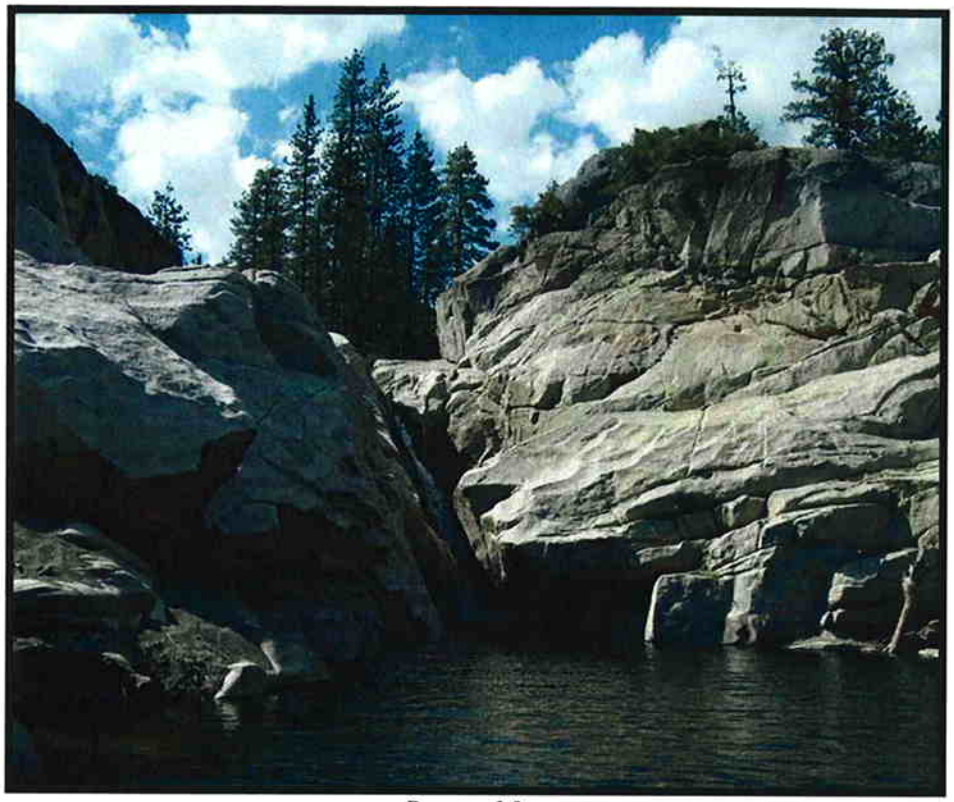
PCWA-L-37

WATER TEMPERATURE MONITORING STATION INSTALLATION PCWA MIDDLE FORK PROJECT

DRAFT REPORT



Prepared for:

Placer County Water Agency
144 Ferguson Road
Auburn, CA 95604

Prepared by:

Surface Water Resources, Inc.
2031 Howe Ave., Suite 110
Sacramento, CA 95825

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WATER TEMPERATURE MONITORING STATION INSTALLATION PCWA MIDDLE FORK PROJECT FERC NO. 2079

Draft Report

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1.0 INTRODUCTION

1.1 MIDDLE FORK PROJECT OPERATIONS

Placer County Water Agency (Agency) constructed the Middle Fork Project (MFP) (FERC Project No. 2079) as a multiple-purpose development designed to conserve and control waters of the Middle Fork American River, the Rubicon River, Long Canyon Creek, and Duncan Creek for irrigation, domestic and commercial purposes, and for hydroelectric power generation. Principal features include two storage and five diversion dams, five powerplants, water transmission facilities, and over twenty miles of tunnels (**Figure 1**). The powerplants have a combined dependable generating capacity of 190,700 kilowatts. The project storage reservoirs, Hell Hole and French Meadows, have a combined capacity of approximately 340,000 acre-feet.

Several water diversions exist within the MFP system. Water from Duncan Creek is diverted to French Meadows Reservoir at the Duncan Creek Dam *via* the Duncan Creek Tunnel. At French Meadows Reservoir, which also stores water from the Middle Fork American River, water is diverted to French Meadows Powerplant and Hell Hole Reservoir *via* the French Meadows Tunnel. The Middle Fork Tunnel then transports water from Hell Hole Reservoir to Stephenson Powerplant and Interbay on the Middle Fork American River. Additional water is captured and diverted into the Middle Fork Tunnel from North and South Long Canyon creeks. Finally, the Ralston Tunnel moves water at Interbay Dam to Ralston Powerplant on the Rubicon River, at which point the water flows into Ralston Afterbay and the Middle Fork American River.

Although MFP operations and maintenance activities occur at discrete locations within the Middle Fork American River watershed, numerous waters bodies within the watershed have the potential to be affected by project operations. Potentially affected riverine environments associated with the MFP may include reaches of Duncan Creek, the Rubicon River, North and South Long Canyon creeks, Long Canyon Creek downstream of the confluence of North and South Long Canyon creeks, the Middle Fork American River, and the North Fork American River downstream of project facilities. Reservoirs potentially affected by the MFP include Hell Hole Reservoir, French Meadows Reservoir and the small impoundments created by Duncan Creek, North Long Canyon Creek, South Long Canyon Creek, Interbay and Ralston Afterbay dams. Furthermore, operations of other entities also have the potential to affect the waters of the MFP including Sacramento Municipal Utility District (South Fork Rubicon River in the Rubicon River watershed) and Georgetown Public Utility District (Pilot Creek in the Rubicon River watershed).

1.2 CONTINUING MFP EVALUATIONS

The Federal Energy Regulatory Commission (FERC) license for the operation of the MFP will expire in February 2013, and the Agency is currently in a preliminary planning phase to renew the license. Section 4.51(f)(3) of 18 CFR requires reporting of certain types of information in the FERC application for license of major hydropower projects, including a discussion of the fish, wildlife and botanical resources in the vicinity of the project. The discussion needs to identify

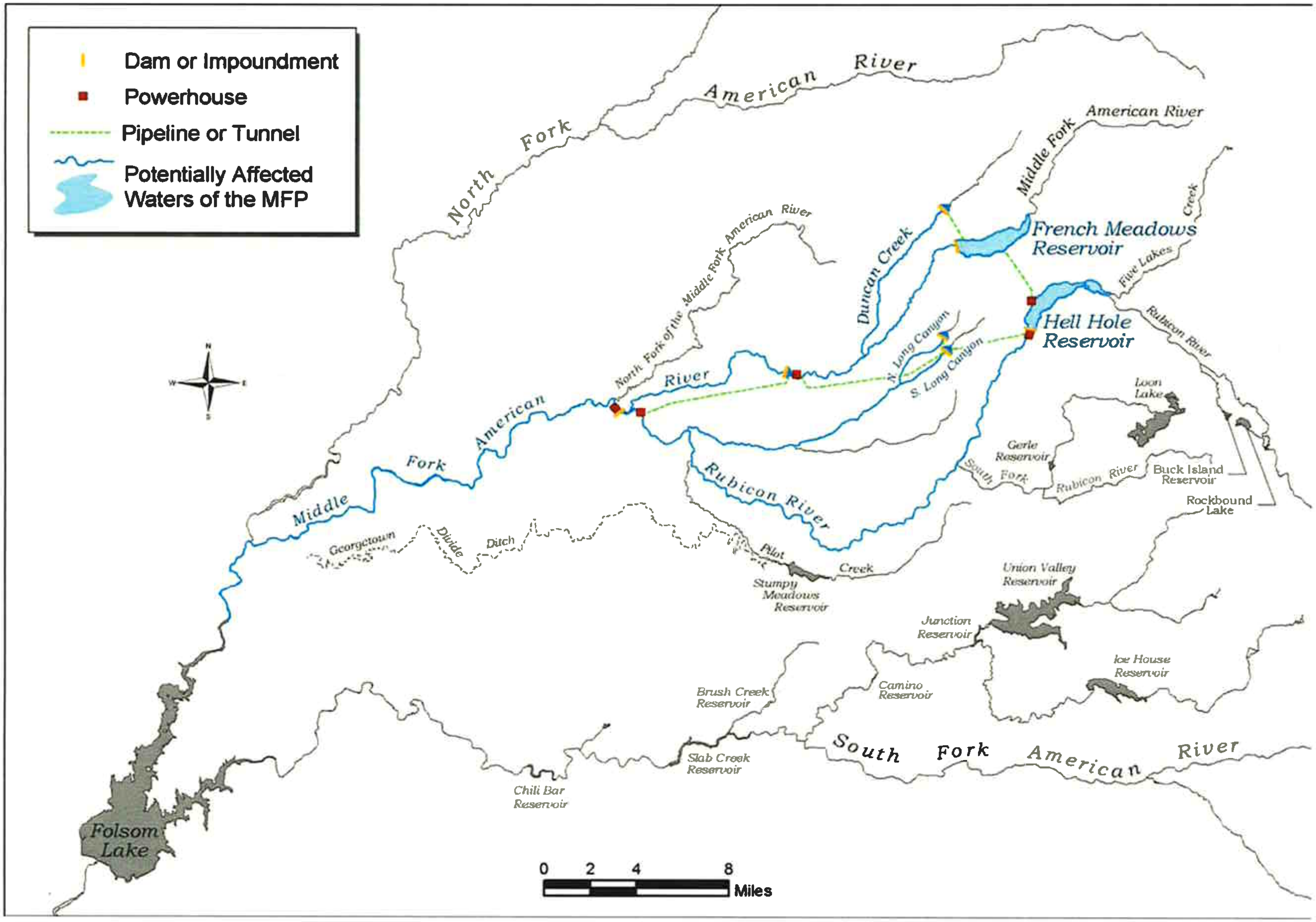


Figure 1. Overview map of Placer County Water Agency MFP area and adjacent watersheds.

potential effects of the project on these resources, including a description of any anticipated continuing impact for on-going and future operations. Preliminarily identified environmental considerations include potential project effects on flow-dependent habitat availability, including water temperature considerations.

In addition to FERC license renewal, the Agency is periodically involved in the sale and transfer of water from project facilities to downstream entities. Water transfers require a petition to be filed with the State Water Resources Control Board (SWRCB) requesting a temporary change in the water right agreement related to the point of re-diversion, place and purpose of use. An environmental analysis describing the potential impacts to fish, wildlife, and instream beneficial uses must be included with the petition to the SWRCB.

The Agency's continued stewardship of the MFP and its aquatic resources will benefit from additional information related to the characteristics of the MFP area, including water temperature.

2.0 WATER TEMPERATURE MONITORING PROGRAM OBJECTIVES

2.1 Overview

The principal objective of the MFP water temperature monitoring program is to consistently record instream water temperature at several operationally and biologically important sites within the MFP area, thereby augmenting the present water temperature database. When combined with instream flow data (currently being monitored at several operationally significant locations in the MFP area), the continuous data sets will serve as explanatory parameters for the evaluation of biological and ecological functional relationships that can be utilized during the MFP relicensing process. Additionally, these data sets will assist in the identification of potential MFP operational schedule and infrastructure modifications, as appropriate.

2.2 Evaluation of Potential Project-Related Effects

The concept behind the water temperature monitoring program is to gather water temperature data at appropriate locations to identify potential effects of MFP operations on the area's aquatic environment. More specifically, the water temperature monitoring program is designed to identify potential project-related changes in water temperature due to water diversions and hydropower generation. While data collected from the recently installed water temperature monitoring stations are expected to satisfy the objective of identifying potential project-related water temperature effects, and to provide substantial information that could be used in water temperature simulations, additional monitoring would be necessary to fully develop and calibrate predictive water temperature models (PCWA 2003).

2.3 Evaluation of Infrastructure and Operational Modifications

Modifications to MFP infrastructure, physical instream habitat conditions, or project operations, potentially could provide opportunities for the improvement of river hydrology and water temperature conditions within the MFP area. Because physical and operational modifications have the potential to increase project expenditures or decrease project revenue, evaluation of potential changes requires an understanding of the extent of anticipated benefits, if any, or of unanticipated direct or indirect impacts. The water temperature monitoring program will serve to assist in understanding the potential changes in the MFP aquatic environment associated with potential MFP operational or infrastructure modifications.

2.4 Biologic Application

Water temperature is a crucial environmental factor affecting the production and condition of biologic resources in riverine and lacustrine environments. Among numerous other processes, water temperature influences the decomposition rate of organic materials, the metabolism and growth rates of aquatic organisms, the behavior and the timing of life history events, and inter-specific interactions.

A water temperature monitoring program is critical to determine the influences of MFP operations on water temperatures and, thus, the potential effects of operations on the aquatic resources in the project area. Water temperature data, along with known physiologic water temperature indices and fish population data, may serve to illustrate the influence of MFP operations on physiological and behavioral function in fish during each lifestage, and provide a basis for establishing regulatory compliance benchmarks and operational guidance. Due to natural and anthropogenic perturbations in the aquatic ecosystem and seasonal and annual climatological variability, several years of instream water temperature data may be necessary to evaluate potential project-related effects, or MFP operational or infrastructural modifications, on aquatic resources.

3.0 WATER TEMPERATURE MONITORING STATION INSTALLATION GUIDELINES

3.1 Monitoring Locations

The water temperature monitoring sites were carefully selected to satisfy monitoring program objectives. **Figure 2** provides an overview of the pre-existing and recently installed water temperature monitoring locations described in detail within this installation report.

3.1.1 General Site Selection Criteria

The evaluation of infrastructure and operational modifications, project influences on instream characteristics, and functional relationships between instream characteristics and biological and

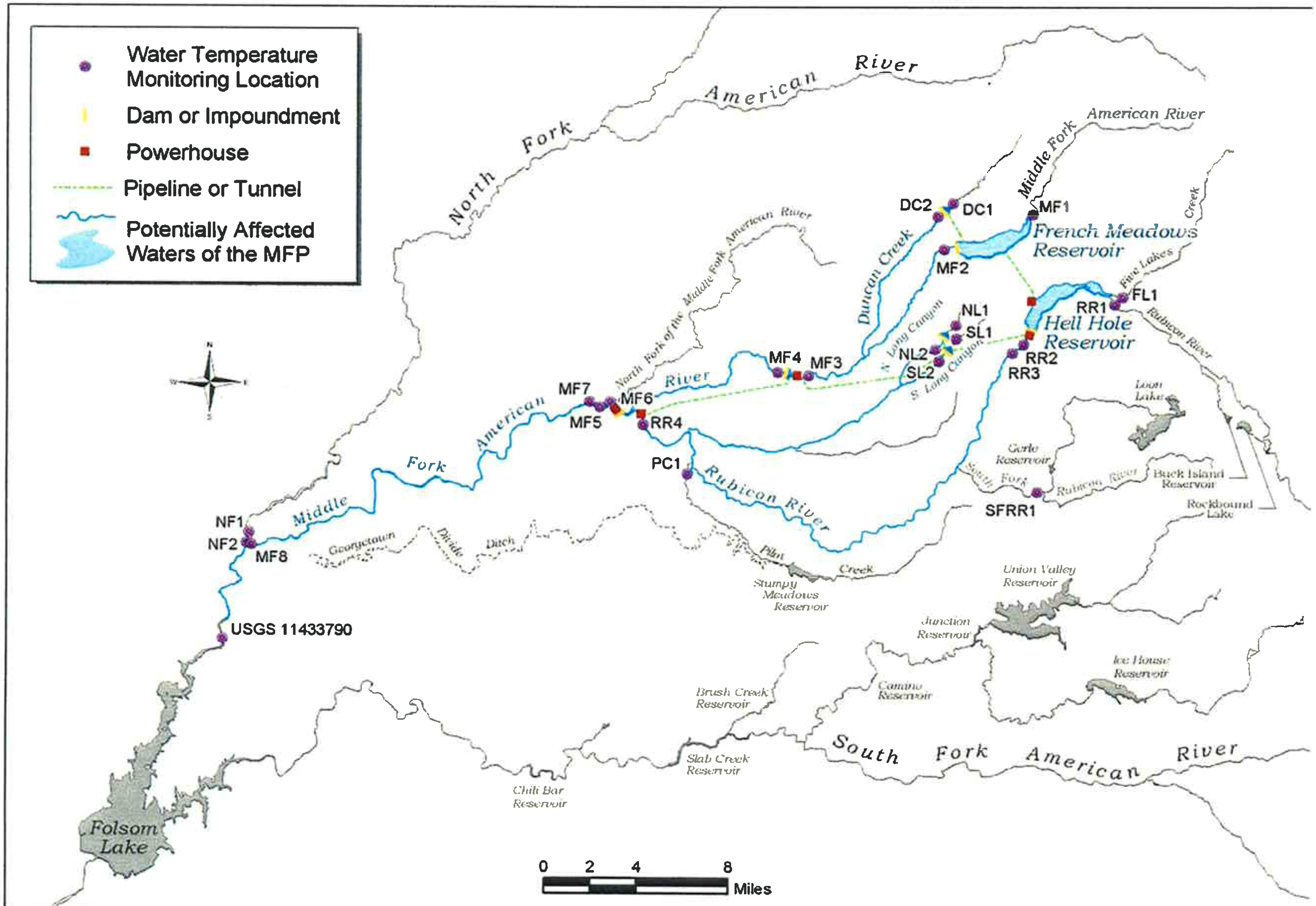


Figure 2. Overview of water temperature monitoring station locations.

ecological responses requires, in part, the continuous collection of complete, representative and applicable water temperature data from numerous monitoring locations within the MFP area.

Monitoring locations are situated to capture the complex movement of water throughout the MFP system. For example, water monitoring stations bracket identified "neck points" such as up- and downstream of a water diversion where project operations regulate or re-regulate the surrounding waters. Water temperature monitoring stations also were installed at locations such that the resulting data characterize the instream conditions of the river reaches within the MFP environment.

Monitoring locations also were chosen to produce data consistent with previous or existing monitoring programs. The utilization of existing monitoring locations results in an extension of the monitoring period of record. The Agency currently operates and maintains several streamflow monitoring gages within the MFP area as part of tracking FERC-mandated instream flow requirements. Additionally, the United States Geological Survey (USGS) operates a water temperature monitoring device in the North Fork American River at the former Auburn Dam site. The existing network of flow and water temperature monitoring sites provides a valuable record of historical data upon which to continue to build an environmental monitoring program. Therefore, in order to maintain the applicability of these historical records, as well as minimize capital costs to the Agency, existing monitoring locations are utilized in this monitoring program, wherever appropriate.

3.1.2 Specific Gage Placement and Installation Considerations

The methodology described in this report was utilized for installing water temperature monitoring stations in the MFP area. The methods described herein applied to the installation of *Onset 32K StowAway Tidbit*™ water temperature loggers at 22 sites in the MFP area. Each water temperature monitoring station location was identified to characterize potential changes in water temperature associated with MFP operations.

The specific placement and procedures for installing the water temperature gages required consideration of several issues. The installation of each logger followed standard manufacturer and USGS protocols. Water temperature gages were placed in areas considered to be representative of the thermal characteristics of the river in the area. Locations with: (1) observable groundwater upwelling; (2) unmixed tributary inflow; (3) direct sun exposure; and (4) isolated pools were avoided wherever possible to minimize confounding factors that may influence stream temperatures. The water temperature data loggers were placed as near the thalweg of the stream channel as possible to ensure complete mixing of the water, in consideration of potential seasonal fluctuations in streamflow.

Due to the level of public access within the MFP, the potential exists for vandalism and theft of instream monitoring equipment. However, the specific monitoring sites were selected to be as inconspicuous as possible. Additionally, the water temperature loggers were secured such that specialized tools would be required for removal.

Personnel safety, both during station installation and data collection, was the overriding consideration for specific water temperature station site selection. River stage is seasonally highly variable within the MFP, and sites were selected such that they could be accessed at all but the highest streamflows. However, access to numerous sites requires hiking over varied terrain, climbing over and along boulders and bedrock, and wading through streams, often in remote areas. Furthermore, the specific gage site selection considered recreational safety issues as well. The waters within the MFP are utilized for a variety of activities including boating, fishing and hiking. Therefore, monitoring equipment was positioned to minimize conflicts between recreational use and the monitoring of instream conditions.

This monitoring program is designed to minimize obstruction and disturbance of surrounding environments. While the utilization of several existing monitoring locales will limit the disturbance to riparian and instream habitat, during new equipment installation, instrument deployment, and data retrieval, personnel strive to minimize disruption to the surrounding environment. Entry and exit to and from all monitoring sites that are accessible by foot followed existing paths and river channels; the construction of roads or trails for monitoring activities was not needed.

4.0 INDIVIDUAL WATER TEMPERATURE MONITORING STATION INSTALLATION

Several water temperature monitoring stations were recently installed as part of this monitoring program. **Table 1** describes the approximate location and measurement objective for each of the 22 water temperature monitoring stations, as well as whether the water temperature monitoring location is associated with existing flow gaging stations. Table 1 also describes two existing water temperature gages that monitor waters flowing into or out of the MFP area.

Nine water temperature monitoring locations are proximate to existing flow measurement locations. This association is not coincidental, as the existing flow measuring devices also are situated to sufficiently capture project operation effects, but the monitoring program will also benefit from the coupling due to the potential relationship between instream flow and water temperature. The collection of both parameters at several monitoring sites will assist in the delineation between the proportional contribution of each environmental factor in evaluations regarding biologic and ecologic functional relationships.

4.1 WATER TEMPERATURE MONITORING STATION INSTALLATION PROTOCOL

Each water temperature monitoring station location was evaluated prior to installation. Pre-installation evaluations were conducted to help determine the optimal location of the monitoring sites, preferred installation procedure and to identify other potential site-specific considerations. For example, evaluation of the monitoring station located on the Rubicon River downstream of Hell Hole Reservoir revealed a long stretch of river that flowed subsurface under required summer flow conditions. Further discussions concluded that an additional water temperature

Table 1. Water temperature monitoring station locations.

Stream	Description of Location	Station ID	Geographic Coordinates	Flow Gage Association USGS Number PCWA Number	Date Installed	Measurement Objective
Middle Fork American River	Directly upstream of French Meadows Reservoir	MF1	N 39°08.105' W 120°41.530'	N/A	October 2, 2003	Continuously record water temperature in the Middle Fork American River upstream of its confluence with French Meadows Reservoir
Middle Fork American River	Directly downstream of French Meadows Dam	MF2	N 39°06.586' W 120°28.871'	11427500 R3	September 24, 2003	Continuously record water temperature in the Middle Fork American River downstream of French Meadows Reservoir
Middle Fork American River	Directly upstream of L.J. Stephenson Powerplant	MF3	N 39°01.529' W 120°35.650'	11427760 R4	October 9, 2003	Continuously record water temperature in the Middle Fork American River before the influence of the water released from the Middle Fork Tunnel
Middle Fork American River	Directly downstream of Interbay Dam	MF4	N 39°01.570' W 120°36.181'	N/A	October 9, 2003	Continuously record water temperature in the Middle Fork American River downstream of Interbay Dam
Middle Fork American River	Directly downstream of Ralston Afterbay Dam	MF5	N 39°00.250' W 120°44.928'	N/A	October 9, 2003	Continuously record temperature of the water released from the bypass and/or over the dam spillway
Middle Fork American River	Directly downstream of Oxbow Powerplant	MF6	N 39°00.380' W 120°44.834'	11433212	October 14, 2003	Continuously record temperature of the water released from the Oxbow Powerplant
Middle Fork American River	Downstream of the North Fork of the Middle Fork American River confluence	MF7	N 38°59.998' W 120°45.203'	11433300 R11	October 15, 2003	Continuously record water temperature in the Middle Fork American River after the influence of the North Fork of the Middle Fork American River
Middle Fork American River	Directly upstream of North Fork American River confluence	MF8	N 38°54.835' W 121°02.195'	N/A	October 15, 2003	Continuously record water temperature in the Middle Fork American River before the influence of the North Fork American River
Rubicon River	Directly upstream of Hell Hole Reservoir	RR1	N 39°04.695' W 120°20.851'	N/A	September 30, 2003	Continuously record water temperature in the Rubicon River upstream of its confluence with Hell Hole Reservoir

Table 1 (cont.)

STREAM	DESCRIPTION OF LOCATION	STATION ID	GEOGRAPHIC COORDINATES	FLOW GAGE ASSOCIATION USGS NUMBER PCWA NUMBER	DATE INSTALLED	MEASUREMENT OBJECTIVE
Rubicon River	Directly downstream of Hell Hole Dam	RR2	N 39°03.299' W 120°24.539'	11428800 R6	October 14, 2003	Continuously record water temperature in the Rubicon River downstream of Hell Hole Dam
Rubicon River	Downstream of Hell Hole Dam and directly downstream of intermittent river segment	RR3	N 39°02.555' W 120°25.546'	N/A	October 14, 2003	Continuously record water temperature in the Rubicon River after the influence of subsurface streamflow
Rubicon River	Directly upstream of Ralston Powerplant	RR4	N 39°00.060' W 120°43.230'	N/A	October 2, 2003	Continuously record water temperature in the Rubicon River after the influence of numerous tributary inflows and instream heating effects
South Fork Rubicon River[a]	Directly downstream of Gerle Creek confluence	SFRR1	N/A	SMUD	N/A	Continuously record water temperature in the South Fork Rubicon River downstream of Gerle Reservoir
North Fork American River	Directly upstream of Middle Fork American River confluence	NF1	N 38°55.323' W 121°02.316'	N/A	October 15, 2003	Continuously record water temperature in the North Fork American River before the influence of the Middle Fork American River
North Fork American River	Directly downstream of Middle Fork American River confluence	NF2	N 38°54.919' W 121°02.431'	N/A	October 15, 2003	Continuously record water temperature in the North Fork American River after the influence of the Middle Fork American River
North Fork American River	Former Auburn Dam site	N/A	N 38°51'06" W 121°03'26"	11433790	July 1999	Continuously record water temperatures in North Fork American River prior to confluence with Folsom Reservoir
Duncan Creek	Directly upstream of Duncan Creek Dam	DC1	N 39°08.419' W 120°28.753'	11427700 R1	September 24, 2003	Continuously record water temperature in Duncan Creek before the water diversion
Duncan Creek	Directly downstream of Duncan Creek Dam	DC2	N 39°07.972' W 120°29.045'	11427750 R2	September 24, 2003	Continuously record water temperature in Duncan Creek after the water diversion
North Fork Long Canyon Creek	Directly upstream of North Fork Dam	NL1	N 39°03.068' W 120°28.910'	N/A	October 2, 2003	Continuously record water temperatures in North Fork Long Canyon Creek upstream of North Fork Dam

Table 1 (cont.)

STREAM	DESCRIPTION OF LOCATION	STATION ID	GEOGRAPHIC COORDINATES	FLOW GAGE ASSOCIATION USGS NUMBER PCWA NUMBER	DATE INSTALLED	MEASUREMENT OBJECTIVE
North Fork Long Canyon Creek	Directly downstream of North Fork Dam	NL2	N 39°03.040' W 120°28.907'	11433085 R28	September 24, 2003	Continuously record water temperatures in North Fork Long Canyon Creek downstream of North Fork Dam
South Fork Long Canyon Creek	Directly upstream of South Fork Dam	SL1	N 39°03.077' W 120°28.230'	N/A	September 24, 2003	Continuously record water temperatures in South Fork Long Canyon Creek upstream of South Fork Dam
South Fork Long Canyon Creek	Directly downstream South Fork Dam	SL2	N 39°03.620' W 120°28.272'	11433065 R27	October 2, 2003	Continuously record water temperatures in South Fork Long Canyon Creek downstream of South Fork Dam
Pilot Creek	Directly upstream of Rubicon River confluence	PC1	N 38°58.241' W 120°40.996'	N/A	October 24, 2003	Continuously record water temperatures in Pilot Creek upstream of confluence with the Rubicon River
Five Lakes Creek	Directly upstream of Hell Hole Reservoir	FL1	N 39°04.680' W 120°20.540'	N/A	September 30, 2003	Continuously record water temperature in Five Lakes Creek upstream of its confluence with Hell Hole Reservoir

[a] South Fork Rubicon River water temperature monitoring station maintained by SMUD

monitoring station would need to be installed near the location that the Rubicon River surfaces permanently in order to accomplish the goals of the water temperature monitoring program.

4.1.1 Water Temperature Monitoring Installation Equipment

Onset 32K StowAway TidbiT™ water temperature loggers were installed at all 22 locations in the MFP area using the equipment specified in **Table 2.** *The Onset 32K StowAway TidbiT™* water temperature logger specifications are detailed in **Appendix A.**

Table 2. Water temperature station installation equipment and materials.

Equipment and Materials	
Onset 32K StowAway TidbiT™ (-5°C to +37°C) (TBI32-05+37)	Cordless drill
	Philips screwdriver drill bit
4-foot long cedar two-by-four	3/8-inch masonry drill bit
3/8-inch stainless washers	2-inch wood boring bit
3/8-inch stainless nuts	1/2-inch wood boring bit
Stainless mesh screening (~3-inch x 3-inch)	7/8-inch wood boring bit
3.5-inch x 3/8-inch one-piece expansion anchors	Hammer
Battery-powered rotohammer drill	Ratchet

4.1.2 Water Temperature Monitoring Installation Procedure

The step-by-step procedure followed during the installation of each water temperature monitoring station is provided below.

<u>Prefabrication</u>

- Bore 2-inch diameter hole approximately one inch deep into 4-foot long, pre-cut cedar two-by-four, approximately 2 inches from one end
- Bore 1/2-inch diameter hole in center of 2-inch diameter hole through two-by-four
- Mount *Onset 32K StowAway TidbiT™* water temperature logger using single stainless screw inside 2-inch diameter hole
- Cover logger with stainless mesh screen mounted on the cedar two-by-four with a washer/stainless screw combination at the top, and a stainless screw at the bottom

<u>Installation</u>

- Locate appropriate mounting substrate (e.g., large stable boulder, bedrock, concrete weir, etc.), following the considerations described above in Section 3.1.2, to which to mount prefabricated two-by-four and logger
- While holding the two-by-four in its preferred mounted location, place two marks on two-by-four where the anchors will be mounted
- Bore 7/8-inch diameter counter-sink hole approximately 1/2-inch into two-by-four at each mark
- Bore 1/2-inch diameter hole through 7/8-inch diameter counter-sink hole in two-by-four

- Again, while holding pre-drilled two-by-four in its preferred mounted location, mark mounting substrate through pre-drilled holes using rotohammer and masonry drill bit
- Using rotohammer with 3/8-inch diameter masonry drill bit, drill hole at each mark approximately 1/2- to 3/4-inch deep (**Appendix B, Figures B-1 and B-2**)
- Hammer 3.5-inch long, 3/8-inch diameter one-piece expansion anchors firmly into each hole (**Appendix B, Figure B-3**)
- Mount on substrate by sliding two-by-four onto expansion anchors
- Place washer and nut on each anchor and firmly screw into counter-sink hole (**Appendix B, Figure B-4**)

Several considerations influenced the installation of each monitoring station. To ensure that high stream flows would not dislodge the water temperature loggers, each data logger was mounted to large, immovable objects such as large boulders, bedrock and concrete weirs. Furthermore, the water temperature probes were mounted on the downstream face to protect the logger from objects such as rocks that may be tumbling downstream during high flow events, where possible. When the water temperature loggers could not be placed on the downstream face, caution was taken to place the logger in a location that would be protected from high flows. Large objects such as boulders, however, could be considered "heat sinks", which absorb heat and may artificially increase the measured temperature of an attached logger. Care was taken to ensure that the water temperature loggers were not in physical contact with the mounting substrate. Spacers were placed between the substrate and the cedar two-by-four, when necessary, to allow water to circulate around the entire logger, thereby avoiding the potential for artificially increasing the measured water temperature (**Appendix B, Figure B-5**).

4.2 Water Temperature Monitoring Station Site Accounts

The following describes the location and a general description of each of the 22 water temperature monitoring stations installed between September 24 and October 24, 2003. Descriptions of access to most of the water temperature monitoring sites are intentionally brief, as project area familiarity is assumed. Greater detail is given for those sites that are not generally visited by MFP personnel during normal project operations.

4.2.1 Middle Fork American River Upstream of French Meadows Reservoir

Name: Middle Fork American River
Station ID: MF1
Location: Approximately 1.0 mile upstream of French Meadows Reservoir
GPS Coordinates: N 39°08.105'W 120°41.530'
Habitat Type: Step run
Date Installed: October 2, 2003

The water temperature monitoring station located on the Middle Fork American River, upstream of French Meadows Reservoir, was installed on October 2, 2003. The station is located approximately 1.0 mile upstream of French Meadows Reservoir; however, the distance from the reservoir will vary depending on reservoir water surface elevation. The station is located in a step run, approximately 200 meters upstream of the U.S. Forest Service Road (FS) 96 bridge over the Middle Fork American River (**Appendix C, Figure C-1**). The water temperature logger is mounted to a large boulder on the right bank of the river. Access to the station, beginning at the unimproved parking area underneath the bridge, requires walking up the stream channel over cobbles and some boulders.

4.2.2 Middle Fork American River Downstream of French Meadows Reservoir

Name: Middle Fork American River **Station ID:** MF2 **Location:** Weir, approximately 0.25 miles downstream of Anderson Dam (French Meadows) **GPS Coordinates:** N 39°06.586'W 120°28.871' **Habitat Type:** Pool **Date Installed:** September 24, 2003

The water temperature monitoring station located on the Middle Fork American River, immediately downstream of French Meadows Reservoir, was installed on September 24, 2003. The station is located approximately 0.25 miles downstream of French Meadows Reservoir. The water temperature logger was mounted near the left bank of the stream, on the downstream face of a concrete weir (**Appendix C, Figure C-2**). The logger is located near the weir notch, which passes the minimum streamflow and ensures sufficient water mixing and that representative water temperatures are collected. PCWA R3 and USGS 11427500 flow gaging stations are located in the immediate vicinity. Access to the monitoring station is *via* a short drive off the main road that passes over Anderson Dam, followed by a short hike.

4.2.3 Middle Fork American River Upstream of Stephenson Powerplant

Name: Middle Fork American River **Station ID:** MF3 **Location:** Approximately 0.20 miles upstream of Stephenson Powerplant **GPS Coordinates:** N 39°01.529'W 120°35.650' **Habitat Type:** Pool **Date Installed:** October 9, 2003

The water temperature monitoring station located on the Middle Fork American River, upstream of Stephenson Powerplant, was installed on October 9, 2003. The station is located on the left bank of a pool, a few meters upstream of the cable car crossing that provides access to the opposite bank (**Appendix C, Figure C-3**). The water temperature logger is mounted to a large boulder. PCWA R4 and USGS 11427760 streamflows gages are located in the immediate vicinity of the water temperature monitoring station. Access to the station is provided by a spur road above the powerplant, followed by a short hike to the river.

4.2.4 Middle Fork American River Downstream of Interbay Dam

Name: Middle Fork American River **Station ID:** MF4 **Location:** Approximately 30 meters downstream of Interbay Dam **GPS Coordinates:** N 39°01.570'W 120°36.181' **Habitat Type:** Pool **Date Installed:** October 9, 2003

The water temperature monitoring station located on the Middle Fork American River, downstream of Interbay Dam, was installed on October 9, 2003. A large, active landslide on the left bank immediately downstream of Interbay Dam limited installation of the monitoring station to proximate, but undisturbed areas. The water temperature logger is mounted to a very large boulder resting near the left bank of the river in a large pool at the base of Interbay Dam (**Appendix C, Figure C-4**). A permanent ladder along the face of Interbay Dam provides access to the Middle Fork American River below the Interbay Dam. A short hike across boulders is necessary to reach the monitoring station.

4.2.5 Middle Fork American River Downstream of Ralston Afterbay Dam

Name: North Fork American River **Station ID:** MF5 **Location:** Approximately 0.25 miles downstream of Ralston Afterbay Dam **GPS Coordinates:** N 39°00.250'W 120°44.928' **Habitat Type:** Pool **Date Installed:** October 9, 2003

The water temperature monitoring station located on the Middle Fork American River, downstream of Ralston Afterbay Dam, was installed on October 9, 2003. The station is located on the right bank, along the inside of a mild bend of a large main channel pool, approximately 0.25 miles downstream of the Afterbay. The water temperature logger is mounted to a small bedrock outcrop, facing upstream (**Appendix C, Figures C-5 and C-6**). A small maintenance flow is continuously released from the Afterbay outlet into the Middle Fork American River, although a higher flow bypass release occurs from the dam outlet during periods when Oxbow Powerplant is offline. Also, reservoir water spills into this section of the river during high flow events. Most often, however, this section of river remains at low flow until it connects with the release from Oxbow Powerplant, approximately midway between Ralston Afterbay Dam and the North Fork of the Middle Fork American River. The station is accessed *via* a short hike upstream from the parking area near Oxbow Powerplant.

4.2.6 Middle Fork American River Downstream of Oxbow Powerplant

Name: Middle Fork American River **Station ID:** MF6 **Location:** Oxbow Powerplant outlet **GPS Coordinates:** N 39°00.380'W 120°44.834' **Habitat Type:** Pool **Date Installed:** October 14, 2003

The water temperature monitoring station located on the Middle Fork American River at the Oxbow Powerplant outlet was installed on October 14, 2003. The water temperature logger was mounted directly to the right side (facing the outlet) of the concrete powerplant outlet (**Appendix C, Figure C-7**). At the time of the installation, Oxbow Powerplant was offline, thus the water surface elevation of the outlet pool was relatively low. An 8-foot long two-by-four (instead of a 4-foot long two-by-four which was used for most of the other installations) was used for the installation of this logger because river stage fluctuations at this station are relatively greater than at most of the other stations. The longer two-by-four allows easier, and safer, access to the water temperature logger. USGS streamflow gage 11433212 records discharge from Oxbow Powerplant. Access to the station is *via* a short walk to the river from an easily accessed parking area. This area is a popular river rafting put-in.

4.2.7 Middle Fork American River Downstream of North Fork of the Middle Fork American River Confluence

Name: Middle Fork American River **Station ID:** MF7 **Location:** Directly upstream of Horseshoe Bar, approximately 0.80 miles downstream of NF of the Middle Fork American River confluence **GPS Coordinates:** N 38°59.998'W 120°45.203' **Habitat Type:** Pool **Date Installed:** October 15, 2003

The water temperature monitoring station located on the Middle Fork American River, downstream of the North Fork of the Middle Fork American River confluence, was installed on October 15, 2003. The site is located near the PCWA R11 and USGS 11433300 streamflow gages, approximately 0.80 miles downstream of the North Fork of the Middle Fork American River confluence. The water temperature logger is located on the right bank, mounted to bedrock (**Appendix C, Figure C-8**). An 8-foot long two-by-four (instead of a 4-foot long two-by-four which was used for most of the other installations) was used for the installation of this logger because river stage fluctuations at this station are relatively greater than at most of the other stations. The longer two-by-four allows easier, and safer, access to the water temperature logger. A short hike from a small parking area near the gaging station accesses the monitoring station.

4.2.8 Middle Fork American River Upstream of North Fork American River Confluence

Name: Middle Fork American River
Station ID: MF8
Location: Approximately 0.20 miles upstream of North Fork American River confluence
GPS Coordinates: N 38°54.835'W 121°02.195'
Habitat Type: Pool
Date Installed: October 15, 2003

The water temperature monitoring station located on the Middle Fork American River, upstream of the North Fork American River confluence, was installed on October 15, 2003. The site is located approximately 0.20 miles upstream of the North Fork American River confluence. The station is located near the midpoint of a large main channel pool. The water temperature logger is mounted to bedrock that partly forms the left bank of the river (**Appendix C, Figure C-9**). Access to the station is *via* an unimproved foot trail beginning at the parking area off California State Highway 49, east of the North Fork American River Bridge.

4.2.9 Rubicon River Upstream of Hell Hole Reservoir

Name: Rubicon River
Station ID: RR1
Location: Approximately 0.30 miles upstream of Hell Hole Reservoir
GPS Coordinates: N 39°04.695'W 120°20.851'
Habitat Type: Run
Date Installed: September 30, 2003

The water temperature monitoring station located on the Rubicon River, upstream of Hell Hole Reservoir, was installed on September 30, 2003. The site is located approximately 0.40 miles upstream of Hell Hole Reservoir; however, the distance from the reservoir will vary depending of reservoir water surface elevation. The station is located at the head of a main channel run, downstream of a riffle (**Appendix C, Figure C-10**). The left bank of this section of the river is confined by bedrock. The water temperature logger is mounted to channel bedrock on the left bank of the stream. Access to the station requires a boat ride across Hell Hole Reservoir, followed by a short, but often steep, hike along the stream. Some boulder hopping and wading is required. A second potential means of access, *via* a jeep road, was not investigated for this report.

4.2.10 Rubicon River Downstream of Hell Hole Dam

Name: Rubicon River
Station ID: RR2
Location: Weir, right bank, approximately 50 meters downstream of outlet
GPS Coordinates: N 39°00.060'W 120°43.230'
Habitat Type: Pool
Date Installed: October 14, 2003

The water temperature monitoring station located on the Rubicon River, immediately downstream of Hell Hole Reservoir, was installed on October 14, 2003. The site is located approximately 50 meters downstream of the Hell Hole Reservoir outlet. The water temperature logger is mounted near the right bank on a concrete weir, which forms a pool downstream (**Appendix C, Figures C-11 and C-12**). Water spilling over the weir ensures complete mixing and representative water temperatures. The station is located approximately 10 meters downstream of the PCWA R6 and USGS 11428800 flow gaging stations. A paved road behind a locked gate near Hell Hole Dam, followed by a very short hike, provides access to the station.

4.2.11 Rubicon River Downstream of Hell Hole Dam and Downstream of Intermittent River Segment

Name: Rubicon River
Station ID: RR3
Location: Approximately 1.5 miles downstream of Hell Hole Dam
GPS Coordinates: N 39°02.555'W 120°25.546'
Habitat Type: Run
Date Installed: October 14, 2003

The water temperature monitoring station located on the Rubicon River, downstream of Hell Hole Dam and the intermittent river section, was installed on October 14, 2003. The Rubicon River, downstream of Hell Hole Dam, flows intermittently during summer conditions for approximately 1.5 miles. This station is included in the water temperature monitoring program to assist in determining the effects of subsurface flow on water temperature in this area and to accurately describe the water temperature persistence downstream of Hell Hole Dam. The station is located approximately 1.5 miles downstream of Hell Hole Dam, and approximately 200 meters downstream of the point at which the river becomes permanent under summer flow conditions. The station is located near the tail of a main channel run (**Appendix C, Figure C-13**). The water temperature logger is mounted to channel bedrock on the left bank of the river. Starting at station RR2, access to the station requires an arduous hike along the Rubicon River, often over large boulders. A second potential means of access, *via* a dirt road, was not investigated for this report.

4.2.12 Rubicon River Upstream of Ralston Powerplant

Name: Rubicon River
Station ID: RR4
Location: Approximately 0.25 miles upstream of Ralston Powerplant
GPS Coordinates: N 39°03.077'W 120°28.230'
Habitat Type: Run
Date Installed: October 2, 2003

The water temperature monitoring station located on the Rubicon River, upstream of Ralston Powerplant, was installed on October 2, 2003. The station is located on the right bank, in the tail-out of a run, approximately 0.25 miles upstream of the Ralston Powerplant Outlet (**Appendix C, Figure C-14**). The station is located sufficiently upstream to avoid the potential influences of releases from the powerhouse. The logger is mounted to a bedrock outcrop. Access to the station is a short scramble from the road, downhill to the station.

4.2.13 South Fork Rubicon River Downstream of Gerle Creek Reservoir

The water temperature monitoring station on the South Fork Rubicon River was installed, and is currently being operated and maintained, by SMUD. The station is located on the South Fork Rubicon River downstream of Gerle Creek and Gerle Creek Reservoir. SMUD is currently sharing the water temperature data with the Agency.

4.2.14 North Fork American River Upstream of Middle Fork American River Confluence

Name: North Fork American River
Station ID: NF1
Location: Approximately 0.5 miles upstream of Middle Fork American River confluence
GPS Coordinates: N 38°55.323'W 121°02.316'
Habitat Type: Run
Date Installed: October 15, 2003

The water temperature monitoring station located on the North Fork American River, upstream of the Middle Fork American River confluence, was installed on October 15, 2003. The site is located approximately 0.50 miles upstream of the Middle Fork American River confluence, underneath the Foresthill Bridge on Foresthill Road. The water temperature logger is located near mid-channel of a run, mounted to a large boulder (**Appendix C, Figures C-15 and C-16**). Access to the station is *via* an approximate 0.50 mile hike along an improved foot/mountain bike trail beginning at the eastern edge of the bridge that crosses the North Fork American River on Old Foresthill Road.

4.2.15 North Fork American River Downstream of Middle Fork American River Confluence

Name: North Fork American River
Station ID: NF2
Location: Approximately 0.20 miles downstream of Middle Fork American River confluence
GPS Coordinates: N 38°54.919'W 121°02.431'
Habitat Type: Pool
Date Installed: October 15, 2003

The water temperature monitoring station located on the North Fork American River, downstream of the Middle Fork American River confluence, was installed on October 15, 2003. The site is located approximately 0.20 miles downstream of the Middle Fork American River confluence, underneath the North Fork American River Bridge on California State Highway 49. The station is located on the inside of a mild river bend in a main channel pool, facing upstream (**Appendix C, Figure C-17**). The water temperature logger is mounted to an old, large, concrete bridge abutment lying on the left bank of the river. Access to the station is *via* an unimproved foot trail beginning at the eastern edge of the bridge.

4.2.16 North Fork American River Upstream of Folsom Reservoir

The USGS station 11433790 was installed in July near the former Auburn Dam site near Auburn, California. This station is a real-time water temperature monitoring site maintained by the State of California. The water temperature monitoring site homepage is accessible through the Internet at: http://waterdata.usgs.gov/nwis/nwisman/?site_no=11433790&agency_cd=USGS. This monitoring station continuously records water temperature in the North Fork American River upstream of its confluence with Folsom Reservoir.

4.2.17 Duncan Creek Upstream of Duncan Creek Diversion Dam

Name: Duncan Creek
Station ID: DC1
Location: Weir, approximately 0.15 miles upstream of Duncan Creek Diversion Dam
GPS Coordinates: N 39°08.419'W 120°28.753'
Habitat Type: Pool
Date Installed: September 24, 2003

The water temperature monitoring station located on Duncan Creek, upstream of Duncan Creek Diversion Dam, was installed on September 24, 2003. The station is located approximately 0.15 miles upstream of the diversion dam, and approximately 50 meters downstream of a road crossing. The water temperature logger was mounted near the center of the stream, on the downstream face of a concrete weir (**Appendix C, Figure C-18**). The concrete weir forms a pool downstream, in which the temperature logger resides. The water temperature monitoring station is located in proximity to the PCWA R1 and USGS 1142770 streamflow gaging stations. A short hike leads to the monitoring station.

4.2.18 Duncan Creek Downstream of Duncan Creek Diversion Dam

Name: Duncan Creek
Station ID: DC2
Location: Approximately 0.15 miles downstream of Duncan Creek Diversion Dam and 10 meters upstream of PCWA/USGS streamflow gages
GPS Coordinates: N 39°07.972'W 120°29.045'
Habitat Type: Head of main channel pool
Date Installed: September 24, 2003

The water temperature monitoring station located on Duncan Creek, downstream of Duncan Creek Diversion Dam, was installed on September 24, 2003. The station is located approximately 10 meters upstream of the PCWA R2 and USGS 11427750 streamflow gaging stations and approximately 0.15 miles downstream of Duncan Creek Diversion Dam. The water temperature logger is mounted to a bedrock outcrop near the right bank of the creek in the head of a pool (**Appendix C, Figure C-19 and C-20**). Scars from the 2001 Star Fire are clearly visible throughout this area. After pulling off of the service road approximately 0.20 miles prior to reaching Duncan Creek Diversion Dam, a short hike downhill through the burn area along a small, unimproved trail leads to the monitoring station.

4.2.19 North Long Canyon Creek Upstream of North Fork Dam

Name: North Long Canyon Creek
Station ID: NL1
Location: Upstream face of North Fork Dam
GPS Coordinates: N 39°03.068'W 120°28.910'
Habitat Type: Pool
Date Installed: October 2, 2003

The water temperature monitoring station located on North Long Canyon Creek, upstream of North Fork Dam, was installed on October 2, 2003. The station is located on the upstream face of the North Fork Dam, next to the fish water release valve (**Appendix C, Figure C-21**). The water temperature logger was mounted directly to the concrete dam. At the time of installation, the logger was mounted out of the water, to permit access to the logger at higher streamflows when water would be diverted, thus satisfying the monitoring program objectives. The water temperature logger will be watered at times when streamflow would be diverted. Under summer streamflow conditions, the logger is approximately one foot above the wetted surface. The stream habitat type is classified as a pool. Access to the station is by a short walk to the North Fork Dam.

4.2.20 North Long Canyon Creek Downstream of North Fork Dam

Name: North Long Canyon Creek
Station ID: NL2
Location: Approximately 10 meters downstream of concrete weir below North Fork Dam
GPS Coordinates: N 39°03.040'W 120°28.907'
Habitat Type: Step run
Date Installed: September 24, 2003

The water temperature monitoring station located on North Long Canyon Creek, downstream of North Fork Dam, was installed on September 24, 2003. The station is located approximately 10 meters downstream of a concrete weir, along the left bank of the creek (**Appendix C, Figure C-22**). The stream habitat type is classified as a step run. A large log extends directly over the monitoring station, which is mounted to a large boulder. PCWA R28 and USGS 11433085 streamflow gages are located near the water temperature monitoring station. Access to the station is by a short hike downstream from the North Fork Dam.

4.2.21 South Long Canyon Creek Upstream of South Fork Dam

Name: South Long Canyon Creek **Station ID:** SL1 **Location:** Approximately 20 meters upstream of South Fork Dam **GPS Coordinates:** N 39°03.077'W 120°28.230' **Habitat Type:** Pool **Date Installed:** September 24, 2003

The water temperature monitoring station located on South Long Canyon Creek, upstream of South Fork Dam, was installed on September 24, 2003. The station is located approximately 20 meters upstream of the South Fork Dam on the right bank. The water temperature logger is mounted to a bedrock outcrop near the head of a main channel pool (**Appendix C, Figure C-23**). A short hike along the creek upstream from the South Fork Dam leads to the monitoring station.

4.2.22 South Long Canyon Creek Downstream of South Fork Dam

Name: South Long Canyon Creek **Station ID:** SL2 **Location:** Approximately 300 meters downstream of South Fork Dam **GPS Coordinates:** N 39°03.620'W 120°28.272' **Habitat Type:** Step run **Date Installed:** October 2, 2003

The water temperature monitoring station located on South Long Canyon Creek, downstream of South Fork Dam, was installed on October 2, 2003. The station is located approximately 300 meters downstream of the South Fork Dam along the right bank of the creek (**Appendix C, Figures C-24 and C-25**). The water temperature monitoring station is located approximately 20 meters downstream of the PCWA R27 and USGS 11433065 streamflow gaging stations. The logger is mounted to a bedrock outcrop in a step run. Access to the station is by a short hike downstream from the South Fork Dam.

4.2.23 Pilot Creek Upstream of Rubicon River Confluence

Name: Pilot Creek **Station ID:** PC1 **Location:** Approximately 50 meters upstream of Rubicon River confluence **GPS Coordinates:** N 38°58.241'W 120°40.996' **Habitat Type:** Step run **Date Installed:** October 24, 2003

The water temperature monitoring station located on Pilot Creek, upstream of the Rubicon River confluence, was installed on October 24, 2003. The station is located approximately 50 meters upstream of the Rubicon River confluence and approximately 30 meters downstream of the footbridge over Pilot Creek. The water temperature logger was mounted to a bedrock outcrop on the left bank of the creek (**Appendix C, Figure C-26**). Access to the Pilot Creek monitoring station requires an approximate 1.5 mile hike along a trail with very steep terrain. From

Georgetown, California, take Wentworth Springs Road east approximately 7.7 miles. Turn left (north) on Volcanoville Road and follow for 2.4 miles. Turn right (east) on Rubicon Road. **Appendix C, Figure C-27** details the remaining directions to the Pilot Creek water temperature monitoring station.

4.2.24 Five Lakes Creek Upstream of Hell Hole Reservoir

Name: Five Lakes Creek
Station ID: FL1
Location: Right bank, approximately 0.25 miles upstream of Hell Hole Reservoir
GPS Coordinates: N 39°04.680'W 120°20.540'
Habitat Type: Pool
Date Installed: September 30, 2003

The water temperature monitoring station located on Five Lakes Creek, upstream of Hell Hole Reservoir, was installed on September 30, 2003. The site is located approximately 0.30 miles upstream of Hell Hole Reservoir; however, the distance from the reservoir will vary depending of reservoir water surface elevation. The station is located at the head of a main channel pool, immediately downstream of a cascade/riffle complex, in a confined stream segment (**Appendix C, Figure C-28**). The water temperature logger is mounted to channel bedrock on the right bank of the creek. Access to the station requires a boat ride across Hell Hole Reservoir, followed by a short hike upstream along the creek. Some wading is required to access this station.

5.0 REFERENCES

Placer County Water Agency (PCWA). 2003. Middle Fork American River Project – River Hydrology and Water Temperature Monitoring Program – Draft Report. Prepared by Surface Water Resources, Inc. March 2003.

APPENDIX A

ONSET 32K STOWAWAY TIDBIT™ SPECIFICATIONS

Features and Specifications

- Waterproof to 1000 feet
- 5 year non-replaceable battery (typical use*)
- Completely sealed in epoxy; very durable
- Capacity: 32,520 measurements
- Small size: 1.2" wide x 1.6" tall x 0.65" thick (30 x 41 x 17 mm) and 0.8 oz.
- Two measurement ranges†: +24°:F to +99°F (-4°C to +37°C) and -4°F to +122°F (-20°C to +50°C)**
- User-selectable sampling interval: 0.5 seconds to 9 hours, recording times up to several years
- Blinking LED light shows if temperature goes out of user-determined limits
- Uses optic communications through Optic Base Station for launch and readout
- Readout and relaunched in the field with optional Optic Shuttle
- Precision components eliminate the need for user calibration
- Programmable start time/date
- Triggered start with coupler or magnet
- Memory modes stop when full or wrap-around when full
- Nonvolatile EEPROM memory retains data even if battery fails
- Multiple sampling with minimum, maximum or averaging
- Blinking LED light confirms operation
- Time accuracy: ±1 minute per week at +68°F (+20°C)
- Mounting tab
- Compliance certificate available
- NIST-traceable temperature accuracy certification available

*16 three-month deployments in water (+35°F to +80°F) with 4 minute or longer intervals (no multiple sampling), 1 offload per deployment.

** To guarantee specified accuracy, the TidbiT and Optic StowAway units should not be used in condensing environments and water temperatures higher than +30°C (+86°F) for more than 8 weeks cumulatively. Prolonged exposure will lead to measurement drift and eventual failure.

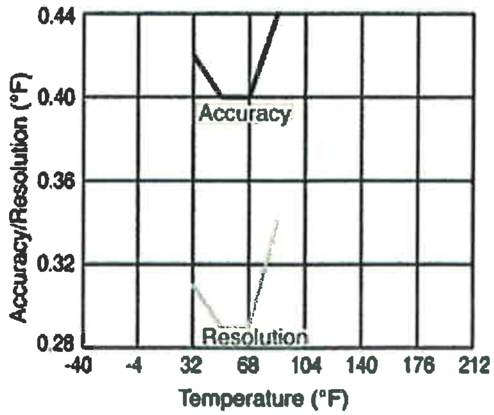
Measurement specifications

-5°C to +37°C Models

- Range†: +24°F to +99°F (-4°C to +37°C)
- Accuracy: ±0.4°F (±0.2°C) at +70°F, see plot at right
- Resolution: 0.29°F (0.16°C) at +70°F, see plot at right
- Response time in water: 5 min. typical to 90%
- Response time in still air: 50 min. typical to 90%
- Response time in air moving 1 meter/second: 18 min. typical to 90%

Temperature Accuracy and Resolution

-5°C to +37°C Models



APPENDIX B

WATER TEMPERATURE MONITORING STATION INSTALLATION

APPENDIX C

WATER TEMPERATURE MONITORING STATION LOCATIONS