PCWA
water • energy • stewardship

PLACER COUNTY WATER AGENCY
SINCE 1957

BOARD OF DIRECTORS
Gray Allen, District 1
Primo Santini, District 2
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Robert Dugan, District 4
Joshua Alpine, District 5

Andrew Fecko, General Manager

BUSINESS CENTER
144 Ferguson Road
MAIL
P.O. Box 6570
Auburn, CA 95604
PHONE
(530) 823-4850
(800) 464-0030
WWW.PCWA.NET

May 24, 2022

Scott McFarland
State Water Resources Control Board
Division of Water Rights
Water Rights Permitting Unit
P.O. Box 2000
Sacramento, CA 95814

SUBJECT: Placer County Water Agency Permit No. 13856 (Application No. 18085)
Petition for Change Involving Water Transfers

Dear Mr. McFarland,

Placer County Water Agency (PCWA) hereby submits to the State Water Resources Control Board (SWRCB) Division of Water Rights a Petition for Change Involving Water Transfers (Petition) to facilitate a 21,053 acre foot (ac-ft) water transfer (Transfer) to East Bay Municipal Water District (EBMUD) pursuant to Water Code §1725-1732. This transfer would involve surplus water currently stored in PCWA's Middle Fork Project reservoirs pursuant to SWRCB water right Permit No. 13856.

In accordance with Water Code §1728, this Transfer shall occur within one year from the date of approval by the SWRCB. Transfer releases to EBMUD would be initiated following approval of the Petition by SWRCB and shall be completed prior to September 30, 2022. As shown in Attachment G, the timing and volume of the proposed Transfer will have a beneficial effect on in-stream flows and water temperature in the Lower American River. In addition, the release of Transfer water will provide a flexible asset to the California Independent System Operator for management of the electrical grid. This Transfer involves water that would not otherwise be released from storage by PCWA but for the purpose of this Transfer.

The attached petition includes all of the information required under Water Code §1725-1732 to demonstrate that this transfer will not injure any downstream legal user of water and would not unreasonably affect fish, wildlife, or any other in-stream beneficial uses.

Enclosed with this submittal are the following:

- One original and one copy of PCWA's Petition for Change Involving Water Transfers (dated May 24, 2022) including the required Environmental Information Form for Petitions (Attachment A);

- A check in the amount of $12,521.50 made payable to the State Water Board for Petition filing fees; and

- A check in the amount of $850 made payable to the California Department of Fish & Wildlife.

PCWA would like to thank SWRCB staff for their continued diligence and expeditious processing of Change Petitions. PCWA is available to assist SWRCB staff with any technical or administrative functions needed to complete the approval process.

If you have any questions or need additional information, please call me at (530) 823-4891. Alternatively, you can reach PCWA's point of contact for water transfers, Benjamin Barker, at (530) 823-1742.

Sincerely,

PLACER COUNTY WATER AGENCY

Darin Reintjes
Director of Resource Management

Enclosures

c: Andrew Fecko, General Manager, PCWA
Mike Tognolini, Director of Water & Natural Resources, EBMUD
Hasan Abdullah, Senior Civil Engineer, EBMUD
Bryan Smith, Program Manager-CVRWQCB Water Quality Certification Division
Kevin Thomas, Regional Manager-R2, California Department of Fish and Wildlife
Placer County Board of Supervisors
Contra Costa County Board of Supervisors
Alameda County Board of Supervisors

Please indicate County where your project is located here:

PLACER

MAIL FORM AND ATTACHMENTS TO:
State Water Resources Control Board
DIVISION OF WATER RIGHTS
P.O. Box 2000, Sacramento, CA 95812-2000
Tel: (916) 341-5300 Fax: (916) 341-5400
http://www.waterboards.ca.gov/waterrights

PETITION FOR CHANGE INVOLVING WATER TRANSFERS

Separate petitions are required for each water right. Mark all areas that apply to your proposed change(s). Incomplete forms may not be accepted. Location and area information must be provided on maps in accordance with established requirements. (Cal. Code Regs., tit. 23, § 715 et seq.) Provide attachments if necessary.

☐ **Point of Diversion** Wat. Code, § 1701
☐ **Point of Rediversion** Wat. Code, § 1701
☐ **Place of Use** Wat. Code, § 1701
☐ **Purpose of Use** Wat. Code, § 1701
☐ **Temporary Urgency** Wat. Code, § 1435
☒ **Temporary Change** Wat. Code, § 1725
☐ **Long-term Transfer** Wat. Code, §§ 382, 1735
☐ **Instream Flow Dedication** Wat. Code, § 1707

Application 18085 Permit 13856 License NA Statement NA

I (we) hereby petition for change(s) noted above and described as follows:

Point of Diversion or Rediversion – Provide source name and identify points using both Public Land Survey System descriptions to ¼-¼ level and California Coordinate System (NAD 83).
Present: Please refer to Attachment A of the attached Environmental Information for Petition.

Proposed: Please refer to Attachment A of the attached Environmental Information for Petition.

Place of Use – Identify area using Public Land Survey System descriptions to ¼-¼ level; for irrigation, list number of acres irrigated.
Present: Please refer to Attachment A of the attached Environmental Information for Petition.

Proposed: Please refer to Attachment A of the attached Environmental Information for Petition.

Purpose of Use
Present: Please refer to Attachment A of the attached Environmental Information for Petition.

Proposed: Please refer to Attachment **A** of the attached Environmental Information for Petition.

Instream Flow Dedication – Provide source name and identify points using both Public Land Survey System descriptions to ¼-¼ level and California Coordinate System (NAD 83).
Upstream Location: NA

Downstream Location: NA

List the quantities dedicated to instream flow in either: ☐ cubic feet per second or ☐ gallons per day:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Will the dedicated flow be diverted for consumptive use at a downstream location? ☐ Yes ☐ No
If yes, provide the source name, location coordinates, and the quantities of flow that will be diverted from the stream.

Proposed New User(s)
Provide the names, addresses, and phone numbers for all proposed new user(s) of the water right.

East Bay Municipal Utility District
375 11th Street Oakland, CA 94607
PO BOX 24055 MS 407 OAKLAND CA 94623-1055
1-866-403-2683

Amount of Water to be Transferred

21,053.00 acre-feet will be transferred. If the basis of right is direct diversion, the average rate of diversion for the maximum 30-day period of use is cubic feet per second or million gallons per day.

General Information – Provide the following information, if applicable to your proposed change(s).

Have you attached an analysis which documents that the amount of water to be transferred or exchanged would have been consumptively used or stored in the absence of the proposed temporary change or long-term transfer? ☒ Yes ☐ No

Have you attached an analysis of any changes to streamflow, water quality, timing of diversion or use, return flows, or effects on legal users from the proposed temporary change or long-term transfer? ☒ Yes ☐ No

Have you attached an analysis that shows the proposed temporary change or long-term transfer will not unreasonably affect fish, wildlife, or other instream beneficial uses? ☒ Yes ☐ No

I (we) have access to the proposed point of diversion or control the proposed place of use by virtue of:
☐ ownership ☐ lease ☐ verbal agreement ☒ written agreement

If by lease or agreement, state name and address of person(s) from whom access has been obtained.

PCWA has access to the proposed point of diversion by virtue of written agreement with East Bay Municipal Utility District for the Proposed Points of Re-Diversion and Place of Use sought by this Petition.

Give name and address of any person(s) taking water from the stream between the present point of diversion or rediversion and the proposed point of diversion or rediversion, as well as any other person(s) known to you who may be affected by the proposed change.

U.S Department of the Interior Bureau of Reclamation; San Juan Water District; Carmichael Water District; County of Sacramento; City of Sacramento

Please refer to Attachment A of the attached Environmental Information for Petition for additional details.

All Right Holders Must Sign Below: I (we) declare under penalty of perjury that this involves only the amount of water which would have been consumptively used or stored in the absence of the proposed temporary change, and that the above is true and correct to the best of my (our) knowledge and belief.

Dated 5/24/22 at PLACER COUNTY WATER AGENCY, AUBURN CA

Right Holder or Authorized Agent Signature

Right Holder or Authorized Agent Signature

NOTE: All petitions must be accompanied by:
(1) the form Environmental Information for Petitions, available at:
http://www.waterboards.ca.gov/waterrights/publications_forms/forms/docs/pet_info.pdf
(2) Division of Water Rights fee, per the Water Rights Fee Schedule, available at:
http://www.waterboards.ca.gov/waterrights/water_issues/programs/fees/
(3) Department of Fish and Wildlife fee of $850 (Pub. Resources Code, § 10005)

State of California
State Water Resources Control Board
DIVISION OF WATER RIGHTS
P.O. Box 2000, Sacramento, CA 95812-2000
Tel: (916) 341-5300 Fax: (916) 341-5400
http://www.waterboards.ca.gov/waterrights

ENVIRONMENTAL INFORMATION FOR PETITIONS

This form is required for all petitions.

Before the State Water Resources Control Board (State Water Board) can approve a petition, the State Water Board must consider the information contained in an environmental document prepared in compliance with the California Environmental Quality Act (CEQA). <u>This form is not a CEQA document.</u> If a CEQA document has not yet been prepared, a determination must be made of who is responsible for its preparation. <u>As the petitioner, you are responsible for all costs associated with the environmental evaluation and preparation of the required CEQA documents.</u> Please answer the following questions to the best of your ability and submit any studies that have been conducted regarding the environmental evaluation of your project. If you need more space to completely answer the questions, please number and attach additional sheets.

DESCRIPTION OF PROPOSED CHANGES OR WORK REMAINING TO BE COMPLETED
For a petition for change, provide a description of the proposed changes to your project including, but not limited to, type of construction activity, structures existing or to be built, area to be graded or excavated, increase in water diversion and use (up to the amount authorized by the permit), changes in land use, and project operational changes, including changes in how the water will be used. For a petition for extension of time, provide a description of what work has been completed and what remains to be done. Include in your description any of the above elements that will occur during the requested extension period.

Placer County Water Agency (PCWA) proposes to transfer up-to 21,053 acre-feet (AF) of Middle Fork American River Project (MFP) water (Transfer Water) currently stored in Hell Hole Reservoir on the Rubicon River and French Meadows Reservoir on the Middle Fork American River to the East Bay Municipal Utility District (EBMUD) for designated beneficial use within the EBMUD service area. To accomplish this transfer, the following temporary (one year or less) changes in Place of Use (POU) and Point(s) of Rediversion (PORD) are being sought by Petition pursuant to PCWA Water Right Application 18085 (Permit No. 13856) consistent with California Water Code §1725-§1732, which includes:

1) Allow for rediversion of Transfer Water by EBMUD at the "Freeport Intake" owned by Freeport Regional Water Authority (FRWA) of which EBMUD is a member agency (Attachment B), and

2) Allow for the consumptive use of Transfer Water within the EBMUD service area boundaries (Attachment C) consistent with existing beneficial use designations.

Insert the attachment number here, if applicable: A

Coordination with Regional Water Quality Control Board

For change petitions only, you must request consultation with the Regional Water Quality Control Board regarding the potential effects of your proposed change on water quality and other instream beneficial uses. (Cal. Code Regs., tit. 23, § 794.) In order to determine the appropriate office for consultation, see: http://www.waterboards.ca.gov/waterboards_map.shtml. Provide the date you submitted your request for consultation here, then provide the following information.

Date of Request

05/24/2022

Will your project, during construction or operation, (1) generate waste or wastewater containing such things as sewage, industrial chemicals, metals, or agricultural chemicals, or (2) cause erosion, turbidity or sedimentation? ☐ Yes ☒ No

Will a waste discharge permit be required for the project? ☐ Yes ☒ No

If necessary, provide additional information below:

Consistent with Water Code § 1726, a copy of this Petition will be sent prior to Public Notice to:
Bryan Smith - Program Manager
Central Valley Regional Water Quality Control Board - Water Certification Division
11020 Sun Center Drive #200; Rancho Cordova, CA 95670-6114

Insert the attachment number here, if applicable:

Local Permits

For temporary transfers only, you must contact the board of supervisors for the county(ies) both for where you currently store or use water and where you propose to transfer the water. (Wat. Code § 1726.) Provide the date you submitted your request for consultation here.

Date of Contact

05/24/2022

For change petitions only, you should contact your local planning or public works department and provide the information below.

Person Contacted: Date of Contact:

Department: Phone Number:

County Zoning Designation:

Are any county permits required for your project? If yes, indicate type below. ☐ Yes ☒ No

Grading Permit Use Permit Watercourse Obstruction Permit

Change of Zoning General Plan Change Other (explain below)

If applicable, have you obtained any of the permits listed above? If yes, provide copies. ☐ Yes ☐ No

If necessary, provide additional information below:

Consistent with Water Code § 1726, a copy of this Petition will be sent prior to Public Notice to each respective Board of Supervisors in Placer County, Contra Costa County, and Alameda County.

Insert the attachment number here, if applicable:

Federal and State Permits

Check any additional agencies that may require permits or other approvals for your project:

☐ Regional Water Quality Control Board ☐ Department of Fish and Game

☐ Dept of Water Resources, Division of Safety of Dams ☐ California Coastal Commission

☐ State Reclamation Board ☐ U.S. Army Corps of Engineers ☐ U.S. Forest Service

☐ Bureau of Land Management ☐ Federal Energy Regulatory Commission

☐ Natural Resources Conservation Service

Have you obtained any of the permits listed above? If yes, provide copies. ☐ Yes ☐ No

For each agency from which a permit is required, provide the following information:

Agency	Permit Type	Person(s) Contacted	Contact Date	Phone Number

If necessary, provide additional information below:

No State or Federal Permits are required for this proposed project.

Consistent with Water Code § 1726, a copy of this Petition will be sent prior to Public Notice to the CDFW North Central Regional (R2) Manager at 1701 Nimbus Road, Rancho Cordova, CA 95670 Phone: (916) 358-2900.

Insert the attachment number here, if applicable:

Construction or Grading Activity

Does the project involve any construction or grading-related activity that has significantly altered or would significantly alter the bed, bank or riparian habitat of any stream or lake? ☐ Yes ☒ No

If necessary, provide additional information below:

NA

Insert the attachment number here, if applicable:

Archeology

Has an archeological report been prepared for this project? If yes, provide a copy. ☐ Yes ☒ No

Will another public agency be preparing an archeological report? ☐ Yes ☒ No

Do you know of any archeological or historic sites in the area? If yes, explain below. ☐ Yes ☒ No

If necessary, provide additional information below:

NA

Insert the attachment number here, if applicable:

Photographs

For all petitions other than time extensions, attach complete sets of color photographs, clearly dated and labeled, showing the vegetation that exists at the following three locations:

- ☐ Along the stream channel immediately downstream from each point of diversion
- ☐ Along the stream channel immediately upstream from each point of diversion
- ☐ At the place where water subject to this water right will be used

Maps

For all petitions other than time extensions, attach maps labeled in accordance with the regulations showing all applicable features, both present and proposed, including but not limited to: point of diversion, point of rediversion, distribution of storage reservoirs, point of discharge of treated wastewater, place of use, and location of instream flow dedication reach. (Cal. Code Regs., tit. 23, §§ 715 et seq., 794.)

Pursuant to California Code of Regulations, title 23, section 794, petitions for change submitted without maps may not be accepted.

All Water Right Holders Must Sign This Form:
I (we) hereby certify that the statements I (we) have furnished above and in the attachments are complete to the best of my (our) ability and that the facts, statements, and information presented are true and correct to the best of my (our) knowledge. Dated 05/24/2022 at Placer County Water Agency, Auburn, CA .

Water Right Holder or Authorized Agent Signature

Water Right Holder or Authorized Agent Signature

NOTE:
- **Petitions for Change may not be accepted unless you include proof that a copy of the petition was served on the Department of Fish and Game. (Cal. Code Regs., tit. 23, § 794.)**
- **Petitions for Temporary Transfer may not be accepted unless you include proof that a copy of the petition was served on the Department of Fish and Game and the board of supervisors for the county(ies) where you currently store or use water and the county(ies) where you propose to transfer the water. (Wat. Code § 1726.)**

Attachment A

Environmental Information for Petitions

Attachment A

Introduction

Placer County Water Agency (PCWA) proposes to transfer up-to 21,053 acre-feet (AF) of Middle Fork American River Project (MFP) water (Transfer Water) currently stored in Hell Hole Reservoir on the Rubicon River and French Meadows Reservoir on the Middle Fork American River (MFAR) to the East Bay Municipal Utility District (EBMUD) for designated beneficial use within the EBMUD service area. To accomplish this transfer, the following temporary (one year or less) changes in Place of Use (POU) and Point(s) of Rediversion (PORD) are being sought by Petition pursuant to PCWA Water Right Application 18085 (Permit No. 13856) and consistent with California Water Code §1725-§1732, which includes:

1) Allow for rediversion of Transfer Water by EBMUD at the "Freeport Intake" owned by Freeport Regional Water Authority (FRWA) of which EBMUD is a member agency (**Attachment B**), and
2) Allow for the consumptive use of Transfer Water within the EBMUD service area boundaries (**Attachment C**) consistent with existing beneficial use designations.

Transferring Agencies Overview

Placer County Water Agency

PCWA is a public agency created and existing pursuant to the provisions of the Placer County Water Agency Act (Water Code Appx. Ch. 81.). PCWA owns and operates the MFP and holds appropriative water rights for the MFP pursuant to Permits 13856 and 13858, issued on Applications 18085 and 18087, by the State Water Rights Board, predecessor to the State Water Resources Control Board (SWRCB). SWRCB Permits 13856 and 13858, both issued in 1963 and amended in 1975, allow for the combined diversion and storage of 315,000 Acre Feet per Annum (AFA) of MFP water held primarily in two on-stream storage reservoirs (French Meadows and Hell Hole Reservoir).

PCWA's MFP is a multi-purpose project designed to manage waters of the MFAR, the Rubicon River and tributaries thereto for beneficial Domestic, Municipal & Industrial, Recreational, and Irrigation uses as well as hydro-electrical power generation. Principal project features include two storage reservoirs, five associated diversion dams (Duncan, North Fork Long Canyon, South Fork Long Canyon, Middle Fork Interbay, and Ralston Afterbay), and five power plants (French Meadows, Hell Hole, Middle Fork, Ralston, and Oxbow).

For the purposes of this proposed 21,053 AF transfer, PCWA will be solely exercising Permit 13856, which allows for the storage and consumptive use of 249,000 AF of MFP water (25,000 AF at Duncan Creek diversion; 95,000 AF in French Meadows; and 129,000 in Hell Hole Reservoir).

East Bay Municipal Water District

EBMUD, a public utility, was formed under the Municipal Utility District (MUD) Act, passed by the California Legislature in 1921. EBMUD supplies water to 1.4 million people plus industrial, commercial, institutional, and irrigation water users in the East Bay region of the San Francisco Bay Area. EBMUD's 332-square-mile water service area encompasses incorporated and unincorporated areas within Alameda and Contra Costa Counties. EBMUD's principal raw water source is the Mokelumne River in the Sierra Nevada, with a diversion point at Pardee Reservoir in Calaveras and Amador Counties. EBMUD's existing water supplies are sufficient in non-drought years. To meet customer demands in dry years, EBMUD's water supplies can be supplemented with up to 133,000 AF of water from the Central Valley Project (CVP) or purchased via transfer water using the Freeport Facility with an intake located on the Sacramento River.

Due to California's persistent drought conditions, EBMUD is experiencing low water supply storage levels in Pardee Reservoir for 2022. As a result, EBMUD's Board of Directors declared a continuing water shortage emergency within EBMUD's service area, declared a Stage 2 drought, adopted a mandatory District-wide water use reduction goal of 10%, and declared the need to use the Freeport Facility to deliver supplemental supplies to EBMUD's service area. Since EBMUD's 2022 request for CVP dry-year contract deliveries only resulted in Public Health & Safety allocations, EBMUD needs to supplement its Mokelumne River and CVP supplies via the Transfer Water sought under this Petition to meet 2022 demands, even with the currently imposed restrictions in place. As such, the Transfer Water that PCWA intends to deliver to EBMUD will provide supplemental water to meet EBMUD customer demands during the declared District-wide Stage 2 Drought and will be used entirely within the EBMUD service area (**Attachment C**).

Description of Proposed Transfer

PCWA proposes to release up to 21,053 AF of stored surplus water from the MFP for the period spanning July 15, 2022 through September 30, 2022 (78 days) for transfer to EBMUD ("Transfer Water"). EBMUD proposes to redivert 20,000 AF (assuming 5% losses applied to 21,053 AF) using Freeport Intake. The Transfer Water will be released from Hell Hole Reservoir through Middle Fork Powerhouse, rediverted to Ralston Afterbay through Ralston Powerhouse, and ultimately released to the Middle Fork American River (MFAR) from Ralston Afterbay through Oxbow Powerhouse (Point of Delivery), a 6.1 Mega Watt (MW) hydroelectric generation facility that discharges approximately 1,040 cubic feet per second (cfs) at peak generating capacity. Ralston Afterbay is PCWA's most downstream regulating reservoir on the MFAR. Water released from Ralston Afterbay via the Oxbow Powerhouse flows for approximately 24 miles to confluence with the North Fork American River (NFAR) and then another 8 miles into Folsom Reservoir. The travel time for a release of 1,000 cfs (ramped up from a 200 cfs base flow) for this 32 mile stretch of the MFAR (between Ralston Afterbay and Folsom Reservoir) is approximately 14 hours. Folsom Reservoir is a POD and PORD under PCWA's consumptive water rights, including P13856. The use of Folsom Reservoir to temporarily store and subsequently release Transfer

Water will be covered under a Warren Act Agreement between EBMUD and Reclamation, if deemed necessary.

Reclamation would release the Transfer water from Folsom Reservoir to EBMUD on a schedule will not disrupt normal CVP or State Water Project (SWP) operations and will adhere to all current flow standards for the LAR (from Lake Natoma to the confluence with the Sacramento River) as well as the current regulatory requirements for Delta operations.

As described in **Attachment G**, Reclamation would release the Transfer Water from Folsom Reservoir on top of (in addition to) projected CVP operations resulting in increased LAR flows throughout the period of transfer.

PCWA 2022 Operations

As part of the Petition approval process, and consistent with §81-5(a) of the PCWA ACT, the PCWA Board of Directors must determine that the demands of their Placer County customers will be met prior to declaring that surplus water is available for an out-of-county transfer.

To make this determination, the volume of Transfer Water delivered must be measured against PCWA's baseline operations plan for 2022, which considers the following factors:

1. The most up-to-date hydrologic inflow forecasts (May 15, 2022)
2. All PCWA customer demands within Placer County based on American River Pump Station (ARPS) pumping limitations,
3. Contractual obligations to meet San Juan Water District (SJWD) and City of Roseville demands,
4. MFP FERC required recreational rafting releases,
5. MFP FERC required minimum instream flow requirements,
6. MFP FERC required minimum pool and carryover storage requirements,
7. Evaporative losses, and
8. Discretionary power releases.

PCWA anticipates a nearly full allocation of their 110,400 AF contracted Pacific Gas & Electric Drum-Spaulding Project supply in 2022 to meet demands within the Zone 6 Service Area. The Drum-Spaulding Project supply is the main source (and in some areas the sole source) for PCWA Service Area in Placer County and is supplemented by PCWA's American River Pump Station (ARPS) during high demands and PG&E outages. As such, PCWA anticipates an average year demand of 10,000 to 15,000 AF of MFP water from the ARPS in 2022.

In addition, both the City of Roseville (Roseville) and the San Juan Water District (SJWD) will use MFP water to supplement their demands in 2022 as a result of receiving a CVP M&I Health & Safety allocation for 2022 contract supplies. The 2022 delivery of MFP water to Roseville and SJWD will not be affected by this proposed transfer to EBMUD. Further, the delivery of MFP water to Sacramento

Suburban Water District has been suspended for 2022 as required by MFP water right conditions due to the projected inflow to Folsom being above the threshold for delivery (March – November UIFR <1.6 MAF).

Pursuant to §81-5(a)of the PCWA ACT, the PCWA Board of Directors must adopt a Resolution declaring a surplus of Middle Fork Project water in 2022 - asserting that the Agency will have a surplus to the Agency's needs in 2022.

Based on operations projections, that include the withdrawal of an additional 21,053 AF from MFP storage to transfer to EBMUD, the 2022/2023 MFP carryover storage target would be 111,630 AF, as shown in **Attachment E** and described in detail below. This 2022 carryover target includes a previous refill agreement deficit carried over from the 2020/2021 Transfers to Westlands Water District (WWD) of 17,317 AF.

MFP Carryover Storage/Refill Reservation

Depending on hydrologic conditions, PCWA has a typical end-of-the-year (December-February) combined carryover target (storage low point) of 150,000 AF in its MFP reservoirs (French Meadows and Hell Hole). Following dry year transfers of MFP water in 2020 and 2021, PCWA vacated and accrued a cumulative transfer refill deficit of 41,053 AF. In accordance with the approved 2021 Refill Agreement between PCWA, USBR, and DWR, the wet hydrologic conditions observed in December of 2021 resulted in PCWA accruing a refill of 23,736 AF of the cumulative transfer refill deficit. As such, the operational carryover target in 2022 resulting from a partial refill of the vacated storage would be 132,683 AF. The proposed 21,053 AF transfer requested under this Petition would require a new 2022 refill agreement executed between the Agency and USBR. PCWA would carry an additional 21,053 AF deficit in its MFP carryover target forward (totaling 38,370 AF) in time until conditions identified in the 2022 refill agreement allow refill of the deficit. As a result, the 2022 MFP combined end-of-year carryover target following the proposed transfer would be 111,630 AF.

In order to accomplish the transfer, PCWA proposes to release 21,053 AF of surplus water from MFP storage reservoirs during the months of July, August, and September of 2022. The proposed with-transfer carryover level of 111,630 AF (**Attachment E**) remains well above the minimum carryover level required by FERC of 49,966 AF of total combined storage (24,950 AF in French Meadows & 25,016 AF in Hell Hole) and is more than sufficient to meet PCWA’s downstream demands (e.g., consumptive water supply, minimum instream flow requirements, etc.) should water year 2023 be critically dry. The 21,053 AF of additional water released from MFP storage, which would have otherwise remained in storage in the absence of this transfer, is the water that is proposed to be transferred.

Period of Transfer/Exchange

As shown in the 2022 MFP Operation Plan (**Attachment E)**, PCWA is planning on the release of Transfer Water beginning on approximately July 15, 2022 (or immediately following approval of the Petition) through approximately September 30, 2022 (via Oxbow Powerhouse). Transfer releases are anticipated to be introduced to the MFAR at an average daily rate ranging from 130 cfs – 170 cfs, for a period of approximately 78 days, totaling 21,053 AF. Consistent with the conclusions made by Reclamation in their Record of Decision (ROD) signed on April 7, 2020 to implement Alternative No. 2 [Full Range of Transfers] (Proposed Action) analyzed in their Final Long-Term Water Transfers Environmental Impact Statement/Environmental Impact Report (EIS/EIR), which includes PCWA Temporary Transfers of up to 47,000 AF per year for the period 2020 through 2024, transfer water delivered via Folsom Reservoir could be released for delivery to EBMUD during the period of July through November, consistent with the most current 2019 Biological Opinion for the Long Term Operation of the CVP.

The dates targeted for transfer are contingent on regulatory approvals, PCWA MFP operational constraints, authorizations for points of rediversion, and the ability of Reclamation to release water from Folsom Reservoir to meet contractual obligations and support fisheries resources and water quality objectives in the LAR as well as the Delta.

Agency Coordination and Consultation

As a requirement of this transfer, PCWA will enter into a reservoir refill agreement with Reclamation. The refill agreement will ensure that other downstream legal users of water with vested rights in the American River watershed are not unreasonably affected or negatively impacted by the proposed transfer. Reclamation will coordinate with DWR to ensure refill conditions are met so as not to negatively impact SWP or CVP storage conditions. Reclamation will also coordinate SWP and CVP operations with DWR to ensure that Transfer Water is consistent with the Coordinated Operations Agreement.

To accomplish this transfer, if deemed necessary, EBMUD will execute a Warren Act Contract with Reclamation in order to temporarily store and convey the Transfer Water through CVP facilities. As part of this Warren Act contract (federal action), and as the Federal Lead Agency, Reclamation holds discretion for initiating consultation with NMFS and/or the USFWS under Section 7 of the Federal Endangered Species Act (FESA) for federally listed threatened and endangered species. In the Final Long-Term Water Transfers Environmental Impact Statement/Environmental Impact Report (EIS/EIR), EBMUD is covered as a buyer of transfer water with Freeport Intake being the point of rediversion.

Reclamation would ensure that Transfer releases adhere to applicable instream flow and temperature mandates in the LAR and Delta. As shown in **Attachment G**, and as concluded in similar PCWA transfers (2014/2015/2020/2021) approved by SWRCB, implementation of this Transfer would not harm and would provide reasonable temperature benefits to CESA and FESA listed species, as well as improving aquatic habitat conditions in the LAR.

Further, PCWA will be sending a copy of this Petition to the California Department of Fish and Wildlife (CDFW) as well as the Central Valley Regional Water Quality Control Board (CVRWQCB) who act as responsible agencies consistent with Water Code §1726(c).

Point of Diversion or Rediversion

Current:

A. PCWA's current points of diversion (POD) are located at California Grid Coordinates, Zone II, NAD 27, Mount Diablo B&M:

Water Body	POD Location	N	E	Quart.	Sec.	T-N	R-E
Duncan Creek	Duncan Creek	538,130	2,431,040	NW SW	24	15	13
M.F. American River	French Meadows	530,100	2,434,250	NW NE	36	15	13
Rubicon River	Hell Hole	510,750	2,452,000	SW SE	16	14	14
S.F. Long Canyon	Long Canyon	507,675	2,434,250	SW NE	24	14	13
N.F. Long Canyon	Long Canyon	506,970	2,431,250	NW SW	24	14	13
M.F. American River	Ralston Interbay	498,137	2,397,300	NW NE	35	14	12
M.F. American River	Ralston Afterbay	490,160	2,357,100	NW NW	3	13	11
N.F. American River	Auburn	444,400	2,267,400	NE SW	23	12	8

B. PCWA's current points of rediversion (PORD) are located at California Grid Coordinates, Zone II, NAD 27, Mount Diablo B&M:

Water Body	PORD	N	E	Quart.	Sec.	T-N	R-E
M.F. American River	French Meadows	530,100	2,434,250	NW NE	36	15	13
Rubicon River	Hell Hole	510,750	2,452,000	SW SE	16	14	14
M.F. American River	Ralston Interbay	498,137	2,397,300	NW NE	35	14	12
M.F. American River	Ralston Afterbay	490,160	2,357,100	NW NW	3	13	11
N.F. American River	Auburn	444,400	2,267,400	NE SW	23	12	8
American River	Folsom Dam	380,461	2,240,626	SW NE	24	10	7

Proposed Point(s) of Rediversion:

C. No changes are requested in this Petition for PCWA's current points of diversion or points of rediversion.

After release from the Point of Delivery (Oxbow Powerhouse), the Transfer Water will flow down the lower American and Sacramento Rivers to be rediverted, less carriage and conveyance losses (assumed to be 5%), at the Freeport Intake. After such rediversion, Transfer Water would be conveyed to the EBMUD service area using EBMUD-owned facilities or facilities covered in the Warren Act contract with Reclamation.

Accordingly, PCWA proposes to temporarily add the following point of rediversion under this Petition:

Freeport Regional Water Authority Intake (Freeport Intake)

This Point of Rediversion is located 38° 28' 21.28" N; 121° 30' 23.44" W, California Coordinate System, Zone 3, NAD 83, being within the SW ¼ of NE ¼ of Section 11, T7N, 4E, MDB&M. This proposed Point of Rediversion is identified on maps filed with the Division of Water Rights (Division) under the Reclamation CVP Water Rights and is also shown in **Attachment B**.

PCWA Place of Use

Current: Western Placer County and northern Sacramento County, as shown on a map set dated July 31, 1996 on file with the Division and as shown in **Attachment D**.

Proposed: No change in PCWA's current POU is proposed; PCWA proposes to add the service area of EBMUD as an additional POU to facilitate the temporary water transfer to EBMUD. This proposed temporary (one year) addition to the PCWA POU includes the EBMUD service area as shown in **Attachment C**.

Purpose of Use

Current: Domestic, Municipal & Industrial, Recreational, Irrigation.

Proposed: No change is being requested in PCWA's current purpose of use within its designated POU; EBMUD would use the Transfer Water predominantly for Municipal & Industrial uses within its service area.

Season of Use, Direct Diversion Use (cfs), and Storage (AF)

Current: See project description and water rights permit.

Proposed: No change requested.

Access to Proposed Point of Rediversion

EBMUD is a member of the FRWA, which owns and operates the Freeport intake facilities at the proposed new point of rediversion. PCWA and EBMUD have an agreement under which EBMUD would divert water made available for transfer by PCWA in 2022. EBMUD, therefore, would divert the water (20,000 AF after losses) at the proposed point of rediversion using EBMUD's allocated portion of the Freeport Intake capacity. For purposes of the rediversion of water under Permit 13856, PCWA would have access to that location through its agreement with EBMUD; EBMUD's address and Point of Contact for this purpose are as stated in the petition.

The proposed transfer/exchange water is presently used or stored within the county/counties of:

Placer & Sacramento

<u>The proposed transfer/exchange water will be beneficially used within the following county/counties:</u>

Alameda & Contra Costa

<u>Checklist Questions:</u>

1a. Would the transfer/exchange water have been consumptively used or stored in the absence of the proposed temporary change (See WC 1725)?

<u>Yes.</u> The 21,053 AF of proposed Transfer Water is currently stored in PCWA's MFP reservoirs and would remain in storage absent this transfer, as described above.

1b. Provide an analysis which provides documentation that the amount of water to be transferred/exchanged would have been consumptively used or stored in the absence of the proposed temporary change.

To provide EBMUD with the Transfer Water sought under this Petition, PCWA proposes to transfer a surplus 21,053 AF of MFP storage, which as of May 23, 2022 is at 271,000 AF (102% of average YTD). As stated above, the release of this surplus water would be accomplished in synchronization with PCWA's hydroelectric power generation between July 15, 2022 and September 30, 2022. **Attachment E** shows the 2022 MFP operational plan both with and without the transfer. Please refer to the ***PCWA 2022 Operations*** discussion above for justification that the Transfer Water would have been consumptively used or stored in the absence of the proposed temporary change. Consistent with §81-5 of the PCWA ACT, the Agency must ensure that the needs of their Placer County customers are met prior to determining that surplus water is available for out-of-county transfer and/or sale.

2a. If the point of diversion/rediversion is being changed, are there any person(s) taking water from the stream between the present point of diversion/rediversion and the proposed point?

Yes – Execution of a refill agreement will ensure that other downstream legal users of water are not unreasonably affected or negatively impacted by the proposed transfer. In addition, See 2b.

2b. Are there any persons taking water from the stream between the present point of diversion or return flow and the proposed point of diversion or return flow?

There are several water users taking water from the American River between PCWA's current points of return flow and the points at which any downstream water user would return water to the system. PCWA would not transfer water such that it would adversely impact water users within the PCWA service area and PCWA will continue to deliver MFP stored water (Roseville, SJWD, and PCWA Zone 6 via ARPS) as described above to its existing Placer County customers with or without the proposed temporary water transfer. In addition, PCWA will be entering into a refill agreement with Reclamation to ensure that there are no adverse impacts to the SWP/CVP or any other downstream users during the refill of the MFP reservoirs following the transfer. Therefore, there will be no change in the return flow pattern to water users within PCWA's service area or impacts to other downstream users of water.

3a. Provide an analysis of any changes in streamflow, water quality, timing of diversion or use, return flows, or effects on legal users resulting from the proposed transfer/exchange.

Middle Fork and North Fork American Rivers

This transfer will not significantly alter flows, water quality, or reduce the ability for legal users to lawfully take water on the Middle Fork and/or North Fork American rivers when compared to baseline conditions of PCWA's MFP operations. During the transfer period, PCWA will be generating power, as is always done during periods of peak summer energy demand. Peak power generation at the point of transfer release, at Oxbow Powerhouse, is 6 megawatts (MW) which equates to a discharge of approximately 1,040 cfs. The release of Transfer Water would generally occur at times when PCWA is not using the full generation capacity at Oxbow Powerhouse and would occur within the 'shoulder hours' or off-peak times when generation is typically not scheduled. As such, PCWA's release of Transfer Water will, therefore, fall into the same range of flows (approximately 150 cfs to 1,100 cfs) that occur normally in the Middle Fork and North Fork American rivers, during recreational whitewater rafting flow releases or during periods of peak generation common for the spring and summer months.

Physical habitat and water chemistry conditions in the tributary streams and rivers associated with the MFP are of high quality, with low concentrations of mineral constituents and other substances generally conforming to regulatory water quality objectives and standards. Historical data shows that generally all of the constituents analyzed in project-affected waters (within and downstream of project impoundments) complied with current regulatory standards; Water Quality Technical Study Report - AQ 11 prepared in support of the Federal Energy Regulatory Commission (FERC) Environmental Impact Statement (EIS) for PCWA's MFP FERC Relicensing Project No. 2079 is provided electronically as **Attachment F** for a detailed description of general water quality conditions within the MFP watershed.

In addition, as owner and operator of a Public Water System, PCWA conducts routine California Code of Regulations (CCR) Title 22 water quality sampling at the ARPS (approximately four miles upstream of Folsom Reservoir pursuant to Section 116275 of the California Safe Drinking Water Act, which is contained in Part 12, Chapter 4 of the California Health and Safety Code. PCWA's California Department of Public Health and Safety (DPHS) Monitoring requirements set forth in California Department of Public Health and Safety Permit No. 01-02-07(P) 003 issued on December 10, 2007 are set to ensure that MFP surface water diverted from the North Fork American River at the ARPS meets current DPHS drinking water standards as well as Central Valley Regional Water Quality Control Plan (Basin Plan) Water Quality Standards and Objectives. Data from the ARPS DPHS water quality sampling for 2021 is also attached electronically in **Attachment F** as an example of the high-quality water received from the American River Basin.

Based on the clean, cold, generally high-quality water released from the MFP, the increase in timing, duration, and magnitude of flows during the transfer period will benefit downstream water temperatures and instream flow conditions as detailed in **Attachment G.**

Receiving Water Bodies: Lower American and Sacramento Rivers

After release at Oxbow Powerhouse, Transfer Water will flow first into Folsom Reservoir where it will be temporarily held in storage by Reclamation and scheduled for release to Freeport Intake (**Attachment B**). **Attachment G** shows that Transfer Water will, in general, decrease the temperature of water from the North Fork American River entering Folsom Reservoir - as well as slightly decrease temperatures in the Lower American River when released in July, August, and September. Reclamation will ultimately be responsible for coordination and scheduling of the volume and timing of releases from Folsom Reservoir to the Point of Rediversion so that conditions are realized in the receiving water bodies consistent with existing state and federal regulations, endangered species acts, and all biological opinions in effect at the time of the transfer. These releases from Folsom will enter the LAR which in turn flows into the Sacramento River.

Although Transfer Water may be released by PCWA and rediverted by EBMUD for a period of up to one year or less from the date of SWRCB approval (Water Code §1728), it is currently anticipated that the water will be released from the MFP July through September as shown in **Attachment E**. In case there are operational issues in transferring the full amount during the July through September period, the rediversion may be extended to October consistent with the Final Long-Term Water Transfers Environmental Impact Statement/Environmental Impact Report (EIS/EIR). During these summer months, stream flows in the American River, Sacramento River, and Sacramento-San Joaquin Delta are typically dominated by CVP and SWP releases to meet Delta Water Quality objectives, fulfill contractual deliveries, and facilitate temporary water transfers. This is largely due to the fact that the normal, historical unimpaired hydrology of the American and Sacramento rivers, as well as those of the Delta and its tributaries, would typically support a declining hydrograph during these summer months. In a year like 2022 when CVP/SWP deliveries have been significantly cut, PCWA's 'supplemental' Transfer releases will have a greater ability to benefit the biological resources downstream of the MFP. As shown in **Attachment G**, modeling indicates that the Transfer will slightly benefit water temperatures in the lower American River over the summer with water released on top of Reclamations projected operations for Folsom Reservoir.

Thus, while the exact schedule and daily volume of transfer releases that will be implemented by Reclamation operations for Folsom Reservoir cannot be stated with precision at this time, it is the intent to make transfer releases from Folsom during July, August, and September as described **Attachment G**.

Furthermore, this determination is consistent with the conclusions made by Reclamation in their Record of Decision (ROD) signed on April 7, 2020 to implement Alternative No. 2 [Full Range of Transfers] (Proposed Action) analyzed in their Final Long-Term Water Transfers Environmental Impact Statement/Environmental Impact Report (EIS/EIR), which includes PCWA Temporary Transfers of up to 47,000 AF per year for the period 2021 through 2024.

3b. State reasons you believe the proposed temporary change will not injure any legal user of the water, see Water Code Section 1727(b)(1).

No legal user of water will be injured due to PCWA's transfer since the transfer of water will only slightly increase, not decrease, streamflow below PCWA's MFP reservoirs. Any such increase will be minor and will not cause any water flows to increase above normal seasonal levels, nor would the increased flows violate regulatory flow requirements as Reclamation will be adhering to their CVP Biological Opinion and the MFMS for the LAR. The 21,053 AF of proposed Transfer Water is currently held in storage in accordance with PCWA's water rights and would not be available to any other legal user of water absent this transfer. The Transfer will not affect PCWA's ability to meet future demands or contractual obligations – even if water year 2023 is dry. Additionally, PCWA will enter into a reservoir refill agreement with Reclamation, ensuring that future refill of any storage deficit in PCWA's MFP reservoirs created by the transfer will not reduce the amount of water the SWP/CVP or other water users could otherwise divert during the hydrologic refill cycle following the transfer.

4. Consult with staff of the applicable Regional Water Quality Control Board concerning the proposed temporary change. State the name and phone number of person(s) contacted. Summarize their opinion concerning compliance with CCR 794(b) and any Regional Board requirements.

PCWA will send a copy of this Petition prior to the posting of the Public Notice and opening of the 15-day comment period to the CVRWQCB. PCWA has executed numerous transfers similar to this proposed transfer in the past without any concerns in water quality noted by the CVRQWCB. The MFP water proposed for transfer is very high-quality runoff derived predominantly from snowmelt and rains falling in largely undeveloped higher elevation portions of Placer County in the Sierra Nevada's. As detailed above and as referenced in **Attachment G**, the slight increase in flows in downstream reaches resulting from this transfer will improve water quality by decreasing or moderating water temperatures in the LAR.

5a. Consult with the California Department of Fish and Wildlife (CDFW) pursuant to 14 CCR 794(b) concerning the proposed temporary change. State the name and phone number of the person(s) contacted and their opinion concerning the potential effect(s) of the proposed temporary change on fish, wildlife, or other instream beneficial uses, and state any measures recommended for mitigation.

Consistent with Water Code § 1726, a copy of this Petition will be sent prior to Public Notice to the CDFW North Central Regional Manager at 1701 Nimbus Road, Rancho Cordova, CA 95670 Phone: (916) 358-2900. PCWA expects CDFW to concur that the transfer will not unreasonably affect fish or wildlife resources because very similar transfers have occurred in the past with no adverse impacts identified by CDFW. In the past, CDFW has advocated such PCWA transfers as part of the transfer of water to the CAL-FED Environmental Water Account (EWA). CDFW has reviewed many similar transfers from PCWA since the early 1990's and have never indicated that instream beneficial uses would be adversely affected by the introduction of PCWA Transfer Water to downstream reaches.

5b. Does the proposed use serve to preserve or enhance wetlands habitat, fish and wildlife resources, or recreation in or on the water (See WC § 1707)?

No. This Petition is not for instream flow dedication pursuant to WC § 1707.

While the primary purpose of this Petition will be for designated beneficial uses within the EBMUD service area, the release of Transfer Water from PCWA's MFP reservoirs will provide up to 21,053 AF of supplementary flows in the Middle Fork and North Fork American rivers to the proposed Point of Rediversion providing multiple benefits along the way as described herein.

Releasing 21,053 AF of transfer water in a drier year provides additional benefits including, achieving drier year flow augmentation objectives in the Lower American River, enhancing drier year hydropower generation, and potentially enhancing commercial and recreational rafting opportunities in the MFAR.

Making additional water available to PCWA's and Reclamation's powerhouses during the peak summer power load is important for grid regulation in California. Hydroelectric power generation is the primary source of flexible generation used by the California ISO to regulate the fluctuations of the electric grid in California. The MFP is regularly called upon by California ISO to provide critical grid support services when abrupt changes in load occur.

PCWA's summer power generation releases support the regional whitewater economy and a whitewater rafting industry averaging approximately 20,000 user-days on the MFAR. The prime rafting season starts on Memorial Day weekend (May 28th-29th) and extends through September 30th. The proposed Transfer will likely increase recreational opportunities in the MFAR during the summer period above the baseline releases required under PCWA's FERC license for a Below Normal water year type.

5c. Provide an analysis of potential effect(s) on fish, wildlife, or other instream beneficial uses which may arise from the proposed change.

As explained above, the proposed transfer will improve water quality and provide numerous benefits for many instream beneficial uses including fish and wildlife resources. There is no evidence that the proposed transfer will negatively affect fish and wildlife or other beneficial instream uses in any unreasonable, significant, or measurable way.

When the Transfer Water is diverted at the Freeport intake facility (**Attachment B**), all applicable existing state and federal regulations will be followed for the operation of the facilities. Additionally, there is close monitoring and coordination between Reclamation, USFWS, NMFS, and the CDFW regarding the effects of operations on the sensitive aquatic species inhabiting the LAR based on the ambient conditions and water levels of Folsom Reservoir at the time of the Transfer. Because all state and federal resource agencies are currently working closely on LAR flow conditions, if any adverse condition arises, they will be quick to react to avoid significant impacts to species of special concern (i.e., listed and protected under state or federal laws).

PCWA has submitted numerous change petitions for temporary transfers over the years, which have all been granted by the SWRCB without cause for concern and have never been associated with or responsible for identifiable adverse water quality or flow conditions resulting in take of any listed species nor have these transfers ever adversely affected downstream beneficial uses.

5d. State reasons you believe the proposed temporary change will not unreasonably affect fish, wildlife, or other instream beneficial uses, see Water Code Section 1727(b)(2).

See response to Question 5c above.

6a. Does any agency involved in the proposed transfer/exchange rely upon section 382 of the Water Code to allow the delivery of water outside of the agency's service area?

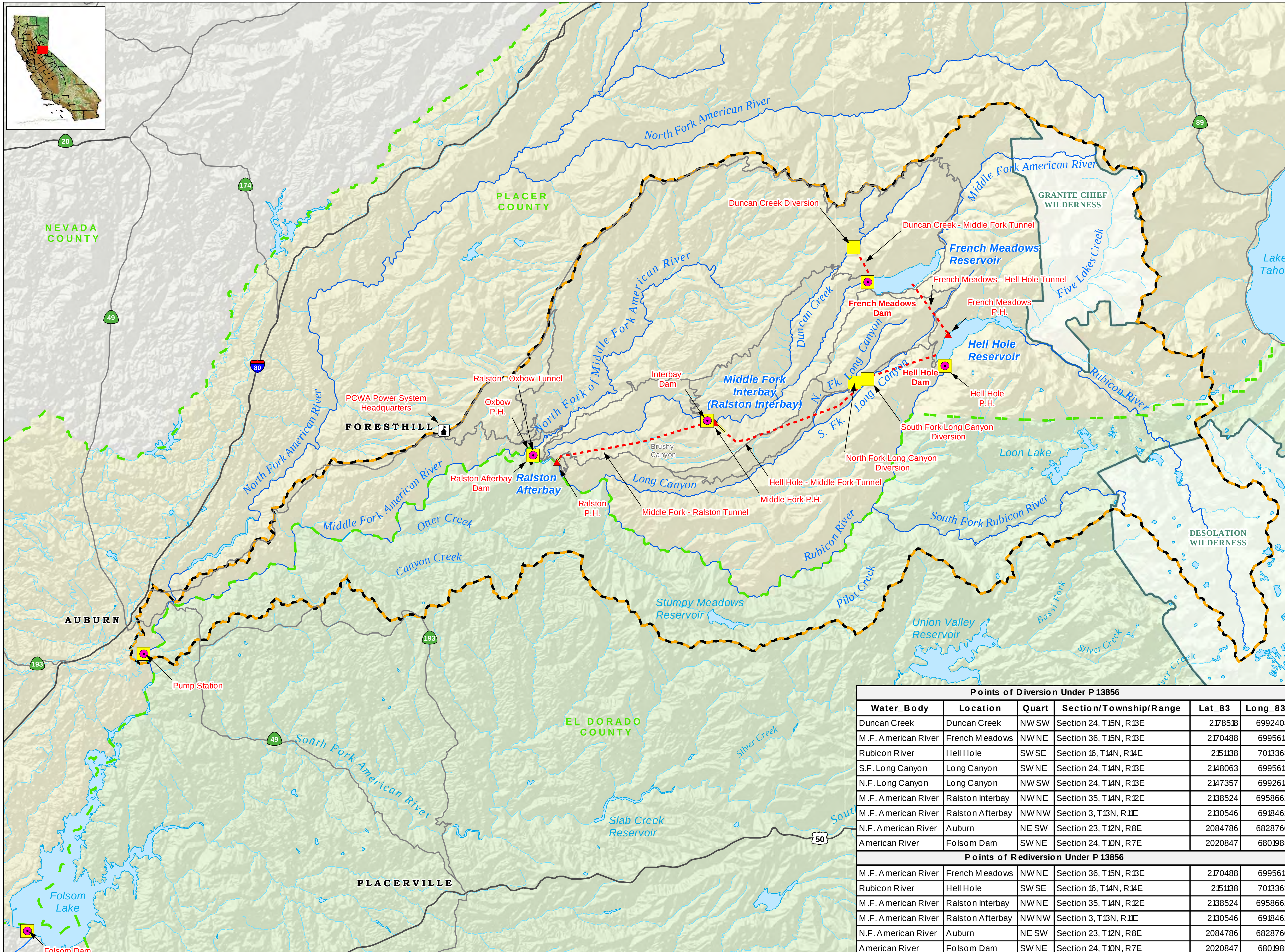
No. PCWA has independent legal authority for this transfer under §81-5 of the PCWA ACT. (See Water Code Appx. Ch. 81.)

6b. If yes, provide an analysis of the effect of the proposed transfer/exchange on the overall economy of the area from which the water is being transferred.

N/A

Attachment B

PCWA & EBMUD Points of Diversion and Rediversion



Points of Diversion Under P 13856					
Water_Body	**Location**	**Quart**	**Section/Township/Range**	**Lat_83**	**Long_83**
Duncan Creek	Duncan Creek	NW SW	Section 24, T15N, R13E	2178518	6992403
M.F. American River	French Meadows	NW NE	Section 36, T15N, R13E	2170488	6995613
Rubicon River	Hell Hole	SW SE	Section 16, T14N, R14E	2151138	7013363
S.F. Long Canyon	Long Canyon	SW NE	Section 24, T14N, R13E	2148063	6995613
N.F. Long Canyon	Long Canyon	NW SW	Section 24, T14N, R13E	2147357	6992613
M.F. American River	Ralston Interbay	NW NE	Section 35, T14N, R12E	2138524	6958662
M.F. American River	Ralston Afterbay	NW NW	Section 3, T13N, R11E	2130546	6918462
N.F. American River	Auburn	NE SW	Section 23, T12N, R8E	2084786	6828760
American River	Folsom Dam	SW NE	Section 24, T10N, R7E	2020847	6801985
Points of Rediversion Under P 13856					
M.F. American River	French Meadows	NW NE	Section 36, T15N, R13E	2170488	6995613
Rubicon River	Hell Hole	SW SE	Section 16, T14N, R14E	2151138	7013363
M.F. American River	Ralston Interbay	NW NE	Section 35, T14N, R12E	2138524	6958662
M.F. American River	Ralston Afterbay	NW NW	Section 3, T13N, R11E	2130546	6918462
N.F. American River	Auburn	NE SW	Section 23, T12N, R8E	2084786	6828760
American River	Folsom Dam	SW NE	Section 24, T10N, R7E	2020847	6801985

Project Facilities*

- Powerhouse
- Tunnel
- Penstock

* All MFP facilities labeled in red.

Transportation

- Major Road
- Minor Road

Hydrography

- Watercourse
- Water Body

Designated Boundary

- County Boundary
- Wilderness Area
- Middle Fork American River Watershed**

**Modified from Calwater Ver. 2.2 to represent drainage above high-water mark of Folsom Lake

Points of Diversion (POD) and Rediversion (PORD)

- POD
- PORD

PCWA

Placer County Water Agency
PCWA Petition for Change Involving Water Transfers
February 2014

Attachment B1

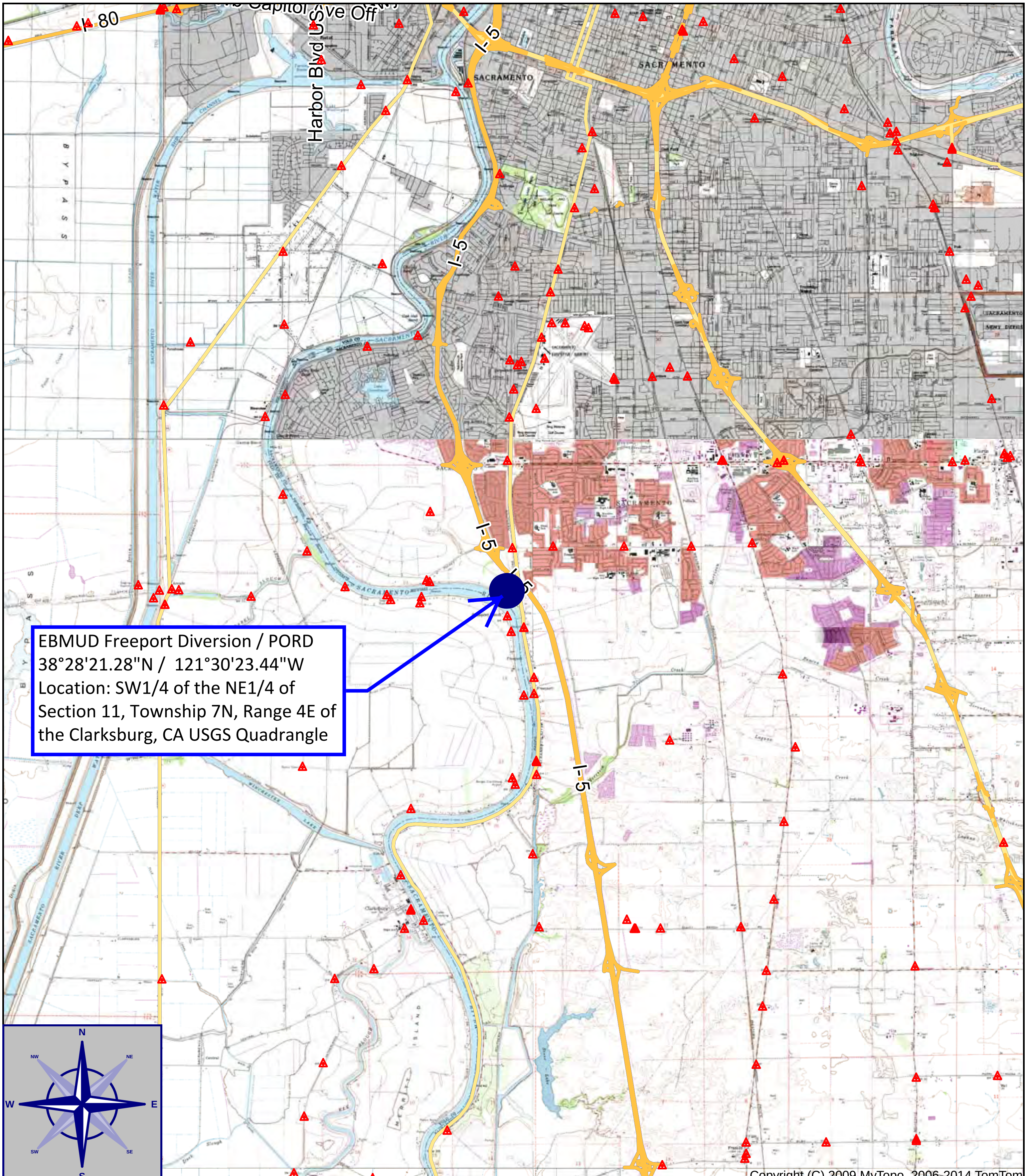
Points of Diversion and Rediversion under P13856

Date: 5/1/2013

0 0.5 1 2 3 4 5 Miles

Projection: CA State Plane, Zone 2
Datum: NAD 83

\\Sac-fs01\gis\GIS\Entrix\3116501\map\HydroMaps\PCWA_POD_PODR_17i11i_01.mxd



ATTACHMENT B2:
FREEPORT DIVERSION / EBMUD PORD

SWRCB TRANSFER PETITION
PCWA/EBMUD

June 2015

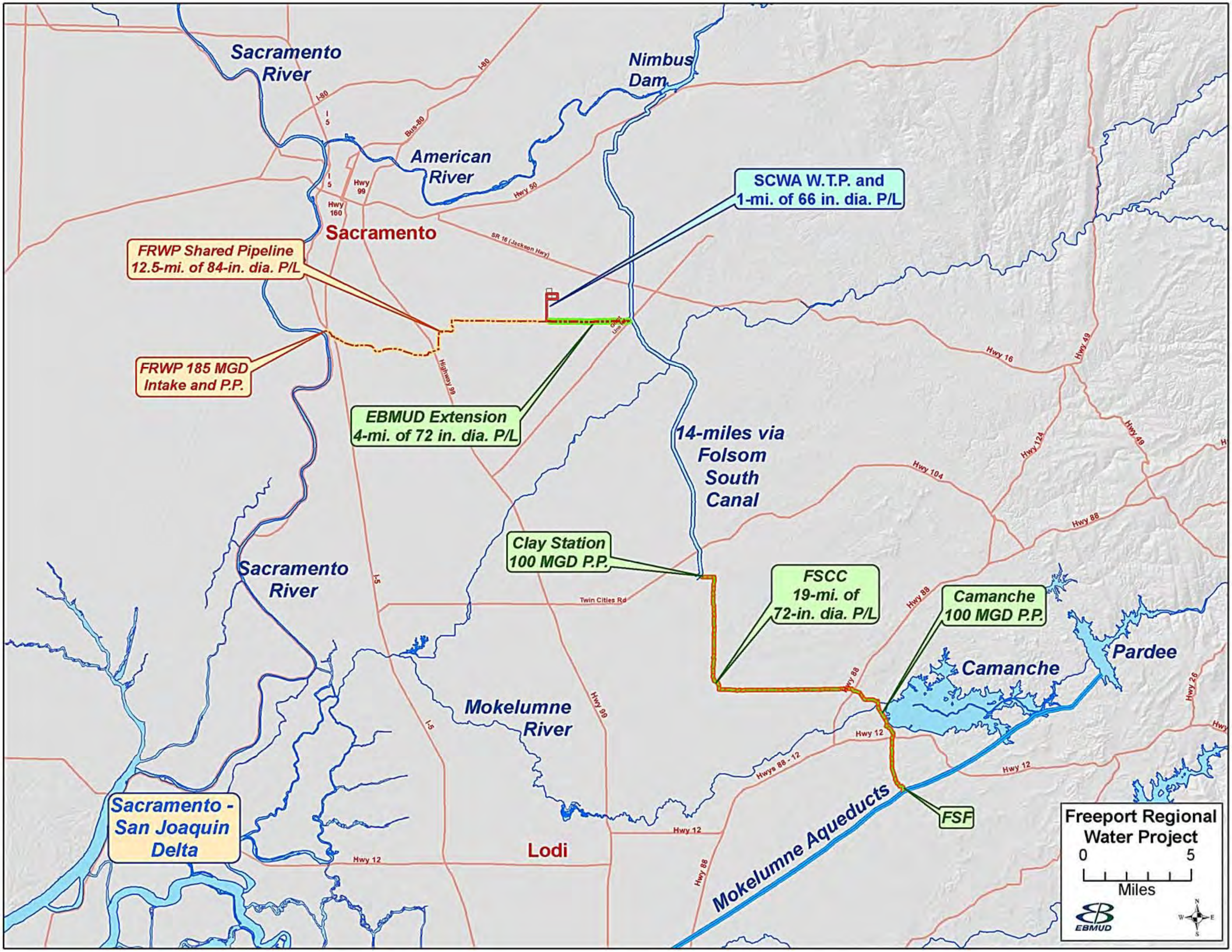
SCALE 1:96000

0 1 2 3 4 5 6 MILES

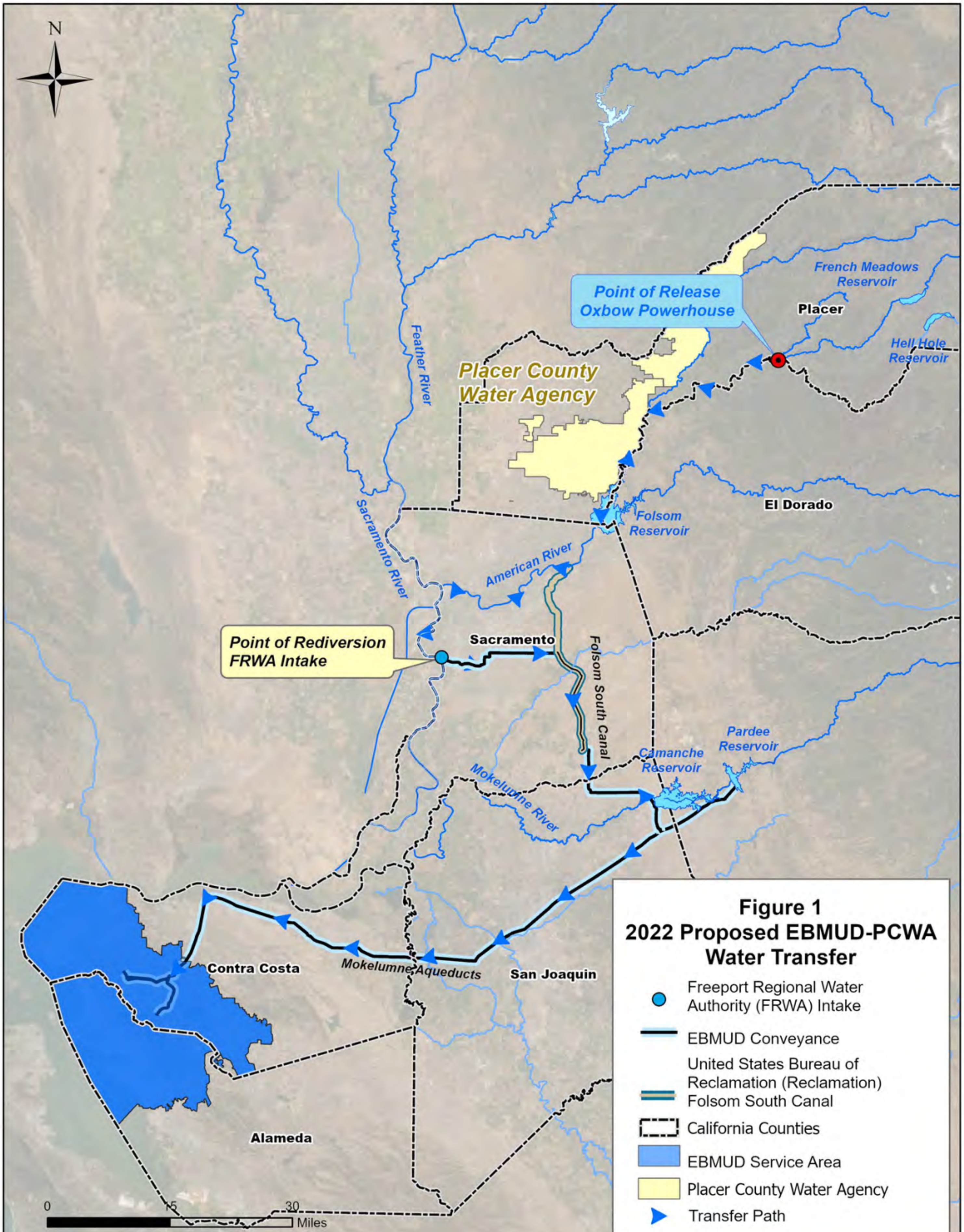
0 10000 20000 30000 FEET

0 10000 METERS

Attachment B3- EBMUD Freeport Diversion



Sacramento River
Nimbus Dam
I-80
I-5
Bus-80
American River
Hwy 99
Hwy 160
Hwy 50
SCWA W.T.P. and 1-mi. of 66 in. dia. P/L
Sacramento
SR 16 (Jackson Hwy)
FRWP Shared Pipeline 12.5-mi. of 84-in. dia. P/L
FRWP 185 MGD Intake and P.P.
Highway 99
EBMUD Extension 4-mi. of 72 in. dia. P/L
Hwy 16
Hwy 49
14-miles via Folsom South Canal
Hwy 124
Hwy 104
Hwy 88
Clay Station 100 MGD P.P.
Sacramento River
FSCC 19-mi. of 72-in. dia. P/L
Twin Cities Rd
Camanche 100 MGD P.P.
Pardee
Camanche
Mokelumne River
Hwy 12
Hwys 88 - 12
Hwy 26
Mokelumne Aqueducts
FSF
Sacramento - San Joaquin Delta
Lodi
Freeport Regional Water Project
0
5
Miles
EBMUD


N
Point of Release
Oxbow Powerhouse
French Meadows
Reservoir
Placer
Hell Hole
Reservoir
Feather River
Placer County
Water Agency
Sacramento River
Folsom
Reservoir
El Dorado
American River
Point of Rediversion
FRWA Intake
Sacramento
Folsom South Canal
Pardee
Reservoir
Camanche
Reservoir
Mokelumne River
Contra Costa
Mokelumne Aqueducts
San Joaquin
Alameda
0
15
30
Miles
Figure 1
2022 Proposed EBMUD-PCWA
Water Transfer
Freeport Regional Water
Authority (FRWA) Intake
EBMUD Conveyance
United States Bureau of
Reclamation (Reclamation)
Folsom South Canal
California Counties
EBMUD Service Area
Placer County Water Agency
Transfer Path

Attachment C

East Bay Municipal Utility District POU

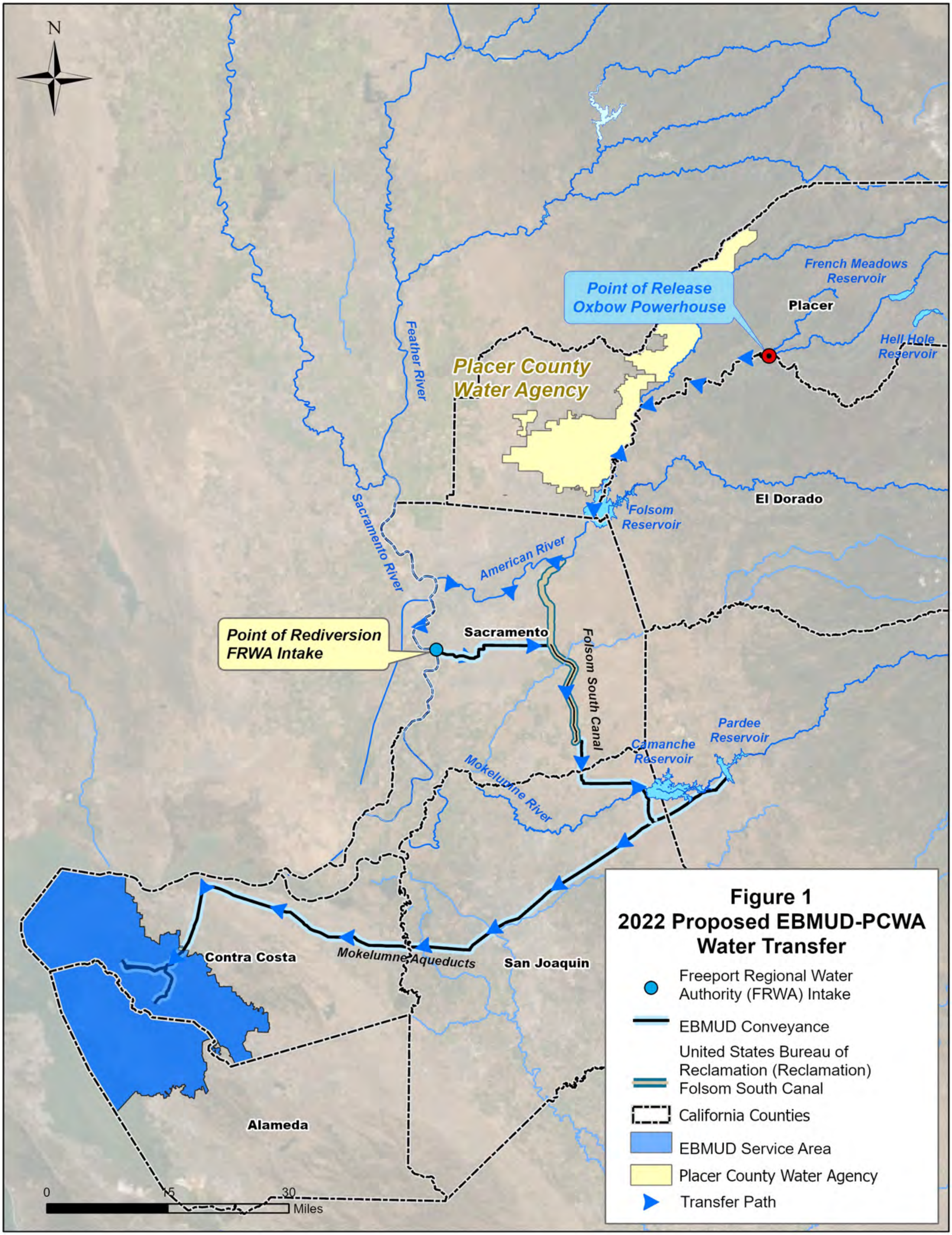
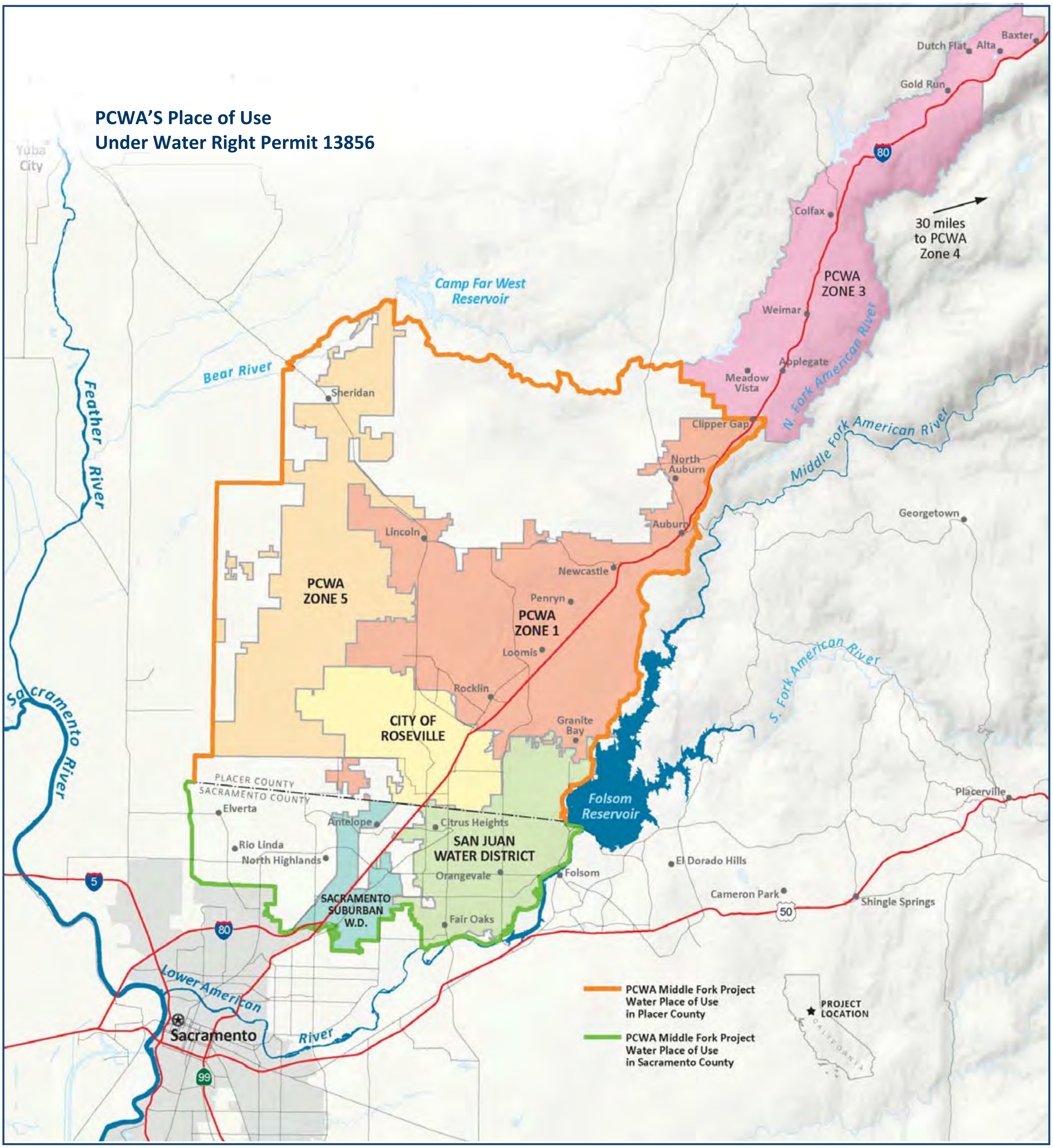


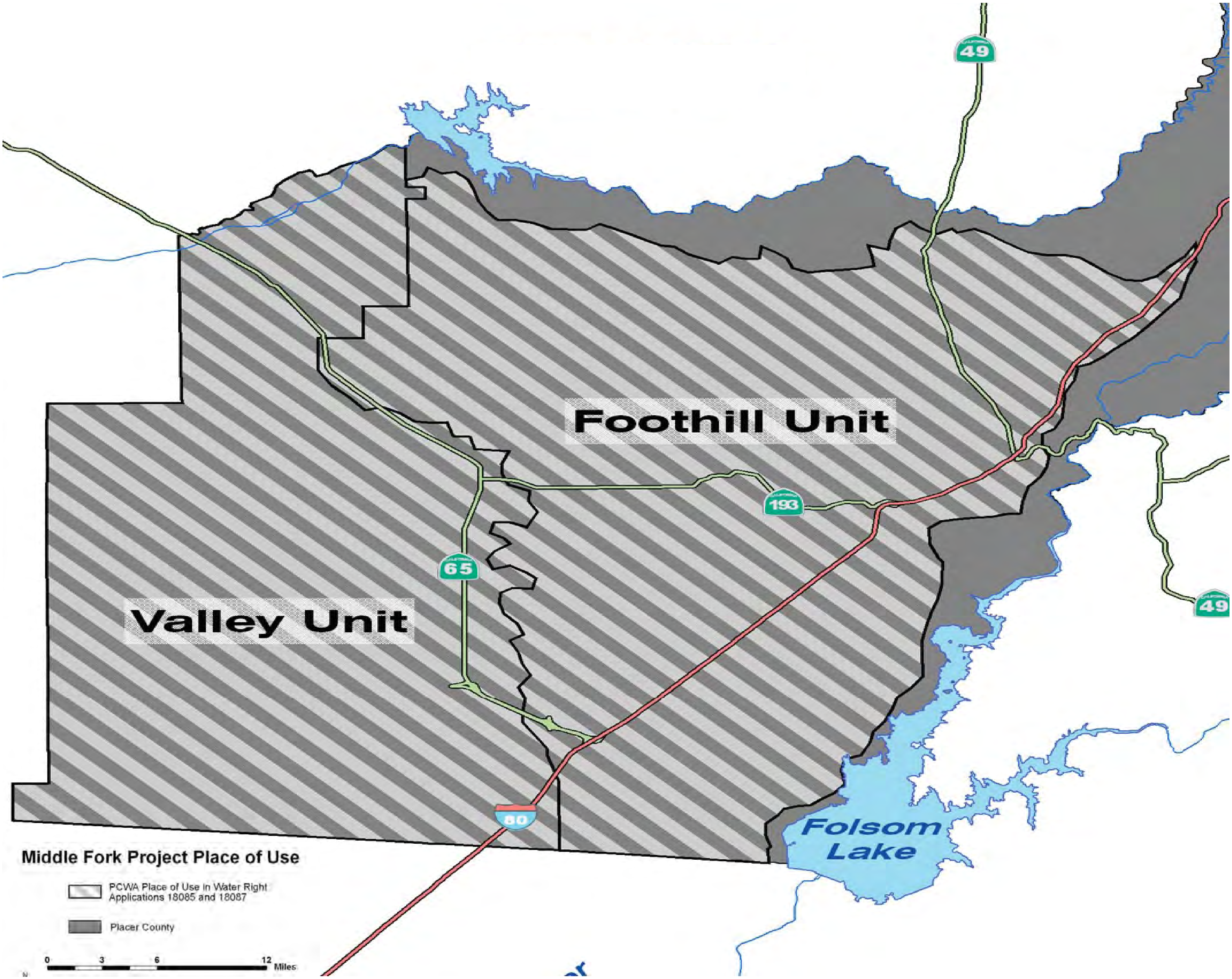
Figure 1
2022 Proposed EBMUD-PCWA Water Transfer

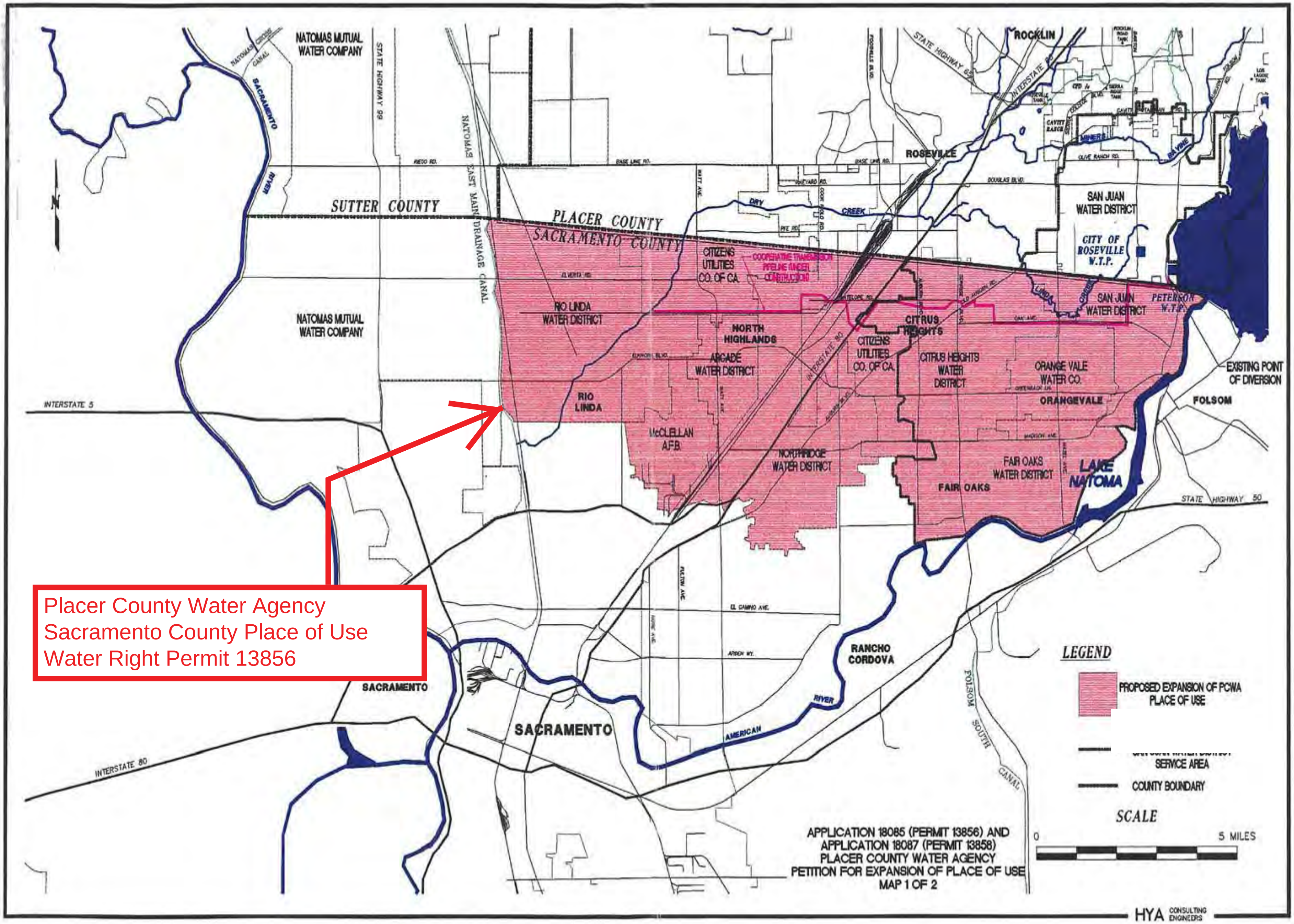
Current Area Served
EBMUD'S Sphere of Influence by LAFCO
EBMUD Ultimate Service Boundary
San Pablo Bay
Suisun Bay
San Francisco Bay
Crockett
Rodeo
Pinole
Hercules
San Pablo
Richmond
El Cerrito
Albany
Berkeley
Emeryville
Piedmont
Oakland
Alameda
San Francisco
San Leandro
San Lorenzo
Castro Valley
Orinda
Lafayette
Moraga
Walnut Creek
Pleasant Hill
Alamo
Danville
San Ramon
Briones Reservoir
San Pablo Reservoir
Lafayette Reservoir
Upper San Leandro Reservoir
Chabot Reservoir
80
780
680
4
242
580
24
880
980
13
NOT TO SCALE

Attachment D

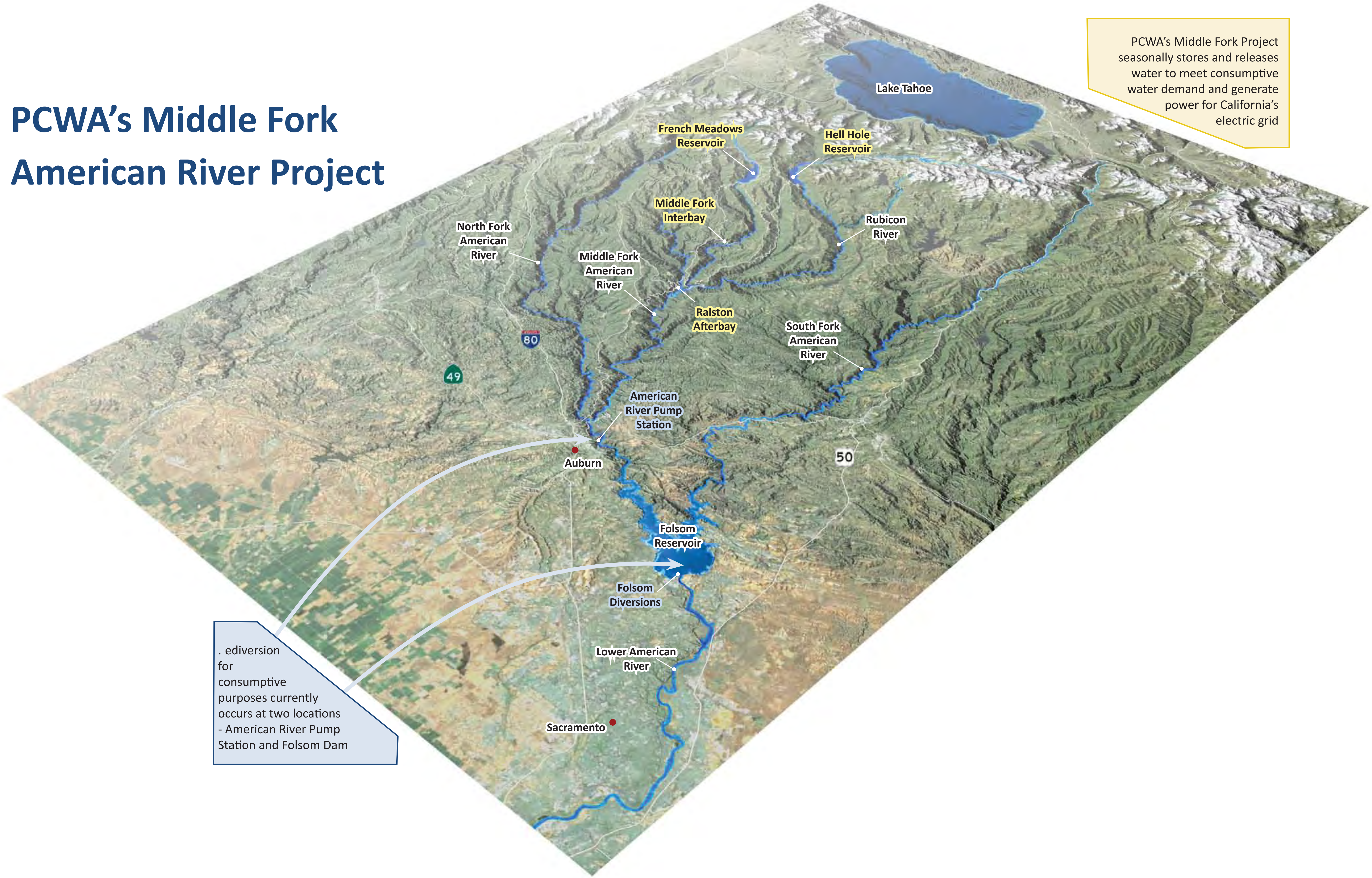
PCWA POU


PCWA'S Place of Use
Under Water Right Permit 13856
Yuba City
Feather River
Sacramento River
Bear River
Camp Far West Reservoir
Sheridan
Lincoln
PCWA ZONE 5
PCWA ZONE 1
PCWA ZONE 3
Dutch Flat
Alta
Baxter
Gold Run
Colfax
30 miles to PCWA Zone 4
Weimar
Applegate
Meadow Vista
N. Fork American River
Clipper Gap
Middle Fork American River
North Auburn
Auburn
Georgetown
Newcastle
Penryn
Loomis
Rocklin
S. Fork American River
Granite Bay
CITY OF ROSEVILLE
PLACER COUNTY
SACRAMENTO COUNTY
Elverta
Antelope
Citrus Heights
Folsom Reservoir
Placerville
Rio Linda
North Highlands
SAN JUAN WATER DISTRICT
Orangevale
Folsom
El Dorado Hills
Cameron Park
Shingle Springs
SACRAMENTO SUBURBAN W.D.
Fair Oaks
Lower American River
Sacramento
PCWA Middle Fork Project Water Place of Use in Placer County
PCWA Middle Fork Project Water Place of Use in Sacramento County
PROJECT LOCATION
CALIFORNIA


49
Foothill Unit
193
65
Valley Unit
80
Folsom Lake
49
Middle Fork Project Place of Use
PCWA Place of Use in Water Right Applications 18085 and 18087
Placer County
0 3 6 12 Miles

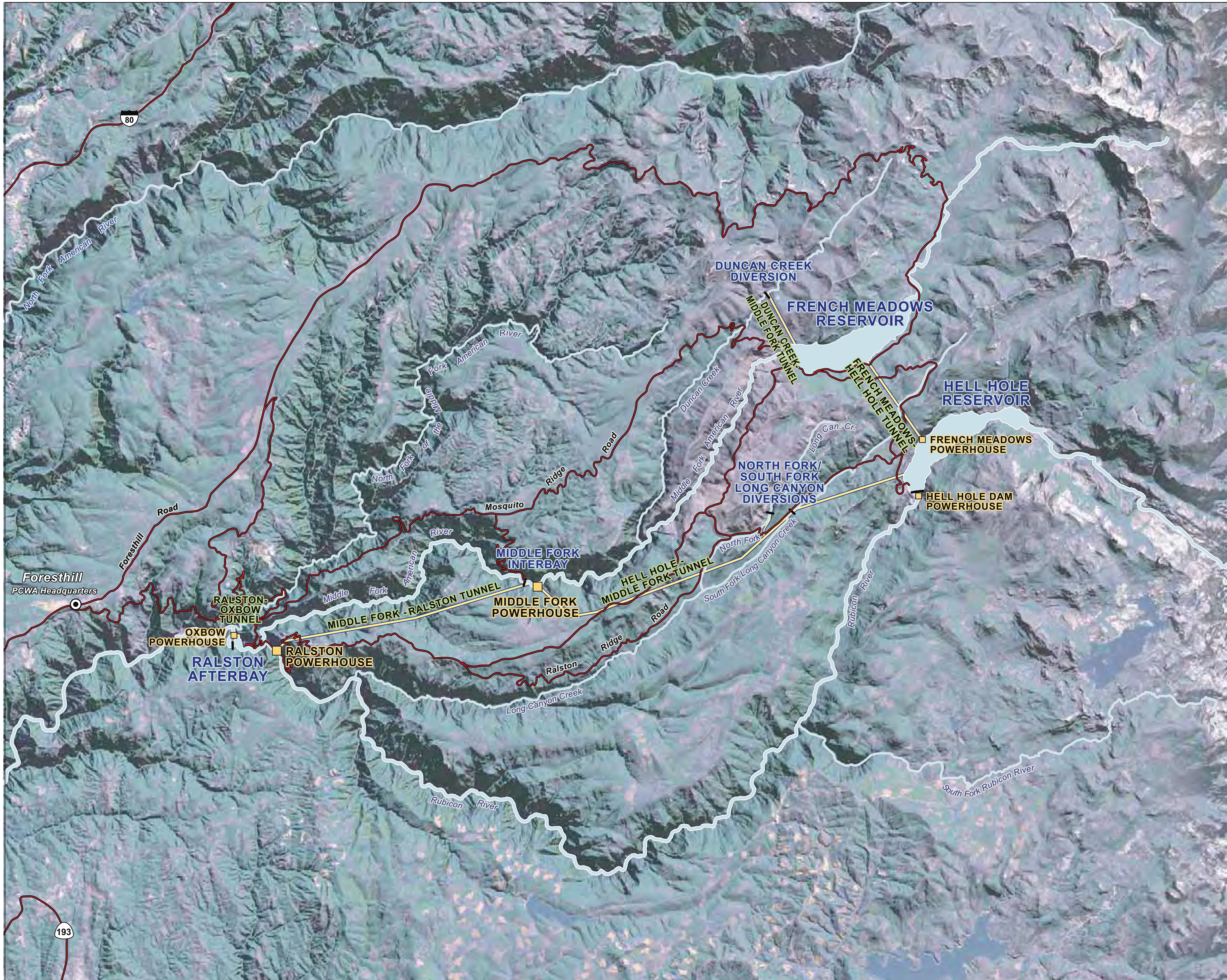

Placer County Water Agency
Sacramento County Place of Use
Water Right Permit 13856
NATOMAS MUTUAL WATER COMPANY
STATE HIGHWAY 99
NATOMAS EAST MAIN DRAINAGE CANAL
SACRAMENTO RIVER
SUTTER COUNTY
PLACER COUNTY
SACRAMENTO COUNTY
ROCKLIN
ROSEVILLE
SAN JUAN WATER DISTRICT
CITY OF ROSEVILLE W.T.P.
DRY CREEK
CITIZENS UTILITIES CO. OF CA
RIO LINDA WATER DISTRICT
NORTH HIGHLANDS
ARCADE WATER DISTRICT
CITRUS HEIGHTS
CITRUS HEIGHTS WATER DISTRICT
ORANGE VALE WATER CO.
ORANGEVALE
SAN JUAN WATER DISTRICT
PETERSON W.T.P.
EXISTING POINT OF DIVERSION
FOLSOM
RIO LINDA
McCLELLAN A.F.B.
NORTHRIDGE WATER DISTRICT
FAIR OAKS WATER DISTRICT
FAIR OAKS
LAKE NATOMA
STATE HIGHWAY 50
INTERSTATE 5
INTERSTATE 80
SACRAMENTO
RANCHO CORDOVA
AMERICAN RIVER
FOLSOM SOUTH CANAL
LEGEND
PROPOSED EXPANSION OF PCWA PLACE OF USE
SERVICE AREA
COUNTY BOUNDARY
SCALE
0
5 MILES
APPLICATION 18085 (PERMIT 13856) AND
APPLICATION 18087 (PERMIT 13858)
PLACER COUNTY WATER AGENCY
PETITION FOR EXPANSION OF PLACE OF USE
MAP 1 OF 2
HYA CONSULTING ENGINEERS

PCWA's Middle Fork American River Project



PCWA's Middle Fork Project seasonally stores and releases water to meet consumptive water demand and generate power for California's electric grid

. ediversion for consumptive purposes currently occurs at two locations - American River Pump Station and Folsom Dam



Middle Fork Project Facts and Figures

PROJECT SUMMARY

Project Completed 1967	
Total Energy Production Capacity:	223.7 MW
Average Annual Energy Production:	1,039,078 MWh
Total Gross Water Storage:	345,560 acre-feet (af)
Earth and Rockfill Dams:	11,900,000 cubic yards
Concrete Dams and Diversions:	94,000 cubic yards
Tunnels and Penstocks:	23.2 miles

RESERVOIRS AND DIVERSIONS	Elevation	Storage Capacity
Duncan Creek Diversion	5,265´	20 af
French Meadows Reservoir	5,244.5´	134,993 af
Hell Hole Reservoir	4,630´	207,590 af
North Fork Long Canyon Diversion	4,716´	0.39 af
South Fork Long Canyon Diversion	4,640´	0.83 af
Middle Fork Interbay	2,529´	175 af
Ralston Afterbay	1,179'	2,782 af

POWERHOUSES		Production Capacity
French Meadows Powerhouse	4,630´	15.3 MW
Hell Hole Powerhouse	4,240´	0.73 MW
Middle Fork Powerhouse	2,529´	122.4 MW
Ralston Powerhouse	1,175´	79.2 MW
Oxbow Powerhouse	1,089´	6.1 MW

TUNNELS		Discharge Capacity
Duncan Creek-Middle Fork Tunnel	-	400 cfs
French Meadows-Hell Hole Tunnel	-	400 cfs
Hell Hole-Middle Fork Tunnel	-	920 cfs
Middle Fork-Ralston Tunnel	-	836 cfs
Ralston-Oxbow Tunnel	-	1,088 cfs

PCWA

Placer County Water Agency
Middle Fork American River Project

Middle Fork Project and Vicinity

N W E S
0 1 2
Miles

Rev. Date: 1/27/11

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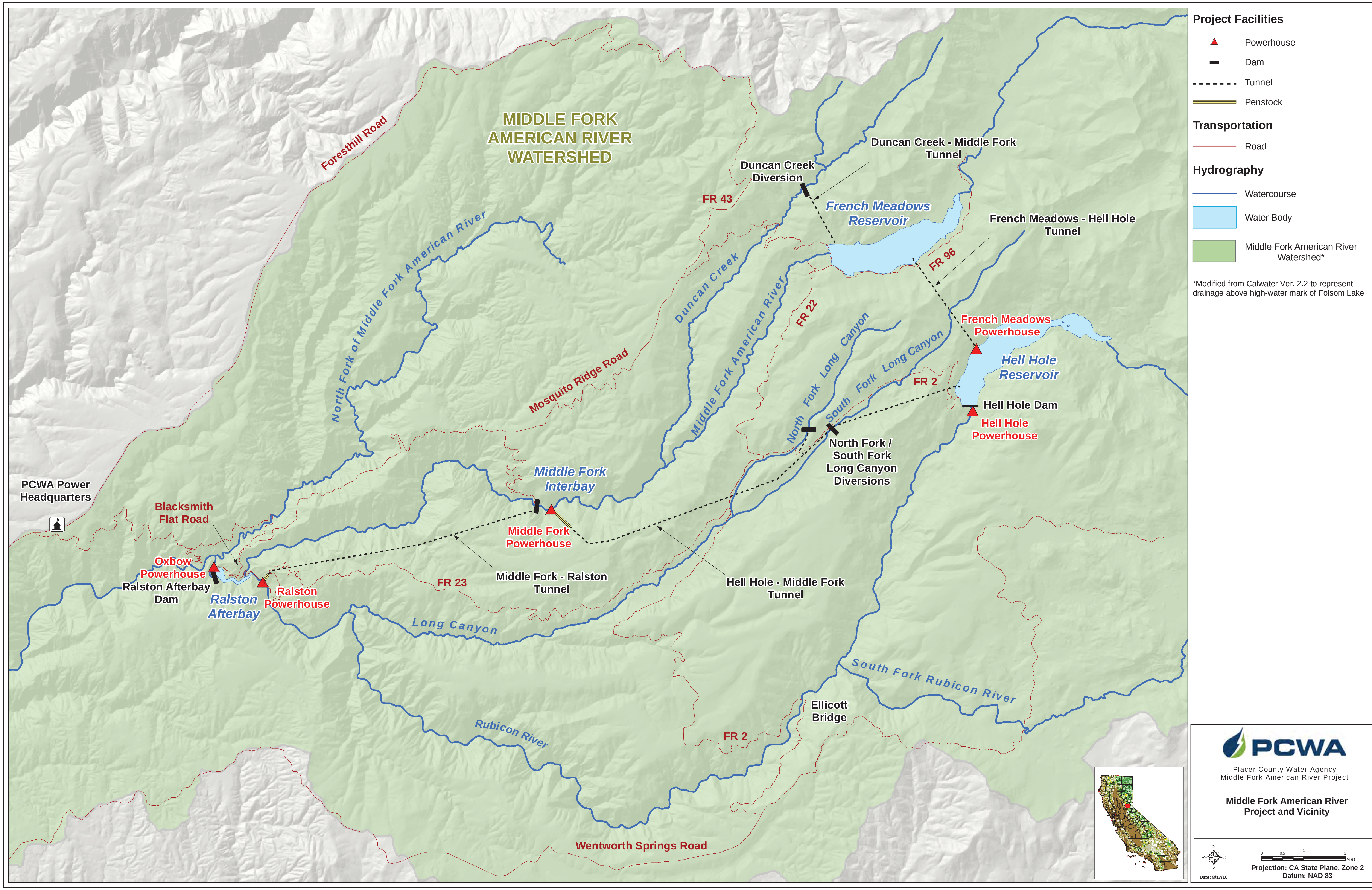
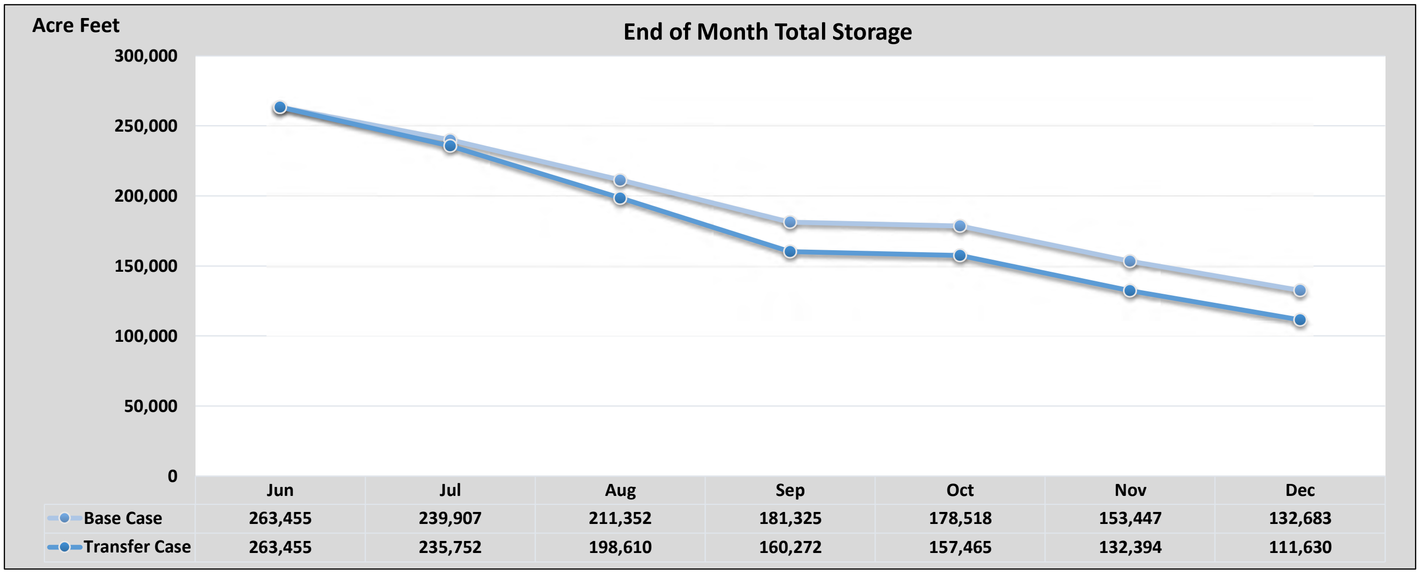


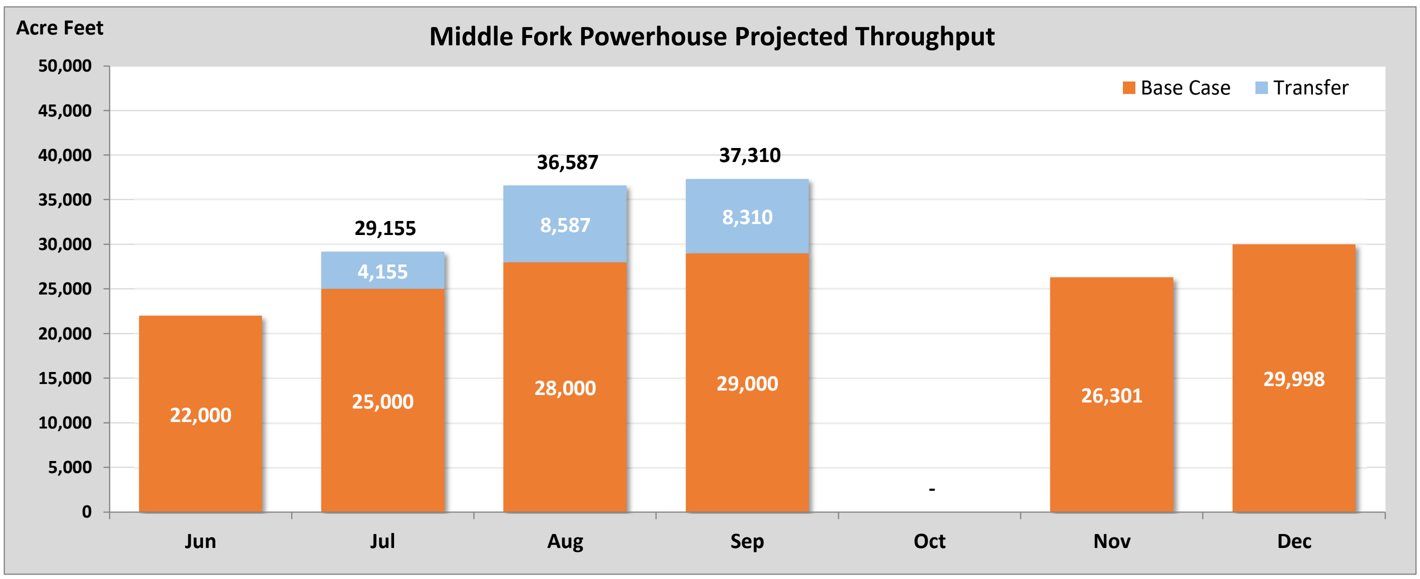
MIDDLE FORK AMERICAN RIVER WATERSHED
Foresthill Road
Duncan Creek Diversion
Duncan Creek - Middle Fork Tunnel
FR 43
French Meadows Reservoir
French Meadows - Hell Hole Tunnel
FR 96
North Fork of Middle Fork American River
Duncan Creek
Middle Fork American River
FR 22
French Meadows Powerhouse
Hell Hole Reservoir
North Fork Long Canyon
South Fork Long Canyon
FR 2
Hell Hole Dam
Hell Hole Powerhouse
Mosquito Ridge Road
North Fork / South Fork Long Canyon Diversions
Middle Fork Interbay
PCWA Power Headquarters
Blacksmith Flat Road
Middle Fork Powerhouse
Oxbow Powerhouse
Ralston Afterbay Dam
Ralston Afterbay
Ralston Powerhouse
FR 23
Middle Fork - Ralston Tunnel
Hell Hole - Middle Fork Tunnel
Long Canyon
South Fork Rubicon River
Ellicott Bridge
Rubicon River
FR 2
Wentworth Springs Road
Project Facilities
Powerhouse
Dam
Tunnel
Penstock
Transportation
Road
Hydrography
Watercourse
Water Body
Middle Fork American River Watershed*
*Modified from Calwater Ver. 2.2 to represent drainage above high-water mark of Folsom Lake
PCWA
Placer County Water Agency
Middle Fork American River Project
Middle Fork American River Project and Vicinity
Date: 8/17/10
Projection: CA State Plane, Zone 2
Datum: NAD 83
Z:\GIS\Entrix\3116501\map\GeneralMaps\PCWA_MFAR_ExecSummary_17i11i_01.mxd

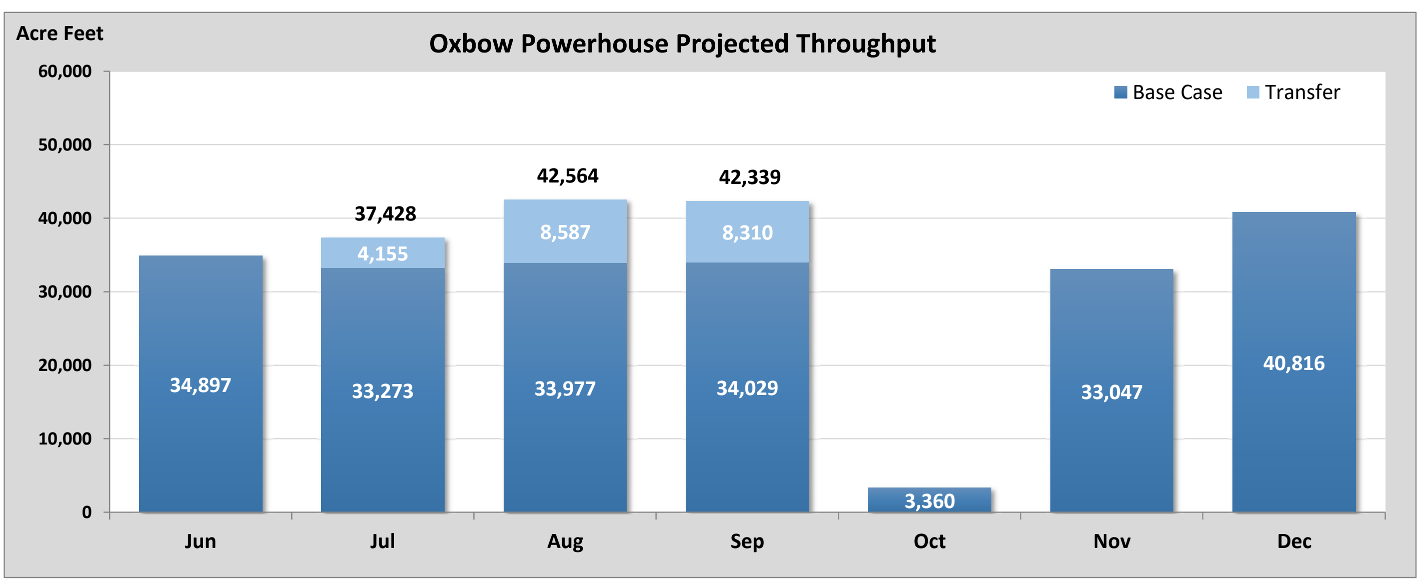
Attachment E

PCWA MFP 2022 Operations Plan



	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Base Case	263,455	239,907	211,352	181,325	178,518	153,447	132,683
Transfer Case	263,455	235,752	198,610	160,272	157,465	132,394	111,630





Updated: 5/20/22

Attachment F(a)

Water Quality Technical Reports

Placer County Water Agency
Middle Fork American River Project
(FERC No. 2079)

FINAL

AQ 11 - WATER QUALITY
TECHNICAL STUDY REPORT - 2007

Placer County Water Agency
P.O. Box 6570
Auburn, CA 95604

June 2008

Page

List of Tables

List of Figures

List of Maps

List of Appendices

1.0 INTRODUCTION

This report describes water quality studies conducted by the Placer County Water Agency (PCWA) in accordance with the AQ 11 - Water Quality Technical Study Plan (AQ 11 - TSP) for the Middle Fork American River Project (MFP or Project). The stakeholder-approved TSP was included in Supporting Document (SD) H of the Pre-Application Document (PAD) filed with the Federal Energy Regulatory Commission (FERC or Commission) on December 13, 2007 (PCWA 2007). A draft report was distributed to the Aquatics Technical Working Group (TWG) on February 1, 2008 for a 60 day comment period. The comment period ended on April 4, 2008. Oral comments were received at the March 10, 2008 Aquatics TWG meeting and have been addressed in this report. No written comments were received.

Water quality studies were conducted in the vicinity of the MFP during the spring and fall 2007 to characterize the physical, chemical, and bacterial water quality conditions upstream and downstream of Project facilities. The study consisted of summarizing current water quality objectives from the literature, implementing a water quality field sampling field program, and comparing water quality data from field with pertinent regulatory objectives and criteria. In addition, a screening level study of methyl mercury concentrations in sport fish tissue muscle was completed.

The water quality field sampling program included: (1) *in-situ* measurements; (2) collection of water quality samples for laboratory chemical analysis, hereafter referred to as the general water quality sampling; (3) voluntary water quality sampling that enhanced the approach described in the AQ 11 - TSP; (4) coliform sampling; and (5) measurement of water temperature and dissolved oxygen (profiles) in Project reservoirs. Fish for the methyl mercury muscle tissue analysis were also collected from the Project reservoirs and one location in the Middle Fork American River peaking reach (downstream of Oxbow Powerhouse, the lowermost Project facility) near Otter Creek.

The following sections provide a detailed description of the study objectives, study implementation, extent of the study area, study approach, study results, and literature cited.

2.0 STUDY OBJECTIVES

The objective of the water quality studies described in the AQ 11 - TSP is to characterize physical, chemical, and bacterial water quality conditions in the bypass reaches and the peaking reach, comparison reaches, and Project reservoirs and diversion pools and compare to the Central Valley Regional Water Quality Control Board (CVRWQCB 1998) Basin Plan objectives and water quality objectives.

3.0 STUDY IMPLEMENTATION

Figure 11-1 shows the AQ 11 - TSP objective and the study elements and activities that relate to completion of the study. It also shows how information developed through the water quality studies will be documented and provided to the stakeholders. The following sections summarize the study elements completed, any deviations from the TSP and the rationale, outstanding study elements, and proposed modifications to the TSP.

3.1 STUDY ELEMENTS COMPLETED

The following study elements have been completed:

- Collected *in-situ* and general water quality measurements on the bypass reaches, peaking reaches, reservoirs, and diversion pools in spring (39 locations) and fall (36 locations).
- Collected fecal coliform samples at 17 sites.
- Collected fish samples at Project reservoirs (Hell Hole, French Meadows, Ralston Afterbay, Middle Fork Interbay) and at one river site (Middle Fork American River downstream of Ralston Afterbay) for mercury fish tissue analyses.
- Provided water quality samples to State-certified laboratories approved by the State Water Resources Control Board for chemical analyses.
- Compared water quality results to the CVRWQCB Basin Plan objectives and water quality objectives (CVRWQCB, Fourth Edition revised February 2007).
- Compared fish tissue results to the California's Office of Environmental Health Hazard Assessment (OEHHA) guidelines.

3.2 DEVIATIONS FROM TECHNICAL STUDY PLAN

The water quality studies proceeded as described in the AQ 11 - TSP except for the following deviations:

General Water Quality Sampling

- Water quality samples were not collected during high and low flow events at all of the sampling locations along the peaking reach of the Middle Fork American River during the spring and fall sampling events, as indicated in the TSP. Instead, water quality samples were collected in the peaking reach once during the spring sampling event and again during the fall sampling event. During each event, water quality samples were collected at each of the locations identified in the TSP, under a range of flow conditions.
- One metal (manganese) was not analyzed during the spring sampling event due to a transcription error. Manganese was sampled during the fall sampling event.

Coliform Sampling

- According to the fecal coliform sampling protocols, fecal coliform samples were to be collected five times within a 30 day period between July 4 and Labor Day. Two of the fecal coliform sampling locations were sampled the week after Labor

Day (the fifth sample in 30 days) because of a sampling location change late in the summer. Two of the sampling locations were changed to better meet the water quality sampling objectives. The location changes were agreed to by the Aquatics TWG.

<u>Voluntary Enhancements</u>

- *In-situ* measurements were taken at three additional locations (leakage channels and main channel) downstream of Hell Hole Reservoir and five additional locations (leakage channels and main channel) downstream of French Meadows Reservoir.
- Additional water samples were collected and analyzed for dissolved metals and total mercury due to the presence of a rust-color staining on the substrate and precipitate at these selected locations described above.
- The TSP states that the water quality analytical results would be compared to the Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board Central Valley Region, Fourth Edition, published in September 1998. The analytical results were compared to the most recent version of the Basin Plan, which was updated with amendments in February 2007.

Fish Tissue Sampling

- Five of the 10 recommended fish caught at French Meadows Reservoir (two brown trout and three rainbow trout) were analyzed for individual methyl mercury concentrations in the fish muscle tissue. The remaining five fish (brown trout) that were caught should have been analyzed individually. However, these five fish were analyzed as a composite.

<u>Voluntary Enhancements</u>

- In addition to the ten fish caught at Hell Hole Reservoir (brown trout, rainbow trout, and lake trout that were analyzed for individual methyl mercury concentration), five additional fish (brown trout) were caught and analyzed as a composite sample.

3.3 Outstanding Study Elements

The following describes the only outstanding element of the water quality study:

- Consult with Aquatic TWG to discuss contingency water quality related studies.

3.4 Proposed Modification to Technical Study Plan

These are no proposed modifications to the AQ 11 - TSP.

4.0 EXTENT OF STUDY AREA

The study area included bypass and comparison reaches, the peaking reach, Project reservoirs, and diversion pools. The sampled locations are listed in Table AQ 11-1 and are shown on Maps AQ 11-1 and 11-2.

5.0 STUDY APPROACH

This section describes the study approach used to conduct the water quality studies in the study area. This section first describes the sources that were reviewed to identify the existing water quality objectives relevant to the physical, chemical, and bacterial constituents that were analyzed during this study. The section next describes the field sampling methods and associated laboratory analyses methods and reporting employed during the collection of *in-situ* measurements, general water quality sampling, coliform sampling, and fish tissue sampling. This section concludes with a discussion of quality assurance / quality control procedures.

5.1 EXISTING WATER QUALITY OBJECTIVES

Existing water quality objectives for the physical, chemical, and bacterial constituents analyzed in this study were identified by reviewing The Sacramento River Basin and San Joaquin River Basin Water Quality Control Plan (CVRWQCB, Fourth Edition revised February 2007), California Toxics Rule (CTR) "Water Quality Standards: Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California" (Federal Register, 65 FR 31682, EPA 2000) and the National Toxics Rule (NTR) "Water Quality Standards: Establishment of Numeric Criteria for Priority Toxic Pollutants" (Federal Register, 57 FR 60848, EPA 1992). The Basin Plan includes water quality objectives established by the State Water Resources Control Board (SWRCB) for waters in the Upper American River Watershed. The CTR and NTR, which consider background levels based on criteria that protect both human health and aquatic life, were also reviewed. The SWRCB selects the most controlling (most stringent) of these values to determine compliance with the Clean Water Act.

The California's Office of Environmental Health Hazard Assessment (OEHHA) guidelines (Cal EPA 2005 and Klasing and Brodberg 2006) were also reviewed for fish tissue analysis.

5.2 WATER QUALITY FIELD SAMPLING PROGRAM

The water quality field sampling program was conducted during spring and fall 2007 and included collection of: (1) *in-situ* measurements; (2) general water quality samples; (3) voluntary enhanced water quality samples; (4) coliform samples; and (5) fish tissue samples. The locations of sampling stations for each of these sampling activities are summarized in Tables AQ 11-1 and 11-3 and are shown on Maps AQ 11-1 through 11-4.

Three spring sampling locations within the Project area were not sampled in the fall. These locations included Duncan Creek above Middle Fork American River confluence

(DC-3 RM0.2) and the Middle Fork American River above and below Duncan Creek confluence (MFAR-3 RM39.9 and MFAR-4 RM39.5). After the spring sampling event and following consultation with the Aquatic TWG, access to these locations was determined to be unsafe for continued sampling.

5.2.1 *In-situ* Measurements

In-situ measurements in the stream and river study reaches were made at each of the sampling locations listed in Table AQ 11-1 during the spring runoff period (May 14 through 31, 2007) and during the low flow (base flow) period in the fall (September 24 through October 3, 2007). The *in-situ* measurements included dissolved oxygen (DO), pH, specific conductance, and water temperature. These four parameters were measured at each sampling location on the stream and river reaches and Middle Fork Interbay using portable multi-probe water quality meters (YSI® or Hydrolab Quanta). Hach Environmental (Loveland, CO) and Equipco (Concord, CA) calibrated the water quality meters prior to the spring and fall sampling events, respectively. In addition, the DO sensor was calibrated in the field to adjust for changes in elevations and barometric pressure at each sampling location prior to data collection. The *in-situ* measurements were taken just below the water surface at representative locations within the stream.

In-situ water quality measurements were also collected during the general water quality sampling program at Project reservoirs (French Meadows Reservoir, Hell Hole Reservoir, and Ralston Afterbay) as outlined in the AQ 11 - TSP (Table AQ 11-1) using portable, multi-probe water quality meters (YSI® or Hydrolab Quanta). A secchi depth was also measured at these locations to determine the clarity of the water column. Middle Fork Interbay was only sampled at the surface as outlined in the AQ 11 - TSP.

5.2.2 General Water Quality Sampling

General water quality samples were collected once during the spring runoff period (May 14 through 31, 2007) and once during the low flow (base flow) period in the fall (September 24 through October 4, 2007) at sampling locations listed in Table AQ 11-1. The location of all the sampling sites were identified using a Global Positioning System (GPS) unit and the coordinates recorded in a field log book. Water quality samples in bypass reaches, peaking reach, and comparison reaches were collected in representative portions of the stream channel, using methods consistent with the Environmental Protection Agency (EPA) 1669 sampling protocol *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria*. Water quality samples collected from the streams and rivers were analyzed for the parameters listed in Table AQ 11-2, which include a suite of general parameters, dissolved metals, total mercury, and total and fecal coliform.

General water quality samples were also collected once during the spring and fall at Project reservoirs (Table AQ 11-1). In Hell Hole Reservoir, French Meadows Reservoir, and Ralston Afterbay, the samples were collected at the surface and immediately below the thermocline, if the reservoir was thermally stratified. If the Project reservoir was not thermally stratified, then water quality samples were collected at mid-depth of the reservoir. A boat with gasoline engine was used to access the various reservoir sampling locations. Prior to sample collection, the engine was turned off for five to ten minutes to minimize the potential for sample contamination.

Surface water quality samples from Project reservoirs were collected using similar methods as those used for the stream water quality collection. Sub-surface water quality samples for laboratory analysis were collected using a Teflon® Kemmerer style sampler to ensure integrity of the sample collected from depth. Water quality samples collected from the reservoirs were analyzed for the parameters listed in Table AQ 11-2. Laboratory analysis for hydrocarbons were conducted on water quality samples collected from French Meadows and Hell Hole reservoirs and Ralston Afterbay, where motorized boating may occur.

All water quality samples were decanted into laboratory-supplied sample containers. Sample bottles requiring chemical preservation (HCl, HNO_3, or H_2SO_4) were preserved by Test America Laboratory (Morgan Hill, California). Samples collected for dissolved metals were filtered in the field with pre-cleaned 0.45 μm filtration units supplied by Brooks Rand Laboratory (Seattle, Washington). The sample containers were labeled with the sampling site ID and the date and time that the sample was collected. The sample container was stored on ice and delivered to a State-certified water quality laboratory for analyses in accordance with maximum holding periods. A chain-of-custody record was also maintained with the samples at all times.

5.2.3 Voluntary Enhanced Water Quality Sampling

Voluntary enhanced water quality samples not specified in the AQ 11 - TSP were collected during the spring and fall general water quality sampling program. The additional sampling was initiated by PCWA when field personnel observed and reported the presence of rust color staining of the substrate and a precipitate at select locations below Hell Hole Dam and French Meadows Dam. Based on experience in other relicensing water quality studies, the staining was thought to be result of iron oxidation and warranted further investigation. The locations of the voluntary enhanced water quality samples are described in Table AQ 11-3 and identified on Maps AQ 11-3 and AQ 11-4. The additional samples were collected immediately downstream of Hell Hole Dam (May 22, 2007) and French Meadows Dam (August 6, 2007) in the leakage channels and river locations upstream and downstream of the confluence of the leakage channel. Water quality samples collected from the leakage and river channel were analyzed for hardness, dissolved metals (arsenic, cadmium, copper, iron, lead, manganese, nickel and total chromium), and total mercury.

5.2.4 Coliform Sampling

Total and fecal coliform sampling was conducted to determine if the study waters met Basin Plan objectives for contact recreational activities. Samples were collected at all locations listed in Table AQ 11-1 in the spring (May 14 through 31, 2007) and fall (September 24 through October 3, 2007) concurrent with the general water quality sampling program. These samples were analyzed for total and fecal coliform in accordance with the AQ 11 - TSP.

Sampling for fecal coliform also occurred at near-shore locations adjacent to recreation facilities at Project reservoirs and along bypass reaches where substantial contact recreation (swimming, fishing, rafting, etc.) occurs. These sampling locations were identified in the AQ 11 - TSP and are provided in Table AQ 11-1 and depicted on Map AQ 11-2.

The samples for fecal coliform analysis at 15 of the 17 locations with substantial contact recreation were collected five times within a thirty-day period between August 6, 2007 and Labor Day. The sampling was conducted over Labor Day weekend, rather than July 4th to attempt to capture the highest holiday recreation use. July 4 occurred in the middle of the week in 2007 and therefore recreation use was assumed to be higher during the Labor Day weekend. Two of the coliform sampling locations (FC-9 and FC-11) were not sampled during the first week (August 6, 2007) due to a location change after the first sampling event. Sampling at these two locations extended one additional week after Labor Day until September 10, 2007 in order to complete the 5 samples in a 30-day period.

The sample containers were provided by Diamond Water Laboratory (Auburn, California). The containers were labeled with the sampling site ID and the date and time that the sample was collected. The sample container was stored on ice and delivered to the local State-certified water quality laboratory for analyses in accordance with maximum holding periods. A chain-of-custody record was also maintained with the samples at all times.

5.2.5 Water Quality Laboratory Analysis and Reporting

Water quality samples collected during the general water quality sampling program and coliform sampling were submitted for laboratory analysis at a State-certified laboratory approved by the State Water Resources Control Board (SWRCB) for chemical analysis (total of 31 analytes). The analytes tested are listed in Table AQ 11-2 and are described in Appendix A. Twenty analytes (general parameters and hydrocarbons) were submitted to Test America Laboratory, nine analytes (a suite of dissolved metals and total mercury) were submitted to Brooks Rand Laboratory, and two analytes (total and fecal coliform) were submitted to Diamond Water Laboratory. The laboratories provided reports of each chemical parameter analyzed and the associated laboratory method detection limit, reporting limit, and practical quantification limit.

The reporting units from Test America and Brooks Rand laboratories were reported in mg/L (ppm), µg/L (ppb), or ng/L (ppt). To keep the data results consistent with the reporting parameters listed for the Basin Plan, CTR, and NTR, all lab results were converted to the appropriate unit, if necessary. If these sources do not have a criterion for an analyte, then the units provided in the laboratory reports were used. Conversions between the units are shown in Appendix B.

5.3 WATER TEMPERATURE AND DISSOLVED OXYGEN RESERVOIR PROFILES

Reservoir profiles were completed at selected sampling locations in Hell Hole Reservoir, French Meadows Reservoir, and Ralston Afterbay during the spring and fall sampling period as described in the AQ 11 - TSP. The reservoir profile measurements included water temperature and DO at 1-meter (m) depth intervals to determine if thermal stratification was present. If a thermocline was present, the water quality parameters were measured below the thermocline at 2-m intervals or less to the bottom of the reservoir. If a thermocline was not present, measurements were made at 2-m intervals or less below the mid-depth point to the bottom of the reservoir. Results of the sampling were compiled and presented in tabular and graphical format in Appendix C.

The sampling locations within the Project reservoirs are described below.

Hell Hole Reservoir

Water quality depth profiles and sampling were conducted at three locations on May 30, 2007 and October 1-2, 2007 (Map AQ 11-1). HH-1 was located at the front of the reservoir near the dam, HH-2 was in the middle of the reservoir near the French Meadows Powerhouse, and HH-3 was the upstream most location within the reservoir. Between the spring and fall sampling events, the reservoir water surface elevation steadily declined, resulting in a decrease in the maximum depth sampled. Reservoir storage during the spring and fall sampling events was obtained from the California Department of Water Resources website (DWR 2007), and surface elevations were estimated from PCWA storage capacity curves (PCWA 2007). Water surface elevations were estimated at:

May 30, 2007: 4,583 ft msl
October 1, 2007: 4,514 ft msl.

French Meadows Reservoir

Water quality depth profiles and sampling were conducted at three locations on May 30, 2007 and October 3, 2007 (Map AQ 11-1). FM-1 was located at the front of the reservoir near the dam, FM-2 was in the middle of the reservoir, and FM-3 was just downstream from the French Meadows boat ramp in the middle of the reservoir. Between the spring and fall sampling events, the reservoir water surface elevation steadily declined, resulting in a decrease in the maximum depth sampled. Reservoir storage during the spring and fall sampling events was obtained from the California Department of Water Resources website (DWR 2007), and surface elevations were estimated from PCWA storage capacity curves (PCWA 2007). Water surface elevations during the spring and fall sampling events were estimated at:

May 30, 2007: 5,243 ft msl
October 3, 2007: 5,206 ft msl.

Ralston Afterbay

Water quality depth profiles and sampling were conducted at one location just behind the float barriers on May 29, 2007 and September 26, 2007 (Map AQ 11-1). Water surface elevations during the spring and fall sampling events were estimated by PCWA at:

> **May 29, 2007**: 1,177 ft msl
> **September 26, 2007**: 1,175 ft msl.

Monthly reservoir profiles (consisting of temperature, DO, and specific conductance) at the same reservoir locations described above were also completed by PCWA in 2005-2007 as part of early relicensing studies. The results of the 2005 and 2006 reservoir profiles are presented in the PAD, SD (G) (PCWA 2007). The 2007 reservoir profile results will be summarized in early 2008 and provided to the Aquatics TWG under separate cover.

5.4 FISH TISSUE COLLECTION AND ANALYSIS FOR METHYL MERCURY

A screening level study of methyl mercury concentrations in sport fish muscle tissue was conducted at selected locations in the study area. As identified in the AQ 11 - TSP, at least 10 non-hatchery sport fish of edible size were collected from each of the following locations: Hell Hole Reservoir, French Meadows Reservoir, Middle Fork Interbay, Ralston Afterbay, and the Middle Fork American River near the Otter Creek confluence. Larger fish and species with greater potential for bioaccumulation were targeted for collection and analysis. The initial goal of the study was to collect five fish each of two different species from each location based on the following priority ranking. The two species present with the highest priority ranking would be targeted for collection (1 = highest priority) as follows:

1) bass
2) pikeminnow
3) lake trout
4) brown trout
5) rainbow trout

If five fish of two different species were not caught, then fish from a third species was included in the analysis.

At the four reservoirs, fish were captured in clean nylon gill nets. In the Middle Fork American River near Otter Creek fish were captured by electrofishing and hook-and-line sampling. For each fish collected, the species, fork length, total length, and weight were recorded.

The field handling procedures were consistent with those outlined in California Environmental Protection Agency (Cal EPA 2005) and those used at the Department of Fish and Game Marine Pollution Studies Laboratory at Moss Landing (Method # MPSL-

102a). The fish were placed into zipper-closure bags and immediately placed on ice in a cooler. The fish were then stored in a freezer prior to shipment to the analytical laboratory. All fish were shipped in an ice chest packed with ice and delivered by an overnight courier to Brooks Rand Laboratory (Seattle, Washington). Each cooler was shipped with a chain of custody form showing the sample identification number and collection date and time of each sample.

Muscle tissue from individual fish was analyzed for concentrations of methyl mercury in accordance with the General Protocol for Sport Fish Sampling and Analysis developed by the Cal EPA (2005) and with methods comparable to those used at the Department of Fish and Game Marine Pollution Studies Laboratory at Moss Landing. The results of the fish fillet analyses were reported in ng/g. These were converted to mg/kg fish (ppm) to be consistent with the OEHHA guidelines. The conversion is provided in Appendix B.

In one instance at French Meadows Reservoir, five brown trout were sent to the laboratory for analysis as one composite sample. For Hell Hole Reservoir, in addition to the 10 individual fish analyzed, a composite sample of five brown trout was analyzed.

5.5 QUALITY ASSURANCE/ QUALITY CONTROL PROCEDURES

Standard precautions were established for the collection of water quality samples. At each station, all samples were collected by the same person, wearing ultra-trace sampling gloves. Water quality samples were collected using the designated collection bottle supplied by the appropriate laboratory. Upon collection, each sample was immediately labeled with the date and time and logged on a chain-of-custody form and placed into a cooler filled with ice.

Water quality samples were delivered to the analytical laboratory within the appropriate holding times. Coliform samples were delivered to the laboratory on the same day of collection, while all other samples were delivered between 24 to 48 hours of the sample collection time by courier. A chain-of-custody form accompanied all samples from the time of collection to delivery and submittal to the analytical laboratory.

In-stream water samples were collected just below the water surface in areas of steady flow. Water samples from the reservoirs and impoundments were collected below the water surface following the same quality control (QC) procedures. Additional precautions were followed when sampling from a motorized boat. Samples were collected from the bow of the boat after the motor was turned off for at least five to ten minutes to avoid possible hydrocarbon contamination from the motor boat. Sampling equipment was cleaned with a cleaning solution and distilled water prior to sample collection.

Standard quality assurance (QA) procedures were performed by the laboratories during analyses of water samples. These included matrix and laboratory spikes and spike duplicates, matrix duplicates, and method blanks as appropriate. A summary of the QA measures were included with each certified laboratory report.

A QA/QC screening level review was also conducted on all of these laboratory analytical reports. Results of the QA/QC review are presented in Appendix D.

6.0 STUDY RESULTS

6.1 REVIEW OF EXISTING WATER QUALITY OBJECTIVES

The Basin Plan identifies specific water quality objectives of allowable limits or levels of water quality constituents. These objectives are established for the protection of beneficial uses of the waters associated with the MFP (CVRWQCB 2007). If water quality is maintained at levels that meet these objectives, the beneficial uses of the waters are considered to be protected. The beneficial uses identified in the Basin Plan that pertain to water associated with the MFP include: (1) municipal and domestic supply; (2) agricultural irrigation and stock watering; (3) power generation; (4) contact recreation; (5) non-contact recreation; (6) coldwater habitat and spawning habitat for fisheries; and (7) wildlife habitat. The definition of each of these beneficial uses is provided in Table AQ 11-4.

Water quality objectives include both numeric and narrative objectives (Table AQ 11-2). The Basin Plan provides specific numeric objectives for bacteria, *in-situ* measurements, and for chemical or metal constituents. The objectives for chemical and metal constituents are derived from various sources such as maximum contaminant levels (MCLs) that are provided in Title 22 of the California Code of Regulations or from the CTR or NTR. The most stringent objectives were used for this study.

Often more stringent objectives are provided by the CTR and the NTR to protect aquatic life and human health. The CTR and NTR numeric objective for cadmium (Cd), copper (Cu), lead (Pb) and nickel (Ni) is more stringent than the Basin Plan objective. The CTR and NTR have established more stringent criteria for these metals to protect freshwater aquatic life. The CTR and NTR set acute and chronic criteria that are hardness-dependent and must be calculated on a location-by-location basis. For each of these metals, the water quality criterion decreases with decreasing water hardness. These calculated criteria and laboratory results are shown in Tables AQ 11-9, AQ 11-12, and AQ 11-15. The formulas for calculating hardness-dependent criteria are provided in the CTR and NTR guidance documents (US EPA 2007 and 2007a).

The Basin Plan also specifies a water temperature thermal heating objective that states, "Natural water temperatures shall not be altered unless it can be demonstrated to the satisfaction of the Regional Board that such alteration does not adversely affect beneficial uses. At no time or place shall the temperature be increased more than 5°F (2.8°C) above the natural receiving water."

Several of the parameters analyzed do not have established objectives. Various literature sources were reviewed for each parameter to identify guidelines or ranges of the different parameters that might be expected for the MFP area. The ranges are described in Appendix A.

The results of the water quality sampling field program were compared to the most stringent water quality objectives identified Table AQ 11-2. The locations where the objectives have not been met were identified and are discussed in the following results section.

6.2 WATER QUALITY SAMPLING AND ANALYTICAL RESULTS

The following sections provide a discussion of the results of the water quality field sampling program (including the *in-situ* measurements, general water quality sampling, voluntary enhanced water quality sampling, and coliform sampling) associated with the spring and fall sampling events. Within this section the results from the stream and river reaches are discussed first, followed by the results of the sampling on Project reservoirs. The results of the *in-situ* measurements and coliform sampling for the spring and fall sampling events are summarized below. For the other general water quality parameters in the streams and rivers, only those that do <u>not</u> meet the most stringent Basin Plan, CTR, or NTR water quality objective are summarized.

6.2.1 Water Quality Results from Streams and Rivers

All the parameters measured in Project area streams and rivers during the spring and fall sampling event met with the Basin Plan, CTR, and NTR objectives with the exception of dissolved oxygen at three locations near the confluence of Duncan Creek and Middle Fork American River in the spring, and manganese in the fall at one location on the Middle Fork American River below French Meadows Dam at the gaging station.

In-situ **Field Measurements**

The results of *in-situ* measurements collected in streams and rivers in the vicinity of the MFP during the sampling periods are shown in Tables AQ 11-5 and 11-6. The results of the measurements indicate that three sampling locations did not meet the Basin Plan objectives for dissolved oxygen in the spring. All measurements met the Basin Plan objectives for pH. There are no Basin Plan objectives for temperature, and specific conductance, but measurements were all within expected ranges.

Dissolved Oxygen

According to the Basin Plan objectives, DO concentrations shall not be reduced below a minimum level of 7.0 mg/L for waters designated as COLD. DO concentration will vary with other parameters such as temperature, elevation, photosynthetic activity, biotic activity, stream discharge, and the concentration of other solutes (Hem 1989, Michaud 1994). Increasing temperature or elevation will result in lower DO (MELP 1998).

Dissolved oxygen measurements typically ranged between 7.1 and 11.7 during the spring and fall sampling events. These measurements are consistent with Basin Plan objective. However, at three locations during the spring sampling event, DO was below the Basin Plan objective of 7.0 mg/L. These locations included Duncan Creek above Middle Fork American River confluence (DC-3 RM0.2) and the Middle Fork American River above and below the Duncan Creek confluence (MFAR-3 RM39.9 and MFAR-4

RM39.5). DO concentrations at these locations were measured at 6.2 and 6.3. Based on DO concentrations measured at locations upstream and downstream from these sampling locations, these data are believed to be incorrect due to instrument malfunction or sampling error. These locations were not sampled in the fall due to the unsafe field conditions accessing the sampling locations.

Water Temperature

Measured surface water temperatures generally warm in the downstream direction during both the spring and fall sampling events (Tables AQ 11-5 and AQ 11-6).

Additional water temperature monitoring in rivers and streams in the vicinity of the MFP have been conducted by PCWA as part of ongoing studies. Water temperature data has been collected annually from 2005 through 2007. This monitoring program will continue through summer 2008. The data collected will be summarized and used to evaluate compliance with temperature objectives defined in the Basin Plan. Preliminary water temperature data are presented in the PAD, SD (G), 2005 Water Temperature Report and the 2006 Water Temperature Report (PCWA 2007).

pH

According to the Basin Plan, pH should not be below 6.5 or above 8.5. Furthermore, changes in normal ambient pH levels shall not exceed 0.5 in fresh waters designated as COLD or WARM beneficial uses. Values above 9.5 or below 4.5 are considered lethal to aquatic organisms (EPA 1996; MELP 1998).

Measured pH values were within the range required in the Basin Plan (between 6.5 and 8.5) at all sampling locations.

Specific Conductance

There are no specific Basin Plan objectives for specific conductance. The conductivity of freshwater at 25^{o} C varies between 50 and 1,500 μS/cm (Hem 1989; MELP 1998).

Specific conductance measurements during the spring sampling event ranged from 51 to 82 μS/cm and ranged from 16 to 107 μS/cm during the fall sampling event (Tables AQ 11-5 and AQ 11-6).

General Water Quality Parameters

The laboratory analytical results for the spring and fall sampling programs are summarized in Tables AQ 11-7 through AQ 11-12. Electronic copies of laboratory reports are available on CD. The analytes collected and submitted for laboratory analysis including 17 general parameters, eight dissolved metals, and total mercury. Refer to Table AQ 11-2 for the list of analytes.

During the spring and fall sampling events, all general parameters measured and total mercury samples met the Basin Plan, CTR, or NTR objectives, or were within the expected ranges for the ones that do not have established objectives. All dissolved metal analyses with the exception of dissolved manganese at one location (Middle Fork American River below French Meadows Dam at gaging station) met Basin Plan, CTR, or NTR objectives. The results of the general water quality parameters are summarized in Tables AQ 11-7 through AQ 11-12.

Manganese

The Basin Plan objectives for manganese is 50 μg/L. One sampling location below French Meadows Reservoir, MFAR-2 RM46.6 (Middle Fork American River below French Meadows Dam at gaging station) did not meet the Basin Plan objective (Figure AQ 11-2). The laboratory measured a concentration of 57.7 μg/L. Manganese was not analyzed during the spring sampling event, so it is unknown if MFAR-2 RM46.6 met the Basin Plan objective in the spring (runoff flow). Manganese concentrations in the fall (base flow) met the Basin Plan objective at the sampling locations farther downstream on the Middle Fork American River (Table AQ 11-10).

Voluntary Enhanced Water Quality Sampling

Voluntary enhanced water quality samples, not specified in the AQ 11 - TSP, were collected immediately downstream of Hell Hole Dam (May 22, 2007) and French Meadows Dam (August 6, 2007) in the leakage channels and river locations upstream and downstream of the confluence of the leakage channel. Three locations were sampled below Hell Hole Dam and five locations were sampled below French Meadows Dam. Analyses included *in-situ* measurements, calculated hardness, eight dissolved metals, and total mercury. Flows within the leakage weirs below French Meadows and Hell Hole dams are provided in Appendix E.

Similar to the discussion above, the *in-situ* measurements collected are summarized at each location and only the water quality objectives that did <u>not</u> meet the Basin Plan, CTR or NTR objectives are discussed. The *in-situ* measurements and sampling results are presented in Tables AQ 11-13 through 11-15.

<u>Hell Hole Dam</u>

In Situ Field Measurements

All in-situ field measurements collected below Hell Hole Dam met Basin Plan objectives or were within the expected ranges for the ones that do not have established objectives.

General Water Quality Parameters

The three voluntary enhanced water quality samples collected below Hell Hole Dam met all listed Basin Plan, CTR and NTR objectives.

French Meadows Dam

In Situ Field Measurements

In-situ measurements results indicated that pH and DO did not meet water quality objectives.

- *pH*

  The five sampling locations below French Meadows Dam were all below the Basin Plan objective of 6.5 and ranged between 5.3 and 5.3. The results are listed in Table AQ 11-13.

- *Dissolved Oxygen*

  Two sampling locations (FM-D and FM-E, both located within the main channel) below French Meadows Dam met the Basin Plan objective of 7.0 mg/L. Three sampling locations in the leakage channel (FM-A, FM-B, and FM-C) did not meet the Basin Plan objective and were below 7.0 mg/L. The results are listed in Table AQ 11-13 and are shown in Figure AQ 11-2.

General Water Quality Parameters

Iron and manganese concentrations in the five samples collected below French Meadows Dam exceeded Basin Plan or NTR objectives. These locations are shown with the sampled locations further downstream in Figure AQ 11-2. All other analytes met the listed Basin Plan or NTR objectives (Tables AQ 11-14 and AQ 11-15).

- *Iron*

  The Basin Plan objective for iron is 0.3 mg/L and the NTR objective is 1 mg/L. The Basin Plan specifies a criterion for iron of 0.3 mg/L, based on secondary maximum contaminant levels for drinking water. This criterion is based on a taste, odor, and visual threshold (CTR 2000). When iron is precipitated out of solution due to oxidation, it causes a reddish brown color in the water. The EPA has recommended a value of 1.0 mg/L for a 4-day average continuous concentration for the protection of freshwater aquatic life.

  Three of the five samples collected below French Meadows Dam did not meet the Basin Plan and NTR objectives for iron and ranged from 16.0 mg/L to 20.4 mg/L. All of these locations are in the small leakage channels draining from the base of French Meadows Dam. These locations are shown on Map AQ 11-4. The laboratory results for iron are summarized in Table AQ 11-14 and Figure AQ 11-2.

  Iron staining was observed along the ground and drainage channels at these three locations, as well as in the Middle Fork American River channel downstream. However, iron results in the plunge pool at the outlet pipe for French Meadow Reservoir (FM-E) and several hundred feet downstream (FM-D) met the Basin Plan and NTR objectives.

- *Manganese*

  The Basin Plan objective for manganese is 50 µg/L and is based on secondary maximum contaminant levels for drinking water. Four of the five locations sampled below French Meadows Dam did not meet the Basin Plan objective. Three of these locations are in the small leakage channels draining from the base of French Meadows Dam (results range from 3,610 µg/L and 4,040 µg/L) and the fourth is in the channel downstream of the dam (62.6 µg/L). These locations are shown on Map AQ 11-4. The laboratory results are summarized in Table AQ 11-14 and Figure AQ 11-2.

Coliform Sampling

Total and fecal coliform samples were collected from streams and rivers in the vicinity of the MFP to determine if study waters met Basin Plan objectives for recreational activities. Coliform concentrations are reported at the number of bacteria colonies per 100 mL of sample water (MPN/100 mL). An objective of 200 colonies/100 mL was used to determine if fecal coliform concentrations met Basin Plan objectives for contact recreational activities. There are no Basin Plan objectives for total coliform.

Total and fecal coliform samples were collected during the spring and fall sampling events (Map AQ 11-2). The laboratory results of the total and fecal coliform concentrations are provided in Tables AQ 11-7 and AQ 11-10 and are summarized below.

The fecal coliform results met Basin Plan objectives during the spring sampling event and ranged from less than 2 to 4/100 mL. Total coliform results during the spring sampling event ranged from less than 2/100 mL to 30/100 mL.

During the fall sampling event, one location (NFLC-2 RM2.9) exceeded the objective for fecal coliform (300/100 mL). The remainder of the fecal coliform results met Basin Plan objectives. Total coliform results ranged from less than 2/100 mL to 900/100 mL.

30-Day, Five Sample Fecal Coliform Sampling

The Basin Plan states that "…the fecal coliform concentration, based on a minimum of not less than five samples for any 30-day period, shall not exceed a geometric mean of 200/100 mL, nor shall more than ten percent of the total samples during any 30-day period exceed 400/100 mL." Seventeen locations throughout the study area were sampled five times over a 30-day period (Table AQ 11-16 and Map AQ 11-2). Sampling began on August 6, 2007 and continued for five subsequent weeks and concluded on Labor Day. At two locations (FC-9 and FC-11), sampling continued until September 10, 2007 due to a sampling location change after the first sampling event on August 6, 2007.

The geometric mean at each of the 17 sampling locations was below the objective of 200/100 mL. However, at one location (FC-15, Ralston Afterbay near the Ralston picnic area) on August 27, 2007, the sample result was 1,600/100 mL. Although, the geometric mean at this location was 30/100 mL, which is below the Basin Plan objective.

6.2.2 Water Quality Results: Reservoir Profiling and Laboratory Analysis

Water quality depth profiles and the water quality sampling program (including *in-situ* measurements, secchi depth, general water quality sampling, and coliform sampling) associated with the spring and fall sampling events were conducted at various locations in Hell Hole Reservoir, French Meadows Reservoir, and Ralston Afterbay. The following provides a summary of the water quality profiling and sampling results for Ralston Afterbay, Hell Hole Reservoir, and French Meadows Reservoir. The temperature and DO profiling measurements are presented in Appendix C. The results of the profiles and *in-situ* measurements are summarized for each reservoir. For the other general water quality parameters, only those that do not meet the most stringent Basin Plan, CTR, or NTR water quality objectives are summarized.

All parameters measured in Hell Hole Reservoir, French Meadows Reservoir, and Ralston Afterbay during the spring and fall sampling program met with the Basin Plan, CTR, and NTR objectives with the exception of dissolved oxygen in Hell Hole and French Meadows reservoirs.

Hell Hole Reservoir

Water Quality Temperature and Dissolved Oxygen Profile Results

The spring water temperature profiles at the three sampling locations were similar. Spring surface temperatures ranged from 12.7°C at HH-3 to 14.5°C at HH-1. Temperatures steadily declined with depth until 30 to 35m below the water surface, where temperatures remained relatively steady at 6 to 7°C down to the bottom of the reservoir. The fall temperature profiles at the three locations were also similar. Fall surface temperatures were slightly warmer than spring surface water temperatures. Fall water temperatures varied only slightly with depth from the surface to approximately 35 to 40 m. At greater depths, temperatures steadily declined to 11 to 15°C. Reservoir bottom temperatures were approximately 5 to 7°C warmer in the fall than those recorded during the spring sampling event. There was no distinct thermal stratification or thermocline measured in either the spring or fall temperature profiles.

The DO profiles during the spring sampling were similar between the three locations. DO concentrations ranged from 8.1 mg/L to 8.8 mg/L at the surface and ranged from 8.4 mg/L to 8.7 mg/L near the bottom. DO concentrations varied little with depth. The spring DO profiles were also similar between each sampling location. Fall concentrations were slightly lower than those measured during the spring sampling event. Surface concentrations ranged from 6.3 mg/L to 7.1 mg/L and decreased to 5.4 mg/L to 5.8 mg/L near the bottom of the reservoir. DO concentrations had a slight decreasing trend with depth. The DO concentrations for most of the three sampling locations during the fall sampling events were below the Basin Plan objective of 7.0 mg/L for COLD water bodies except at the surface for HH-1. The lowest DO measurement of 5.4 mg/L was recorded at the bottom of the reservoir at the HH-2 sampling location. Based on other DO concentrations collected in the fall in 2005 and 2006 from Hell Hole Reservoir (PCWA 2007), these fall 2007 data from Hell Hole Reservoir are believed to be incorrect due to instrument malfunction or sampling error.

In-Situ Field Measurements

In-situ measurements were collected at the surface and at approximately mid-depth in the profile. The sampling depths at the three locations for the spring and fall sampling events are shown below.

Site ID	Spring Sampling Depths (m)	Fall Sampling Depths (m)
HH-1	0 and 30	0 and 23
HH-2	0 and 30	0 and 27
HH-3	0 and 30	0 and 20

The results of the measurements are shown in Tables AQ 11-5 and AQ 11-6.

In-situ temperature and DO measurements followed the same trends as discussed above in the profiles for the spring and fall sampling events. Surface water temperatures were warmer than the mid-depth measurements. DO concentration measurements were slightly higher at mid-depth than at the surface for the spring sampling, but were slightly lower at two of the three sampling locations in the fall.

All pH measurements are within the objective listed in the Basin Plan. Surface pH measurements were higher than mid-depth measurements for all three sampling locations during the spring and fall sampling events. Surface pH measurements ranged from 6.9 to 7.1 in the spring and 6.7 to 7.9 in the fall. Mid-depth pH measurements ranged from 6.7 to 6.8 in the spring and 6.8 to 7.1 in the fall. Surface pH measurements were greater in the fall than in the spring at HH-1 and HH-3, but were less at HH-2. All mid-depth pH measurements were greater during the fall sampling event than in the spring sampling event.

Specific conductance measurements were similar between the surface and mid-depth and between the spring and fall sampling events. Spring measurements were approximately 20 μS/cm and fall measurements were ranged between 30 and 40 μS/cm.

Secchi depth measurements were conducted at the three sampling locations. The secchi depths for each sampling location during the spring and fall sampling events are shown below.

Site ID	Spring Sampling Secchi Depth (m)	Fall Sampling Secchi Depth (m)
HH-1	9	10
HH-2	11	10
HH-3	8	9.4

General Water Quality Parameters

All the spring and fall parameters analyzed met the Basin Plan, CTR, or NTR objectives. All sampling locations were within or below the suggested ranges discussed in Appendix A for parameters analyzed without established objectives.

Coliform Sampling

All fecal coliform concentrations met the 200/100 mL objective during the spring and fall sampling events.

<u>French Meadows Reservoir</u>

Water Quality Temperature and Dissolved Oxygen Profile Results

The spring water temperature profiles at the three locations were similar (surface temperatures at approximately 16°C). Temperatures steadily declined until approximately 20 m in depth, where temperatures remained relatively steady at 7 to 8°C down to the bottom. The fall temperature profiles at the three locations were similar with surface temperatures (approximately 15°C) and were slightly cooler than spring surface water temperatures. Fall water temperature profiles were different from the spring water temperature profiles. In the fall, water temperatures varied only slightly in depth from the surface to approximately 20 m. Below this depth, temperatures rapidly declined to 8°C at FM-1 and FM-2. Bottom temperatures were warmer at FM-3 (the shallowest location) than at the other two sampling locations. A thermocline was measured in the spring temperature profiles between 10 and 15 m and during the fall between 20 and 25 m.

The DO profiles during the spring sampling were similar at the three locations. Spring DO concentrations ranged from 7.7 mg/L to 7.9 mg/L at the surface and generally increased to the thermocline, then slowly decreased to the bottom of the reservoir. DO concentrations near the bottom of the reservoir ranged from 6.1 mg/L to 8.4 mg/L. The fall DO profiles were also similar at each sampling location. Fall DO surface concentrations were slightly higher than during the spring sampling event. Surface concentrations ranged from 8.2 mg/L to 8.5 mg/L and stayed relatively constant down to the thermocline. DO concentrations then increased at the thermocline (only at FM-1 and FM-2), followed by decreasing concentrations to the bottom of the reservoir (4.3 mg/L to 7.4 mg/L). The DO concentrations for most of the three sampling locations during the spring and fall sampling events met the Basin Plan objective of 7.0 mg/L for COLD water bodies. DO measurements below 7 mg/L were measured at FM-1 during the spring, and at FM-2 during the spring and fall near the bottom of the reservoir sampling areas.

In-Situ Field Measurements

In-situ measurements were collected at the surface and at approximately mid-depth or at the thermocline. The sampling depths at the three locations for the spring and fall sampling events are shown below. The results of the measurements are shown in Tables 11-5 and 11-6.

Site ID	Spring Sampling Depths (m)	Fall Sampling Depths (m)
FM-1	0 and 30	0 and 22.5
FM-2	0 and 20	0 and 22.5
FM-3	0 and 15	0 and 22.5

In-situ temperature and DO measurements followed the same trends as discussed above in the profiles for the spring and fall sampling events. Surface water temperatures were warmer than the mid-depth measurements. DO concentration measurements were slightly higher at mid-depth than at the surface for the spring sampling. In comparison, in the fall, DO concentrations were greater at the surface that at mid-depth.

All pH measurements were within the acceptable ranges of 6.5 to 8.5, as listed in the Basin Plan. Surface pH measurements were higher than mid-depth measurements for all three sampling locations during the spring and fall sampling events. Spring surface and mid-depth pH measurements were overall slightly higher during the fall sampling event. Surface pH measurements ranged from 6.6 to 6.9 in the spring and from 7.2 to 7.9 in the fall. Mid-depth pH measurements ranged from 6.5 to 6.6 in the spring and from 6.5 to 6.7 in the fall.

Specific conductance measurements were similar between the surface and mid-depth and between the spring and fall sampling events. Spring measurements were approximately 30 μS/cm and fall measurements were approximately 20 μS/cm.

Secchi depth measurements were conducted at the three sampling locations during the spring event. Measurements were taken at only one location during the fall event due to high winds on the reservoir later in the day. The winds and water currents would have prevented accurate secchi depth measurements, as the disk would not drop vertically, skewing the results. At the one sampling location, water clarity was better during the fall than during the spring. The secchi depths for each sampling locations during the spring and fall sampling events are shown below.

Site ID	Spring Sampling Secchi Depth (m)	Fall Sampling Secchi Depth (m)
FM-1	6.5	9.5
FM-2	7.5	Too Windy*
FM-3	7	Too Windy*

*Conditions on the reservoir were too windy for collecting accurate measurements.

General Water Quality Parameters

All the spring and fall parameters analyzed met the Basin Plan, CTR, or NTR objectives. All sampling locations were within or below the expected ranges discussed in Appendix A for parameters analyzed without established objectives.

Coliform Sampling

All fecal coliform concentrations met the 200/100 mL objective during the spring and fall sampling events.

Ralston Afterbay

Water Quality Temperature and Dissolved Oxygen Profile Results

Spring surface temperature in Ralston Afterbay was measured at 19 °C and decreased to 10.5 °C near the bottom of the afterbay. In comparison, temperatures in the fall were fairly constant with depth, ranging from 13.5 °C at the surface to 12 °C near the bottom. Some thermal stratification was present during the spring profiling event, but not during the fall profiling event.

The DO at the surface was 10.3 mg/L and 11.0 mg/L for the spring and fall sampling events, respectively. The concentration of DO generally increased with increasing depth (and with decreasing water temperature) to 10 m below the water surface. During the spring when the depth exceeded 10 m, DO concentrations decreased. DO concentrations ranged between 10.0 mg/L and 11.6 mg/L during both sampling events throughout the entire profile.

In-Situ Field Measurements

In-situ measurements were collected at the surface and at approximately mid-depth in the profile. The sub-surface measurements were collected at 6 m and at 5 m during the spring and fall sampling events, respectively. The results of the measurements are shown in Tables AQ 11-5 and AQ 11-6.

In-situ temperature and DO measurements followed the same trend as discussed above in the profiles for the spring and fall sampling events. Surface water temperatures were warmer than the mid-depth measurements and conversely, DO measurements were higher at mid-depth than at the surface.

In-situ pH measurements were between 6.0 and 7.0, acceptable limits within the Basin Plan. Spring pH measurements were 6.6 at the surface and 6.5 at mid-depth. Fall pH measurements were 7.0 at the surface and 6.8 at mid-depth.

Specific conductance measurements were similar between the surface and mid-depth and between the spring and fall sampling events. Spring measurements ranged between 30 and 50 μS/cm. Fall measurements ranged between 30 and 40 μS/cm.

Secchi depth measurements were also collected at the sampling location. Water clarity remained the same between the two sampling periods, with secchi depth readings of 7 m for both the spring and fall sampling events.

General Water Quality Parameters

All the spring and fall parameters analyzed met the Basin Plan, CTR, or NTR objectives. In addition, the results of the analyses for the parameters without established objectives were within the expected ranges discussed in Appendix A.

Coliform Sampling

All fecal coliform concentrations met the 200/100 mL objective during the spring and fall sampling events.

6.3 FISH TISSUE ANALYSIS

The following section provides a discussion of the fish tissue analysis from the Project reservoirs, Ralston Afterbay, Middle Fork Interbay, and the Middle Fork American River near Otter Creek. Laboratory analyses of methyl mercury were conducted on muscle tissue samples from individual and composite fish samples. The screening value for methyl mercury in fish established by the OEHHA to determine if additional studies are warranted is 0.08 ppm (which is equal to 0.08 mg/kg fish).

Methyl mercury concentrations in at least one fish from each location exceeded the OEHHA screening value of 0.08 mg/kg fish. Twenty-three of the 45 individual fish analyzed exceeded the screening value. The highest concentrations (up to 1.140 mg/kg) were measured in fish from Hell Hole Reservoir, where the largest fish were caught. A summary of the fish that were caught, including the species, fork and total lengths, and weight, is provided in Table AQ 11-17. The direct relationship between methyl mercury concentrations and the weight of the fish for each of the sampling locations is shown in Figure AQ 11-3. The results of the fish tissue sampling at each location are summarized below.

In Hell Hole Reservoir, eight of the ten individual fish analyzed (brown trout, lake trout, and rainbow trout), as well as the composite sample of brown trout, exceeded the OEHHA guidelines. Methyl mercury concentrations in the fish tissue from Hell Hole Reservoir ranged from 0.004 mg/kg fish to 1.14 mg/kg fish. All the brown trout analyzed exceeded the screening level.

In French Meadows Reservoir, three of the five individual fish, including both brown trout exceeded 0.08 ppm. The composite sample of five brown trout also exceeded the screening value. The highest methyl mercury concentration measured in the fish from French Meadows Reservoir was 0.357 mg/kg fish.

Only one of the ten brown and rainbow trout caught in Middle Fork Interbay exceeded the screening value. The concentration of the rainbow trout measured was 0.135 mg/kg fish.

Eight of the ten fish caught, including all the Sacramento pikeminnows and the four largest brown trout, in Ralston Afterbay exceeded the screening value. The highest concentration measured in the fish caught in Ralston Afterbay was 0.348 mg/kg fish.

Methyl mercury concentrations in three of the ten fish caught in the Middle Fork American River near Otter Creek exceeded 0.08 mg/kg fish. Only rainbow trout were caught at this location. The exceedances occurred in the three of the four largest fish caught at this location. The greatest concentration measured in fish from the Middle Fork American River was 0.130 mg/kg fish.

6.4 Quality Assurance/ Quality Control Procedures

A detailed summary of the QA/QC review of these reports can be found in Appendix D, Tables D-1 through D-4. A summary of potential issues identified in the QA/QC reports from each laboratory and sampling event is also provided in Appendix D.

The QA/QC review from the Test America (TA) and Brooks Rand (BR) laboratories indicated that most sample results (spring and fall sampling event, voluntary enhanced sampling below Project reservoirs, and fish tissue sampling) were acceptable, with only four sample results considered estimates. The results that were considered estimates include the spring sample at FM-3 (S) for TOC, and for three of the additional samples below French Meadows Dam (FM-A, FM-B, and FM-C) for manganese.

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TABLES

Table AQ 11-1. Water Quality Monitoring and Sampling Station Locations for 2007 Sampling Program.

Sample ID	Location Name	GPS Coordinates		Spring Sampling Program	Weekly Sampling						Fall Sampling Program
		UTM10_ NAD 83 X	UTM10_ NAD 83 Y	May 14-31	Aug 6	Aug. 13	Aug. 20	Aug. 27	Sept. 3	Sept. 10	Sept. 24-Oct. 3
Duncan Creek											
DC-1 RM8.9	Duncan Creek above diversion	718058	4334904	X							X
DC-2 RM8.8	Duncan Creek below diversion	717492	4334534	X							X
DC-3 RM0.2	Duncan Creek above Middle Fork American River confluence	712310	4324261	X							
Middle Fork American River											
MFAR-1 RM52.8	Middle Fork American River above French Meadows Reservoir	724030	4334663	X							X
FM-1 (S)	French Meadows Reservoir surface (lower)	718930	4332295	X							X
FM-1	French Meadows Reservoir sub-surface (lower)	718930	4332295	X							X
FM-2 (S)	French Meadows Reservoir surface (middle)	720708	4332155	X							X
FM-2	French Meadows Reservoir sub-surface (middle)	720708	4332155	X							X
FM-3 (S)	French Meadows Reservoir surface (upper)	722241	4332680	X							X
FM-3	French Meadows Reservoir sub-surface (upper)	722241	4332680	X							X
MFAR-2 RM 46.6	Middle Fork American River below French Meadows Dam at gaging station	717789	4331977	X							X
MFAR-3 RM39.9	Middle Fork American River above Duncan Creek confluence	712707	4324155	X							
MFAR-4 RM39.5	Middle Fork American River below Duncan Creek confluence	712202	4323824	X							
MFAR-5 RM36.3	Middle Fork American River above Interbay Reservoir	708507	4322669	X							X
IR-1 RM35.7	In Middle Fork Interbay	717789	4331977	X							X
MFAR-6 RM35.5	Middle Fork American River below Middle Fork Interbay	707362	4322470	X							X
MFAR-7 RM26.1	Middle Fork American River above Ralston Afterbay	696379	4320205	X							X
Ralston Afterbay Downstream											
RA-1(S)	Ralston Afterbay surface	695348	4319604	X							X
RA-1	Ralston Afterbay sub-surface	695348	4319604	X							X
MFAR-8 RM24.7	Middle Fork American River below dam	694987	4319551	X							X
MFAR-9 RM24.3	Middle Fork American River below Oxbow Powerhouse tailrace	695104	4319974	X							X

Table AQ 11-1. Water Quality Monitoring and Sampling Station Locations for 2007 Sampling Program (continued).

Sample ID	Location Name	GPS Coordinates		Spring Sampling Program	Weekly Sampling						Fall Sampling Program
		UTM10_ NAD 83 X	UTM10_ NAD 83 Y	May 14-31	Aug 6	Aug. 13	Aug. 20	Aug. 27	Sept. 3	Sept. 10	Sept. 24-Oct. 3
MFAR-10 RM9.1	Middle Fork American River below the Drivers Flat Road Rafting Take-Out	679156	4314631	X							X
MFAR-11 RM0.1	Middle Fork American River above North Fork American River	670249	4309058	X							X
NFAR-1 RM20.6	North Fork American River below Middle Fork American River	669795	4308943	X							X
Rubicon River											
RR-1 RM35.9	Rubicon River above Reservoir	729518	4328802	X							X
HH-1 (S)	Hell Hole Reservoir surface (lower)	724117	4326670	X							X
HH-1	Hell Hole Reservoir sub-surface (lower)	724117	4326670	X							X
HH-2 (S)	Hell Hole Reservoir surface (middle)	724599	4328282	X							X
HH-2	Hell Hole Reservoir sub-surface (middle)	724599	4328282	X							X
HH-3 (S)	Hell Hole Reservoir surface (upper)	726090	4329264	X							X
HH-3	Hell Hole Reservoir sub-surface (upper)	726090	4329264	X							X
RR-2 RM30.2	Rubicon River below dam at gaging station	724209	4326071	X							X
RR-3 RM 22.8	Rubicon River above South Fork Rubicon River confluence	719372	4316701	X							X
SFRR-1 RM0.2	South Fork Rubicon River above Rubicon River confluence	719482	4316246	X							X
RR-4 RM22.5	Rubicon River below South Fork Rubicon River confluence	719153	4316364	X							X
RR-5 RM3.8	Rubicon River above Long Canyon Creek confluence	700507	4318147	X							X
RR-6 RM3.5	Rubicon River below Long Canyon Creek confluence	700162	4318171	X							X
RR-7 RM0.7	Rubicon River above Ralston Afterbay	697119	4319216	X							X
Long Canyon Creek											
NFLC-1 RM3.2	North Fork Long Canyon Creek above diversion	717980	4325629	X							X
NFLC-2 RM2.9	North Fork Long Canyon Creek below diversion	717848	4325174	X							X
NFLC-3 RM0.3	North Fork Long Canyon Creek above Long Canyon Creek confluence	715004	4322534	X							X
SFLC-1 RM3.4	South Fork Long Canyon Creek above diversion	719042	4325646	X							X
SFLC-2 RM3.1	South Fork Long Canyon Creek below diversion	718669	4325275	X							X
SFLC-3 RM0.2	South Fork Long Canyon Creek above Long Canyon Creek confluence	715314	4322198	X							X

Table AQ 11-1. Water Quality Monitoring and Sampling Station Locations for 2007 Sampling Program (continued).

Sample ID	Location Name	GPS Coordinates		Spring Sampling Program	Weekly Sampling						Fall Sampling Program
		UTM10_ NAD 83 X	UTM10_ NAD 83 Y	May 14-31	Aug 6	Aug. 13	Aug. 20	Aug. 27	Sept. 3	Sept. 10	Sept. 24-Oct. 3
LCC-1 RM11.3	Long Canyon Creek below North Fork and South Fork Long Canyon creeks confluence	714962	4321986	X							X
LCC-2 RM0.3	Long Canyon Creek above Rubicon River confluence	700544	4318487	X							X
Fecal Coliform											
FC-1	Middle Fork American River below Ahart Campground	724066	4336067		X	X	X	X	X		
FC-2	Middle Fork American River below Gates Group Campground	723679	4335535		X	X	X	X	X		
FC-3	Middle Fork American River below Coyote and Lewis Campground	723578	4334312		X	X	X	X	X		
FC-4	French Meadows Reservoir near McGuire Picnic Area	722892	4333328		X	X	X	X	X		
FC-5	French Meadows Reservoir near McGuire Boat Ramp	722565	4333376		X	X	X	X	X		
FC-6	French Meadows Reservoir near French Meadows Campground	722654	4332703		X	X	X	X	X		
FC-7	French Meadows Reservoir near French Meadows Boat Ramp	722249	4332433		X	X	X	X	X		
FC-8	French Meadows Reservoir near Poppy Campground	721628	4333151		X	X	X	X	X		
FC-9	Hell Hole Reservoir near Upper Hell Hole Reservoir Campground	728501	4329059			X	X	X	X	X	
FC-10	Hell Hole Reservoir near Hell Hole Boat Ramp	723737	4326842		X	X	X	X	X		
FC-11	South Fork Long Canyon Creek above Big Meadows Campground	722744	4328540			X	X	X	X	X	
FC-12	South Fork Long Canyon Creek below Big Meadows Campground	722119	4328056		X	X	X	X	X		
FC-13	South Fork Long Canyon Creek above Middle Meadows Campground	719274	4325849		X	X	X	X	X		
FC-14	South Fork Long Canyon Creek below Middle Meadows Campground	718907	4325560		X	X	X	X	X		
FC-15	Ralston Afterbay near Ralston Picnic Area	696326	4319720		X	X	X	X	X		
FC-16	Middle Fork American River below Oxbow Powerhouse (Horseshoe Bar Area)	695159	4320291		X	X	X	X	X		
FC-17	Middle Fork American River below the Drivers Flat Road Camping and Rafting Take-out	679156	4314631		X	X	X	X	X		

Table AQ 11-2. Summary of Water Quality Analytical Tests, Including Laboratory Methods and Detection Limits, and Chemical Water Quality Objectives.

					State and Federal Criteria					
Analyte	Units[1]	Analysis Method[2]	Method Detection Limit (MDL)[3]	Practical Quantitation Limit (PQL)[4]	Basin Plan[5]	CA Toxics Rule (CTR)[6]	National Toxics Rule (NTR)[7]	Sample Container	Hold Time	Preservative/Comment
In-Situ Measurements										
Oxygen, dissolved (DO)	mg/L	Water Quality Meter	Not Applicable	Not Applicable	7.0[8]	NS	NS[9]	Not Applicable	Not Applicable	None
Secchi Depth	meter	Secchi Disc	Not Applicable	Not Applicable	NS	NS	NS	Not Applicable	Not Applicable	None
pH	unitless	Water Quality Meter	Not Applicable	Not Applicable	6.5 – 8.5[10]	NS	6.5 – 9.0[11]	Not Applicable	Not Applicable	None
Water Temperature	Celsius	Water Quality Meter	Not Applicable	Not Applicable	NS	NS	NS	Not Applicable	Not Applicable	None
Specific Conductance	uS/cm at 25 °C	Water Quality Meter	Not Applicable	Not Applicable	NS	NS	NS	Not Applicable	Not Applicable	None
General Parameters										
Calcium	mg/L	EPA-200.7	Not Applicable	0.50	NS	NS	NS	1L plastic	180 days	Refrigerate
Chloride	mg/L	EPA-300.0	Not Applicable	1.0	250[12]	NS	230/860[13]	1L plastic	28 days	Refrigerate
Hardness (as $CaCO_3$)	mg/L	SM2340B	Not Applicable	1.0	NS	NS	NS	1L plastic	180 days	HNO_3, refrigerate
Magnesium	ug/L	EPA-200.7	Not Applicable	100	NS	NS	NS	1L plastic	180 days	HNO_3, refrigerate
Nitrate/Nitrite (NO_3)	mg/L	EPA-300.0	Not Applicable	0.20	1	NS	NS	1L plastic	28 days	Refrigerate
Ammonia as N	mg/L	EPA-350.3	Not Applicable	0.1	1.5[14]	NS	(15)	1L plastic	28 days	H_2SO_4,Refrigerate
Total Kjeldahl Nitrogen (TKN)	mg/L	EPA-351.2	Not Applicable	0.100	NS	NS	NS	1L plastic	28 days	H_2SO_4,Refrigerate
Total Phosphorus	mg/L	EPA-365.3	Not Applicable	0.1	NS	NS	NS	1L plastic	28 days	H_2SO_4,Refrigerate
Ortho-phosphate	mg/L	SM4500P-E	Not Applicable	0.010	NS	NS	NS	1L plastic	48 hours	Refrigerate
Potassium	mg/L	EPA-200.7	Not Applicable	2.0	NS	NS	NS	1L plastic	180 days	HNO_3, refrigerate
Sodium	mg/L	EPA-200.7	Not Applicable	0.50	NS	NS	NS	1L plastic	180 days	HNO_3, refrigerate
Sulfate (SO_4)	mg/L	EPA-300.0	Not Applicable	0.50	250[12]	NS	NS	1L plastic	28 days	Refrigerate
Total Dissolved Solids	mg/L	SM2540C	Not Applicable	10	500[12]	NS	NS	1L plastic	7 days	Refrigerate
Total Suspended Solids	mg/L	SM2540D	Not Applicable	10	NS	NS	NS	1L plastic	7 days	Refrigerate
Turbidity	NTU	EPA-180.1	Not Applicable	0.10	(16)	NS	NS	1L plastic	48 hours	Refrigerate
Organic Carbon, Total (TOC)	mg/L	SM5310B	Not Applicable	1.00	NS	NS	NS	250 mL amber glass	28 days	HCL, refrigerate
Total Alkalinity (as $CaCO_3$)	mg/L	SM2320B	Not Applicable	5.0	NS	NS	>20[17]	1L plastic	14 days	Refrigerate
Metals-Dissolved										
Arsenic	ug/L	EPA-1368	0.06	0.20	10	150/340[13]	150/340[13]	250 mL plastic	180 days	Field filtered, refrigerate
Cadmium	ug/L	EPA-1368	0.004	0.01	5	Hardness Dependent[13, 18]	Hardness Dependent[13, 18]	250 mL plastic	180 days	Field filtered, refrigerate
Copper	mg/L	EPA-1368	0.00004	0.0002	1[12]	1.3[20], Hardness Dependent[13, 18]	1.3[20], Hardness Dependent[13, 18]	250 mL plastic	180 days	Field filtered, refrigerate
Iron	mg/L	EPA-1368	0.0014	0.005	0.3[12]	NS	1[19]	250 mL plastic	180 days	Field filtered, refrigerate
Lead	ug/L	EPA-1368	0.01	0.05	15	Hardness Dependent[13, 18]	Hardness Dependent[13, 18]	250 mL plastic	180 days	Field filtered, refrigerate
Manganese	ug/L	EPA-1368	0.01	0.05	50[12]	NS	NS	250 mL plastic	180 days	Field filtered, refrigerate
Nickel	ug/L	EPA-1368	0.04	0.20	100	610[20], 4,600[21], Hardness Dependent[13, 18]	610[20], 4,600[21], Hardness Dependent[13, 18]	250 mL plastic	180 days	Field filtered, refrigerate
Chromium-Total	ug/L	EPA-1368	0.03	0.15	50	NS	NS	250 mL plastic	180 days	Field filtered, refrigerate
Metals-Total										
Mercury	ug/L	EPA-1361e	0.00015	0.0004	NS	0.05	0.77/1.4[13]	250 mL plastic	180 days	Refrigerate
Methyl mercury	mg/Kg fish	EPA-1630 mod./MSPL-102a	0.001-0.01	0.003-0.029	NS	NS	0.3[22]	Teflon sheet and ziplock bag	Not Applicable	Freeze

Quality Analytical Tests, Including Laboratory Methods and Detection Limits, and Chemical Water Quality Objectives (continued).

d[2]	Method Detection Limit (MDL)[3]	Practical Quantitation Limit (PQL)[4]	State and Federal Criteria			Sample Container	Hold Time	Preservative/Comment
			Basin Plan[5]	CA Toxics Rule (CTR)[6]	National Toxics Rule (NTR)[7]			
	Not Applicable	0.50	5[12]	NS	NS	40mL VOA	14 days	HCL, refrigerate
	Not Applicable	50	NS	NS	(23)	40mL VOA	14 days	HCL, refrigerate
	Not Applicable	4.8	(24)	NS	(25)	1L amber glass	48 hours	HCL, refrigerate
3	Not Applicable	2	NS	NS	NS	NS	24 hours	Refrigerate
	Not Applicable	2-1600	200	NS	NS	100 mL plastic	24 hours	Refrigerate

not available, laboratory supplied units were used. (Note: µg/L-ppb and mg/L=ppm)

The most recent methods available were used for the water quality analysis.

an be reported with a 99% confidence that the analyte concentration is greater than zero." (40 CFR Part 136)

e reliably measured within specified limits of precision and accuracy during routine laboratory operating conditions." (50 FR 46906)

ver Basins rely on California primary and secondary Maximum Concentration Level objectives as criteria for water quality to be used as a municipal and domestic supply for human consumption.

y on USEPA standards developed under the Clean Water Act for human consumption of water and aquatic organisms with an adult risk for carcinogens estimated to be one in one million as contained in the
ber 1, 1996.

SEPA standards developed under the Clean Water Act for human consumption of water and aquatic organisms with an adult risk for carcinogens estimated to be one in one million as contained in the IRIS

d to all states not complying with the Clean Water Act section 303(c)(2)(B).

mean is recommended to achieve the required intergravel dissolved oxygen concentrations.

than 8.5. Changes in normal ambient pH should not exceed 0.5.

values between the first and second numbers shown.

on Levels for California drinking water quality objectives that do not necessarily indicate a toxic amount of contaminate. Rather these standards dictate water quality objectives designed to preserve taste,

tration (4-day average)/maximum concentration (1-hour average).

quality factors shall not exceed the following limits: where natural turbidity is between 0 and 5 NTU's, increases shall not exceed 1 NTU. Where natural turbidity is between 5 and 50 NTU's, increases

een 50 and 100 NTU's, increases shall not exceed 10 NTU's. Finally, where natural turbidity is greater than 100 NTU's, increases shall not exceed 10%.

xcept where natural concentrations are less (USEPA's 1976 'Red Book'). The 'Red Book' also recommends that natural alkalinity not be reduced by more than 25%.

a function of hardness and decreases as hardness decreases. The actual criteria are calculated based on the hardness (as $CaCO_3$) of the sample water.

ncentration (4-day average).

g Water Sources (consumption of water an aquatic organisms).

quatic organism consumption only).

C) for methyl mercury and was published by the USEPA in a document titled Water Quality Criterion for the Protection of Human Health: Methyl mercury-Final (EPA-823-R-01-001, January 2001).

artially updated in 1997.

: taste and odor threshold and USEPA SNARL = 100 ug/L. TPH-gasoline: taste and odor threshold and proposed USEPA SNARL = 5 mg/L.

materials in concentrations that cause nuisance, result in a visible film or coating on the surface of the water or on objects in the water, or otherwise adversely affect beneficial uses.

rease, particularly from the tastes and odors that emanate from petroleum products (USEPA's 1986 'Gold Book').

00 mL of water.

0 mL of water.

Table AQ 11-3. List of Voluntary Enhanced Water Quality Sampling Locations.

Hell Hole Reservoir

Sample ID	Sample Location Description	GPS Coordinates UTM10_ NAD 83X	GPS Coordinates UTM10_ NAD 83Y
RR-2A	Rubicon River below Hell Hole Reservoir outlet pipe	724275	4326213
RR-EC	Leakage channel below Hell Hole Reservoir	724237	4326112
RR-BEC	Rubicon River below Hell Hole Reservoir and leakage channel	724232	4326108

French Meadows Reservoir

Sample ID	Sample Location Description	GPS Coordinates UTM10_ NAD 83X	GPS Coordinates UTM10_ NAD 83Y
FM-A	Leakage channel A below French Meadows Reservoir	718622	4332105
FM-B	Leakage channel B below French Meadows Reservoir	718569	4332212
FM-C	Leakage channel C below French Meadows Reservoir	718569	4332226
FM-E*	Middle Fork American River below French Meadows Reservoir outlet pipe	718551	4332220
FM-D*	Middle Fork American River below French Meadows Reservoir and spillway channel	718304	4332195

*Sampling IDs are listed in upstream to downstream order

Table AQ 11-4. The Sacramento River Basin and San Joaquin River Basin Water Quality Control - Definition of Beneficial Uses.

Beneficial Use	**Definition**
Municipal and Domestic Supply (MUN)	Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.
Agricultural Supply (AGR)	Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation (including leaching of salts), stock watering, or support of vegetation for range grazing.
Hydropower Generation (POW)	Uses of water for hydropower generation.
Water Contact Recreation (REC-1)	Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, whitewater activities, fishing, or use of natural hot springs.
Non-contact Water Recreation (REC-2)	Uses of water for recreational activities involving proximity to water, but where there is generally no body contact with water, nor any likelihood of ingestion of water. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.
Cold Freshwater Habitat (COLD)	Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.
Spawning, Reproduction and/or Early Development (SPWN)	Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.
Wildlife Habitat (WILD)	Uses of water that support terrestrial or wetland ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats or wetlands, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

Source: Table II of *The Sacramento River Basin and San Joaquin River Basin Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board –Control Valley Region Fourth Edition revised February 2007*.

Table AQ 11-5. Summary of *In-Situ* Stream Measurements Collected During the Spring 2007 Sampling Event.

Sample ID	Location Name	Date	Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductance (µS/cm at 25 °C)	pH	Sample Water Depth[1] (m)	Secchi Depth[2] (m)
Duncan Creek								
DC-1 RM8.9	Duncan Creek above diversion	5/22/2007	7.24	8.9	57	7.6	0	
DC-2 RM8.8	Duncan Creek below diversion	5/22/2007	7.97	8.8	57	7.9	0	
DC-3 RM0.2	Duncan Creek above Middle Fork American River confluence	5/17/2007	11.16	6.3	67	8.2	0	
Middle Fork American River								
MFAR-1 RM51.6	Middle Fork American River above French Meadows Reservoir	5/22/2007	8.23	9.0	53	7.7	0	
FM-1 (S)	French Meadows Reservoir surface (lower)	5/30/2007	16.32	7.9	25	6.9	0	6.5
FM-1	French Meadows Reservoir sub-surface (lower)	5/30/2007	7.17	8.2	23	6.5	30	
FM-2 (S)	French Meadows Reservoir surface (middle)	5/31/2007	16.12	7.7	25	6.6	0	7.5
FM-2	French Meadows Reservoir sub-surface (middle)	5/31/2007	8.25	8.4	24	6.5	20	
FM-3 (S)	French Meadows Reservoir surface (upper)	5/31/2007	16.45	7.9	25	6.6	0	7
FM-3	French Meadows Reservoir sub-surface (upper)	5/31/2007	9.89	8.8	23	6.6	15	
MFAR-2 RM 46.6	Middle Fork American River below French Meadows Dam at gaging station	5/22/2007	10.60	9.0	54	7.4	0	
MFAR-3 RM39.9	Middle Fork American River above Duncan Creek confluence	5/17/2007	13.17	6.3	66	7.7	0	

Table AQ 11-5. Summary of *In-Situ* Stream Measurements Collected During the Spring 2007 Sampling Event (continued).

Sample ID	Location Name	Date	Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductance (µS/cm at 25 °C)	pH	Sample Water Depth[1] (m)	Secchi Depth[2] (m)
MFAR-4 RM39.5	Middle Fork American River below Duncan Creek confluence	5/17/2007	12.44	6.2	67	7.8	0	
MFAR-5 RM36.3	Middle Fork American River above Middle Fork Interbay	5/16/2007	13.25	8.9	68	8.4	0	
IR-1 RM35.7	In Middle Fork Interbay	5/16/2007	13.77	8.8	66	7.2	0	
MFAR-6 RM35.5	Middle Fork American River below Middle Fork Interbay	5/16/2007	10.02	9.3	60	7.7	0	
MFAR-7 RM26.1	Middle Fork American River above Ralston Afterbay	5/22/2007	15.44	8.5	82	7.4	0	
Ralston Afterbay Downstream								
RA-1(S)	Ralston Afterbay surface	5/29/2007	19.15	10.3	53	6.6	0	7
RA-1	Ralston Afterbay sub-surface	5/29/2007	12.03	11.4	36	6.5	6	
MFAR-8 RM24.7	Middle Fork American River below dam	5/21/2007	18.76	8.0	63	7.0	0	
MFAR-9 RM24.3	Middle Fork American River below Oxbow Powerhouse tailrace	5/21/2007	15.32	8.9	66	7.3	0	
MFAR-10 RM9.1	Middle Fork American River below the Drivers Flat Road Rafting Take-Out	5/14/2007	16.53	9.7	64	6.8	0	
MFAR-11 RM0.1	Middle Fork American River above North Fork American River	5/16/2007	19.73	8.7	67	7.3	0	
NFAR-1 RM20.6	North Fork American River below Middle Fork American River	5/16/2007	18.51	8.7	72	7.4	0	

Table AQ 11-5. Summary of *In-Situ* Stream Measurements Collected During the Spring 2007 Sampling Event (continued).

Sample ID	Location Name	Date	Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductance (µS/cm at 25 °C)	pH	Sample Water Depth[1] (m)	Secchi Depth[2] (m)
Rubicon River								
RR-1 RM35.9	Rubicon River above Reservoir	5/24/2007	9.60	10.3	52	7.8	0	
HH-1 (S)	Hell Hole Reservoir surface (lower)	5/30/2007	14.52	8.5	28	7.0	0	9
HH-1	Hell Hole Reservoir sub-surface (lower)	5/30/2007	6.65	8.7	27	6.7	30	
HH-2 (S)	Hell Hole Reservoir surface (middle)	5/30/2007	14.72	8.1	28	6.9	0	11
HH-2	Hell Hole Reservoir sub-surface (middle)	5/30/2007	7.99	8.8	27	6.7	30	
HH-3 (S)	Hell Hole Reservoir surface (upper)	5/30/2007	12.72	8.8	29	7.1	0	8
HH-3	Hell Hole Reservoir sub-surface (upper)	5/30/2007	7.79	9.0	26	6.8	30	
RR-2 RM30.2	Rubicon River below dam at gaging station	5/22/2007	7.13	9.8	54	7.1	0	
RR-3 RM 22.8	Rubicon River above South Fork Rubicon River confluence	5/23/2007	12.19	8.8	75	7.4	0	
SFRR-1 RM0.2	South Fork Rubicon River above Rubicon River confluence	5/23/2007	11.83	8.8	51	7.5	0	
RR-4 RM22.5	Rubicon River below South Fork Rubicon River confluence	5/23/2007	12.78	8.9	69	7.5	0	
RR-5 RM3.8	Rubicon River above Long Canyon Creek confluence	5/21/2007	16.30	8.4	75	6.9	0	

Table AQ 11-5. Summary of *In-Situ* Stream Measurements Collected During the Spring 2007 Sampling Event (continued).

Sample ID	Location Name	Date	Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductance (µS/cm at 25 °C)	pH	Sample Water Depth[1] (m)	Secchi Depth[2] (m)
RR-6 RM3.5	Rubicon River below Long Canyon Creek confluence	5/21/2007	16.26	8.4	72	7.3	0	
RR-7 RM0.7	Rubicon River above Ralston Afterbay	5/21/2007	19.61	8.6	71	7.3	0	
Long Canyon Creek								
NFLC-1 RM3.2	North Fork Long Canyon Creek above diversion	5/15/2007	12.86	8.8	55	7.5	0	
NFLC-2 RM2.9	North Fork Long Canyon Creek below diversion	5/15/2007	13.80	8.7	54	7.7	0	
NFLC-3 RM0.3	North Fork Long Canyon Creek above Long Canyon Creek confluence	5/15/2007	10.81	9.2	63	7.3	0	
SFLC-1 RM3.4	South Fork Long Canyon Creek above diversion	5/15/2007	11.31	8.8	59	6.5	0	
SFLC-2 RM3.1	South Fork Long Canyon Creek below diversion	5/15/2007	11.68	9.1	58	6.6	0	
SFLC-3 RM0.2	South Fork Long Canyon Creek above Long Canyon Creek confluence	5/15/2007	9.51	9.3	60	7.2	0	
LCC-1 RM11.3	Long Canyon Creek below North Fork and South Fork Long Canyon creeks confluence	5/15/2007	9.61	9.3	60	7.3	0	
LCC-2 RM0.3	Long Canyon Creek above Rubicon River confluence	5/21/2007	15.14	8.8	69	7.5	0	

1: Water sample was collected just below the water surface unless otherwise noted.
2: Secchi depth measurements were only collected in the reservoirs.
3: Instrument malfunction, no in-situ measurements available.

Table AQ 11-6. Summary of *In-Situ* Stream Measurements Collected During the Fall 2007 Sampling Event.

Sample ID	Location Name	Date	Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductance (µS/cm at 25 °C)	pH	Sample Water Depth[1] (m)	Secchi Depth[2]
Duncan Creek								
DC-1 RM8.9	Duncan Creek above diversion	9/25/2007	12.25	7.2	67	7.8	0	
DC-2 RM8.8	Duncan Creek below diversion	9/25/2007	11.61	7.0	65	7.1	0	
DC-3 RM0.2	Duncan Creek above Middle Fork American River confluence	NS	NS	NS	NS	NS	NS	
Middle Fork American River								
MFAR-1 RM51.6	Middle Fork American River above French Meadows Reservoir	10/3/2007	8.79	13.6	33	7.5	0	
FM-1 (S)	French Meadows Reservoir surface (lower)	10/3/2007	15.07	8.3	34	7.8	0	9.5
FM-1	French Meadows Reservoir sub-surface (lower)	10/3/2007	10.07	7.3	33	6.7	22.5	
FM-2 (S)	French Meadows Reservoir surface (middle)	10/3/2007	15.23	8.3	33	7.9	0	Too windy
FM-2	French Meadows Reservoir sub-surface (middle)	10/3/2007	10.23	7.7	30	6.6	22.5	
FM-3 (S)	French Meadows Reservoir surface (upper)	10/3/2007	15.36	8.6	33	7.2	0	Too windy
FM-3	French Meadows Reservoir sub-surface (upper)	10/3/2007	11.36	7.7	33	6.5	22.5	
MFAR-2 RM 46.6	Middle Fork American River below French Meadows Dam at gaging station	10/3/2007	8.93	11.7	16	7.5	0	
MFAR-3 RM39.9	Middle Fork American River above Duncan Creek confluence	NS	NS	NS	NS	NS	NS	

Table AQ 11-6. Summary of *In-Situ* Stream Measurements Collected During the Fall 2007 Sampling Event (continued).

Sample ID	Location Name	Date	Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductance (µS/cm at 25 °C)	pH	Sample Water Depth[1] (m)	Secchi Depth[2]
MFAR-4 RM39.5	Middle Fork American River below Duncan Creek confluence	NS	NS	NS	NS	NS	NA	
MFAR-5 RM36.3	Middle Fork American River above Middle Fork Interbay	9/24/2007	11.75	7.8	62	8.0	0	
IR-1 RM35.7	In Middle Fork Interbay	9/24/2007	12.14	7.8	66	8.0	0	
MFAR-6 RM35.5	Middle Fork American River below Middle Fork Interbay	9/24/2007	12.41	7.7	39	7.8	0	
MFAR-7 RM26.1	Middle Fork American River above Ralston Afterbay	9/26/2007	13.52	10.5	54	7.4	0	
Ralston Afterbay Downstream								
RA-1(S)	Ralston Afterbay surface	9/26/2007	13.24	10.9	41	7.0	0	7
RA-1	Ralston Afterbay sub-surface	9/26/2007	12.38	11.3	36	6.8	5	
MFAR-8 RM24.7	Middle Fork American River below dam	9/26/2007	17.58	9.9	42	6.9	0	
MFAR-9 RM24.3	Middle Fork American River below Oxbow Powerhouse tailrace	9/26/2007	13.08	11.3	39	7.1	0	
MFAR-10 RM9.1	Middle Fork American River below the Drivers Flat Road Rafting Take-Out	9/24/2007	13.90	10.2	46	7.7	0	
MFAR-11 RM0.1	Middle Fork American River above North Fork American River	9/25/2007	13.62	10.5	49	7.7	0	
NFAR-1 RM20.6	North Fork American River below Middle Fork American River	9/25/2007	14.45	10.0	63	7.7	0	

Table AQ 11-6. Summary of *In-Situ* Stream Measurements Collected During the Fall 2007 Sampling Event (continued).

Sample ID	Location Name	Date	Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductance (µS/cm at 25 °C)	pH	Sample Water Depth[1] (m)	Secchi Depth[2]
Rubicon River								
RR-1 RM35.9	Rubicon River above Reservoir	10/2/2007	11.74	7.8	107	7.1	0	
HH-1 (S)	Hell Hole Reservoir surface (lower)	10/1/2007	16.66	7.2	36	7.9	0	10
HH-1	Hell Hole Reservoir sub-surface (lower)	10/1/2007	15.81	6.3	31	6.8	23	
HH-2 (S)	Hell Hole Reservoir surface (middle)	10/1/2007	16.10	6.4	33	6.7	0	10
HH-2	Hell Hole Reservoir sub-surface (middle)	10/1/2007	15.82	6.3	32	7.0	27	
HH-3 (S)	Hell Hole Reservoir surface (upper)	10/2/2007	15.80	6.3	44	7.8	0	9.4
HH-3	Hell Hole Reservoir sub-surface (upper)	10/2/2007	15.76	6.3	40	7.2	20	
RR-2 RM30.2	Rubicon River below dam at gaging station	10/3/2007	8.97	9.9	18	6.9	0	
RR-3 RM 22.8	Rubicon River above South Fork Rubicon River confluence	9/25/2007	11.34	7.6	54	7.1	0	
SFRR-1 RM0.2	South Fork Rubicon River above Rubicon River confluence	9/25/2007	11.56	7.7	25	8.4	0	
RR-4 RM22.5	Rubicon River below South Fork Rubicon River confluence	9/25/2007	11.64	7.3	30	7.0	0	
RR-5 RM3.8	Rubicon River above Long Canyon Creek confluence	9/27/2007	15.40	8.4	56	7.7	0	
RR-6 RM3.5	Rubicon River below Long Canyon Creek confluence	9/27/2007	15.27	8.3	59	7.3	0	
RR-7 RM0.7	Rubicon River above Ralston Afterbay	9/26/2007	17.86	9.7	62	7.2	0	

Table AQ 11-6. Summary of *In-Situ* Stream Measurements Collected During the Fall 2007 Sampling Event (continued).

Sample ID	Location Name	Date	Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductance (µS/cm at 25 °C)	pH	Sample Water Depth[1] (m)	Secchi Depth[2]
Long Canyon Creek								
NFLC-1 RM3.2	North Fork Long Canyon Creek above diversion	10/2/2007	8.46	9.7	41	7.4	0	
NFLC-2 RM2.9	North Fork Long Canyon Creek below diversion	10/2/2007	10.52	9.0	42	7.4	0	
NFLC-3 RM0.3	North Fork Long Canyon Creek above Long Canyon Creek confluence	10/2/2007	8.46	9.8	29	7.3	0	
SFLC-1 RM3.4	South Fork Long Canyon Creek above diversion	10/2/2007	8.81	8.8	34	7.1	0	
SFLC-2 RM3.1	South Fork Long Canyon Creek below diversion	10/2/2007	8.85	9.6	34	7.4	0	
SFLC-3 RM0.2	South Fork Long Canyon Creek above Long Canyon Creek confluence	10/2/2007	7.52	9.7	29	7.0	0	
LCC-1 RM11.3	Long Canyon Creek below North Fork and South Fork Long Canyon creeks confluence	10/2/2007	8.17	7.6	29	7.5	0	
LCC-2 RM0.3	Long Canyon Creek above Rubicon River confluence	9/27/2007	14.30	8.6	92	7.4	0	

1: Water sample was collected just below the water surface unless otherwise noted.
2: Secchi depth measurements were only collected in the reservoirs.
NS: No sample was collected at this location during the fall sampling event due to dangerous access conditions.

Table AQ 11-7. Summary of Analytical Results for Water Quality Samples Collected during the Spring 2007 Sampling Event.

				Station	DC-1 RM8.9	DC-2 RM8.8	DC-3 RM0.2	MFAR-1 RM51.6	FM-1(S)	FM-1	FM-2(S)	FM-2	FM-3(S)	FM-3	MFAR-2 RM 46.6	MFAR-3 RM39.9	MFAR-4 RM39.5	MFAR-5 RM36.3	IR-1 RM35.7	MFAR-6 RM35.5	MFAR-7 RM26.1	RA-1(S)	RA-1	MFAR-8 RM24.7	MFAR-9 RM24.3	MFAR-10 RM9.1	MFAR-11 RM0.1	NFAR-1 RM20.6
				Date	5/22/2007	5/22/2007	5/1707	5/22/2007	5/31/2007	5/31/2007	5/31/2007	5/31/2007	5/31/2007	5/31/2007	5/22/2007	5/17/2007	5/17/2007	5/16/2007	5/16/2007	5/16/2007	5/22/2007	5/29/2007	5/29/2007	5/21/2007	5/21/2007	5/14/2007	5/16/2007	5/16/2007
				Time	9:45	10:40	11:00	11:40	9:30	8:40	10:00	10:40	13:15	12:15	12:30	12:30	12:00	9:25	10:10	8:50	8:00	12:30	10:40	14:00	13:30	15:50	15:10	14:30
General Parameters	**Units**	**PQL**	**WQ Criteria**																									
Calcium	mg/L	0.5	NS		2.7	2.8	4.8	2.3	2.1	2.3	2.2	2.2	2.2	2.2	2.6	4.5	4.7	5.3	4.9	3.5	7.4	5.7	4.3	4.8	4.8	4.7	5.1	6
Chloride	mg/L	1.0	250[1]		ND	ND	1.1	ND	ND	ND	ND	ND	ND	ND	ND	1.3	1.2	1.2	1.1	1.1	1.2	1.7	1.2	1.5	1.8	1.5	1.6	1.5
Hardness (as $CaCO_3$)	mg/L	1.0	NS		9.5	9.8	16	8.2	7.5	8.1	7.8	7.9	7.8	7.8	9	15	15	17	16	12	23	18	14	16	16	17	18	21
Magnesium	µg/L	100	NS		680	690	910	600	540	570	560	580	570	570	620	800	890	970	920	730	1200	1000	810	980	910	1200	1300	1500
Nitrate/Nitrite (NO_3)	mg/L	0.20	1[1]		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ammonia as N	mg/L	0.100	1.5		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Kjeldahl Nitrogen (TKN)	mg/L	0.100	NS		4.2	8.4	0.56	3.1	1.4	2	1.1	2.5	78	5	7	0.56	0.56	3.9	1.1	0.56	2.8	1.4	1.7	0.56	0.56	0.84	0.56	0.56
Total Phosphorus	mg/L	0.100	NS		ND	0.49	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.13	ND	ND	ND	ND	ND	ND
Ortho-phosphate	mg/L	0.010	NS		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium	mg/L	0.20	NS		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	mg/L	0.50	NS		1.3	1.3	1.5	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.9	1.8	1.8	1.8	1.5	2	2.3	1.9	1.9	2	1.8	1.7	1.8
Sulfate (SO_4)	mg/L	0.50	250[1]		0.56	0.58	0.98	ND	ND	ND	ND	ND	ND	ND	ND	0.73	0.88	0.74	0.75	0.72	2.9	1.4	0.76	1.5	1.3	1.7	1.8	2
Total Dissolved Solids	mg/L	10	500[1]		32	24	30	30	40	44	40	44	38	40	28	50	38	46	34	24	44	48	26	36	50	38	60	38
Total Suspended Solids	mg/L	10	NS		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Turbidity	NTU	0.10	(5)		ND	0.16	3.8	ND	1.1	1.1	1.1	1.2	0.78	0.6	0.44	1.2	0.13	0.86	2.2	0.44	0.12	0.41	1.2	0.38	0.15	0.27	0.44	0.53
Organic Carbon, Total (TOC)	mg/L	1.00	NS		ND	ND	ND	1.3	1	1.1	1.6	1.2	1.6	1.4	1.1	ND	ND	ND	ND	ND	1.4	1.3	1.9	ND	ND	ND	ND	ND
Total Alkalinity	mg/L	5.0	>20[3]		**16**	**14**	**16**	**14**	22	22	24	**20**	**20**	22	**14**	**18**	**20**	22	**18**	**16**	**20**	22	**16**	**20**	**20**	**16**	22	26
Metals-Dissolved																												
Arsenic	µg/L	0.20	10[1]		0.060^{U}	0.060^{U}	0.060^{U}	0.090^{B}	0.130^{B}	0.120^{B}	0.130^{B}	0.110^{B}	0.110^{B}	0.120^{B}	0.130^{B}	0.120^{B}	0.090^{B}	0.100^{B}	0.090^{B}	0.170^{B}	0.230	0.220	0.200^{B}	0.170^{B}	0.170^{B}	0.220	0.240	0.450
Cadmium	µg/L	0.010	(6)		0.005^{B}	0.005^{B}	0.004^{U}	0.006^{B}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}
Copper	mg/L	0.00020	(6)		0.00015^{B}	0.00016^{B}	0.000130^{B}	0.000160^{B}	0.000190^{B}	0.000220	0.000190^{B}	0.000180^{B}	0.000180^{B}	0.000180^{B}	0.000190^{B}	0.000140^{B}	0.000160^{B}	0.000180^{B}	0.000590	0.000240	0.000330	0.000340	0.000390	0.000310	0.000340	0.000410	0.00030	0.000430
Iron	mg/L	0.005	0.3[1]		0.0014^{U}	0.019300	0.0028^{B}	0.005^{B}	0.0014^{U}	0.0022^{B}	0.0014^{U}	0.0014^{U}	0.00410^{B}	0.0014^{U}	0.135000	0.013100	0.008400	0.006600	0.005300	0.007400	0.00260^{B}	0.005400	0.008300	0.071600	0.022100	0.008200	0.007400	0.014600
Lead	µg/L	0.050	(6)		0.010^{U}	0.010^{U}	0.010^{U}	0.030^{B}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}
Manganese	µg/L	0.05	50[1]		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Nickel	µg/L	0.20	(6)		0.180	0.170	0.160^{B}	0.080^{B}	0.040^{U}	0.040^{U}	0.040^{U}	0.040^{U}	0.040^{U}	0.040^{U}	0.060^{B}	0.070^{B}	0.110^{B}	0.100^{B}	0.120^{B}	0.090^{B}	0.210	0.090^{B}	0.090^{B}	0.150^{B}	0.130^{B}	0.230	0.250	0.380
Chromium-Total	µg/L	0.15	50[1]		0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}
Metals-Total																												
Mercury	µg/L	0.0004	0.05[2]		0.000360^{B}	0.000270^{B}	0.0004^{B}	0.000430	0.000290^{B}	0.000860	0.000350^{B}	0.000420	0.000340^{B}	0.000610	0.000330^{B}	0.000350^{B}	0.000400^{B}	0.000530	0.000380^{B}	0.000560	0.000330^{B}	0.000340^{B}	0.000680	0.000370^{B}	0.000360^{B}	0.000850	0.000610	0.001480
Hydrocarbons																												
Methyl-tertiary-butyl Ether (MtBE)	µg/L	0.50	5[1]																			ND	ND					
Total Petroleum Hydrocarbons (as gasoline and as diesel)	µg/L	50	NS																			ND	ND					
Oil and Grease	mg/L	4.8	NS																			ND	ND					
Bacteria																												
Total Coliform (3x5, 6 hr hold)	MPN/100 mL	2	NS		<2	<2	<2	4	<2	70	<2	<2	<2	23	<2	4	<2	<2	4	<2	23	4	6	2	13	30	2	7
Fecal Coliform (3x5)	MPN/100 mL	2-1600	200/100[1]		<2	<2	<2	4	<2	70	<2	<2	<2	23	<2	4	<2	<2	4	<2	23	4	6	2	13	30	2	7

Table AQ 11-7. Summary of Analytical Results for Water Quality Samples Collected during the Spring 2007 Sampling Event (continued)

Station				RR-1 RM35.9	HH-1(S)	HH-1	HH-2(S)	HH-2	HH-3(S)	HH-3	RR-2 RM30.2	RR-3 RM 22.8	SFRR-1 RM0.2
Date				5/24/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/23/2007	5/23/2007
Time				10:40	13:45	13:00	11:00	10:30	12:00	11:30	14:00	11:40	11:00
General Parameters	**Units**	**PQL**	**WQ Criteria**										
Calcium	mg/L	0.5	NS	2.5	3.2	2.9	2.8	2.9	2.9	2.8	2.8	4.4	2.4
Chloride	mg/L	1.0	250[1]	1.2	ND	ND	ND	ND	ND	ND	ND	5.3	ND
Hardness (as $CaCO_3$)	mg/L	1.0	NS	8.3	11	9.6	9.3	9.6	9.6	9.3	9.3	14	8.2
Magnesium	µg/L	100	NS	ND	670	570	560	580	570	560	550	730	530
Nitrate/Nitrite (NO_3)	mg/L	0.20	1[1]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ammonia as N	mg/L	0.100	1.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Kjeldahl Nitrogen (TKN)	mg/L	0.100	NS	ND	ND	ND	0.56	2.2	1.1	0.84	0.56	ND	ND
Total Phosphorus	mg/L	0.100	NS	ND	ND	ND	ND	ND	ND	ND	ND	0.56	ND
Ortho-phosphate	mg/L	0.010	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium	mg/L	0.20	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	mg/L	0.50	NS	ND	1.7	1.4	1.3	1.4	1.4	1.4	1.4	3.8	1.5
Sulfate (SO_4)	mg/L	0.50	250[1]	ND	0.59	0.62	0.66	0.62	0.69	0.61	0.77	0.74	ND
Total Dissolved Solids	mg/L	10	500[1]	40	38	20	20	20	20	16	28	50	34
Total Suspended Solids	mg/L	10	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Turbidity	NTU	0.10	(5)	0.16	0.44	0.25	0.32	0.35	0.19	0.15	0.15	0.29	0.24
Organic Carbon, Total (TOC)	mg/L	1.00	NS	2.3	1.7	1.9	1.7	2	1.7	2.1	1.2	ND	1
Total Alkalinity	mg/L	5.0	>20[3]	22	**12**	**12**	**9.8**	**9.8**	**12**	**12**	**12**	**16**	**12**
Metals-Dissolved													
Arsenic	µg/L	0.20	10[1]	0.330	0.220	0.200^{B}	0.190^{B}	0.210	0.200^{B}	0.210	0.210	0.190^{B}	0.060^{U}
Cadmium	µg/L	0.010	(6)	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}
Copper	mg/L	0.00020	(6)	0.000200^{B}	0.000270	0.000490	0.000270	0.000290	0.000250	0.000260	0.000310	0.000430	0.000130^{B}
Iron	mg/L	0.005	0.3[1]	0.014700	0.001400^{U}	0.001400^{U}	0.001400^{U}	0.001400^{U}	0.001400^{U}	0.001400^{U}	0.001400^{U}	0.001400^{U}	0.001400^{U}
Lead	µg/L	0.050	(6)	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.050^{B}	0.010^{U}
Manganese	µg/L	0.05	50[1]	*	*	*	*	*	*	*	*	*	*
Nickel	µg/L	0.20	(6)	0.090^{B}	0.100^{B}	0.100^{B}	0.100^{B}	0.100^{B}	0.090^{B}	0.090^{B}	0.090^{B}	0.100^{B}	0.100^{B}
Chromium-Total	µg/L	0.15	50[1]	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}
Metals-Total													
Mercury	µg/L	0.0004	0.05[2]	0.000480	0.000510	0.000650	0.000350^{B}	0.000680	0.000520	0.000740	0.000480	0.000370^{B}	0.000410
Hydrocarbons													
Methyl-tertiary-butyl Ether (MtBE)	µg/L	0.50	5[1]		ND	ND	ND	ND	ND	ND			
Total Petroleum Hydrocarbons (as gasoline and as diesel)	µg/L	50	NS		ND	ND	ND	ND	ND	ND			
Oil and Grease	mg/L	4.8	NS		ND	ND	ND	ND	ND	ND			
Bacteria													
Total Coliform (3x5, 6 hr hold)	MPN/100 mL	2	NS	7	<2	<2	<2	<2	<2	<2	8	30	8
Fecal Coliform (3x5)	MPN/100 mL	2-1600	200/100[1]	7	<2	<2	<2	<2	<2	<2	8	30	8

Station	RR-4 RM22.5	RR-5 RM3.8	RR-6 RM3.5	RR-7 RM0.7	NFLC-1 RM3.2	NFLC-2 RM2.9	NFLC-3 RM0.3	SFLC-1 RM3.4	SFLC-2 RM3.1	SFLC-3 RM0.2	LCC-1 RM11.3	LCC-2 RM0.3
Date	5/23/2007	5/21/2007	5/21/2007	5/21/2007	5/15/2007	5/15/2007	5/15/2007	5/15/2007	5/15/2007	5/15/2007	5/15/2007	5/21/2007
Time	12:20	9:20	10:15	14:45	13:30	14:10	10:20	11:30	11:55	9:30	8:50	9:40
General Parameters												
Calcium	3.6	5.2	5	5.3	2.5	2.6	2.9	2.7	3.2	2.6	3	4.7
Chloride	4.2	3.5	3	2.9	1	1.1	1.2	1	1	1.1	1	1.4
Hardness (as $CaCO_3$)	12	17	16	17	9.2	9.6	11	10	12	9.7	11	17
Magnesium	640	900	950	1000	730	750	830	810	970	780	880	1200
Nitrate/Nitrite (NO_3)	ND	ND	ND	ND	0.2	ND	ND	ND	ND	ND	ND	ND
Ammonia as N	ND	ND	0.62	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Kjeldahl Nitrogen (TKN)	ND	ND	0.84	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
Total Phosphorus	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ortho-phosphate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	3	2.9	2.9	2.9	1.8	1.9	2.3	1.7	2.1	1.9	2.3	2.6
Sulfate (SO_4)	0.66	1.3	1.1	1.3	ND	ND	ND	ND	ND	ND	ND	0.67
Total Dissolved Solids	90	62	60	48	22	50	48	48	40	44	36	86
Total Suspended Solids	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Turbidity	0.15	0.25	0.12	0.11	0.18	0.22	0.46	ND	ND	0.3	0.44	0.19
Organic Carbon, Total (TOC)	ND	ND	ND	ND	1.1	ND	ND	ND	ND	ND	ND	ND
Total Alkalinity	**14**	22	22	**20**	**12**	**12**	**18**	**18**	**16**	**14**	**16**	22
Metals-Dissolved												
Arsenic	0.170^{B}	0.160^{B}	0.140^{B}	0.160^{B}	0.060^{U}	0.070^{B}	0.150^{B}	0.080^{B}	0.090^{B}	0.140^{B}	0.140^{B}	0.160^{B}
Cadmium	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}
Copper	0.000380	0.000360	0.000330	0.000350	0.000100^{B}	0.000090^{B}	0.000200^{B}	0.000100^{B}	0.000110^{B}	0.000130^{B}	0.000150^{B}	0.000200^{B}
Iron	0.001400^{U}	0.001400^{U}	0.001400^{U}	0.001400^{U}	0.001400^{U}	0.001400^{U}	0.0091	0.001400^{U}	0.003100^{B}	0.001400^{U}	0.003600^{B}	0.001600^{B}
Lead	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}
Manganese	*	*	*	*	*	*	*	*	*	*	*	*
Nickel	0.090^{B}	0.130^{B}	0.120^{B}	0.140^{B}	0.040^{U}	0.040^{U}	0.050^{B}	0.040^{U}	0.040^{U}	0.040^{U}	0.040^{U}	0.100^{B}
Chromium-Total	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}
Metals-Total												
Mercury	0.000320^{B}	0.000230^{B}	0.000240^{B}	0.000200^{B}	0.000610	0.000770	0.001010	0.000310^{B}	0.000430	0.000440	0.000750	0.000540
Hydrocarbons												
Methyl-tertiary-butyl Ether (MtBE)												
Total Petroleum Hydrocarbons (as gasoline and as diesel)												
Oil and Grease												
Bacteria												
Total Coliform (3x5, 6 hr hold)	17	30	23	4	<2	<2	2	<2	4	2	2	17
Fecal Coliform (3x5)	17	30	23	4	<2	<2	2	<2	4	2	2	17

Note: Bold results do not meet the listed criteria

within specified limits of precision and accuracy during routine laboratory operation conditions.

ND: Not Detected above the PQL

NS: No standard

*: Not sampled

U: Results are less than or equal to the method detection limit (MDL) and are considered 'non-detect'.

B: Results are above the MDL and less than or equal to the practical quantitation limit (PQL) and should be considered estimates.

1: Basin Plan criteria for the Sacramento and San Joaquin Rivers Basins.

2: California Toxics Rule Criteria (CTR)

3: National Toxics Rule Criteria (NTR)

4: pH, temperature and life cycle dependent. See Table 11-11 for criteria and results.

5:Increases in turbidity attributable to controllable water quality factors shall not exceed the following limits: where natural turbidity is between 0 and 5 NTU's, increases shall not exceed 1 NTU. Where natural turbidity is between 5 and 50 NTU's, increases shall not exceed 20%. Where natural turbidity is between 50 and 100 NTU's, increases shall not exceed 10 NTU's. Finally, where natural turbidity is greater than 100 NTU's, increases shall not exceed 10%.

6: Criteria is hardness dependent which is expressed as a function of hardness and decreases as hardness decreases. The actual criteria are calculated based on the hardness (as $CaCO_3$) of the sample water. Refer to Table 11-12 for sample site criteria and results.

Table AQ 11-8. Calculated Ammonia Concentration Criteria for the Spring 2007 Sampling Event.

Sample ID	Location Name	Date	pH	Temperature (°C)	Ammonia Criteria Continuous Concentration with fish early life stages present (NTR)[1] mg/L	Ammonia Concentration mg/L
DC-1 RM8.9	Duncan Creek above diversion	5/22/2007	7.6	7.24	3.98	#N/A
DC-2 RM8.8	Duncan Creek below diversion	5/22/2007	7.9	7.97	2.99	#N/A
DC-3 RM0.2	Duncan Creek above Middle Fork American River confluence	5/17/2007	8.2	11.16	1.85	#N/A
MFAR-1 RM52.8	Middle Fork American River above French Meadows Reservoir	5/22/2007	7.7	8.23	3.74	#N/A
FM-1 (S)	French Meadows Reservoir surface (lower)	5/30/2007	6.9	16.32	5.43	#N/A
FM-1	French Meadows Reservoir sub-surface (lower)	5/30/2007	6.5	7.17	6.68	ND
FM-2 (S)	French Meadows Reservoir surface (middle)	5/31/2007	6.6	16.12	5.89	#N/A
FM-2	French Meadows Reservoir sub-surface (middle)	5/31/2007	6.5	8.25	6.71	ND
FM-3 (S)	French Meadows Reservoir surface (upper)	5/31/2007	6.6	16.45	5.76	#N/A
FM-3	French Meadows Reservoir sub-surface (upper)	5/31/2007	6.6	9.89	6.55	ND
MFAR-2 RM 46.6	Middle Fork American River below French Meadows Dam at gaging station	5/22/2007	7.4	10.60	4.73	#N/A
MFAR-3 RM39.9	Middle Fork American River above Duncan Creek confluence	5/17/2007	7.7	13.17	3.66	#N/A
MFAR-4 RM39.5	Middle Fork American River below Duncan Creek confluence	5/17/2007	7.8	12.44	3.07	#N/A
MFAR-5 RM36.3	Middle Fork American River above Middle Fork Interbay	5/16/2007	8.4	13.25	1.29	ND
IR-1 RM35.7	In Middle Fork Interbay	5/16/2007	7.2	13.77	5.42	#N/A
MFAR-6 RM35.5	Middle Fork American River below Middle Fork Interbay	5/16/2007	7.7	10.02	3.42	ND
MFAR-7 RM26.1	Middle Fork American River above Ralston Afterbay	5/22/2007	7.4	15.44	4.46	#N/A
RA-1(S)	Ralston Afterbay surface	5/29/2007	6.6	19.15	4.89	ND
RA-1	Ralston Afterbay sub-surface	5/29/2007	6.5	12.02	6.70	ND
MFAR-8 RM24.7	Middle Fork American River below dam	5/21/2007	7.0	18.76	4.43	#N/A
MFAR-9 RM24.3	Middle Fork American River below Oxbow Powerhouse tailrace	5/21/2007	7.3	15.32	4.88	#N/A
MFAR-10 RM9.1	Middle Fork American River below the Drivers Flat Road Rafting Take-Out	5/14/2007	6.8	16.53	5.58	#N/A
MFAR-11 RM0.1	Middle Fork American River above North Fork American River	5/16/2007	7.3	19.73	3.74	ND
NFAR-1 RM20.6	North Fork American River below Middle Fork American River	5/16/2007	7.4	18.51	3.66	#N/A
RR-1 RM35.9	Rubicon River above Reservoir	5/24/2007	7.8	9.60	3.18	#N/A
HH-1 (S)	Hell Hole Reservoir surface (lower)	5/30/2007	7.0	14.52	5.89	#N/A
HH-1	Hell Hole Reservoir sub-surface (lower)	5/30/2007	6.7	6.65	6.49	ND
HH-2 (S)	Hell Hole Reservoir surface (middle)	5/30/2007	6.9	14.72	6.02	#N/A
HH-2	Hell Hole Reservoir sub-surface (middle)	5/30/2007	6.7	7.99	6.46	ND
HH-3 (S)	Hell Hole Reservoir surface (upper)	5/30/2007	7.1	12.72	5.59	#N/A
HH-3	Hell Hole Reservoir sub-surface (upper)	5/30/2007	6.8	7.79	6.28	ND
RR-2 RM30.2	Rubicon River below dam at gaging station	5/22/2007	7.2	7.13	5.53	#N/A
RR-3 RM 22.8	Rubicon River above South Fork Rubicon River confluence	5/23/2007	7.4	12.19	4.59	#N/A
SFRR-1 RM0.2	South Fork Rubicon River above Rubicon River confluence	5/23/2007	7.5	11.83	4.29	#N/A
RR-4 RM22.5	Rubicon River below South Fork Rubicon River confluence	5/23/2007	7.5	12.78	4.55	ND
RR-5 RM3.8	Rubicon River above Long Canyon Creek confluence	5/21/2007	6.9	16.30	5.42	#N/A
RR-6 RM3.5	Rubicon River below Long Canyon Creek confluence	5/21/2007	7.3	16.26	4.65	#N/A
RR-7 RM0.7	Rubicon River above Ralston Afterbay	5/21/2007	7.3	19.61	3.61	ND
NFLC-1 RM3.2	North Fork Long Canyon Creek above diversion	5/15/2007	7.5	12.86	4.40	ND
NFLC-2 RM2.9	North Fork Long Canyon Creek below diversion	5/15/2007	7.7	13.8	3.58	#N/A
NFLC-3 RM0.3	North Fork Long Canyon Creek above Long Canyon Creek confluence	5/15/2007	7.3	10.81	4.94	#N/A
SFLC-1 RM3.4	South Fork Long Canyon Creek above diversion	5/15/2007	6.5	11.31	6.66	ND
SFLC-2 RM3.1	South Fork Long Canyon Creek below diversion	5/15/2007	6.6	11.68	6.54	ND
SFLC-3 RM0.2	South Fork Long Canyon Creek above Long Canyon Creek confluence	5/15/2007	7.2	9.51	5.53	#N/A
LCC-1 RM11.3	Long Canyon Creek below North Fork and South Fork Long Canyon creeks confluence	5/15/2007	7.3	9.61	5.08	#N/A
LCC-2 RM0.3	Long Canyon Creek above Rubicon River confluence	5/21/2007	7.5	15.14	4.27	#N/A

[1]Ammonia criteria calculated using guidelines from the National Toxics Rule (NTR), which is based on ambient pH and temperature conditions.
ND: Not detected

Table 11-9. Hardness-based Water Quality Criteria for Cadmium, Copper, Lead, and Nickel for the Spring 2007 Sampling Event.

Station ID	DC-1 RM8.9	DC-2 RM8.8	DC-3 RM0.2	MFAR-1 RM51.6	FM-1(S)	FM-1	FM-2(S)	FM-2	FM-3(S)	FM-3	MFAR-2 RM 46.6	MFAR-3 RM39.9	MFAR-4 RM39.5	MFAR-5 RM36.3	IR-1 RM35.7	MFAR-6 RM35.5	MFAR-7 RM26.1	RA-1(S)	RA-1	MFAR-8 RM24.7	MFAR-9 RM24.3	MFAR-10 RM9.1	MFAR-11 RM0.1
Date Sampled	5/22/2007	5/22/2007	5/1707	5/22/2007	5/31/2007	5/31/2007	5/31/2007	5/31/2007	5/31/2007	5/31/2007	5/22/2007	5/17/2007	5/17/2007	5/16/2007	5/16/2007	5/16/2007	5/22/2007	5/29/2007	5/29/2007	5/21/2007	5/21/2007	5/14/2007	5/16/2007
Time Sampled	9:45	10:40	11:00	11:40	9:30	8:40	10:00	10:40	13:15	12:15	12:30	12:30	12:00	9:25	10:10	8:50	8:00	12:30	10:40	14:00	13:30	15:50	15:10
Hardness ($CaCO_3$) (mg/L)	9.5	9.8	16	8.2	7.5	8.1	7.8	7.9	7.8	7.8	9	15	15	17	16	12	23	18	14	16	16	17	18
Cadmium (Cd)																							
Laboratory Result (ug/L)	0.005[B]	0.005[B]	0.004[U]	0.006[B]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]
Maximum Criterion (ug/L)	0.20	0.21	0.34	0.18	0.16	0.17	0.17	0.17	0.17	0.17	0.19	0.32	0.32	0.36	0.34	0.26	0.48	0.38	0.30	0.34	0.34	0.36	0.38
Continuous Criterion (ug/L)	0.05	0.05	0.07	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.07	0.07	0.07	0.07	0.06	0.09	0.07	0.06	0.07	0.07	0.07	0.07
Copper (Cu)																							
Laboratory Result (mg/L)	0.000150[B]	0.000160[B]	0.000130[B]	0.000160[B]	0.000190[B]	0.000220	0.000190[B]	0.000180[B]	0.000180[B]	0.000180[B]	0.000190[B]	0.000140[B]	0.000160[B]	0.000180[B]	0.000590	0.000240	0.000330	0.000340	0.000390	0.000310	0.000340	0.000410	0.000300
Maximum Criterion (mg/L)	0.0015	0.0015	0.0024	0.0013	0.0012	0.0013	0.0012	0.0012	0.0012	0.0012	0.0014	0.0022	0.0022	0.0025	0.0024	0.0018	0.0034	0.0027	0.0021	0.0024	0.0024	0.0025	0.0027
Continuous Criterion (mg/L)	0.0012	0.0012	0.0019	0.0011	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0011	0.0018	0.0018	0.0020	0.0019	0.0015	0.0026	0.0021	0.0017	0.0019	0.0019	0.0020	0.0021
Lead (Pb)																							
Laboratory Result (ug/L)	0.010[U]	0.010[U]	0.010[U]	0.030[B]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]
Maximum Criterion (ug/L)	4.63	4.79	8.38	3.91	3.53	3.85	3.69	3.74	3.69	3.69	4.35	7.79	7.79	8.98	8.38	6.04	12.64	9.58	7.20	8.38	8.38	8.98	9.58
Continuous Criterion (ug/L)	0.18	0.19	0.33	0.15	0.14	0.15	0.14	0.15	0.14	0.14	0.17	0.30	0.30	0.35	0.33	0.24	0.49	0.37	0.28	0.33	0.33	0.35	0.37
Nickel (Ni)																							
Laboratory Result (ug/L)	0.180[B]	0.170[B]	0.160[B]	0.080[B]	0.040[U]	0.040[U]	0.040[U]	0.040[U]	0.040[U]	0.040[U]	0.060[B]	0.070[B]	0.110[B]	0.100[B]	0.120[B]	0.090[B]	0.210	0.090[B]	0.090[B]	0.150[B]	0.130[B]	0.230	0.250
Maximum Criterion (ug/L)	63.92	65.62	99.35	56.44	52.33	55.85	54.10	54.68	54.10	54.10	61.06	94.07	94.07	104.57	99.35	77.88	135.05	109.76	88.73	99.35	99.35	104.57	109.76
Continuous Criterion (ug/L)	7.10	7.29	11.03	6.27	5.81	6.20	6.01	6.07	6.01	6.01	6.78	10.45	10.45	11.61	11.03	8.65	15.00	12.19	9.86	11.03	11.03	11.61	12.19

Station ID	NFAR-1 RM20.6	RR-1 RM35.9	HH-1(S)	HH-1	HH-2(S)	HH-2	HH-3(S)	HH-3	RR-2 RM30.2	RR-3 RM 22.8	SFRR-1 RM0.2	RR-4 RM22.5	RR-5 RM3.8	RR-6 RM3.5	RR-7 RM0.7	NFLC-1 RM3.2	NFLC-2 RM2.9	NFLC-3 RM0.3	SFLC-1 RM3.4	SFLC-2 RM3.1	SFLC-3 RM0.2	LCC-1 RM11.3	LCC-2 RM0.3
Date Sampled	5/16/2007	5/24/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/22/2007	5/23/2007	5/23/2007	5/23/2007	5/21/2007	5/21/2007	5/21/2007	5/15/2007	5/15/2007	5/15/2007	5/15/2007	5/15/2007	5/15/2007	5/15/2007	5/21/2007
Time Sampled	14:30	10:40	13:45	13:00	11:00	10:30	12:00	11:30	14:00	11:40	11:00	12:20	9:20	10:15	14:45	13:30	14:10	10:20	11:30	11:55	9:30	8:50	9:40
Hardness ($CaCO_3$) (mg/L)	21	8.3	11	9.6	9.3	9.6	9.6	9.3	9.3	14	8.2	12	17	16	17	9.2	9.6	11	10	12	9.7	11	17
Cadmium (Cd)																							
Laboratory Result (ug/L)	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]
Maximum Criterion (ug/L)	0.44	0.18	0.23	0.21	0.20	0.21	0.21	0.20	0.20	0.30	0.18	0.26	0.36	0.34	0.36	0.20	0.21	0.23	0.21	0.26	0.21	0.23	0.36
Continuous Criterion (ug/L)	0.08	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.04	0.06	0.07	0.07	0.07	0.05	0.05	0.05	0.05	0.06	0.05	0.05	0.07
Copper (Cu)																							
Laboratory Result (mg/L)	0.000430	0.000200[B]	0.000270	0.000490	0.000270	0.000290	0.000250	0.000260	0.000310	0.000430	0.000130[B]	0.000380	0.000360	0.000330	0.000350	0.000100[B]	0.000090[B]	0.000200[B]	0.000100[B]	0.000110[B]	0.000130[B]	0.000150[B]	0.000200[B]
Maximum Criterion (mg/L)	0.0031	0.0013	0.0017	0.0015	0.0014	0.0015	0.0015	0.0014	0.0014	0.0021	0.0013	0.0018	0.0025	0.0024	0.0025	0.0014	0.0015	0.0017	0.0015	0.0018	0.0015	0.0017	0.0025
Continuous Criterion (mg/L)	0.0024	0.0011	0.0014	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0017	0.0011	0.0015	0.0020	0.0019	0.0020	0.0012	0.0012	0.0014	0.0013	0.0015	0.0012	0.0014	0.0020
Lead (Pb)																							
Laboratory Result (ug/L)	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.050[B]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]
Maximum Criterion (ug/L)	11.40	3.96	5.47	4.68	4.51	4.68	4.68	4.51	4.51	7.20	3.91	6.04	8.98	8.38	8.98	4.46	4.68	5.47	4.91	6.04	4.74	5.47	8.98
Continuous Criterion (ug/L)	0.44	0.15	0.21	0.18	0.18	0.18	0.18	0.18	0.18	0.28	0.15	0.24	0.35	0.33	0.35	0.17	0.18	0.21	0.19	0.24	0.18	0.21	0.35
Nickel (Ni)																							
Laboratory Result (ug/L)	0.380	0.090[B]	0.100[B]	0.100[B]	0.110[B]	0.100[B]	0.090[B]	0.090[B]	0.090[B]	0.100[B]	0.100[B]	0.090[B]	0.130[B]	0.120[B]	0.140[B]	0.040[U]	0.040[U]	0.050[B]	0.040[U]	0.040[U]	0.040[U]	0.040[U]	0.100[B]
Maximum Criterion (ug/L)	125.04	57.02	72.36	64.49	62.78	64.49	64.49	62.78	62.78	88.73	56.44	77.88	104.57	99.35	104.57	62.21	64.49	72.36	66.75	77.88	65.05	72.36	104.57
Continuous Criterion (ug/L)	13.89	6.33	8.04	7.16	6.97	7.16	7.16	6.97	6.97	9.86	6.27	8.65	11.61	11.03	11.61	6.91	7.16	8.04	7.41	8.65	7.23	8.04	11.61

Note: Bold results do not meet the calculated criteria
U: Results are less than or equal to the method detection limit (MDL) and are considered 'non-detect'.
B: Results are above the MDL and less than or equal to the practical quantitation limit (PQL) and should be considered estimates.
California Toxics Rule (CTR) standard was used for Cu, Pb, and Ni. National Toxics Rule (NTR) standard was used for Cd.
Formulas used are provided in Appendix C.

Table AQ 11-10. Summary of Analytical Results of Water Quality Sampling for Fall 2007.

				Station	DC-1 RM8.9	DC-2 RM8.8	DC-3 RM0.2	MFAR-1 RM51.6	FM-1(S)	FM-1	FM-2(S)	FM-2	FM-3(S)	FM-3	MFAR-2 RM 46.6	MFAR-3 RM39.9	MFAR-4 RM39.5	MFAR-5 RM36.3	IR-1 RM35.7	MFAR-6 RM35.5	MFAR-7 RM26.1	RA-1(S)	RA-1
				Date	9/25/2007	9/25/2007	*	10/3/2007	10/3/2007	10/3/2007	10/3/2007	10/3/2007	10/3/2007	10/3/2007	10/3/2007	*	*	9/24/2007	9/24/2007	9/24/2007	9/26/2007	9/26/2007	9/26/2007
				Time	15:30	16:00	*	12:00	9:30	9:00	11:00	10:15	13:00	12:30	11:25	*	*	11:15	10:40	11:50	13:15	10:15	10:40
General Parameters	**Units**	**PQL**	**WQ Criteria**																				
Calcium	mg/L	0.5	NS		7	6.3	*	4.9	2.4	2.4	2.4	2.5	2.5	2.4	2.7	*	*	6.9	6.8	3.7	6	4	3.7
Chloride	mg/L	1.0	250[1]		1	1	*	3.7	1.1	ND	2.2	1	1.3	2.3	2	*	*	1.4	1.3	1.1	1.5	1.8	1.5
Hardness (as $CaCO_3$)	mg/L	1.0	NS		25	22	*	18	8.4	8.4	8.4	8.7	8.8	8.5	9.3	*	*	22	22	12	19	13	12
Magnesium	µg/L	100	NS		1900	1600	*	1300	590	590	580	600	610	600	630	*	*	1200	1200	670	980	710	660
Nitrate/Nitrite (NO_3)	mg/L	0.20	1[1]		ND	ND	*	ND	ND	ND	ND	ND	ND	ND	ND	*	*	ND	ND	ND	ND	ND	ND
Ammonia as N	mg/L	0.100	1.5		ND	ND	*	0.121	0.167	0.133	0.117	0.207	0.101	0.122	ND	*	*	ND	ND	ND	ND	ND	ND
Total Kjeldahl Nitrogen (TKN)	mg/L	0.100	NS		0.268	ND	*	ND	ND	ND	0.173	0.211	0.148	0.102	ND	*	*	0.26	0.32	0.352	0.374	0.317	0.293
Total Phosphorus	mg/L	0.100	NS		ND	ND	*	ND	ND	ND	ND	ND	ND	ND	ND	*	*	0.058	ND	ND	ND	ND	ND
Ortho-phosphate	mg/L	0.010	NS		ND	ND	*	ND	ND	ND	ND	ND	ND	ND	ND	*	*	ND	ND	ND	ND	ND	ND
Potassium	mg/L	0.20	NS		ND	ND	*	ND	ND	ND	ND	ND	ND	ND	ND	*	*	ND	ND	ND	ND	ND	ND
Sodium	mg/L	0.50	NS		2.8	2.5	*	2.8	1.3	1.3	1.2	1.3	1.3	1.3	1.2	*	*	2	2.2	1.6	1.7	1.8	1.7
Sulfate (SO_4)	mg/L	0.50	250[1]		1.4	1.4	*	1.2	0.65	0.72	0.57	2.9	0.68	0.66	0.83	*	*	1.5	1.5	0.94	2.3	1.1	0.98
Total Dissolved Solids	mg/L	10	500[1]		52	52	*	76	58	66	46	52	58	54	52	*	*	52	52	38	38	26	26
Total Suspended Solids	mg/L	10	NS		ND	ND	*	ND	ND	ND	ND	ND	ND	ND	ND	*	*	ND	ND	ND	ND	ND	ND
Turbidity	NTU	0.10	(5)		ND	0.8	*	0.41	0.36	0.3	0.5	0.4	0.42	0.41	0.44	*	*	0.19	ND	0.25	0.4	0.76	0.25
Organic Carbon, Total (TOC)	mg/L	1.00	NS		ND	ND	*	ND	1.59	ND	ND	ND	ND	ND	ND	*	*	ND	ND	1.5	ND	ND	ND
Total Alkalinity	mg/L	5.0	>20[3]		31	30	*	21	**14**	**14**	**14**	**13**	**13**	**13**	**14**	*	*	24	29	**17**	24	**17**	**17**
Metals-Dissolved																							
Arsenic	µg/L	0.20	10[1]		0.090[B]	0.150[B]	*	0.120[B]	0.150[B]	0.110[B]	0.120[B]	0.150[B]	0.150[B]	0.150[B]	0.110[B]	*	*	0.100[B]	0.110[B]	0.200[B]	0.200[B]	0.170[B]	0.170[B]
Cadmium	µg/L	0.010	(6)		0.004[U]	0.004[U]	*	0.005[B]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	*	*	0.004[U]	0.004[U]	0.005[B]	0.004[U]	0.004[U]	0.005[B]
Copper	mg/L	0.00020	(6)		0.000170	0.000310	*	0.000210	0.000190	0.000170	0.000200	0.000220	0.000180	0.000220	0.000170	*	*	0.000160	0.000220	0.000380	0.000320	0.000330	0.000310
Iron	mg/L	0.005	0.3[1]		0.012300	0.196000	*	0.001400[U]	0.001400[U]	0.001400[U]	0.001400[U]	0.001400[U]	0.001400[U]	0.001400[U]	0.022800	*	*	0.016500	0.017100	0.018300	0.016300	0.012800	0.012200
Lead	µg/L	0.050	(6)		0.010[U]	0.010[U]	*	0.0510	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	0.010[U]	*	*	0.010[U]	0.022[B]	0.033[B]	0.010[U]	0.010[U]	0.010[U]
Manganese	µg/L	0.05	50[1]		0.406	46.820	*	1.520	0.299	1.800	0.570	0.355	0.595	1.850	**57.700**	*	*	1.200	1.100	4.970	0.937	6.700	6.780
Nickel	µg/L	0.20	(6)		0.050[B]	0.120[B]	*	0.040[U]	0.040[U]	0.040[U]	0.040[U]	0.040[U]	0.040[U]	0.040[U]	0.040[U]	*	*	0.050[B]	0.040[U]	0.060[B]	0.080[B]	0.050[B]	0.040[U]
Chromium-Total	µg/L	0.15	50[1]		0.030[U]	0.030[U]	*	0.050[B]	0.030[U]	0.030[U]	0.030[U]	0.030[U]	0.030[U]	0.030[U]	0.030[U]	*	*	0.030[U]	0.030[U]	0.030[U]	0.030[U]	0.030[U]	0.030[U]
Metals-Total																							
Mercury	µg/L	0.0004	0.052		0.000230[B]	0.000410	*	0.000240[B]	0.000210[B]	0.000250[B]	0.000190[B]	0.000330[B]	0.000230[B]	0.000240[B]	0.000390[B]	*	*	0.000360[B]	0.000360[B]	0.00069	0.000180[B]	0.000340[B]	0.000320[B]
Hydrocarbons															-								
Methyl-tertiary-butyl Ether (MtBE)	µg/L	0.50	5[1]						ND	ND	ND	ND	ND	ND								ND	ND
Total Petroleum Hydrocarbons (as gasoline and as diesel)	µg/L	50	NS						ND	ND	ND	ND	ND	ND								ND	ND
Oil and Grease	mg/L	4.8	NS						ND	ND	ND	ND	ND	ND								ND	ND
Bacteria																							
Total Coliform (3x5, 6 hr hold)	MPN/100 mL	2	NS		50	70	*	50	<2	2	<2	2	2	<2	13	*	*	220	500	130	80	27	22
Fecal Coliform (3x5)	MPN/100 mL	2-1600	200/100[1]		4	<2	*	17	<2	<2	<2	<2	<2	<2	<2	*	*	4	7	<2	11	2	<2

Table AQ 11-10. Summary of Analytical Results of Water Quality Sampling for Fall 2007 (continued).

				Station	MFAR-8 RM24.7	MFAR-9 RM24.3	MFAR-10 RM9.1	MFAR-11 RM0.1	NFAR-1 RM20.6	RR-1 RM35.9	HH-1(S)	HH-1	HH-2(S)	HH-2	HH-3(S)	HH-3	RR-2 RM30.2	RR-3 RM 22.8	SFRR-1 RM0.2	RR-4 RM22.5
				Date	9/26/2007	9/26/2007	9/24/2007	9/25/2007	9/25/2007	10/2/2007	10/1/2007	10/1/2007	10/1/2007	10/1/2007	10/2/2007	10/2/2007	10/3/2007	9/25/2007	9/25/2007	9/25/2007
				Time	14:15	14:45	13:25	9:00	9:40	11:40	14:55	14:15	12:00	12:50	10:15	9:00	10:20	13:00	12:30	13:30
General Parameters	**Units**	**PQL**	**WQ Criteria**																	
Calcium	mg/L	0.5	NS		4.2	3.8	4.2	5	7	7.9	2.8	2.9	2.8	2.8	2.9	2.9	3	4.3	2.1	4
Chloride	mg/L	1.0	250[1]		1.4	1.6	1.5	1.5	1.8	24	1	ND	ND	ND	ND	ND	2.4	6.1	ND	5.1
Hardness (as $CaCO_3$)	mg/L	1.0	NS		14	12	14	17	24	25	9.3	9.7	9.3	9.3	9.6	9.5	9.8	13	6.6	12
Magnesium	µg/L	100	NS		810	680	940	1100	1700	1200	550	590	570	560	570	560	560	620	330	600
Nitrate/Nitrite (NO_3)	mg/L	0.20	1[1]		ND	ND	ND	ND	ND	0.29	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ammonia as N	mg/L	0.100	1.5		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.118	ND
Total Kjeldahl Nitrogen (TKN)	mg/L	0.100	NS		ND	0.462	0.277	0.253	0.324	ND	ND	0.341	0.246	0.293	ND	ND	ND	0.524	0.601	0.328
Total Phosphorus	mg/L	0.100	NS		0.106	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ortho-phosphate	mg/L	0.010	NS		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium	mg/L	0.20	NS		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	mg/L	0.50	NS		1.7	1.7	1.8	1.9	2.5	7.3	1.4	1.5	1.4	1.4	1.5	1.4	1.3	3.5	1.1	3.2
Sulfate (SO_4)	mg/L	0.50	250[1]		1.2	1	1.5	1.6	2.4	1.2	0.67	0.63	0.72	0.63	0.63	0.65	0.94	0.77	0.86	0.78
Total Dissolved Solids	mg/L	10	500[1]		36	60	44	34	46	94	46	44	46	50	34	38	86	52	14	32
Total Suspended Solids	mg/L	10	NS		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Turbidity	NTU	0.10	(5)		0.56	0.46	ND	0.2	0.27	ND	0.21	0.34	0.3	0.36	0.34	0.3	0.54	0.13	ND	ND
Organic Carbon, Total (TOC)	mg/L	1.00	NS		ND	ND	1.3	ND	ND	ND	ND	1.47	ND	ND	ND	ND	ND	ND	ND	ND
Total Alkalinity	mg/L	5.0	>20[3]		**17**	**17**	**18**	22	28	**17**	**15**	**15**	**14**	**15**	**14**	**15**	**12**	**17**	**11**	**14**
Metals-Dissolved																				
Arsenic	µg/L	0.20	10[1]		0.170^{B}	0.180^{B}	0.210	0.240	0.340	0.280	0.210	0.210	0.220	0.190^{B}	0.220	0.200^{B}	0.190^{B}	0.180^{B}	0.060^{U}	0.160^{B}
Cadmium	µg/L	0.010	(6)		0.013	0.004^{U}	0.004^{U}	0.004^{U}	0.005^{B}	0.008^{B}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}	0.004^{U}
Copper	mg/L	0.00020	(6)		0.000340	0.000310	0.000320	0.000290	0.000330	0.000140	0.000270	0.000280	0.000260	0.000280	0.000280	0.000270	0.000510	0.000370	0.000130	0.000290
Iron	mg/L	0.005	0.3[1]		0.049400	0.012700	0.016600	0.014900	0.021300	0.001400^{U}	0.001400^{U}	0.001400^{U}	0.001400^{U}	0.001400^{U}	0.001400^{U}	0.001400^{U}	0.015700	0.008800	0.006400	0.007700
Lead	µg/L	0.050	(6)		0.015^{B}	0.010^{U}	0.010^{U}	0.012^{B}	0.015^{B}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.025^{B}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}	0.010^{U}
Manganese	µg/L	0.05	50[1]		16.700	7.720	3.560	1.120	1.290	0.847	0.871	0.391	0.354	0.479	1.190	0.696	44.900	0.188	0.334	0.114
Nickel	µg/L	0.20	(6)		0.015^{B}	0.040^{U}	0.130^{B}	0.140^{B}	0.140^{B}	0.040^{U}	0.040^{U}	0.040^{U}	0.040^{U}	0.040^{U}	0.040^{U}	0.040^{U}	0.040^{U}	0.040^{U}	0.050^{B}	0.040^{U}
Chromium-Total	µg/L	0.15	50[1]		0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.130^{B}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}	0.030^{U}
Metals-Total																				
Mercury	µg/L	0.0004	0.052		0.000320^{B}	0.000350^{B}	0.000740	0.000540	0.000460	0.000150^{U}	0.000350^{B}	0.000430	0.000320^{B}	0.000400^{B}	0.000300^{B}	0.000280^{B}	0.001260	0.000150^{U}	0.000200^{B}	0.000230^{B}
Hydrocarbons																				
Methyl-tertiary-butyl Ether (MtBE)	µg/L	0.50	5[1]								ND	ND	ND	ND	ND	ND				
Total Petroleum Hydrocarbons (as gasoline and as diesel)	µg/L	50	NS								ND	ND	ND	ND	ND	ND				
Oil and Grease	mg/L	4.8	NS								ND	ND	ND	ND	ND	ND				
Bacteria																				
Total Coliform (3x5, 6 hr hold)	MPN/100 mL	2	NS		7	6	240	50	140	8	2	13	2	<2	<2	<2	4	30	8	27
Fecal Coliform (3x5)	MPN/100 mL	2-1600	200/100[1]		<2	<2	4	7	4	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2

Table AQ 11-10. Summary of Analytical Results of Water Quality Sampling for Fall 2007 (continued).

				Station	RR-5 RM3.8	RR-6 RM3.5	RR-7 RM0.7	NFLC-1 RM3.2	NFLC-2 RM2.9	NFLC-3 RM0.3	SFLC-1 RM3.4	SFLC-2 RM3.1	SFLC-3 RM0.2	LCC-1 RM11.3	LCC-2 RM0.3
				Date	9/27/2007	9/27/2007	9/26/2007	10/2/2007	10/2/2007	10/2/2007	10/2/2007	10/2/2007	10/2/2007	10/2/2007	9/27/2007
				Time	9:45	10:20	13:45	12:10	12:30	11:10	13:00	13:20	11:20	10:00	10:00
General Parameters	**Units**	**PQL**	**WQ Criteria**												
Calcium	mg/L	0.5	NS		5	5.2	5.8	5.8	5.7	3.7	4.6	4.7	3.7	3.6	9.6
Chloride	mg/L	1.0	250[1]		5.2	5.2	4.9	ND	ND	1.5	ND	ND	1.9	1.7	3.8
Hardness (as $CaCO_3$)	mg/L	1.0	NS		16	17	19	21	21	13	17	18	13	13	33
Magnesium	µg/L	100	NS		870	930	1100	1700	1700	980	1400	1400	1000	970	2100
Nitrate/Nitrite (NO_3)	mg/L	0.20	1[1]		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ammonia as N	mg/L	0.100	1.5		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Kjeldahl Nitrogen (TKN)	mg/L	0.100	NS		2.72	0.34	0.267	ND	ND	ND	ND	ND	0.123	0.108	0.32
Total Phosphorus	mg/L	0.100	NS		ND	ND	ND	ND	ND	ND	0.103	ND	ND	ND	ND
Ortho-phosphate	mg/L	0.010	NS		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium	mg/L	0.20	NS		2	ND	2.2	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	mg/L	0.50	NS		3	3.1	3.3	4	4	3.9	2.7	2.7	3.3	3.5	4.2
Sulfate (SO_4)	mg/L	0.50	250[1]		1.4	1.5	1.8	0.98	ND	0.63	ND	ND	1	0.88	2.1
Total Dissolved Solids	mg/L	10	500[1]		38	46	50	64	92	84	84	66	66	66	72
Total Suspended Solids	mg/L	10	NS		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Turbidity	NTU	0.10	(5)		ND	0.1	0.27	ND	0.28	0.15	0.16	0.1	ND	0.2	ND
Organic Carbon, Total (TOC)	mg/L	1.00	NS		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Alkalinity	mg/L	5.0	>20[3]		**19**	**20**	22	35	32	24	29	28	23	23	40
Metals-Dissolved															
Arsenic	µg/L	0.20	10[1]		0.120[B]	0.130[B]	0.130[B]	0.150[B]	0.140[B]	0.260	0.100[B]	0.110[B]	0.180[B]	0.210	0.210
Cadmium	µg/L	0.010	(6)		0.004[U]	0.004[U]	0.005[B]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]	0.004[U]
Copper	mg/L	0.00020	(6)		0.000280	0.000270	0.000280	0.00013[B]	0.00012[B]	0.000400	0.000150	0.00012[B]	0.0002[B]	0.000300	0.000300
Iron	mg/L	0.005	0.3[1]		0.001400[U]	0.001400[U]	0.013100	0.001400[U]	0.007100	0.001400[U]	0.001400[U]	0.015200	0.001400[U]	0.001400[U]	0.001400[U]
Lead	µg/L	0.050	(6)		0.010[U]	0.011[B]	0.064	0.010[U]	0.010[U]	0.048[B]	0.011[B]	0.010[U]	0.010[U]	0.015[B]	0.015[B]
Manganese	µg/L	0.05	50[1]		0.183	0.203	0.404	0.097	21.200	0.716	1.020	6.700	0.434	0.703	0.636
Nickel	µg/L	0.20	(6)		0.040[U]	0.040[U]	0.040[U]	0.040[U]	0.040[U]	0.040[U]	0.040[U]	0.040[U]	0.040[U]	0.040[U]	0.040[U]
Chromium-Total	µg/L	0.15	50[1]		0.060[B]	0.060[B]	0.030[U]	0.030[U]	0.030[U]	0.030[U]	0.050[B]	0.040[B]	0.050[B]	0.040[B]	0.030[U]
Metals-Total															
Mercury	µg/L	0.0004	0.052		0.000150[U]	0.000170[B]	0.000150[U]	0.00050	0.001040	0.001230	0.000180[B]	0.000260[B]	0.000320[B]	0.000770	0.000360
Hydrocarbons															
Methyl-tertiary-butyl Ether (MtBE)	µg/L	0.50	5[1]												
Total Petroleum Hydrocarbons (as gasoline and as diesel)	µg/L	50	NS												
Oil and Grease	mg/L	4.8	NS												
Bacteria															
Total Coliform (3x5, 6 hr hold)	MPN/100 mL	2	NS		300	900	170	4	300	80	170	11	13	23	30
Fecal Coliform (3x5)	MPN/100 mL	2-1600	200/100[1]		<2	<2	2	<2	300	2	170	2	2	8	2

Note: Bold results do not meet the listed criteria

PQL: Practical Quantitation Limit: the lowest concentration of an analyte that can be reliably measured within specified limits of precision and accuracy during routine laboratory operating conditions.

ND: Not detected above the PQL.

NS: No standard.

*: Sample location was not sampled during the fall sampling event due to dangerous access conditions.

U: Results less than or equal to the method detection limit (MDL) and are considered 'non-detect'.

B: Results are above the MDL and less than or equal to the practical quantitation limit (PQL) and should be considered estimates.

1: Basin Plan criteria for the Sacramento and San Joaquin Rivers Basins.

2: California Toxics Rule Criteria (CTR)

3: National Toxics Rule Criteria (NTR)

4: pH, temperature and life cycle dependent. See Table 11-14 for criteria and results.

5: Increases in turbidity attributable to controllable water quality factors shall not exceed the following limits: where natural turbidity is between 0 and 5 NTU's, increases shall not exceed 1 NTU. Where natural turbidity is between 5 and 50 NTU's, increases shall not exceed 20%. Where natural turbidity is between 50 and 100 NTU's, increases shall not exceed 10 NTU's. Finally, where natural turbidity is greater than 100 NTU's, increases shall not exceed 10%.

6: Criteria are hardness dependent which is expressed as a function of hardness and decreases as hardness decreases. The actual criteria are calculated based on the hardness (as $CaCO_3$) of the sample water. Refer to Table 11-15 for sample site criteria and results.

Attachment F (b)

ARPS Title 22 Water Quality Sampling Results 2021

American River Water Quality Results 2021					
Group/Constituent Identification	Sampling Date	Result	Maximum Contaminant Level (for drinking water purposes only)	Detection Limit for the Purposes of Reporting	Unit
ALKALINITY, TOTAL	11-09-2021	32.60			MG/L
CARBON, TOTAL	11-09-2021	1.35		.3	MG/L
FOAMING AGENTS (SURFACTANTS)	09-16-2021	0	.5		MG/L
TURBIDITY	08-11-2021	0.55	5	.1	NTU
ALUMINUM	08-11-2021	0	1000	50	UG/L
ARSENIC	08-11-2021	0	10	2	UG/L
BARIUM	08-11-2021	0	1000	100	UG/L
CADMIUM	08-11-2021	0	5	1	UG/L
CHLORIDE	08-11-2021	1.87	500		MG/L
CHROMIUM	08-11-2021	0	50	10	UG/L
HYDROXIDE AS CALCIUM CARBONATE	08-11-2021	0			MG/L
COPPER, FREE	08-11-2021	0	1000	50	UG/L
FLUORIDE	08-11-2021	0	2	.1	MG/L
IRON	08-11-2021	0	300	100	UG/L
MAGNESIUM	08-11-2021	1.33			MG/L
MANGANESE	08-11-2021	0	50	20	UG/L
MERCURY	08-11-2021	0	2	1	UG/L
NICKEL	08-11-2021	0	100	10	UG/L
PERCHLORATE	08-11-2021	0	6	2	UG/L
NITRATE	08-11-2021	0	10	.4	mg/L
NITRITE	08-11-2021	0	1	.4	mg/L
SELENIUM	08-11-2021	0	50	5	UG/L
SILVER	08-11-2021	0	100	10	UG/L
SODIUM	08-11-2021	2.43			MG/L
SULFATE	08-11-2021	1.60	500	.5	MG/L
CONDUCTIVITY @ 25 C UMHOS/CM	08-11-2021	58.77	1600		US
ANTIMONY, TOTAL	08-11-2021	0	6	6	UG/L
BERYLLIUM, TOTAL	08-11-2021	0	4	1	UG/L
THALLIUM, TOTAL	08-11-2021	0	2	1	UG/L
ZINC	08-11-2021	0	5000	50	UG/L
COLOR	08-11-2021	0	15		UNITS
HARDNESS, TOTAL (AS CACO3)	08-11-2021	20.2			MG/L
CALCIUM	08-11-2021	5.87			MG/L
ODOR	08-11-2021	3	3	1	TON
PH	08-11-2021	7.06			
ALKALINITY, TOTAL	08-11-2021	26.4			MG/L
ALKALINITY, BICARBONATE	08-11-2021	26.4			MG/L
ALKALINITY, CARBONATE	08-11-2021	0			MG/L
TDS	08-11-2021	57	1000		MG/L
TRICHLOROFLUOROMETHANE	08-11-2021	0	150	5	UG/L
TRANS-1,3-DICHLOROPROPENE	08-11-2021	0	.5	.5	UG/L
CIS-1,3-DICHLOROPROPENE	08-11-2021	0	.5	.5	UG/L
METHYL TERT-BUTYL ETHER	08-11-2021	0	13	3	UG/L
1,2,4-TRICHLOROBENZENE	08-11-2021	0	5	.5	UG/L
CIS-1,2-DICHLOROETHYLENE	08-11-2021	0	6	.5	UG/L
1,3-DICHLOROPROPENE	08-11-2021	0	.5	.5	UG/L
1,2,3-TRICHLOROPROPANE	08-11-2021	0	0.005		UG/L
TRICHLOROTRIFLUOROETHANE	08-11-2021	0	1200	10	UG/L
CARBON, TOTAL	08-11-2021	0.72		.3	MG/L
XYLENES, TOTAL	08-11-2021	0	1750	0.5	UG/L
XYLENE, META AND PARA	08-11-2021	0		.5	UG/L
DICHLOROMETHANE	08-11-2021	0	5	.5	UG/L
O-DICHLOROBENZENE	08-11-2021	0	600	.5	UG/L
P-DICHLOROBENZENE	08-11-2021	0	5	.5	UG/L
VINYL CHLORIDE	08-11-2021	0	.5	.5	UG/L
1,1-DICHLOROETHYLENE	08-11-2021	0	6	.5	UG/L
1,1-DICHLOROETHANE	08-11-2021	0	5	.5	UG/L
TRANS-1,2-DICHLOROETHYLENE	08-11-2021	0	10	.5	UG/L
1,2-DICHLOROETHANE	08-11-2021	0	.5	.5	UG/L
1,1,1-TRICHLOROETHANE	08-11-2021	0	200	.5	UG/L
CARBON TETRACHLORIDE	08-11-2021	0	.5	.5	UG/L
1,2-DICHLOROPROPANE	08-11-2021	0	5	.5	UG/L
TRICHLOROETHYLENE	08-11-2021	0	5	.5	UG/L
1,1,2-TRICHLOROETHANE	08-11-2021	0	5	.5	UG/L
TETRACHLOROETHYLENE	08-11-2021	0	5	.5	UG/L
1,1,2,2-TETRACHLOROETHANE	08-11-2021	0	1	.5	UG/L
CHLOROBENZENE	08-11-2021	0	70	.5	UG/L
BENZENE	08-11-2021	0	1	.5	UG/L
TOLUENE	08-11-2021	0	150	.5	UG/L
ETHYLBENZENE	08-11-2021	0	300	.5	UG/L
STYRENE	08-11-2021	0	100	.5	UG/L
O-XYLENE	08-11-2021	0		.5	UG/L
CARBON, TOTAL	05-13-2021	0.86		.3	MG/L
HYDROXIDE AS CALCIUM CARBONATE	02-10-2021	0			MG/L
ALKALINITY, TOTAL	02-10-2021	20.5			MG/L
ALKALINITY, BICARBONATE	02-10-2021	20.5			MG/L
ALKALINITY, CARBONATE	02-10-2021	0			MG/L
CARBON, TOTAL	02-10-2021	0.75		.3	MG/L

Attachment G(a)

Environmental Effects of PCWA Water Transfers

Technical Memorandum

Attachment G

Environmental Effects of PCWA Water Transfers In Drier Years on Folsom Reservoir and the Lower American River

Placer County Water Agency

May 2020

Table of Contents

List of Tables

List of Figures

List of Appendices

List of Acronyms

TAF	Thousand acre-feet
ATSP	Automated Temperature Selection Procedure
cfs	cubic feet per second
CISO	California Independent System Operator
CVP	Central Valley Project
EBMUD	East Bay Municipal Utility District
F	Fahrenheit
C	Celsius
MET	Meteorological
MFP	Middle Fork American River Project
PCWA	Placer County Water Agency
Reclamation	U.S. Bureau of Reclamation
WWD	Westlands Water District

1.0 INTRODUCTION

Placer County Water Agency (PCWA) has implemented numerous temporary water transfers from its Middle Fork American River Project (MFP) in drier water years over the past 30 years (**Table 1; Appendix G1**). Water transfers release water from MFP storage that would not otherwise have been released in the drier years resulting in an increase in the availability of water both for environmental and water supply purposes.

In 2000, PCWA water transfers from the MFP into the North Fork American River/Folsom Reservoir and the Lower American River were included in the Water Forum Agreement[1] environmental objective – namely to preserve the fish, wildlife, recreational, and aesthetic values of the Lower American River in drier years. As part of the agreement, up to 47,000 acre-feet of water would be made available for transfer from PCWA's MFP storage (French Meadows and Hell Hole reservoirs)[2] in drier years. PCWA holds consumptive rights for the MFP water under Water Right Permits 13856 and 13858 issued by the State Water Rights Board (predecessor to the current State Water Resources Control Board or State Water Board) on January 10, 1963 (State Water Rights Board Decision D-1104). For the purposes of transferring water, PCWA exercises Water Right Permit 13856 and also enters into a MFP Refill Agreement with the United States Bureau of Reclamation (Reclamation) to ensure non-injury to any downstream legal water users. Historically, depending on the terms of the agreement, the water released from the MFP reservoirs for transfer was only refilled during subsequent wet seasons/years when Folsom Reservoir was full or spilling water in flood control and the Delta was in excess conditions.

Typically, transfers occur in the summer and fall, but have also occurred at other times of the year (**Table 1**). Transfer water is released from PCWA's MFP storage reservoirs in drier years by reducing the normal carryover storage of the reservoirs for that year (water that otherwise would remain in storage). The transfer water is released from the cold water pool of Hell Hole Reservoir through 20 miles of tunnels to Middle Fork Interbay and Ralston Afterbay where it enters the Middle Fork American River downstream of Oxbow Powerhouse (24 miles upstream of Folsom Reservoir) (**Figure 1**). The water temperature of the transfer water through Oxbow Powerhouse is cold (typically 45-50°F) when it enters the Middle Fork American River. These cold water releases result in reduced water temperature in both the Middle Fork and North Fork American rivers, as well as, Folsom Reservoir inflow (approximately 65°F in the transfer years). The cooler Folsom Reservoir inflow travels across the cool-water metalimnion of the reservoir (approximately 65°F), and provides additional cool water (both the original river flow and the additional transfer water) to blend with cold hypolimnion water at the Folsom Dam power penstock shutters to improve temperature release conditions into the Lower

[1] The Water Forum Agreement, negotiated by a diverse group of businesses, agricultural leaders, citizens groups, conservation interests, water managers and local governments in Sacramento, Placer, and El Dorado counties, has two coequal objectives: (1) provide a reliable and safe water supply for the region's economic and planned development; and (2) preserve the fish, wildlife, recreational, and aesthetic values of the Lower American River.

Table 1. PCWA Historical Water Transfers (1990-2020).

Calendar Year	Water Transfer (ac-ft)	Monthly Release Amounts (ac-ft)													Transfer Recipient
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Release[1] (ac-ft)	
1990	38,597												38,597	38,597	Westlands Water District, San Luis, San Francisco
1991	40,000												40,000	40,000	San Francisco, Santa Clara
1992	10,000												10,000	10,000	State Water Bank
1993															
1994	20,000												20,000	20,000	State Water Bank
1995														0	
1996														0	
1997	12,000							17,000	18,000					12,000	Sac Area Flood Control
1998														0	
1999														0	
2000														0	
2001	20,000									21,800	400			22,200	Environmental Water Account
2002														0	
2003														0	
2004	18,700									7,900	7,900	2,900		18,700	Environmental Water Account
2005														0	
2006														0	
2007														0	
2008	20,000									29	8,139	139	21,268	29,575	Westlands Water District
2009	20,000								5,209	15,415				20,624	San Diego
2010														0	
2011														0	
2012														0	
2013	20,000					20,000								20,000	Westlands Water District (WWD)
2014	40,000				5,000			10,745	12,155	12,100					East Bay Municipal District & WWD
2015	12,000							2,840	6,916	2,244					East Bay Municipal District
2016															
2017															
2018															
2019															
2020	20,000[2]							5,000[2]	8,000[2]	7,000[2]					Westlands Water District

[1] In some years, release volumes were greater than the transfer amount.

[2] Proposed for 2020.

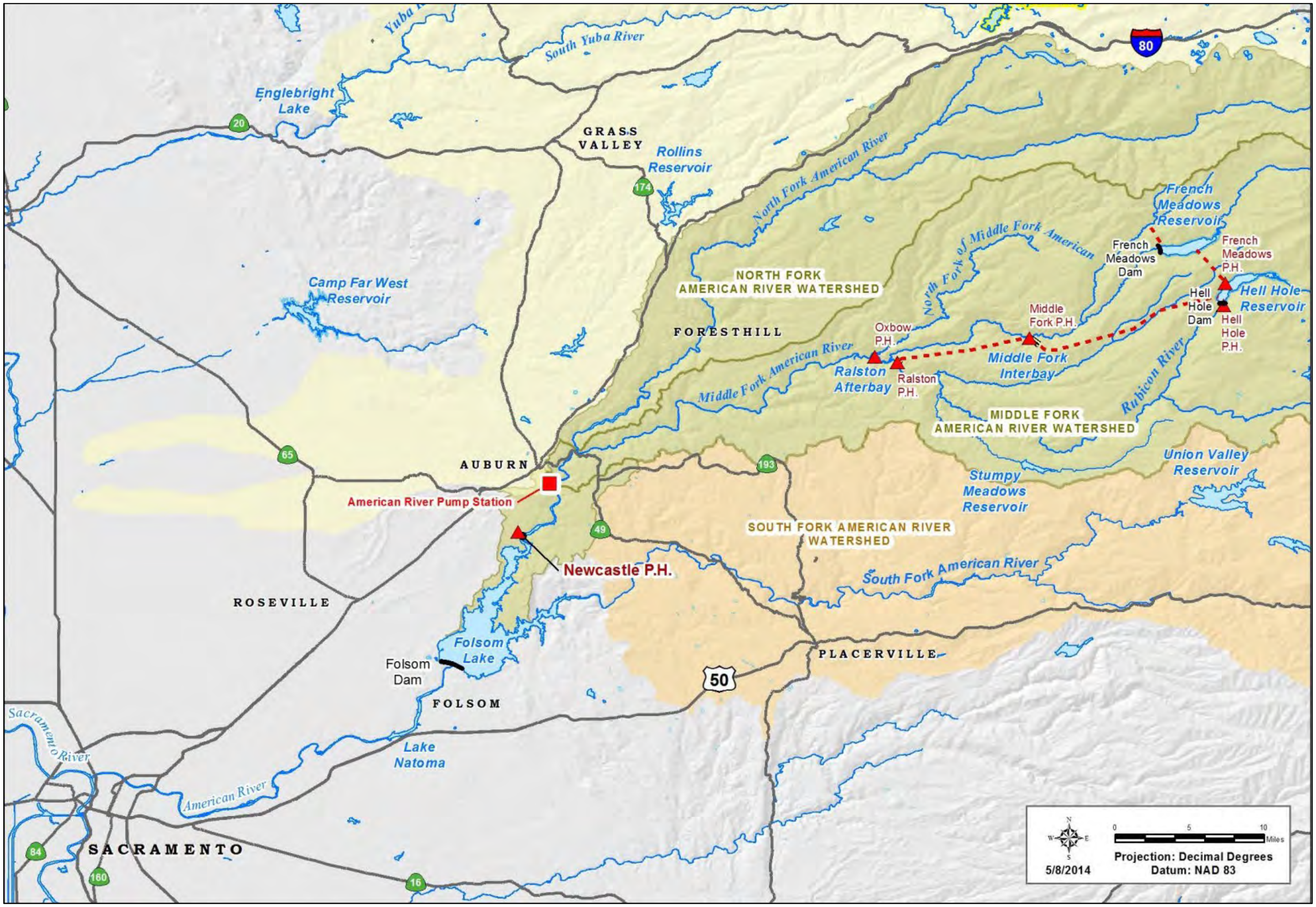


Figure 1. PCWA Middle Fork American River Project, Folsom Reservoir, and Lower American River.

American River. The resulting increased flows in the Lower American River (due to the addition of transfer water) also decrease the rate of warming of the Lower American River providing additional benefits to habitat for anadromous salmonids (e.g., cooler water temperature in the river).

This technical memorandum describes the effects of transferring water from PCWA's MFP in drier years for environmental purposes or consumptive use by other parties downstream of the confluence of the Lower American River and Sacramento River. The technical memorandum includes an analysis of the effects of transfers on North Fork American River inflow hydrology and water temperature into Folsom Reservoir; Folsom Reservoir storage and water temperature; and Lower American River hydrology and water temperature. Additional effects from transfers such as meeting Water Forum Agreement drier year objectives, greater hydropower generation, improved CAISO grid regulation, increased whitewater rafting opportunities, and providing supplemental water supplies in drier years are also discussed.

2.0 WATER TRANSFER HYDROLOGY

2.1. Representative Transfer

The transfer schedules in **Table 2** were used to represent a range of PCWA transfer amounts. Transfers historically have been 10,000 AF to 40,000 AF and recently the stored MFP water has been released approximately evenly from July - September (sometimes other months) (**Table 1**). Reclamation and San Luis & Delta-Mendota Water Authority also completed a Long-Term Water Transfers Environmental Impact Report/Environmental Impact Statement (2019) that covers July – September PCWA transfers.

The transfer water released through MFP hydroelectric facilities (e.g., Oxbow Powerhouse) into the Middle Fork American River then into the North Fork American River (**Figure 1**) would be temporarily stored in Folsom Reservoir pursuant to a Warren Act Contract between the transfer recipient and Reclamation. Reclamation would provide the transfer water to the transfer recipient on a schedule that is mutually agreeable and/or beneficial to Reclamation, the recipient, and the environment. The release of transfer water from Folsom Reservoir could occur on top of or as part of Reclamation's forecasted operations (see Section 2.3 Reclamation Operations and Forecast), or as a combination of these two options. Following release of the transfer water by Reclamation, the water would enter the Sacramento River at the confluence of the Lower American River and then be delivered to the buyer (e.g., Freeport Intake on the Sacramento River or Jones pumping plant in the south Delta).

Preliminary modeling indicated that an evenly distributed transfer release in the July – September window (**Table 2**) was also representative of conditions that would occur if the transfer distribution or window was slightly modified. For example, releasing more water in one month and less in the next or releasing water a month earlier or later had a negligible effect on water temperature modeling results.

Table 2. Representative Schedules of PCWA's MFP Water Transfer Releases into Folsom Reservoir.

Representative Transfer	Transfer Amount (AF)			
	July	August	September	Total
35,000 AF	11,667	11,667	11,667	35,000
20,000 AF	6,667	6,667	6,667	20,000
12,000 AF	4,000	4,000	4,000	12,000

2.2. PCWA Operations and Forecast (Folsom Reservoir Inflow)

North Fork American River inflows to Folsom Reservoir with and without the representative transfers for a typical dry year (2014) are shown in **Table 3**. PCWA uses their OASIS operations forecast model of the MFP and North Fork American River in the spring to project operations throughout the remainder of each year. The model is used looking forward with forecasted inflows from the National Weather Service's California-Nevada River Forecasting Center (CNRFC). The simulation period for transfers is typically April/May through December. For the July – September period, North Fork American River inflow to Folsom Reservoir would increase 54%, 31%, and 18% for the 35 TAF, 20 TAF, and 12 TAF transfers, respectively.

Table 3. With and Without Transfers Example Forecasted PCWA Operations of the MFP[1] at the North Fork American River below the American River Pump Stations (based on 2014) (bold text shows changes from baseline).

North Fork American River Bl ARPS[2] Operations Scenario	Month (Acre-feet)							
	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Baseline Without Transfer	51,390	22,707	23,876	21,409	20,066	6,830	24,706	51,211
35 TAF Transfer	51,390	22,707	**35,543**	**33,076**	**31,733**	6,830	24,706	51,211
20 TAF Transfer	51,390	22,707	**30,543**	**28,076**	**26,733**	6,830	24,706	51,211
12 TAF Transfer	51,390	22,707	**27,876**	**25,409**	**24,066**	6,830	24,706	51,211

[1] May 15, 2014 Inflow projections through September are based on a 75% probability of exceedance of future precipitation. October through December projections are based on a 90% historical inflow exceedance.
[2] ARPS is American River Pump Station

2.3. Reclamation Operations and Forecast (Folsom Reservoir Storage and Outflow)

The baseline Reclamation operations forecast for Folsom Reservoir and the Lower American River without a PCWA transfer is shown in **Table 4** and **Figure 2**. The three representative PCWA transfers are also shown in **Table 4** and **Figure 2** under two scenarios, (1) PCWA transfer water is released from Folsom

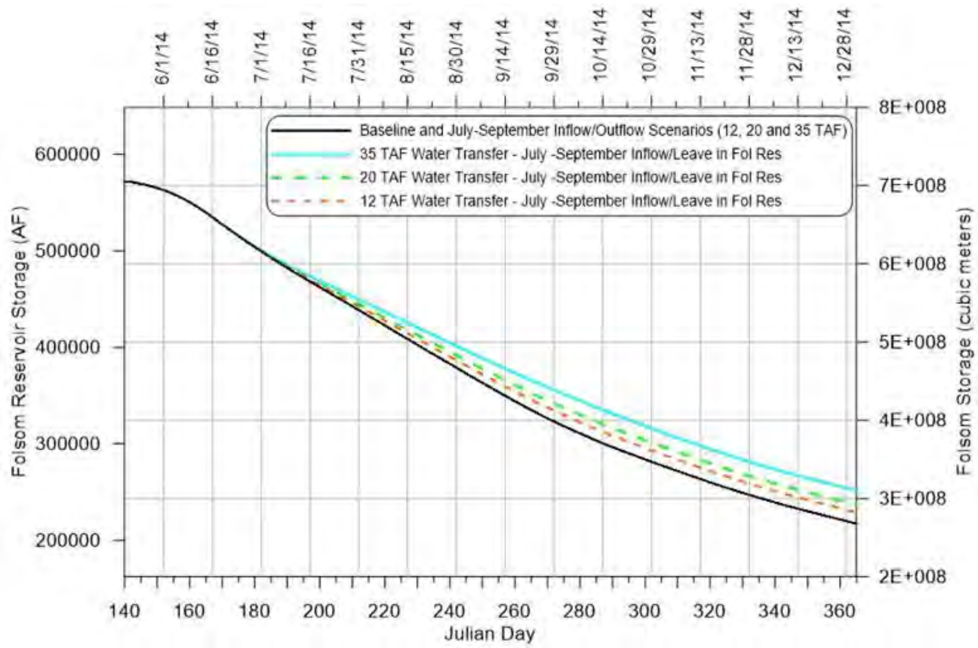
Reservoir the same month it comes in (July – September inflow/outflow) and (2) PCWA transfer water remains in Folsom Reservoir through the end of the year (July – September inflow/leave in Folsom Reservoir)[3].

Reclamation operations forecasts for Folsom Reservoir and the Lower American River are provided monthly. PCWA used the May 15, 2014 90% runoff exceedance Folsom Reservoir operations forecast as the without transfer baseline to model hydrology and water temperature effects of the representative transfers.

Table 4. With and Without Transfers Example Reclamation 90% Runoff Exceedance Operations Forecast (based on June, 2014 Reclamation forecast) (bold text shows changes from baseline).

Folsom Reservoir and Lower American River Operations Scenario		Month (Acre-feet)							
		MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Folsom Reservoir Storage (TAF)									
Baseline Without Transfer Reclamation 90% Forecast		539	498	407	339	294	254	219	300
Transfer Water July – September Inflow/Outflow	35 TAF								
	20 TAF	539	498	407	339	294	254	219	300
	12 TAF								
Transfer Water July – September Inflow/Leave in Folsom Reservoir	35 TAF	539	498	**419**	**362**	**329**	**289**	**254**	**335**
	20 TAF	539	498	**414**	**352**	**314**	**274**	**239**	**320**
	12 TAF	539	498	**411**	**347**	**306**	**266**	**231**	**312**
Lower American River Flow (cfs)									
Baseline Without Transfer Reclamation 90% Forecast		1513	1417	2109	1759	1240	805	800	706
Transfer Water July – September Inflow/Outflow	35 TAF	1513	1417	**2299**	**1949**	**1436**	805	800	706
	20 TAF	1513	1417	**2217**	**1867**	**1352**	805	800	706
	12 TAF	1513	1417	**2174**	**1824**	**1307**	805	800	706
Transfer Water July – September Inflow/Leave in Folsom Reservoir	35 TAF								
	20 TAF	1513	1417	2109	1759	1240	805	800	706
	12 TAF								

[3] Reclamation could potentially provide recipients water from another source by exchanging timing of water releases from other storage reservoirs while the water is held temporarily in Folsom Reservoir.



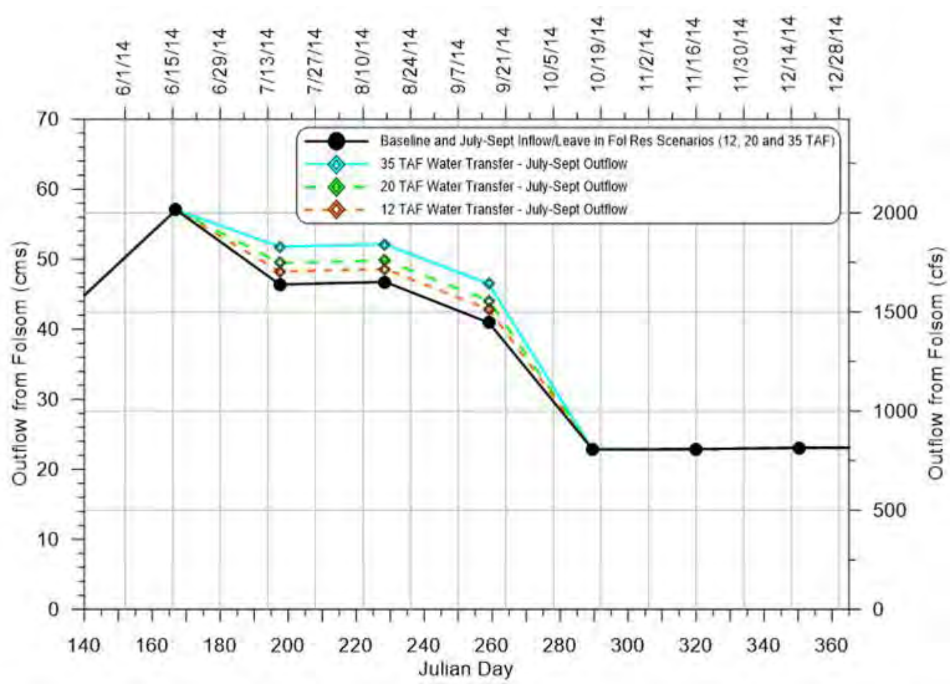


Figure 2. Folsom Reservoir Monthly Average Storage (Top) and Lower American River Outflow (Bottom) for the Baseline Without Transfer (Black Line) and the Representative 12 TAF, 20 TAF, and 35 TAF Transfer Scenarios.

2.4. Middle Fork American River Project Refill Agreement

In order to refill MFP reservoirs following the release of the transfer water without injury to downstream water right holders, PCWA would enter into a MFP Refill Agreement with Reclamation. The Refill Agreement minimizes the potential for refill of MFP reservoirs to affect Folsom Reservoir annual storage after a transfer. PCWA has a typical end-of-the-year (December-February) combined carryover target (storage low point) of 150,000 AF in its MFP reservoirs (French Meadows and Hell Hole). Following each of the representative transfer amounts, PCWA would carry an additional 12 TAF, 20 TAF, or 35 TAF deficit, respectively, in its carryover storage forward in time until conditions identified in the Refill Agreement allow PCWA to relieve the deficit in MFP reservoirs (e.g., Folsom Reservoir fills/reaches flood control levels).

2.5. Transfer Recipient Water Supply

The transfer recipient (e.g., Westlands Water District, EBMUD, etc.) would obtain water in a year of very critical need. For example, Westlands Water District provides water supply to over 600,000 acres of farmland within Fresno and Kings counties. Westlands Water District's long-term source of water supply is the Central Valley Project (CVP), operated by Reclamation. In drier years Reclamation's allocation to Westlands Water District can be as low as zero percent of their annual contract amount. Transfers are necessary in drier years to protect valuable agricultural products on these farmlands. EBMUD provides water supply to over 1.34 million people plus industrial, commercial, institutional, and irrigation water users in the East Bay region of San Francisco Bay Area. EBMUD's long-term source of water supply is the Mokelumne River. In dry years, EBMUD supplements its water supplies with CVP water from the Central Valley Project (CVP) under its long-term renewal contract and transfers water from willing sellers if water is available. CVP supplies can be reduced such as in 2015 when EBMUD's allocation was just 25% of the water to which it was entitled under its CVP contract. Transfers are necessary for EBMUD to provide essential public services.

3.0 INFLOW WATER TEMPERATURE TO FOLSOM RESERVOIR

Summer water temperatures in the North Fork American River and South Fork American River decrease with increased flow releases from the upstream hydropower facilities/deep water reservoirs. The effect of the representative transfers is to increase North Fork American River flows into Folsom Reservoir and decrease inflow water temperature. The transfer would not affect South Fork American River inflow to Folsom Reservoir (PCWA does not operate any facilities in the watershed). Inflow water temperatures into Folsom Reservoir were modeled using multivariate regression water temperature models based on 15 years of real data that include a wide range of inflow/climate conditions. The regression models accurately predict inflow water temperature based on flow, air temperature, and time of year (the time of year implicitly accounts for solar radiation) for the two rivers. Meteorological (MET) data from a year representative of average meteorological conditions was used for the modeling. The 2008 MET data, which also occurred in a dry year, was the most representative of average conditions (**Figure 3**). Details of the water temperature models are provided in **Appendix G2** of this document.

3.1. North Fork American River

The water temperature decrease of the three representative transfer scenarios in the North Fork American River just upstream of Folsom Reservoir is shown in **Figure 4.** The temperature decrease is 0.8˚F – 2.1˚F in July, 0.6˚F – 1.7˚F in August, 0.6˚F – 1.8˚F in September. The Folsom Reservoir inflow temperature decrease occurs due to the increased flow from the upstream cold water reservoirs. **Appendix G3** illustrates the accuracy of the temperature modeling based on 2014 predicted inflow water temperatures and measured inflow water temperatures.

3.2. South Fork American River

South Fork American River inflow water temperature to Folsom Reservoir is unaffected by PCWA transfers. The inflow water temperature method used for the South Fork American River water temperature modeling is provided in **Appendix G2.** **Appendix G3** illustrates the accuracy of the temperature modeling based on the 2014 measured inflow water temperatures.

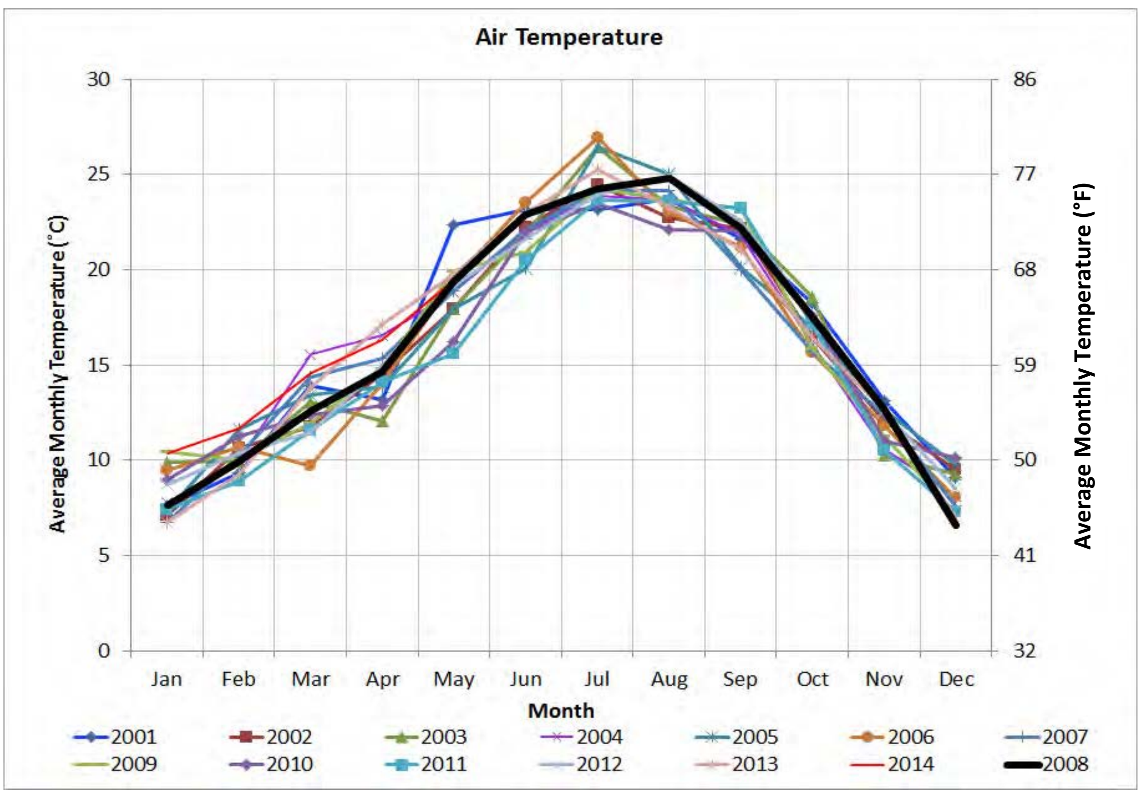


Figure 3. Example of Recent Meteorological (MET) Data (Air Temperature) (2001-2014).

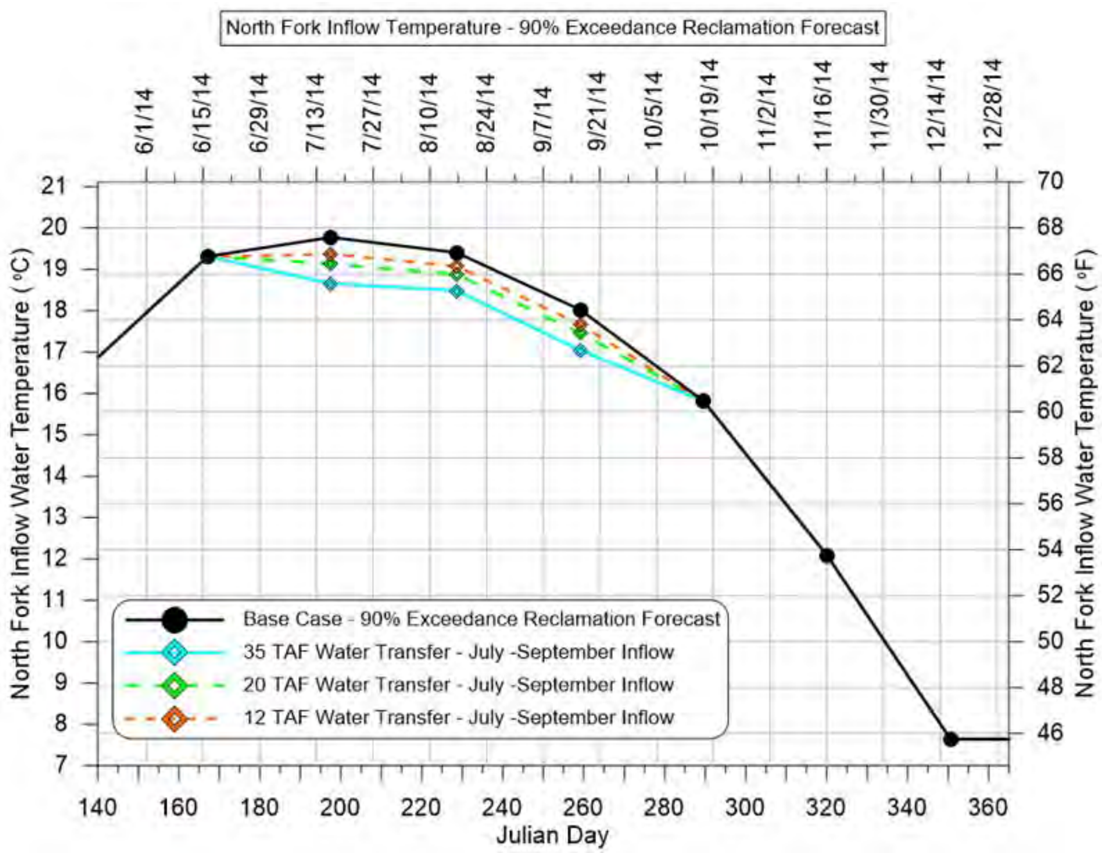


Figure 4. Water Temperature in the North Fork American River upstream of Folsom Reservoir for the Baseline Without Transfer and the 12 TAF, 20 TAF, and 35 TAF Water Transfer Options.

4.0 FOLSOM RESERVOIR WATER TEMPERATURE MODELING

Folsom Reservoir water temperature modeling was accomplished with a well-calibrated, high-resolution, two-dimensional CE-QUAL-W2 model of Folsom Reservoir (**Appendix G4**) coupled with an accurate regression model of the Lower American River at Watt Avenue (**Appendix G5**). MET data from 2008 (representative year meteorological conditions) was used for the modeling (e.g., **Figure 3**). Initial conditions for Folsom Reservoir water temperature in May were set based on measured water temperature profiles. The model was set up to iteratively determine the lowest (coolest) Water Forum Flow Management Standard Automated Temperature Selection Procedure[4] (ATSP) water temperature schedule that was achievable for each scenario in the Lower American

[4] To meet regulatory temperature targets in the Lower American River at Watt Avenue the Water Forum Flow Management Standard (Water Forum 2007) includes an incremental list of Automated Temperature Selection Procedure (ATSP) schedules. The primary objective of the temperature schedules are to maintain suitable temperatures for Central Valley steelhead during the summer rearing period and Chinook salmon spawning/incubation during the fall months given inflows, available reservoir volume, and outflows.

River at Watt Avenue (**Appendix G4**).

Figure 5a shows an example of the late August thermal structure of the reservoir (epilimnion, metalimnion, and hypolimnion) and the age of the reservoir water for a with and without transfer scenario, which illustrates an increased cool water metalimnion flow to the powerhouse shutters at the dam in the with transfer scenarios. The increased flow provides additional water and colder water (average 1.8°F colder for the 35 TAF transfer) for blending at the shutters (**Figure 5b**). CE-QUAL-W2 Modeling shows this occurs throughout the summer transfer period. The cooler North Fork American River water and increased flow as a result of the transfers, which enters Folsom Reservoir at the same temperature and density as the metalimnion (approximately 65°F), traverses the reservoir to the powerhouse shutters. Both the increased cool water flow into Folsom Reservoir and increased flow released into the Lower American River from the transfer water, individually or together, result in slightly reduced Lower American River water temperatures (see **Section 5.0**)

5.0 LOWER AMERICAN RIVER WATER TEMPERATURE

Modeling results indicate that the 12 TAF, 20 TAF, and 35 TAF transfers result in slightly cooler water temperature regimes in the Lower American River. Water temperature at Watt Avenue decreased approximately one ATSP schedule depending on the transfer scenario (**Table 5**; **Figure 5**). Water temperature typically decreased by 1°F for a month (September) (**Figure 5**).

Table 5. Watt Avenue Water Temperature ATSP Schedules for the Without Transfer (Base Case) and Water Transfer Scenarios (Note: Lower ATSP Schedules Equal Colder Water Temperature) (bold text shows changes from baseline).

Model Scenario	CE-QUAL-W2 ATSP Temperature Schedule	ATSP Schedule Water Temperature Decrease
Baseline Without Transfer Reclamation 90% Forecast		
0 TAF Transfer	51	--
Transfer Water July – September Inflow/Outflow		
35 TAF Transfer	**50**	**1°F September**
20 TAF Transfer	**50**	**1°F September**
12 TAF Transfer	51	--
Transfer Water July – September Inflow/Leave in Folsom Reservoir		
i35 TAF Transfer	**50**	**1°F September**
20 TAF Transfer	**50**	**1°F September**
12 TAF Transfer	**50**	**1°F September**

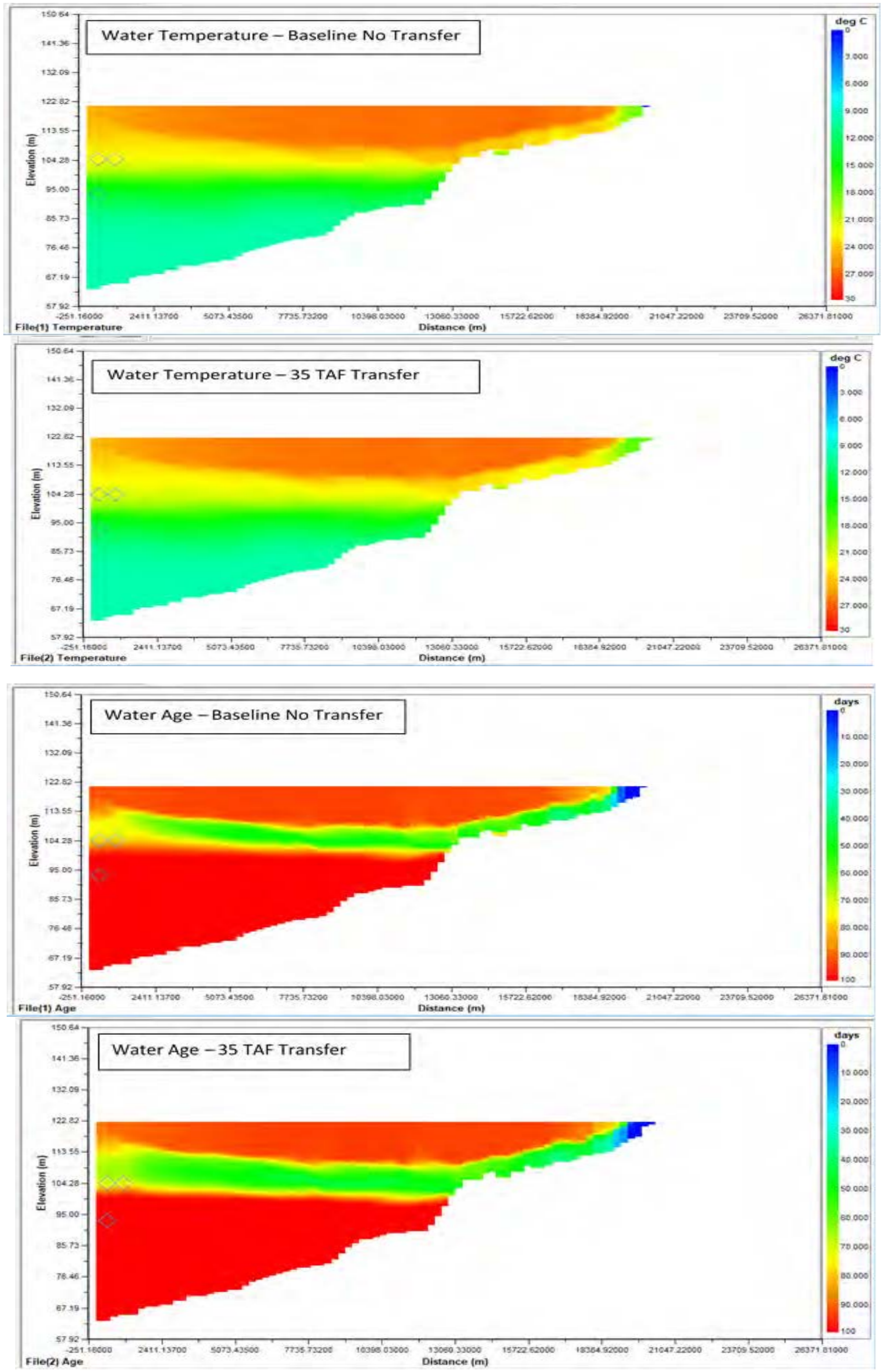


Figure 5a. Folsom Reservoir Water Temperature (Top) and Water Age (Bottom) for the Without and With 35 TAF Transfer Scenario Modeling (September 1, 2014) (note the more pronounced metalimnion flow to the powerhouse shutters, blue diamonds, in the with transfer modeling).

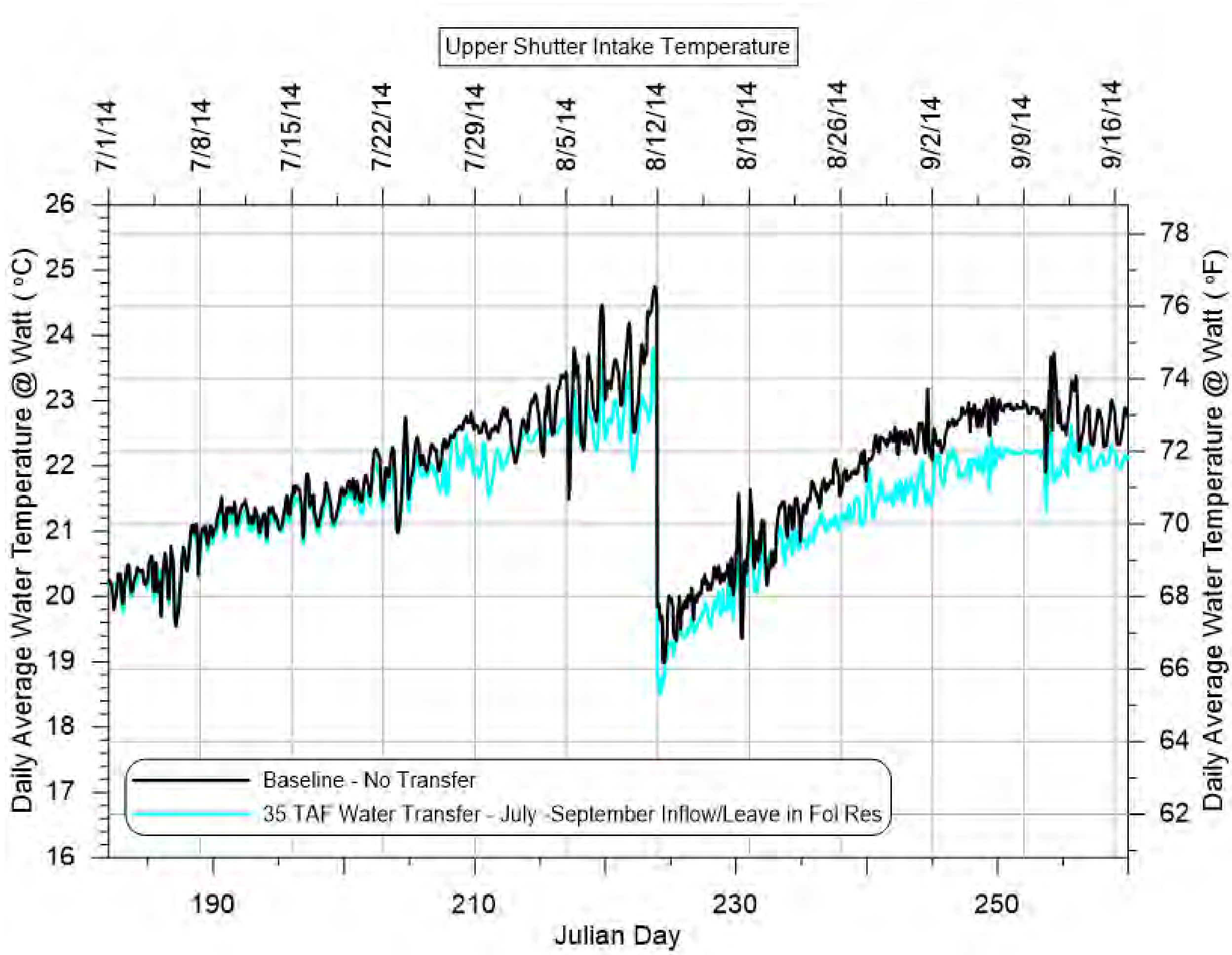


Figure 5b. Folsom Reservoir Upper Shutter Intake Water Temperature for the Without and With 35 TAF Transfer Scenario Modeling (2014)

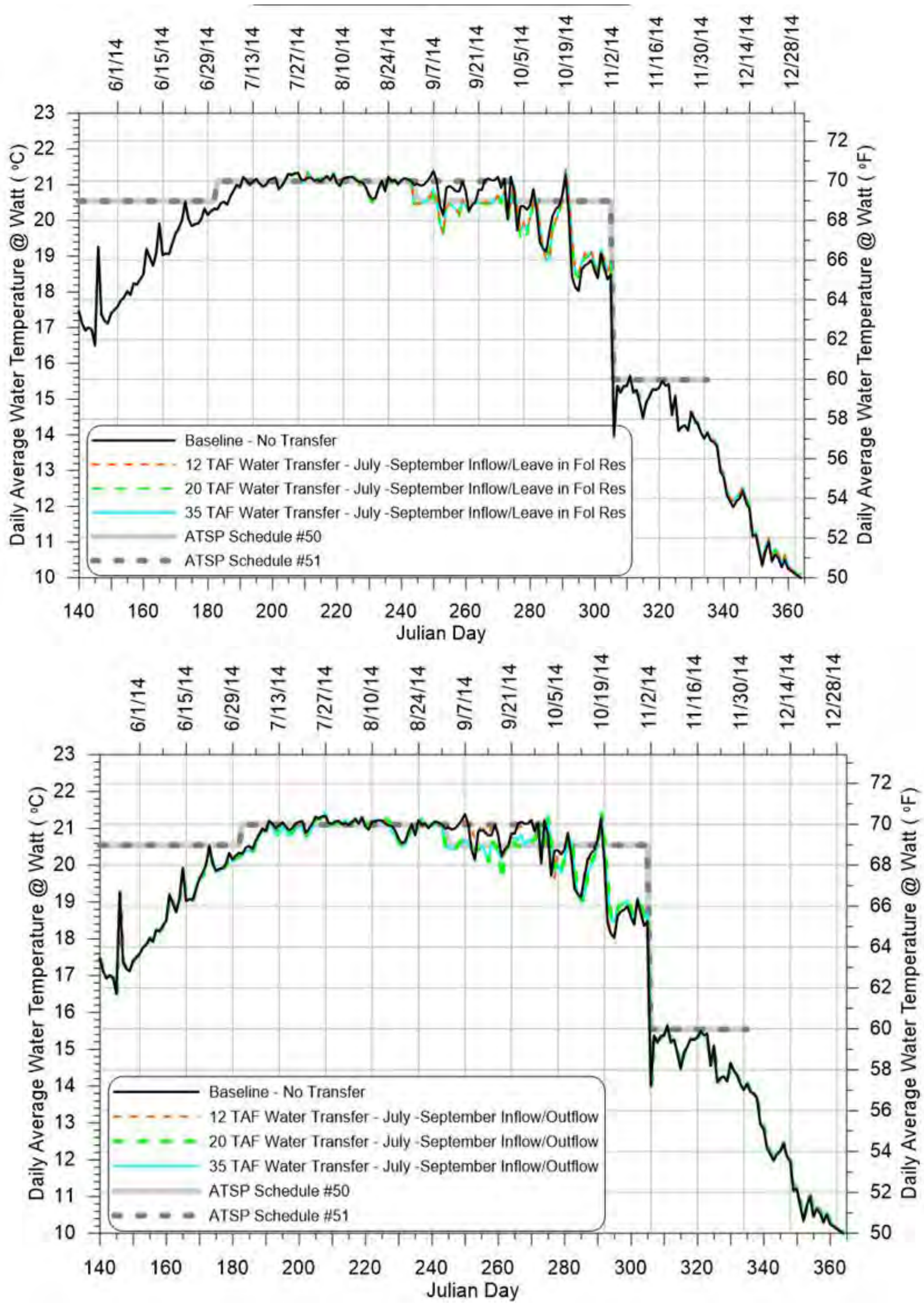


Figure 6. Lower American River Watt Avenue Water Temperature Modeling and ATSP Schedule Results for the Baseline Without Transfer and the 12 TAF, 20 TAF, and 35 TAF Transfer Scenarios (Bottom, July-September inflow/outflow; Top, July-September inflow/leave in Folsom Reservoir).

In addition to the cooler water inflows to Folsom Reservoir, another mechanism for decreased water temperature in the Lower American River as a result of transfers is reduced warming in the Lower American River with increased outflow from Folsom Dam. **Figure 7** shows how increased flow in the 1,000 cfs to 2,000 cfs range (i.e., the flow range that occurs during 2014 modeling; **Figure 2**) reduces warming in the river. For example, an increase in flow from 1,000 cfs to 1,500 cfs or an increase from 1,500 cfs to 2,000 cfs, decreases water temperature at Watt Avenue by 1.7°F and 1.2 °F, respectively.

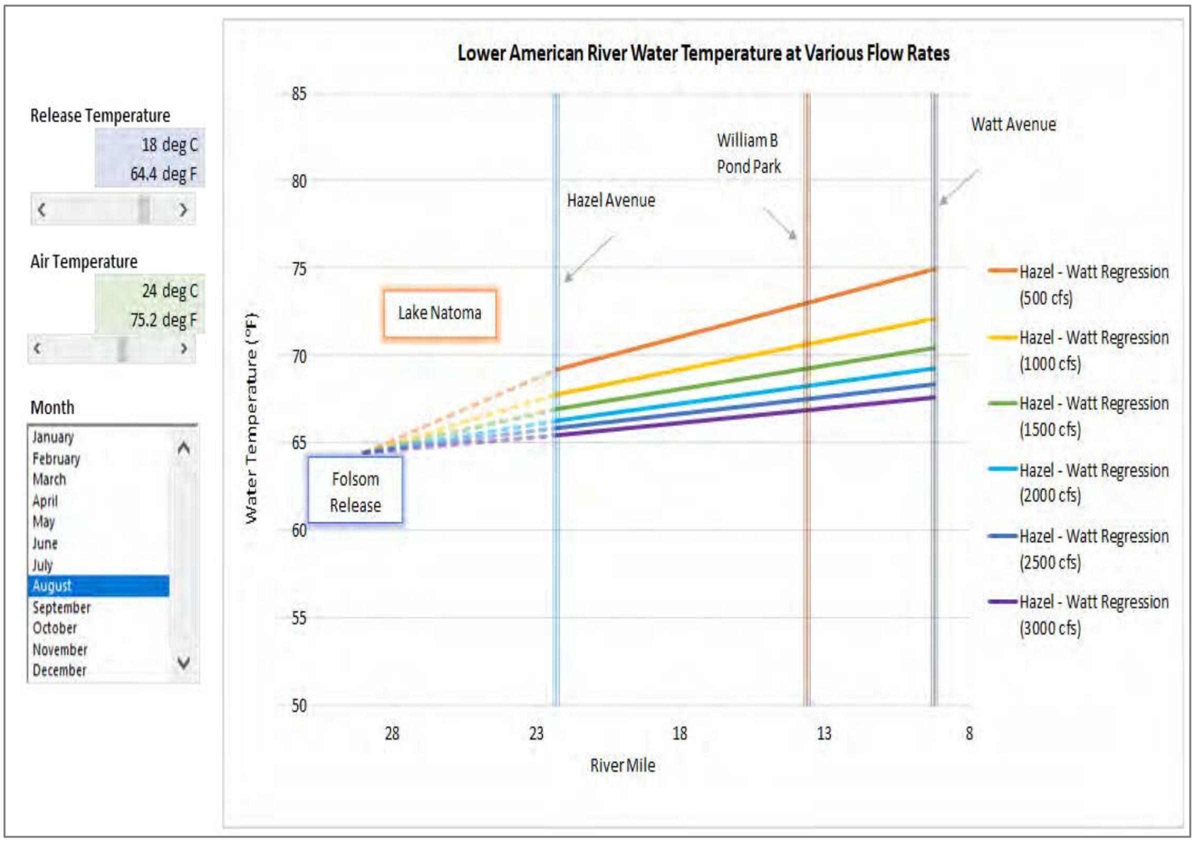


Figure 7. Temperature Model for the Lower American River Showing that Increased Flow Released from Folsom Dam Reduces Warming and Water Temperature at Watt Avenue (note the dam release temperature of 64°F and resulting Watt Avenue temperature of approximately 70°F for the 1,500 cfs flow is similar to conditions that occur in the 2014 transfer scenario modeling).

6.0 ADDITIONAL DRIER YEAR WATER TRANSFER EFFECTS

Releasing transfer water in a drier year has additional beneficial effects, including achieving drier year flow augmentation objectives in the Water Forum Agreement, increasing hydropower generation and CAISO grid regulation capacity, and increasing commercial and recreational rafting opportunities in the Middle Fork American River.

PCWA's purveyor-specific Water Forum Agreement includes a commitment to release additional water from the MFP in drier years to preserve and protect the natural resources of the Lower American River. These environmental releases are conditioned upon PCWA's ability to find a willing buyer to purchase the water downstream of the confluence of the Sacramento and Lower American rivers. Transfer to a willing buyer provides certainty that releases will be made into the Lower American River and will bolster critically low storage in Folsom Reservoir.

Making additional water available to PCWA's and Reclamation's powerhouses during the peak summer power load period of a drier year is important for grid regulation in California. Hydroelectric power generation is the primary source of flexible generation used by the California Independent System Operator (California ISO) to regulate the fluctuations of the electric grid in California. As a consequence of the drier year conditions, there is a significant reduction in hydroelectric generation capacity. The MFP is regularly called upon by California ISO to provide critical grid support services when load changes occur.

PCWA's summer power generation releases support the regional whitewater economy and a whitewater rafting industry of 20,000 user-days on the MFAR. The prime rafting season starts on Memorial Day weekend (May 24-26) and extends through the summer to Labor Day (September 1). Transfers would provide an additional rafting opportunities during the peak boating season (July and August).

7.0 CONCLUSION

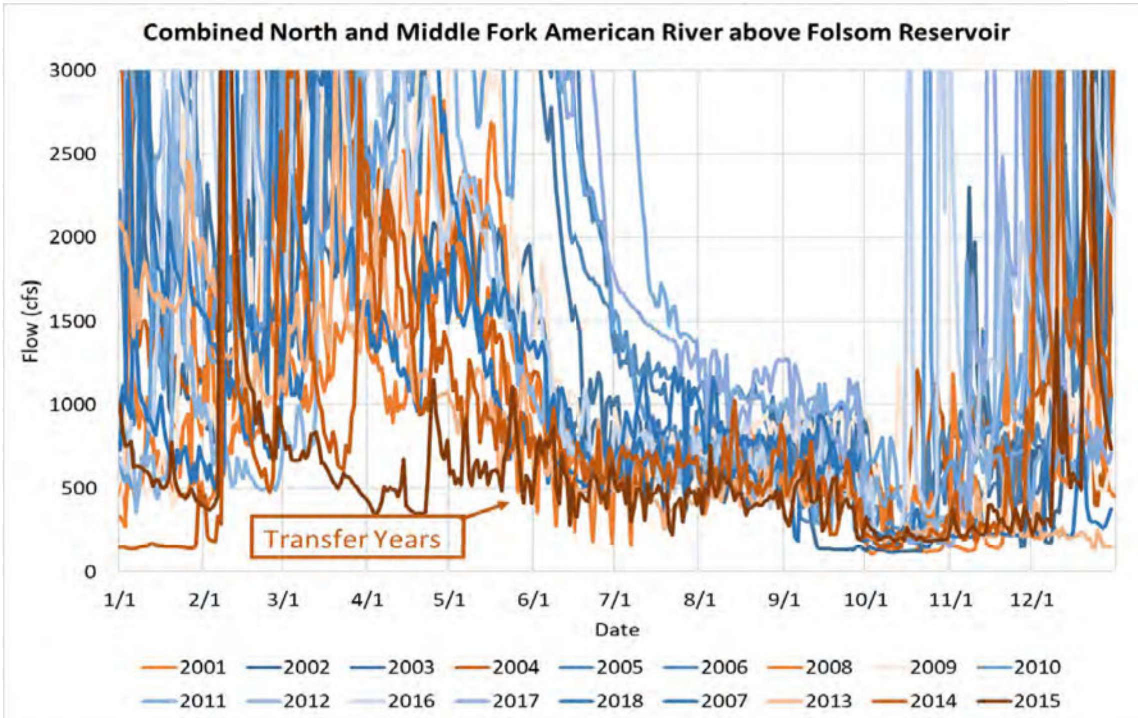
The PCWA transfers release water from PCWA's MFP reservoirs that would not otherwise be released in drier years and would remain in storage absent the transfer. The transfers would not injure any legal user of the water and would benefit fish, wildlife, recreation, and other instream beneficial uses.

Specifically, the drier year transfers would provide the following beneficial effects:

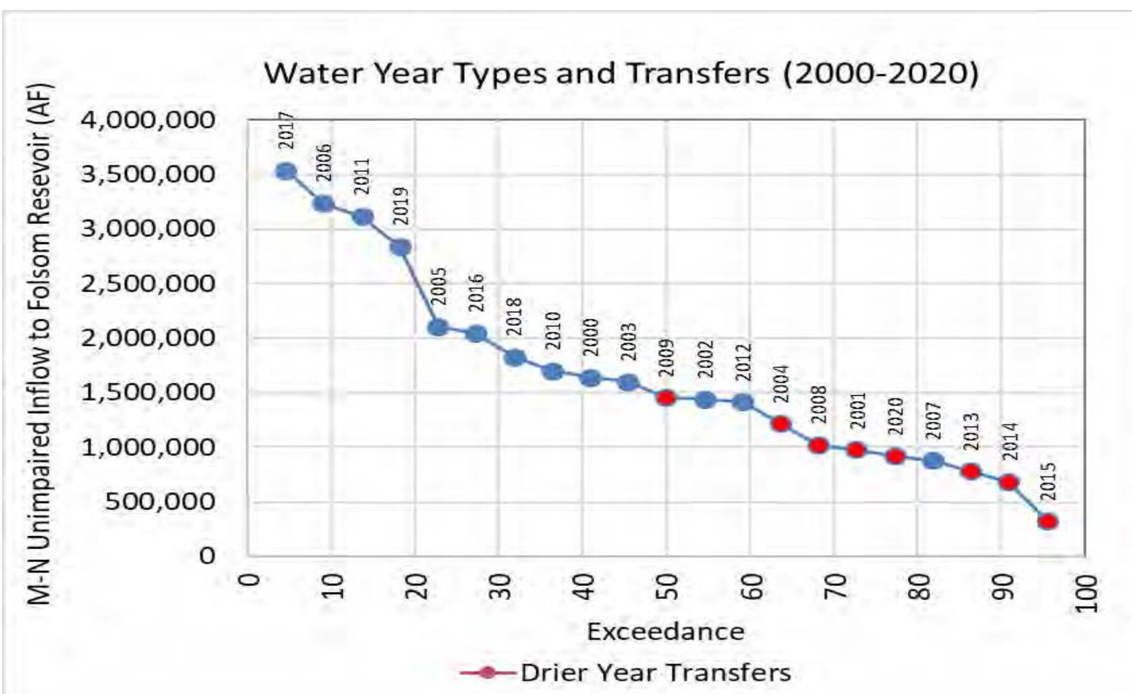
- Increased water supply for environmental and water supply purposes
- Increased drier year flow in the Lower American River and/or storage in Folsom Reservoir;
- Decreased water temperature in the Lower American River; and
- Additional benefits, including meeting Water Forum Agreement drier year objectives, increasing drier year hydropower generation/grid regulation capacity, and enhancing Middle Fork American River whitewater rafting opportunities.

APPENDIX G1

ADDITIONAL TEMPERATURE MODLEING FIGURES



Appendix G1 Figure 1. Combined North and Middle Fork American River flow above Folsom Reservoir (January 2001- December 2015).



Appendix G1 Figure 2. Exceedance Plot of March - November Unimpaired Inflow to Folsom Reservoir (2000-2020) Showing Years with Transfers.

APPENDIX G2

FOLSOM RESERVOIR INFLOW WATER TEMPERATURE REGRESSION MODELS

Table of Contents

List of Tables

List of Figures

List of Maps

List of Acronyms

CDEC	California Data Exchange Center
MFAR	Middle Fork American River
NFAR	North Fork American River
SFAR	South Fork American River
USGS	U.S. Geological Survey

Introduction

This appendix documents inflow water temperature into Folsom Reservoir and the relationship between water temperature, air temperature and flow for both the North Fork and South Fork American rivers (NFAR and SFAR). The sources for flow and temperature data, monthly regression relationships between flow, air and water temperatures, and comparisons of empirical versus modeled water temperatures (regression-based) are provided below.

Data Sources

The nearest NFAR and SFAR flow and temperature gages with recent historical data were used to characterize Folsom Reservoir inflow water temperature. Descriptions of the gaging and temperature stations are provided in Appendix G2 Table 1, and the locations are shown on Appendix G2 Map 1. All data were quality controlled prior to use in the analyses.

North Fork/Middle Fork American Rivers

Flow

The nearest active upstream gaging stations to Folsom Reservoir are located on the NFAR at North Fork Dam, CA (USGS gage no. 11427000) and on the MFAR near Foresthill, CA (USGS gage no. 11433300). 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 inlet to Folsom Reservoir (July 1999 – June 2014).

Water Temperature

Historical daily water temperature data were obtained from the USGS gaging station/California Data Exchange Center (CDEC) on the NFAR at Auburn Dam Site near Auburn, CA (USGS gage no. 11433790/station NFA) (July 1999 – June 2014). This location is just upstream of Folsom Reservoir.

South Fork American River

Flow

The nearest active upstream gaging station to Folsom Reservoir located on the SFAR is the USGS gaging station near Placerville, California (USGS gage no. 11444500). This 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 (time period when water temperature is a function of flow).

Water Temperature

Historical water temperature data for the SFAR were obtained from USGS gaging station on the SFAR near Pilot Hill, California (USGS gage no. 11446030).

Flow and Water Temperature Relationships

North Fork/Middle Fork American River and SFAR water temperatures were strongly correlated with flow in the May – September time period and weakly correlated with flow in other months. Monthly regression relationships were developed from the empirical flow and water temperature data. In instances where the regressions needed to be applied on a daily basis throughout the year, the monthly regression coefficients were interpolated from the center of the month.

North Fork American River

For the NFAR water temperature into Folsom Reservoir a multiple regression equation that relates mean monthly North Fork American River flows (USGS gage near North Fork Dam) and mean monthly MFAR inflow (USGS gage near Foresthill) was developed to predict mean monthly water temperatures (November 1999 – June 2014) (Appendix G2 Table 2). Comparisons of the NFAR empirical and modeled water temperature for the inflows into Folsom Reservoir is provided in Appendix G2 Figure 1 and a time series plot showing the empirical and modeled water temperature is shown in Appendix G2 Figure 2.

South Fork American River

For the SFAR water temperature into Folsom Reservoir, a monthly regression relationship was developed from empirical flow and water temperature data from the SFAR average monthly water temperatures (USGS gage near Pilot Hill approximately 0.1 mile downstream of Weber Creek) and SFAR average monthly flows (SFAR USGS gage near Placerville) (August 1999 – June 2014) (Appendix G2 Table 3). Comparison of the SFAR measured and modeled water temperature for the inflows into Folsom Reservoir (November 1999 – June 2014) is provided in Appendix G2 Figure 3 and a time series plot showing the measured and modeled water temperature is shown in Appendix G2 Figure 4.

APPENDIX G2

TABLES

Appendix G2 Table 1. Data Sources for Folsom Reservoir Inflow Water Temperature Regression Analyses.

River Reach and Attribute	Data Sources					
	Operator	Name	Identification Number	Location (lat/long)	Period of Record Available	Period of Record Used in Regression Analyses
North Fork/ Middle Fork American River Watersheds						
North Fork American River Daily Average Flow	USGS	NF American R a North Fork Dam CA	11427000	38.93611°N/121.0228°W	10/1/1941-present; hourly	7/1/1999-6/30/2014
Middle Fork American River Daily Average Flow	USGS	MF American R nr Foresthill CA	11433300	39.00611°N/120.7597°W	10/1/1958-9/30/2012; daily	
Daily Average Water Temperature	USGS/ CDEC	NF American River at Auburn Dam	11433790/ NFA	38.852000°N/121.057000°W	7/21/1999-present; hourly	
South Fork American River Watershed						
Daily Average Flow	USGS	South Fork American River near Placerville	11444500	38.77111°N/120.8153°W	10/1/1911-9/30/2012; daily	8/1/1999-6/30/2014
Daily Average Water Temperature	USGS	South Fork American River near Pilot Hill	11446030	38.76306°N/121.0072°W	8/4/1999-present; hourly	

Abbreviations:
USGS: United States Geological Survey
CDEC: California Data Exchange Center

Appendix G2 Table 2. 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-June 2014 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.

Appendix G2 Table 3. 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-June 2014 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)

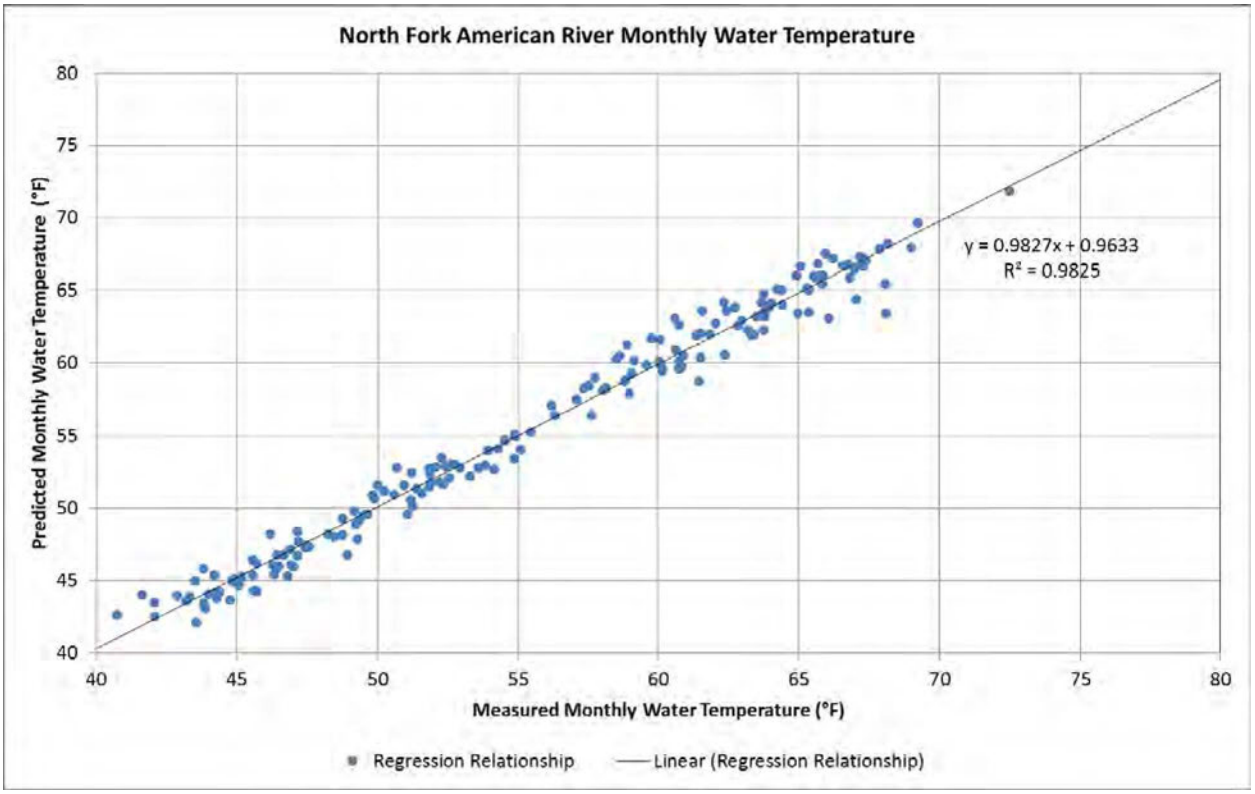
y =South Fork American River Mean Monthly Temperature (°F) near Pilot Hill, CA (USGS gage no. 11446030)

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.

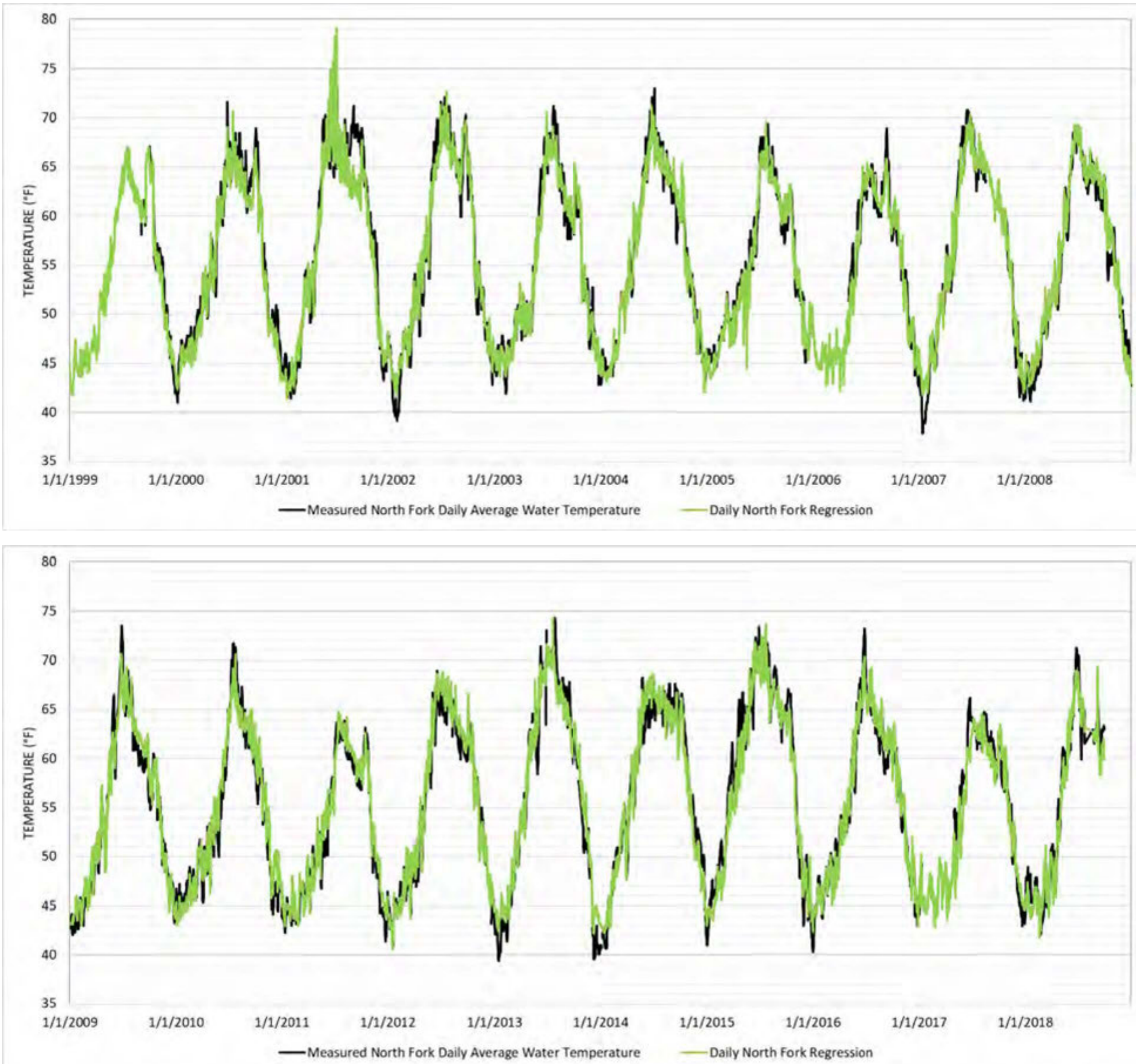
APPENDIX G2

FIGURES



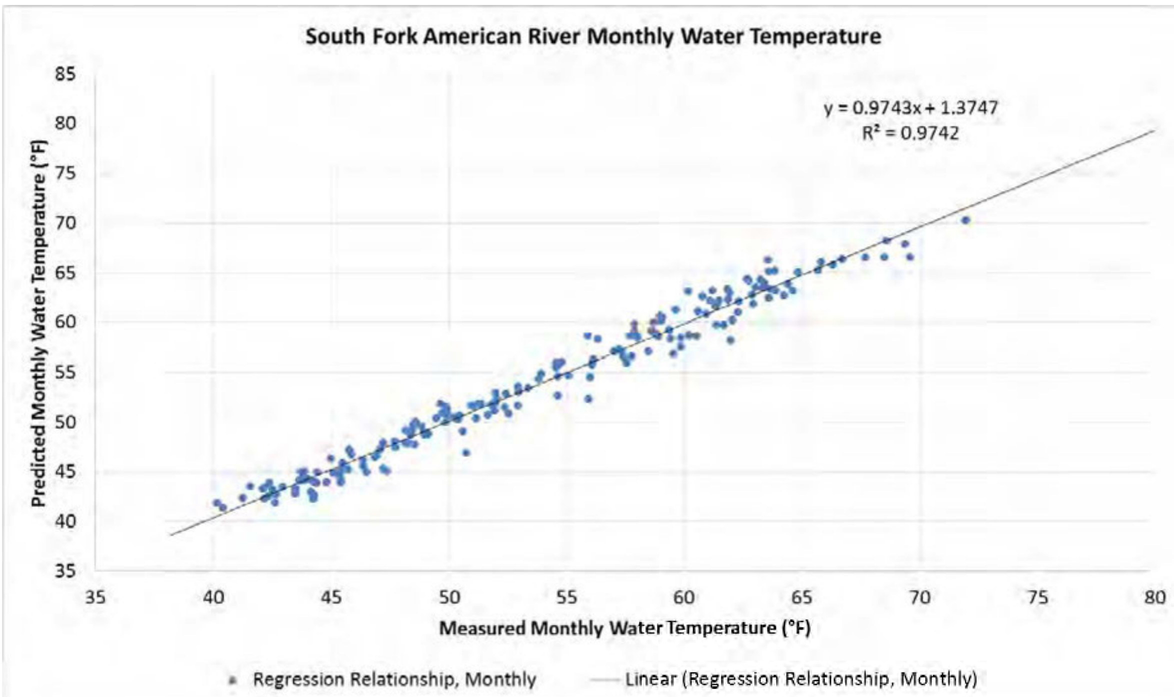
Data sources: Measured water temperature: NFAR mean monthly temperature (°F) upstream of Folsom Reservoir (USGS gage no. 11433790/CDEC station CDEC-NFA); Modeled (regression) water temperature: NFAR monthly flow (cfs) (USGS gage no. 11427000), MFAR mean monthly flow (cfs) (USGS Gage 11433300 until Sept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

Appendix G2 Figure 1. Measured versus Modeled (Regression) North Fork American River Temperature into Folsom Reservoir (July 1999-June 2014).



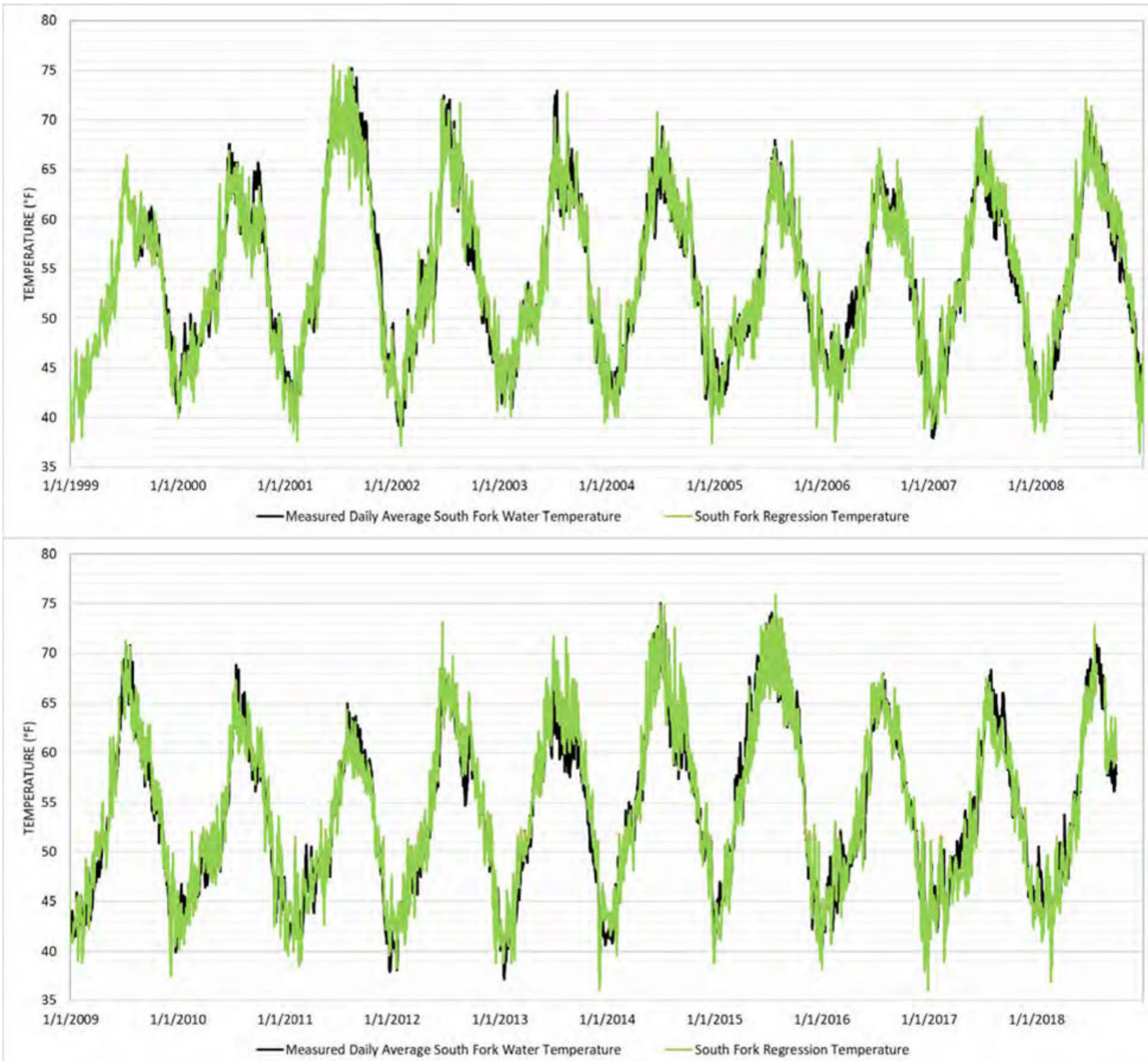
Data sources: Measured water temperature: North Fork American River mean monthly water temperature (°F) upstream of Folsom Reservoir (USGS gage no. 11433790/CDEC station NFA); Modeled (regression) water temperature: NFAR mean monthly flow (cfs) ((USGS gage no. 11427000), MFAR mean monthly flow (cfs)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

Appendix G2 Figure 2. Time Series of Measured and Modeled North Fork American River Temperature into Folsom Reservoir (July 1999-Oct 2018).



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).

Appendix G2 Figure 3. Measured versus Modeled (Regression) South Fork American River Temperature into Folsom Reservoir (August 1999–June 2014).

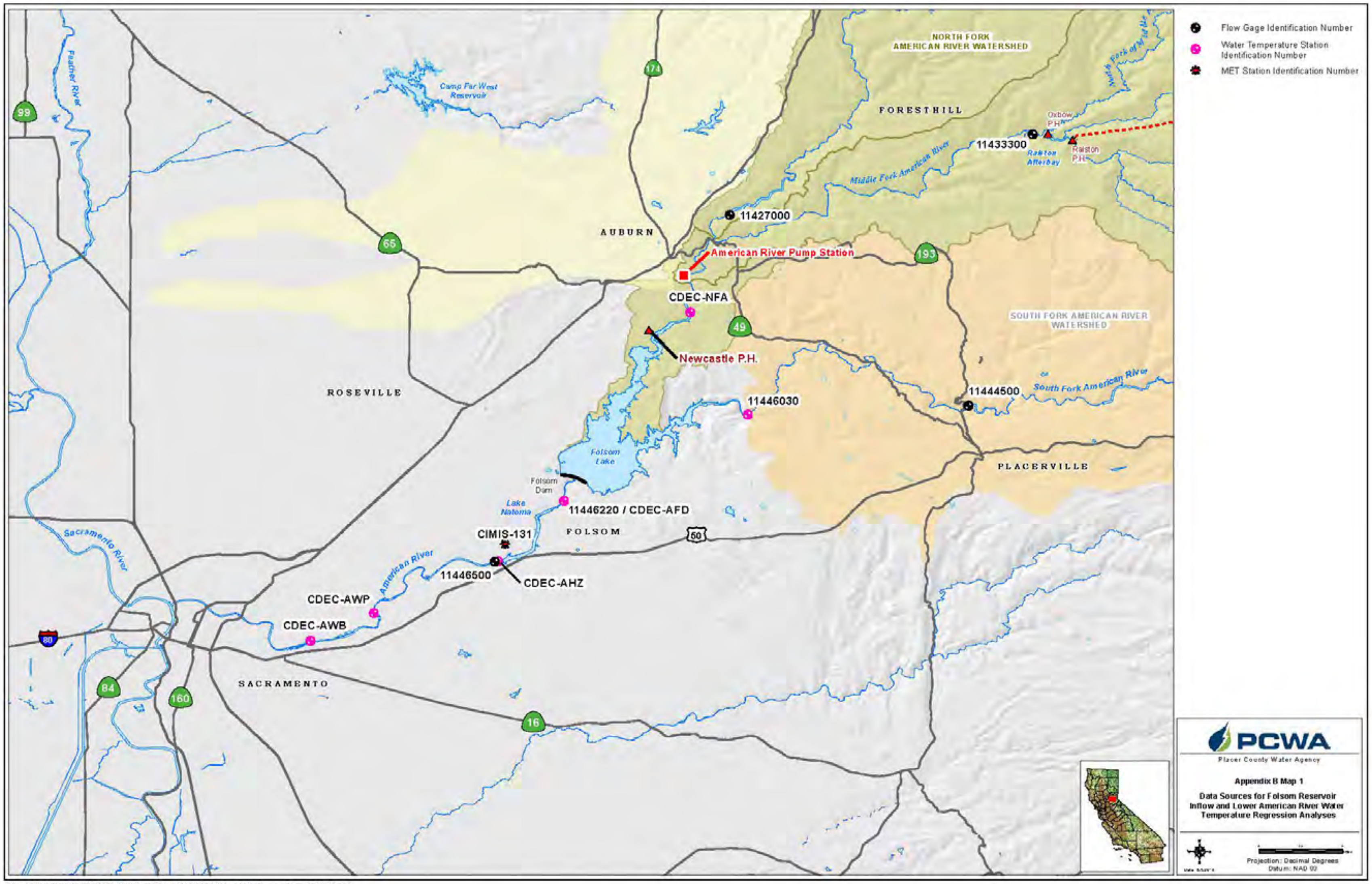


Data sources: Measured Temperatures: South Fork American River monthly average water temperature (°F) (USGS gage no. 11446030).
Modeled (regression) water temperature: Monthly average air temperature (°F) (CIMIS-131) and monthly average flow at Chili Bar (cfs) (USGS gage no. 11444500).

Appendix G2 Figure 4. Time Series of Measured and Modeled South Fork American River Temperature (August 1999-June 2018).

APPENDIX G2

MAP

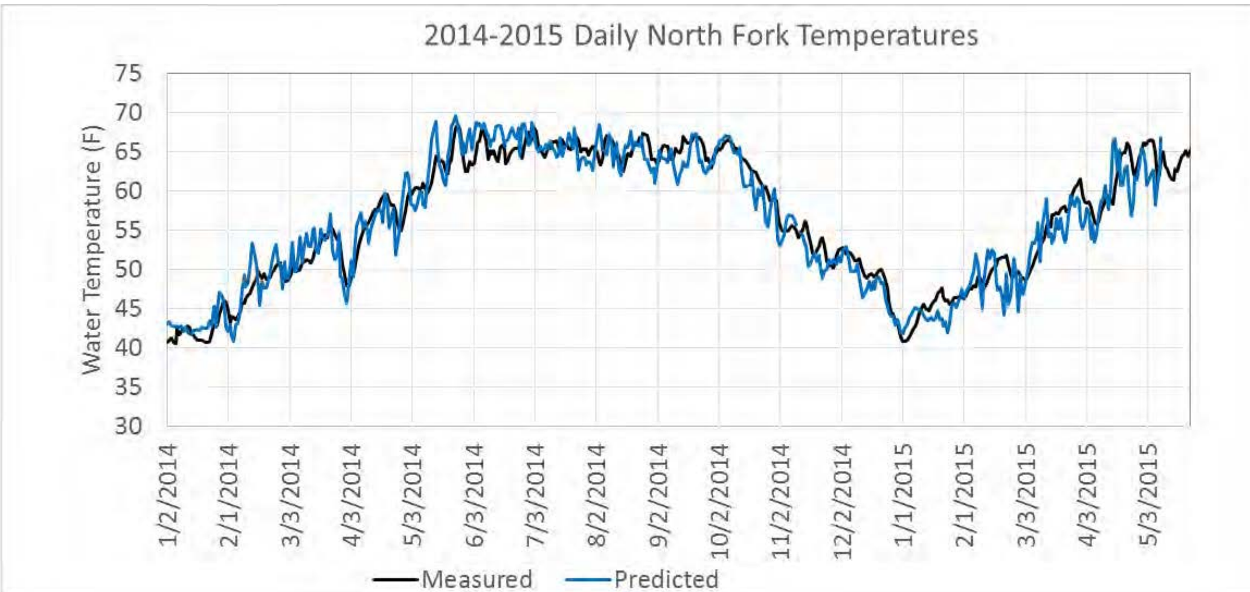


Appendix G2 Map 1. Data Source Locations

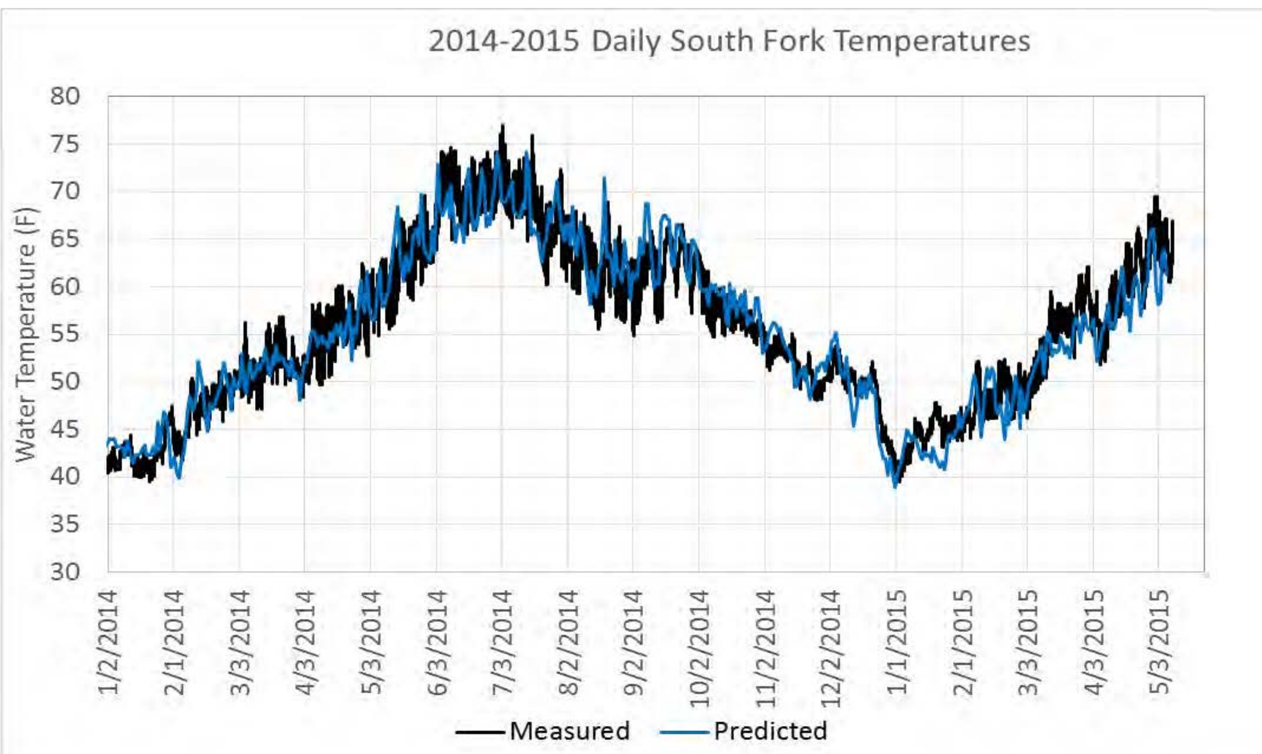
APPENDIX G3

NORTH FORK, SOUTH FORK, AND LOWER AMERICAN RIVER

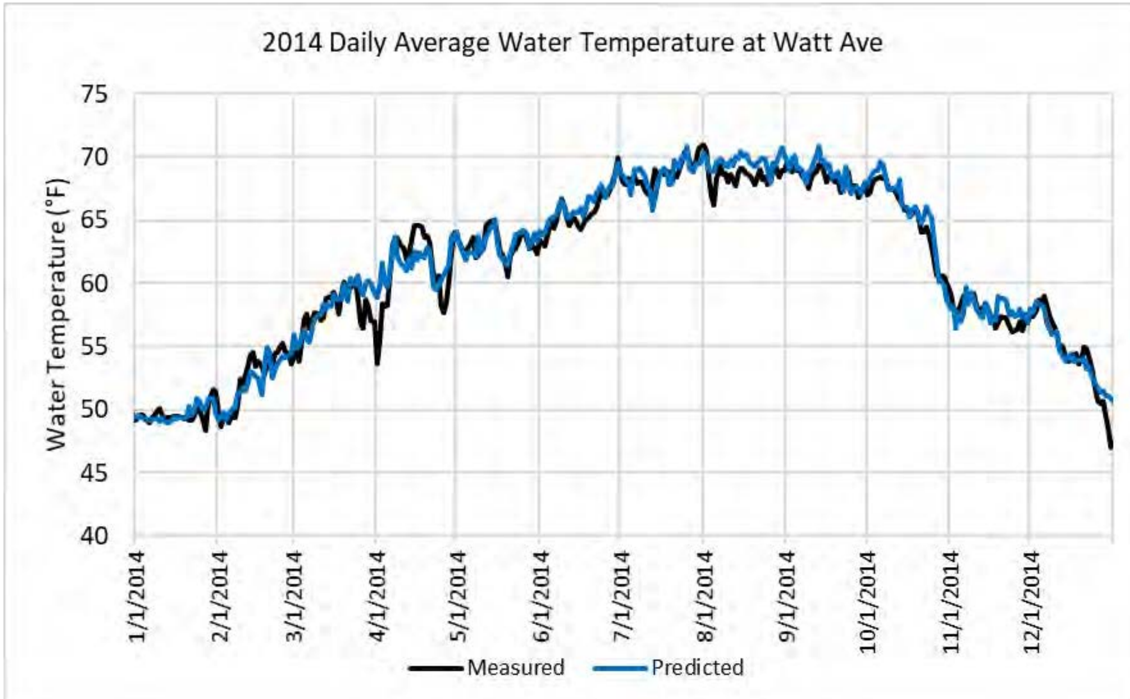
REGRESSION MODEL PERFORMANCE FOR 2014.



Appendix G3 Figure 1. **Measured and Predicted (Regression) North Fork American River Temperature into Folsom Reservoir (January 2014- May 2015).**



Appendix G3 Figure 2. **Measured and Predicted (Regression) South Fork American River Temperature into Folsom Reservoir (January 2014- May 2015).**



Appendix G3 Figure 3. Measured and Predicted (Regression) Lower American River Temperature at Watt Avenue (January 2014 - Jan 2014).

APPENDIX G4

FOLSOM RESERVOIR CE-QUAL-W2 WATER TEMPERATURE MODEL

Table of Contents

List of Tables

List of Figures

List of Acronyms

ATSP	Automated Temperature Selection Procedure
SFAR	South Fork American River
WSE	water surface elevation

Abstract

Folsom Reservoir, located near Sacramento, California, USA, is a deep-storage reservoir that provides municipal water, power generation, and cold water releases for salmonid fish in the Lower American River. The dam has discrete temperature control shutters on the three powerhouse intakes. The shutters can be installed or removed in sections and they allow the dam operator to choose different water levels from each intake to blend outflow water temperature to accommodate downstream temperature requirements. The dam also has a municipal water outlet with a continuously adjustable temperature control device and a set of low-level outlets that are used for water temperature control.

A complex model of the reservoir was developed using the CE-QUAL-W2 model (Cole and Wells 2013) and calibrated to historical operations over a 10-year time period. Absolute mean temperature errors in model profiles and in downstream temperature were 0.56°C and 0.58°C, respectively, well less than the target of <1°C. Significant leakage through the temperature control shutters at the dam was identified during model calibration.

A customized operational model tool was developed using the CE-QUAL-W2 model to automatically determine how best to select outlet shutter positions to maximize efficient use of the limited cold water available within the reservoir to meet the downstream temperature regulatory targets for fish in the Lower American River. The model proved successful in running long-term simulations that can be used to evaluate reservoir operations based on modified or forecasted hydrological and meteorological inputs.

Introduction

A Folsom Reservoir water temperature modeling tool was developed to evaluate alternative inflow hydrology and reservoir operations scenarios and shutter operations for Folsom Dam to meet regulatory temperature targets in the Lower American River (i.e., Automated Temperature Selection Procedure [ATSP] schedules identified in the Water Forum Flow Management Standard [Water Forum 2004; Water Forum 2006]). The primary objective of the temperature schedules are to maintain suitable temperatures for Central Valley steelhead during the summer rearing period and Chinook salmon spawning/incubation during the fall months given inflows, available reservoir volume, and outflows.

Folsom Dam was designed to be able to release water from various elevations within the reservoir simultaneously. Dam operators install or remove discrete temperature shutters on the three powerhouse intakes to take water from different depths to blend outflows to meet downstream regulatory temperature objectives. Operators also adjust the elevation of the municipal water supply outlet and operate the low-level outlets on the dam to modify outflow water temperatures / preserve cold water resources in the reservoir.

The water temperature modeling tool was developed to automatically determine the best shutter settings and flow rates through each of the three powerhouse intakes to meet the coldest ATSP outflow temperature schedule possible and to utilize cold water in the reservoir most effectively. This includes a user specified target temperature for the municipal outlet and use of the low-level outlets in late fall to access cold water that remains in the reservoir below the powerhouse outlets.

The modeling tool uses CE-QUAL-W2 (Cole and Wells 2013), a 2-D hydrodynamic and temperature model, modified with new model code to enhance and automate temperature shutter modeling capability (including low-level outlets) and ATSP temperature schedule selection capability. The completed modeling tool allows modelers to run scenarios in which the model itself determines the optimal operation of powerhouse shutters, municipal outtake, and low-level outlets to meet downstream temperature targets.

Background Information

Folsom Dam and reservoir are located approximately 20 miles northeast of the city of Sacramento, California, on the American River. This reservoir has a capacity of 976,000 acre-feet (1,203,878,290 cubic meters) and drains an area of approximately 1,875 square miles (4,856 square kilometers). The dam was built by the U.S. Army Corps of Engineers between 1948 and 1956, at which point operation of the dam was transferred to the Bureau of Reclamation (U.S. Dept. of Interior 2013). Downstream of Folsom Dam, the American River provides important habitat for Central Valley steelhead and Chinook salmon. Water temperatures in this section of the river play a critical role in determining the health of these, as well as other aquatic species.

Folsom Dam was constructed with a total of twenty different outlets and outlet structures. Three power generation penstocks are each fitted with discrete, removable/installable shutters that allow for four different configurations (discrete inflow elevations). These configurations allow the operator to pull water from different depths depending on water level and desired outflow temperature. In addition to the powerhouse shutters, a variable elevation temperature control device is used to divert water for municipal use. The remaining structures are all at fixed locations and include eight rectangular river outlets and eight spillway gates. These are generally used only for flood control and occasionally for temperature control in the late fall (low-level outlets). The use of the low-level outlets in the fall results in water bypassing the power generators. The locations of the main features on Folsom Dam are shown in Appendix G4 Figure 1. An earlier model study of Folsom Reservoir by the Bureau of Reclamation (Bender et al. 2007) was conducted in 2007. In that study, the CE-QUAL-W2 model was also used but with a coarser bathymetric grid than what was used in this study (described below).

Model Bathymetry

Bathymetric data for Folsom Reservoir were collected by means of multi-beam sonar and photogrammetry during the fall of 2005 as part of a sedimentation study conducted by the Bureau of Reclamation (Ferrari 2007). These data were used to develop a 3-D bathometric representation of Folsom Reservoir as seen in Appendix G4 Figure 2. This grid was in turn used to develop the CE-QUAL-W2 model grid, shown in Appendix G4 Figure 3. The grid was divided up into a total of three branches with 191 segments each having an average length of 250 meters. The vertical model resolution was 0.61 meter or 2 feet. The model grid matched the 2005 Sediment Survey volume elevation and surface area elevation curves (Ferrari 2007).

Historical Model Calibration

The model was calibrated for a 10-year period between January 1, 2001, and December 31, 2011. Boundary conditions for inflow, meteorological data, and outflow during this period were developed. A very detailed approach for filling in data gaps was undertaken to provide a good set of boundary conditions for the 10-year period.

Secchi disk data from 1979 were used to estimate the average light extinction coefficient. Calculations show that the light extinction coefficient varied from 0.3 to 0.7 m^{-1} with an average value close to the CE-QUAL-W2 default value of 0.45 m^{-1}.

Inflows included the North and Middle Forks of the American River, the South Fork American River (SFAR), Mormon Ravine, and Newcastle Powerplant. Outflows included three penstocks with discrete shutter settings, municipal water withdrawals with variable shutter settings, low-level outlet releases, spills, and evaporation.

Air temperature, dew point temperature, wind speed and direction, cloud cover, and solar radiation were collected from various meteorological stations in the vicinity of Folsom Reservoir for this time period. Most of the model development uncertainty was in filling meteorological data gaps (e.g., wind data) and in estimating the amount of leakage into the lower level powerhouse outlets from the shutters.

Almost one thousand temperature profiles were taken over this 10-year period at six stations in Folsom Reservoir with a profile frequency of about once per month (data were collected by Bureau of Reclamation). Appendix G4 Figure 4 compares two representative model predictions with field data for temperature profiles taken in August 2002 and October 2007. Error statistics for the 10-year model period versus measured profiles are shown in Appendix G4 Table 1.

A comparison of all measured profile data to model profiles over the 10-year period is shown in Appendix G4 Figure 5.

Model predicted water temperatures and measured water temperatures immediately downstream of Folsom Dam were also compared (Appendix G4 Figure 6). Absolute mean errors for downstream temperatures were less than 0.6°C.

Automatic Model Simulation Tools

Three individual model tools were developed and verified using boundary condition and meteorological data from the same time period to fully automate shutter operation. The three tools are as follows:

Automatic Municipal Water Intake Elevation

Based on the available historical data, 2006 and 2011, operators of the municipal water intake structure generally tried to extract water at approximately 18°C (65°F) or cooler during most time periods, given operational constraints (e.g., reservoir water surface elevation, minimum and maximum inlet elevations). This capability was built into the model, allowing the modeler to specify the municipal intake constraints: (1) target temperature; (2) maximum and minimum inlet elevations; and (3) minimum inlet elevation below the water surface elevation (WSE).

In addition to these constraints, operation rules were set including the following:

1. On March 1 of each model year, the elevation of the intake was raised as high as possible given the WSE constraint;
2. If not raised to maximum on March 1st, the model continued checking on a daily basis until the intake could be raised to a maximum elevation;
3. If intake temperature criteria were violated, the intake was lowered in 1 meter increments until water temperature met criteria; and
4. The model continued lowering intake elevation as dictated by the temperature criteria until Dec 1 of each model year, or until the minimum water intake elevation was reached.

Automatic Shutter Operations

The automatic shutter operation algorithm was developed to divide flow through each of the three powerhouse penstocks and to determine when to change the shutter configuration to pull water from the appropriate location in the reservoir to achieve target outflow temperatures. Each of the Folsom Dam powerhouse penstock shutters operate independently and have a total of four different elevation settings. The overall flow rate was specified as well as a daily water temperature target that the model was trying to match. A code was developed to calculate the percent flow to be directed through each penstock and the shutter elevations given the following constraints:

1. Minimum and maximum flow through each powerhouse; and
2. Shutter minimum elevation below WSE at any time (8.23 meters); otherwise the shutter opening would be lowered to the next lowest level.

An extensive set of operational rules were set up to apportion flow through each of the powerhouse penstocks and determine when the shutter opening needed to be lowered in order to meet temperature criteria. When all shutter openings were at their lowest level and temperature criteria were still not being met, the model was set up to allow a portion of the outflow water to pass through the lower level river outlets at the bottom of the dam – completely bypassing the powerhouse (a date range can be set in the input data to constrain when this operation can occur).

Automatic Temperature Schedule Choice

An algorithm was developed that allowed the model to run and to converge on the coldest ATSP temperature schedule that could be met. The model user provides ten temperature target “schedules” or daily average temperature time-series files, ranging from coolest (#1) to warmest (#10). The model starts with schedule #5 and runs until it violates a temperature criterion more than three times in a season (either consecutively or cumulatively), at which point it restarts to an earlier time and chooses a warmer target schedule. Conversely if the starting temperature target file was too warm and the outflow temperatures never violate the temperature target, the model restarts to an earlier time and reruns using a cooler temperature target file. This logic for running the model is shown in Appendix G4 Figure 7.

Example Results of Automatic Shutter and Municipal Outlet Scenario

An example of the combined outflow temperature results of the automated temperature model for 2008 is shown compared to an historical operations calibration model in Appendix G4 Figure 8. Compared to actual operations, the model code optimized Lower American River water temperature by releasing warmer water earlier in the summer and maintaining significantly cooler temperatures later into the fall spawning season. Resulting water temperatures approximately 32 km (20 miles) downstream at Watt Avenue are shown in Appendix G4 Figure 9.

Conclusions

Using extensive flow, water temperature, and meteorological empirical data from 2001 to 2011, a fully calibrated CE-QUAL-W2 model of Folsom Reservoir was developed. The model performed very well when compared to in-lake temperature profile and downstream temperature data, with absolute mean errors of less than 0.6^{o}C for both metrics. This calibrated model was then run using a series of tools developed to allow complete automation of the municipal outlet and powerhouse penstock shutters.

Acknowledgements

Calibration data sets were provided by the U.S. Bureau of Reclamation. We benefitted greatly by learning from previous modeling efforts by Chris Hammersmark, CBEC Inc., who has used the 1D Iterative Coldwater Pool Management Model extensively to model Folsom Reservoir.

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APPENDIX G4

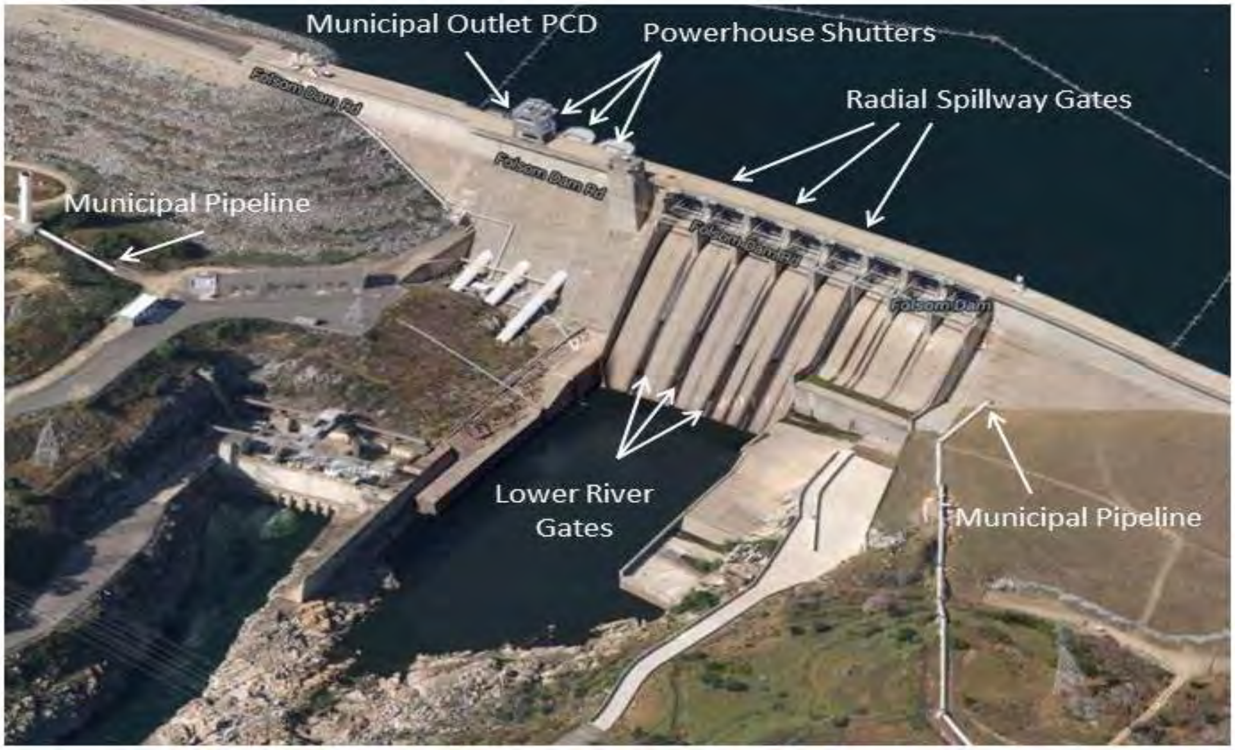
TABLES

Appendix G4 Table 1. Modeled Versus Measured Temperature Profile Error Statistics.

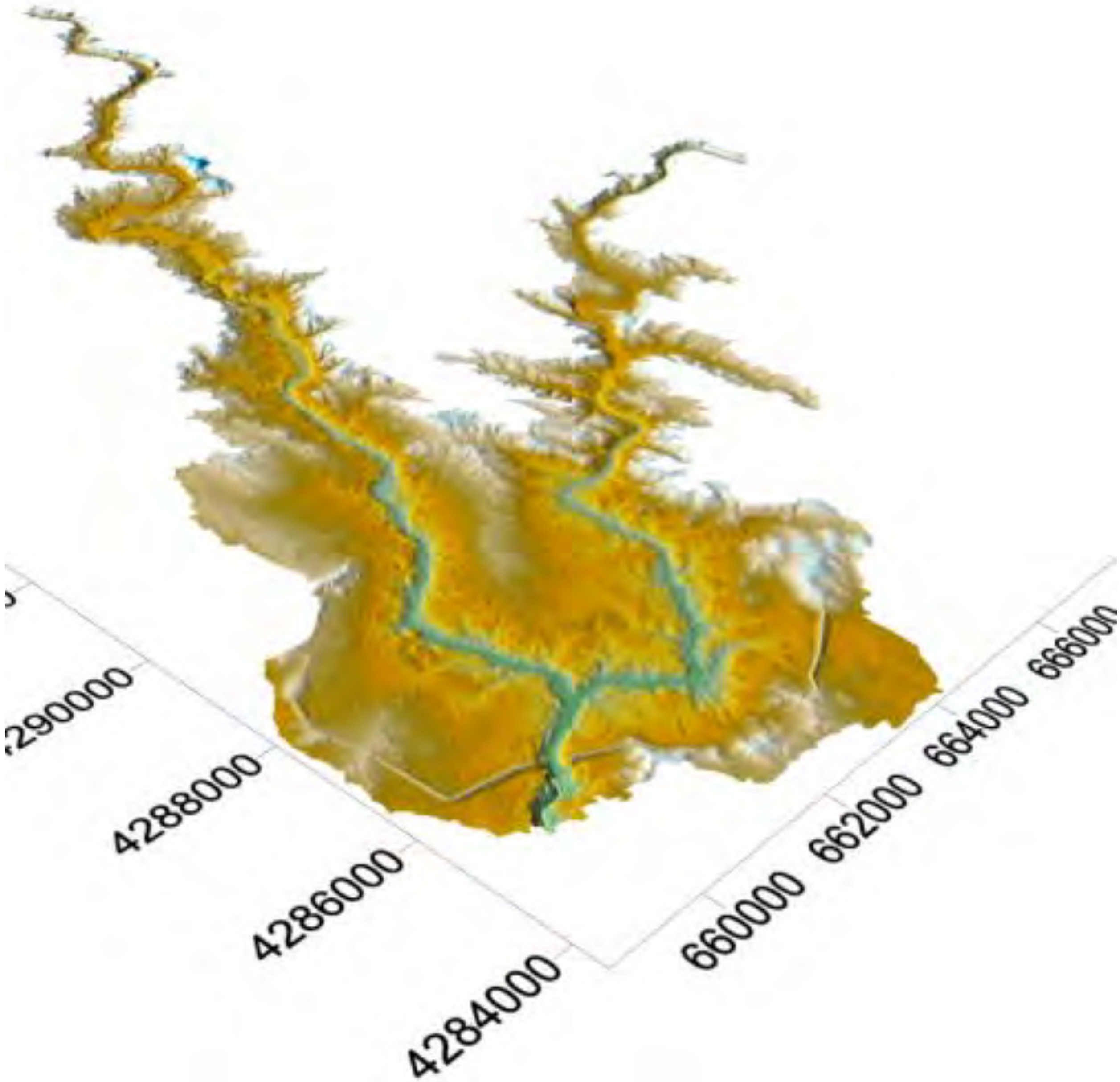
Temperature Profile Model Segment (USBR Site)	# of Profiles	# of Individual Temperature Observations	Mean Error °C	Absolute Mean Error °C	Root Mean Squared Error °C
63 (Site A)	169	4421	-0.050	0.607	0.772
72 (Site E)	154	4681	-0.093	0.589	0.769
91 (Site C)	154	4861	0.032	0.520	0.669
105 (Dam)	178	7190	-0.049	0.530	0.689
151 (Site B)	154	4283	0.175	0.585	0.726
169 (Site D)	171	5943	0.011	0.506	0.648
Average overall statistics:			**0.004**	**0.556**	**0.712**

APPENDIX G4

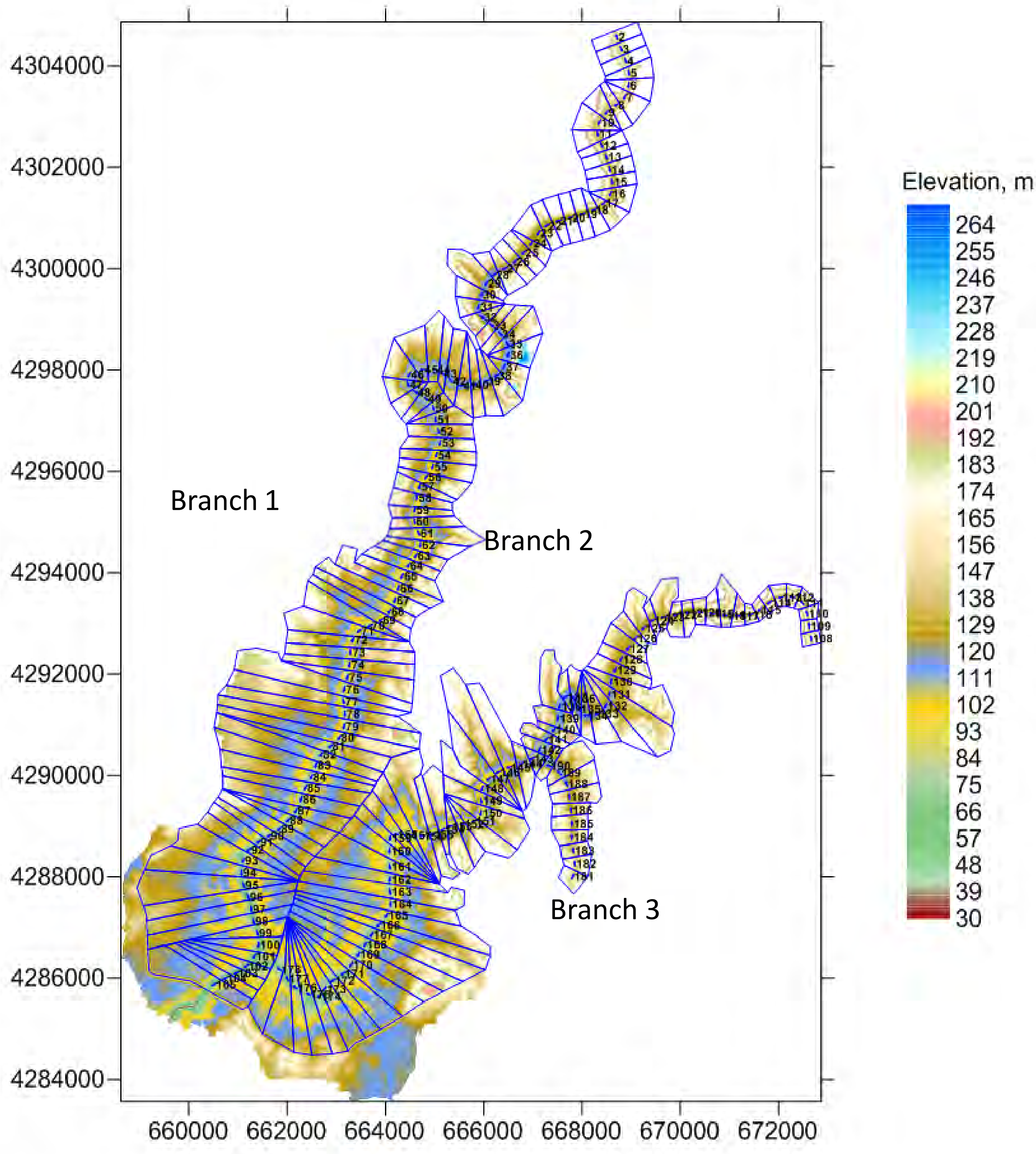
FIGURES



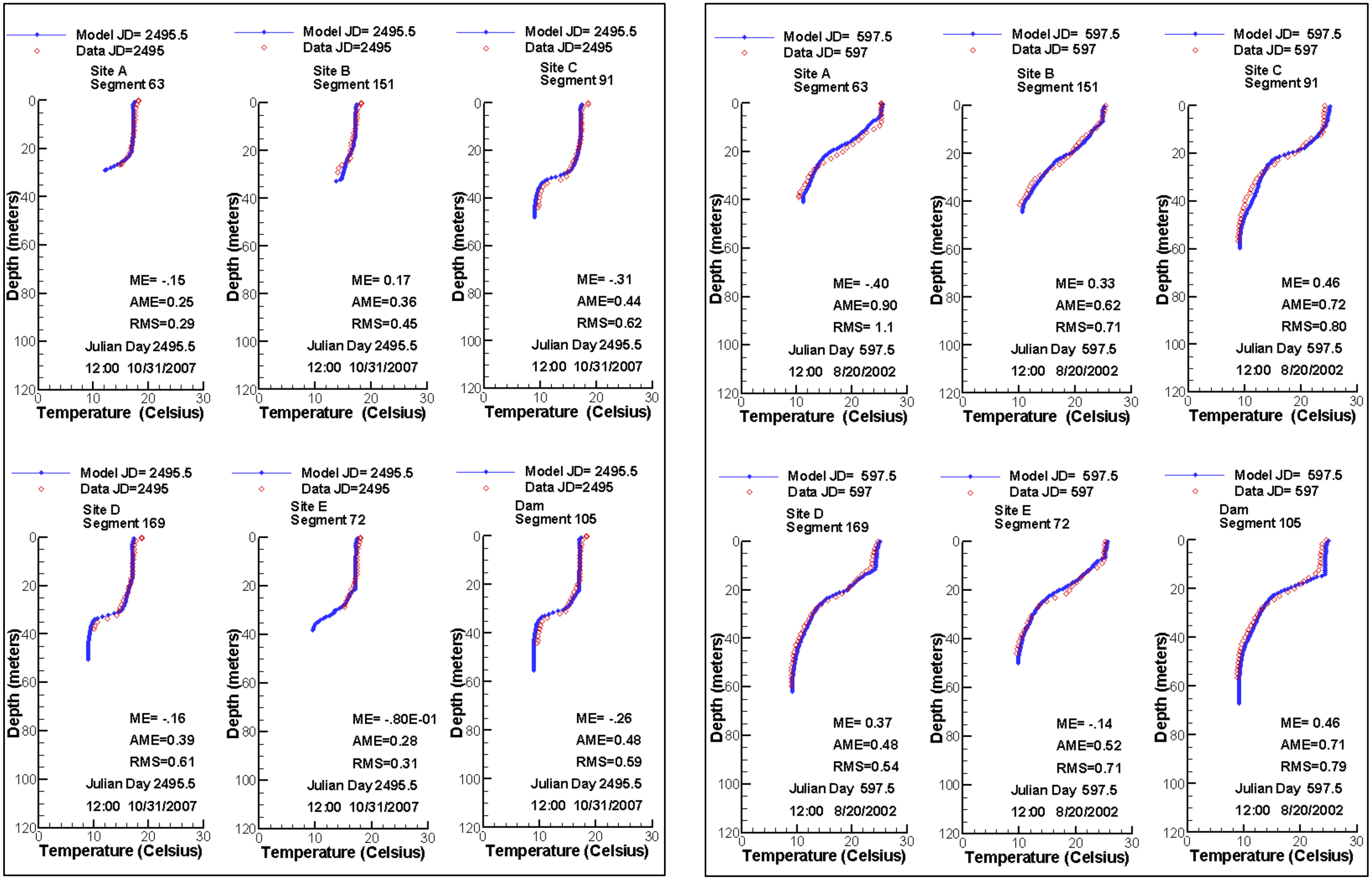
Appendix G4 Figure 1. Folsom Dam Outlet Structures (Google Maps, 2013)



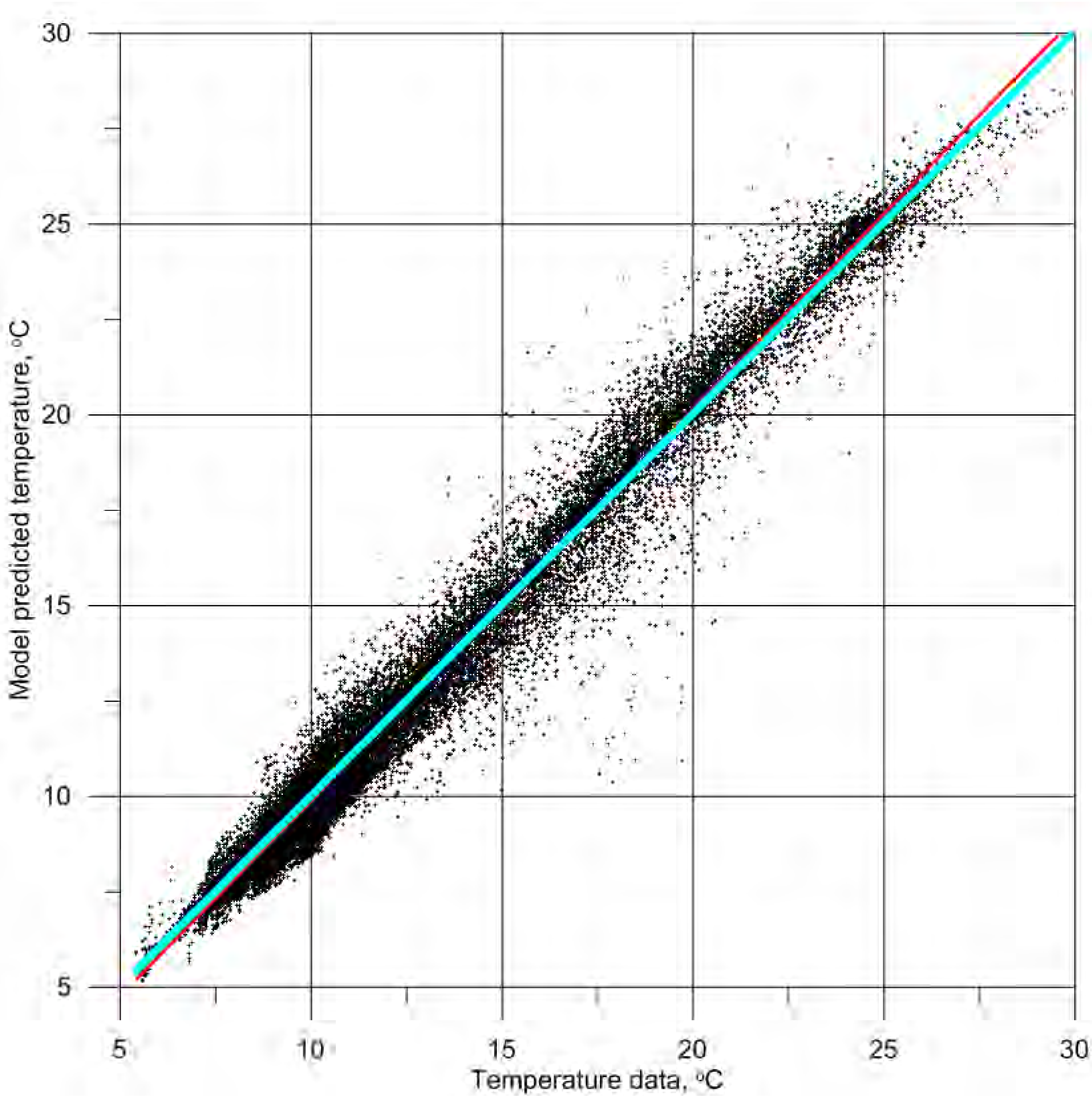
Appendix G4 Figure 2. **Folsom Reservoir Bathymetry Showing the North Fork and South Fork of the American River Channels (dimensions are in meters).**



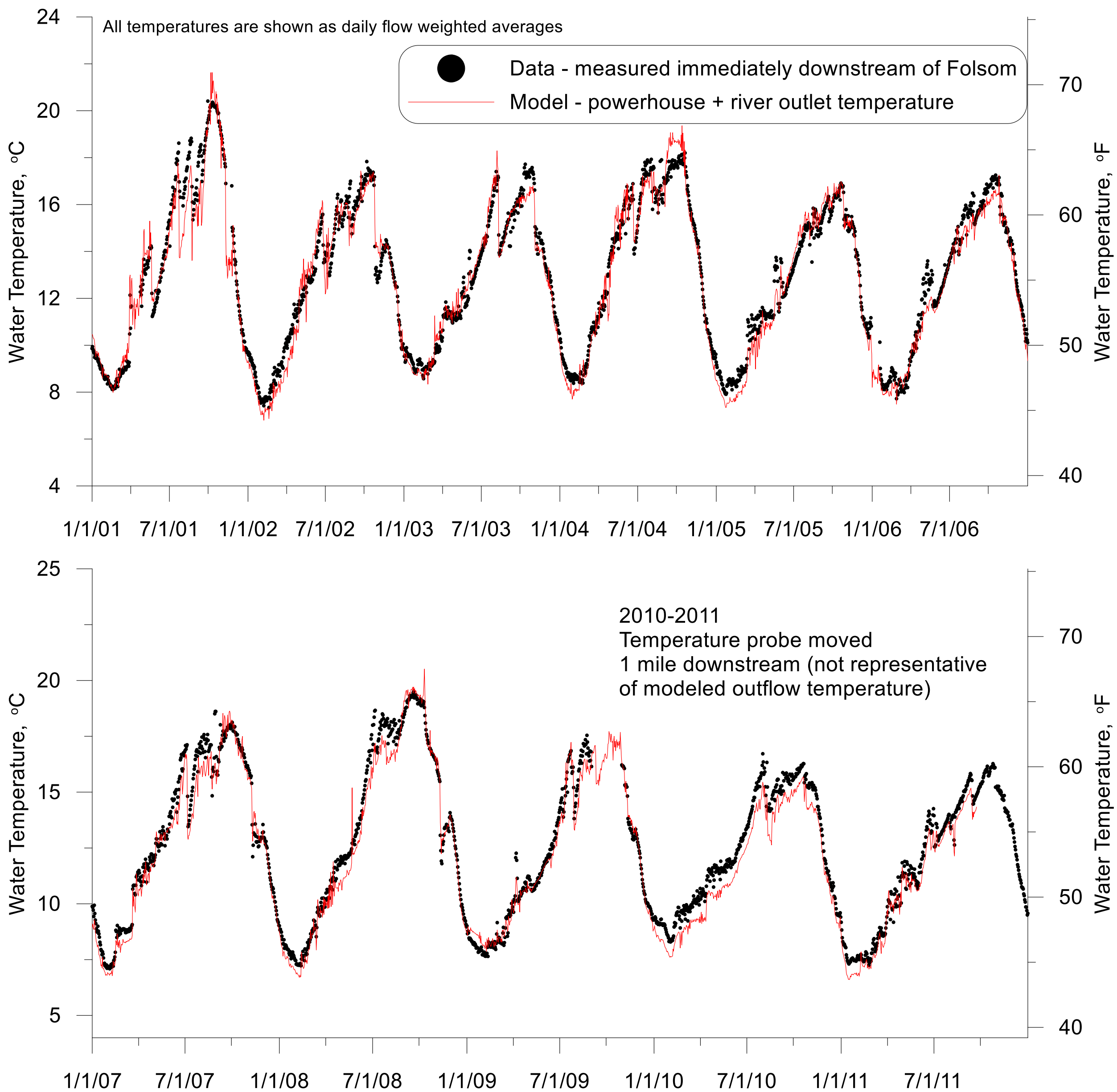
Appendix G4 Figure 3. **Model Grid Segment Layout for the Three Model Branches (dimensions are in meters).**



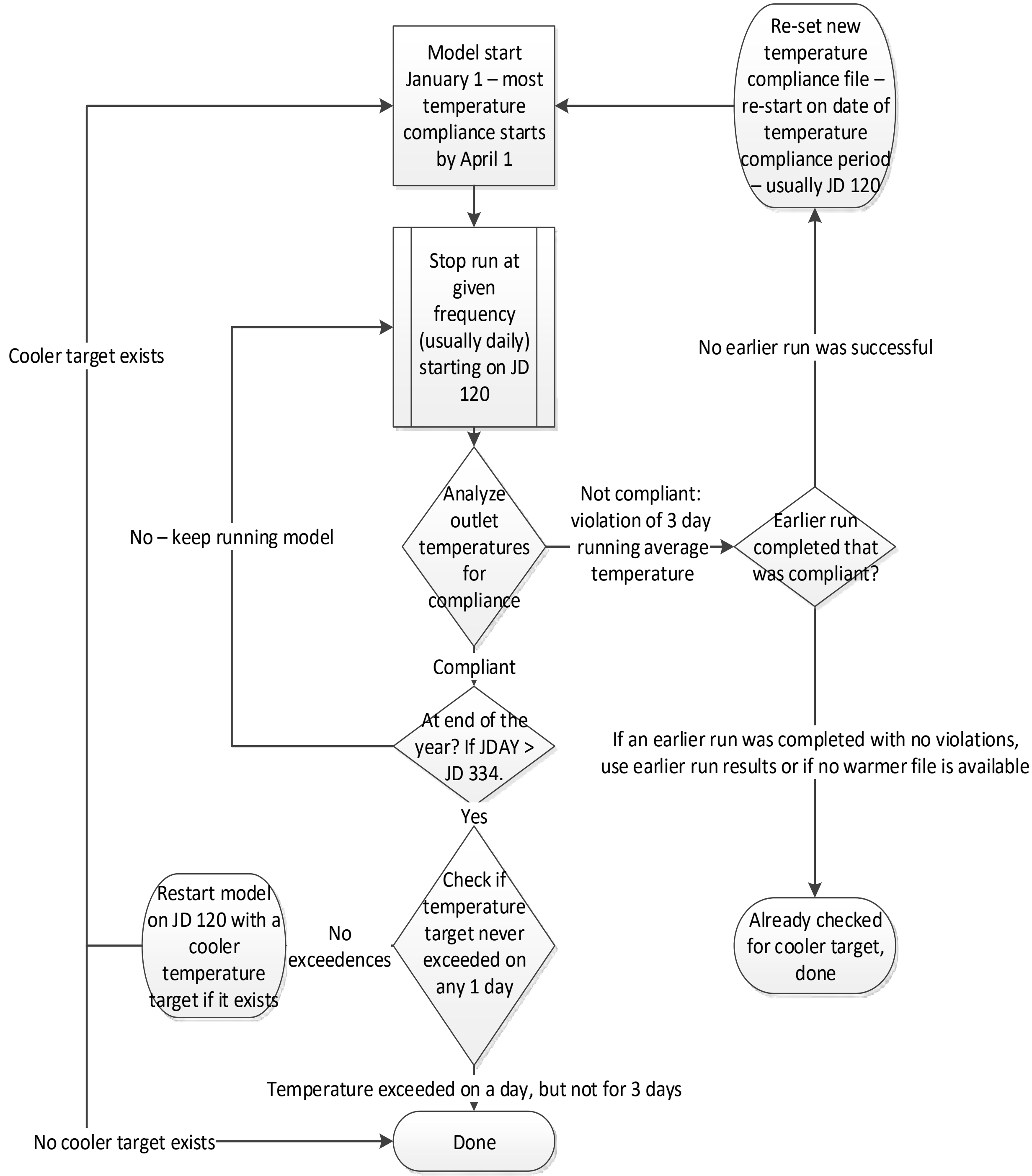
Appendix G4 Figure 4. **Model Temperature Profiles Compared to Measured. Temperature Profiles on August 20, 2002 (left) and October 31, 2007 (right) at Six Different Stations in Folsom Reservoir.**



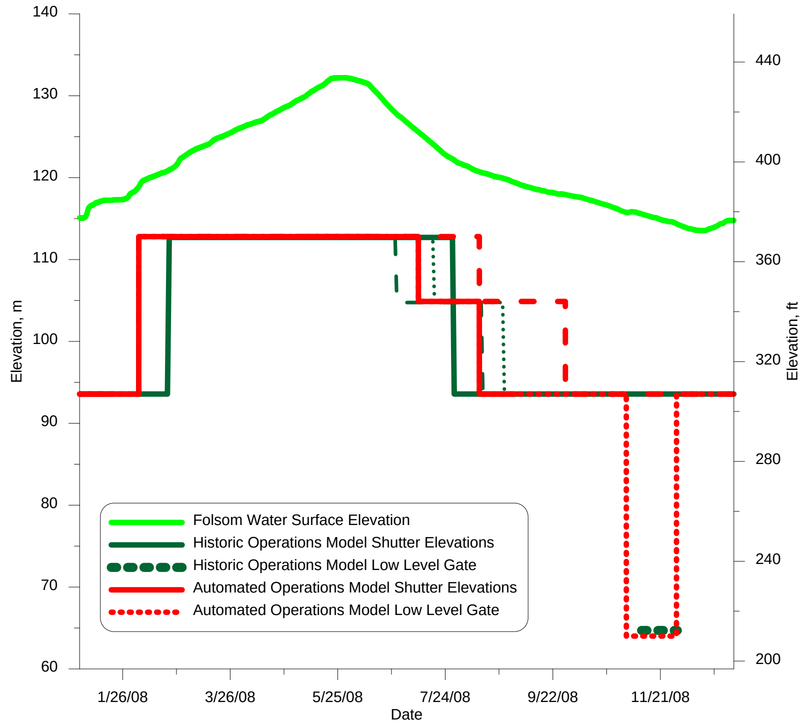
Appendix G4 Figure 5. **Comparison of Model Predicted Temperature Profile and Measured Temperature Profile Data between 2001 and 2011. (Slope of the linear regression through the origin is 1.002 with an R2 of 0.996 [red line]; blue line is a 1:1 slope).**



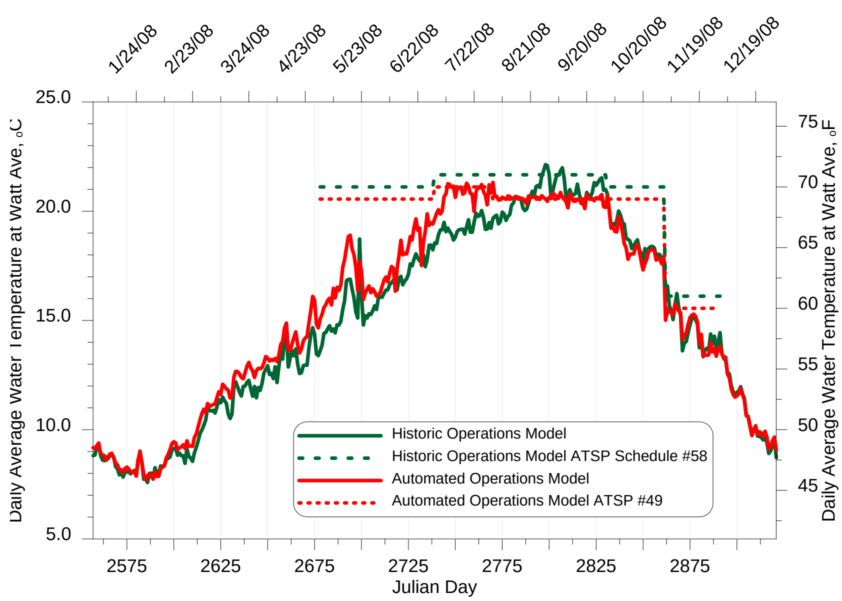
Appendix G4 Figure 6. **Model Predicted Temperatures below Folsom Dam Compared to Measured Temperatures Immediately Downstream of Folsom Dam between 2001 and 2009. For 2010 and 2011, Model Predictions and Observed Data are shown, but not completely comparable because the Observed Data were collected 1 mile downstream of Folsom Dam.**



Appendix G4 Figure 7. Flow Chart for Automatic Model Selection of Optimal Temperature Schedule.



Appendix G4 Figure 8 **Comparison of Historical Versus Automated Water Temperature Model Shutter Operations below Folsom Dam, 2008 (dark green lines represent historical operation of the three shutters; red lines represent automated operations of the three shutters.)**



Appendix G4 Figure 9. **Comparison of Historical Versus Automated Model Operations for Watt Avenue Water Temperature, 2008. (Note: These results were obtained by using a combination of the CE-QUAL-W2 model and an American River water temperature regression between Folsom Dam and Watt Avenue).**

APPENDIX G5

LOWER AMERICAN RIVER WATER TEMPERATURE REGRESSION MODELS

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Table of Contents

List of Tables

List of Figures

List of Maps

List of Acronyms

ATSP	Automated Temperature Selection Procedure
CDEC	California Data Exchange Center
CIMIS	California Irrigation Management Information System
FOL	Folsom
FSC	Folsom South Canal
LAR	Lower American River
MET	meteorological
RM	river mile
TCD	temperature control device

Introduction

This appendix documents a multiple regression modeling approach for predicting daily average water temperature in the Lower American River (LAR) based on air temperature, Nimbus discharge to the LAR, and Folsom Dam release water temperature. Water temperature regression equations were developed for the LAR at Hazel and Watt Avenues and at any river mile location along the LAR between Nimbus Dam and the confluence with the Sacramento River. The regression relationships are suitable to be used in a variety of ways to predict LAR water temperatures, but were specifically developed to be used in combination with the Folsom Reservoir CE-QUAL-W2 Temperature Model (Appendix G4) to iterate between Automated Temperature Selection Procedure (ATSP) schedules (Water Forum 2004; Water Forum 2006) and to analyze the effects of different alternatives on LAR water temperatures.

Lower American River Data Sources

The sources for the discharge, water temperature, and air temperature data used in the regression equations are provided in Appendix G5 Table 1 and the locations of these data sources are shown in Appendix G5 Map 1. All data were quality controlled prior to use in the analyses.

Methods

Regression Equation Input Data

Water temperature regression variables used for the LAR were 1) daily average discharge in the LAR, 2) daily average water temperature below Folsom Dam, 3) daily average air temperature and 4) river mile / river location (Appendix G5 Table 1). The discharge used in the water temperature regressions was calculated by daily-averaging Folsom Dam outflows (California Data Exchange Center ([CDEC] CDEC-FOL) and subtracting the daily average Folsom South Canal Diversion flows (CDEC-FSC). The resulting discharge approximated the daily average flow in the LAR. The water temperature data for Folsom Dam releases were obtained from the U.S. Geological Survey (USGS) gaging station / CDEC station below Folsom Dam (USGS 11446220/ CDEC-AFD). Historical local air temperature data for the LAR were obtained from the California Irrigation Management Information System (CIMIS) meteorological (MET) station at Fair Oaks (CIMIS-131).

Historical water temperature data for the LAR below Lake Natoma were available from three locations: Hazel Avenue (river mile [RM] 22.3); William B Park (RM 13.3); and Watt Avenue (RM 9.2). In addition, some limited water temperature data (limited years) at various locations on the American River were obtained from CBEC, Inc. (Chris Hammersmark, pers. comm.) and used to “spot” validate the regressions.

Multiple Regression Equation Approach

General

To predict daily average water temperature at Hazel Avenue or Watt Avenue, a multiple regression equation was developed at each location that related daily average water temperature at that location to daily average flow releases into the LAR, daily average water temperature of Folsom Dam (CDEC-FOL) releases, and local daily average air temperatures (CIMIS-131 at Fair Oaks) for the period 2001 –2009[1]. To predict daily average water temperature at any river mile on the LAR, the river mile water temperature regression included the river mile of each water temperature station (Hazel Avenue, William B. Pond, Watt Avenue) in the dataset as an additional parameter.

The daily average water temperature regressions were developed for each month of the year. The monthly approach helped account for seasonal variables not included in the regressions (e.g., solar radiation). The regression relationships were, however, designed to predict daily water temperatures for any day of the year. To do that, the regression equation monthly coefficients and constants are linearly interpolated between the monthly values (with monthly values centered at the middle of each month) to obtain daily regression coefficients for each day of the year.

WATER RELEASE LAG TIME

When water is released from Folsom Dam, it takes between 1 and 8 days for the water to travel through Lake Natoma, be released from Nimbus Dam, and reach Watt Avenue, depending on the flow rate. When flows or the water temperature of Folsom Dam releases were relatively steady from day-to-day, incorporating a release lag time into the regression equations did not significantly increase the accuracy of the regression equations. Conversely, if releases, particularly the water temperature of the releases, changed significantly from day-to-day (e.g., water from different reservoir levels), incorporating the water release lag time into the regression was beneficial. For the Watt Avenue regression, which was specifically intended to be used in conjunction with the Folsom Reservoir CE-QUAL-W2 model to update Folsom Reservoir temperature control device (TCD) operations and meet ATSP schedules on a daily basis, a version of the regression equations was developed that incorporated the released water lag time.

A mathematical relationship for calculating lag time between Folsom Dam and Watt Avenue was developed by analyzing hydrodynamic results from the CE-QUAL-W2 model of Lake Natoma (Technical Memorandum 6 Lake Natoma CE-QUAL-W2 Model and Calibration Report) and the HecRas model of the Lower American (Chris Hammersmark, pers. comm.). The relationship is shown in Appendix G5 Figure 1. The equation is as follows[2]:

$$Lag\ time\ (days) = 3966.8 * (35.314 * Flow(cms))\hat{}(-0.944) \quad \textbf{(1)}$$

Based on sensitivity analyses, it was determined that the best-fit Watt Avenue temperature regression included lagging only the Folsom release temperature using Equation 1. Time lagging other variables (flow rate, air temperature) was not beneficial to the regression.

[1] The location of the gaging station at Watt Avenue moved in 2009; only data prior to this were used in the development of the regression relationships.

[2] Final equation provided by Chris Hammersmark (CBEC, Inc.) by email to Vanessa Martinez (Cardno) on 1/29/2015

Results

Hazel Avenue

The monthly constants and regression coefficients used to predict daily average water temperature for Hazel Avenue are shown in Appendix G5 Table 2. The overall regression performance is shown in Appendix G5 Figure 2 by plotting measured versus regression-based average daily temperatures at Hazel Avenue. A time series comparison of the predicted and measured water temperatures from 2001 to 2018 at Hazel Avenue is shown in Appendix G5 Figure 3. Flow rate influenced water temperature in the later spring/summer, but had less effect on water temperature in winter/early spring months.

Watt Avenue

The monthly constants and regression coefficients used to predict daily average water temperatures at Watt Avenue are shown in Appendix G5 Table 3 for the Folsom release temperature time lagged regression and in Appendix G5 Table 4 for the “without time lag” regression. The overall regression performance (with lagged release temperature) is shown in Appendix G5 Figure 4 by plotting measured versus regression-based average daily temperatures at Watt Avenue. A time series comparison of the predicted and measured water temperatures from 2001 to 2018 at Watt Avenue is shown in Appendix G5 Figure 5. Discharge influenced water temperature in the later spring/summer, but had less effect on water temperature in winter/early spring months.

River Mile Locations

The monthly constants and regression coefficients used to predict daily average water temperatures at any specified RM along the LAR are shown in Appendix G5 Table 5. The overall regression performance is shown in Appendix G5 Figure 6 by plotting measured versus regression-based average daily temperatures at river mile locations where data are available. Predicted (regression-based) water temperatures at three river mile locations corresponding to Hazel Avenue, William B Pond Park and Watt Avenue for 2001 through 2018 is shown in Appendix G5 Figure 7. Model versus data comparisons are shown at these same three locations along the Lower American River for 2001-2018 in Appendix G5 Figures 8, 9, and 10. Similar to the Hazel Avenue and Watt Avenue regressions, flow rate influenced water temperature more in the spring/summer months than in the winter months, particularly in the lower sections of the reach.

APPENDIX G5

TABLES

Appendix G5 Table 1. Data Sources for the Lower American River Water Temperature Regression Analyses.

Name	Data Collected	Operator	Station No.	Location		Period of Record Available	Period of Record Used in Regression Analyses
				Lat.	Long.		
Flow Stations							
Folsom Lake outflows	Daily Average Flow	US Bureau of Reclamation/ CDEC	CDEC-FOL	38.683	121.183	2/1/1995-present	1/1/2001-8/31/2009
Folsom South Canal	Diversion Flow	US Bureau of Reclamation/ CDEC	CDEC-FSC	38.650	121.183	7/11/2001-present	7/11/2001-8/31/2009
Water Temperature Stations							
American R. below Folsom Dam	Daily Water Temperature	USGS/ CDEC	USGS 11446220/ CDEC-AFD	38.688	121.166	10/24/1998-present	1/1/2001-8/31/2009
American R. at Hazel Ave. Bridge	Daily Water Temperature	USGS/ CDEC	USGS 11446220/ CDEC-AHZ	38.636	121.224	6/29/2001-present	6/29/2001-8/31/2009
American R. at William B. Pond Park	Daily Water Temperature	USGS/ CDEC	USGS 11446700/ CDEC-AWP	38.591	121.332	1/10/2001-present	10/1/2007-8/31/2009
American R. below Watt Ave. Bridge	Daily Water Temperature	USGS/ CDEC	USGS 11446980/ CDEC-AWB	38.567	121.387	11/30/1998-present	1/1/2001-8/31/20091
Meteorological Station							
CIMIS at Fair Oaks	Daily Average Air Temperature	CIMIS	CIMIS at Fair Oaks	38.650	121.218	4/18/1997-present	4/18/1997-8/31/2009

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

[1] Location of gaging station was moved in 2009; only data prior to this were used in the development of the regressions.

Appendix G5 Table 2. Coefficients Used for the Multiple Regression for Predicting Lower American River Average Daily Water Temperature at Hazel Avenue

Month	Constant	A	B	C	R^2
Predicted Water Temp = Const. + A(Ave Air Temp) + B(Ave Water Temp below Folsom) + C(Log [Ave Flow])					
Jan	1.9464	0.0134	0.9398	-0.6182	0.838
Feb	3.0658	0.0634	0.8055	-0.8259	0.665
Mar	4.8402	0.0304	0.8408	-1.5306	0.859
Apr	8.0496	0.0490	0.6082	-1.7821	0.854
May	7.5008	0.0356	0.8387	-2.4903	0.934
Jun	9.2531	0.0257	0.7968	-2.9129	0.931
Jul	7.0760	-0.0156	0.8855	-1.9229	0.885
Aug	9.1246	0.0316	0.7682	-2.6583	0.751
Sep	9.7662	0.0845	0.6947	-3.2732	0.841
Oct	9.7572	0.0595	0.5984	-2.1663	0.865
Nov	8.1662	0.1901	0.5111	-1.8145	0.673
Dec	1.5390	0.0293	0.8908	-0.2236	0.925

Regression Variables:

Ave Air Temp = Daily average air temperature at CIMIS at Fair Oaks (CIMIS-131) (°C)

Ave Water Temp below Folsom = Daily water temperature below Folsom Data at USGS/CDEC station (USGS gage no. 11446220/CDEC station AFD) (°C)

Ave Flow = Daily-averaged hourly flow below Folsom Reservoir (CDEC station FOL) – South Canal Diversion (CDEC station FSC) (cubic meters per second [cms])

Predicted Temp = Lower American River at Hazel Avenue (°C)

Appendix G5 Table 3. Coefficients Used for the Multiple Regression for Predicting Lower American River Average Daily Water Temperature at Watt Avenue with Time Lagged Water Temperature.

Month	Constant	A	B	C	R^2
Predicted Water Temp = Const. + A(Ave Air Temp) + B(Lagged Ave Water Temp below Folsom) + C(Log[Ave Flow])					
Jan	1.818763	0.112641331	0.73259158	-0.147712419	0.57
Feb	3.539369	0.205141039	0.775380578	-1.499333534	0.45
Mar	4.987294	0.168695197	0.961301503	-2.512509452	0.91
Apr	8.855085	0.158340582	0.718969803	-3.034734768	0.91
May	11.86438	0.138534042	0.742039709	-4.371801735	0.95
Jun	12.62007	0.086480404	0.800890216	-4.43688051	0.95
Jul	13.08971	0.049031621	0.682266998	-3.293149439	0.94
Aug	16.90057	0.072653186	0.622758693	-5.222428569	0.91
Sep	15.26052	0.182748074	0.454786001	-4.508935727	0.84
Oct	2.757994	0.240015186	0.668043404	-0.344582923	0.82
Nov	-1.8198	0.231285327	0.828705359	0.703644524	0.96
Dec	-1.35138	0.167591589	0.685635625	1.786194262	0.87

Regression Variables:

Ave Air Temp = Daily average air temperature at CIMIS at Fair Oaks (CIMIS-131) (°C)

Ave Water Temp below Folsom = Daily water temperature below Folsom Data at USGS/CDEC station (USGS gage no. 11446220/ CDEC station AFD) (°C)

Ave Flow = Daily-averaged hourly flow below Folsom Reservoir (CDEC station FOL) – South Canal Diversion (CDEC station FSC) (cubic meters per second [cms])

Low Flows – water temperatures at low flows were modeled with HEC-5Q as described in the text.

Predicted Temp = Lower American River at Watt Avenue (°C)

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

Appendix G5 Table 4. Coefficients Used for the Multiple Regression for Predicting Lower American River Average Daily Water Temperature at Watt Avenue without Time Lagged Water Temperature.

Month	Constant	A	B	C	R^2
Predicted Water Temp = Const. + A(Ave Air Temp) + B(Ave Water Temp below Folsom) + C(Log[Ave Flow])					
Jan	1.96471	0.112234	0.794124	-0.4599	0.59
Feb	2.807373	0.19099	0.859157	-1.40971	0.53
Mar	4.540722	0.158975	0.945175	-2.20309	0.88
Apr	8.476506	0.146524	0.686462	-2.57868	0.92
May	10.9384	0.15328	0.746008	-4.05553	0.93
Jun	12.99852	0.072963	0.790918	-4.44247	0.92
Jul	13.53072	0.058166	0.665339	-3.51614	0.87
Aug	16.56891	0.096824	0.602078	-5.15153	0.84
Sep	13.88743	0.186215	0.494713	-4.14767	0.85
Oct	3.846972	0.205693	0.685195	-0.77901	0.87
Nov	-4.20459	0.209982	0.960059	1.231348	0.93
Dec	1.040451	0.161682	0.754327	0.099866	0.89

Regression Variables:

Ave Air Temp = Daily average air temperature at CIMIS at Fair Oaks (CIMIS-131) (°C)

Ave Water Temp below Folsom = Daily water temperature below Folsom Data at USGS/CDEC station (USGS gage no. 11446220/ CDEC station AFD) (°C)

Ave Flow = Daily-averaged hourly flow below Folsom Reservoir (CDEC station FOL) – South Canal Diversion (CDEC station FSC) (cubic meters per second [cms])

Predicted Temp = Lower American River at Watt Avenue (°C)

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

Appendix G5 Table 5. Coefficients Used for the River Mile Multiple Regression to Predict Average Daily Water Temperature at Specified Locations along the Lower American River.

Month	Constant	A	B	C	D	R^2
Predicted Water Temp = Constant + A(Ave Air T) + B(Ave Water T below Folsom) + C(Log[Ave Flow]) + D(RM)						
Jan	2.235497	0.055418	0.825738	-0.52645	0.008751	0.62
Feb	3.560284	0.136864	0.811086	-1.0953	-0.03644	0.56
Mar	6.527125	0.093312	0.85848	-1.95242	-0.08413	0.84
Apr	10.22137	0.100764	0.627146	-2.31341	-0.09348	0.87
May	10.58013	0.109122	0.845379	-3.40188	-0.12297	0.92
Jun	14.22662	0.048251	0.753645	-3.97143	-0.12483	0.92
Jul	13.63687	0.019043	0.760111	-3.24759	-0.1279	0.89
Aug	16.68644	0.062428	0.614724	-4.15399	-0.13937	0.84
Sep	14.90653	0.133762	0.548928	-4.02447	-0.11092	0.86
Oct	8.962731	0.133697	0.569276	-1.72354	-0.03133	0.81
Nov	7.706451	0.269051	0.453618	-1.73661	0.008454	0.68
Dec	0.97066	0.095728	0.836114	-0.16038	0.022549	0.90

Regression Variables:

Ave Air Temp = Daily average air temperature at CIMIS at Fair Oaks (CIMIS-131) (°C)

Ave Water Temp below Folsom = Daily water temperature below Folsom Data at USGS/CDEC station (USGS gage no. 11446220/ CDEC station AFD) (°C)

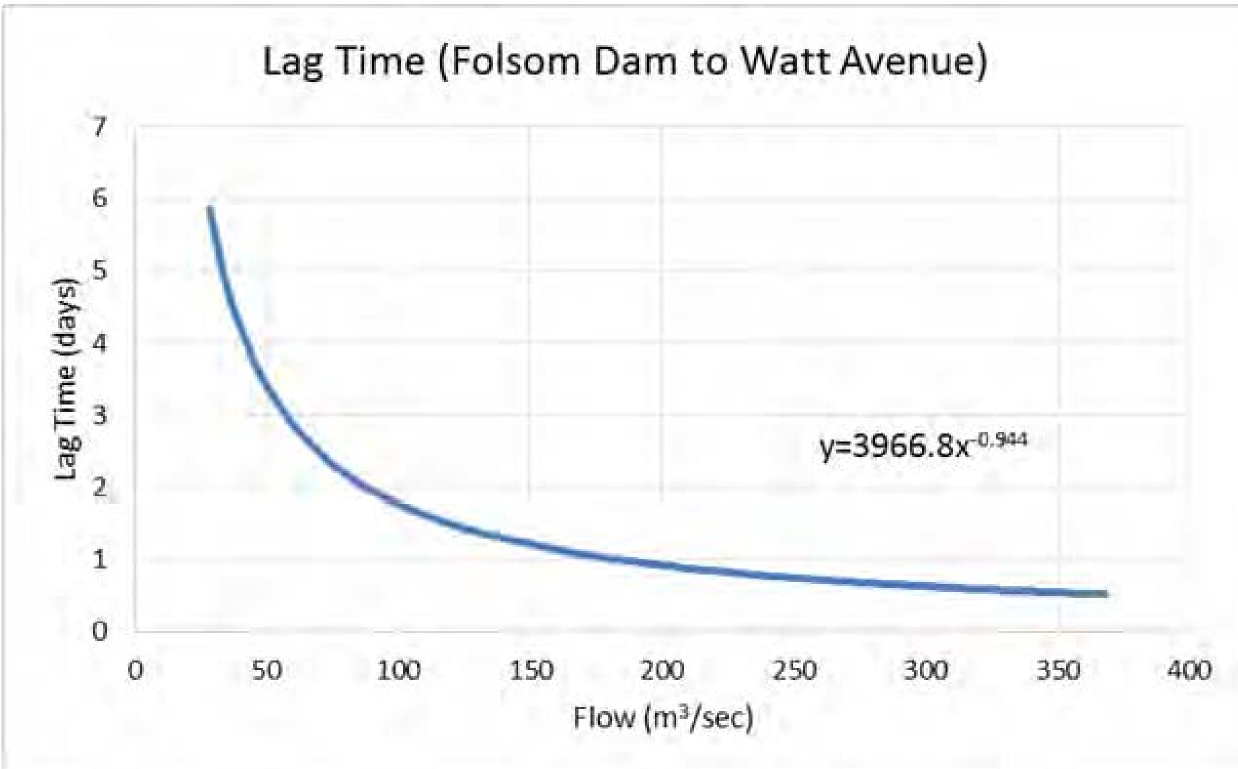
Ave Flow = Daily-averaged hourly flow below Folsom Reservoir (CDEC station FOL) – South Canal Diversion (CDEC station FSC) (cubic meters per second [cms])

RM = River Mile

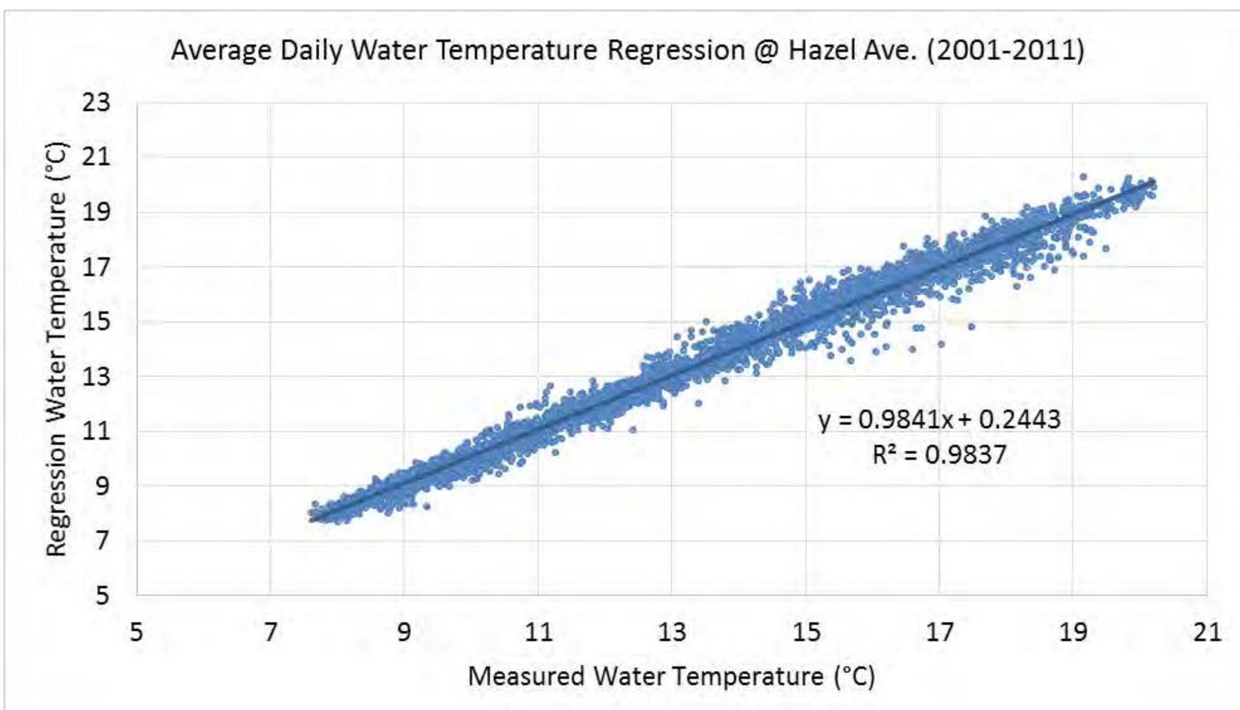
Predicted Temp = Lower American River at RM “X” (°C)

APPENDIX G5

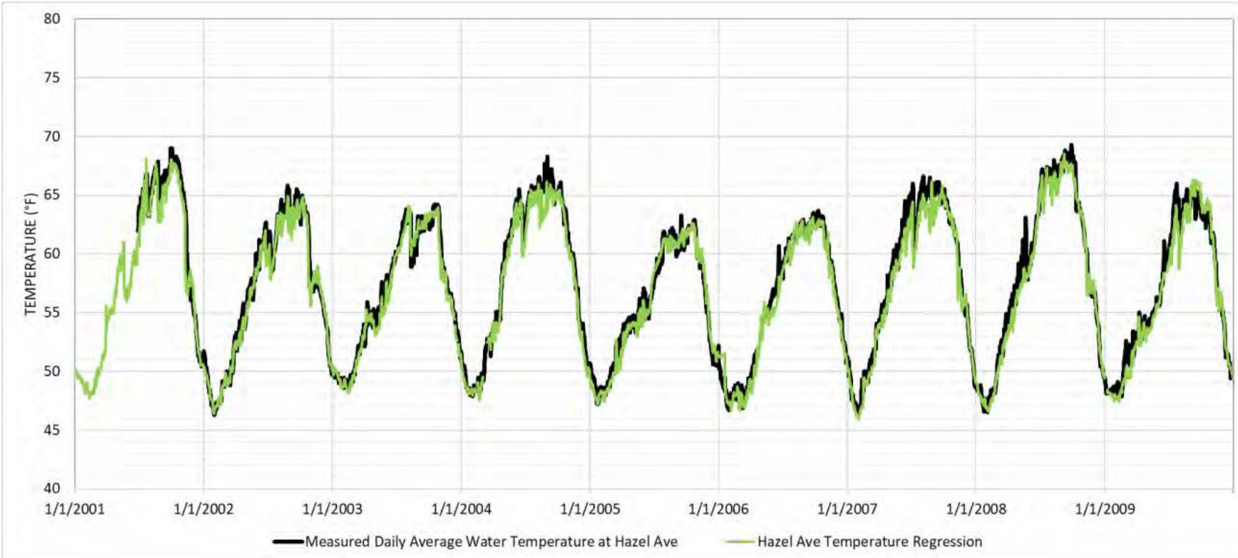
FIGURES

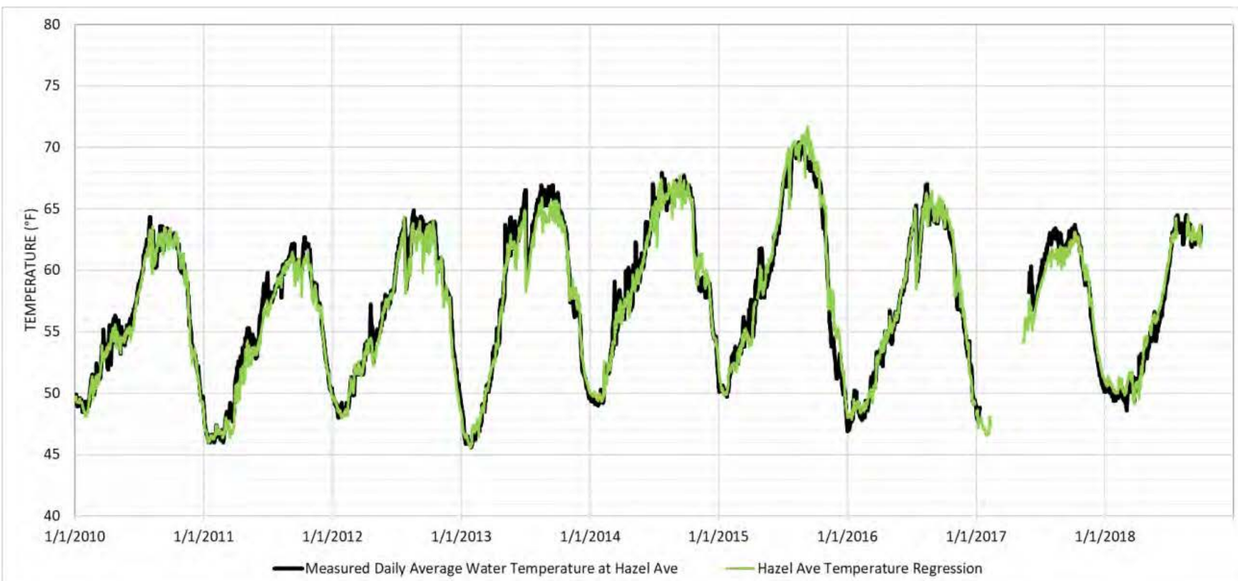


Appendix G5 Figure 1. **Flow Travel (Lag) time to Watt Avenue versus Flow.**

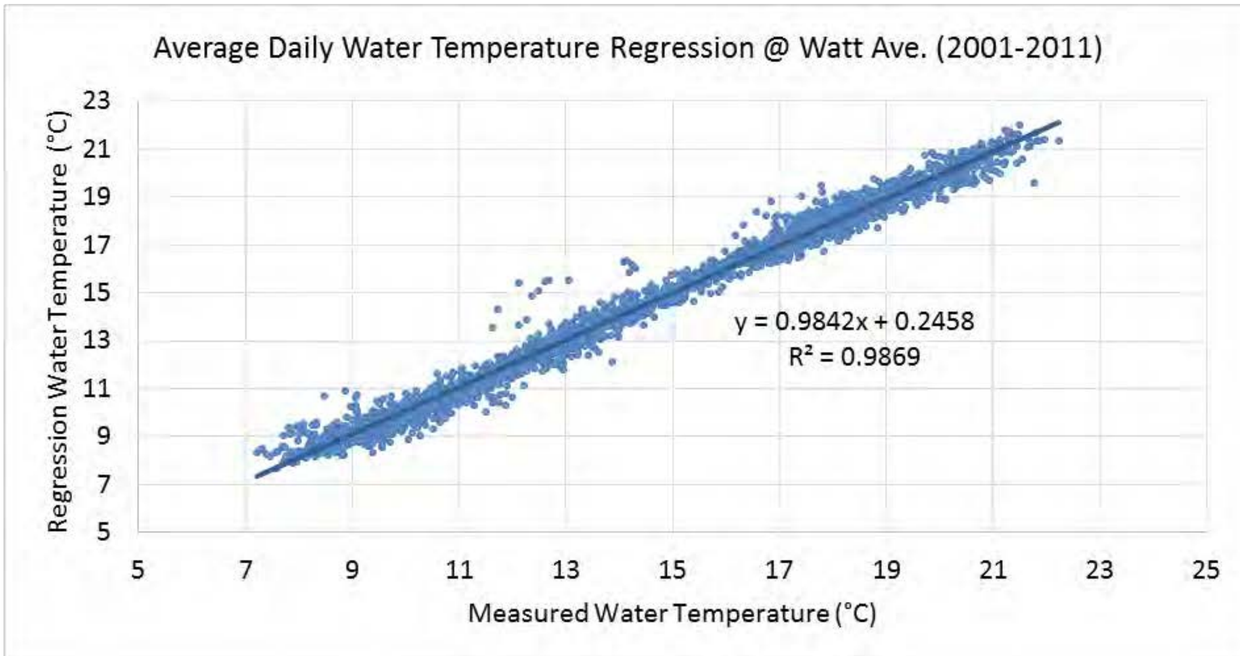


Appendix G5 Figure 2. **Measured versus Modeled (Regression) Average Daily Water Temperature at Hazel Avenue.**

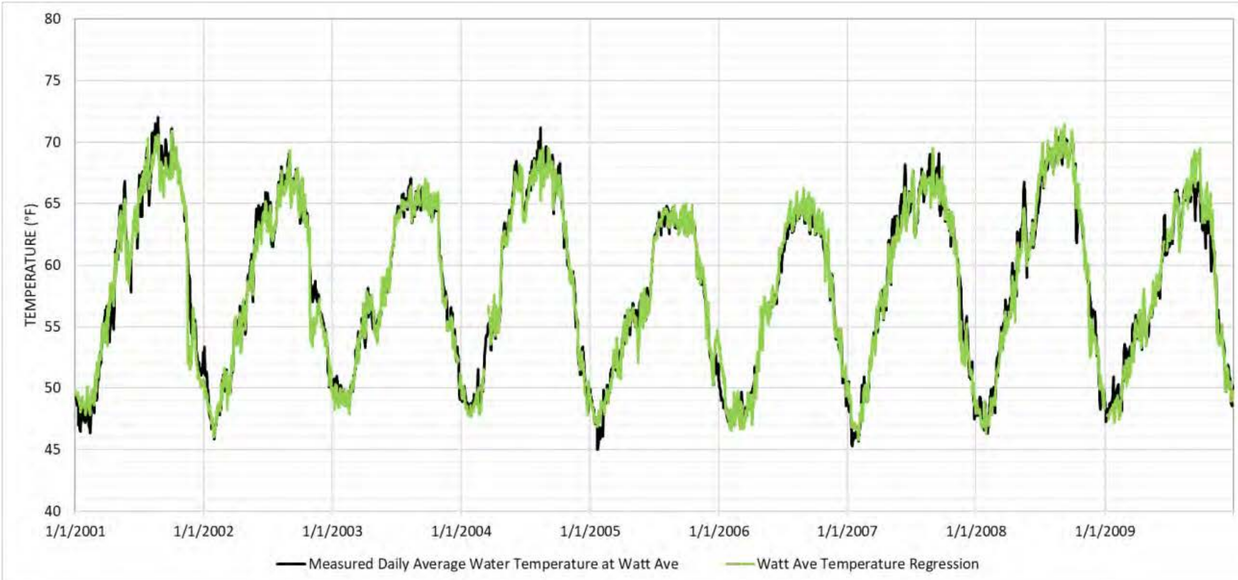


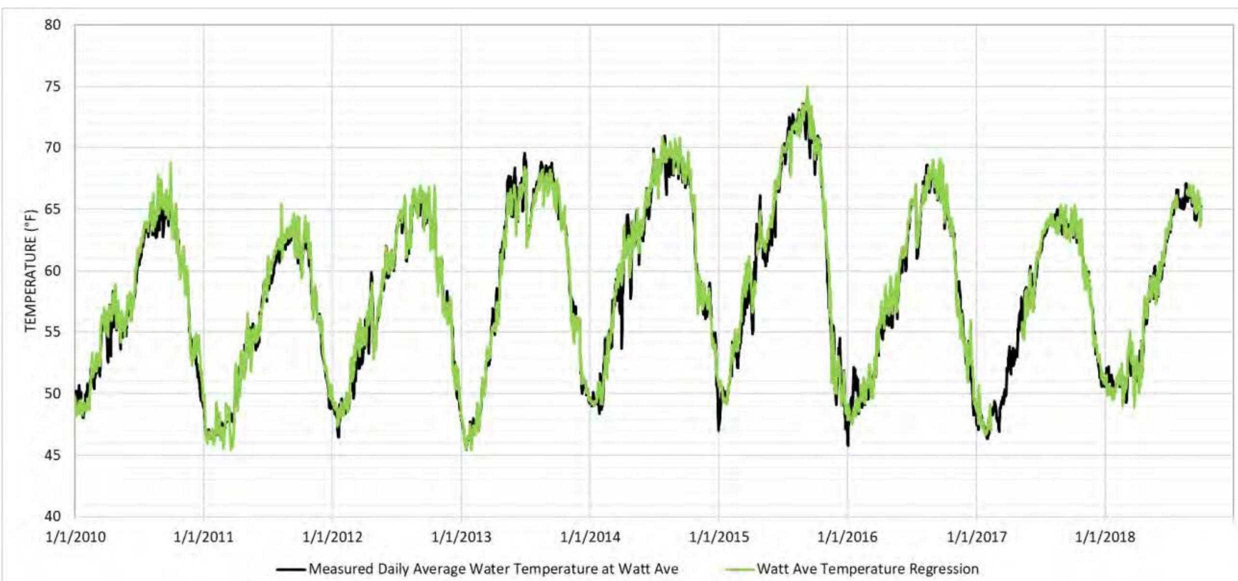


Appendix G5 Figure 3. **Comparison of Measured and Modeled (Regression) Water Temperature on the Lower American River at Hazel Avenue (2001-2018): 2001-2009 (top), and 2010-2018 (bottom).**

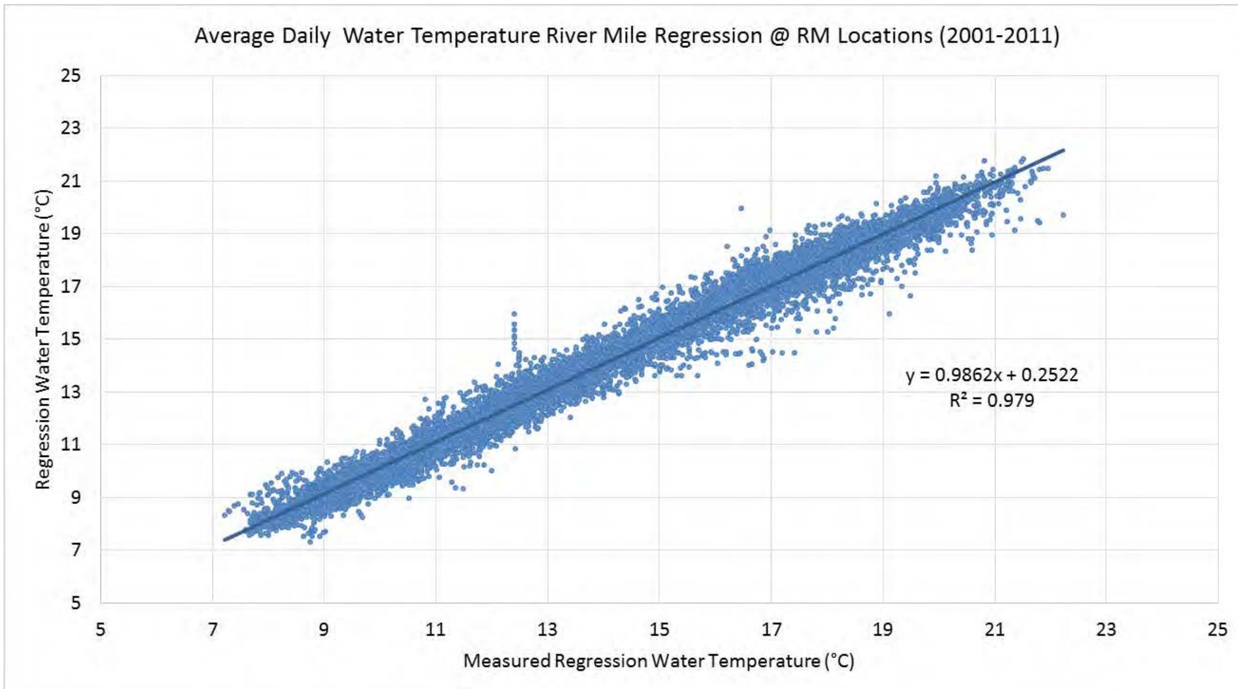


Appendix G5 Figure 4. Measured versus Modeled (Regression) Average Daily Water Temperature at Watt Avenue.

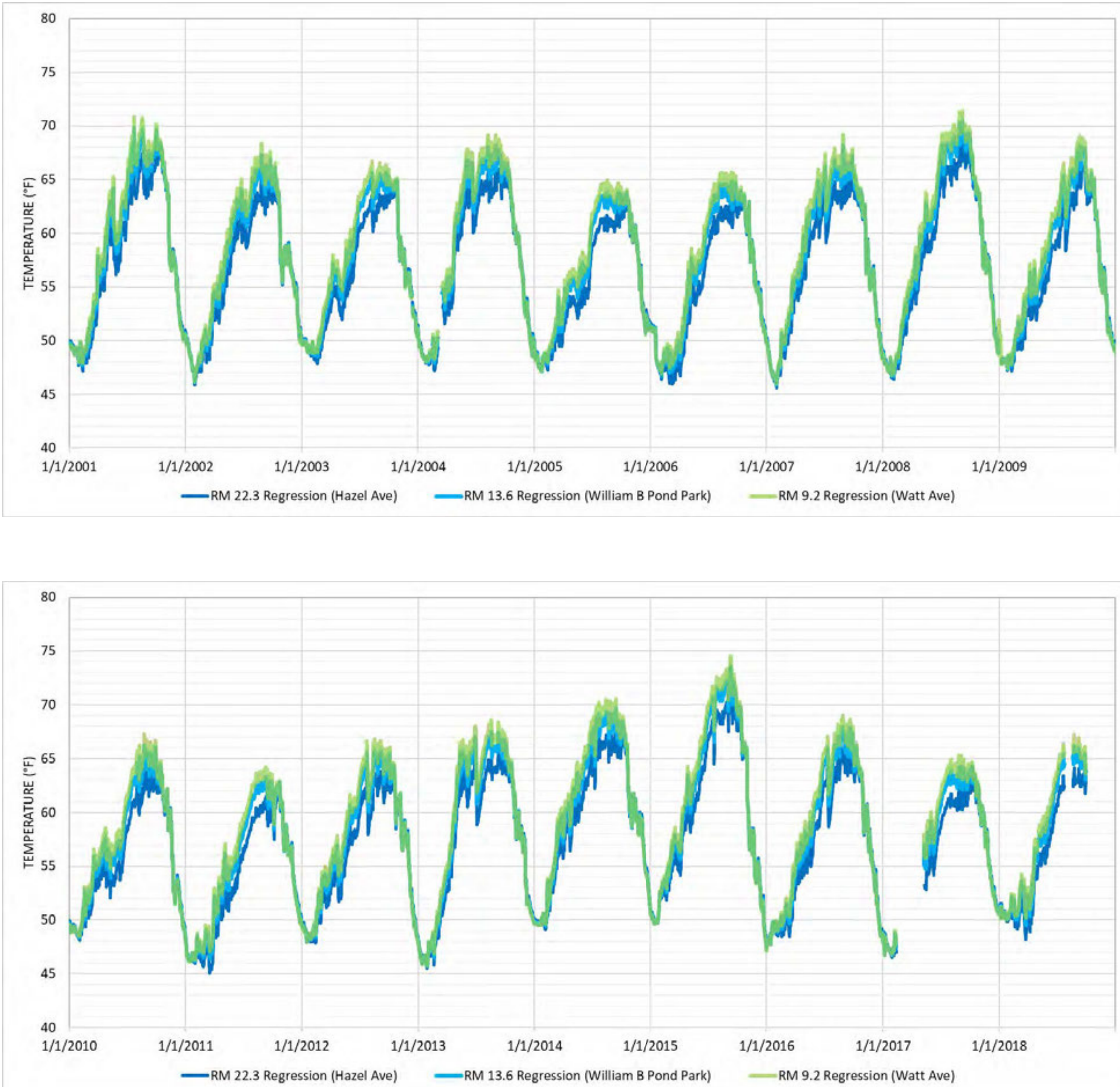




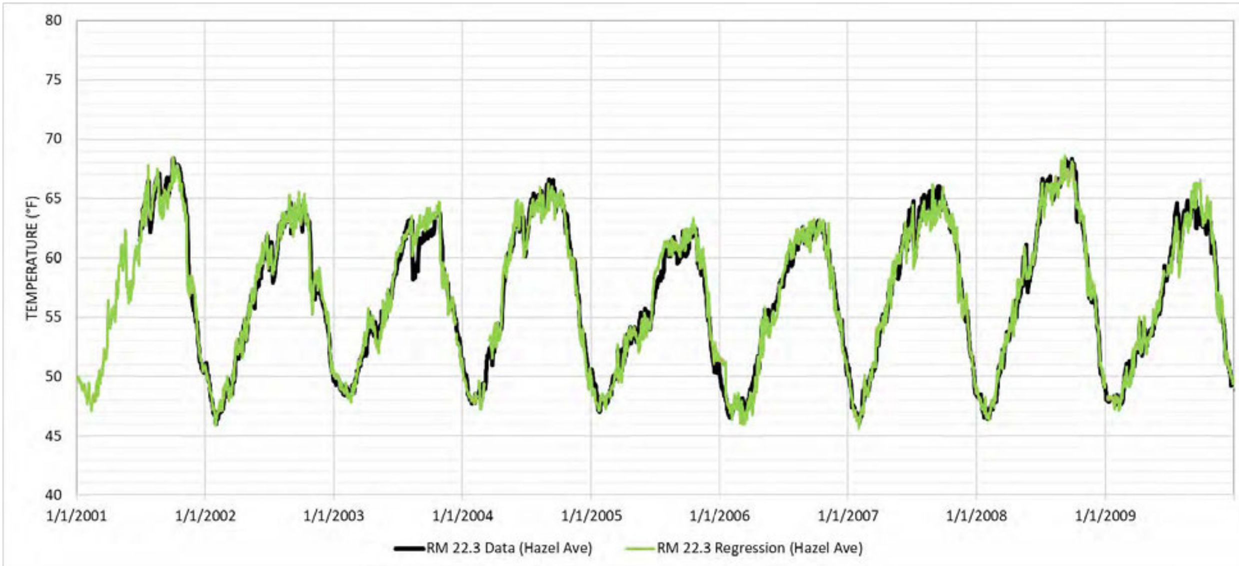
Appendix G5 Figure 5. **Comparison of Measured and Modeled (Regression) Water Temperature on the Lower American River at Watt Avenue (2001-2018): 2001-2009 (top), and 2010-2018 (bottom).**

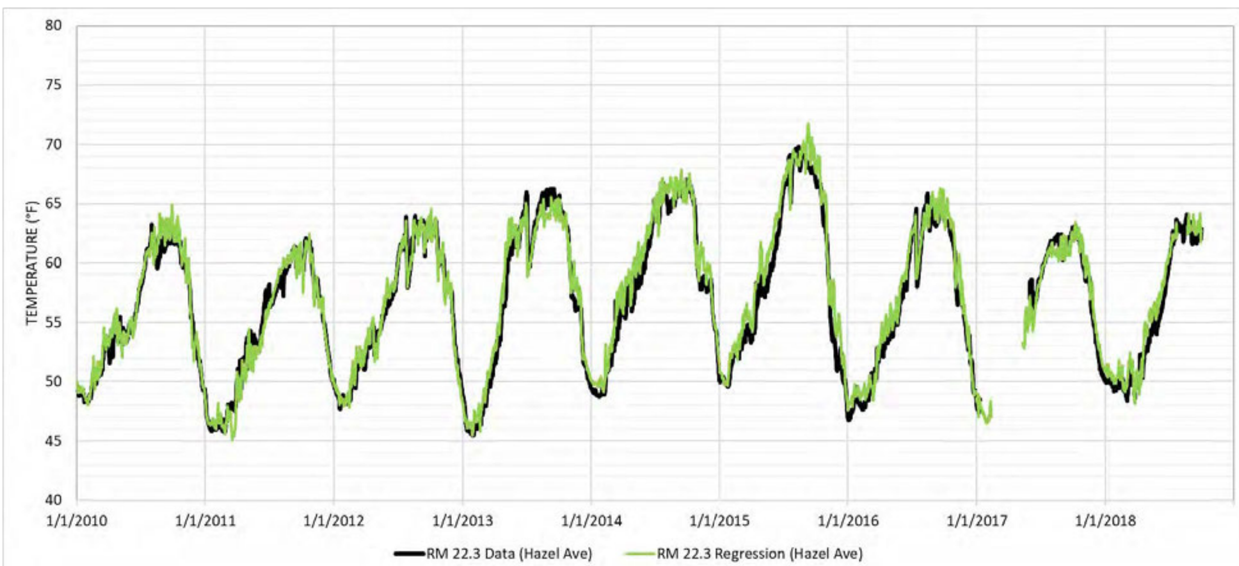


Appendix G5 Figure 6. **Measured versus Modeled (Regression) Average Daily Water Temperatures at Various River Mile Locations.**

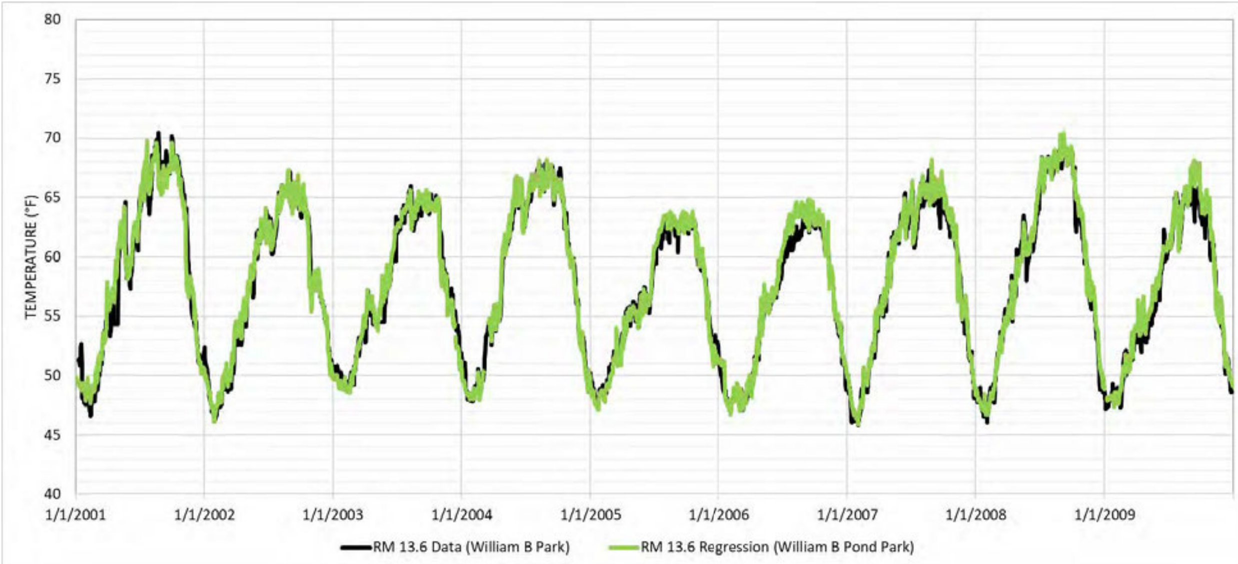


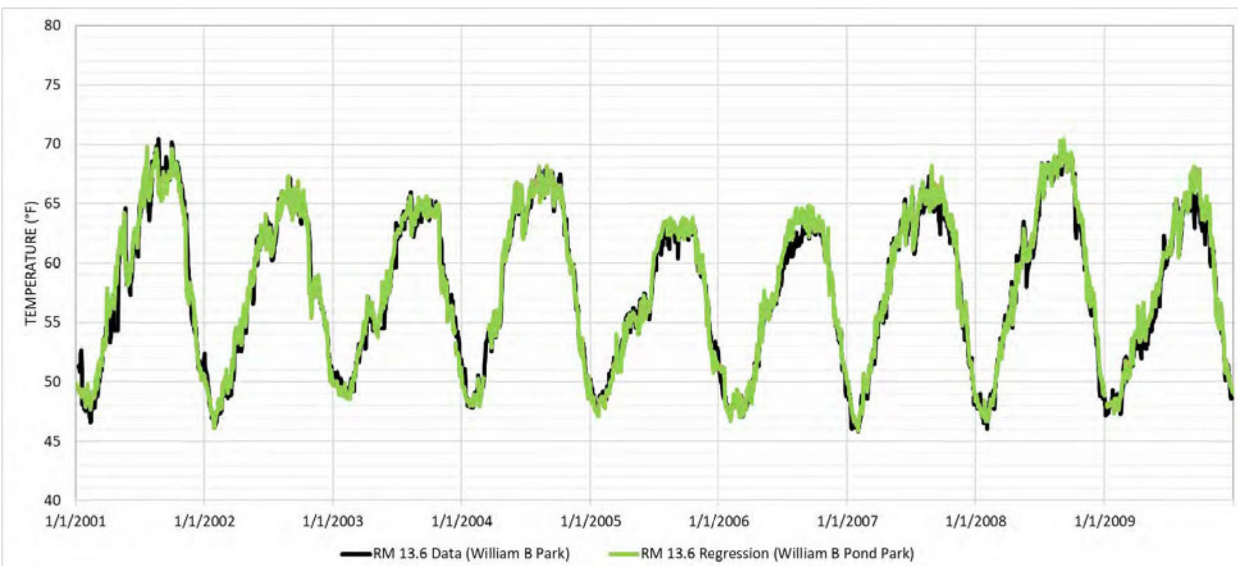
Appendix G5 Figure 7. **Comparison of Modeled (River Mile Regression) Water Temperatures at three river mile locations along on the Lower American River (2001-2018): 2001-2009 (top), and 2010-2018 (bottom).**



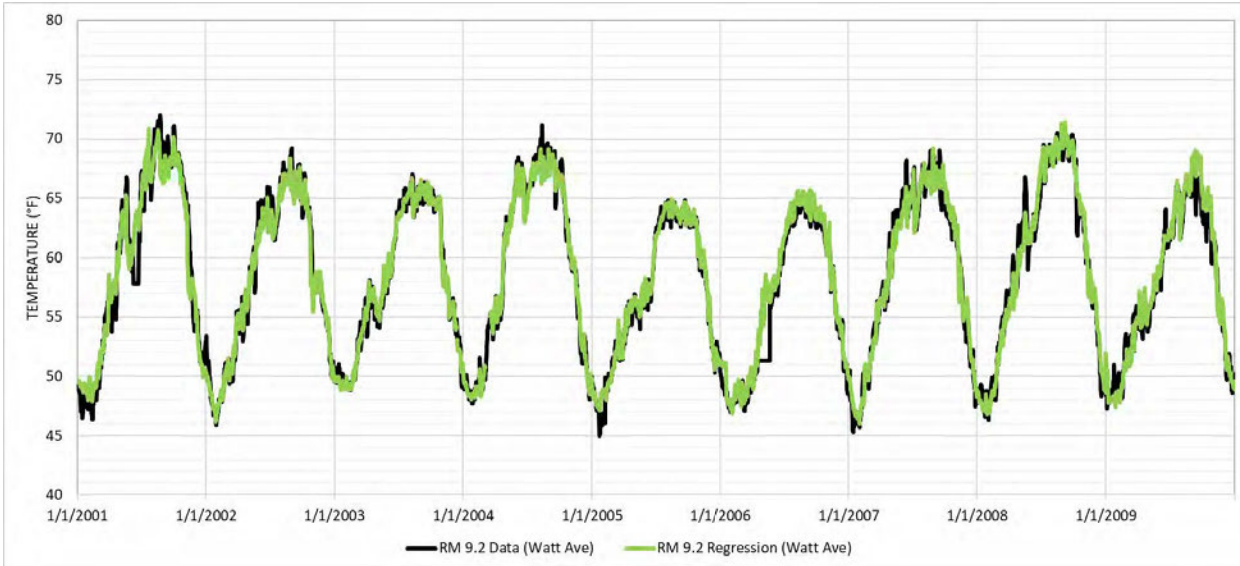


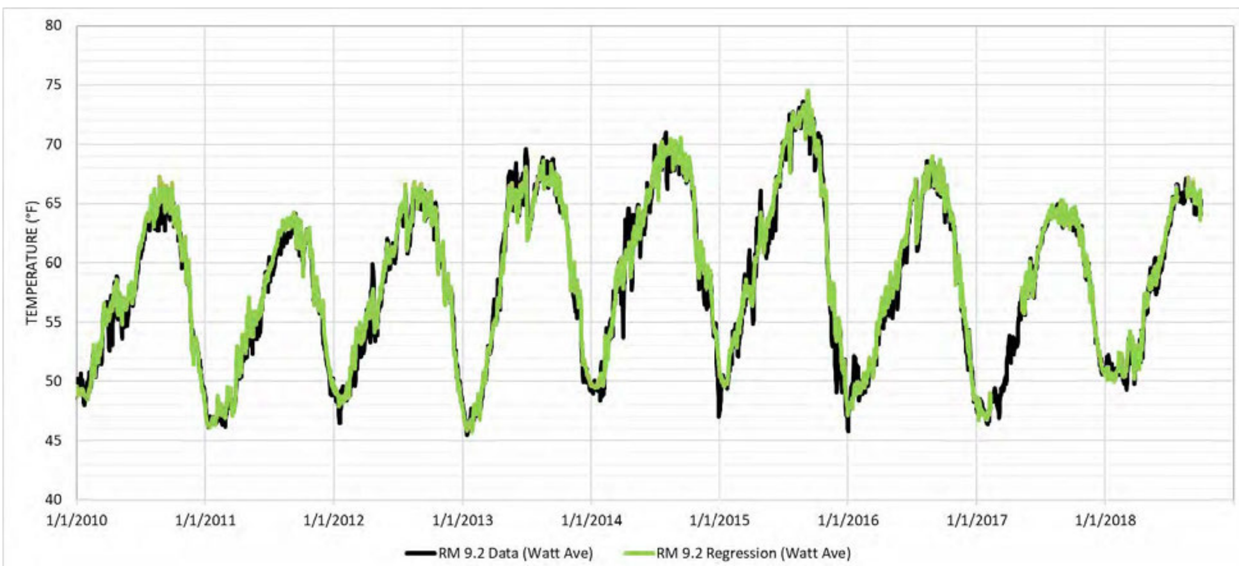
Appendix G5 Figure 8. Comparison of Measured and Modeled (River Mile Regression) Water Temperature on the Lower American River at river mile 22.3 (Hazel Avenue) (2001-2018): 2001-2009 (top), and 2010-2018 (bottom).





Appendix G5 Figure 9. **Comparison of Measured and Modeled (River Mile Regression) Water Temperature on the Lower American River at river mile 13.6 (William B Pond Park) (2001-2018): 2001-2009 (top), and 2010-2018 (bottom).**

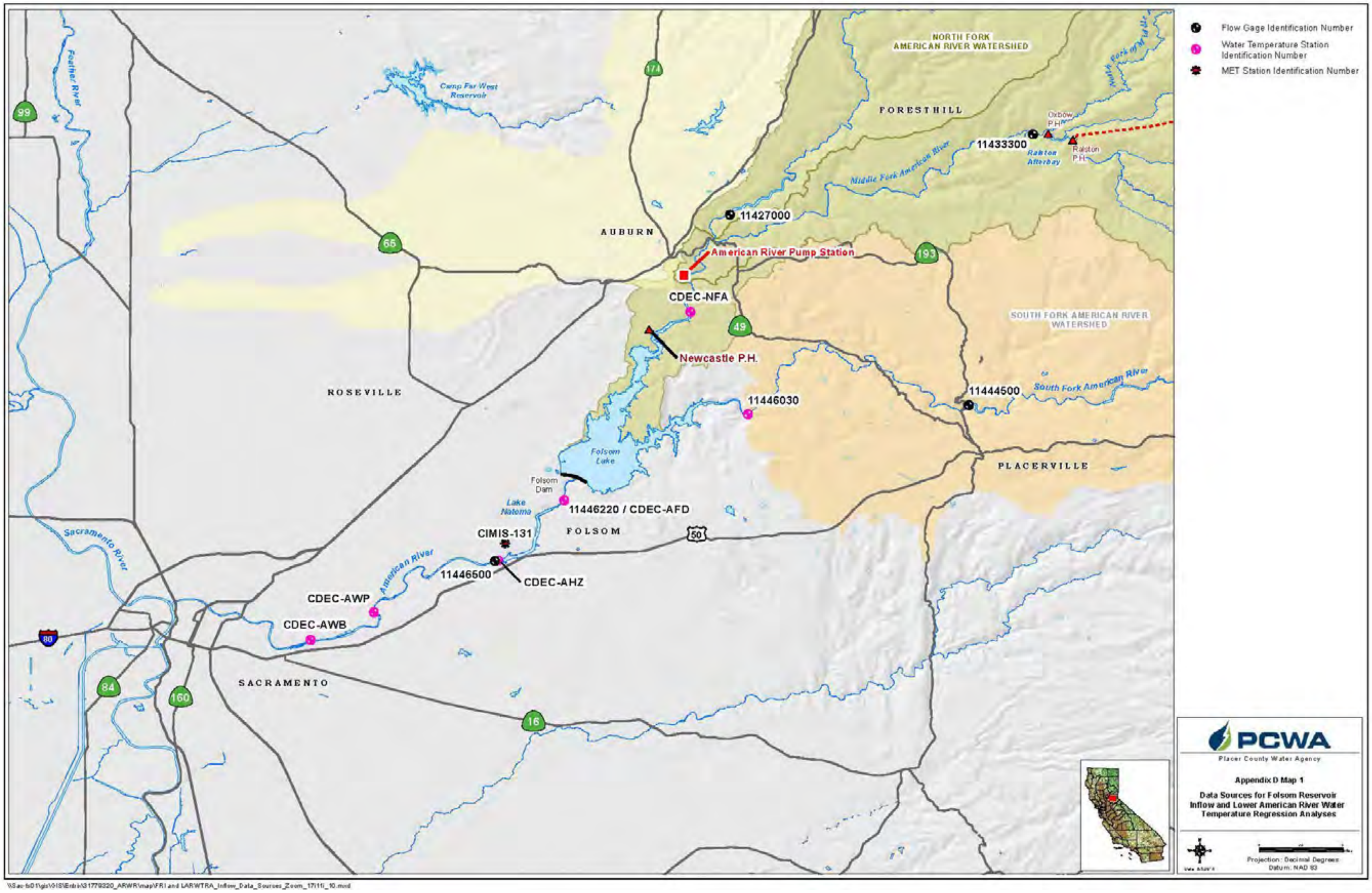




Appendix G5 Figure 10. **Comparison of Measured and Modeled (River Mile Regression) Water Temperature on the Lower American River at river mile 9.2 (Watt Avenue) (2001-2018): 2001-2009 (top), and 2010-2018 (bottom).**

APPENDIX G5

MAP



Appendix G5 Map 1. **Data Source Locations**

Attachment G (b)

2022 CEQUAL W2 Supplement

May 20, 2022

Ben Barker
Placer County Water Agency
Energy Marketing Manager
(530) 863-8342
Email: bbarker@pcwa.net

Mr. Barker,

Attached below is a CE-QUAL-W2 temperature model run of Reclamation's May forecasted operations for Folsom Reservoir and the lower American River (Figure 1). The model result was provided to the American River Group for development of the May water temperature management plan (May 19, 2022). The model run shows that an achievable summer target water temperature at Hazel Avenue is 66°F (using 2014 meteorological data). We have also ran PCWA's proposed 20 TAF water transfer (July 15th through September 30th; 140 cfs additional daily Folsom Reservoir inflow and outflow). Figure 1 shows that the transfer has a neutral or slightly beneficial effect on water temperature. This is the typical effect we have observed for a transfer that enters and exits the reservoir simultaneously.

If you have any questions, please contact us.

Thank you,

R. Craig Addley, (435) 881-1835, craig.addley@cardno.com
Vanessa Martinez, (503) 380-4573, vanessa.martinez@cardno.com

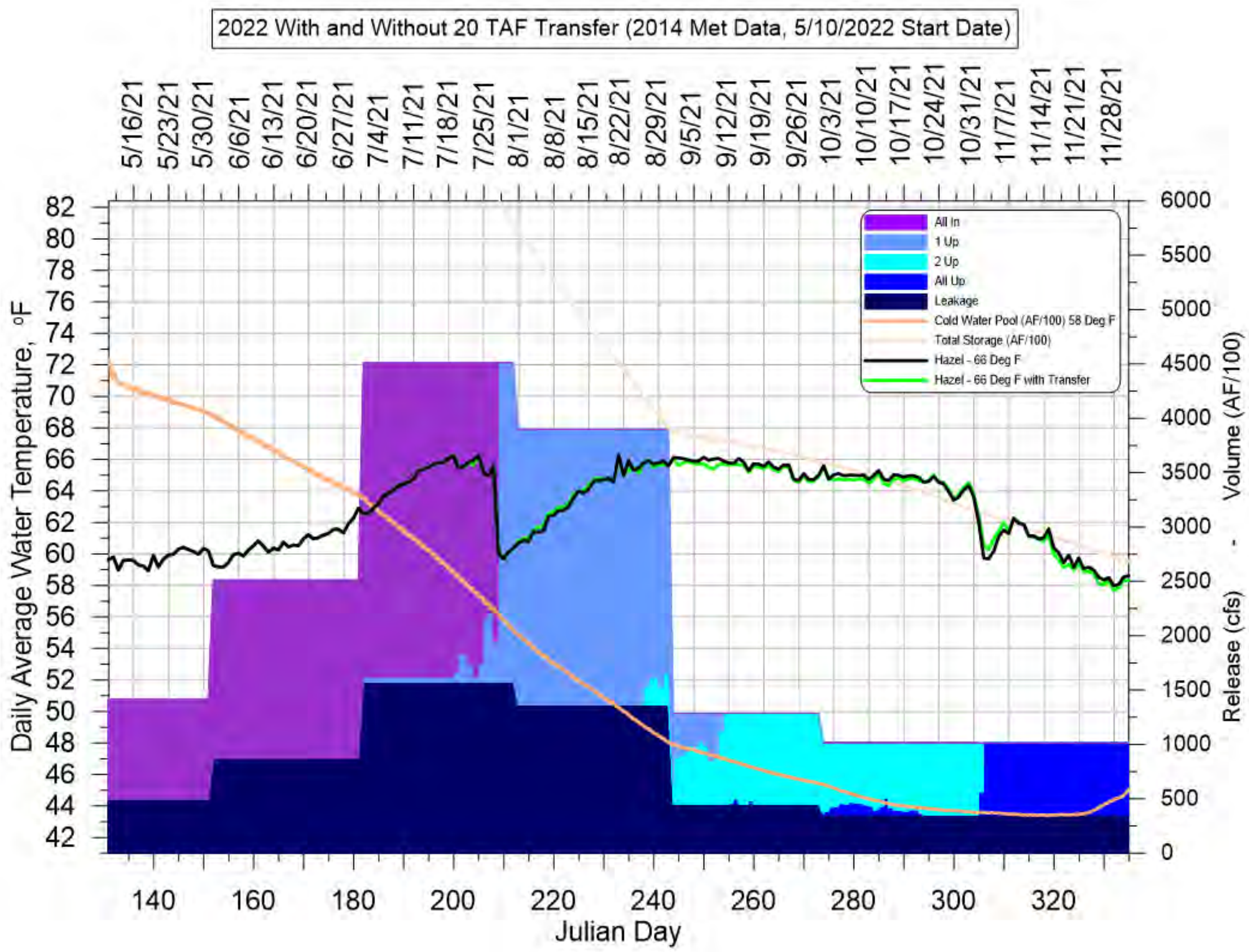


Figure 1. Base CE-QUAL-W2 model run for Reclamation's May forecasted operations using 2014 Meteorology (Hazel – 66 Deg F; black solid line) and PCWA water transfer (Hazel – 66 Deg F; light green solid line).