EXHIBIT ARWA-902

Technical Memorandum 4

Folsom Reservoir Inflow Water Temperature Relationships

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1.0 INTRODUCTION

This technical report documents the water temperature relationships developed originally by Placer County Water Agency (PCWA) and used by the Sacramento Water Forum to model Folsom Reservoir inflow water temperatures. The relationships are used to model water temperatures for the CalSim II[1] monthly period of record (POR) 1922-2003 and/or other time periods of interest, as appropriate. The inflow water temperatures are used as inputs to the Folsom Reservoir CE-QUAL-W2 water temperature model developed originally by PCWA and used by the Sacramento Water Forum (see Technical Memorandum 5 – Folsom Reservoir CE-QUAL-W2 Model and Calibration).

Folsom Reservoir inflows include water from the North Fork American River (NFAR); South Fork American River (SFAR); upper Yuba-Bear rivers via the Newcastle Powerhouse/South Canal; and local run-off inflow into Folsom Reservoir (Map 1). The Middle Fork American River (MFAR) flows into the NFAR above Folsom Reservoir. Inflow temperature regressions were developed for the NFAR, SFAR, and South Canal. Data do not exist to quantify the local inflow water temperatures. For the purposes of this modeling, the local inflow water temperatures were assumed to be the same as the NFAR water temperatures.

Monthly average water temperature regression equations were developed for the NFAR, SFAR and South Canal. Monthly SFAR and South Canal river water temperature tables for the CalSim II POR record are also included in this memorandum based on a fixed hydrology inflow data set. For most modeling scenarios, the hydrology in the SFAR and South Canal is static and a single inflow water temperature data set can be developed for each. For the NFAR, a static inflow water temperature data set was not developed to allow for potential modeling scenarios that could alter hydrology in the NFAR. Therefore, water temperatures are determined using regression equations for specific modeling scenarios. Also, because the temporal resolution of hydrology modeling scenarios in the NFAR based on PCWA Middle Fork Project (MFP) operations is typically daily, daily water temperature regression equations were developed in addition to the monthly equations for the NFAR.

2.0 FOLSOM RESERVOIR INFLOW WATER TEMPERATURE

Descriptions of the available flow gaging stations and water temperature monitoring stations used in the modeling are provided in**Error! Reference source not found.** and the locations are shown on Map 1. All data were quality controlled by Cardno prior to use in the analyses.

2.1 NORTH FORK AMERICAN RIVER

2.1.1 MEASURED FLOW AND TEMPERATURE DATA SOURCES

The nearest active upstream gaging stations to Folsom Reservoir are located on the NFAR at North Fork Dam, CA (United States Geological Survey [USGS] gage no. 11427000) and on the

[1] The Central Valley Project (CVP)/State Water Project (SWP) Simulation Model II (CalSim II) simulates the water resources of California's Central Valley and Sacramento-San Joaquin Delta regions, including the operations of the Central Valley Project (CVP) and the State Water Project (SWP).

MFAR near Foresthill, CA (USGS gage no. 11433300 and California Data Exchange Center [CDEC] gage OXB). The MFAR flows into the NFAR downstream of both of these gages. Daily average flows from the MFAR gage were combined with the daily average flows measured on the NFAR gage to produce an estimate of flow at the NFAR inlet to Folsom Reservoir (July 1999 – May 2015).

Historical daily water temperature data were obtained from the USGS/ CDEC station on the NFAR at the Auburn Dam site near Auburn, CA (USGS gage no. 11433790/CDEC station NFA) (July 1999 – May 2015). This location is just upstream of Folsom Reservoir. A limited data set (2003-2008) of daily water temperatures collected on the MFAR below Oxbow Powerhouse in support of PCWA's MFP relicensing studies was also used (PCWA MF24.3).

Local historical air temperatures were obtained from the California Irrigation Management Information System (CIMIS) Fair Oaks meteorological (MET) station CIMIS-131 (see Technical Memorandum 8 – Historical 1922-2003 Meteorological Dataset).

2.1.2 Development of Inflow Water Temperature over the Period of Record (WY 1922-2003)

Initial Testing

An initial daily multiple regression approach was tested using the fullest available data set (2003-2008) to help guide development of reduced parameter multiple regression equations that could be used for water temperature modeling. Daily NFAR inflow water temperatures were modeled using MFAR flow, NFAR flow, release water temperature from the Oxbow Powerhouse, local air temperature, and the day of the year (Figure 1; $R^2 = 0.98$; Attachment A Figure 1). MFAR flow in the multiple regressions was lagged 24 hours (daily) to account for travel time.

Final Method

To model daily and monthly NFAR temperatures over the POR (WY 1922-2003), a multiple regression approach that used a set of parameters available for the entire POR was required. The initial daily regression modeling approach accurately characterized water temperature; however, Oxbow Powerhouse water temperature was only available for a short time window, not for the entire 1922-2003 POR. All of the other parameters were available in the simulation modeling for the 1922-2003 POR; therefore, a concurrent mean daily and monthly data set (July 1999 – May 2015) of NFAR inflow water temperature, NFAR flow, MFAR flow, and air temperature at CIMIS-131 was used to develop and test daily and monthly multiple regressions. Regression equations were developed for each month of the year using either average daily values or average monthly values. This "monthly" approach was used to help account for the seasonal variability in water temperature (e.g., seasonal solar radiation).

2.1.3 Results

The daily and monthly NFAR inflow temperature multiple regression equations are provided in Table 2 and Table 3, respectively. A comparison of the July 1999 – May 2015 NFAR measured and modeled monthly water temperature for the NFAR inflows into Folsom Reservoir is provided in Figure 2 ($R^2 = 0.98$). A time series plot showing the relatively good correspondence between measured and modeled water temperatures is shown in Figure 3 (daily results) and Figure 4

(monthly results). MFAR flow strongly influenced water temperatures in the late spring through summer months in the multiple regressions (higher MFAR flow equaled lower inflow temperatures), but had less effect on water temperatures in the cooler/wetter months. The influence of just MFAR flows (no other parameters) on NFAR inflow temperatures to Folsom Reservoir is shown graphically in Attachment A Figure 2. For scenario modeling, the Table 2 or Table 3 equations are used to calculate NFAR inflow water temperatures for each scenario.

2.2 SOUTH FORK AMERICAN RIVER

2.2.1 MEASURED FLOW AND TEMPERATURE DATA SOURCES

Flow data were available from USGS gaging station near Placerville, CA (USGS gage no. 11444500) (8/1999-9/2014) / CDEC gaging station at Chili Bar (CDEC-CBR) (8/1999-5/2015), which is the active SFAR[2] gaging station nearest to Folsom Reservoir). The gage does not account for local inflows between the gage site and the inlet to Folsom Reservoir; however, very little inflow occurs below this gage during the drier months and in drier years (the time period when water temperature is primarily a function of flow).

Historical water temperature data for the SFAR were obtained from the USGS gaging station on the SFAR near Pilot Hill, CA (USGS gage no. 11446030) / CDEC-ARP gaging station (August 1999-May 2015). A limited data set of daily water temperatures measured at Chili Bar Dam that were collected in support of the PG&E Chili Bar relicensing studies were also used (2002-2004).

Historical local air temperatures were obtained from the Fair Oaks CIMIS MET station number CIMIS-131.

2.2.2 DEVELOPMENT OF INFLOW WATER TEMPERATURE OVER THE PERIOD OF RECORD (WY 1922-2003)

Initial Testing

An initial daily multiple regression approach was tested using the fullest available data set (2002-2004) to help guide development of a reduced parameter monthly multiple regression. Daily SFAR inflow water temperatures were modeled using SFAR flow, release water temperature from Chili Bar Dam, local air temperature, and the day of the year (Figure 5; $R^2 = 0.98$; Attachment B Figure 1). SFAR flow in the multiple regressions was lagged 24 hours (daily) to account for travel time.

Final Method

To model monthly SFAR temperatures over the POR (WY 1922-2003), a multiple regression approach was required that used a set of monthly parameters available for the entire POR. The initial daily regression approach accurately characterized water temperature, however, Chili Bar

[2] Flows in the SFAR are regulated by two hydroelectric projects. Sacramento Municipal Utility District's (SMUD) Upper American River Project (UARP) regulates flows in the upper Rubicon River, Silver Creek, and the SFAR above Chili Bar Reservoir, as well as storage in Union Valley Reservoir. Flows immediately downstream of SMUD's UARP project are regulated by PG&E's Chili Bar Hydroelectric Project.

Dam water temperature data were only available for a short time window, not the entire 1922-2003 POR. All of the other parameters were available in the simulation modeling for the 1922-2003 POR; therefore, a concurrent mean monthly data set (August 1999 – May 2015) of SFAR inflow water temperature, SFAR flow, and air temperature at CIMIS-131 was used to develop and test the monthly multiple regression. The individual monthly regression approach accounted for the seasonal variability in water temperatures originally accounted for in the daily regression modeling.

2.2.3 RESULTS

The monthly SFAR Folsom Reservoir inflow temperature multiple regression equations are provided in Table 4. A comparison of the July 1999 – May 2015 SFAR measured and modeled monthly water temperature for the SFAR inflows into Folsom Reservoir is provided in Figure 6 (R^2 = 0.97). A time series plot showing the relatively good correspondence between measured and modeled water temperatures is shown in Figure 7. SFAR flow strongly influenced water temperatures in the late spring through summer months in the multiple regressions (higher SFAR flows correlated with lower inflow temperatures), but had less effect on water temperatures in the cooler/wetter months. The influence of just SFAR flows (no other parameters) on SFAR inflow temperatures to Folsom Reservoir is shown graphically in Attachment B Figure 2.

For scenario modeling, the mean monthly SFAR inflow water temperatures for the POR (1922-2003) are provided in Attachment C Table 1. SFAR inflows typically do not change under different modeling scenarios and, therefore, the SFAR inflow water temperatures typically remain static between scenarios.

2.3 SOUTH CANAL

South Canal water (originating in the Yuba and Bear Rivers) is diverted into the Bear River Canal, located immediately downstream of Rollins Reservoir. From there, the water flows through a series of canals and powerhouses until it is discharged from the Wise Powerhouse into the South Canal. From this point, the water flows in the canal for approximately 5 miles until it reaches Newcastle Powerhouse forebay. The water either enters the Newcastle Powerhouse penstock and/or spills into Mormon Ravine. In either case, the water then enters Folsom Reservoir. Prior to reaching the Newcastle Powerhouse forebay, some or much (depending on the season) of the water is diverted from the series of canals to meet local water demand (e.g. Nevada Irrigation District and PCWA).

2.3.1 MEASURED FLOW AND TEMPERATURE DATA SOURCES

Historical water temperature data were obtained from two PCWA water temperature stations (14-A and 3-A). These two water temperature stations are located downstream of the Pacific Gas and Electric Company's (PG&E) Wise Powerhouse release and about 5 miles upstream of the Newcastle Powerhouse forebay.

2.3.2 DEVELOPMENT OF INFLOW WATER TEMPERATURE OVER THE PERIOD OF RECORD (WY 1922-2003)

The South Canal inflow water temperatures over the period of record were estimated based on the 2006-2012 monthly averaged water temperatures measured at the two water temperature stations (14-A and 3-A).

2.3.3 RESULTS

Figure 8 shows the daily average water temperatures upstream of the Newcastle Powerhouse for each year and the monthly average water temperature for both stations (all years combined; orange line). The mean monthly temperatures used over the full POR (1922-2003) are provided in Table 5. These inflow temperatures typically do not change under various modeling scenarios.

3.0 TABLES

Table 1. Data Sources for the Folsom Reservoir Inflow Water Temperature Analyses.

River Reach and Parameter / Station Name	Data Sources				
	Operator	Station Number	Location (lat/long)	Period of Record Available	Period of Record Used in Regression Analyses
North Fork American River					
Flow Stations					
NF American R at North Fork Dam CA	USGS CDEC	USGS 11427000 CDEC-NFD	38.93611°N 121.0228°W	10/1/1941-present;	7/1999-5/2015
MF American R near Foresthill CA	USGS CDEC	USGS 11433300 CDEC-OXB	39.00611°N 120.7597°W	10/1/1958-present	
Water Temperature Stations					
NF American River at Auburn Dam	USGS CDEC	USGS 11433790 CDEC-NFA	38.85200°N 121.05700°W	7/21/1999-present	7/1999-05/2015
MF24.3 Water Temperature Logger	PCWA[1]	PCWA MF24.3	39.00611°N 120.7597°W	11/4/2003-10/30/2008	11/4/2003-10/9/2008
South Fork American River					
Flow Stations					
South Fork American River near Placerville	USGS CDEC	USGS 11444500 CDEC-CBR	38.77111°N 120.8153°W	10/1/1911-present	8/1999-5/2015
Water Temperature Stations					
South Fork American River near Pilot Hill	USGS	USGS 11446030 CDEC-ARP	38.76306°N 121.0072°W	8/4/1999-present	8/1999-5/2015
Below Chili Bar	PG&E[2]	PG&E UNIT64	38.77111°N 120.8153°W	7/9/2002-10/18/2004	7/9/2002-10/18/2004
South Canal					
Water Temperature Station					
Downstream of the NID buy point	PCWA	PCWA 14-A	~38.888453°N 121.102597°W	8/4/2006-12/31/2012	Entire data record
Downstream of the NID South Canal buy point	PCWA	PCWA 3-A	~38.888453 N 121.102597 W	1/1/2005-12/31/2012	
American River Watershed					
Air Temperature Meteorological Stations					
CIMIS at Fair Oaks	CIMIS	CIMIS-131	38.65056°N 121.2181°W	4/18/1997-present, daily	4/18/1997-5/2015

Abbreviations:
CIMIS: California Irrigation Management Information System
USGS: United States Geological Survey
CDEC: California Data Exchange Center

[1] Water temperatures were monitored in support of the Middle Fork Project relicensing activities. These data were used in the development of the water temperature regressions.

[2] Water temperatures were monitored in support of the PG&E Chili Bar project relicensing studies below Chili Bar. These data were used in the development of the water temperature regressions.

Table 2. Daily Regression Equations to Model North Fork American River Folsom Reservoir Inflow Water Temperatures based on Daily Average North Fork and Middle Fork American River Flows and Daily Average Local Air Temperature (based on July 1999-May 2015 data).

Month	Regression Equation	R^2
x_{UNFA} = Upper North Fork American River Mean Daily Flow (cfs) x_{MFA}= Middle Fork American River Mean Daily Flow (cfs) X_{AIR} = Mean Daily Air Temperature (^oF) y = North Fork American River Mean Daily Temperature (°F) upstream of Folsom Reservoir		
Jan	y=31.82015 + 2.51788*LOGXUNFA - 0.55882*LOGXMFA + 0.14874*XAIR	0.38
Feb	y=31.28552 + 2.58066*LOGXUNFA - 2.56160*LOGXMFA + 0.28303*XAIR	0.37
Mar	y=44.03115 + 3.00982*LOGXUNFA - 6.80179*LOGXMFA + 0.30140*XAIR	0.57
Apr	y=63.25327 + 3.02199*LOGXUNFA - 11.67280*LOGXMFA +0.26183*XAIR	0.74
May	y=77.96225 - 6.21275*LOGXUNFA - 6.68463*LOGXMFA + 0.28473*XAIR	0.80
Jun	y=89.38163 - 2.75058*LOGXUNFA - 10.09773*LOGXMFA + 0.15191*XAIR	0.82
Jul	y=101.90264 + 2.74989*LOGXUNFA - 17.16170*LOGXMFA + 0.09592*XAIR	0.70
Aug	y=99.95267 - 0.30042*LOGXUNFA - 13.83532*LOGXMFA + 0.04660*XAIR	0.48
Sep	y=85.78494 - 5.17625*LOGXUNFA - 8.47934*LOGXMFA + 0.11504*XAIR	0.51
Oct	y=52.71800 + 0.78575*LOGXUNFA - 5.62430*LOGXMFA + 0.30419*XAIR	0.62
Nov	y=35.19889 + 0.48433*LOGXUNFA - 1.29713*LOGXMFA + 0.36471*XAIR	0.52
Dec	y=27.31532 - 0.57265*LOGXUNFA + 3.28619*LOGXMFA + 0.23489*XAIR	0.32

Regression Variables:

x_{UNFA} = Upper North Fork American River Mean Daily Flow (cfs) at the North Fork Dam, CA (USGS gage no. 11427000)

x_{MFA}= Middle Fork American River Mean Daily Flow (cfs) near Foresthill, CA (USGS Gage 11433300 until Sept 20 2014)(CDEC OXB starting Oct 1, 2014)X_{AIR} = Air Temperature (°F) at Fair Oaks (CIMIS-131)

y = North Fork American River Mean Daily Temperature (°F) upstream of Folsom Reservoir

Table 3. Monthly Regression Equations to Model North Fork American River Folsom Reservoir Inflow Water Temperatures based on Monthly Average North Fork and Middle Fork American River Flows and Monthly Average Local Air Temperature (based on July 1999-May 2015 data).

Month	Regression Equation	R^2
x_{UNFA} = Upper North Fork American River Mean Monthly Flow (cfs) x_{MFA}= Middle Fork American River Mean Monthly Flow (cfs) X_{AIR} = Mean Monthly Air Temperature (^oF) y = North Fork American River Mean Monthly Temperature (°F) upstream of Folsom Reservoir		
Jan	y=27.04771 + 2.81189*LOGXUNFA - 0.47640*LOGXMFA + 0.22371*XAIR	0.41[1]
Feb	y=5.75243 - 0.19558*LOGXUNFA - 0.60664*LOGXMFA + 0.83013*XAIR	0.84
Mar	y=26.99404 + 1.05901*LOGXUNFA - 4.49126*LOGXMFA + 0.58994*XAIR	0.94
Apr	y=60.67131 - 5.84327*LOGXUNFA - 4.03140*LOGXMFA + 0.37980*XAIR	0.95
May	y=54.68841 - 8.46923*LOGXUNFA - 2.37403*LOGXMFA + 0.55234*XAIR	0.95
Jun	y=102.01746 - 1.00915*LOGXUNFA - 13.59212*LOGXMFA + 0.05733*XAIR	0.94
Jul	y=128.91632 + 5.08863*LOGXUNFA - 24.95334*LOGXMFA - 0.03006*XAIR	0.85
Aug	y=113.54756 - 1.68439*LOGXUNFA - 10.14214*LOGXMFA - 0.23823*XAIR	0.44[1]
Sep	y=112.39111 - 5.79512*LOGXUNFA - 9.37626*LOGXMFA - 0.20727*XAIR	0.51[1]
Oct	y=39.95207 - 1.73580*LOGXUNFA - 2.56164*LOGXMFA + 0.46824*XAIR	0.61[1]
Nov	y=31.38417 + 0.24565*LOGXUNFA - 0.46914*LOGXMFA +0.40474*XAIR	0.41[1]
Dec	y=21.28772 - 0.64300*LOGXUNFA + 2.63127*LOGXMFA + 0.40135*XAIR	0.48[1]

Regression Variables:

x_{UNFA} = Upper North Fork American River Mean Monthly Flow (cfs) at the North Fork Dam, CA (USGS gage no. 11427000)

x_{MFA}= Middle Fork American River Mean Monthly Flow (cfs) near Foresthill, CA (USGS Gage 11433300 until Sept 20 2014)(CDEC OXB starting Oct 1, 2014)

X_{AIR} = Air Temperature (°F) at Fair Oaks (CIMIS-131)

y = North Fork American River Mean Monthly Temperature (°F) upstream of Folsom Reservoir

[1]Low r-squared values are the result of a narrow range in temperatures in these months. These regressions represent the average water temperature.

Table 4. Monthly Regression Equations to Model South Fork American River Folsom Reservoir Inflow Water Temperatures based on Monthly Average South Fork American River Flows and Local Air Temperature (based on August 1999-May 2015 data).

Month	Regression Equation	R^2
y = Predicted water temperature (°F) x = South Fork American River mean monthly flow (cfs) Air = Mean monthly air temperature (°F)		
Jan	$y = 20.69984 + 2.91534*\text{Log } X_{SFA} + 0.28960*X_{AIR}$	0.45
Feb	$y = 5.75472 - 0.48212*\text{Log } X_{SFA} + 0.79575*X_{AIR}$	0.75
Mar	$y = 47.13000 - 4.35076*\text{Log } X_{SFA} + 0.26830*X_{AIR}$	0.78
Apr	$y = 65.08803 - 7.54184*\text{Log } X_{SFA} + 0.18307*X_{AIR}$	0.75
May	$y = 62.42750 - 11.48169*\text{Log } X_{SFA} + 0.46790*X_{AIR}$	0.96
Jun	$y = 79.92108 - 12.88612*\text{Log } X_{SFA} + 0.30343*X_{AIR}$	0.94
Jul	$y = 77.94852 - 11.71646*\text{Log } X_{SFA} + 0.28672*X_{AIR}$	0.79
Aug	$y = 105.01906 - 16.61535*\text{Log } X_{SFA} + 0.08482*X_{AIR}$	0.79
Sep	$y = 88.16222 - 10.85794*\text{Log } X_{SFA} + 0.04886*X_{AIR}$	0.56
Oct	$y = 59.29323 - 7.31408*\text{Log } X_{SFA} + 0.28409*X_{AIR}$	0.61
Nov	$y = 30.69185 - 0.47584*\text{Log } X_{SFA} + 0.40891*X_{AIR}$	0.31[1]
Dec	$y = 9.20239 - 0.14844*\text{Log } X_{SFA} + 0.77211*X_{AIR}$	0.65

Regression Variables:

x = South Fork American River mean monthly flow (cfs) near Placerville, CA (USGS Gage 11444500 through Sept 30 2014) (CDEC CBR from Oct 1 2015)

y =South Fork American River Mean Monthly Temperature (°F) near Pilot Hill, CA (USGS gage no. 11446030)

Air = Mean monthly air temperature at Fair Oaks (CIMIS-131) (°F)

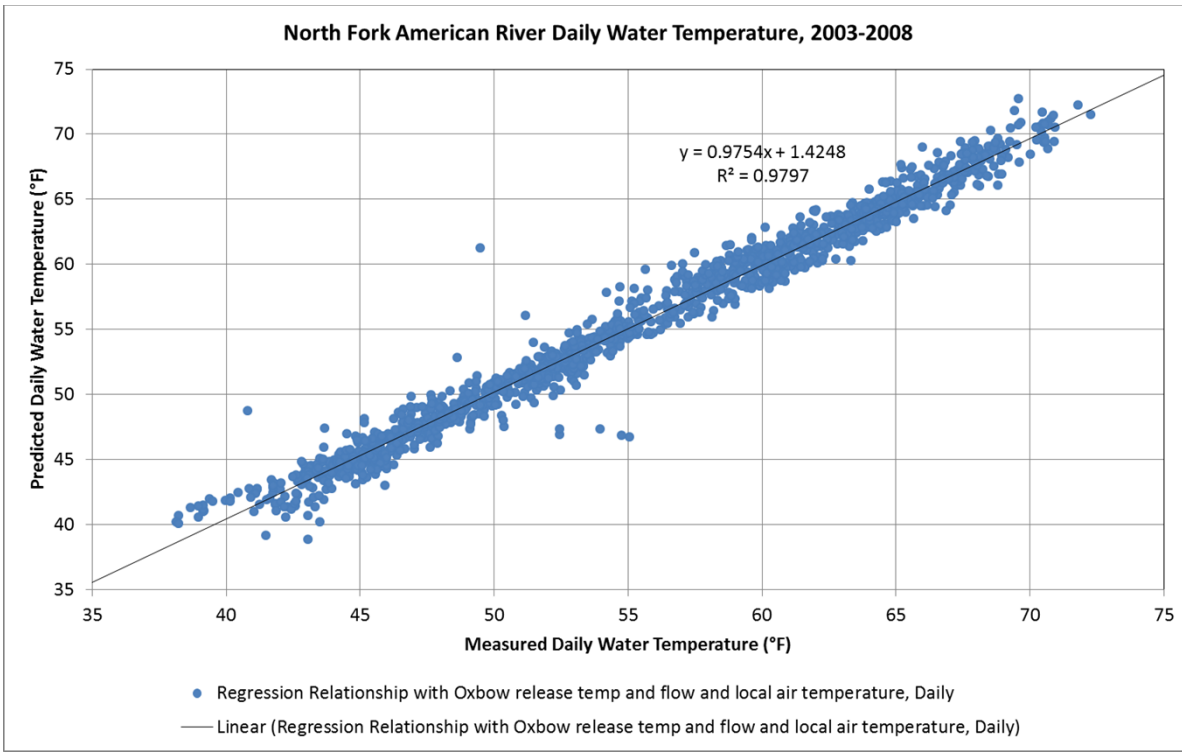
[1] Low r-squared values are the result of a narrow range in temperatures in these months. These regressions represent the average water temperature.

Table 5. South Canal Monthly Average Folsom Reservoir Inflow Water Temperatures.

Month	Monthly Average Temperature[1] (°F)
Jan	46.02
Feb	46.48
Mar	48.94
Apr	49.83
May	52.32
Jun	55.61
Jul	59.43
Aug	63.05
Sep	64.82
Oct	60.24
Nov	53.48
Dec	48.53

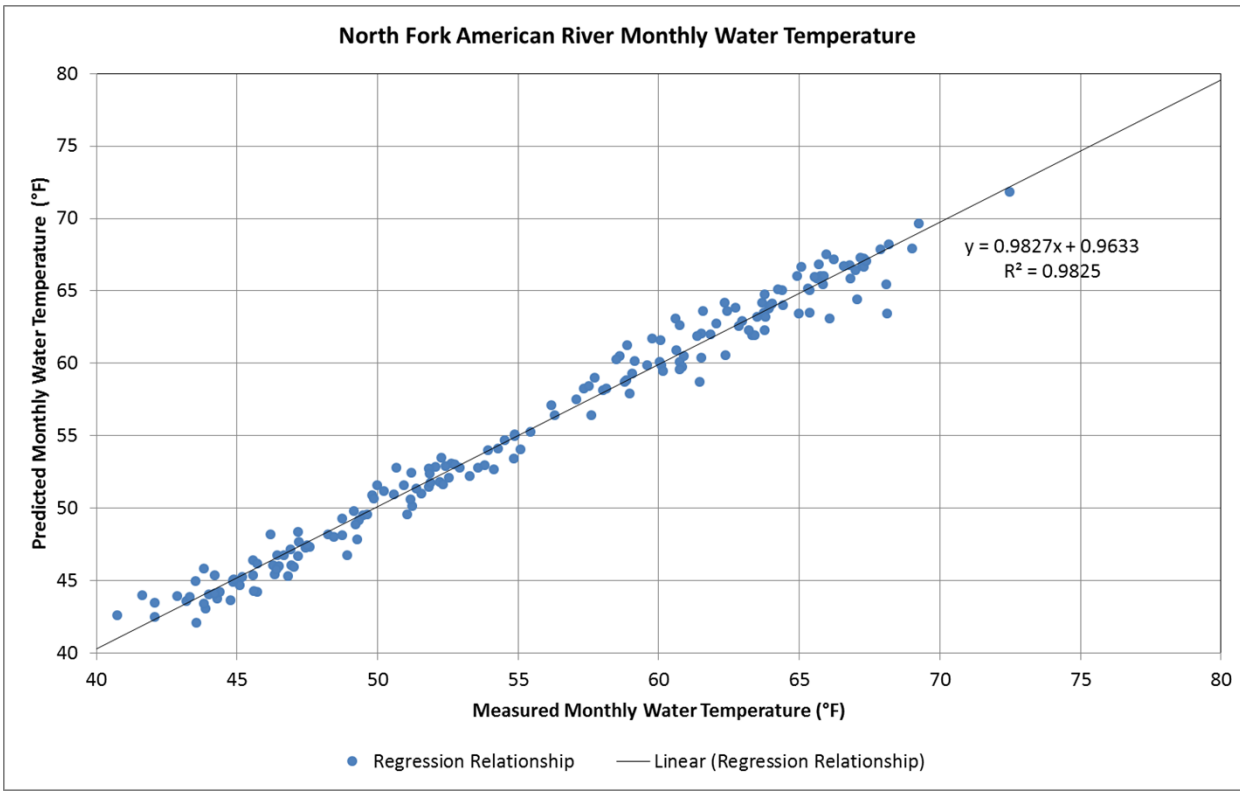
[1] Monthly average water temperature measured at station 14-A (8/4/2006-12/31/2012) and station 3-A (1/1/2005-12/31/2012).

4.0 FIGURES



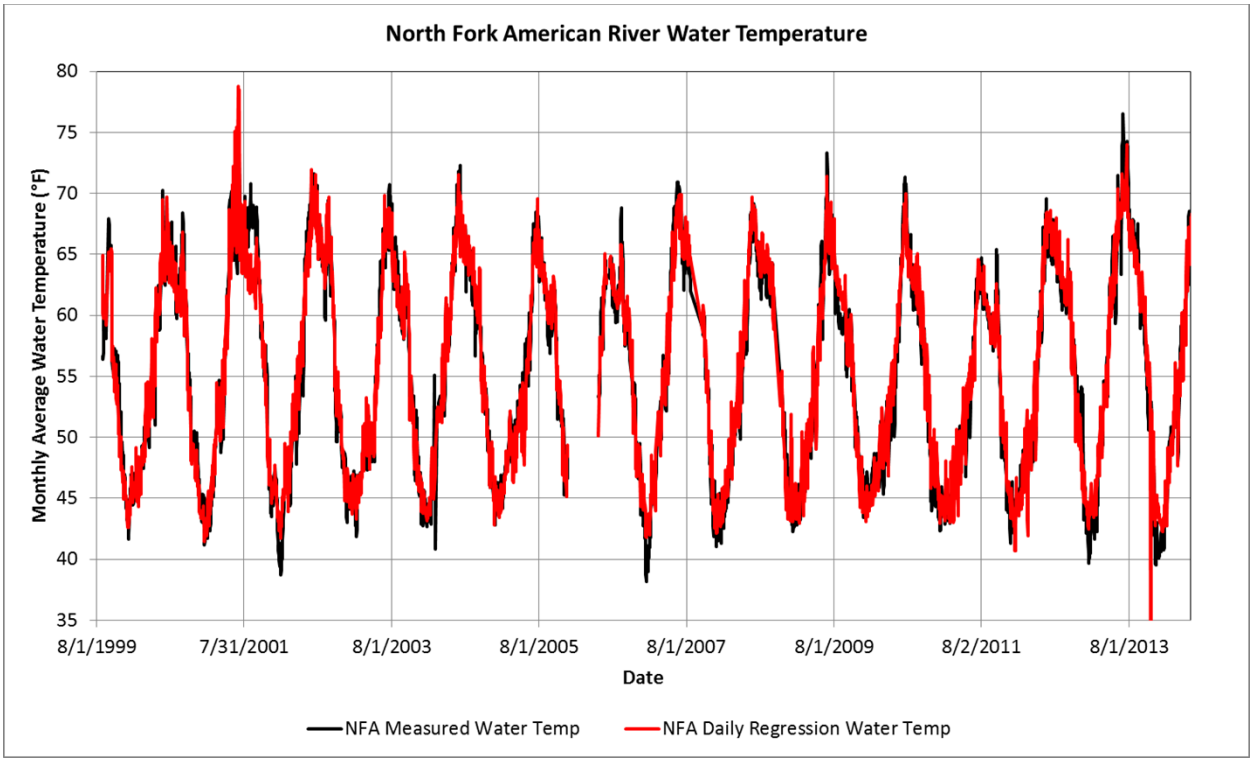
Data sources: Measured water temperature: NFAR daily average water temperature at Auburn Dam (ºF) (USGS/CDEC gage no. 11433790/CDEC-NFA); Modeled (regression) water temperature: Daily average local air temperature (CIMIS-131 (ºF)); NFAR daily average flow (cfs) (USGS gage no. 11427000); MFAR daily average flow (cfs) (USGS Gage 11433300 until Sept 20 2014)(CDEC OXB starting Oct 1, 2014); MF24.3 daily average water temperature (ºF).

Figure 1. 2003-2008 Daily Measured versus Modeled (Regression) North Fork American River Folsom Reservoir Inflow Water Temperature based on Mean Daily North and Middle Fork American River Flows, Mean Daily Air Temperature, and Middle Fork American River Mean Daily Water Temperature at MF24.3.



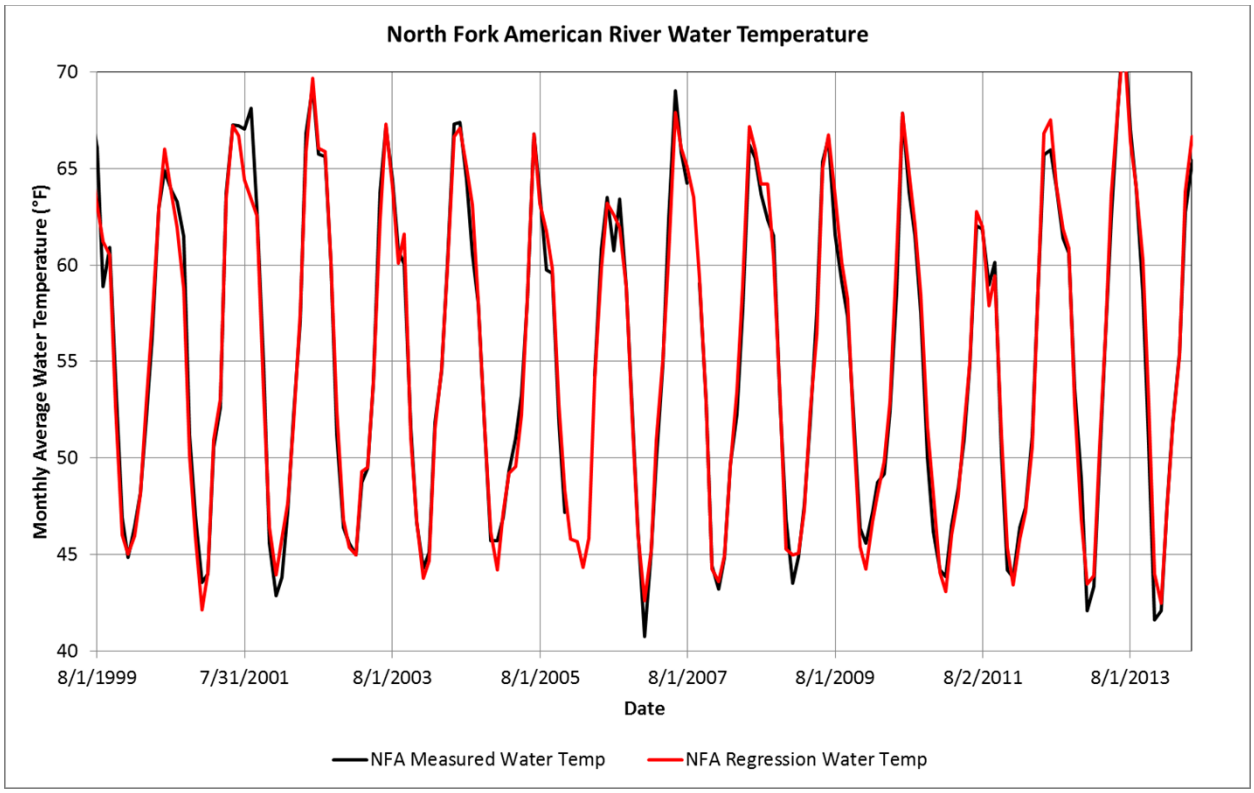
Data sources: Measured water temperature: NFAR mean monthly temperature (°F) upstream of Folsom Reservoir (USGS gage no. 11433790/CDEC station CDEC-NFA); Modeled (regression) water temperature: NFAR monthly flow (cfs) (USGS gage no. 11427000), MFAR mean monthly flow (cfs) (USGS Gage 11433300 until Sept 20 2014) (CDEC OXB starting Oct 1, 2014), and monthly average local air temperature (°F) (CIMIS-131).

Figure 2. 1999-2015 Measured versus Modeled (Multiple Regression) North Fork American River Monthly Water Temperature into Folsom Reservoir based on Mean Monthly North and Middle Fork American Flows and Mean Monthly Air Temperature.



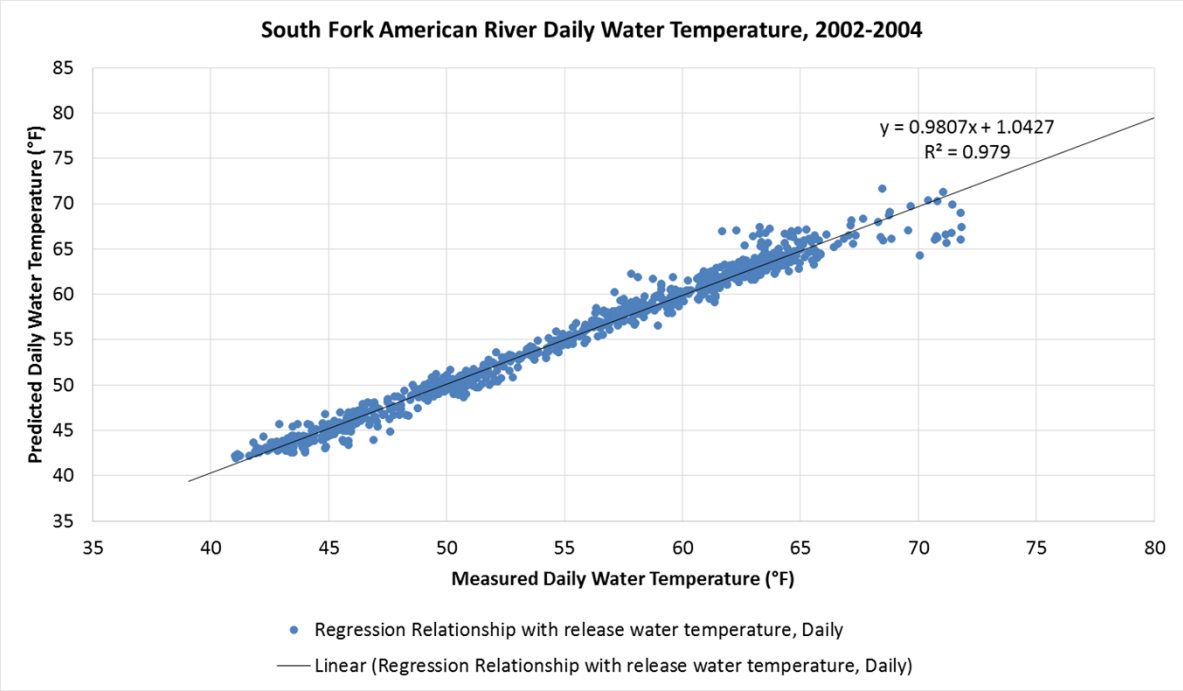
Data sources: Measured water temperature: North Fork American River mean daily water temperature (°F) upstream of Folsom Reservoir (USGS gage no. 11433790/CDEC station NFA); Modeled (regression) water temperature: NFAR mean daily flow (cfs) ((USGS gage no. 11427000), MFAR mean daily flow (cfs) (USGS Gage 11433300 until Sept 20 2014) (CDEC OXB starting Oct 1, 2014), and daily average local air temperature (°F) (CIMIS-131).

Figure 3. 1999-2014 Time Series of Measured and Modeled (Multiple Regression) North Fork American River Daily Water Temperature into Folsom Reservoir based on Mean Daily North and Middle Fork American Flows and Mean Daily Air Temperature.



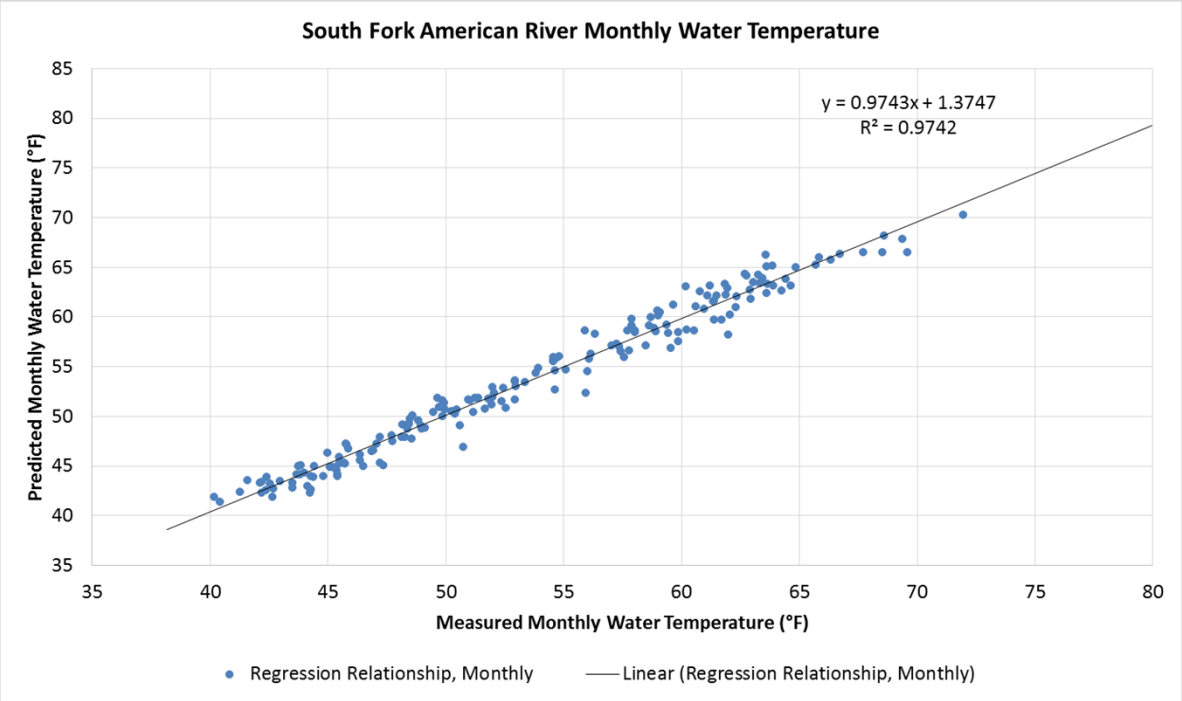
Data sources: Measured water temperature: North Fork American River mean monthly water temperature (°F) upstream of Folsom Reservoir (USGS gage no. 11433790/CDEC station NFA); Modeled (regression) water temperature: NFAR mean monthly flow (cfs) ((USGS gage no. 11427000), MFAR mean monthly flow (cfs) (USGS Gage 11433300 until Sept 20 2014) (CDEC OXB starting Oct 1, 2014), and monthly average local air temperature (°F) (CIMIS-131).

Figure 4. 1999-2014 Time Series of Measured and Modeled (Multiple Regression) North Fork American River Monthly Water Temperature into Folsom Reservoir based on Mean Monthly North and Middle Fork American Flows and Mean Monthly Air Temperature.



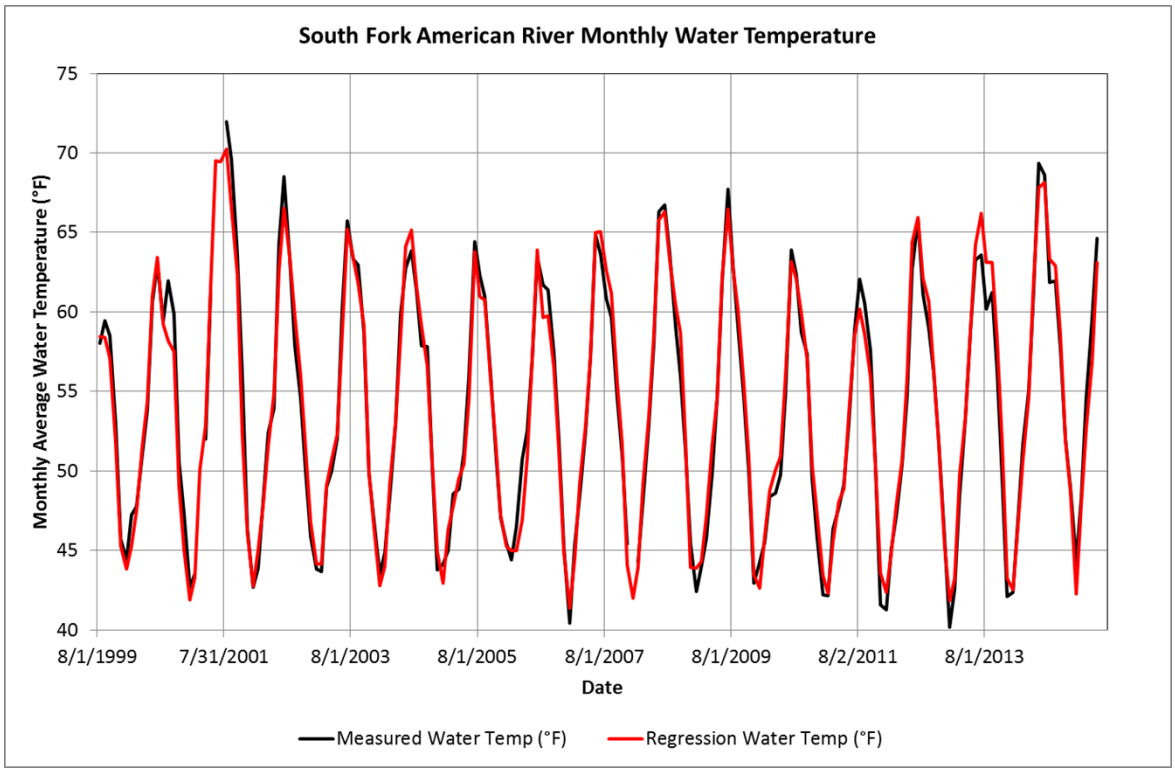
Data sources: Measured water temperature: Daily average SFAR water temperature (°F) (USGS gage no. 11446030); Modeled (regression) water temperature: Daily average local air temperature (°F) (CIMIS-131); daily average SFAR flow (cfs) (USGS gage no. USGS/CDEC gage no. 11444500/CDEC-CBR); daily average SFAR water temperature below Chili Bar Dam (°F) (PG&E UNIT64)

Figure 5. 2002-2004 Measured versus Modeled (Multiple Regression) South Fork American River Daily Water Temperature into Folsom Reservoir based on Mean Daily Air Temperature, Mean Daily South Fork American River Flows, and Mean Daily Water Temperature in the South Fork American River below Chili Bar Dam.



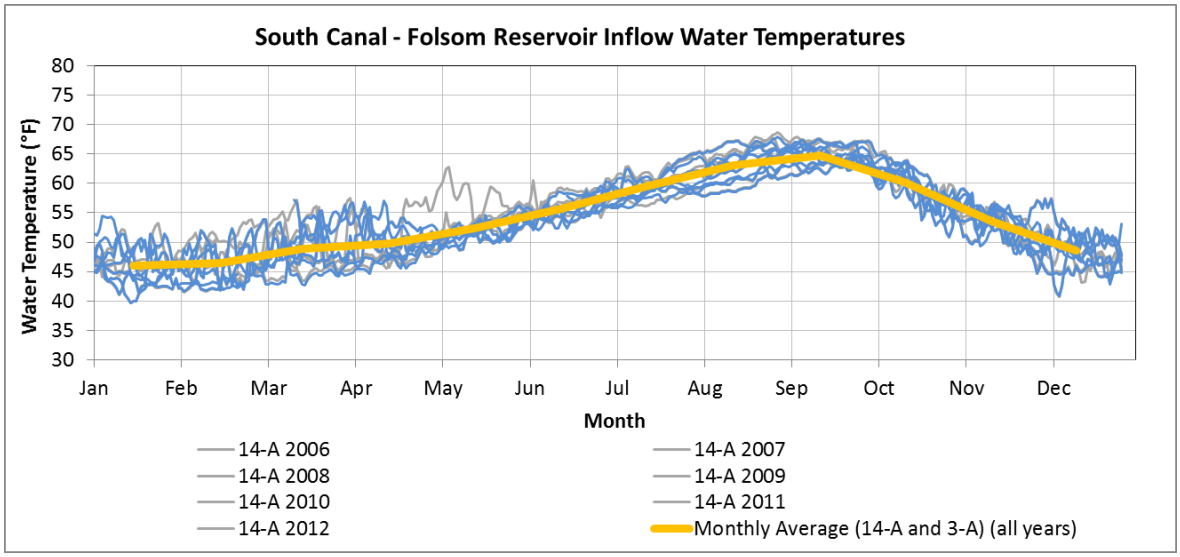
Data sources: Measured water temperature: Monthly average water temperature (°F) (USGS gage no. 11446030). Modeled (regression) water temperature: Monthly average air temperature (°F) (CIMIS-131) and monthly average flow at Chili Bar (cfs) (USGS gage no. USGS/CDEC gage no. 11444500/CDEC-CBR).

Figure 6. 1999-2015 Measured versus Modeled (Multiple Regression) South Fork American River Monthly Water Temperature into Folsom Reservoir based on Mean Monthly South Fork American River Flows below Chili Bar and Mean Monthly Air Temperature.



Data sources: Measured Temperatures: South Fork American River monthly average water temperature (°F) (USGS gage no. 11446030). Modeled (regression) water temperature: Monthly average air temperature (°F) (CIMIS-131) and monthly average flow at Chili Bar (cfs) (USGS gage no. 11444500).

Figure 7. 1999-2015 Time Series of Monthly Measured and Modeled (Multiple Regression) South Fork American River Temperature.



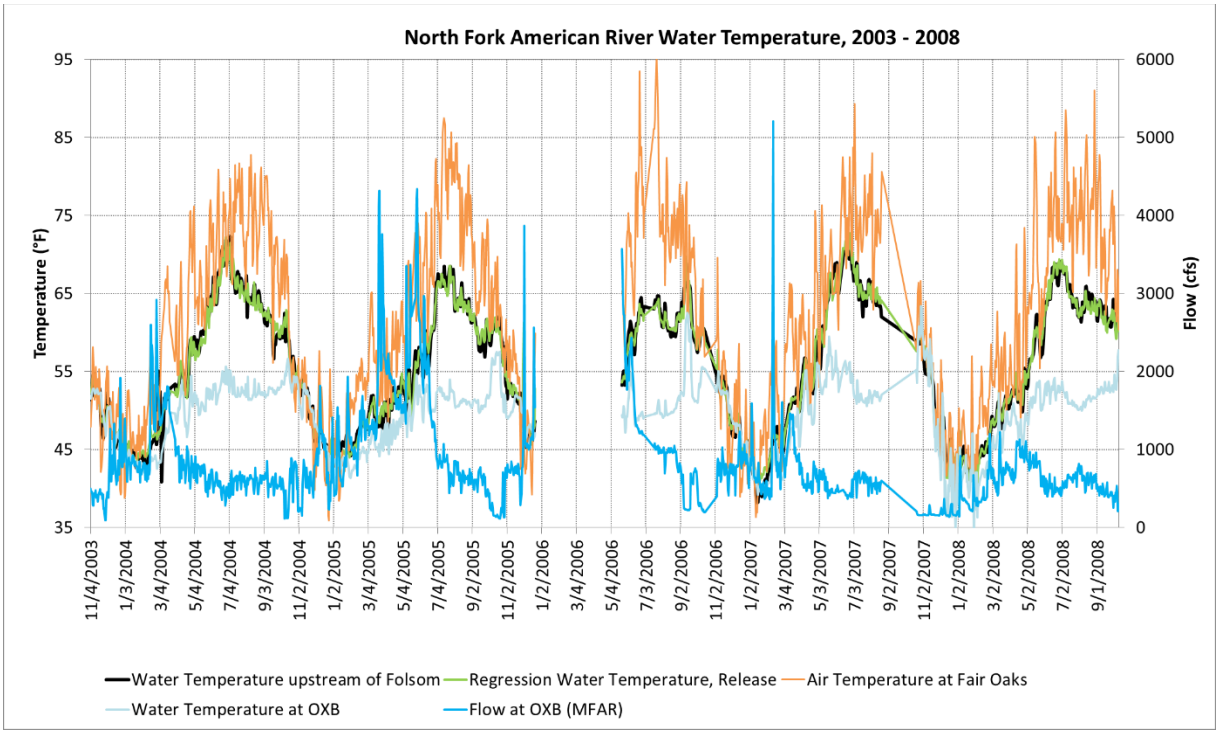
Data sources and POR: station 14-A (8/4/2006-12/31/2012) and station 3-A (1/1/2005-12/31/2012).

Figure 8. South Canal Daily and Monthly Water Temperatures Measured at Water Temperature Station 14-A and 3-A upstream of the Newcastle Powerhouse.

5.0 MAPS

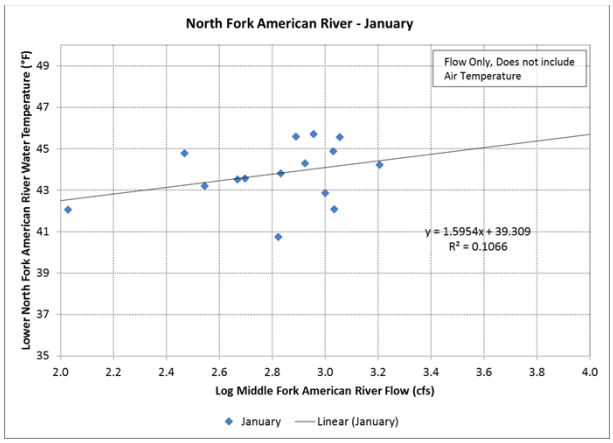
TECHNICAL MEMORANDUM 4 ATTACHMENT A

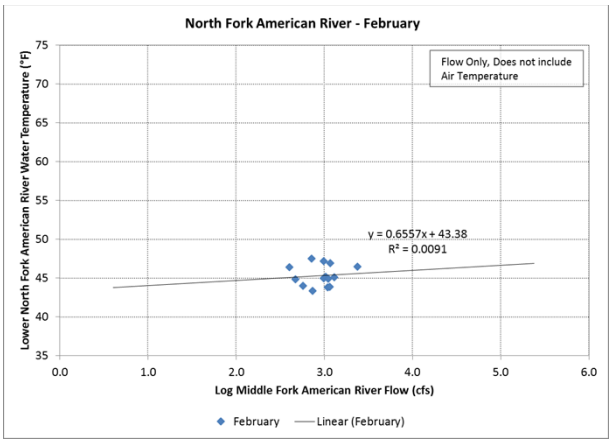
North Fork American River Water Temperature and Flow Regression Data

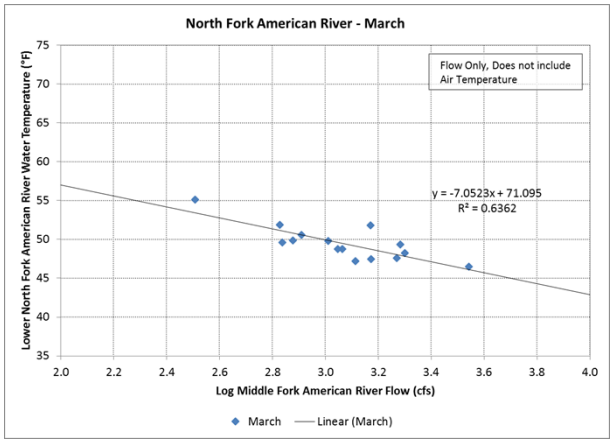


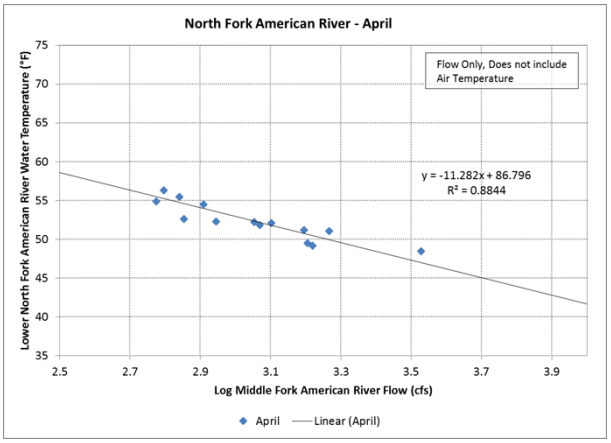
Data sources: Daily average NFAR water temperature (°F) (USGS/CDEC gage no. 11433790/CDEC-NFA); Daily average local air temperature (°F) (CIMIS-131); MFAR daily average flow (cfs) (USGS Gage 11433300 until Sept 20 2014) (CDEC OXB starting Oct 1, 2014); MF24.3 (°F)

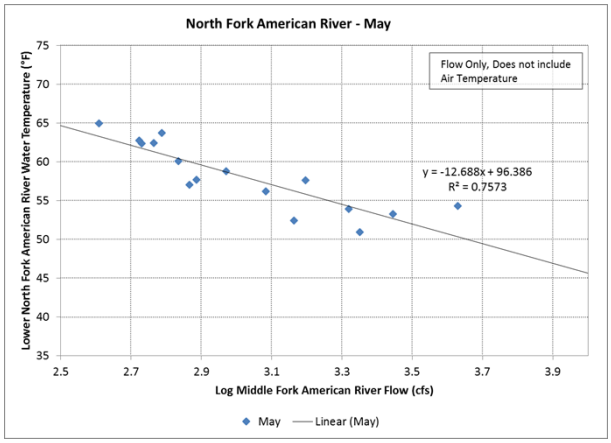
Attachment A Figure 1. 2003-2008 Measured versus Modeled (Multiple Regression) North Fork American River Daily Water Temperature into Folsom Reservoir based on Mean Daily North and Middle Fork American River Flows, Mean Daily Air Temperature, and Middle Fork American River Mean Daily Water Temperature at Oxbow Powerhouse (MF24.3).

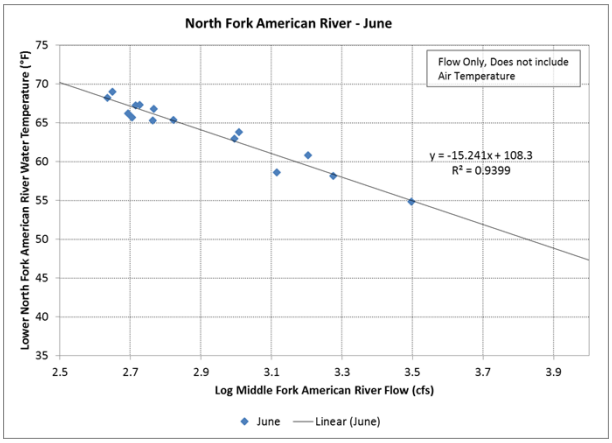

North Fork American River - January
Flow Only, Does not include Air Temperature
y = 1.5954x + 39.309
R² = 0.1066
Lower North Fork American River Water Temperature (°F)
Log Middle Fork American River Flow (cfs)
January
Linear (January)

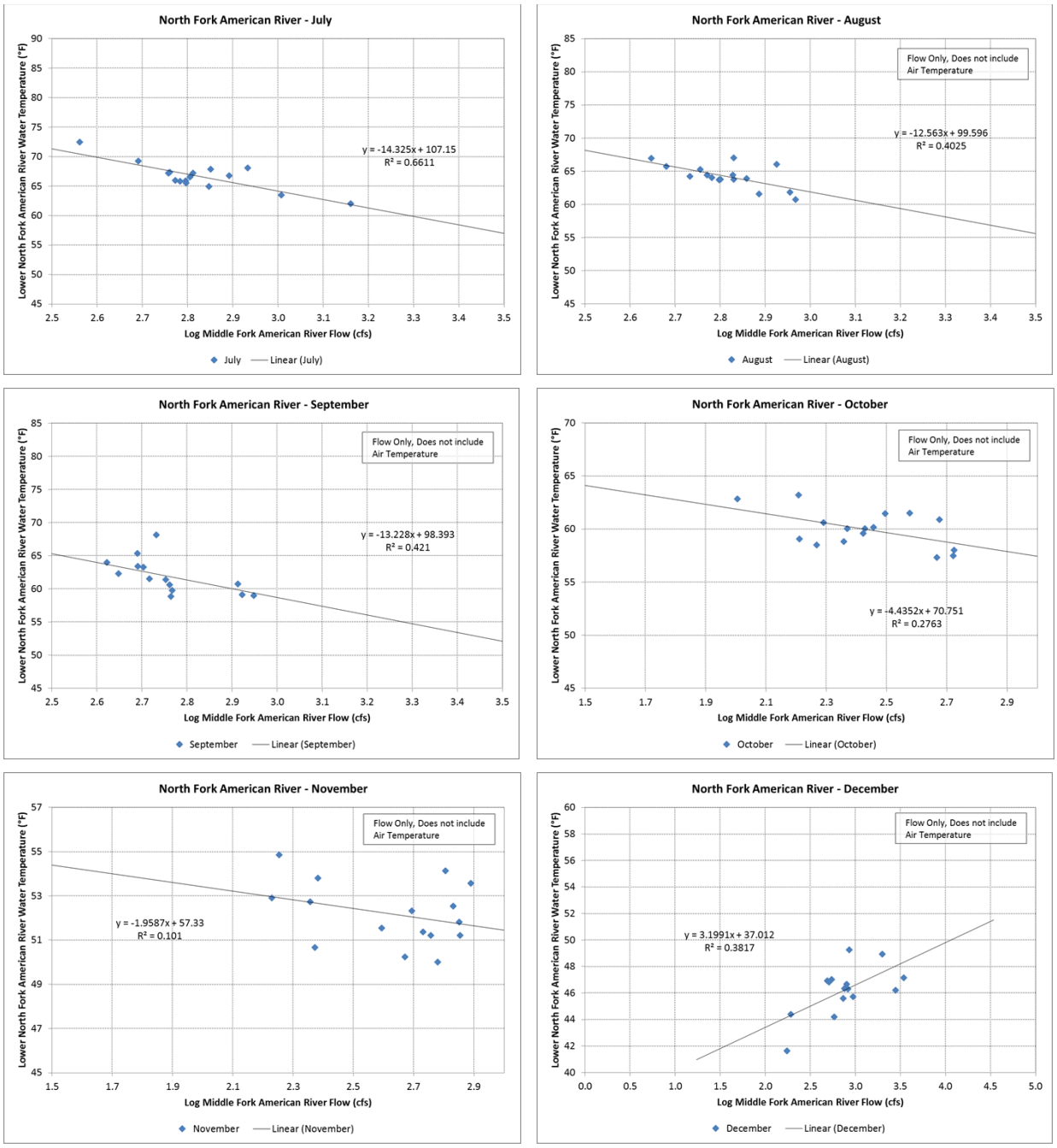

North Fork American River - February
Flow Only, Does not include Air Temperature
y = 0.6557x + 43.38
R² = 0.0091
Lower North Fork American River Water Temperature (°F)
Log Middle Fork American River Flow (cfs)
February
Linear (February)


North Fork American River - March
Flow Only, Does not include Air Temperature
y = -7.0523x + 71.095
R² = 0.6362
Lower North Fork American River Water Temperature (°F)
Log Middle Fork American River Flow (cfs)
March
Linear (March)


North Fork American River - April
Flow Only, Does not include Air Temperature
y = -11.282x + 86.796
R² = 0.8844
Lower North Fork American River Water Temperature (°F)
Log Middle Fork American River Flow (cfs)
April
Linear (April)


North Fork American River - May
Flow Only, Does not include Air Temperature
y = -12.688x + 96.386
R² = 0.7573
Lower North Fork American River Water Temperature (°F)
Log Middle Fork American River Flow (cfs)
May
Linear (May)


North Fork American River - June
Flow Only, Does not include Air Temperature
y = -15.241x + 108.3
R² = 0.9399
Lower North Fork American River Water Temperature (°F)
Log Middle Fork American River Flow (cfs)
June
Linear (June)

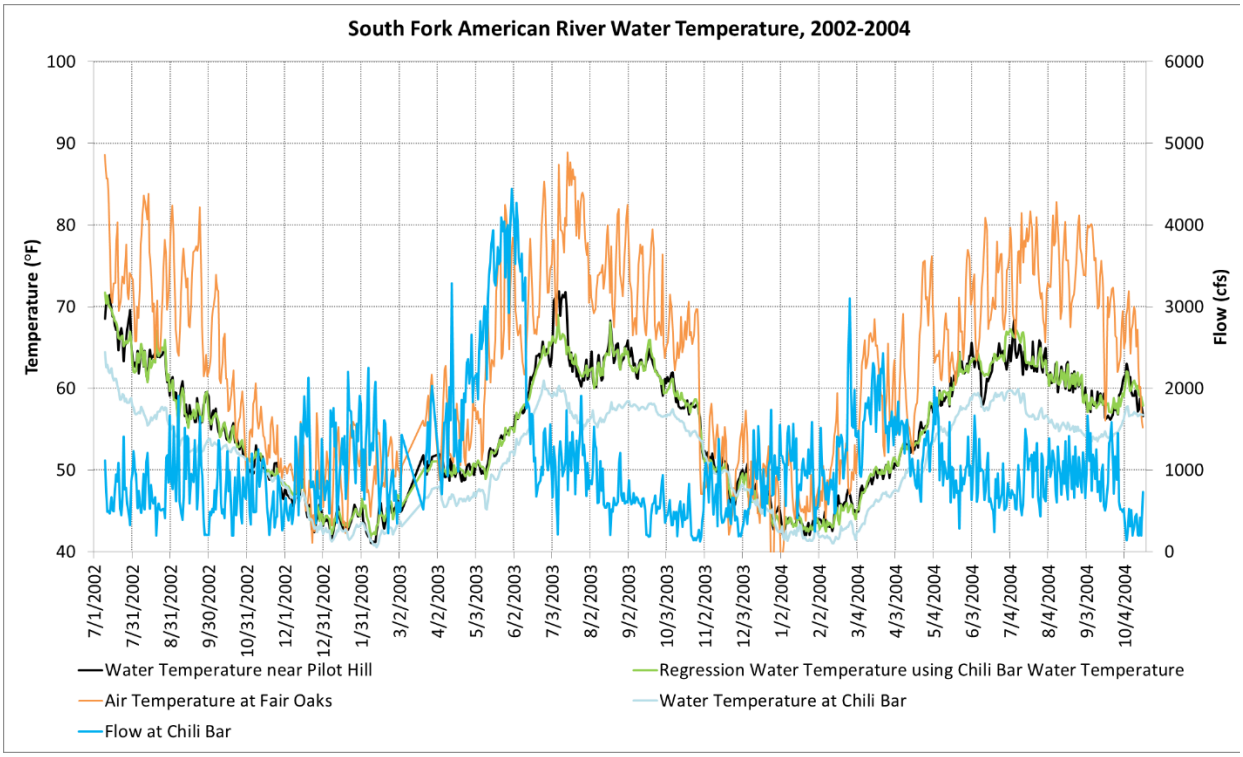


Data source:
NFAR mean monthly temperature (°F) upstream of Folsom Reservoir (USGS gage no. 11433790/CDEC station CDEC-NFA)
MFAR daily average flow (cfs) (USGS GAGE 11433300 until Sept 20 2014) (CDEC OXB starting Oct 1, 2014)

Attachment A Figure 2. 1999-2014 North Fork American River Monthly Flow versus Monthly Water Temperature.

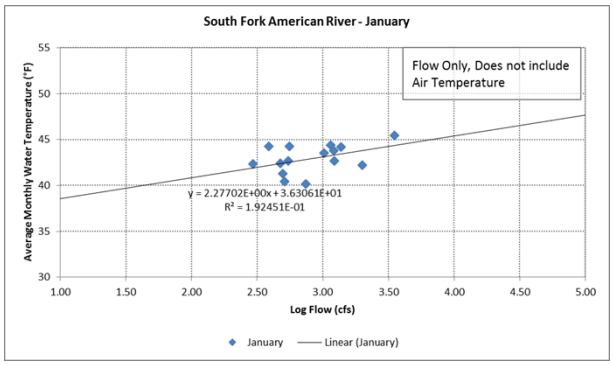
TECHNICAL MEMORANDUM 4 ATTACHMENT B

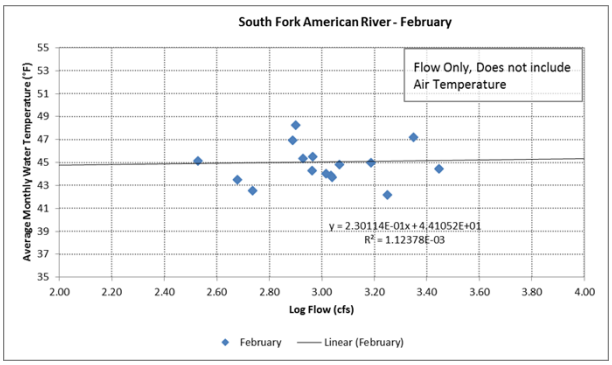
South Fork American River Water Temperature and Flow Regression Data

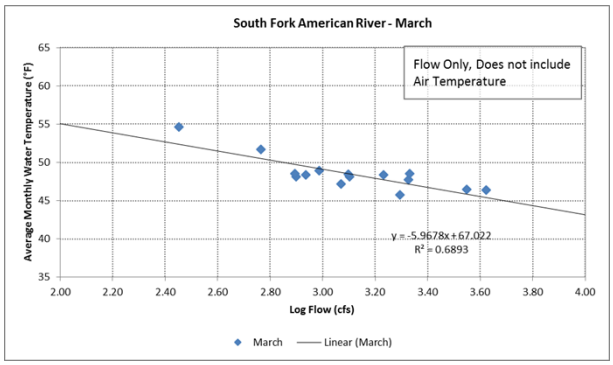


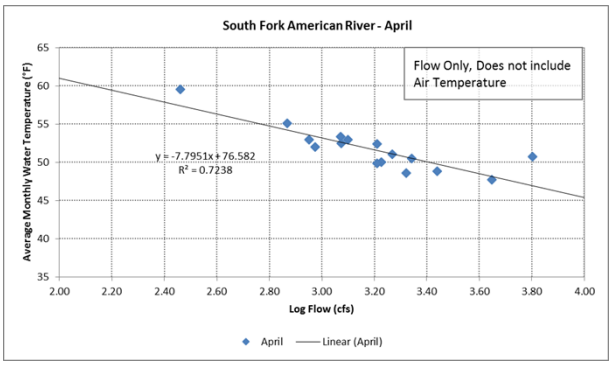
Data sources: Daily average water temperature (°F) (USGS gage no. 11446030); daily average local air temperature (°F) (CIMIS-131); daily average flow at Chili Bar (cfs) (USGS gage no. 11444500); daily average SFAR water temperature below Chili Bar (°F) (PG&E unit no. 64)

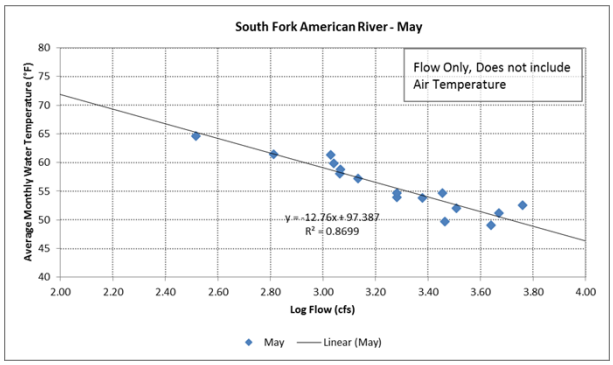
Attachment B Figure 1. 2002-2004 Measured versus Modeled (Regression) South Fork American River Daily Water Temperature into Folsom Reservoir based on Mean Daily South Fork American River Flows and Water Temperature below Chili Bar and Mean Daily Air Temperature.

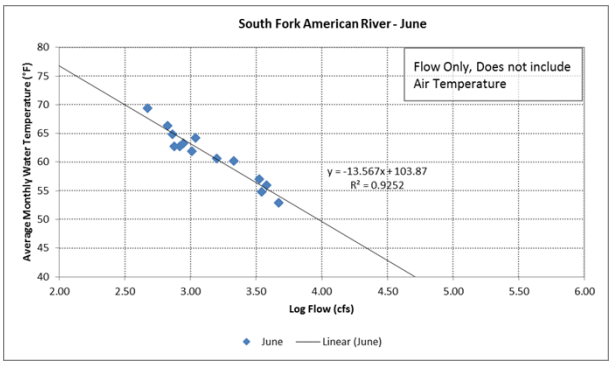

South Fork American River - January
Flow Only, Does not include Air Temperature
y = 2.27702E+00x + 3.63061E+01
R² = 1.92451E-01
Average Monthly Water Temperature (°F)
Log Flow (cfs)
January
Linear (January)

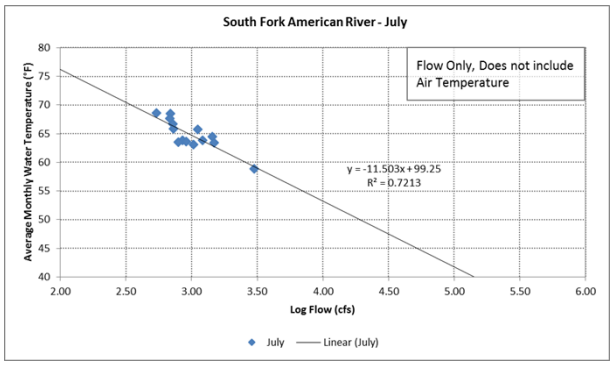

South Fork American River - February
Flow Only, Does not include Air Temperature
y = 2.30114E-01x + 4.41052E+01
R² = 1.12378E-03
Average Monthly Water Temperature (°F)
Log Flow (cfs)
February
Linear (February)

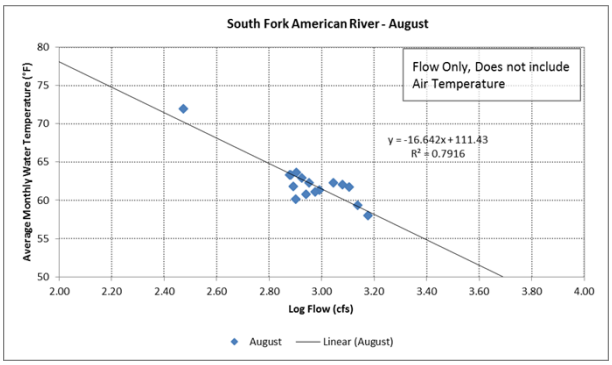

South Fork American River - March
Flow Only, Does not include Air Temperature
y = -5.9678x + 67.022
R² = 0.6893
Average Monthly Water Temperature (°F)
Log Flow (cfs)
March
Linear (March)

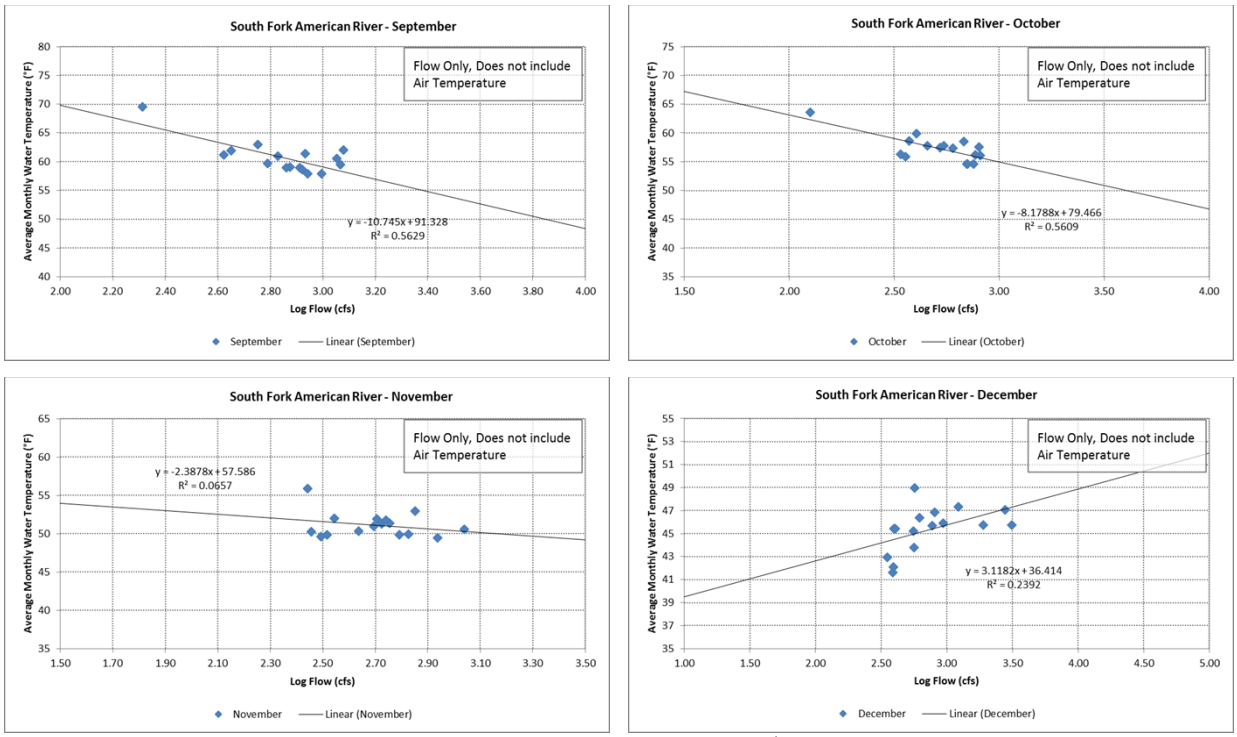

South Fork American River - April
Flow Only, Does not include Air Temperature
y = -7.7951x + 76.582
R² = 0.7238
Average Monthly Water Temperature (°F)
Log Flow (cfs)
April
Linear (April)


South Fork American River - May
Flow Only, Does not include Air Temperature
y = -12.76x + 97.387
R² = 0.8699
Average Monthly Water Temperature (°F)
Log Flow (cfs)
May
Linear (May)


South Fork American River - June
Flow Only, Does not include Air Temperature
y = -13.567x + 103.87
R² = 0.9252
Average Monthly Water Temperature (°F)
Log Flow (cfs)
June
Linear (June)


South Fork American River - July
Flow Only, Does not include Air Temperature
y = -11.503x + 99.25
R² = 0.7213
Average Monthly Water Temperature (°F)
Log Flow (cfs)
July
Linear (July)


South Fork American River - August
Flow Only, Does not include Air Temperature
y = -16.642x + 111.43
R² = 0.7916
Average Monthly Water Temperature (°F)
Log Flow (cfs)
August
Linear (August)



Data source: Flow: South Fork American River monthly average flow (cfs) near Placerville, CA (USGS gage no. 11444500)/ CDEC Chili Bar gage (CDEC-CBR gage) Water Temperature: South Fork American River monthly average water temperature (°F) near Pilot Hill, CA (USGS gage no. 11446030)

Attachment B Figure 2. 1999-2014 South Fork American River Monthly Flow versus Monthly Water Temperature.

TECHNICAL MEMORANDUM 4 ATTACHMENT C

South Fork American River Folsom Reservoir Inflow Monthly Water Temperatures (WY 1922-2003)

Attachment C Table 1. South Fork American River Folsom Reservoir Monthly Inflow Water Temperatures (WY 1922-2003).

Year	Monthly Water Temperature (°F)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1921												
1922	40	40	46	50	51	54	63	63	60	55	49	44
1923	43	42	49	49	51	58	63	62	59	56	52	43
1924	41	47	51	56	62	64	66	67	62	56	50	40
1925	41	44	48	50	52	59	64	62	59	56	50	43
1926	40	45	50	51	60	68	68	67	60	56	52	43
1927	43	44	47	49	51	56	63	62	59	56	51	43
1928	42	44	46	49	56	65	66	64	59	56	50	41
1929	40	42	49	53	58	63	67	66	60	57	51	46
1930	43	47	48	52	57	64	67	63	59	57	51	44
1931	42	47	51	56	62	63	68	67	62	57	50	44
1932	42	43	49	52	54	58	62	63	60	57	53	40
1933	41	42	50	54	56	60	68	64	60	58	51	44
1934	43	46	50	55	63	69	67	69	62	56	52	45
1935	43	44	47	49	52	57	63	62	59	55	49	44
1936	45	44	48	50	53	56	63	62	59	57	50	43
1937	40	42	47	51	53	61	65	63	59	56	52	45
1938	42	42	45	49	51	54	61	61	59	56	50	46
1939	42	42	49	54	61	68	67	69	60	56	51	47
1940	45	47	47	49	54	62	65	62	59	57	51	49
1941	45	47	48	50	52	58	63	62	59	56	52	48
1942	45	45	48	49	50	55	62	61	59	57	52	47
1943	45	47	46	49	55	59	63	61	59	57	52	47
1944	43	45	49	53	57	62	66	63	59	57	51	47
1945	43	46	47	52	52	61	65	63	59	56	51	47
1946	44	42	48	50	53	61	65	62	59	56	51	46
1947	41	46	49	54	61	66	67	64	59	55	50	45
1948	44	43	48	50	52	56	63	62	59	57	51	44
1949	40	43	47	52	54	64	67	63	59	57	53	45
1950	43	46	48	50	54	57	64	63	59	56	53	49
1951	45	45	47	50	54	62	66	62	59	56	52	46
1952	45	45	46	49	52	52	61	59	58	56	51	47
1953	46	46	49	51	53	55	63	61	59	56	52	47
1954	43	45	47	51	57	65	68	62	59	57	51	45
1955	43	44	50	52	57	62	66	63	59	57	52	49
1956	46	43	48	51	52	56	62	61	59	55	52	45
1957	42	47	48	53	54	61	66	62	59	56	51	46
1958	44	49	46	48	52	55	62	60	59	58	52	50
1959	44	46	51	55	61	68	68	68	59	58	52	46
1960	43	46	49	53	59	68	68	65	60	57	51	46
1961	41	47	50	55	58	68	68	69	60	57	52	45
1962	41	43	48	51	55	61	66	63	59	53	52	46
1963	42	50	48	49	51	59	64	62	59	56	51	43
1964	43	44	49	53	57	63	66	62	59	58	51	50
1965	45	45	48	49	53	58	63	60	59	56	52	42
1966	43	44	49	52	59	70	67	66	59	57	53	47
1967	45	44	47	49	52	53	61	61	58	56	53	44
1968	42	48	49	54	59	68	67	64	59	56	52	45
1969	45	43	47	49	53	55	63	62	58	55	52	49
1970	47	48	48	51	57	61	67	62	59	56	52	46
1971	43	43	47	51	52	57	63	61	59	55	51	43
1972	41	45	48	53	56	64	66	63	59	55	50	41
1973	45	46	47	51	54	62	65	62	58	55	50	47
1974	46	45	47	49	53	58	62	60	58	58	52	46
1975	43	47	48	52	54	56	63	62	59	55	51	47
1976	43	47	50	56	63	67	68	66	63	59	52	44
1977	41	46	51	58	61	66	68	67	63	59	52	49
1978	46	47	48	50	55	58	65	62	58	56	51	43
1979	43	44	48	51	54	61	66	64	59	55	51	47

Attachment C Table 1. South Fork American River Folsom Reservoir Monthly Inflow Water Temperatures (WY 1922-2003) (continued).

Year	Monthly Water Temperature (°F)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1980	46	46	47	51	53	58	63	61	58	56	52	46
1981	43	46	49	53	59	66	67	66	63	57	52	48
1982	44	45	45	47	50	55	62	61	57	54	50	45
1983	44	45	45	48	50	51	56	58	58	55	51	49
1984	45	44	48	51	56	59	65	63	59	55	52	45
1985	42	45	48	52	56	65	67	65	58	57	50	43
1986	45	47	46	50	55	60	65	62	58	56	53	46
1987	42	47	49	55	62	66	66	67	63	59	52	47
1988	43	47	51	55	61	65	68	67	63	59	52	45
1989	42	43	47	52	57	62	67	65	59	55	51	42
1990	43	44	49	54	59	64	68	66	62	58	51	41
1991	42	48	48	53	57	61	67	66	62	59	52	45
1992	42	48	50	55	64	66	67	67	63	59	52	45
1993	44	45	48	50	52	58	63	62	58	56	51	45
1994	43	44	50	55	61	66	67	67	63	58	49	44
1995	46	46	45	49	49	53	58	59	58	56	53	49
1996	45	47	47	50	52	59	65	63	58	55	52	49
1997	47	46	48	52	57	60	66	64	59	55	52	45
1998	45	45	47	49	50	52	59	60	57	55	51	43
1999	44	44	46	50	52	57	63	61	58	56	52	45
2000	44	45	47	52	54	62	65	64	60	55	49	44
2001	42	43	50	53	62	70	67	69	59	57	52	46
2002	43	45	47	51	55	63	67	63	59	56	51	47
2003	44	44	49	50	52	60	67	62	59	--		