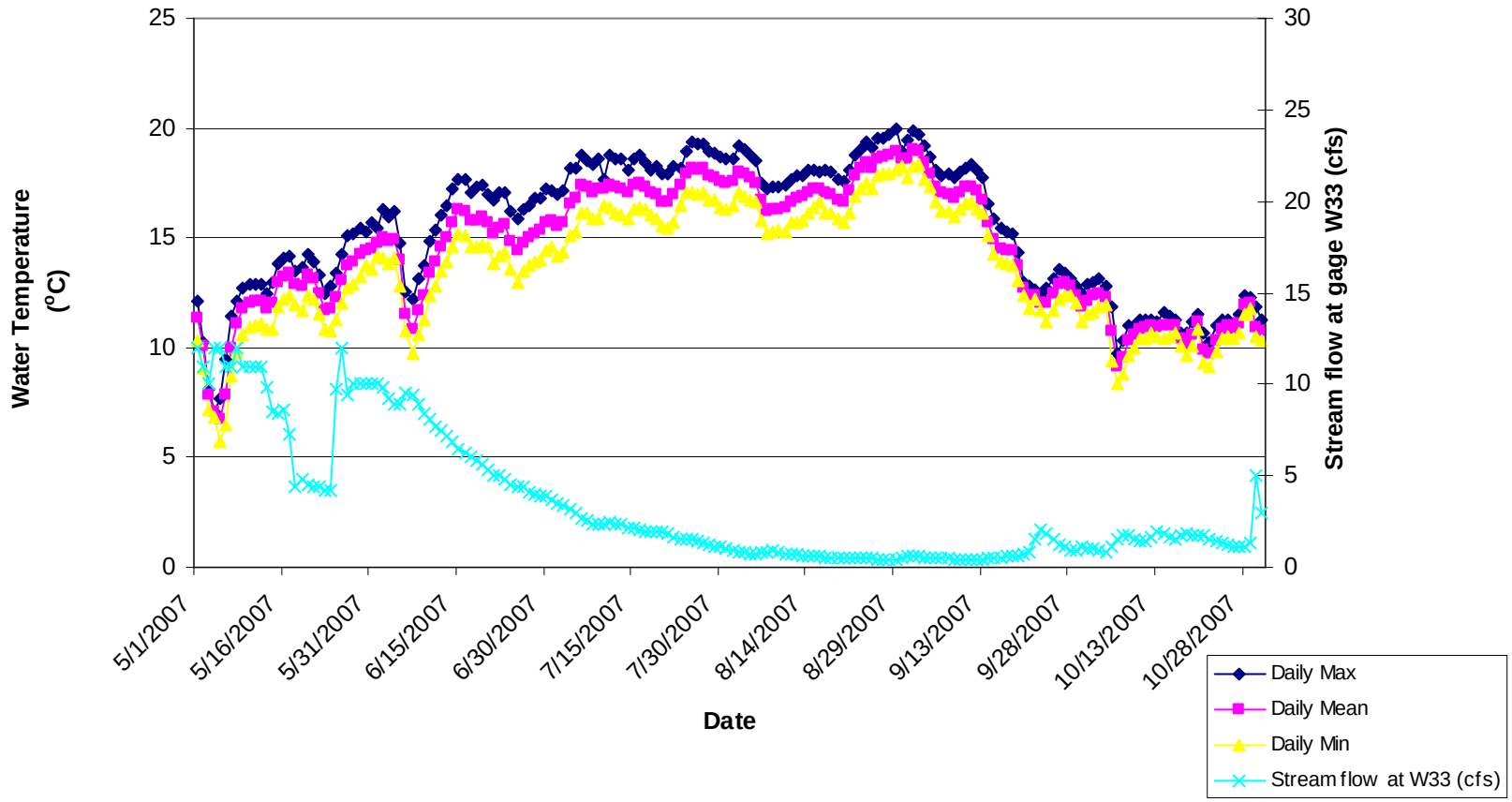
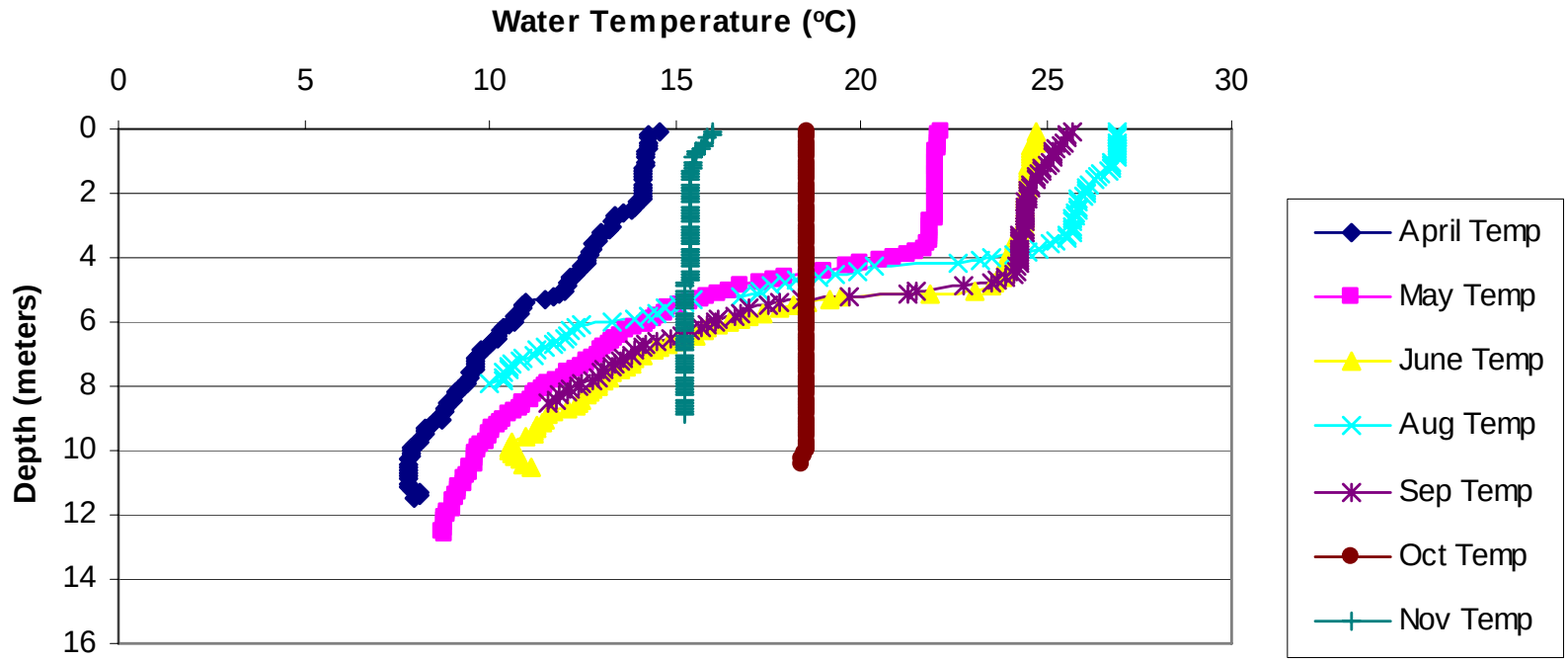


Figure 3.1-3
Bass Lake Water Temperature Profiles, April 26 through November 1, 2007



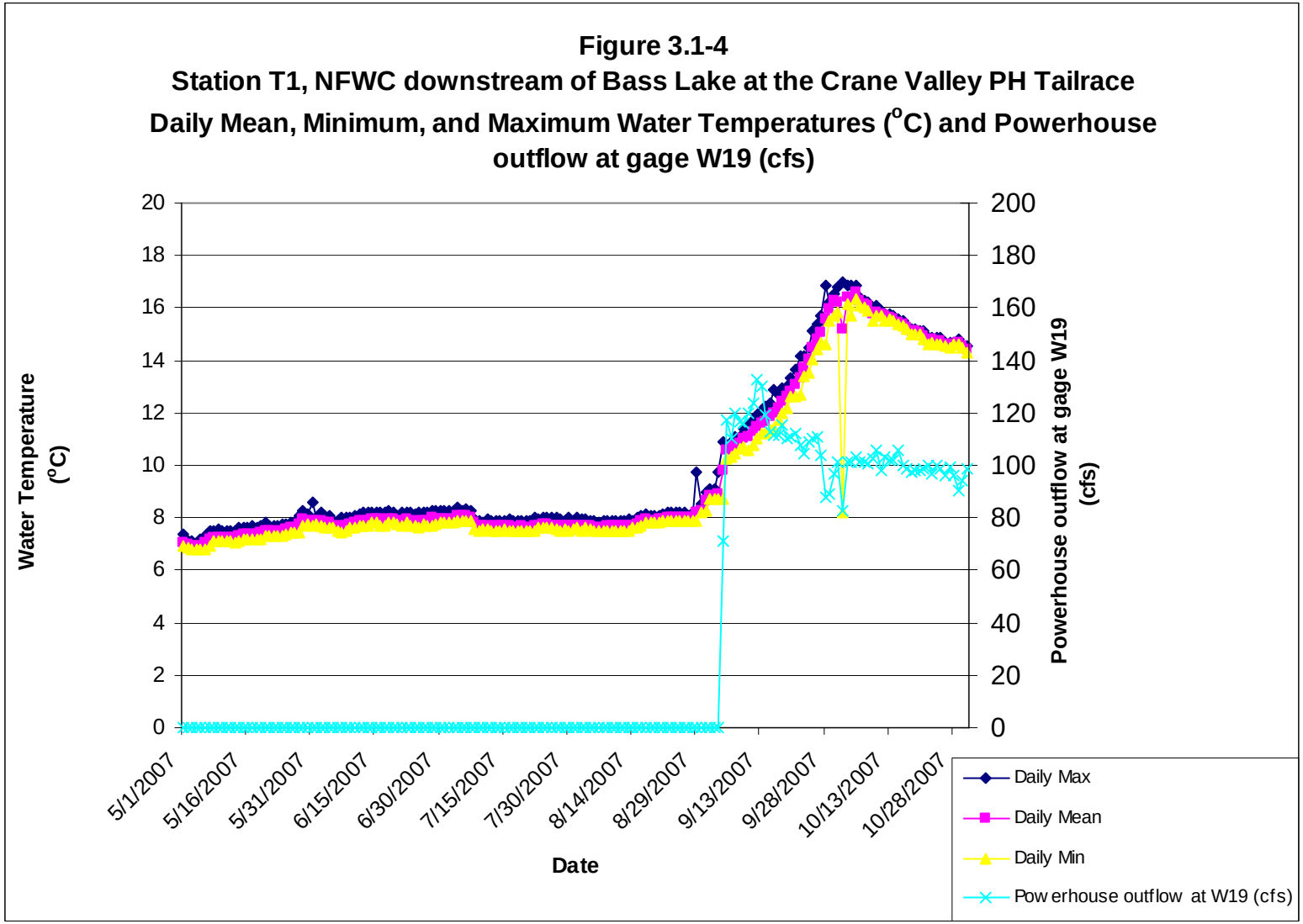
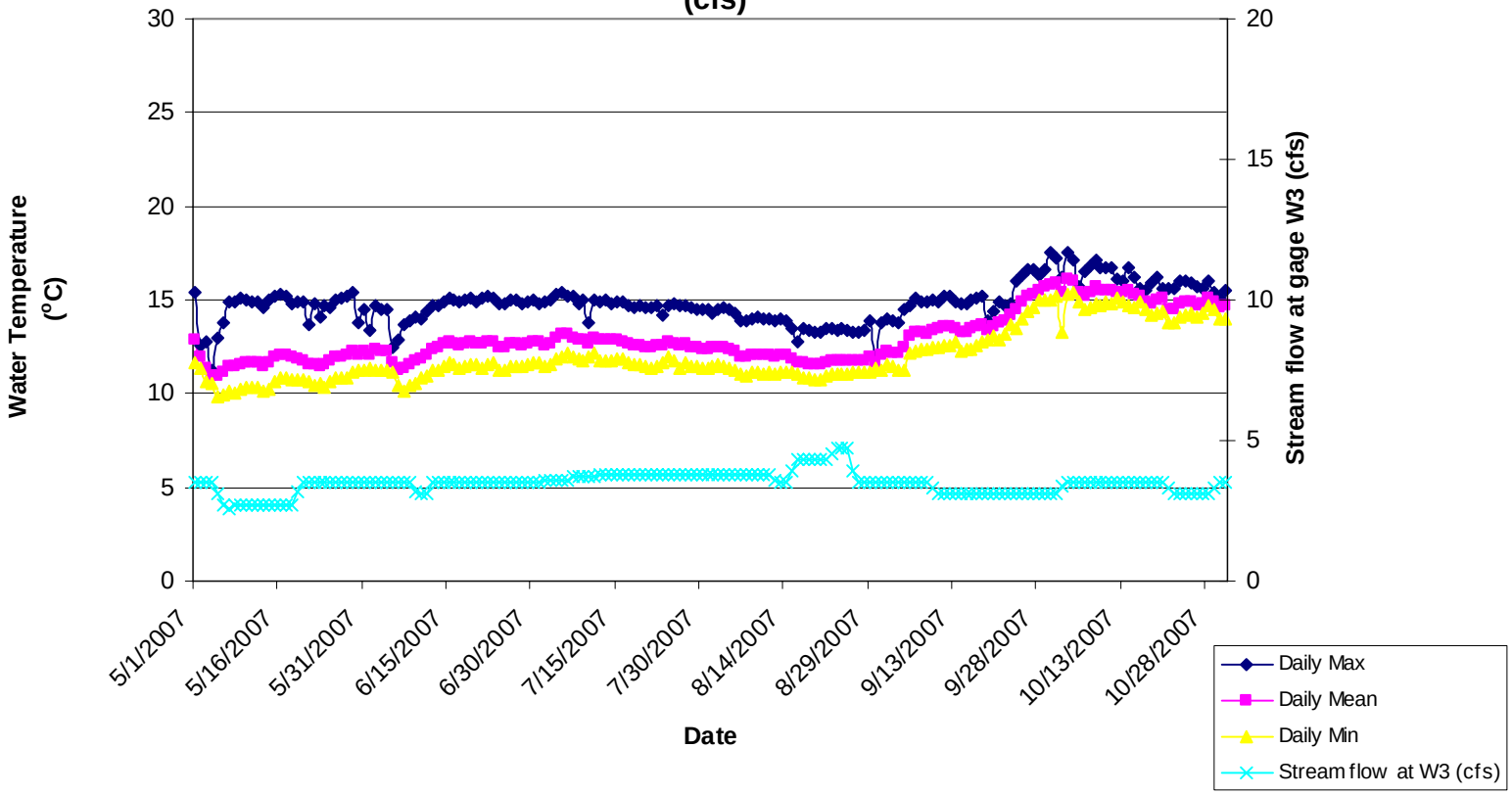


Figure 3.1-4
Station T1, NFWC downstream of Bass Lake at the Crane Valley PH Tailrace
Daily Mean, Minimum, and Maximum Water Temperatures (°C) and Powerhouse outflow at gage W19 (cfs)
Water Temperature (°C)
Powerhouse outflow at gage W19 (cfs)
Date
0
2
4
6
8
10
12
14
16
18
20
0
20
40
60
80
100
120
140
160
180
200
5/1/2007
5/16/2007
5/31/2007
6/15/2007
6/30/2007
7/15/2007
7/30/2007
8/14/2007
8/29/2007
9/13/2007
9/28/2007
10/13/2007
10/28/2007
Daily Max
Daily Mean
Daily Min
Powerhouse outflow at W19 (cfs)

Figure 3.1-5
Station T2, NFWC River Mile 7.13, below Bass Lake
Daily Mean, Minimum, and Maximum Water Temperatures (°C) and stream flow at gage W3 (cfs)



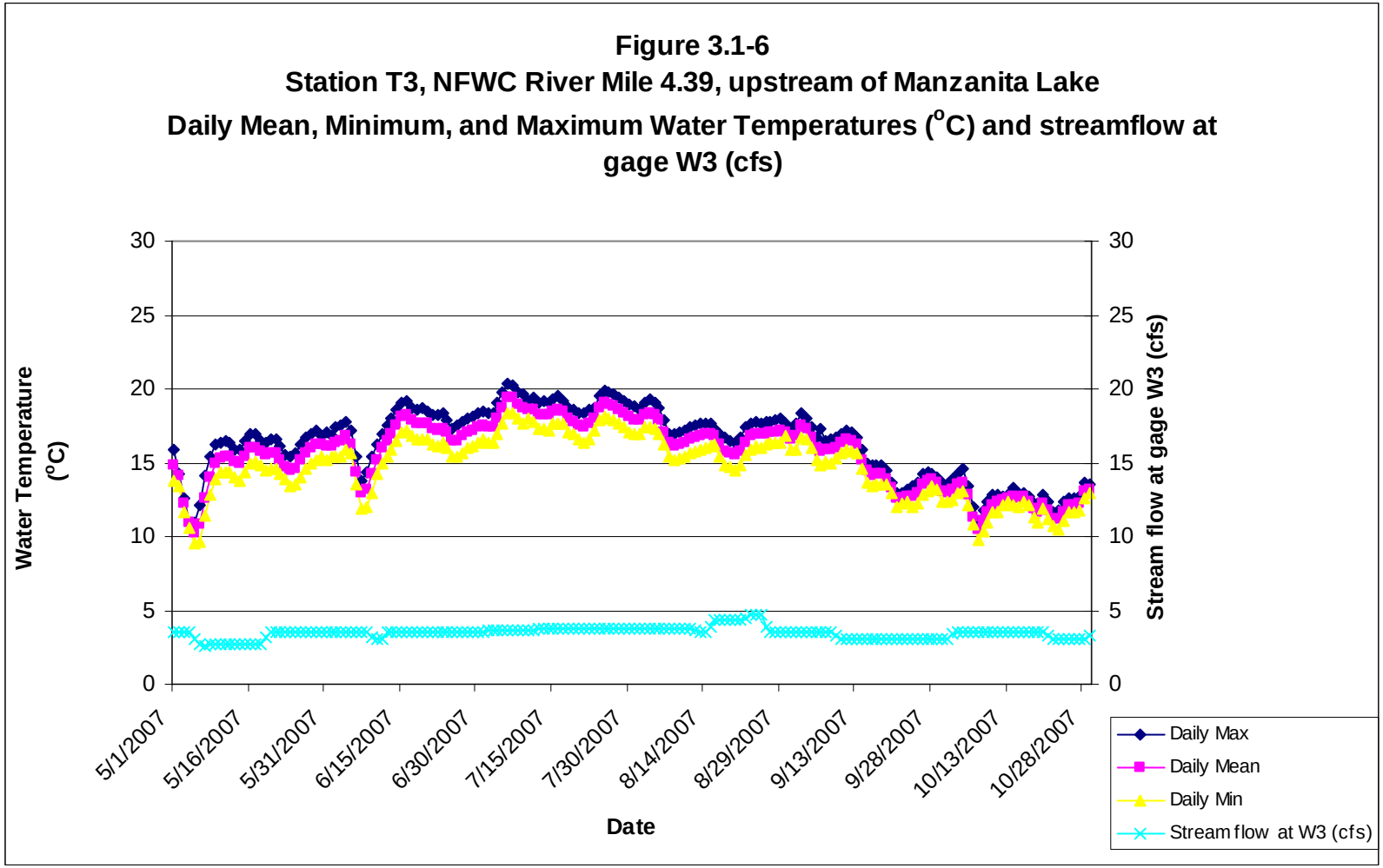


Figure 3.1-6
Station T3, NFWC River Mile 4.39, upstream of Manzanita Lake
Daily Mean, Minimum, and Maximum Water Temperatures (°C) and streamflow at gage W3 (cfs)
Water Temperature (°C)
Stream flow at gage W3 (cfs)
30
25
20
15
10
5
0
5/1/2007
5/16/2007
5/31/2007
6/15/2007
6/30/2007
7/15/2007
7/30/2007
8/14/2007
8/29/2007
9/13/2007
9/28/2007
10/13/2007
10/28/2007
Date
Daily Max
Daily Mean
Daily Min
Stream flow at W3 (cfs)

Figure 3.1-7
Station T4, Manzanita Lake at the Project Diversion
Daily Mean, Minimum, and Maximum Water Temperatures (°C)

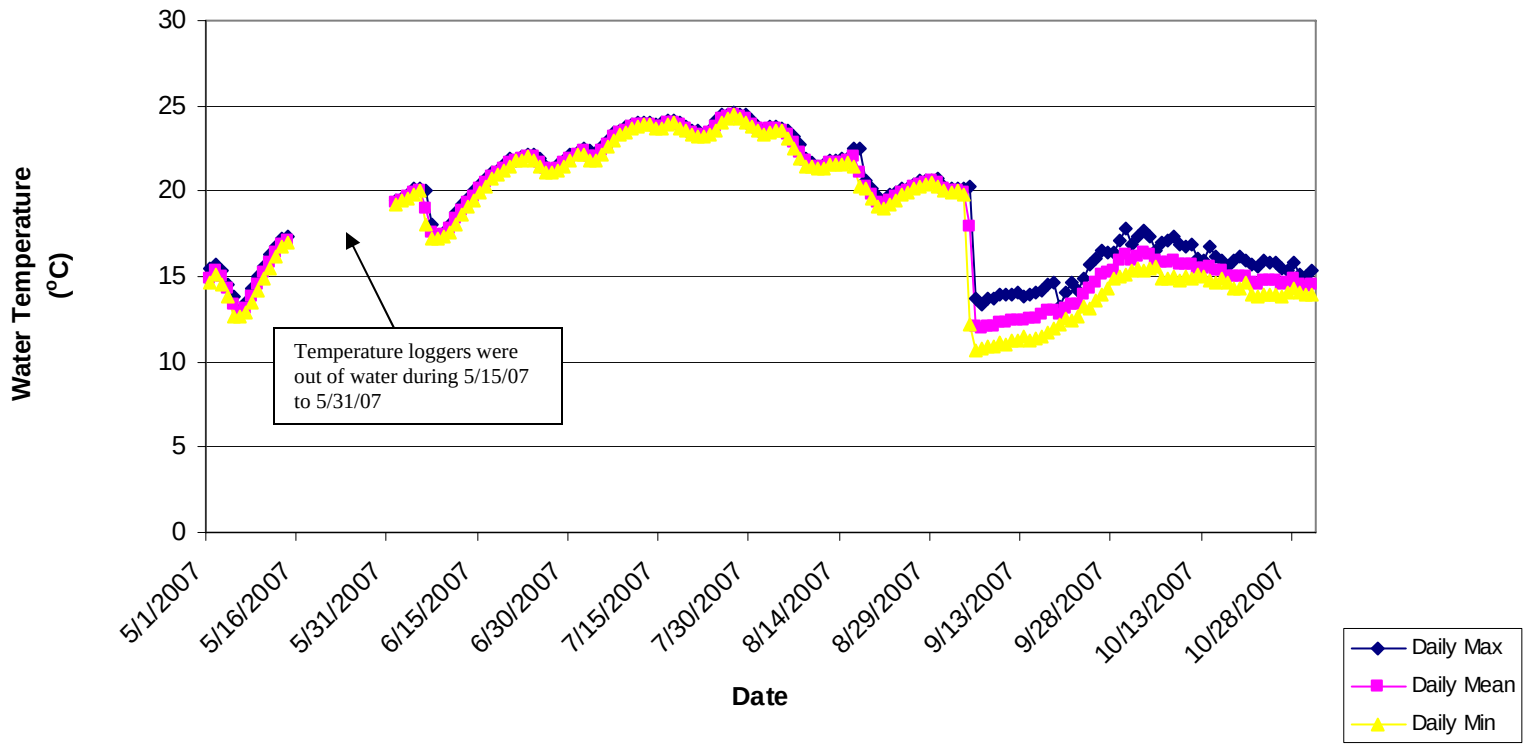


Figure 3.1-8
Station T5, NFWC River Mile 3.0, downstream of Manzanita Lake
Daily Mean, Minimum, and Maximum Water Temperatures (°C) and Spill at gage W29 (cfs)

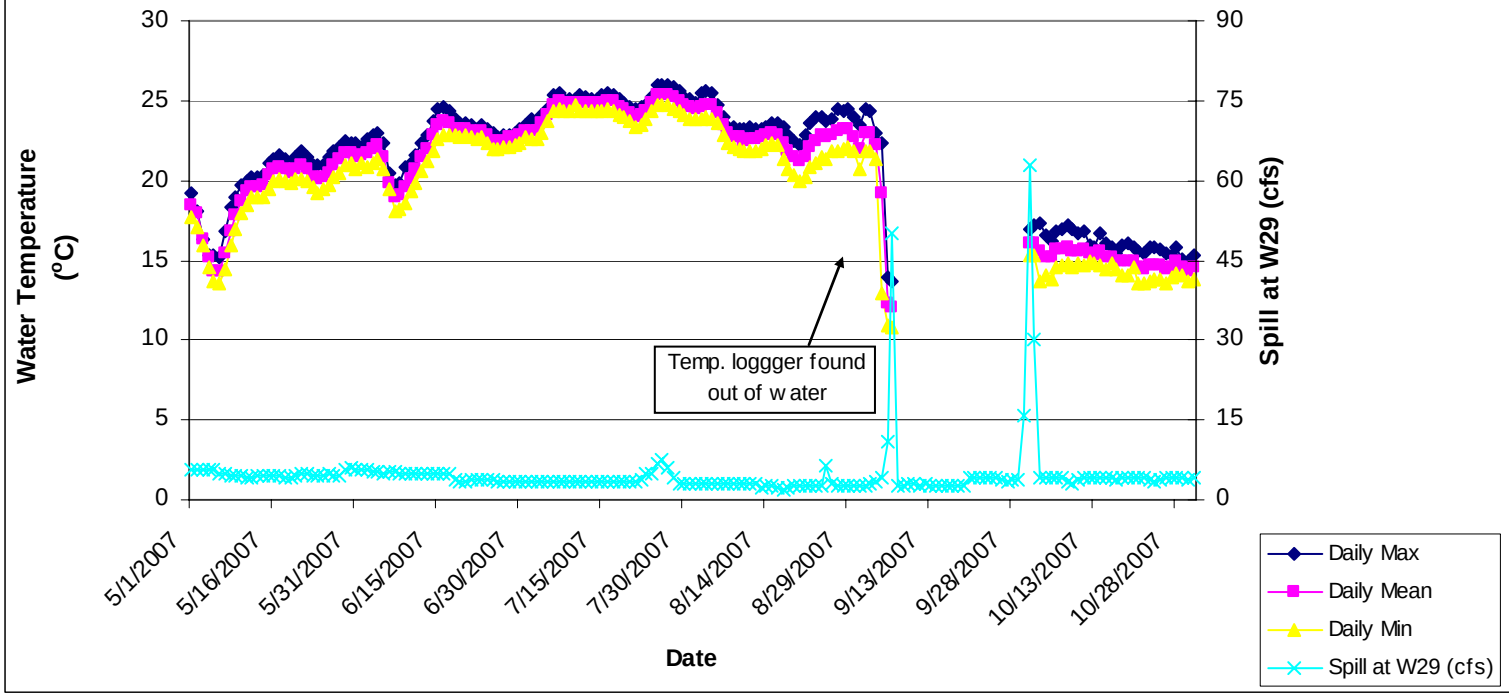


Figure 3.1-9
Station T6, NFWC River Mile 0.25, upstream of the NFWC Diversion Dam
Daily Mean, Minimum, and Maximum Water Temperatures (^{o}C) and Spill at gage W15 (cfs)

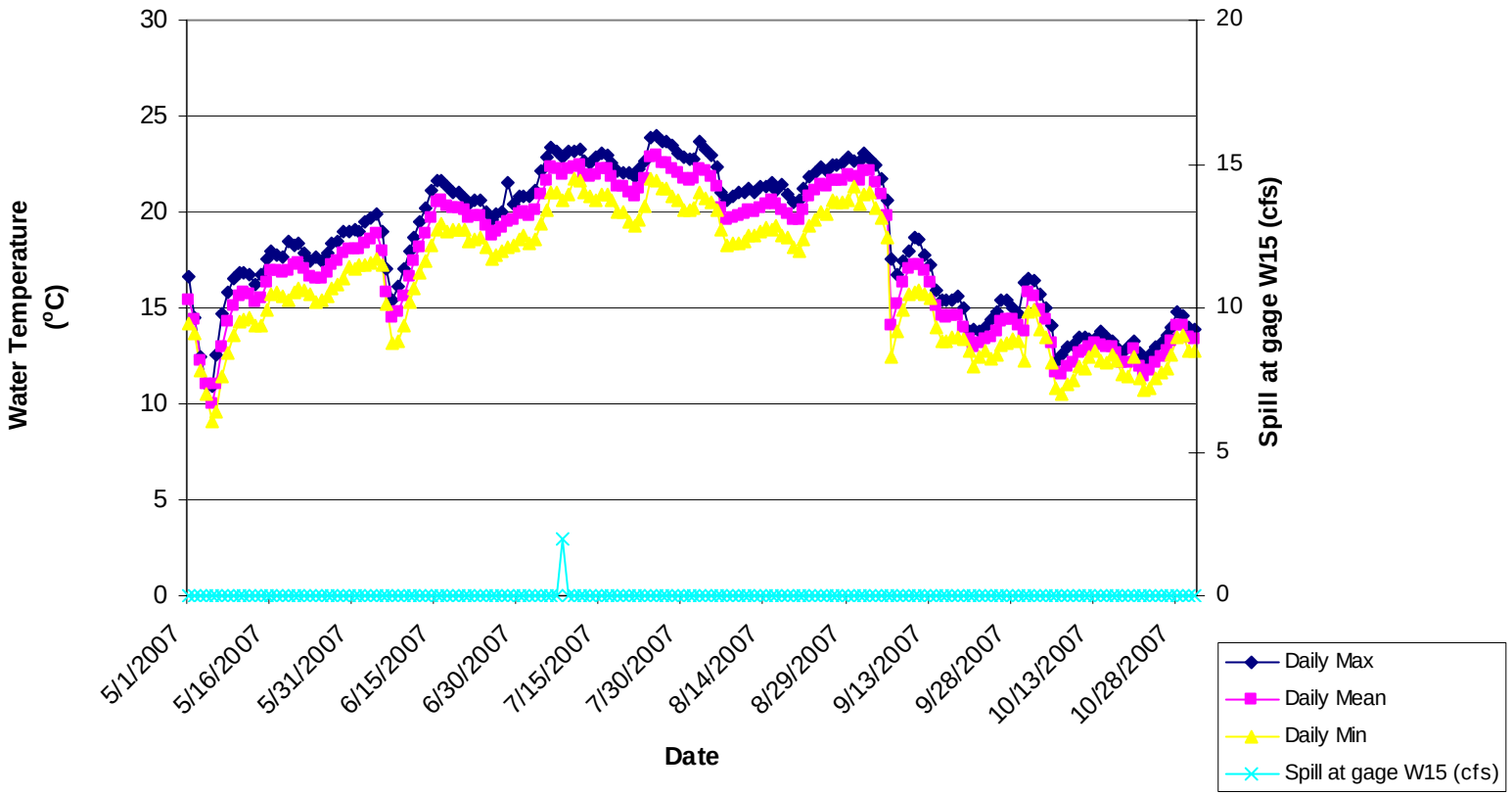


Figure 3.1-10
Station T9, SFWC River Mile 0.1, upstream of the SFWC Diversion Dam
Daily Mean, Minimum, and Maximum Water Temperatures (°C) and spill at gage W13 (cfs)

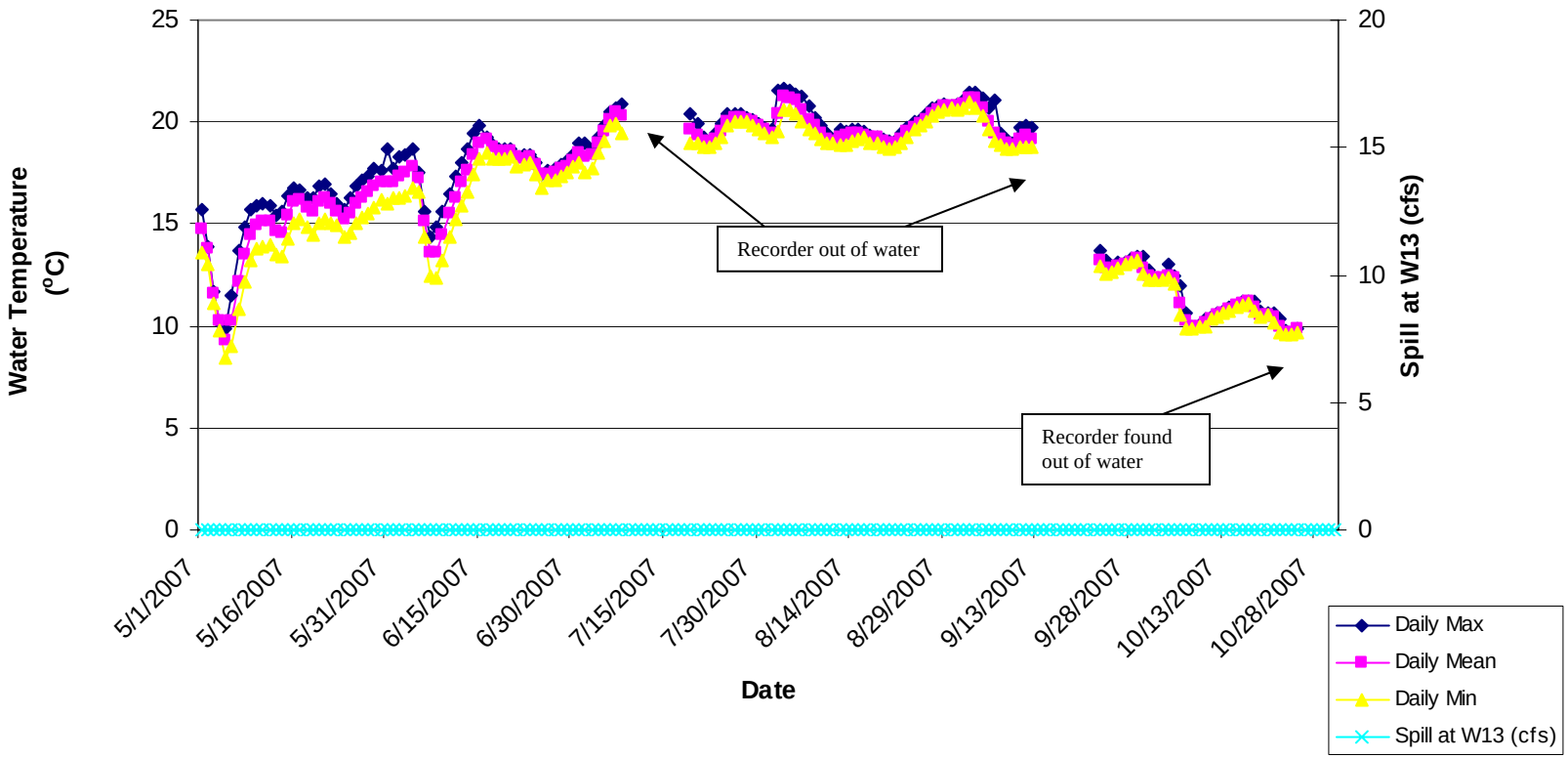


Figure 3.1-11
Station T13, Willow Creek downstream of the sand trap spill channel confluence
Daily Mean, Minimum, and Maximum Water Temperatures (°C)

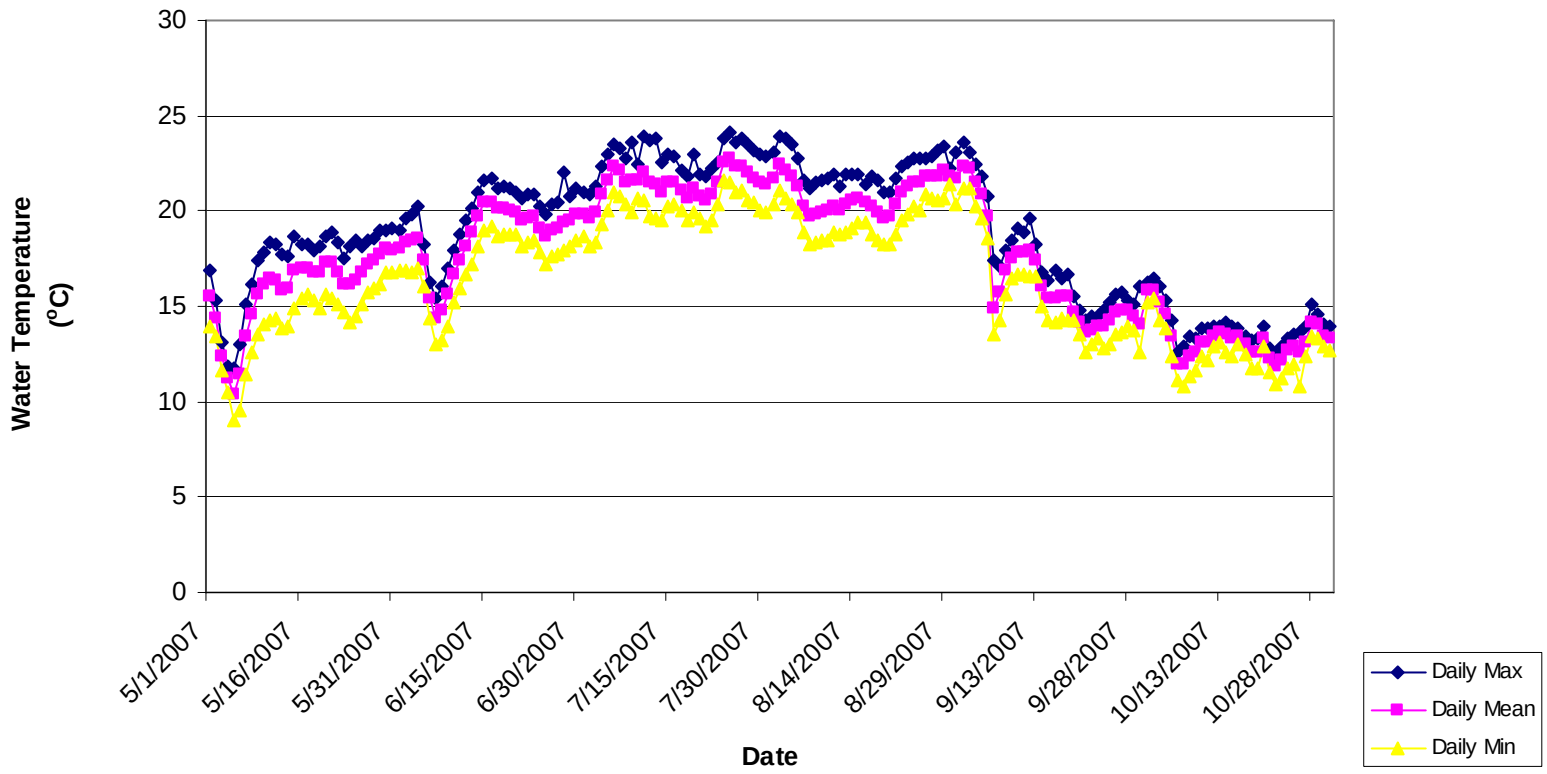


Figure 3.1-12
Station T10, Willow Creek River Mile 4.3, at Gage W-26
Daily Mean, Minimum, and Maximum Water Temperatures (°C) and stream flow at gage W26 (cfs)

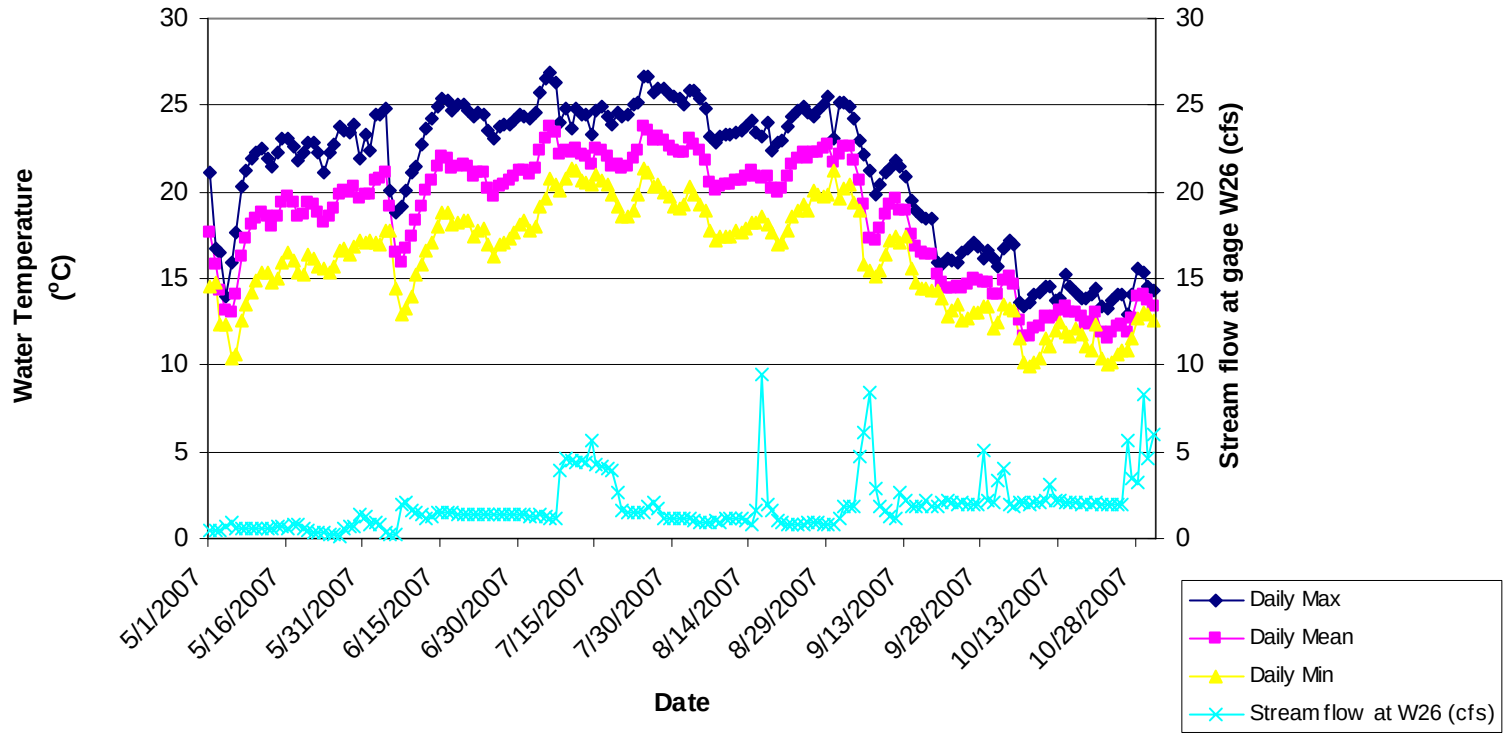
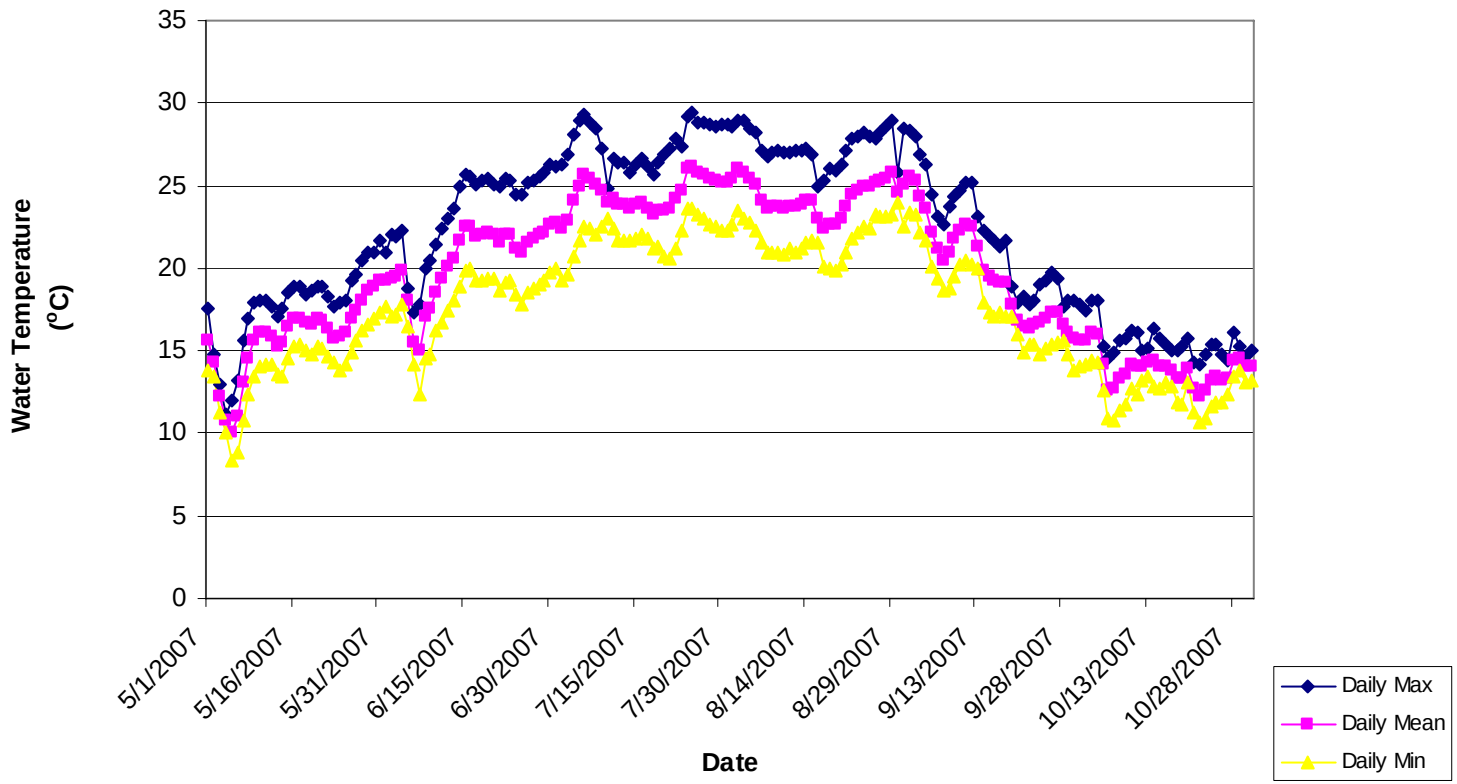


Figure 3.1-13
Station T11, Willow Creek River Mile 1.8, at the mouth of Whiskey Creek
Daily Mean, Minimum, and Maximum Water Temperatures (^{o}C)



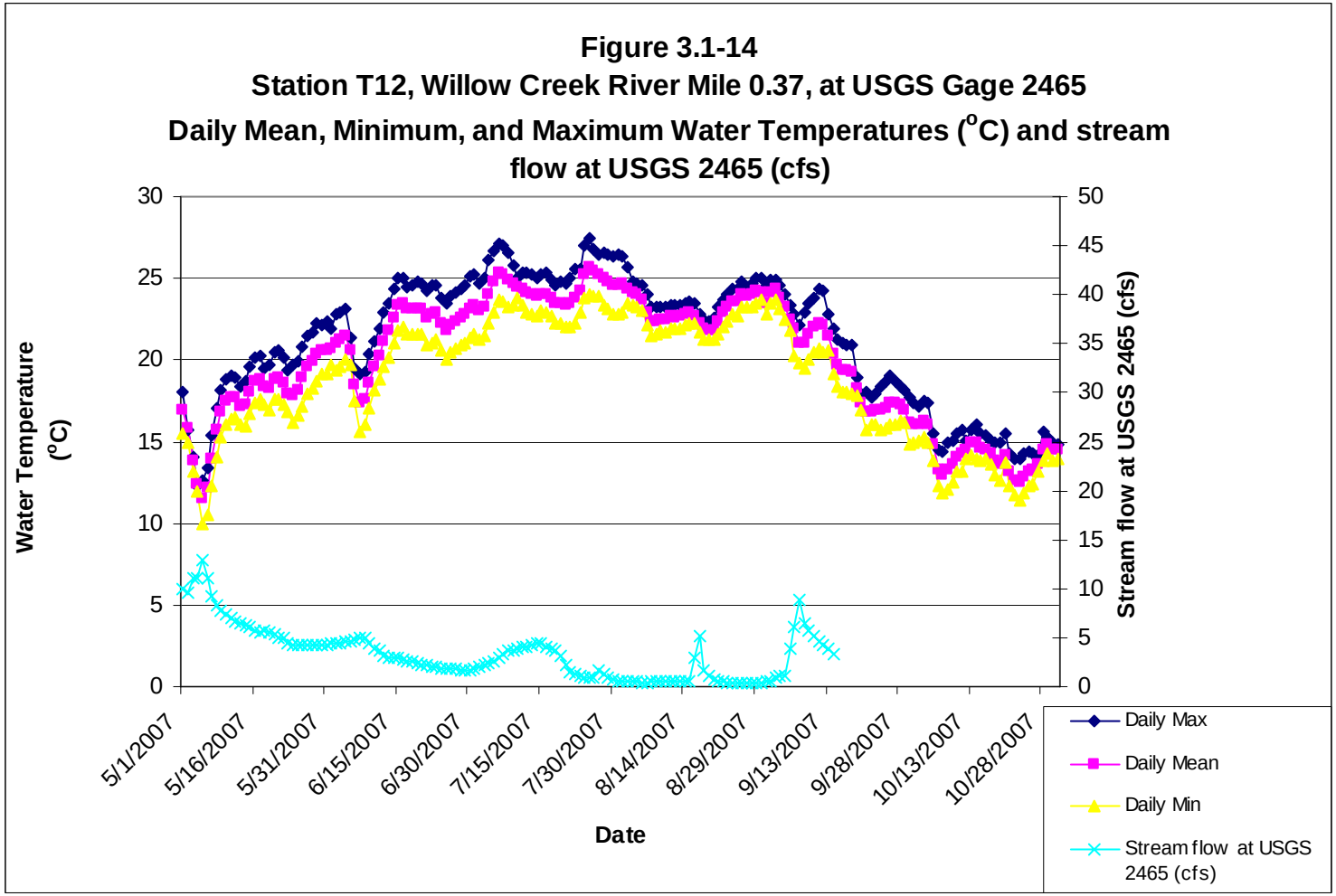


Figure 3.1-14
Station T12, Willow Creek River Mile 0.37, at USGS Gage 2465
Daily Mean, Minimum, and Maximum Water Temperatures (°C) and stream flow at USGS 2465 (cfs)
Water Temperature (°C)
Stream flow at USGS 2465 (cfs)
Date
30
25
20
15
10
5
0
50
45
40
35
30
25
20
15
10
5
0
5/1/2007
5/16/2007
5/31/2007
6/15/2007
6/30/2007
7/15/2007
7/30/2007
8/14/2007
8/29/2007
9/13/2007
9/28/2007
10/13/2007
10/28/2007
Daily Max
Daily Mean
Daily Min
Stream flow at USGS 2465 (cfs)

Figure 3.1-15
Station T7, SFWC River Mile 6.59, upstream of the Browns Creek Diversion Dam
Daily Mean Water Temperatures (^oC) and Daily Mean Air Temperatures (^oC)

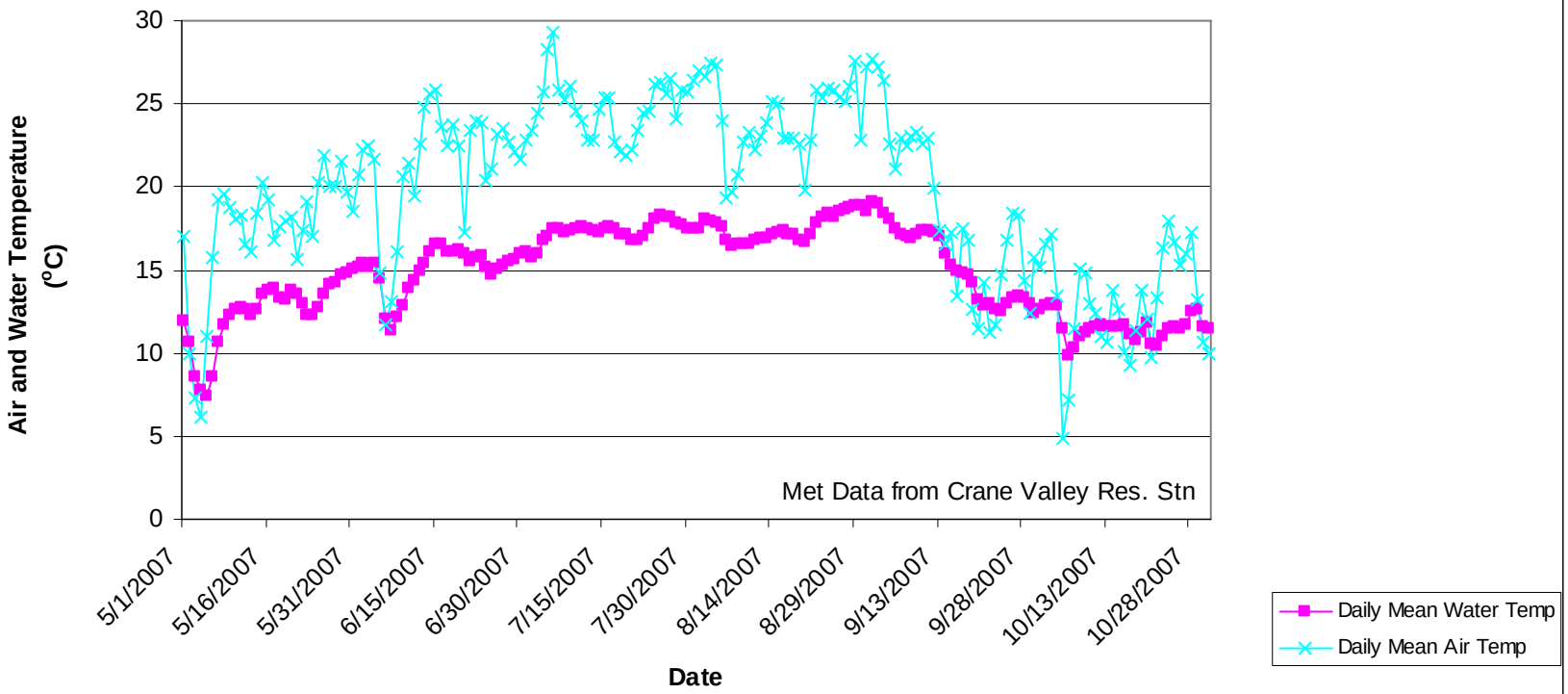


Figure 3.1-16
Station T8, SFWC River Mile 6.5, downstream of the Browns Creek Diversion Dam
Daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and stream flow at gage W33 (cfs)

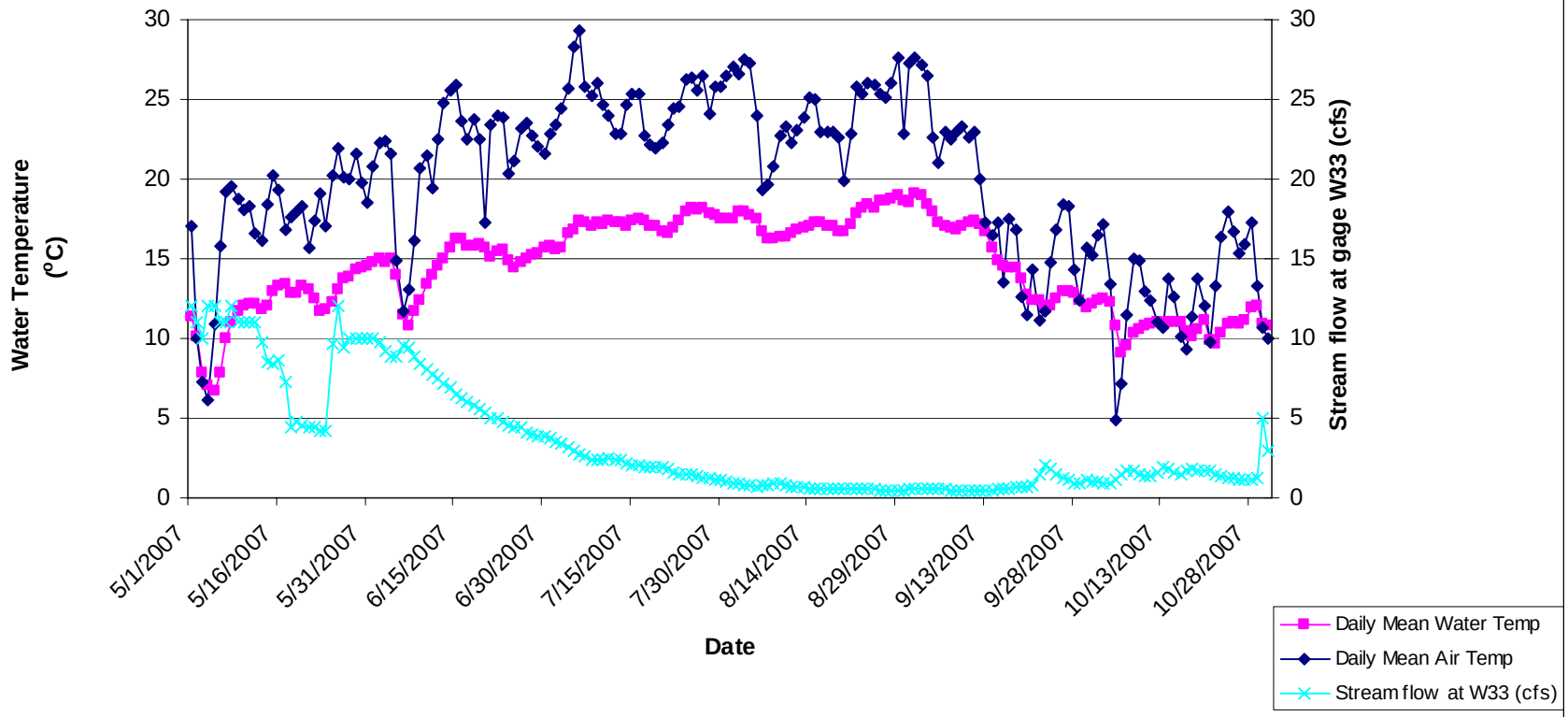


Figure 3.1-17
Station T1, NFWC downstream of Bass Lake at the Crane Valley PH Tailrace
Daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and Powerhouse outflow at gage W19 (cfs)

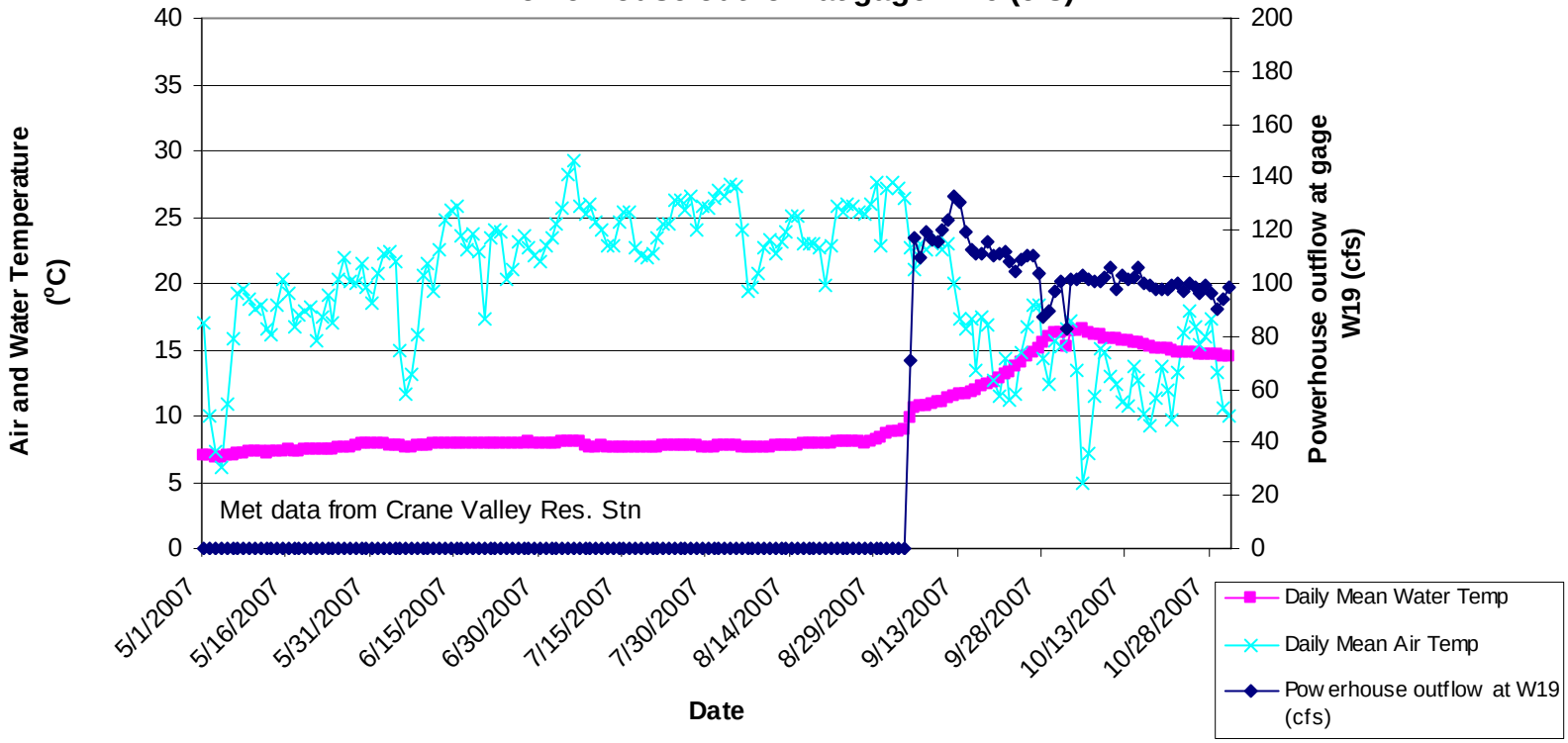


Figure 3.1-18
Station T2, NFWC River Mile 7.13, below Bass Lake
Daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and stream flow at gage W3 (cfs)

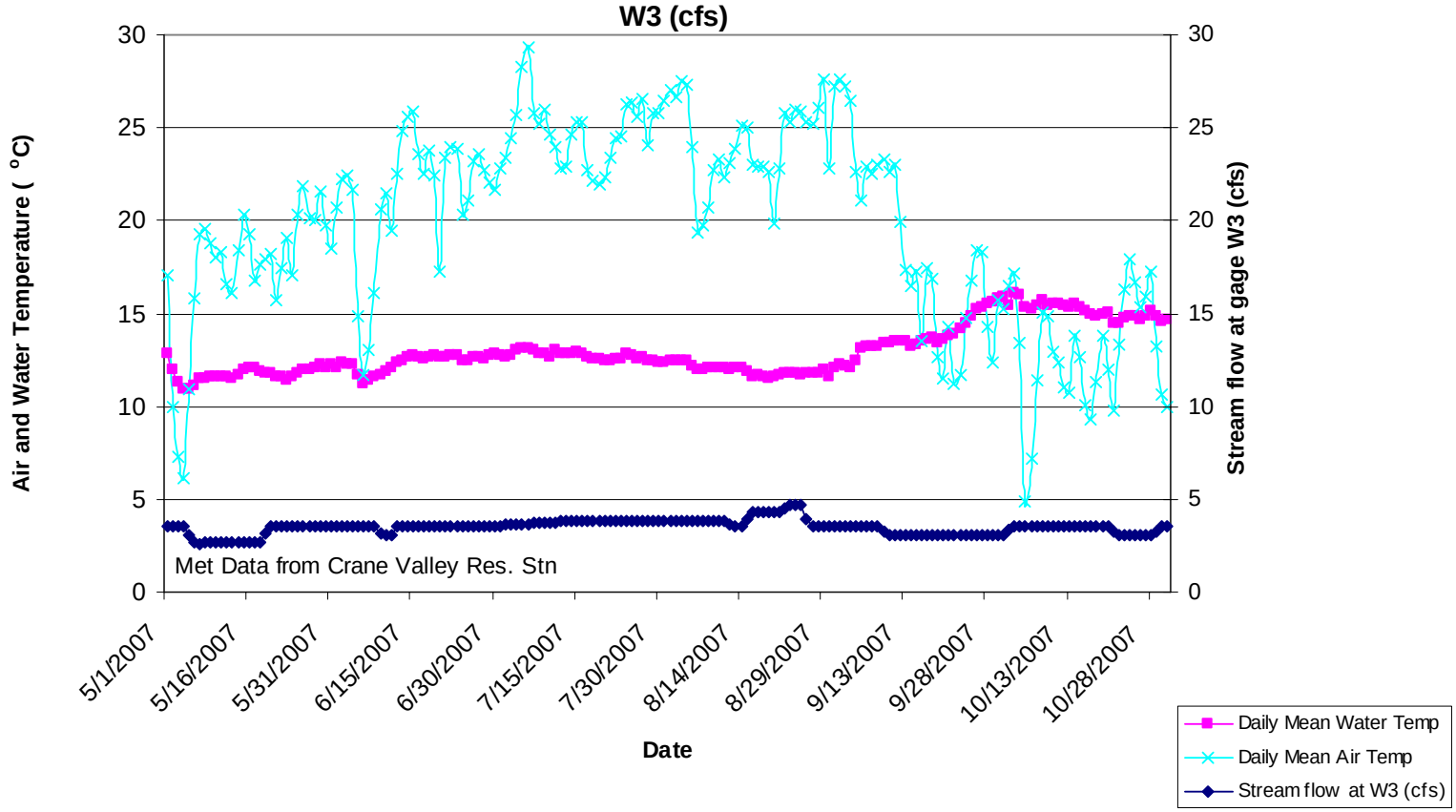
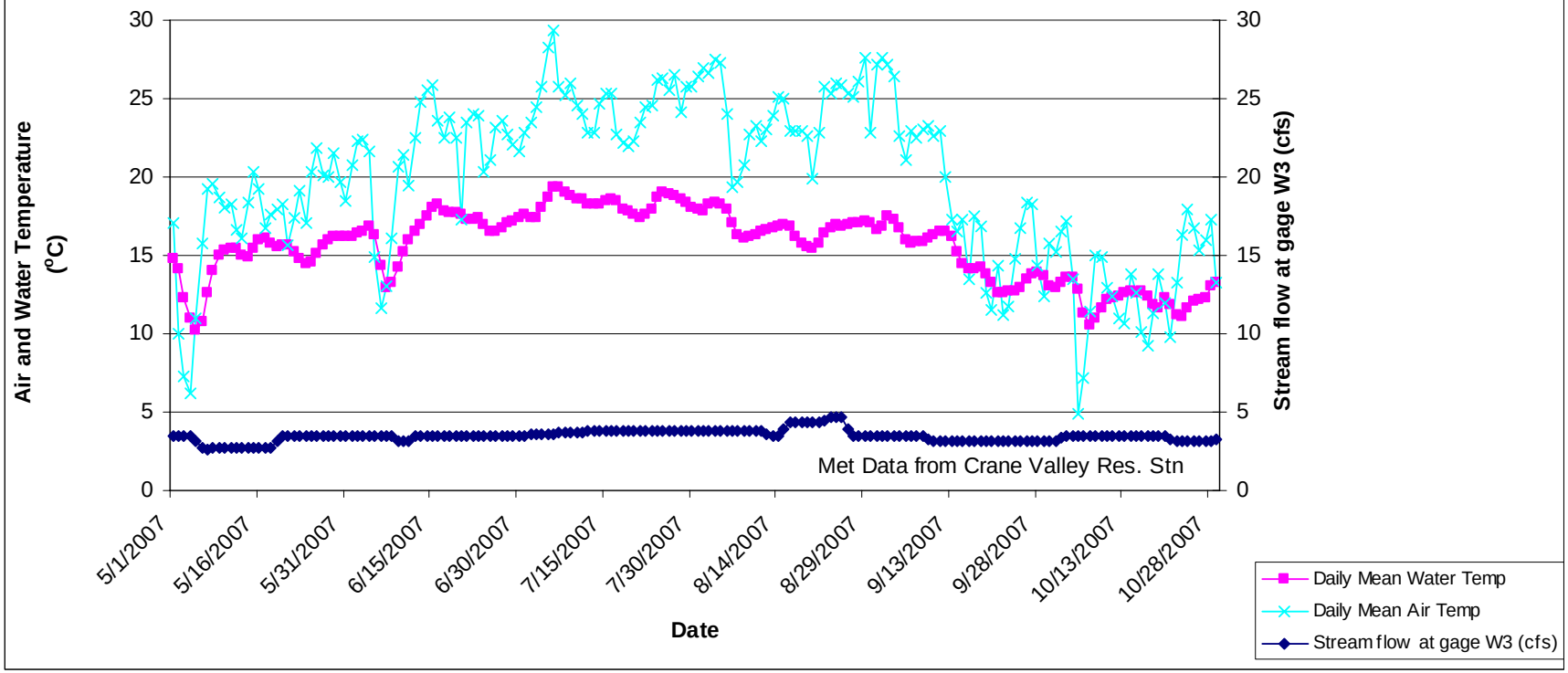


Figure 3.1-19
Station T3, NFWC River Mile 4.39, upstream of Manzanita Lake
Daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and stream flow at gage W3 (cfs)



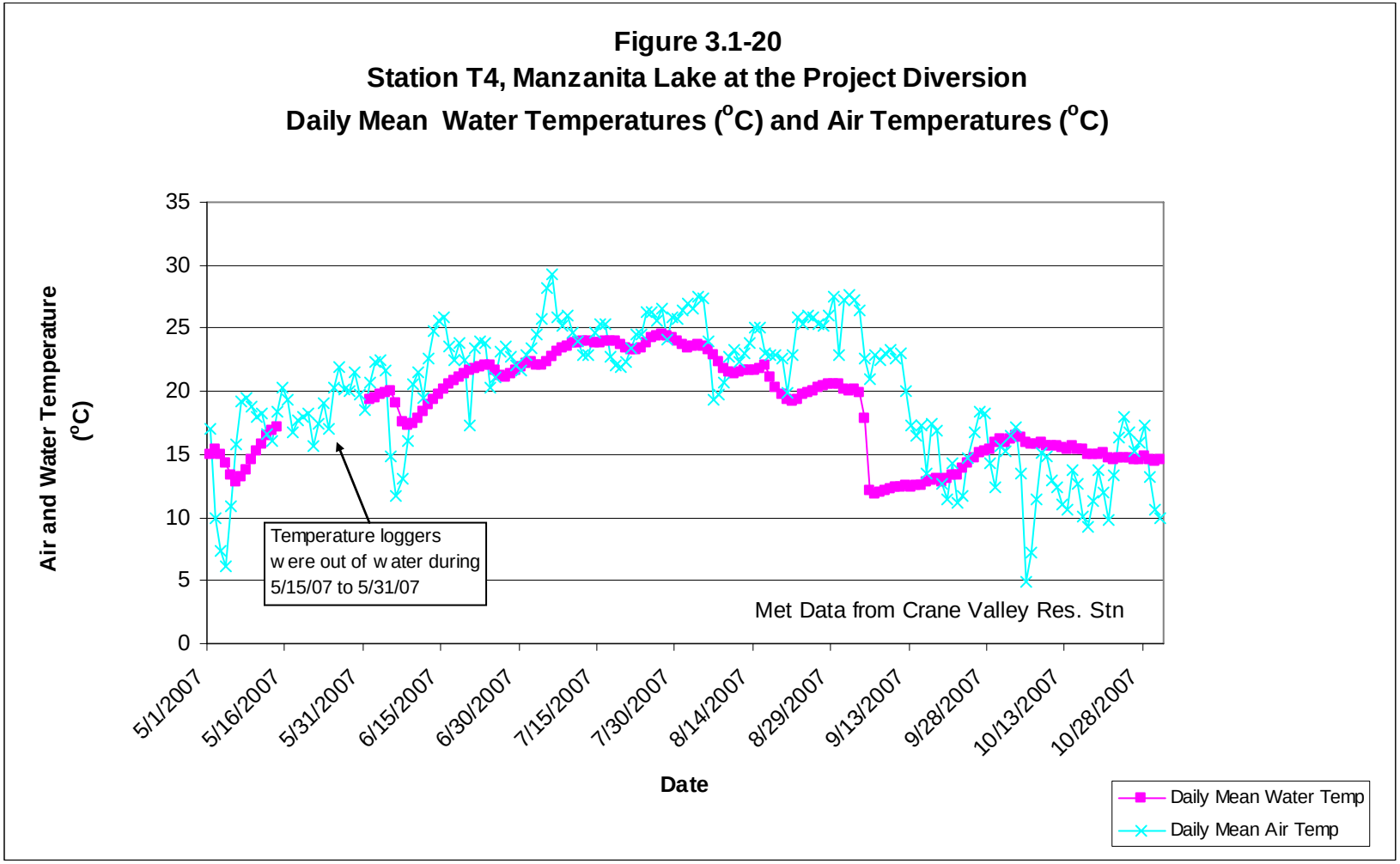


Figure 3.1-20
Station T4, Manzanita Lake at the Project Diversion
Daily Mean Water Temperatures (°C) and Air Temperatures (°C)
Air and Water Temperature (°C)
35
30
25
20
15
10
5
0
Temperature loggers were out of water during 5/15/07 to 5/31/07
Met Data from Crane Valley Res. Stn
5/1/2007
5/16/2007
5/31/2007
6/15/2007
6/30/2007
7/15/2007
7/30/2007
8/14/2007
8/29/2007
9/13/2007
9/28/2007
10/13/2007
10/28/2007
Date
Daily Mean Water Temp
Daily Mean Air Temp

Figure 3.1-21
Station T5, NFWC River Mile 3.0, downstream of Manzanita Lake
Daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and Spill at gage W29 (cfs)

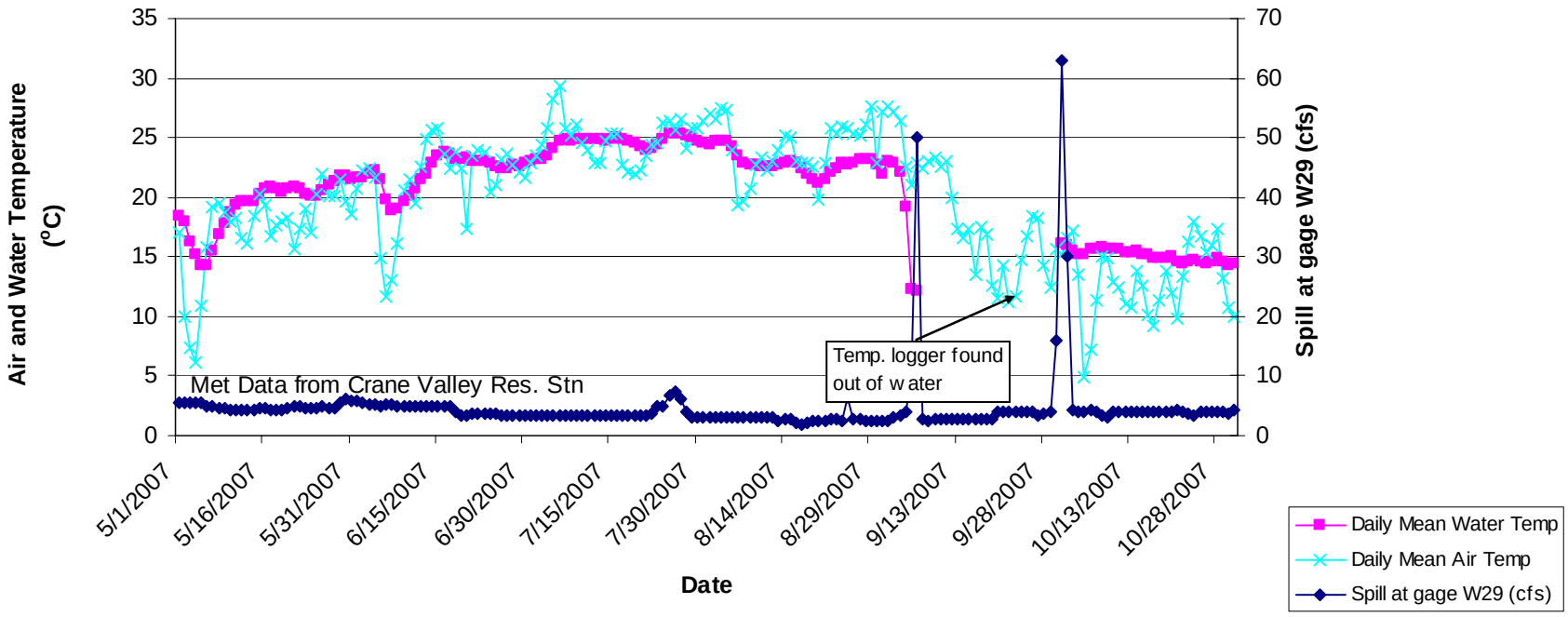


Figure 3.1-22
Station T6, NFWC River Mile 0.25, upstream of the NFWC Diversion Dam
Daily Mean Water Temperatures (^{o}C), Daily Mean Air Temperatures (^{o}C), and Spill at gage W15 (cfs)

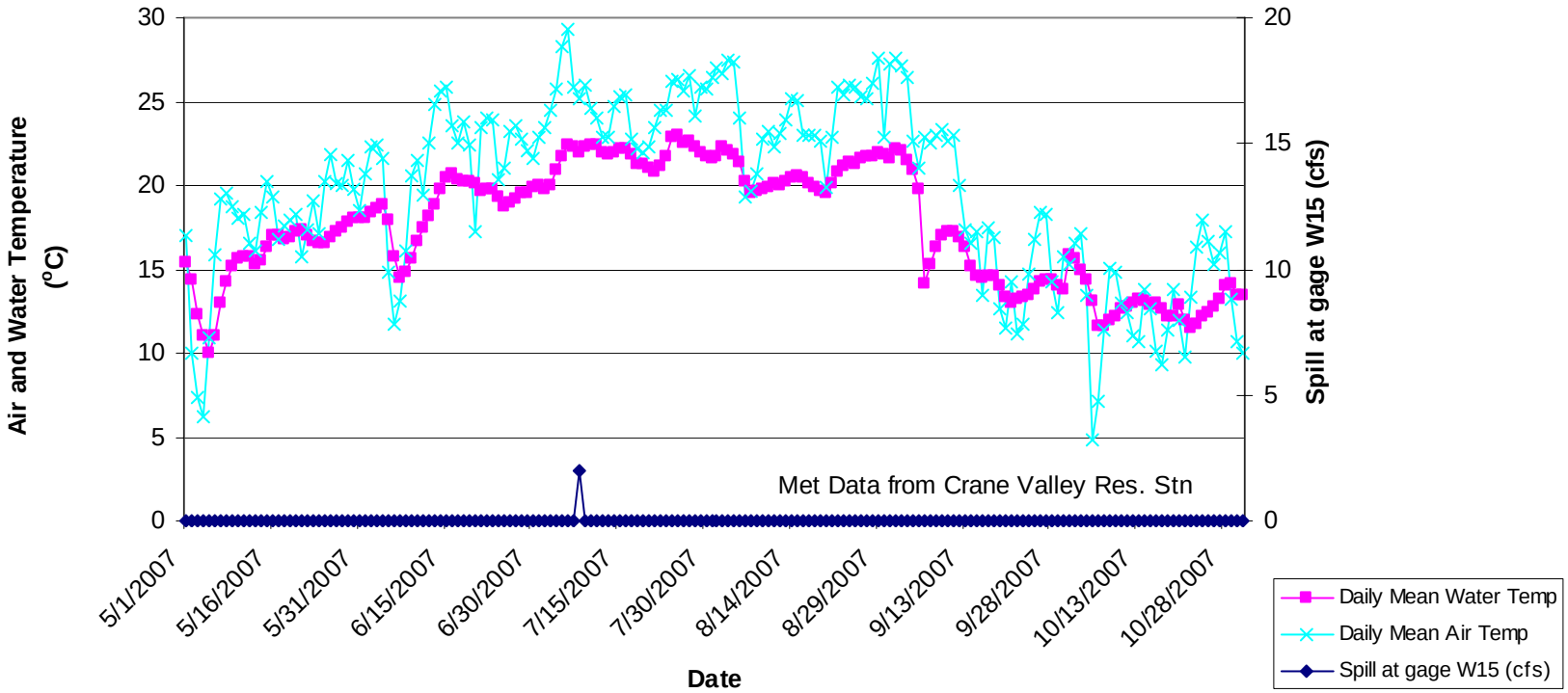


Figure 3.1-23
Station T9, SFWC River Mile 0.1, upstream of the SFWC Diversion Dam
Daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and spill at gage W13 (cfs)

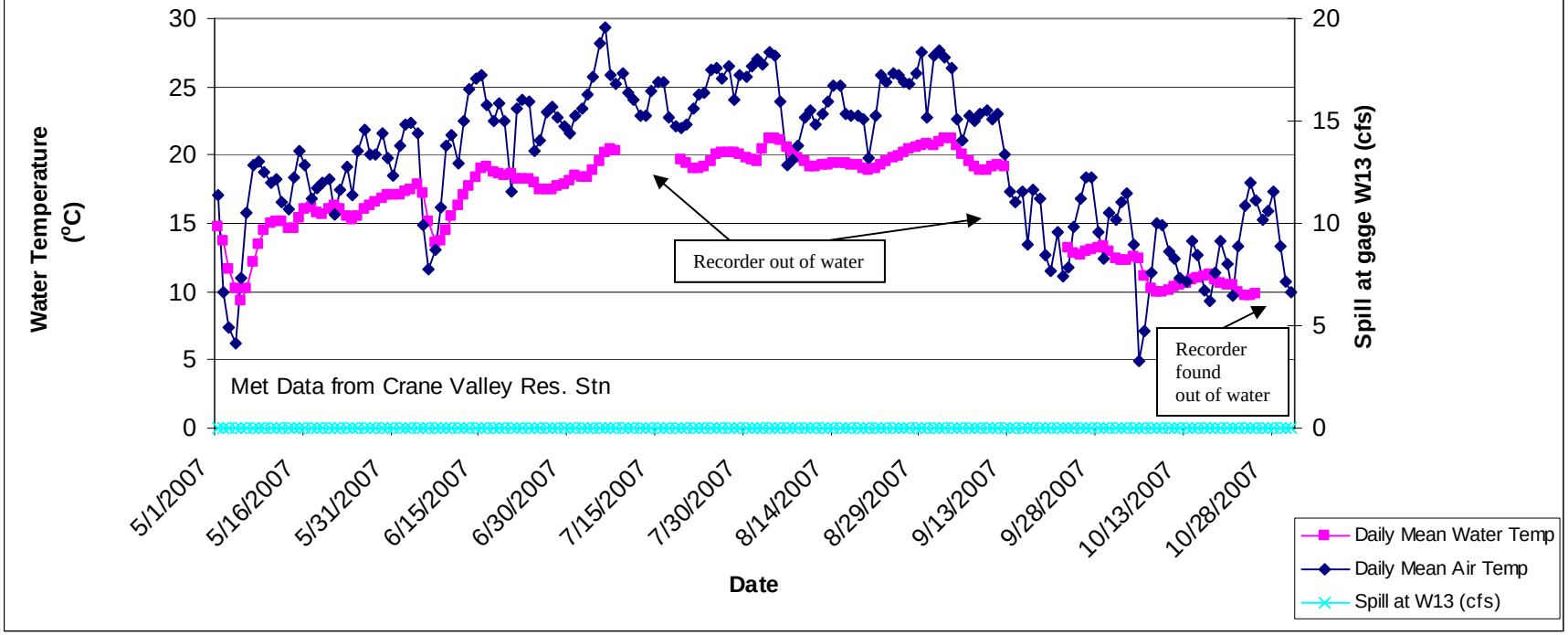


Figure 3.1-24
Station T13, Willow Creek downstream of the sand trap spill channel confluence
Daily Mean Water Temperatures (^oC) and Daily Mean Air Temperatures (^oC)

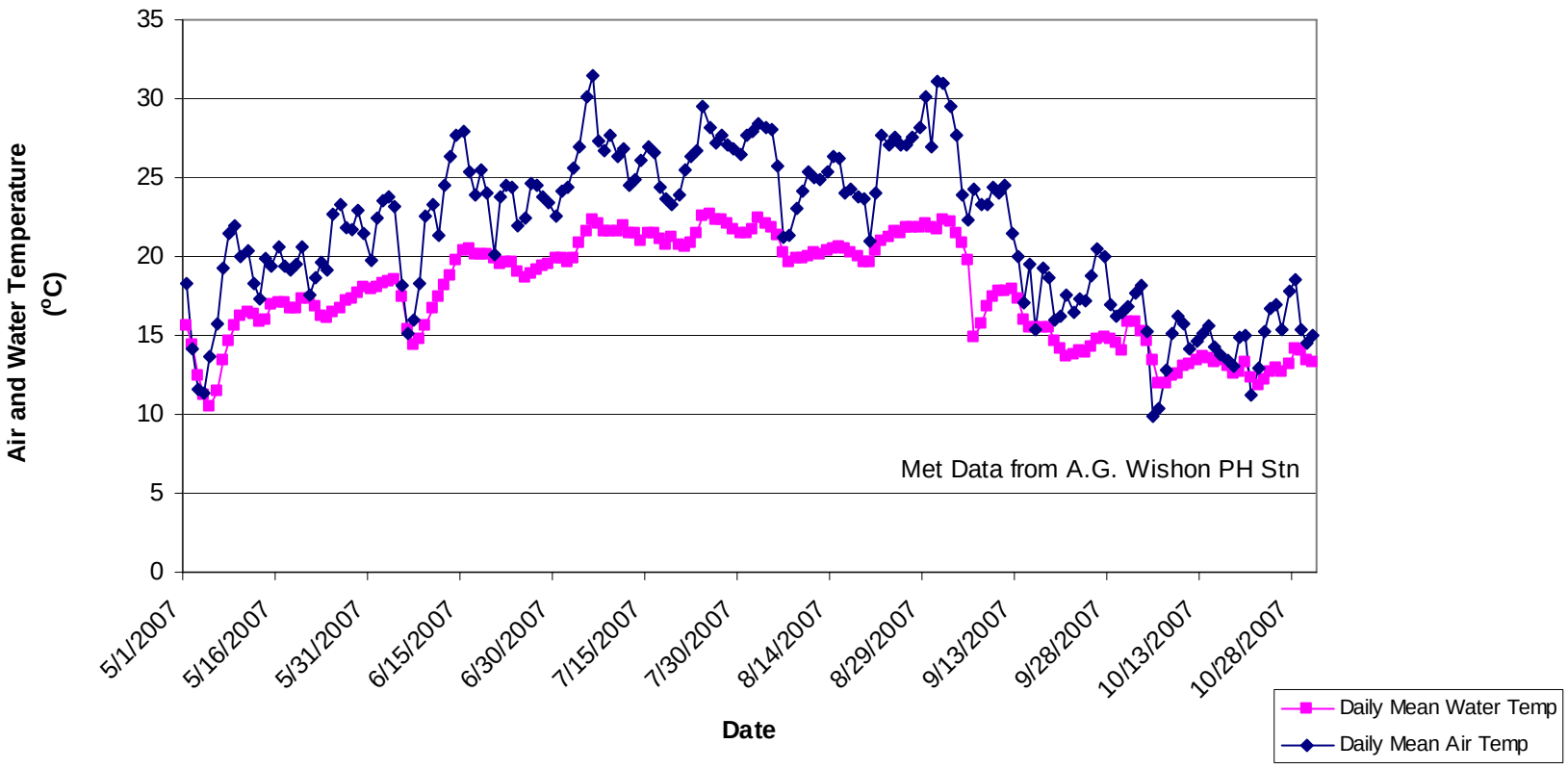
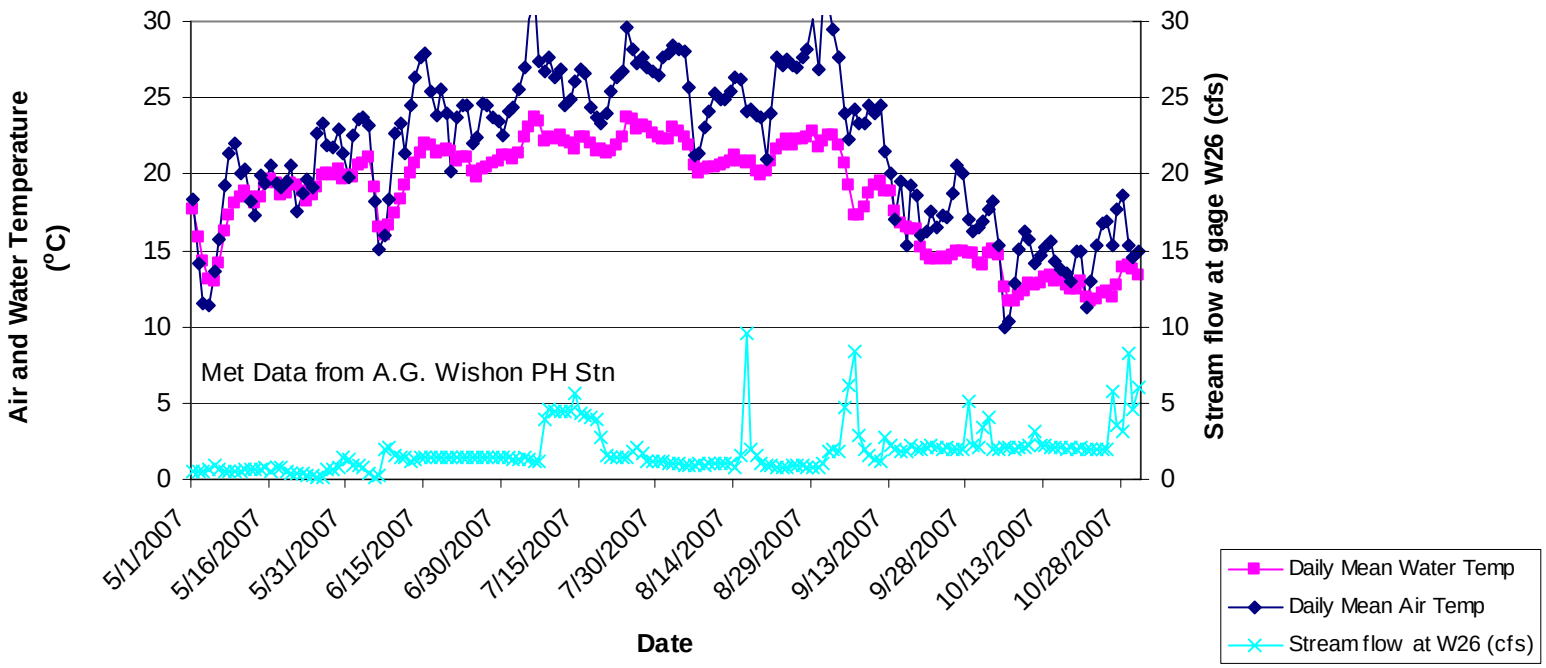


Figure 3.1-25
Station T10, Williow Creek River Mile 4.3, at Gage W-26
Daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and stream flow at gage W26 (cfs)



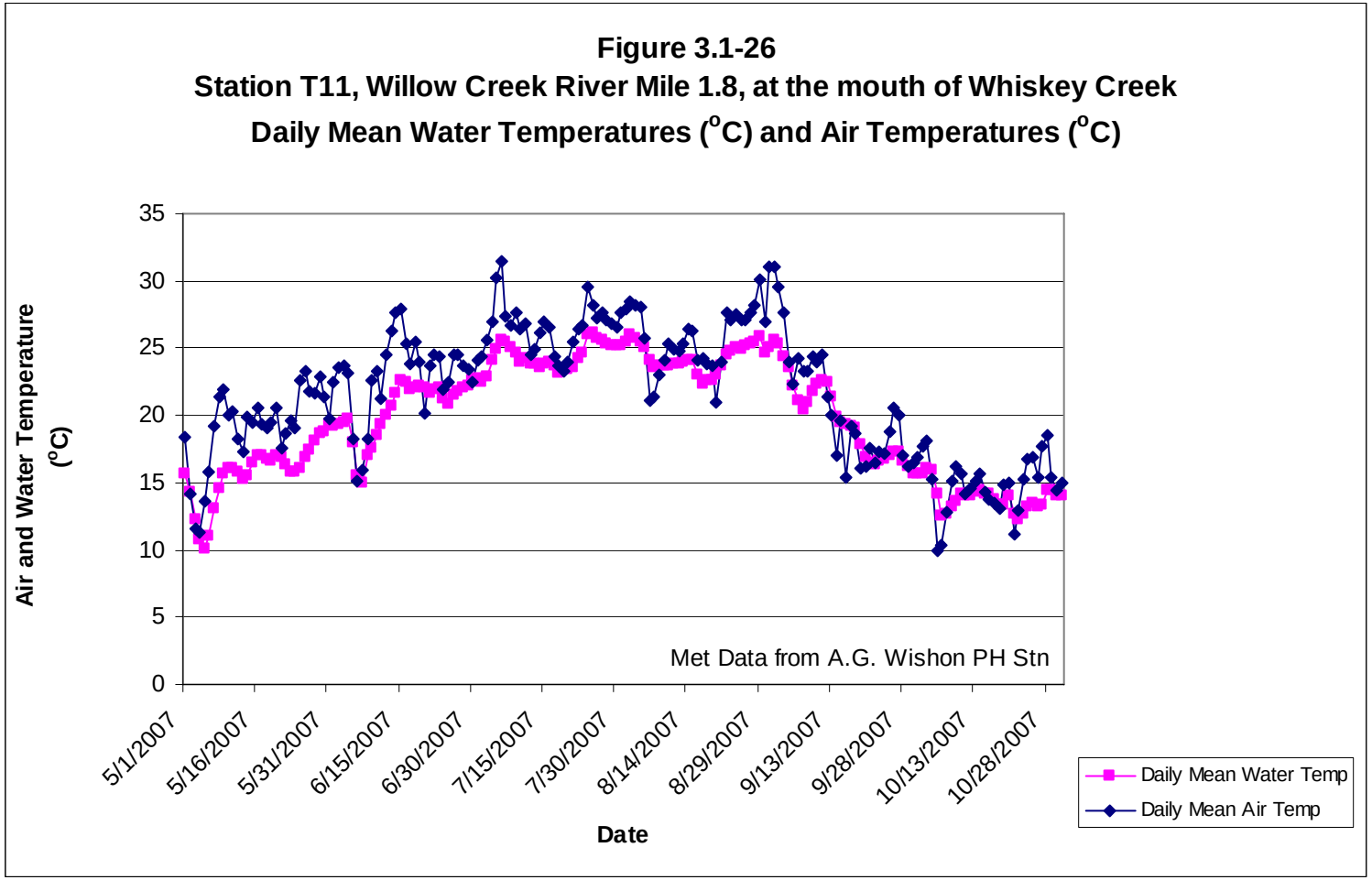


Figure 3.1-26
Station T11, Willow Creek River Mile 1.8, at the mouth of Whiskey Creek
Daily Mean Water Temperatures (°C) and Air Temperatures (°C)
Air and Water Temperature (°C)
35
30
25
20
15
10
5
0
Met Data from A.G. Wishon PH Stn
5/1/2007
5/16/2007
5/31/2007
6/15/2007
6/30/2007
7/15/2007
7/30/2007
8/14/2007
8/29/2007
9/13/2007
9/28/2007
10/13/2007
10/28/2007
Date
Daily Mean Water Temp
Daily Mean Air Temp

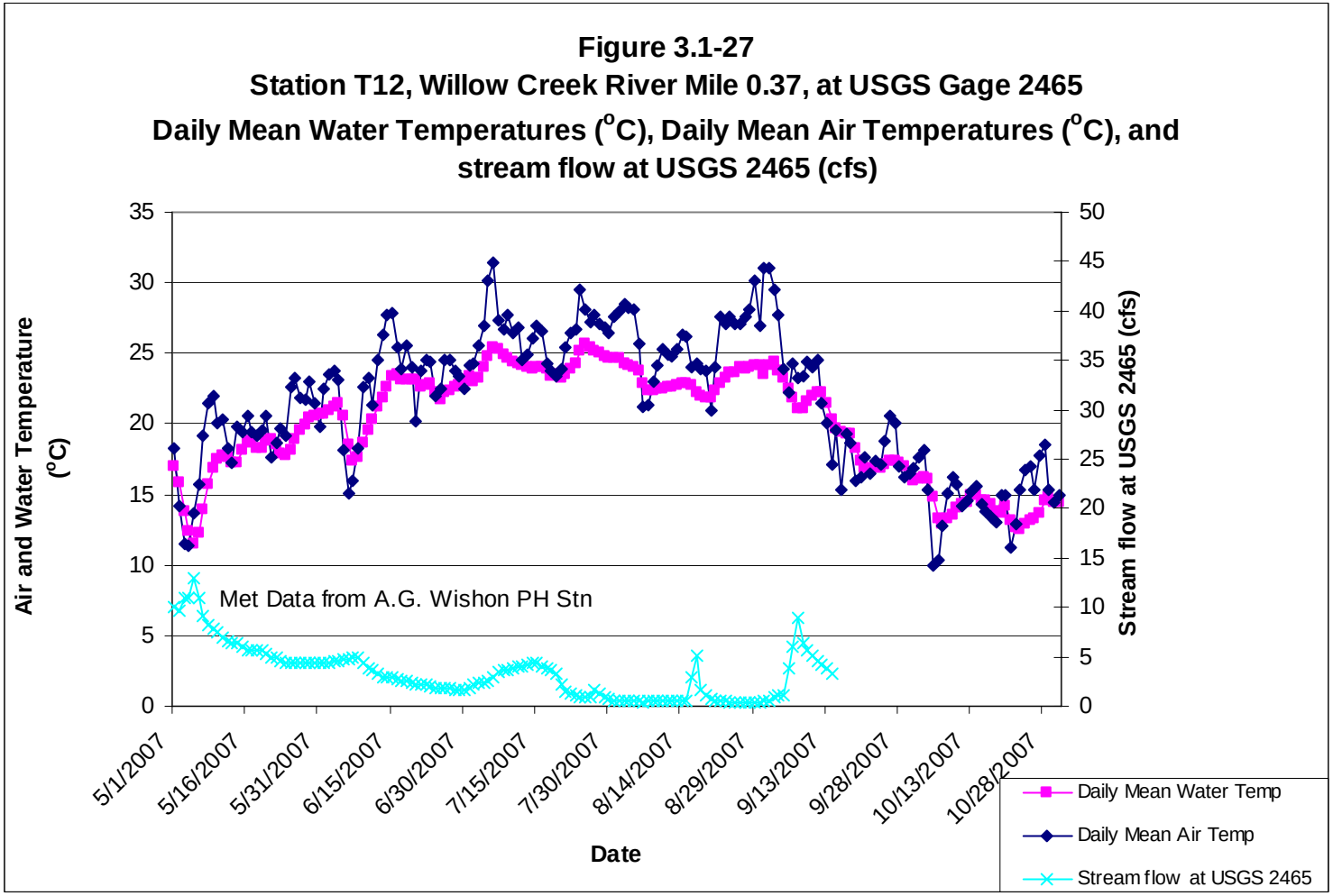


Figure 3.1-27
Station T12, Willow Creek River Mile 0.37, at USGS Gage 2465
Daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and stream flow at USGS 2465 (cfs)
Air and Water Temperature (°C)
Stream flow at USGS 2465 (cfs)
Met Data from A.G. Wishon PH Stn
Date
5/1/2007
5/16/2007
5/31/2007
6/15/2007
6/30/2007
7/15/2007
7/30/2007
8/14/2007
8/29/2007
9/13/2007
9/28/2007
10/13/2007
10/28/2007
Daily Mean Water Temp
Daily Mean Air Temp
Stream flow at USGS 2465