RECLAMATION

Managing Water in the West

FINDING OF NO SIGNIFICANT IMPACT

Title

FONSI-15-07-CCAO

Recommended by: Date: 7/23/15

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INTRODUCTION

The proposed Warren Act (WA) contract between Reclamation and the East Bay Municipal Utility District (EBMUD) will be for the storage and conveyance of up to 12,000 acre-feet (AF) of non-Project (water not developed as part of the Central Valley Project) water supplied by the Placer County Water Agency (PCWA). PCWA will release 12,000 AF of water from their Middle Fork Project (MFP) reservoirs through the Central Valley Project (CVP) facilities at Folsom Reservoir, Lake Natoma and the Folsom South Canal.

PROPOSED ACTION

Under the proposed transfer, PCWA will release the 12,000 AF of stored MFP water between July and September of 2015 through their MFP hydroelectric facilities into the Middle Fork American River, then into the North Fork American River, and Folsom Reservoir.

The transfer water will be released from Folsom Reservoir into Lake Natoma, which is impounded by Nimbus Dam. The water would be released from Nimbus dam into the Lower American River and subsequently will flow into the Lower Sacramento River. The transfer water will be diverted from the Lower Sacramento River by EBMUD at the Freeport Regional Water Project (FRWP) intake facility, near the town of Freeport below the confluence of the American and Sacramento Rivers. After rediversion at the Freeport Intake, the water will be pumped eastward through the Freeport Regional Water Authority's Joint Pipeline and EBMUD Gerber Pipeline into the Folsom South Canal, where it crosses Grant Line Road. The water would then flow 12 miles southward along the Folsom South Canal where it will be diverted at EBMUDs Clay Pumping Plant and pumped into EBMUDs Folsom South Canal Connection facilities, ultimately entering the Mokelumne Aqueducts for conveyance to EBMUDs service area in the East Bay.

FINDINGS

The Bureau of Reclamation has determined that awarding a temporary 1-year Warren Act contract to EBMUD for storage and conveyance of 12,000 AF of non-Project will not significantly impact the quality of the human environment. This water will be stored and conveyed through federal facilities from PCWA to EBMUD and is not a major federal action that will significantly affect the quality of the human environment. Therefore, an Environmental Impact Statement (EIS) is not required and will not be prepared for this project, based on the fact that there will be no short-term or long-term adverse impacts on the human environment resulting from the Proposed Action.

This decision is based on a thorough review of the 2015 Temporary Warren Act Contract between The United States and East Bay Municipal Utility District Environmental Assessment (EA dated July 2015). This decision is in accordance with the National Environmental Policy Act (NEPA) of 1969, as amended, the Council on Environmental Quality's (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500-1508) and the Department of the Interior (DOI) regulations for implementation of NEPA (43 CFR Part 46).

Under this section is a short statement about our findings:

Indian Trust Assets (ITA's) – There are no known ITA's or treaty rights exercised by tribes, nor are there any reservations or trust lands located within or adjacent to the Proposed Action that will be affected. The Proposed Action does not have a potential to affect ITA.

Indian Sacred Sites - There are no identified Indian Sacred Sites within the action area and therefore this project will not inhibit use or access to any Indian Sacred Sites.

Global Climate Change – The Proposed Action will not emit greenhouse gases that would exceed the 25,000 metric ton/year threshold. Trends in climate change will not be affected, nor will climate change have an impact on implementation of the Proposed Action.

Environmental Justice - There will be no impact to any populations; therefore, there will be no adverse human health or environmental effects to minority or low-income populations.

Water Supply and Hydrology - There will be no adverse effects to water supply and hydrology, or injury to any legal user of water as a result of the Proposed Action. Because potential change in monthly storage in Folsom Reservoir will be small and in a positive direction (more storage) under the Proposed Action, water supply availability to CVP customers or other legal users of water will not decrease and there would be no harm to CVP customers.

The release of transfer water from Folsom Reservoir and Lake Natoma may increase the flow in the Lower American River by $\leq$155 cubic feet per second (cfs). Because no decrease in flow will occur under the Proposed Action, water supply availability to CVP customers or other legal users of water will not decrease and there will be no effects to CVP customers.

Flows on the Sacramento River below the confluence of the American River will increase by less than 2%, while flows above the confluence will remain unchanged. Water supply availability to CVP customers and other legal users of water would not decrease and there would be no harm to these customers.

Diversion of PCWA water at the FWRP Intake will be at flow rates between approximately 80-155 cfs (with an optimal average of 140 cfs). The maximum flow rate of EBMUDs diversion will not exceed 155 cfs, and remain well below the design and permitted capacity of 286 cfs. The operation of the FRWP Intake will have no adverse effects on water supply and hydrology as the facility will comply with all permitted flow rate and annual volume limits.

PCWA transfer water entering the Folsom South Canal, combined with flow traveling to the Cosumnes Power Plant would result in a canal flow rate of no more than 200 cfs, well below the canal capacity of 3,500 cfs. Therefore, conveyance of PCWA transfer water would have no adverse effect on the flow rate in the canal.

Water Quality – Because only a small increase (≤ 12,000 AF) in monthly storage would occur under the Proposed Action Alternative, there would be no adverse change in water quality in Folsom Reservoir. Operations of Lake Natoma may change slightly under the Proposed Action, and the increase in release from Folsom may provide slight improvements to the water quality by increasing the dilution of contaminants in Lake Natoma. The slight increase in flows may provide slightly better water quality in the Lower American River by increasing the dilution of contaminants; therefore, no adverse impacts will occur.

Water quality in the Sacramento is not expected to have a notable effect because the higher overall flows in the Sacramento River will dilute any potential benefits from higher American River flows.

The concentrations of some physical and chemical constituents in Sacramento River water are generally higher than in American River water that is presently in the canal. Consequently, there would be a change in the quality of water delivered to SMUD whenever water deliveries to EBMUD are occurring. In general, the blended Sacramento River water and American River water would be very low in all constituents and would not adversely affect existing beneficial uses or preclude the use of Folsom South Canal water for any other beneficial uses.

Biological Resources - Under the Proposed Action, changes in flows in the Action Area will be relatively small and result in only a minor change in overall stage. The flow changes under the Proposed Action are not of the magnitude to affect geomorphic processes or riparian recruitment, and the small changes in flow will not change environmental conditions for special status species.

Aquatic Resources – Potential impacts to fisheries and aquatic resources are identified in Appendix C of the Draft EA, while Appendix D of the EA provides a detailed analysis of changes in hydrology and water temperature in Folsom Reservoir and the Lower American River which was used to assess potential effects on aquatic species in those water bodies.

All water diverted into the FRWP intake passes through a fish screen designed to prevent impingement and entrainment of delta smelt and anadromous salmonids. Fish screen design criteria and guidelines are issued by the California Department of Fish and Wildlife (CDFW), the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS). Implementation of the Proposed Action Alternative will comply with existing biological opinions and regulatory requirements identified in Chapter 4 of the EA, and therefore will not result in any adverse impacts to fisheries or aquatic resources in the Action Area.

Cultural Resources - Under the Proposed Action, Reclamation will permit the re-diversion of non-Project water through federal facilities. There would be no modifications of water conveyance facilities and no activities that would result in ground disturbance. The Proposed Action will result in no historic properties being affected pursuant to 36 CFR Part 800.3(a)(1).

SUMMARY OF ENVIRONMENTAL IMPACTS

The expected environmental effects of the Proposed Action are described in Chapter 3 of the attached EA. The environmental analysis indicated that the Proposed Action meets the purpose and need described in the EA with negligible effects on the human environment.

ENVIRONMENTAL COMMITMENTS

Reclamation is obligated to ensure fulfillment of any environmental commitments prescribed to mitigate or eliminate impacts resulting from implementation of the Proposed Action.

The following commitments are assumed under the Proposed Action:

- All applicable federal and state regulations will be followed and remain consistent with the 2008 USFWS, 2009 NMFS biological opinions (BiOps) on the continued long-term operations of the CVP and State Water Project, and the 2004 USFWS, 2004 NMFS BiOps on the construction, operations and maintenance of the Freeport Regional Water Project.

- The Proposed Action of releasing 12,000 AF of PCWA transfer water into Folsom Reservoir will begin in late July and continue no later than September 2015 in order to achieve maximum cold water benefits to Folsom Reservoir.

- Transfer water will be released from Lake Natoma into the Lower American River beginning in late August/early September at a rate no greater than 155 cfs and cease by early November 2015.

- The maximum diversion rate at the Freeport intake will not exceed 155 cfs, EBMUDs maximum share of the Freeport facility.

- Reclamation will provide transfer water to EBMUD on a schedule that is mutually agreeable and/or beneficial to Reclamation, EBMUD and the environment.

RECLAMATION

Managing Water in the West

Temporary Warren Act Contract Between the United States and the East Bay Municipal Utility District

Central California Area Office, Folsom, CA

Environmental Assessment (EA)

U.S. Department of the Interior
Bureau of Reclamation
Mid-Pacific Region
Central California Area Office
Folsom, California

July 2015

Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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List of Acronyms and Abbreviations

AF	acre-feet
BA	Biological Assessment
Bay-Delta	San Francisco Bay/Sacramento-San Joaquin Delta
BiOp	Biological Opinion
CALFED	CALFED Bay-Delta Program
CDFW	California Department of Fish and Wildlife, formerly California Department of Fish and Game
cfs	cubic feet per second
Corps	U.S. Army Corps of Engineers
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
D-1641	State Water Resources Control Board Decision 1641
Delta	Sacramento-San Joaquin Delta
DWR	Department of Water Resources
EA	Environmental Assessment
EBMUD	East Bay Municipal Utility District
EDWPA	El Dorado Water and Power Authority
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ERPP	Ecosystem Restoration Program Plan
ESA	Federal Endangered Species Act of 1973, as amended
ESU	Evolutionarily Significant Unit
FERC	Federal Energy Regulatory Commission
Freeport	Freeport Regional Water Project
FRWA	Freeport Regional Water Authority
ITA	Indian Trust Asset
M&I	municipal and industrial
MGD	million gallons per day
MFP	Middle Fork American River Project
MOU	memorandum of understanding
NMFS	National Marine Fisheries Service
PCWA	Placer County Water Agency
Reclamation	U.S. Bureau of Reclamation
RM	River Mile

SCWA	Sacramento County Water Agency
SMUD	Sacramento Municipal Utility District
SWP	State Water Project
State Water Board	State Water Resources Control Board
TDS	total dissolved solids
TOC	total organic carbon
TSS	total suspended solids
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Society
WAC	Warren Act Contract
WFA	Water Forum Agreement

Section 1 – Introduction

1.1 Background

The United States Bureau of Reclamation (Reclamation) is proposing a one-year temporary Warren Act contract (WAC)[1] with the East Bay Municipal Utility District (EBMUD) for the storage and conveyance of up to 12,000 acre-feet (AF) of non-Project water through Folsom Reservoir and Folsom South Canal. The temporary WAC is necessary to support a temporary water transfer between EBMUD and Placer County Water Agency (PCWA) in 2015. This Environmental Assessment (EA) was developed to support Reclamation's decision to issue a temporary WAC.

EBMUD, a public utility, was formed under the Municipal Utility District Act, passed by the California Legislature in 1921. EBMUD supplies water to 1.34 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 (Figure 1). 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 supplements its water supplies with water from the Central Valley Project (CVP) under its long-term renewal contract (No. 14-06-200-5183 A-LTR1), and transfers from willing sellers, using the recently completed Freeport Regional Water Project (Freeport) Facility with an intake located on the Sacramento River.

In 2012, EBMUD adopted the Water Supply Management Program 2040 Plan (WSMP 2040) that identifies solutions to meet EBMUD's long-term, dry-year needs. In addition to aggressive water conservation and recycling programs, the WSMP 2040 recommends securing dry-year water through voluntary water transfers to augment supplemental water available under EBMUD's CVP contract.

In August 2013, EBMUD and PCWA executed a memorandum of understanding (MOU) to develop a long-term transfer agreement under which EBMUD would purchase dry-year water (non-Project water) from PCWA. The source of non-Project water for the transfer is PCWA's Middle Fork American River Project (MFP). PCWA holds rights for the transfer water under Water Right Permits

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[1] The Warren Act (43 U.S.C. §523) of 1911 provides authorization to the Secretary of the Interior to enter into WACs with water purveyors to carry non-Project water (i.e., water not developed as part of the CVP) through Federal facilities.

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 20, 1963 (State Water Rights Board Decision D-1104). The MOU provides EBMUD with a right of first refusal to purchase water available on a short-term, one-year basis in the interim period prior to execution of the long-term transfer agreement.

On February 11, 2014, EBMUD's Board of Directors adopted a preliminary dry-year response plan to respond to 2014 drought conditions. The preliminary dry-year response plan asks customers to voluntarily cut back their current water use by 10%. In addition, the preliminary dry-year response plan identifies the need for EBMUD to be prepared to purchase supplemental water supplies that can be delivered through the Freeport Facility if dry-year conditions continue and Mokelumne storage drops below levels required to reliably meet customer demands.

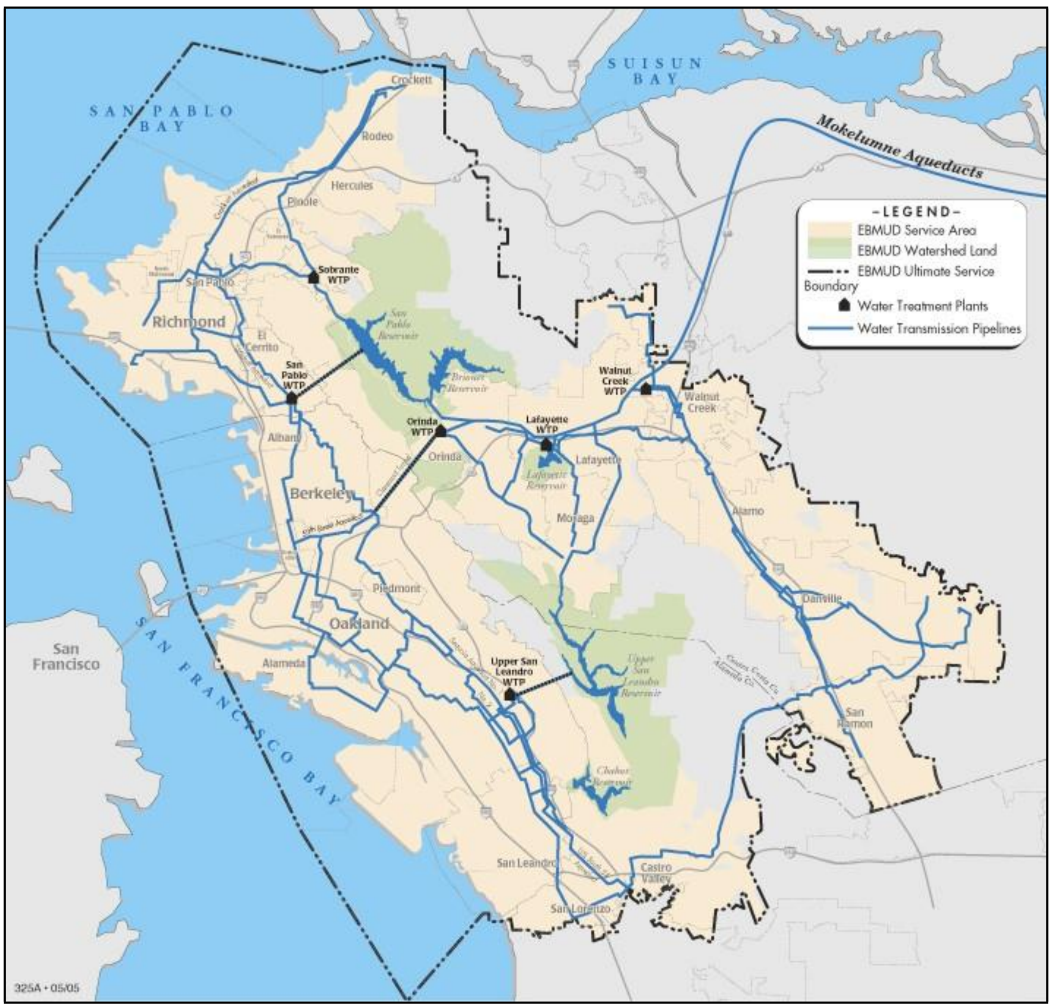

Figure 1. EBMUDs Service Area

In spring 2014, EBMUD and PCWA implemented a one-year transfer and received approval of a temporary WAC contract for conveyance only (less than 30 days storage) of 5,000 AF of transfer water from PCWA through Folsom Reservoir and Folsom South Canal. The 2014 transfer provided water for fish screen testing at the Freeport Intake and ultimately was delivered to meet the dry-year needs of EBMUD's customers.

The proposed long-term transfer agreement and temporary short-term transfers (such as implemented in 2014 and proposed in 2015) between EBMUD and PCWA are consistent with PCWA's long-standing Water Forum Agreement (WFA) commitment to release additional water from MFP storage in dry 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 American rivers. Under the long-term partnership envisioned by EBMUD and PCWA, EBMUD would become the buyer of PCWA's additional releases, thereby providing certainty that PCWA's environmental releases will continue in the future.

1.2 Project Description

EBMUD is proposing a one-year temporary WAC with Reclamation for the storage and conveyance of up to 12,000 AF of non-Project water through Folsom Reservoir and Folsom South Canal. The temporary WAC is necessary to support a short-term water transfer between EBMUD and PCWA in 2015. Under the proposed water transfer, PCWA would release up to 12,000 AF of additional water from its MFP storage into Folsom Reservoir. This transfer water is additional water that would not otherwise be released by PCWA were it not for the proposed water transfer.

The transfer water would be released by PCWA into Folsom Reservoir (July through September); temporarily stored in Folsom Reservoir (July through November); and released by Reclamation (late-August through November). Water released from Folsom Reservoir for rediversion by EBMUD at the Freeport Intake on the Sacramento River will likely be on top, but could be released as a part, of Reclamation's forecasted operations.

After diversion at the Freeport Intake, the transfer water would be conveyed through the lower reach of the Folsom South Canal, EBMUD's Folsom South Canal Connection Pipeline, and EBMUD's Mokelumne Aqueducts to EBMUD's service area. The exact timing of temporary storage and conveyance of non-Project water through Folsom Reservoir and Folsom South Canal will be developed in consultation with Reclamation. The transfer water would be used to meet PCWA's dry-year environmental release commitments in the WFA and to augment EBMUD's water supply for use by municipal and industrial (M&I) customers within EBMUD's service area. Figure 2 shows the proposed routing and facilities that would be used to convey PCWA transfer water to EBMUD. In addition, PCWA will enter into a refill agreement with Reclamation to ensure the transfer does not injure Reclamation or any downstream user.

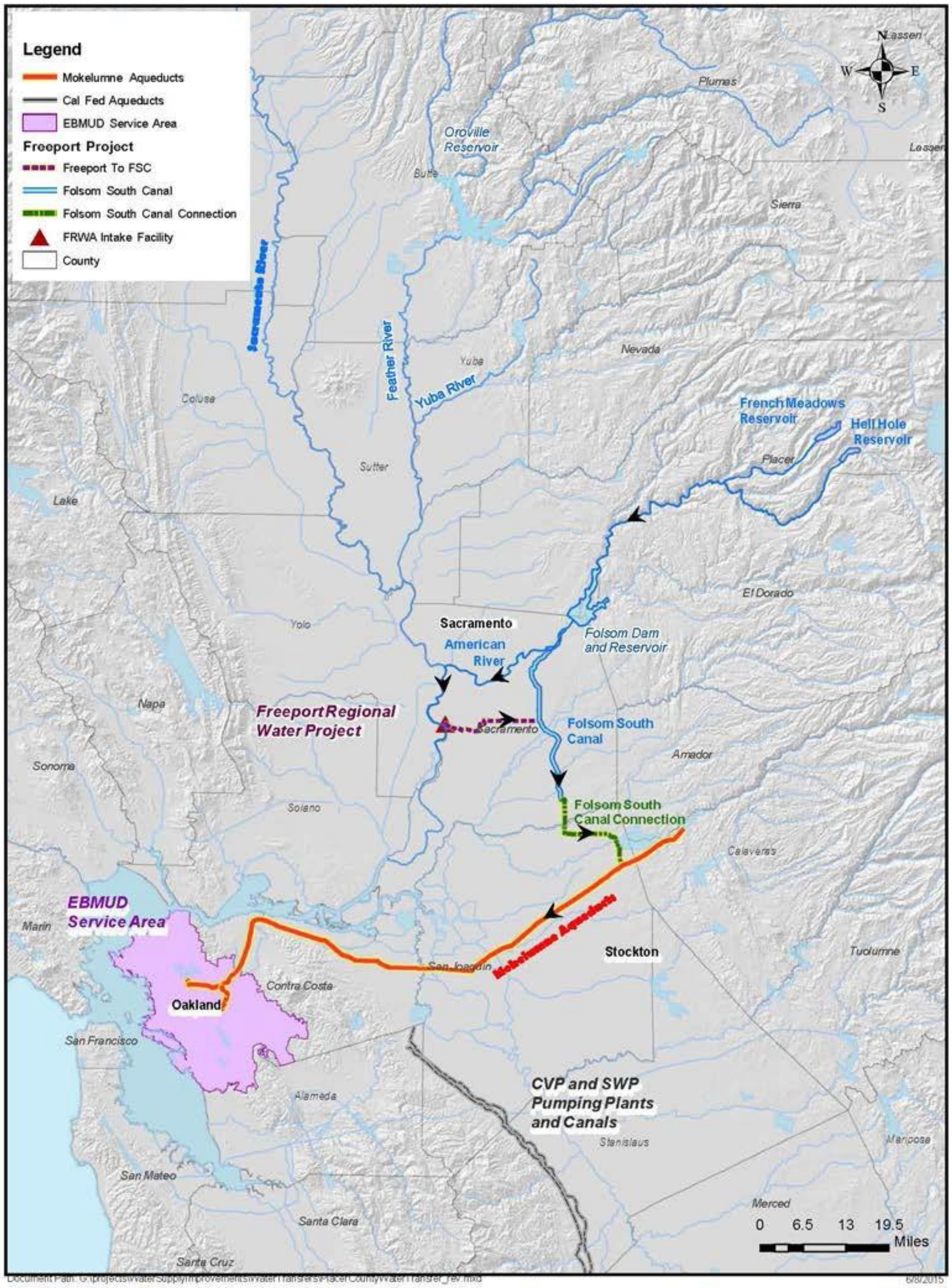

Figure 2. Major Facilities Used to Convey Transfer Water from PCWA to EBMUD

1.3 Purpose and Need

California is now in its fourth year of drought and the dry conditions are so extreme that water years 2012-2014 now rank as the driest consecutive three-year period on record in terms of statewide precipitation. The continuing drought has severely affected EBMUD's water supply with January 2015 constituting the driest January on record and March 2015 constituting the second driest March on record in the Mokelumne River Basin. Given these conditions, on April 14, 2015, EBMUD's Board of Directors declared a continuing water shortage emergency within EBMUD's service area, declared a Stage 4 critical drought (EBMUD's highest level), adopted a mandatory District-wide water use reduction goal of 20%, declared the need to use the Freeport Facility to deliver supplemental supplies to EBMUD's service area, and increased mandatory restrictions on potable water use. Due to the unexpectedly low and virtually unprecedented 2015 allocation to EBMUD of just 25%, or 33,250 AF, of the water to which it is entitled under its CVP contract and uncertainty regarding 2016 water supply conditions, EBMUD is pursuing water transfers in order to prevent or mitigate its existing water supply emergency and ensure its continued ability to provide essential public services. The proposed 2015 temporary water transfer of 12,000 AF evaluated in this document is necessary for EBMUD to provide essential public services.

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Section 2 - Alternatives Including the Proposed Action

This EA considers two possible actions: the No Action Alternative and the Proposed Action. The No Action Alternative reflects future conditions without the Proposed Action and serves as a basis of comparison for determining potential effects to the environment.

2.1 No Action Alternative

Under the No Action Alternative, Reclamation would not enter into a one-year WAC with EBMUD and the transfer from PCWA to EBMUD would not occur. Therefore, EBMUD would not receive up to 12,000 AF of PCWA transfer water. As a result, EBMUD would not be able to mitigate its existing water supply emergency due to extenuating drought conditions and its ability to provide essential public services would be jeopardized. In addition, without the proposed transfer, the increases in instream flow releases in the Middle Fork and North Fork American rivers, Lower American River, and Lower Sacramento River and the increases in Folsom Reservoir water storage/elevation or available coldwater volume resulting from the transfer would not occur.

2.2 Proposed Action Alternative

Under the Proposed Action Alternative, Reclamation would enter into a one-year WAC allowing for the storage and conveyance of up to 12,000 AF of non-Project water from PCWA to EBMUD through Federal facilities. The Federal facilities involved in the storage and conveyance of water include Folsom Reservoir and the Folsom South Canal (Figure 2).

Under the Proposed Action Alternative, PCWA would release an additional 12,000 AF of stored MFP water between July and September of 2015 through MFP hydroelectric facilities into the Middle Fork American River, then into the North Fork American River, and Folsom Reservoir (Figure 3). The 12,000 AF of water proposed to be released for transfer to EBMUD is currently in MFP storage (Hell Hole and French Meadows reservoirs) and would not otherwise be released absent this transfer. Rather, the transfer water held in storage in PCWA's reservoirs would be used to meet PCWA's normal operating carry over target. Reclamation agrees that the release of transfer water from MFP storage is non-Project water that otherwise would not be available to EBMUD. In order to refill MFP reservoirs, without injury to downstream vested water right holders following the transfer, PCWA will enter into a refill agreement with Reclamation, similar to refill agreements that PCWA and Reclamation have entered into on previously completed PCWA transfers.

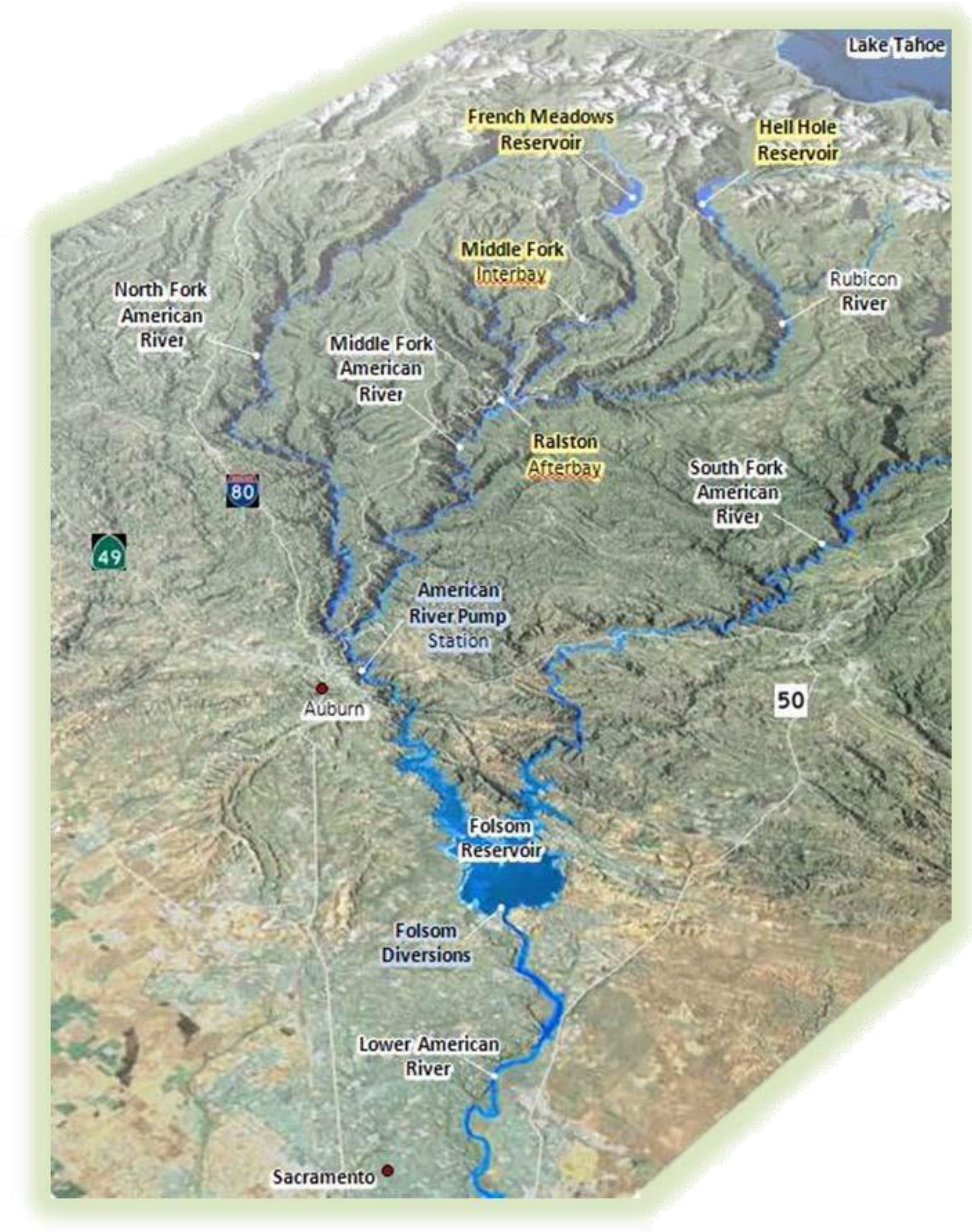

Figure 3. PCWAs Middle Fork American River Project and Other Downstream Facilities

2.2.1 Project Operations

The transfer water would be temporarily stored in Folsom Reservoir pursuant to a WAC between EBMUD and Reclamation. A carriage loss of 5% is assumed through Folsom Reservoir providing 11,400 AF of transfer water to EBMUD for re-diversion at the Freeport Intake. Reclamation would provide the transfer water to EBMUD on a schedule that is mutually agreeable and/or beneficial to Reclamation, EBMUD, and the environment.

Two options for release of transfer water are considered in this document:

- Option 1 (primary): Late August through no later than early November up to 155 cubic feet per second (cfs) of water is released from Folsom Reservoir into the Lower American River on top of (in addition to) Reclamation's forecasted operation releases of water from Folsom Reservoir (total release of 11,400 AF).

- Option 2 (secondary): A total of 11,400 AF of water is transferred to EBMUD as part of Reclamation's forecasted operational releases, effectively increasing the end-of-September storage in Folsom Reservoir by up to 12,000 AF.

However, the transfer schedule could include a combination of these two options.

The volume of transfer water released from the MFP would be balanced with transfer water releases from Folsom Reservoir to ensure that transfer water is deposited into Folsom Reservoir before it is released to the Lower American River. The transfer water would be released from Folsom Reservoir into Lake Natoma, which is impounded by Nimbus Dam. Lake Natoma serves as the re-regulating afterbay for Folsom Reservoir. The water would be released from Nimbus Dam into the Lower American River at a flow rate of ≤155 cfs, and subsequently would flow into the Lower Sacramento River.

The transfer water would be diverted from the Sacramento River by EBMUD at the Freeport Intake (located at River Mile [RM] 47.5) at a flow rate of approximately 140 cfs (range of 80 to 155 cfs) (Figure 4). The maximum flow rate would not exceed 155 cfs, EBMUD's maximum share of Freeport Facility capacity. EBMUD anticipates completing diversion of the 11,400 AF of transfer water in approximately 6-7 weeks.

After rediversion at the Freeport Intake, the water would be pumped eastward through the Freeport Regional Water Authority's (FRWA) Joint Pipeline and EBMUD's Gerber Pipeline into the Folsom South Canal where it crosses Grant Line Road (Canal Mile 12.4). The water would then flow 12 miles southward along the Folsom South Canal. Near the terminus of the canal the water would be diverted by EBMUD's Clay Station Pumping Plant and pumped into EBMUD's Folsom South Canal Connection facilities, ultimately entering the Mokelumne Aqueducts for conveyance to EBMUD's service area in the East Bay. All transfer water would be directed to two of EBMUD's terminal reservoirs: San Pablo Reservoir and Upper San Leandro Reservoir. The water would be treated at EBMUD's conventional treatment plants: Sobrante Water Treatment Plant and Upper San Leandro Water Treatment Plant before entering EBMUD's treated water distribution system.

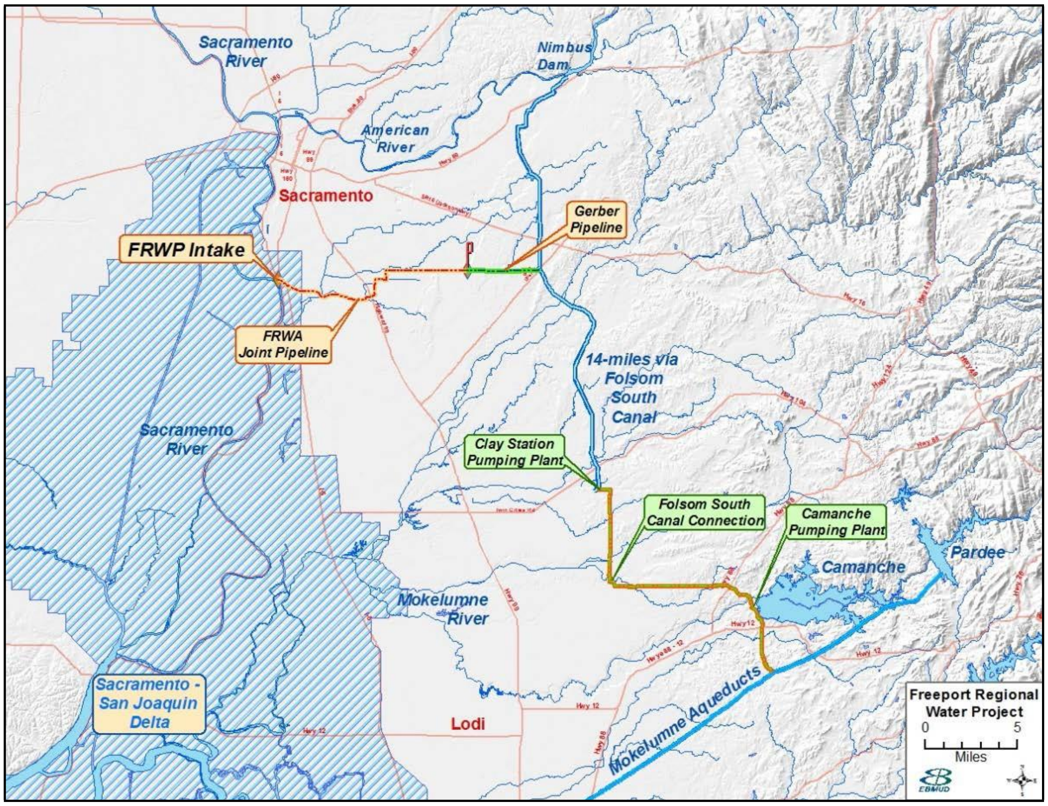

Figure 4. Map of the Freeport Regional Water Project

The Proposed Action Alternative would not involve construction or modification of any facilities. Only existing facilities would be utilized to divert and redivert water. Land uses within the PCWA and EBMUD service areas would not change as a result of the transfer.

The Proposed Action Alternative can only occur after the State Water Board approves of PCWA's Petition for Change for a temporary change to temporarily add the Freeport Intake as a point of rediversion and EBMUD's service area as a place of use to PCWA's water right permits.

Section 3 – Affected Environment and Environmental Consequences

This section describes the affected environment and the environmental consequences involved with implementation of the Proposed Action, in addition to environmental trends and conditions that currently exist. The Action Area includes reservoirs (French Meadows Reservoir, Hell Hole Reservoir, Middle Fork Interbay, Ralston Afterbay, Folsom Reservoir and Lake Natoma); and rivers (Middle and North Fork American rivers, Lower American River and Sacramento River). The Proposed Action Alternative does not affect flows downstream of Freeport Intake. Sacramento-San Joaquin Delta (Delta) inflows, outflows, and water supply availability (exports) to CVP contractors are unchanged. Therefore, affects to the Delta and exports are not further analyzed in this document.

This EA does not analyze resources for which it would be reasonable to assume that no adverse impacts would occur from implementation of the Proposed Action. Reclamation considered and determined that the Proposed Action would not adversely impact the following resources:

Land Use: The Proposed Action Alternative does not include any changes to land uses nor does it conflict with any existing land use plans or policies. Therefore, the Proposed Action Alternative does not have the potential to affect land use.

Cultural Resources: The Proposed Action Alternative involves the rediversion of water through existing Federal facilities. There would be no modification of water conveyance facilities and no activities that would result in ground disturbance. This action is administrative in nature and has no potential to affect historic properties pursuant to the regulations at 36 CFR Part 800.3(a)(1). Therefore, no cultural resources will be affected as a result of implementing the Proposed Action Alternative (Appendix A).

Indian Sacred Sites: Sacred sites are defined in Executive Order 13007 (May 24, 1996) as “any specific, discrete narrowly delineated location on Federal land that is identified by an Indian tribe, or Indian individual determined to be on appropriately authoritative representative of an Indian religion, as sacred by virtue of its established religious significance to, or ceremonial use by, an Indian religion; provided that the tribe or appropriately authoritative representative of an Indian religion has informed the agency of the existence of such a site.” Since no modification of the existing State and Federal facilities is necessary and use of these facilities will remain within existing capacity, no Indian sacred sites will be infringed. The Proposed Action Alternative will not result in any ground disturbance, and therefore, would have no effect on Indian sacred sites.

Indian Trust Assets: Indian Trust Assets (ITAs) are legal interest in property or rights held in trust by the United States for Indian Tribes or individual Indians. Indian reservations, Rancherias, and Public Domain Allotments are common

ITAs in California. The Proposed Action Alternative involves the transfer or water through existing facilities and will not result in changes to any legal interest in property or rights held in trust by the United States for Indian Tribes or individual Indians. Therefore, the Proposed Action Alternative does not have the potential to affect Indian Trust Assets (Appendix B).

Environmental Justice: The Proposed Action Alternative would not have any impact on minority or low-income populations within the Action Area relative to the No Action Alternative. The Proposed Action Alternative will help maintain essential public services for low-income populations.

Socioeconomics: The Proposed Action Alternative involves the transfer of water to supplement supplies to existing customers that have been substantially cut as a result of the long-term drought in California. The proposed transfer helps mitigate unprecedented reductions in EBMUD's existing water supply, thereby facilitating maintenance of essential public services. Therefore, the Proposed Action Alternative does not have the potential to result in economic or social effects related to the natural or physical environment.

Air Quality: The Proposed Action Alternative does not include construction of new facilities. Air quality emissions would not change as a result of implementation of the Proposed Action Alternative nor would it result in an exceedance of any existing air quality standards. Therefore, the Proposed Action Alternative does not have the potential to affect air quality.

Global Climate Change: The Proposed Action Alternative would not emit greenhouse gases that would exceed the 25,000 metric ton/year threshold. Trends in climate change would not be affected. In addition, climate change would not have an impact on implementation of the Proposed Action Alternative Hydrology-Water Supply.

3.1 Hydrology & Water Supply

3.1.1 Affected Environment

French Meadows and Hell Hole Reservoirs

Construction of French Meadows and Hell Hole reservoirs was completed in 1966 and 1965, respectively. Maximum storage capacity is about 135,000 AF in French Meadows Reservoir and 208,000 AF in Hell Hole Reservoir. French Meadows Reservoir is located in the upper Middle Fork American River watershed, about 16 miles west of Lake Tahoe. Hell Hole Reservoir is located about three miles southeast of French Meadows Reservoir on the Rubicon River. Water is released from these storage reservoirs downstream to a re-regulating reservoir, Ralston Afterbay, to maximize hydropower generation, provide recreational boating opportunities, and meet an minimum instream flow requirement of 75 cfs at two locations: (1) downstream of the confluence of the Middle Fork American River and the North Fork of Middle Fork American River and (2) downstream of the American River Pump Station.

Middle Fork and North Fork American Rivers

The American River is a major tributary to the Lower Sacramento River. The Middle Fork American River watershed extends westward to the confluence with the North Fork American River, east of Auburn (elevation 650 feet). The average annual yield for the Middle Fork American River for the period of 1959 through 1991 was 805,000 AF. The Rubicon River is the main tributary to the Middle Fork American River. The main reservoirs in the Middle Fork watershed are French Meadows, Hell Hole, Rubicon, Loon Lake, Gerle Creek, and Stumpy Meadows Lake. PCWA and Sacramento Municipal Utility District (SMUD) operate most of the reservoirs in the Middle Fork American River Watershed.

The Middle Fork joins the North Fork American River before flowing into Folsom Reservoir. Downstream of its confluence with the Middle Fork American River, the North Fork American River flows are a combination of regulated and unregulated flows. Flows in the North Fork below its confluence with the Middle Fork are directly affected by fluctuations in Ralston Afterbay releases, but are attenuated by the unregulated flows from the North Fork, which exhibit less diurnal fluctuation.

The North Fork American River is altered by the run-of-the-river North Fork Dam at Lake Clementine, upstream of its confluence with the Middle Fork American River. No water diversion occurs at Lake Clementine. Average annual runoff in the North Fork American River from 1942 through 1992 was 594,000 AF. North Fork American River flows have been estimated based upon USGS gage measurements (No. 11427000) at the dam.

Folsom Reservoir and Dam

Folsom Reservoir is the principal reservoir on the American River, with a maximum storage capacity of 977,000 AF. Reclamation operates Folsom Dam and Reservoir for the purposes of flood control, meeting water contract water right obligations, providing downstream releases for the Lower American River and helping to meet Delta water quality standards. The El Dorado Irrigation District, City of Roseville, San Juan Water District, Sacramento Suburban Water District, California State Prison, and the City of Folsom are the main entities that divert water from Folsom Reservoir.

Lake Natoma and Nimbus Dam

Lake Natoma serves as the Folsom Dam afterbay and was formed as a result of Nimbus Dam. Lake Natoma has a maximum storage capacity of 9,000 AF, and inundates approximately 500 acres. Lake Natoma is operated as a re-regulating reservoir that accommodates the diurnal flow fluctuations caused by the power peaking operations at Folsom Power Plant. Nimbus Dam, along with Folsom Dam, regulates water releases to the Lower American River.

Nimbus Dam releases are nearly always controlled during significant portions of a water year by either flood control requirements; fishery requirements under Central Valley Project Improvement Act (CVPIA) 3406(b)(2); requirements included in U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) biological opinions (BiOps) issued for coordinated operations of the CVP/State Water Project (SWP); or through coordination with other CVP and SWP releases to meet downstream State Water Board Decision 1641 requirements in the Delta and CVP water supply objectives (Reclamation 2004).

Lower American River

The Lower American River consists of the 23-mile stretch of river from Nimbus Dam to the confluence of the American and Sacramento rivers in the City of Sacramento. Average Lower American River annual flows downstream of Folsom Dam at Fair Oaks are approximately 2,650,000 AF (Reclamation 2004).

Sacramento River

The Sacramento River originates near the slopes of Mount Shasta and flows southward to Suisun Bay. Sacramento River flows are controlled primarily by Reclamation's Shasta Dam. Flows in the Sacramento River normally peak during December through February. The drainage area upstream of Sacramento is 23,502 square miles. The historical average annual flow for the Sacramento River at Freeport is 16,677,000 AF. The Feather and American rivers are the two largest contributors to the Sacramento River. The Lower Sacramento River is defined as that section of the river downstream of its confluence with the Lower American River.

Freeport Facility

The Freeport Facility, completed in partnership with Sacramento County Water Agency (SCWA) in 2011, is used to divert transfer water from the Sacramento River and transport it to EBMUD's Mokelumne Aqueducts in San Joaquin County. The Freeport Facility consists of an intake, pipelines, a canal and pumping plants, shown in Figure 4. The Freeport Intake is located on the Sacramento River, at the southern boundary of the City of Sacramento, near the town of Freeport. This location is within the legal boundary of the Sacramento-San Joaquin Delta since the river there is under tidal influence. The intake, used to pump water from the Sacramento River to the Folsom South Canal, has a capacity of 185 million gallons per day (MGD) (286 cfs). EBMUD's allocated share of that capacity is 100 MGD (155 cfs), and SCWA is allocated the remaining 85 MGD (131 cfs) of capacity. The Freeport Facility also includes two nearly identical pumping plants and a pipeline that convey Freeport water from the Folsom South Canal near it's terminus to the Mokelumne Aqueducts. This segment of the project has a capacity of 100 MGD (155 cfs).

Folsom South Canal

The Folsom South Canal originates at Nimbus Dam, on the American River, in Sacramento County, and extends 26.7 miles southward. As originally planned, the canal was to continue another 42 miles, but there are no current plans to lengthen the existing canal. The design capacity of the canal is 3,500 cfs. During most years there are only two regular users of the canal: American States Water Company, which uses the canal to convey approximately 7 cfs for a short distance downstream of the canal inlet; and SMUD, which uses the canal to transport approximately 20 cfs from Nimbus Dam to the diversion for SMUD's Cosumnes Power Plant at Canal Mile 24.7. In accordance with its CVP contract, EBMUD may use the canal during dry years to convey its CVP water from Grant Line Rd. to its turnout near the terminus of the canal.

3.1.2 Environmental Consequences

No Action

Under the No Action Alternative, the transfer would not occur, EBMUD would not receive the additional water supply, and increased instream flow and reservoir elevations would not occur (remain unchanged). Likewise, there would be no change to the volume of coldwater available in Folsom Reservoir. The Lower American River would receive no benefit from increased flows.

Proposed Action

The analysis of the potential effects on water resources associated with the Proposed Action Alternative was based on the following criteria:

- Changes in reservoir storage and river flows relative to the No Action Alternative of sufficient magnitude to affect the water supply availability to CVP and PCWA contractors.

French Meadows and Hell Hole Reservoir

Under the Proposed Action Alternative, storage at French Meadows and Hell Hole reservoirs would be reduced relative to the No Action Alternative by 12,000 AF. PCWA has identified combined carryover storage of 94,500 AF under the No Action Alternative. The Proposed Action Alternative would reduce the carryover storage to 82,500 AF.

No legal user of water would be injured because PCWA's transfer of water would only slightly increase, not decrease, streamflows below PCWA's MFP reservoirs. Any increase would be minor and would not cause any water flows to increase above normal seasonal levels, or to violate any regulatory requirements. The released water was stored by PCWA in accordance with its water rights and would not otherwise be available to any legal user of water. Additionally, PCWA would enter into a reservoir refill agreement with Reclamation, ensuring that future refill of any storage space in PCWA's MFP reservoirs created by the transfer would only be with water that PCWA would normally have been entitled to in accordance with its water rights and would not injure Reclamation or any downstream user.

The decrease in reservoir storage is equal to the water available for transfer. The volume of water made available under the Proposed Action Alternative is relatively small and does not affect PCWA's ability to meet contractual obligations, or its ability to meet existing customer demand in its service area.

Middle Fork American River below Oxbow Powerhouse and North Fork American River

Water in storage at Hell Hole and French Meadows reservoirs would be sufficient to meet all of PCWA's contractual obligations, including PCWA's own use, with the implementation of the Proposed Action Alternative. The transfer water would be used to supply EBMUD's M&I customers. Under the Proposed Action Alternative, additional on-peak generation would be produced in MFP powerhouses associated with the 12,000 AF of transfer water. The minimum and maximum flow rates for the day would remain the same as under the No Action Alternative, although the duration of the maximum flow would increase during the daily on-peak generation period. Flows in the North Fork American River below the confluence with the Middle Fork American River would be similarly affected, although to a lesser extent due to downstream attenuation of the temporal distribution of flow. Therefore, because water storage in Hell Hole and French Meadows reservoirs is sufficient to meet contractual obligations, and flows would not change substantially in the Middle Fork American River below Oxbow Powerhouse or in the North Fork American River, implementation of the Proposed Action Alternative would not adversely impact hydrology or water supply.

Folsom Reservoir

Under the Proposed Action Alternative, Folsom Reservoir monthly storage would potentially temporarily increase by 12,000 AF. The transfer water entering into Folsom Reservoir would be released by Reclamation into the Lower American River for subsequent rediversion by EBMUD at the Freeport Intake. Because potential change in monthly reservoir storage would be small and in a positive direction (more storage) under the Proposed Action Alternative, water supply availability for CVP customers would not be decreased and there would be no harm to CVP customers.

Lower American River

Under the Proposed Action Alternative, the release of transfer water may increase flow in the Lower American River by ≤155 cfs in late August through early November compared to flows expected under the No Action Alternative. Because no decrease in flow would occur under the Proposed Action Alternative, water supply availability to CVP customers or other legal users of water would not decrease and there would be no affect to CVP customers.

Sacramento River

Flows on the Lower Sacramento River between the confluence with the Lower American River and Freeport Intake would not change significantly under the Proposed Action Alternative. Sacramento River flow rates upstream of the

American River confluence in August and September of 2014 (similar drought year) averaged 8,300 cfs. Assuming flows are similar in 2015, the increase release of ≤155 cfs from the American River would increase flows below the confluence of the American and Sacramento rivers to the Freeport Intake by less than 2%. Sacramento River flow rates upstream of the confluence with the American River and downstream of the Freeport Intake would be unchanged. Water supply availability to CVP customers and other legal users of water would not decrease and there would be no harm to these customers.

Freeport Facility
Diversion of PCWA transfer water at the Freeport Intake would be at flow rates between approximately 80-140 cfs (optimal average of approximately 140 cfs). The maximum flow rate of EBMUD's diversion would not exceed 155 cfs. The total diversion rate at the Freeport Intake, including use of the facility by SCWA, would remain within its design capacity and permitted capacity of 286 cfs. The Incidental Take Permit (ITP) issued by CDFG for the Freeport Intake allows a maximum diversion rate of up to 286 cfs. The total volume diverted in Water Year 2015 would not exceed 147,000 AF, the maximum specified in the ITP for the facility. All PCWA transfer water would be conveyed to the East Bay and would increase the dry year supply to EBMUD customers. Diversion of PCWA transfer water at the Freeport Intake would have no adverse effect as the facility would comply with all permitted flow rate and annual volume limits.

Folsom South Canal
PCWA transfer water entering the Folsom South Canal, combined with flow traveling to the Cosumnes Power Plant would result in a canal flow rate of no more than 200 cfs, well below the canal capacity of 3,500 cfs. Therefore, conveyance of PCWA transfer water would have no adverse effect on the flow rate in the canal.

3.2 Water Quality

3.2.1 Affected Environment

French Meadows Reservoir
Due to its position high in the watershed, French Meadows Reservoir inflow mainly comes from natural granitic/forested watershed snowmelt and as a result the reservoir does not receive a high level of contaminants. Water quality in French Meadows Reservoir is generally considered to be good.

Hell Hole Reservoir
Hell Hole Reservoir, located within the El Dorado National Forest, receives flows from the Rubicon River, a tributary of the Middle Fork American River. Because it is high in the watershed, its inflow mainly comes from natural granitic/forest watershed snowmelt and as a result does not receive a high concentration of

contaminants. Water quality in Hell Hole Reservoir is generally considered to be good.

Middle Fork and North Fork American River

Water quality in the American River is considered to be good (PCWA 2011). Turbidity results indicate that the river carries relatively little sediment during low flows. Several wastewater sources discharge into the North and Middle Fork American rivers or to their tributaries. Sources of wastewater discharge include two sawmills located at Foresthill; one is on a tributary to Devil's Canyon and the North Fork American River, and the other discharges directly into the Middle Fork American River. Levels of pH have exceeded objectives in the Middle Fork American River. This exceedance is attributable to photosynthetic activity (Placer County 1994).

Water quality conditions in the Middle and North American rivers are considered to be high and conform with regulatory water quality objectives and standards (PCWA 2011). There is minimal urbanization within the reach that can be a source of water quality degradation. In addition, there are no active landfills or municipal wastewater systems permitted to discharge treated effluent into this reach. Historical mining activity has occurred but no water quality issues have been identified to date. PCWA conducted a comprehensive water quality and temperature monitoring program in 2007 in the Middle and North Fork American rivers (PCWA 2011). All constituents sampled met regulatory criteria or were with the expected ranges for the criteria that do not have established objectives. Turbidity measures were low (<0.6 NTU), indicating the river carries relatively little sediment or other suspended organic matter during low flows. Historic water quality data from the 1960's to 1980's collected by the United States Geological Survey (USGS), State Water Board, and Reclamation (USEPA 2007) from the Middle and North Fork American rivers indicate that generally all the constituents analyzed complied with current regulatory standards.

Folsom Reservoir/Lake Natoma

Water quality in Folsom Reservoir and Lake Natoma is generally acceptable for the beneficial uses currently defined for these waterbodies. Temperature, dissolved oxygen, conductivity, and toxic metals concentrations generally do not exceed recommended limits.

However, comments about taste and odor have occurred in municipal water supplies diverted from Folsom Reservoir, which were attributed to blue-green algae blooms that occasionally occur in the reservoir as a result of elevated water temperatures during late summer.

Lower American River

Water quality parameters for the Lower American River have typically been well within acceptable limits to achieve water quality objectives and beneficial uses identified for this waterbody (State Water Board 1998). Principal water quality parameters of concern for the river (i.e., pathogens, nutrients, total dissolved solids [TDS], total organic carbon [TOC], priority pollutants, and turbidity) are primarily affected by urban land use practices and associated runoff and stormwater discharges. TOC and TDS levels in the Lower American River are relatively low compared to Sacramento River and Delta and thus are generally not of substantial concern.

Heavy metal concentrations in the river are typically within the range of drinking water standards (City of Sacramento 1993). Comments on taste and odor can occur in water taken from the Lower American River, primarily during late summer. The problems are attributable to increased concentrations of an actinomyces microorganism, which is associated with elevated summer temperatures.

Sacramento River
Water originating from the Sacramento River drainages represents a significant component of the total CVP supply, which provides high-quality water to meet downstream urban and agricultural demands. The Sacramento River Watershed Program has identified mercury, organophosphate pesticides, toxicity, and drinking water parameters as chemicals of concern in the Sacramento River watershed, which includes the Sacramento and Feather rivers, and the Delta (Sacramento River Watershed Program 2001).

The Lower Sacramento River receives urban runoff, either directly or indirectly (through tributary inflow) from the cities of Sacramento, Roseville, Folsom, and their surrounding communities. The Natomas East Main Drainage Canal discharges to the American River immediately upstream of its confluence with the Sacramento River. This canal transfers both agricultural discharges and urban runoff into the Sacramento River.

Folsom South Canal
In wet and normal years, all water entering the Folsom South Canal comes from the American River, diverted from Lake Natoma, just upstream of Nimbus Dam. When EBMUD takes delivery of water diverted at the Freeport Intake to supplement its Mokelumne River supply, Sacramento River water is introduced into the canal at Grantline Road. This results in a blend of American River and Sacramento River water which travels southward along the canal to where it pumped out by SMUD and by EBMUD.

The quality of water in the American River at Lake Natoma and the Sacramento River at Freeport differ since the character of their watersheds are not the same. The American River drains a largely mountainous area with little human development. Consequently the concentration of most dissolved constituents is higher in Sacramento River water than in the American River water. Suspended solids concentration and turbidity are also greater in the Sacramento River.

3.2.2 Environmental Consequences

No Action

Under the No Action Alternative no additional flow from the MFP would be released that could contribute to the dilution of contaminates in the Middle and North Fork American rivers, Folsom and Natoma reservoirs, and the Lower American and Sacramento rivers.

Proposed Action

The analysis of potential changes in water quality associated with the proposed water transfer in the Action Area was based on the following criteria:

- Decrease in end-of-month reservoir storage under the Proposed Action Alternative of sufficient magnitude or duration relative to the No Action Alternative to result in an increase in the concentration of contaminants.

- Decrease in monthly mean river flow under the Proposed Action Alternative of sufficient magnitude or duration relative to the No Action Alternative to result in an increase in the concentration of contaminants.

French Meadows and Hell Hole Reservoir

Under the Proposed Action Alternative, combined storage at French Meadows and Hell Hole reservoirs would be reduced by 12,000 AF relative to the No Action Alternative. Due to their position high in the watershed with inflow mainly coming from snowmelt, the reservoirs do not receive a high level of contaminants, and water quality in French Meadows and Hell Hole reservoirs is generally considered to be good. Therefore, under the Proposed Action Alternative, no adverse water quality changes in French Meadows and Hell Hole reservoirs would occur.

Middle Fork and North Fork American Rivers

The Proposed Action Alternative would provide additional on-peak generation, so the minimum and maximum flow rates for the day would remain the same as under the No Action Alternative, although the duration of the maximum flow would increase during the daily on-peak generation period. The volume of flow in the Middle Fork and North Fork American rivers during the time of release would increase relative to the No Action Alternative. The higher flows would not result in an increase in the concentration of contaminants in the Middle Fork American River below Oxbow Powerhouse, or in the North Fork American River downstream of the confluence with the Middle Fork American River. No adverse changes to water quality would occur.

Folsom Reservoir/Lake Natoma

Because only a small increase (≤12,000 AF) in monthly reservoir storage would occur under the Proposed Action Alternative, there would be no adverse change in water quality in Folsom Reservoir. Moreover, the small potential increases in reservoir storage may provide a slight improvement to the water quality in Folsom

Reservoir by increasing the dilution of contaminants. Under the Proposed Action Alternative, operations of Lake Natoma would change only slightly relative to the No Action Alternative. During the transfer, slightly higher flows may be released from Folsom Reservoir during late August, and late October (≤155 cfs) that may provide a slight improvement in water quality by increasing the dilution of contaminants depending on the release option selected in consultation with Reclamation.

Lower American River below Nimbus Dam

Historically, water quality parameters for the Lower American River have typically been well within acceptable limits to achieve water quality objectives and beneficial uses identified for this waterbody (State Water Board 1998), and remain so today. Under the Proposed Action Alternative, there may be a small increase in flows along the Lower American River below Nimbus Dam in late August through late October (≤155 cfs. The increase in flows may provide slightly better water quality in the Lower American River by increasing the dilution of contaminants.

Sacramento River

Flows on the Lower Sacramento River between the confluence with the Lower American River and the Freeport Intake would not change significantly under the Proposed Action Alternative, (≤155 cfs). Sacramento River flow rates upstream of the confluence with the American River and downstream of the Freeport Intake would be unchanged. Although inflows from the American River provide a slightly better quality compared to the Sacramento River, the implementation of the Proposed Action Alternative is not expected to have a notable effect on water quality in the Sacramento River because the higher overall flows in the Sacramento River (e.g., 8,300 cfs in 2014) will dilute any potential benefits from higher American River flows (the additional flow from the water transfer in the American River represent less than 2% of projected Sacramento River flows during late August through November).

Folsom South Canal

When Sacramento River water is pumped into the canal, the blend downstream of the entry point is between 79 and 89 percent Sacramento River water. The concentrations of some physical and chemical constituents in Sacramento River water are generally higher than in American River water that is presently in the canal. Consequently, there would be a change in the quality of water delivered to SMUD whenever water deliveries to EBMUD are occurring.

In general, the blended Sacramento River water and American River water would be very low in all constituents and would not adversely affect existing beneficial uses or preclude the use of Folsom South Canal water for any other beneficial uses. Transport of suspended sediment into the canal in the form of total suspended solids (TSS) and turbidity could increase. A large majority of sediment that may be in the Sacramento River water would settle within the forebay at the Freeport Intake and within the canal. If fine sediment material remains in suspension and is transported to downstream users (i.e., SMUD), there are presently treatment facilities in place at SMUD's Cosumnes Power Plant to address this potential change in water quality. These facilities were designed by SMUD for Sacramento River flow into the Folsom South Canal at a rate of 155 cfs, EBMUD's allocated capacity at the Freeport Intake. Delivery of PCWA transfer water to EBMUD will never increase the flow rate into the canal above that design assumption. In accordance with an agreement with SMUD, the FRWA is to pay SMUD for incremental costs associated with operation of the treatment facilities. Therefore SMUD's use of water from the Folsom South Canal will not be impacted.

California or Federal water quality standards are not applicable to the Folsom South Canal because it is a constructed conveyance facility, not a natural water body.

For these reasons, addition of PCWA transfer water into the Folsom South Canal would not have an adverse effect on water quality in the canal.

3.3 Biological Resources

3.3.1 Affected Environment

Fisheries and Aquatic Resources

Species of primary management concern include those that are recreationally or commercially important (fall-run Chinook salmon [Oncorhynchus tshawytscha], steelhead [Oncorhynchus mykiss], American shad [Alosa sapidissima], and striped bass [Morone saxatilis]); Federal- and/or State-listed species within the Action Area (winter- and spring-run Chinook salmon, steelhead, delta smelt [Hypomesus transpacificus], and green sturgeon [Acipenser medirostris]); and State species of special concern (late fall-run Chinook salmon, green sturgeon, hardhead [Mylopharodon conocephalus], longfin smelt [Spirinchus thaleichthys], river lamprey [Lamptera ayresi], Sacramento perch [Archoplites interruptu], Sacramento splittail [Pogonichthys macrolepidotus], and California roach [Hesperoleucus symmetricus]).

Special emphasis is placed on these species of primary management concern to facilitate compliance with the State and Federal ESAs. This focus is consistent with: (1) CALFED's 2000 Ecosystem Restoration Program Plan and Multi-Species Conservation Strategy; (2) the programmatic determinations for the CALFED program, which include California Department of Fish and Wildlife's (CDFW) Natural Community Conservation Planning Act approval and the 2009 NMFS, 2008 USFWS BiOps; (4) the 2004 NMFS, 2004 USFWS BiOps on the Construction, Operations and Maintenance of the Freeport Regional Water Project; (4) USFWS's 1997 Draft Anadromous Fish Restoration Program, which identifies specific actions to protect anadromous salmonids; (5) CDFW's 1996 Steelhead Restoration and Management Plan for California, which identifies specific actions to protect steelhead; and (6) CDFW's Restoring Central Valley Streams, A Plan for Action (1993), which identifies specific actions to protect salmonids.

Terrestrial and Riparian Resources

This section describes the existing conditions of terrestrial and riparian resources and consists of identification of communities and associated special-status plant and wildlife species with the potential to occur in the Action Area.

French Meadows and Hell Hole Reservoirs

Steep slopes and well-drained substrates (or bedrock) constrain the occurrence of riparian vegetation around French Meadows and Hell Hole reservoirs, although thin bands, small patches, or individual shrubs or trees characteristic of riparian settings (e.g., Salix spp.) may occur. While the drawdown areas may support sparse riparian vegetation (i.e., small numbers of willow shrubs), they do not support significant riparian habitats (PCWA 2010a).

Upland habitats surrounding French Meadows Reservoir include mixed conifer-fir, interspersed with patches of upper montane mixed chaparral. Hell Hole Reservoir, which is lower and drier, is dominated by canyon live oak and black oak woodlands on its south-facing slopes. The north-facing slopes are dominated by mixed conifer-pine forests (PCWA 2010b).

Special-status plant species potentially occurring in the vicinity of French Meadows and Hell Hole reservoirs include common moonwort (Botrychium lunaria), Stebbins' phacelia (Phacelia stebbinsii), Webber's mousetail (Ivesia webberi), clustered lady's slipper (Cypripedium fasciculatum).

Special-status terrestrial wildlife species potentially occurring in the vicinity of French Meadows and Hell Hole reservoirs include yellow warbler (Setophaga petechia), California spotted owl (Strix occidentalis occidentalis), northern goshawk (Accipiter gentilis), bald eagle (Haliaeetus leucocephalus), willow flycatcher (Empidonax traillii), Townsend's bat (Corynorhinus townsendii), western red bat (Lasiurus blossevillii), mule deer (Odocoileus hemionus), American (Sierra) marten (Martes americana) and ringtail (Bassariscus astutus). There is a known bald eagle nest located adjacent to Hell Hole Reservoir (FERC 2012).

Middle Fork and North Fork American Rivers

The Middle Fork American River downstream of Ralston Afterbay/Oxbow Reservoir is characterized primarily by alder-willow-cottonwood communities. Riparian vegetation is distributed as a continuous narrow corridor along the channel and bar margins, and relatively dense except in areas that have experienced bank failures or other mass wasting events, or in areas of exposed bedrock (PCWA 2010a).

Riparian habitats in undisturbed areas along the North Fork American River (from the confluence of the Middle Fork American River to Folsom Reservoir) are similar to those for the Middle Fork American River. However, riparian habitat downstream of the confluence is highly disturbed and is characterized by unstable slopes and rock outcrops, which are largely unvegetated or have ruderal vegetation (EDWPA 2010).

Ponderosa pine forests and foothill woodland vegetation communities dominate upland habitats along the Middle and North Fork American rivers. Chaparral communities also occur on serpentine slopes of both river canyons, although it is much more common along the Middle Fork (EDWPA 2010).

Special-status plant species potentially occurring along the Middle and North Fork American rivers include Brandegee's clarkia (Clarkia biloba ssp. brandegeeae), Butte County fritillary (Fritillaira eastwoodiae), saw-toothed lewisia (Lewisia serrata), and Red Hills soaproot (Chlorogalum grandiflorum).

Special-status terrestrial wildlife species potentially occurring along the Middle and North Fork American rivers are similar to those described for French Meadows and Hell Hole reservoirs and also include California red-legged frog (Rana draytonii) and foothill yellow-legged frog (Rana boylii).

Folsom Reservoir and Lake Natoma

The shorelines of Folsom Reservoir and Lake Natoma support primarily upland vegetation communities. The reservoir rims (i.e., draw-down zones) are devoid of vegetation, with the exception of willow shrubs that have established in areas that are not subject to fluctuations in water elevations. The only contiguous band of riparian vegetation occurring at Folsom Reservoir is along Sweetwater Creek, on the southern end of the reservoir (City-County Office of Metropolitan Water Planning 1999).

Upland habitats associated with Folsom Reservoir and Lake Natoma includes non-native grasslands, blue oak-pine and mixed oak woodlands (EDWPA 2010).

Special-status plant species potentially occurring in the vicinity of the Folsom Reservoir and Lake Natoma include Jepson's onion (Allium jepsonii), big-scale balsamroot (Balsamorhiza macrolepis var. macrolepis), Parry's horkelia (Horkelia parryi), and Hartweg's golden sunburst (Pseudobahia bahifolia).

Special-status terrestrial wildlife species potentially the Folsom Reservoir and Lake Natoma include valley elderberry longhorn beetle (Desmocerus californicus dimorphus), California red-legged frog, western pond turtle (Actinemys marmorata), Swainson's hawk (Buteo swainsoni), and bald eagle.

Lower American River

The channel morphology and riparian communities along the Lower American River have been highly impacted by human activities over the past century. Currently, a large portion of the Lower American River is characterized by riparian forests dominated by Fremont cottonwood and willows. In addition, backwater ponds and lagoons are present, resulting from both natural gravel deposits and artificial dredging (Sands, et. al., 1985).

Special-status plant species potentially occurring in the vicinity of the Lower American River are similar to those described for Folsom Reservoir and Lake Natoma.

Special-status terrestrial wildlife species potentially occurring in the vicinity of the Lower American River include valley elderberry longhorn beetle, western pond turtle, bald eagle, Swainson's hawk, bank swallow (Riparia riparia), yellow-billed cuckoo (Coccyzus americanus), and western burrowing owl (Athene cunicularia).

Sacramento River

Levees along the approximately 60-mile length of the Lower Sacramento River from the confluence with the American River to Collinsville were constructed immediately adjacent to the river, and riparian vegetation is therefore generally absent or consists of single rows of Fremont cottonwood, sycamore, or willow trees (Gibson 1975).

Special-status plant and terrestrial wildlife species potentially occurring in the vicinity of the lower Sacramento River are similar to those described for the Lower American River.

Freeport Intake

The Freeport Intake is located on the broad alluvial plain of the Sacramento River. Vegetation communities surrounding the facilities are largely disturbed/ruderal and dominated by nonnative annual grasslands. There is no riparian vegetation associated with the Freeport Intake (FRWA 2003).

Special-status plant species potentially occurring in the vicinity of the Freeport Intake include Ahart's dwarf rush (Juncus leiospermus var ahartii) and Hartweg's golden sunburst (Pseudobahia bahifolia).

Special-status terrestrial wildlife species potentially occurring in the vicinity of the Freeport Intake are similar to those described for the Lower American River.

Folsom South Canal

The Folsom South Canal is located in an area characterized by a combination of urban or developed habitat, non-native annual grassland, Valley foothill woodland, vernal pool grassland, and fresh emergent wetland (FRWA 2003).

Special-status plant species potentially occurring in the vicinity of the Folsom South Canal include succulent owl's clover (Castilleja campestris ssp. succulent), Bogg's Lake hedge-hyssop (Gratiola heterosepala), slender Orcutt grass (Orcuttis tenuis), Sacramento Orcutt grass (Orcuttia viscida), and Hartweg's golden sunburst.

Special-status terrestrial wildlife species potentially occurring in the vicinity of the Folsom South Canal include vernal pool fairy shrimp (Branchinecta lynchi), vernal pool tadpole shrimp (Lepidurus packardi), California red-legged frog, giant garter snake (Thamnophis gigas), burrowing owl, and Swainson’s hawk, and American badger (Taxidea taxus).

3.3.2 Environmental Consequences

No Action

The No Action Alternative will not increase flows upstream of Folsom Reservoir in July through September or downstream of Folsom Reservoir in late August through November, or change Folsom Reservoir storage or operations.

Proposed Action

Terrestrial and Riparian Resources

The analysis of potential effects on riparian and special-status terrestrial species associated with the Proposed Action Alternative was based on the following criteria:

- Changes in reservoir storage or river flows relative to the No Action Alternative of sufficient magnitude to adversely affect riparian growth or recruitment.
- Changes in reservoir storage or river flows relative to the No Action Alternative of sufficient magnitude to adversely affect special-status plant and wildlife species (including or direct loss of individuals, habitat loss, or reduced prey availability).

Resources potentially affected by the Proposed Action Alternative include riparian vegetation and special-status plants, or terrestrial wildlife species dependent on vegetation communities within the inundation areas of reservoirs or supported by flows within the river reaches. Potential effects on riparian may result from significant changes in the magnitude and frequency of flows during the growing season (March through October). Water transfer under the Proposed Action Alternative would occur in July through September upstream of Folsom Reservoir and late August November downstream of Folsom Reservoir, potentially modifying reservoir elevations and stream flows in Action Area.

Under the Proposed Action Alternative, changes in flows in the Action Area river reaches are relatively small and result in only a minor change in overall stage. Alteration of the magnitude, frequency, and dynamics of river flows has been shown to result in effects to riparian vegetation (e.g., cottonwoods) through changes in water availability, sediment transport and deposition, and distribution of vegetation. The flow changes under the Proposed Action Alternative, relative to the No Action Alternative, are not of sufficient magnitude to affect geomorphic processes or riparian recruitment. Further, these small flow changes would not change environmental conditions for special-status species. As described in Appendix C, fish and aquatic resources in the Action Area reservoirs or river reaches are not affected by the implementation of the Proposed Action Alternative; therefore prey availability to terrestrial wildlife species is not adversely affected.

Fisheries and Aquatic Resources

Evaluating potential impacts on fishery resources within the Action Area requires an understanding of fish species' life histories and life stage-specific environmental requirements. Time periods associated with individual species life stages are derived from a combination of literature review and analyses of survey data. The analysis of the potential effects on fisheries and aquatic resources associated with the Proposed Action Alternative was based on criteria developed specifically for reservoirs and rivers. Appendix C contains a detailed analysis of the potential effects of the Proposed Action Alternative on fisheries and aquatic resources in the Action Area relative to the No Action Alternative. Appendix D provides a detailed analysis of changes in hydrology and water temperature in Folsom Reservoir and the Lower American River which was used to assess potential effects on aquatic species in those water bodies. Implementation of the Proposed Action Alternative is not expected to affect fisheries or aquatic resources in the Action Area.

3.4 Cumulative Impacts

Cumulative impacts are defined in Council on Environmental Quality Regulations (40 CFR 1508.7 and 1508.25) as follows:

> *"Cumulative impact is the impact on the environment, which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."*

The Proposed Action Alternative involves transferring 12,000 AF of PCWA's MFP water to EBMUD in summer/fall 2015. EBMUD has also executed agreements with Sacramento River Settlement Contractors (Settlement Contractors) and Reclamation that provide the opportunity for transfer of up to a total of 14,000 AF of water to be delivered to EBMUD from the Sacramento River in fall 2015. The transfers from Settlement Contractors were evaluated in Reclamation's Long-Term Water Transfers Final Environmental Impact Statement/Environmental Impact Report (FEIS/EIR) for which Reclamation signed a Record of Decision (ROD) in May 2015. The ROD and the FEIS/EIR describe the direct, indirect, and cumulative impacts over a 10-year period, 2015 through 2024, of potential non-CVP water transfers, such as the transfer from the Settlement Contractors to EBMUD. The scheduling of the 2015 transfer between the Settlement Contractors and EBMUD has not been finalized and is subject to further discussion with Reclamation and resource agencies to ensure the protection of environmental resources. To the extent practical, Reclamation will deliver the Settlement Contractor transfer water on a schedule acceptable to EBMUD given the planned Freeport operations and maximum diversion capacity, which is also protective of environmental resources. The diversion of the transfer water at the Freeport Intake will be consistent with the biological opinions discussed in Section 4.2, below, to ensure protection of environmental resources.

In addition, the 2004 Freeport Regional Water Project EIR/EIS (Freeport Facility EIR/EIS) evaluated the potentially significant environmental impacts of diverting water at Freeport. That EIR/EIS was certified by the FRWA as lead agency, and by EBMUD acting as a responsible agency. The EBMUD Board of Directors then approved the Freeport Facility project and use of the Freeport Facility to convey supplemental water supplies to EBMUD's service area in times of drought. The proposed transfer and all other transfers carried out by EBMUD in 2015 would be carried out within the maximum diversion amounts and rates analyzed in the Freeport Facility EIR/EIS, such that effects associated with the continued flow of transfer water from the American River confluence to the Freeport Facility for diversion and conveyance to EBMUD's service area have been adequately analyzed, and no significant impacts would occur. Further, the proposed transfer involves diversion of a relatively small volume of water which, when combined with all supplemental supplies EBMUD anticipates diverting through the Freeport Facility in 2015, falls within the maximum diversion amounts and rates analyzed in the Freeport Facility EIR/EIS. Accordingly, the potential for significant cumulative impacts to occur is limited and would fall within the range of anticipated cumulative impacts discussed in the Freeport Facility EIR/EIS.

The Proposed Action Alternative, in combination with the transfer between the Settlement Contractors and EBMUD, would not hinder the normal operations of the CVP, Reclamation's ability to deliver water, or result in any adverse impacts to the environment.

Section 4 – Consultation and Coordination

4.1 Public Review Period

Reclamation provided the public with an opportunity to comment on the Draft EA for 7 days between July 14, 2015 and closing on July 21, 2015. A shortened public review period was implemented due to the water transfer deadline of July 24, 2015. No comments were received during the public comment period.

4.2 Federal Endangered Species Act (16 USC § 1531 et seq.)

The Federal Endangered Species Act (ESA) requires that both the USFWS and NMFS maintain lists of threatened species and endangered species. An “endangered species” is defined as “…any species which is in danger of extinction throughout all or a significant portion of its range.” A “threatened species” is defined as“…any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range” (16 USC 1532). Section 9 of the ESA makes it illegal to “take” (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in such conduct) any endangered species of fish or wildlife, and regulations contain similar provisions for most threatened species of fish and wildlife (16 USC 1538).

Section 7 of the ESA requires all Federal agencies to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat. To ensure against jeopardy, each Federal agency must consult with USFWS or NMFS, or both, if the Federal agency determines that its action might impact a listed species. NMFS jurisdiction under the ESA is limited to the protection of marine mammals and fishes and anadromous fishes; all other species are within USFWS jurisdiction.

The USFWS and NMFS have each issued two biological opinions (BiOps) that are relevant to the Proposed Action. First, in 2004, each agency issued a BiOp specifically addressing construction, maintenance, and operation of the Freeport Facility ("Project-Specific BiOps"). Second, in 2008/2009, each agency issued a BiOp for coordinated operations of the CVP/SWP (“OCAP BiOps”), which includes operation of the Freeport Project. Among other things, the incidental take statements in both Freeport Project-specific BiOps address take of listed species that could occur as a result of Freeport Project operation. The 2004 Freeport Project-Specific BiOps are based on a maximum diversion rate of 286 cfs.

Operation of the Freeport Project in 2015, including the diversion of PCWA transfer water, would be well below 286 cfs. Further, the fish screen installed at the Freeport Intake is in compliance with design criteria and guidelines issued by CDFW, USFWS and NMFS for protection of Delta smelt and salmonids from impingement and entrainment. Because the maximum diversions at the Freeport Intake, including the proposed PCWA-EBMUD transfer, will be below the values considered in the BiOps for the facility, the current fish screen will adequately protect fish from impingement and entrainment at the Freeport Intake and effects would be expected to fall within the range of effects already authorized by those BiOps. In addition, for the reasons set forth in this EA, the small changes in the river systems and reservoirs upstream of the Freeport Intake that could result from the transfer are not expected to affect listed species. Consequently, consultation with NMFS and USFWS is not necessary.

On July 9, 2015, Reclamation notified NMFS via email that Reclamation intended to issue a “No Effect” determination to listed species and therefore would not initiate consultation with NMFS. NMFS responded to Reclamation via email on July 20, 2015 and requested a hard copy of Reclamation’s “No Effect” determination letter.

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Appendix A:

Cultural Resources Compliance Memo

CULTURAL RESOURCES COMPLIANCE
Division of Environmental Affairs
Cultural Resources Branch (MP-153)

MP-153 Tracking Number: 15-CCA0-226

Project Name: Warren Act Contract for Storage and Conveyance of Non-CVP Water from Placer County Water Agency (PCWA) to East Bay Municipal Utility District (EBMUD) in 2015

NEPA Document: EA

NEPA Contact: John Hutchings Natural Resource Specialist

MP 153 Cultural Resources Reviewer: Scott Williams, Archaeologist .

Date: July 22, 2015

Reclamation proposes to enter into a temporary one-year WA contract for storage and conveyance of up to 12,000 AF of non-Project water through federal facilities from PCWA to EBMUD. This is the type of undertaking that does not have the potential to cause effects to historic properties, should such properties be present, pursuant to the NHPA Section 106 regulations codified at 36 CFR § 800.3(a)(1). Reclamation has no further obligations under NHPA Section 106, pursuant to 36 CFR § 800.3(a)(I).

The Warren Act (WA) contract would authorize use of the federally owned Folsom Reservoir, Lake Natoma and the Folsom South Canal for storage and conveyance of the PCWA transfer water. Water will be diverted by EBMUD at their Freeport Regional Water Project pump station on the lower Sacramento River, where it will be conveyed to the Folsom South Canal, for later diversion into EBMUD Mokelumne Aqueduct. The Proposed Action would not involve construction or modification of any facilities. Only existing facilities would be utilized to divert, release, convey and re divert water. Land uses within the PCWA and EBMUD service areas would not change as a result of the transfer. After reviewing project documentation provided within EA, Reclamation has concluded this action would not have significant impacts on properties listed, or eligible for listing, on the National Register of Historic Places. This document serves as notification that Section I06 compliance has been completed for this undertaking. Please note that if project activities subsequently change, additional NHPA Section I06 review, including further consultation with the SHPO, may be required.

This document is intended to convey the completion of the NHPA Section I06 process for this undertaking. Please retain a copy in the administrative record for this action. Should changes be made to this project, additional NHPA Section 106 review, possibly including consultation with the State Historic Preservation Officer, may be necessary. Thank you for providing the opportunity to comment.

Appendix B:

Indian Trust Assets Compliance Memo

ITA Determination:

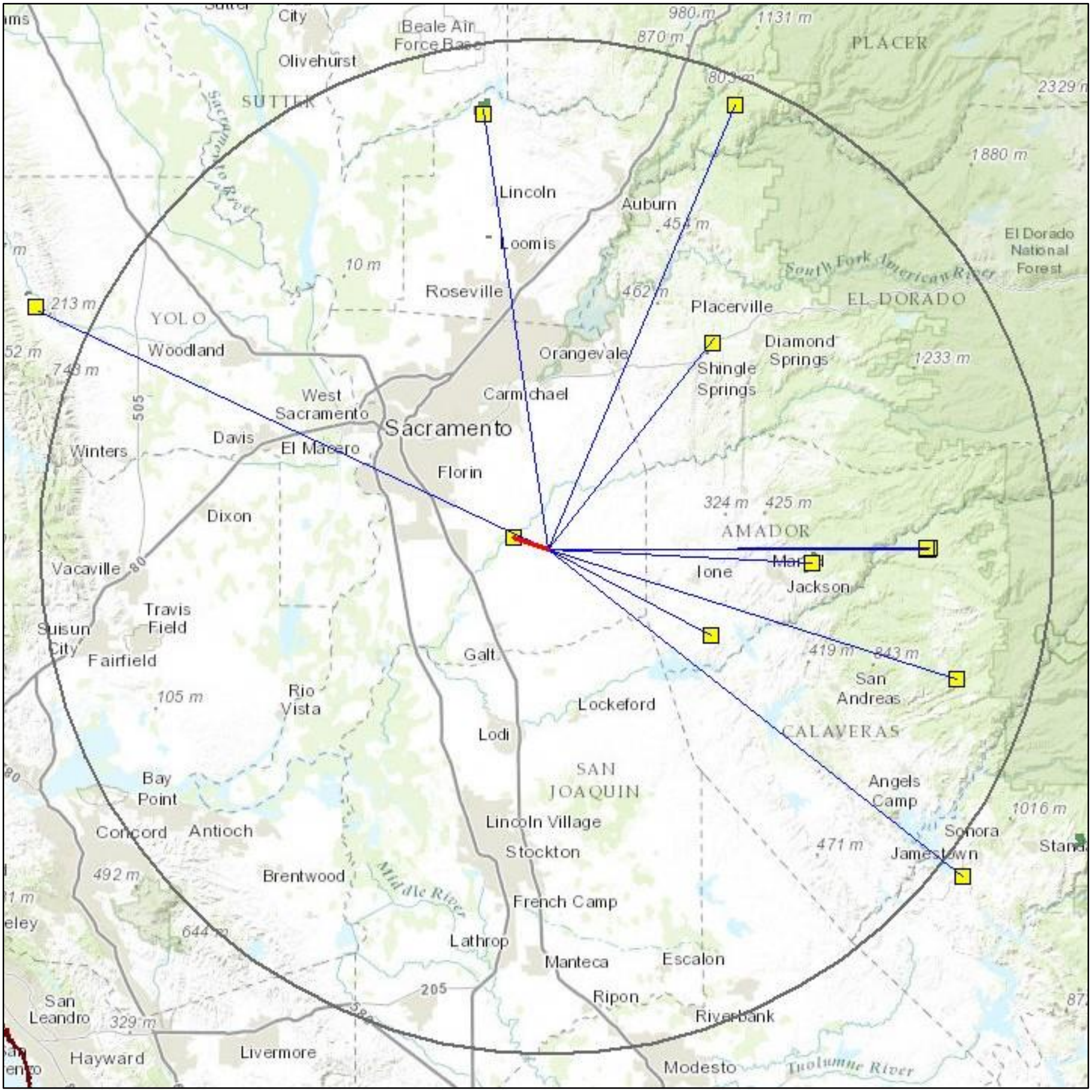
The closest ITA to the proposed FONSI PCWA TO EBMUD WATER TRANSFER activity is the WILTON, WILTON RANCHERIA is about 3.60 miles to the northwest. (see attached image).

Based on the nature of the planned work it does(d-Oe{iiO pear to be in an area that will impact Indian hunting or fishing resources or water rights nor is the proposed activity on actual India ds. It is reasonable to assume that the proposed action will ave any impacts on ITAs.

Marissa M Novoa
Signature

frJ4./'1s,a___OA/ovoa__ 21 July 2015
Printed name of approver Date

FONSI-CC-15-07 ITA Map



PDA

Rancheria

Region Boundaries

1:1,155,581

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Managing Water in the West

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Appendix C: Fisheries and Aquatic Resources

Central California Area Office, Folsom, CA

U.S. Department of the Interior
Bureau of Reclamation
Mid-Pacific Region
Central California Area Office
Folsom, California

July 2015

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1.0 Affected Environment

This section describes the affected environment related to fisheries and aquatic resources in water bodies that may be influenced by implementation of the proposed temporary water transfer to East Bay Municipal Utility District (EBMUD). The following sections describe the aquatic habitats and fish populations within the Action Area, including reservoirs (French Meadows Reservoir, Hell Hole Reservoir, Middle Fork Interbay, Ralston Afterbay, Folsom Reservoir and Lake Natoma); and rivers (Middle and North Fork American rivers, lower American River and Sacramento River). The Proposed Action Alternative does not affect flows downstream of Freeport Intake. Sacramento-San Joaquin Delta (Delta) inflows, outflows, and water supply availability (exports) to CVP contractors are unchanged. Therefore, affects to the Delta and exports are not further analyzed in this document.

Life histories and life stage-specific environmental considerations for several species may differ slightly among the water bodies. Any differences are noted in the discussions of the individual water bodies. If there are not any noted differences, the species life history and general environmental considerations are assumed to be identical to the general discussions in the following sections.

Species of primary management concern include those that are recreationally or commercially important (fall-run Chinook salmon [Oncorhynchus tshawytscha], steelhead [Oncorhynchus mykiss], American shad [Alosa sapidissima], and striped bass [Morone saxatilis]) and Federal-and/or State-listed species or species of special concern within the Action Area (Table 1). Table 1 presents the special-status fish species or species of special concern that could occur within the Action Area, their regulatory status, and the water body where each species is anticipated to occur.

Special emphasis is placed on these species of primary management concern to facilitate compliance with applicable laws, particularly the State and Federal Endangered Species Acts (ESA), and National Marine Fisheries Service (NMFS) and United States Fish and Wildlife Service (USFWS) Biological Opinions (BiOp). This focus is consistent with: (1) CALFED's 2000 Ecosystem Restoration Program Plan (ERPP) and Multi-Species Conservation Strategy (MSCS); (2) the programmatic determinations for the CALFED program, which include California Department of Fish and Wildlife (CDFW) Natural Community Conservation Planning Act (NCCPA) approval and the programmatic BiOps issued by NMFS and USFWS; (3) USFWS's 1997 Draft Anadromous Fish Restoration Program (AFRP), which identifies specific actions to protect anadromous salmonids; (4) CDFW's 1996 Steelhead Restoration and Management Plan for California, which identifies specific actions to protect steelhead; (5) CDFW's Restoring Central Valley Streams, A Plan for Action (1993), which identifies specific actions to protect salmonids; and (6) the 2004 USFWS, 2004 NMFS BiOp for the construction, maintenance and operations of the Freeport Regional Water Project.

Improvement of habitat conditions for these species of primary management concern could protect or enhance conditions for other fish resources, including native resident species.

Table 1. Special-Status Fish Species within the Action Area

Common Name	Scientific Name	Status*	Location
Central Valley fall-/late fall-run Chinook salmon	Oncorhynchus tshawytscha	CSC, FSC[1]	Lower American River, Sacramento River, and the Delta
Central Valley spring-run Chinook salmon	Oncorhynchus tshawytscha	T, ST	Lower American River, Sacramento River, and the Delta
Central Valley winter-run Chinook salmon	Oncorhynchus tshawytscha	E, SE	Sacramento River and the Delta
Central Valley steelhead	Oncorhynchus mykiss	T	Lower American River, Sacramento River, and the Delta
Delta smelt	Hypomesus transpacificus	T, ST	Delta
Southern Distinct Population Segment of North American green sturgeon	Acipenser medirostris	T, CSC	Sacramento River and the Delta
Hardhead	Mylopharodon conocephalus	CSC	Lower American River and Sacramento River
Longfin smelt	Spirinchus thaleichthys	CSC	Delta
River lamprey	Lampetra ayresi	CSC	Lower American River, Sacramento River, and the Delta
Sacramento perch	Archoplites interruptus	CSC	Sacramento River and the Delta
Sacramento splittail	Pogonichthys macrolepidotus	CSC	Lower American River, Sacramento River, and the Delta
California roach	Hesperoleucus symmetricus	CSC	Lower American River and Sacramento River

*Status Key:
E = Endangered, Officially listed (in the Federal Register) as being endangered
T = Threatened, Federally listed as likely to become endangered within the foreseeable future
SE = State Endangered, State listed as endangered
ST = State Threatened, State listed as likely to become endangered
CDC = State Species of Special Concern, CDFW species of special concern
FSC = Federal Species of Concern, Species that has been identified as a species of concern, but has received no formal designation.

[1] National Marine Fisheries Services (NMFS) recognizes the late-fall-run Chinook salmon in the Central Valley fall-run Evolutionary Significant Unit (ESU) (Moyle 2002). On April 15, 2004, NMFS published a notice in the Federal Register acknowledging establishment of a species of concern list, addition of species to the species of concern list, description of factors for identifying species of concern, and revision of the candidate species list. In this notice, NMFS announced the Central Valley fall-run and late fall-run Chinook salmon ESU change in status from a candidate species to a species of concern. In 1999, the Central Valley ESU underwent a status review after NMFS received a petition for listing. Pursuant to that review, NMFS found that the species did not warrant listing as threatened or endangered under the Endangered Species Act (ESA), but sufficient concerns remained to justify addition to the candidate species list. Therefore, according to NMFS' April 15, 2004 interpretation of the ESA provisions, the Central Valley ESU now qualifies as a species of concern, rather than a candidate species (69 FR 19977).

Evaluating potential impacts on fishery resources within the Action Area requires an understanding of fish species' life histories and life stage-specific environmental requirements. General life history information is provided in Section 6 for fish species of primary management concern occurring within the Action Area. Time periods associated with individual species life stages are derived from a combination of literature review and analyses of survey data.

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2.0 Environmental Setting

2.1 French Meadows Reservoir

French Meadows Reservoir supports coldwater recreational fisheries for resident rainbow trout (Oncorhynchus mykiss) and brown trout (Salmo trutta). CDFW typically stocks French Meadows Reservoir with rainbow trout during the summer. The reservoir supports a self-sustaining population of brown trout that migrates from the reservoir to spawning areas in the Middle Fork American River (above the reservoir) during the fall. No physical barriers to brown trout migration are present in the Middle Fork American River (within two miles above the reservoir) during the fall. Fish production in the reservoir is believed to be limited by its high elevation and low productivity compared to natural lakes (Placer County Water Agency [PCWA] 2011b).

2.2 Hell Hole Reservoir

Hell Hole Reservoir is a mid-elevation, oligotrophic Sierra Nevada reservoir (having elevations of approximately 5,000 feet above mean sea level [msl]) that supports coldwater recreational fisheries for resident rainbow, brown, and lake trout (Salvelinus namaycush); and kokanee salmon (Oncorhynchus nerka). CDFW typically stocks Hell Hole Reservoir with resident rainbow and brown trout, and kokanee salmon. Fish production in the reservoir is believed to be limited by its high elevation and low productivity compared to natural lakes (PCWA 2011b).

2.3 Middle Fork Interbay

The Middle Fork Interbay is located on the Middle Fork American River between French Meadows Dam and Ralston Afterbay. Fish assemblages known to occur in the reservoir include rainbow and brown trout. Storage and elevation in Middle Fork Interbay fluctuate very little on a daily, hourly or monthly basis; the reservoir is typically operated at the top of the spill gates. The only exception is during the fall scheduled maintenance outage when transfer water would not be released from the Middle Fork American River Project (MFP). Therefore, the transfer of water would not affect storage or elevation in Middle Fork Interbay. As such, no further discussion of potential storage- or elevation-related impacts to fishery resources in this water body is warranted.

2.4 Ralston Afterbay/Oxbow Reservoir

Fish assemblages found in Ralston Afterbay/Oxbow Reservoir include rainbow and brown trout, hardhead, Sacramento sucker (Catostomus occidentalis), and Sacramento pikeminnow (Ptychocheilus grandis). Ralston Afterbay acts as a regulating reservoir with both hourly and daily storage and elevation fluctuations to meet power demand and downstream whitewater recreational releases. As such, discussion of potential storage- or elevation-related impacts to fishery resources in this water body is included in this analysis.

2.5 Middle Fork and North Fork American Rivers

The Middle Fork American River supports coldwater fish species year-round. The primary sport species in the Middle Fork American River are resident rainbow and brown trout (PCWA 2011a). In addition to rainbow and brown trout, fish sampling surveys of the Middle Fork American River conducted by PCWA in 2007-2009 from Ralston Afterbay downstream to the confluence with the North Fork American River documented the presence of Sacramento sucker, sculpin (Cottus gulosus), hardhead, Sacramento pikeminnow, and California roach (PCWA 2011a). Hardhead and Sacramento pikeminnow minnows were patchily distributed within the reach and were only observed at a few locations (PCWA 2011a). Earlier surveys by the USFWS in 1989 also documented the presence of hitch (Lavinia exilicauda) within the reach (Corps 1991).

The magnitude and timing of flows in the Middle Fork American River are affected by releases from Oxbow Powerhouse. Oxbow Powerhouse is typically operated to follow daily power demand and to provide whitewater boating flows, and is not operated 24 hours per day (except in the wettest water years and/or seasons of the year) leading to inter- and intra-annual flow fluctuations in the reach downstream of Oxbow Powerhouse. Except during high-flow times of the year, releases from Oxbow Powerhouse cause daily fluctuations in flows in the peaking reach of up to approximately 900 cubic feet per second (cfs) (approximately 150 cfs to 1,025 cfs). The current Federal Energy Regulatory Commission (FERC) license for the MFP provides that the Oxbow Powerhouse releases to the Middle Fork American River shall not cause vertical fluctuations in stream stages (measured at the compliance gage located downstream of Oxbow Powerhouse) greater than three feet per hour. However, such fluctuations have the potential to affect stream productivity, especially during periods when flows would otherwise be fairly stable (i.e., summer and early fall). In the peaking reach, evaluations of effective habitat in relation to flow showed that generally species/lifestages with the narrowest range of depth and velocity requirements showed a greater reduction in habitat with changing flow than species/lifestages with broader depth and velocity habitat requirements (e.g., macroinvertebrate food production). Rainbow trout spawning was generally intermediate in sensitivity (PCWA 2011b).

Downstream of its confluence with the Middle Fork American River, the North Fork American River supports both coldwater and warmwater fish assemblages. These species include rainbow and brown trout, smallmouth bass (Micropterus dolomieu), Sacramento pikeminnow, Sacramento sucker, riffle sculpin (Cottus gulosus), brown bullhead (Ictalurus nebulosus), and green sunfish (Lepomis cyanellus). Although some rainbow and brown trout are present, summer and fall water temperatures are generally too warm for significant spawning and early-life stage rearing of trout. The majority of trout that do occur in the North Fork American River below the confluence with the Middle Fork American River are believed to be transitory downstream adult and/or sub-adult migrants that have dispersed into the area from upstream habitats (i.e., Middle Fork American River). No special-status fish species are reported to occur in the North Fork American River downstream of the Middle Fork confluence, although it is possible that hardhead inhabit this section of river.

2.6 Folsom Reservoir

Folsom Reservoir has a maximum storage capacity of approximately 977,000 acre-feet (AF), and has a maximum depth of approximately 266 feet (streambed elevation at the main dam is about 200 feet). Strong thermal stratification occurs within Folsom Reservoir annually between April and November. Thermal stratification establishes a warm surface water layer (epilimnion), a middle water layer characterized by decreasing water temperature with increasing depth (metalimnion or thermocline), and a bottom, coldwater layer (hypolimnion) within the reservoir. In terms of aquatic habitat, the warm epilimnion of Folsom Reservoir provides habitat for warmwater fishes, whereas the reservoir's lower metalimnion and hypolimnion form a "coldwater pool" that provides habitat for coldwater fish species throughout the summer and fall portions of the year. Hence, Folsom Reservoir supports a "two-story" fishery during the stratified portion of the year (April through November), with warmwater species using the upper, warmwater layer and coldwater species using the deeper, colder portion of the reservoir.

Native species that occur in the reservoir include hardhead and Sacramento pikeminnow. However, introduced largemouth bass (Micropterus salmoides), smallmouth bass, spotted bass (Micropterus punctulatus), bluegill (Lepomis macrochirus), black and white crappie (Pomoxis nigromaculatus and P. annularis), and catfish (Ictalurus spp. and Ameiurus spp.) constitute the primary warmwater sport fisheries of Folsom Reservoir. The coldwater sport species present in the reservoir include rainbow and brown trout, kokanee salmon, and Chinook salmon, all of which are currently or have been stocked by CDFW. Although brown trout are no longer stocked, a population still remains in the reservoir. Because these coldwater salmonid species are stream spawners, they do not reproduce within Folsom Reservoir. However some spawning by one or more of these species may occur in the North Fork or South Fork of the American River upstream of Folsom Reservoir.

Folsom Reservoir's coldwater is important not only to the reservoir's coldwater fish species, but also is important to lower American River fall-run Chinook salmon and Central Valley steelhead. Seasonal releases from the reservoir's coldwater pool provide thermal conditions in the lower American River that support annual in-river production of these salmonid species. However, Folsom Reservoir's coldwater volume generally is not large enough to facilitate coldwater releases during the warmest months (July through September) to provide optimal thermal conditions for over-summering juvenile steelhead rearing or fall-run Chinook salmon immigration, spawning, and embryo incubation in the fall. Consequently, management of the reservoir's coldwater volume on an annual basis is essential to providing suitable thermal regimes for fall-run Chinook salmon and steelhead, within the constraints of coldwater availability.

2.7 Lake Natoma

Lake Natoma supports many of the same fisheries found in Folsom Reservoir (rainbow trout, bass, sunfish, and catfish). Some recruitment of warmwater and coldwater fishes likely comes from Folsom Reservoir (e.g., when the reservoir spills). In addition, CDFW stocks Lake Natoma with catchable-sized rainbow trout annually. Although supporting many of the same fish species found in Folsom Reservoir, Lake Natoma's limited primary and secondary production, colder epilimnetic water temperatures (relative to Folsom Reservoir), and daily elevation fluctuations are believed to reduce the size and annual production of many of its fish populations, relative to Folsom Reservoir (USFWS 1991). Lake Natoma's characteristics, coupled with limited public access, result in its lower angler use compared to Folsom Reservoir.

Lake Natoma was constructed to serve as a regulating afterbay for Folsom Reservoir and is located at an elevation of 132 feet above msl. Despite its size (an operating range of 2,800 AF; 8,760 AF total capacity), Lake Natoma can influence the temperature of water flowing through it. High residence times in the lake (e.g., 4+ days at 1,000 cfs), particularly during summer months, have a warming effect on water released from Folsom Reservoir. Water is released from Lake Natoma into the lower American River below Nimbus Dam.

2.8 Nimbus Fish Hatchery

CDFW, under contract with United States Bureau of Reclamation (Reclamation), operates the Nimbus Salmon and Steelhead Hatchery and the American River Trout Hatchery, which produce anadromous fall-run Chinook salmon and steelhead, and non-anadromous rainbow trout, respectively. Both of these hatcheries are located at the same facility immediately downstream of Nimbus Dam. Production goals are 4 million fall-run Chinook salmon smolts and 430,000 yearling steelhead. Historically, juvenile salmon have been released in San Pablo Bay and juvenile steelhead in the lower American River near the confluence with the Sacramento River; however, release location can vary depending on conditions. Trout are stocked in numerous water bodies throughout the region.

The Nimbus Hatchery receives water for its operations directly from Lake Natoma via a 60-inch- diameter pipeline. Water temperatures in the hatchery are dictated by the temperature of water diverted from Lake Natoma, which in turn, is primarily dependent upon several factors including the temperature of water released from Folsom Reservoir, ambient air temperature, and retention time in Lake Natoma. The temperature of water diverted from Lake Natoma for hatchery operations is frequently higher than that which is generally desired for hatchery production of salmonids. Under such conditions, more suitable water temperatures may be achieved by increasing releases at Folsom Dam and/or releasing colder water from a lower elevation within Folsom Reservoir. However, seasonal releases from Folsom Reservoir's limited coldwater pool to benefit hatchery operations must be considered in conjunction with seasonal in-river benefits from such releases.

2.9 Lower American River

At least 43 species of fish have been reported to occur in the lower American River system, including numerous resident native and introduced species, as well as several anadromous species. Although each fish species fulfills an ecological niche, several species are of primary management concern either as a result of their declining status or because of their importance as a recreational and/or commercial fishery. Current recreationally and/or commercially important anadromous species include fall-run Chinook salmon, steelhead, striped bass, and American shad. A variety of centrarchid species including black bass are also recreationally important.

Currently, the river supports a mixed run of hatchery and naturally produced fish. From 1967 through 1991 (the AFRP restoration goal baseline period), lower American River fall-run Chinook salmon spawning comprised approximately 21 percent (i.e., 41,040 fish) of the total fall-run Chinook salmon spawning (i.e., 197,740 fish) in the Sacramento Valley river system, including the Sacramento River and its tributary rivers and creeks.

The lower American River currently provides spawning and rearing habitat for fall-run Chinook salmon and steelhead below Nimbus Dam. The majority of the fall-run Chinook and the steelhead runs are believed to be of hatchery origin (CHSRG 2012).

Special-status fish species within the lower American River include Central Valley steelhead, spring-run Chinook salmon, and fall-run/late-fall-run Chinook salmon. Central Valley steelhead are listed as a threatened species under the Federal ESA and the lower American River is designated as critical habitat. The lower 10 miles of the American River has been designated as critical habitat for spring-run Chinook salmon because of the potential for non-natal rearing. Fall-run/late fall-run Chinook salmon[2] is a Federal species of special concern, and late fall-run Chinook salmon is considered a State species of special concern. Chinook salmon also is a federally managed fish species under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA).

2.10 Sacramento River

The lower Sacramento River is generally defined as the portion of the river from Princeton to the Delta at approximately Chipps Island (near Pittsburg). The lower Sacramento River is predominantly channelized, leveed and bordered by agricultural lands. Aquatic habitat in the lower Sacramento River is characterized primarily by slow-water glides and pools, is depositional in nature, and has lower water clarity and habitat diversity, relative to the upper portion of the river.

Many of the fish species utilizing the upper Sacramento River also use the lower river to some degree, even if only as a migratory pathway to and from upstream spawning and rearing grounds. For example, adult Chinook salmon and steelhead primarily use the lower Sacramento River as an immigration route to upstream spawning habitats and an emigration route to the Delta. The lower river also is used by other fish species (e.g., Sacramento splittail and striped bass) that make little to no use of the upper river (upstream of river mile [RM] 163). Overall, fish species composition in the lower portion of the Sacramento River is quite similar to that of the upper Sacramento River and includes resident and anadromous cold- and warmwater species. Many fish species that spawn in the Sacramento River and its tributaries depend on river flows to carry their larval and juvenile life stages to downstream nursery habitats. Native and introduced warmwater fish species primarily use the lower river for spawning and rearing, with juvenile anadromous fish species also using the lower river and non-natal tributaries, to some degree, for rearing.

Over 30 species of fish are known to use the Sacramento River. Of these, a number of both native and introduced species are anadromous. These species include Chinook salmon, steelhead, green and white sturgeon (*Acipenser transmontanus*), striped bass, and American shad. The majority of adult immigration into the Sacramento River and the subsequent period of holding

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[2] NMFS recognizes the late-fall-run Chinook salmon in the Central Valley fall-run ESU (Moyle 2002). On April 15, 2004, NMFS published a notice in the Federal Register acknowledging establishment of a species of concern list, addition of species to the species of concern list, description of factors for identifying species of concern, and revision of the candidate species list. In this notice, NMFS announced the Central Valley Fall-run and Late Fall-run Chinook Salmon ESU change in status from a candidate species to a species of concern. In 1999, the Central Valley ESU underwent a status review after NMFS received a petition for listing. Pursuant to that review, NMFS found that the species did not warrant listing as threatened or endangered under the ESA, but sufficient concerns remained to justify addition to the candidate species list. Therefore, according to NMFS' April 15, 2004 interpretation of the ESA provisions, the Central Valley ESU now qualifies as a species of concern, rather than a candidate species (69 FR 19977).

occurs from December through July for winter-run Chinook salmon (Moyle 2002; USFWS 1995), from March through October for spring-run Chinook salmon (CDFW 1998; Lindley et al. 2004; Moyle 2002) from July through December for fall-run Chinook salmon (NMFS 2004; Snider et al. 1999; Vogel and Marine 1991), from October through April for late fall-run Chinook salmon (Moyle 2002), and from August through March for steelhead (McEwan 2001; NMFS 2004).

Most winter-run sized Chinook salmon fry and juveniles collected in a rotary screw trap located at RM 205 have been captured from July through April (Coulon 2004). However, NMFS (1993; 1997) reports show that spring-run Chinook salmon juveniles rear and move downstream year-round in the Sacramento River. Moyle (2002) and Vogel and Marine (1991) report that the majority of the juvenile rearing and downstream movement life stage occur from December through June for fall-run Chinook salmon and April through December for late fall-run Chinook salmon. McEwan (2001) reports that steelhead fry and fingerlings rear and move downstream in the Sacramento River year-round. Most steelhead smolts reportedly emigrate from January through June (McEwan 2001; Newcomb and Coon 2001; Snider and Titus 2000a; USFWS 1995a). Other Sacramento River fishes are considered resident species, which complete their lifecycles entirely within freshwater, often in a localized area. Resident species include rainbow and brown trout, largemouth and smallmouth bass, channel catfish (*Ictalurus punctatus*), sculpin, Sacramento pikeminnow, Sacramento sucker, hardhead, and common carp (*Cyprinus carpio*) (Moyle 2002).

Adult striped bass are present in the Sacramento River throughout the year, with peak abundance occurring during the spring months (i.e., April through June) (CDFW 1971; DeHaven 1977; DeHaven 1979). In the Sacramento River, most striped bass spawning is believed to occur between Colusa and the mouth of the Feather River.

The Yolo and Sutter bypasses, floodwater bypasses from the Sacramento River, serve as important Sacramento splittail spawning and early rearing habitat (Sommer et al. 1997). Sacramento splittail spawning can occur anytime between late February and early July but peak spawning occurs in March and April (Moyle 2002). A gradual upstream migration begins in the winter months to forage and spawn, although some spawning activity has been observed in Suisun Marsh (Moyle 2002). Eggs normally incubate for three to seven days depending on water temperature (Moyle 2002). After hatching, splittail larvae remain in shallow weedy areas until water recedes, and they migrate downstream (Meng and Moyle 1995). Downstream movement of juvenile splittail appears to coincide with drainage from the floodplains between May and July (Caywood 1974; Meng and Moyle 1995; Sommer et al. 1997).

2.11 Freeport Regional Water Project Intake

The Freeport Regional Water Project (Freeport) Intake is located on the left bank of the Sacramento River about 10 miles downstream of the confluence with the American River, at RM 47.6. In the vicinity of the intake, the Sacramento River is confined within levees. The Sacramento River at the intake is under tidal influence and thus is within the legal boundary of the Sacramento-San Joaquin Delta. The tides affect the flow rate and the velocity of the river passing by the intake, particularly during low-flow conditions. When average daily flow is less than approximately 10,000 cfs and the highest tides of the month occur, the flow direction of the river at the intake can reverse for up to four hours.

All water diverted into the Freeport Intake passes through a fish screen designed to prevent impingement and entrainment of delta smelt and anadromous salmonids. Fish screen design criteria and guidelines are issued by the California Department of Fish and Wildlife (CDFW), the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS). The criteria for protecting fish species of concern in this reach of the Sacramento River include the following:

- Average approach velocity (water velocity perpendicular to the screen) – less than or equal to 0.2 feet per second.
- Minimum sweeping velocity (water velocity parallel to the screen) – two times the approach velocity
- Exposure time (the time a fish might be exposed to the screen = length of screen/sweeping velocity) – less than 60 seconds
- Screen slot opening size – 1.75 millimeters
- Automated screen cleaner with 5-minute cycle time

The design flow for the fish screens is 209 MGD (324 cfs), 12% above the permitted capacity of the facility. This provides the ability to operate all four pumps in one of the halves of the facility at their maximum capacity while the other half is out of service. An extra 5 percent screen area is provided to assist in meeting velocity-balancing requirements during startup. Because of the unavoidable minimal sweeping flows during slack water and flow reversal events that occur at this location, the fisheries agencies have waived the minimum sweeping velocity and exposure time criteria for this facility.

Federal and State ESA compliance for the Freeport Facility was addressed separately. USFWS and NMFS have each issued two BiOps covering the Freeport Facility. First, in 2004, each agency issued a BiOp specifically addressing construction, maintenance, and operation of the Freeport Facility ("Project-Specific BiOps"). Second, in 2008/2009, each agency issued a BiOp for coordinated operations of the CVP/SWP (Operations Criteria and Plan [OCAP] BiOps) which includes operation of the Freeport Project. Freeport diversions were included in the modeling analyses in the OCAP BOs. Among other things, the incidental take statements in both Freeport Project-Specific BOs address take of listed species that could occur as a result of Freeport Project operation. There are no seasonal water diversion restrictions.

State ESA compliance was attained under an Incidental Take Permit (ITP) issued by the CDFG (now CDFW) on April 18, 2011. The ITP allows a maximum diversion of 147,000 AF in any water year (based on the maximum combined delivery of EBMUD and Sacramento County Water Agency (SCWA) as modeled for the Freeport Project environmental documentation) at a rate of up to 185 million gallons per day (MGD) (286 cfs). Covered species are the longfin and delta smelt. Due to the Freeport Intake design which includes state-of-the-art fish exclusion systems (screens) that comply with CDFW, USFWS, and NMFS criteria, there are no seasonal water diversion restrictions. The ITP expires on December 31, 2030.

In 2013, an annual monitoring report (ICF 2013) was prepared to: (1) present fish entrainment, impingement, and predator monitoring results for the facility; and (2) comply with the terms and conditions of USFWS' BiOp for the effects of the FRWA Intake by demonstrating fish screen effectiveness for minimizing entrainment of delta smelt and evaluating take of delta smelt. Entrainment monitoring documented that no federally listed or state-listed species, including delta and longfin smelt, were detected in the samples collected.

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3.0 General Life History Information of Key Fish Species

3.1 Chinook Salmon

Four principal life history variants of Chinook salmon are recognized and are named for the timing of their spawning runs: fall-run, late fall-run, winter-run and spring-run (Table 2). The Sacramento River supports all four runs of Chinook salmon. The larger tributaries to the Sacramento River (American, Yuba, and Feather rivers) and rivers in the San Joaquin Basin also provide habitat for one or more of these runs. The following describes life history information on each run of Chinook salmon.

Table 1. Generalized Life History Timing of Central Valley Chinook Salmon Runs

Run	Adult Migration Period	Peak Migration Period	Spawning Period[a]	Peak Spawning Period	Fry Emergence Period	Juvenile Stream Residency	Juvenile Emigration Period
Late fall	Oct - Apr	Dec	Early Jan - Mar	Feb - Mar	Apr - Jun	7-13 months	Apr - Dec
Winter	Dec - Jul	Jan - Mar	Late Apr - Oct	May - Jun	Jul - Oct	5-10 months	Jul - Apr
Spring	Mid-Feb - Jul	Apr - May	Late Aug - Dec	Mid-Sep	Nov - Mar	3-15 months	Oct - Mar
Fall	Jul - Dec	Sep - Oct	Late Sep - Mar	Oct - Nov	Dec - Mar	1-7 months	Dec - Jun

Sources: (Vogel and Marine 1991; CDFW 1998; Moyle 2002; NMFS 2004). The time periods identified for spawning include the time required for incubation and initial rearing, before emergence of fry from spawning gravels.

3.1.1 Winter-run Chinook Salmon

Winter-run Chinook salmon occur only in the Sacramento River. The Sacramento River winter- run Chinook salmon ESU is listed as “endangered” under both the Federal and State ESA. In 1993, critical habitat for winter-run Chinook salmon was designated to include the Sacramento River from Keswick Dam, (RM 302) to Chipps Island (RM 0) at the westward margin of the Sacramento-San Joaquin Delta. Also included are waters west of the Carquinez Bridge, Suisun Bay, San Pablo Bay, and San Francisco Bay north of the San Francisco/Oakland Bay Bridge (NMFS 1993).

Adult winter-run Chinook salmon immigration and holding (upstream spawning migration) through the Delta and into the lower Sacramento River occurs from December through July, with a peak during the period extending from January through April (USFWS 1995a). Winter-run Chinook salmon primarily spawn in the main-stem Sacramento River between Keswick Dam (RM 302) and Red Bluff Diversion Dam (RM 243). Winter-run Chinook salmon spawn between late-April and mid-August, with a peak generally in June. Winter-run Chinook salmon embryo incubation in the Sacramento River can extend into October (Vogel and Marine 1991).

Winter-run Chinook salmon fry rearing in the upper Sacramento River exhibit peak abundance during September, with fry and juvenile emigration past Red Bluff Diversion Dam occurring from July through March (Reclamation 1992; Vogel and Marine 1991), although NMFS (NMFS 1993; NMFS 1997) report juvenile rearing and outmigration extending from June through April. Emigration (downstream migration) of winter-run Chinook salmon juveniles past Knights Landing, approximately 155.5 RMs downstream of the Red Bluff Diversion Dam, reportedly occurs between November and March, peaking in December, with some emigration continuing through May in some years (Snider and Titus 2000a; Snider and Titus 2000b). The numbers of juvenile winter-run Chinook salmon caught in rotary screw traps at the Knights Landing sampling location were reportedly dependent on the magnitude of flows during the emigration period (Snider and Titus 2000a; Snider and Titus 2000b). Additional information on the life history and habitat requirements of winter-run Chinook salmon is contained in the NMFS BO for this run (NMFS 1993), which was developed to specifically evaluate impacts on winter-run Chinook salmon associated with CVP and SWP operations.

3.1.2 Spring-run Chinook Salmon

Historically, Central Valley spring-run Chinook salmon occurred in the headwaters of all major river systems in the Central Valley where natural barriers to migration were absent. Beginning in the 1880s, harvest, water development, construction of dams that prevented access to headwater areas, and habitat degradation significantly reduced the number and range of spring-run Chinook salmon in the Central Valley. Today, Mill, Deer, and Butte creeks in the Sacramento River system support self-sustaining, persistent populations of spring-run Chinook salmon. The upper Sacramento, Yuba, and Feather rivers also are reported to support spring-run Chinook salmon. Due to the significantly reduced range and small size of remaining spring-run populations, the Central Valley spring-run Chinook salmon ESU is listed as a "threatened" species under both the State ESA and Federal ESA.

Sacramento River spring-run Chinook salmon are known to use the Sacramento River as a migratory corridor to spawning areas in upstream tributaries. Historically, spring-run Chinook salmon did not utilize the mainstem Sacramento River downstream of the Shasta Dam site except as a migratory corridor to and from headwater streams (CDFW 1998). Currently, the extent of spring-run Chinook salmon utilization of the upper Sacramento River (i.e., upstream of the

Red Bluff Diversion Dam and downstream of Keswick Dam) for other than a migratory corridor is unclear.

All of the potential spring-run Chinook salmon holding and spawning habitat in the mainstem Sacramento River is located upstream from the Red Bluff Diversion Dam and downstream of Keswick Dam (CDFW 1998). The physical environment downstream from Keswick Dam is adequate for spring-run Chinook salmon; however, in some years high water temperatures would prevent egg and embryo survival (USFWS 1990 as reported *in* CDFW 1998). Water temperature downstream from Keswick Dam is a function of flow releases from Shasta Reservoir, the condition of reservoir storage, depth of water released from the reservoir, and meteorological conditions. In years of low storage in Shasta Reservoir and under low flow releases, water temperatures exceed 56°Fdownstream of Keswick Dam during critical months for spring-run Chinook salmon spawning and egg incubation.[3]

Adult spring-run Chinook salmon immigration and holding in California's Central Valley Basin occurs from mid-February through September (CDFW 1998; Lindley et al. 2004). Suitable water temperatures for adult upstream migration reportedly range between 57ºF and 67ºF (NMFS 1997). In addition to suitable water temperatures, adequate flows are required to provide migrating adults with olfactory and other cues needed to locate their spawning reaches (CDFW 1998).

The primary characteristic distinguishing spring-run Chinook salmon from the other runs of Chinook salmon is that adult spring-run Chinook salmon hold in areas downstream of spawning grounds during the summer months until their eggs fully develop and become ready for spawning. NMFS (1997) states, "Generally, the maximum temperature for adults holding, while eggs are maturing, is about 59-60°F, but adults holding at 55-56°F have substantially better egg viability." Spring-run Chinook salmon reportedly spawn, to some extent, the mainstem Sacramento River. Spawning and embryo incubation has been reported to primarily occur during September through mid-February, with spawning peaking in mid-September (DWR 2004b; DWR 2004c; Moyle 2002; Vogel and Marine 1991). Some portion of an annual year-class may emigrate as post-emergent fry (individuals less than 45 mm in length), and some rear in the upper Sacramento river and tributaries during the winter and spring and emigrate as juveniles (individuals greater than 45 mm in length, but not having undergone smoltification) or smolts (silvery colored fingerlings having undergone the smoltification process in preparation for ocean entry). The timing of juvenile emigration from the spawning and rearing grounds varies among the tributaries of origin, and can occur during the period extending from October through April (Vogel and Marine 1991). Critical habitat for spring-run Chinook in the lower

3A water temperature of 56°F represents the upper value of the water temperature range (i.e., 41.0°F to 56.0°F) suggested for maximum survival of eggs and yolk-sac larvae in the Central Valley of California (USFWS 1995c).

American River was updated on September 2, 2005 with an effective date of January 2, 2006 (70 FR 52488).

3.1.3 Fall-run Chinook Salmon

In the Central Valley, fall-run Chinook salmon are the most numerous of the four salmon runs, and continue to support commercial and recreational fisheries of significant economic importance. Fall-run Chinook salmon is currently the largest run of Chinook salmon utilizing the Sacramento River system.

Adult fall-run Chinook salmon generally begin migrating upstream annually in July, with immigration continuing through December in most years (NMFS 2004; Vogel and Marine 1991). It has been reported that fall-run Chinook salmon in the Central Valley immigrate into natal rivers as early as June (Moyle 2002). Adult fall-run Chinook salmon immigration generally peaks in November, and typically greater than 90 percent of the run has entered the river by the end of Novemberdie after spawning in the early spring; although they may be capable of spawning twice during a season, (Bennett 2005; Brown and Kimmerer 2001; Moyle 2002). Delta smelt feed entirely on zooplankton. For the majority of their one-year life span, delta smelt inhabit areas within the western Delta and Suisun Bay characterized by salinities of approximately 2 ppt. Historically, they have been abundant in low (around 2 ppt) salinity habitats. Delta smelt occur in open surface waters and shoal areas (USFWS 1994).

Because delta smelt typically have a one-year life span, their abundance and distribution have been observed to fluctuate substantially within and among years. Delta smelt abundance appears to be reduced during years characterized by either unusually dry years with exceptionally low outflows (1987 through 1991) and unusually wet years with exceptionally high outflows (1982 and 1986). Other factors thought to affect the abundance and distribution of delta smelt within the Bay-Delta estuary include entrainment in water diversions, changes in the zooplankton community resulting from introductions of non-native species, and potential effects of toxins.

3.1.10 Sacramento Splittail

USFWS removed Sacramento splittail from the list of threatened species on September 22, 2003, and did not identify it as a candidate for listing under the ESA. Sacramento splittail are however, identified as a California species of special concern and, informally, as a Federal species of concern. Splittail occur in the Sacramento River, its major tributaries, the San Joaquin River and the Delta.

Sacramento splittail spawning can occur anytime between late February and early July but peak spawning occurs in March and April (Moyle 2002). DWR (2004a) reported that Sacramento splittail spawning, egg incubation and initial rearing in the Feather River primarily occurs during February through May. Attraction flows are necessary to initiate travel onto floodplains where spawning occurs (Moyle et al. 2004). Spawning generally occurs in water with depths of three to six feet over submerged vegetation where eggs adhere to vegetation or debris until hatching (Moyle 2002; Wang 1986). Eggs normally incubate for three to seven days depending on water temperature (Moyle 2002). After hatching, splittail larvae remain in shallow weedy areas until water recedes, and they migrate downstream (Meng and Moyle 1995).

Juvenile Sacramento splittail prefer shallow-water habitat with emergent vegetation during rearing (Meng and Moyle 1995). Sommer et al. (Sommer et al. 2002) reports juvenile splittail are more abundant in the Yolo Bypass floodplain in the shallowest areas of the wetland with emergent vegetation. Downstream movement of juvenile splittail appears to coincide with drainage from the floodplains between May and July (Caywood 1974; Meng and Moyle 1995; Sommer et al. 1997).

Sommer et al. (1997) discuss the resiliency of splittail populations and suggest that because of their relatively long life span, high reproductive capacity, and broad environmental tolerances, splittail populations have the ability to recover rapidly even after several years of drought conditions. This suggests that frequent floodplain inundations are not necessary to support a healthy population. Moyle et al. (2004) report that the ability of splittail to reproduce under the worst conditions insures that the population will persist.

3.1.11 Hardhead

Hardhead are a large (occasionally exceeding 600 mm standard length [SL]), native cyprinid species. They are part of the “pikeminnow-hardhead-sucker” native fish assemblage that occurs in warmwater/transition portions or stream and rivers downstream of the coldwater “rainbow” trout assemblage. Hardhead generally occur in large, undisturbed low- to mid-elevation rivers and streams of the region (Moyle 2002). The species is widely distributed throughout the Sacramento-San Joaquin River system, though it is absent from the valley reaches of the San Joaquin River. Hardhead mature following their second year. Spawning migrations, which occur in the spring into smaller tributary streams, are common. The spawning season may extend into August in the foothill streams of the Sacramento and San Joaquin River basins. Based on recent studies in the Middle Fork American and Rubicon rivers upstream of Ralston Afterbay, hardhead may be spawning from early April into the summer (PCWA 2011). Spawning behavior has not been documented, but hardhead are believed to elicit mass spawning in gravel riffles (Moyle 2002). According to Moyle (2002), streams where hardhead occur have temperatures in excess of 68oF (20oC), with the temperature preference for hardhead between 78.8 and 82.4oF (26-28oC) (Moyle 2002 and Knight 1985). Temperatures ranging from approximately 65°F to 75°F (18.3-23.9oC) are believed to be suitable for hardhead (Cech et al. 1990).

3.1.12 Longfin Smelt

Longfin smelt is a euryhaline species. They are most abundant in San Pablo and Suisun bays (Moyle 2002). They tend to inhabit the middle to lower portion of the water column. The longfin smelt spends the early summer in San Pablo and San Francisco bays, generally moving into Suisun Bay in August. Most spawning is from February to April at water temperatures of 44.6°F to 58.1°F (Moyle 2002). The majority of adults perish following spawning. Longfin smelt eggs have adhesive properties and are probably deposited on rocks or aquatic plants upon fertilization. Newly hatched longfin smelt are swept downstream into more brackish parts of the estuary.

Strong Delta outflow is thought to correspond with longfin smelt survival, as higher flows transport longfin smelt young to more suitable rearing habitat in Suisun and San Pablo bays (Moyle 2002). Longfin smelt are rarely observed upstream of Rio Vista in the Delta (Moyle et al. 1995).

3.1.13 River Lamprey

The anadromous river lamprey is found in coastal streams from San Francisco Bay to Alaska (Moyle 2002). Adults migrate back into freshwater in the fall and spawn from April to June in small tributary streams (Wang 1986). River lamprey are reported to spawn at water temperatures ranging from 55.4°F to 56.3°F (Wang 1986). Adults die after spawning. The adults need clean, gravelly riffles in permanent streams for spawning, while the ammocoetes require sandy backwaters or stream edges in which to bury themselves, where water quality is good and water temperatures do not exceed 77°F. Ammocoetes begin their transformation into adults when they are about 12 cm TL, during the summer. The process of metamorphosis may take 9 to 10 months, the longest known for any lamprey species. Lampreys in the final stages of metamorphosis congregate immediately upriver from saltwater and enter the ocean in late spring. Adults only spend three to four months in saltwater, where they grow rapidly, reaching 25 cm to 31 cm TL (Moyle 2002).

3.1.14 Sacramento Perch

Sacramento perch are deep-bodied, laterally compressed centrarchids. Historically, Sacramento perch were found throughout the Central Valley, the Pajaro and Salinas rivers, and Clear Lake. The only populations today that represent continuous habitation within their native range are those in Clear Lake and Alameda Creek. Within their native range, Sacramento perch also exist primarily in farm ponds, reservoirs, and lakes into which they have been introduced (Moyle 2002). Sacramento perch are often associated with beds of rooted, submerged, and emergent vegetation and other submerged objects. Sacramento perch are able to tolerate a wide range of physicochemical water conditions. This tolerance is thought to be an adaptation to fluctuating environmental conditions resulting from floods and droughts. Thus, Sacramento perch do well in highly alkaline water (McCarraher and Gregory 1970; Moyle 1976). Most populations today are established in warm, turbid, moderately alkaline reservoirs or farm ponds. Spawning occurs during spring and early summer and usually begins by the end of March, continuing through the first week of August (Mathews 1965; Moyle 2002). Introductions of non-native species, not necessarily habitat alterations, are foremost in the cause of Sacramento perch declines (Moyle 2002).

3.1.15 California Roach

The California roach, a native freshwater minnow, is found throughout the Sacramento-San Joaquin Basin (Moyle 2002). California roach are generally found in small, warm intermittent streams, and dense populations are frequently found in isolated pools (Moyle et al. 1982; Moyle 2002). They are most abundant in mid-elevation streams in the Sierra foothills and in the lower reaches of some coastal streams (Moyle 2002). Roach are tolerant of relatively high temperatures (86°F to 95°F) and low oxygen levels (1 to 2 parts per million [ppm]) (Taylor et al. 1982). Roach reach sexual maturity by about the second year (approximately 45 mm SL). Reproduction generally occurs from March to June, usually when temperatures exceed 60.8°F, but may be extended through late July (Moyle 2002).

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4.0 Regulatory Setting

4.1 Federal Endangered Species Act

The ESA requires that both USFWS and NMFS maintain lists of threatened species and endangered species. An "endangered species" is defined as "…any species which is in danger of extinction throughout all or a significant portion of its range." A "threatened species" is defined as"…any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" (16 USC 1532). Section 9 of the ESA makes it illegal to "take" (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in such conduct) any endangered species of fish or wildlife, and regulations contain similar provisions for most threatened species of fish and wildlife (16 USC 1538).

Section 7 of the ESA requires all Federal agencies to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat. To ensure against jeopardy, each Federal agency must consult with USFWS or NMFS, or both, if the Federal agency determines that its action might impact a listed species. NMFS jurisdiction under the ESA is limited to the protection of marine mammals and fishes and anadromous fishes; all other species are within USFWS jurisdiction.

Critical habitat for listed species consists of: (1) the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of Section 4 of the Endangered Species Act, on which are found those physical or biological features (constituent elements) (a) essential to the conservation of the species and (b) which may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provision of Section 4 of the Act, upon a determination by the Secretary of the Department of the Interior that such areas are essential for the conservation of the species.

4.2 Essential Fish Habitat

Section 305(b)(2) of the 1996 reauthorization of the MSFCMA added a provision for Federal agencies to consult with NMFS on impacts to EFH. EFH only applies to Chinook salmon habitat that includes specifically identified waters and substrate necessary for fish spawning, breeding, feeding, or growing to maturity. Consultation on any activity that might adversely affect EFH is required by NMFS under the MSFCMA, as amended by the Sustainable Fisheries Act of 1996. EFH includes all habitats necessary to allow the production of commercially valuable aquatic species, to support a long-term sustainable fishery, and contribute to a healthy ecosystem.

4.3 Central Valley Project Improvement Act and Anadromous Fish Restoration Program

The Central Valley Project Improvement Act (CVPIA) (Title 34 of P.L. 102-575) amends the authorization of the CVP to include fish and wildlife protection, restoration, and mitigation as project purposes of the CVP having equal priority with irrigation and domestic uses of CVP water. It also elevates fish and wildlife enhancement to a level having equal purpose with power generation.

The CVPIA identifies several goals to meet these new purposes. Significant among these is the broad goal of restoring natural populations of anadromous fish, green and white sturgeon American shad, and striped bass in Central Valley rivers and streams to double their recent average levels.

Section 3406(b)(1) jointly imparted the responsibilities of implementing the CVPIA to the USFWS and Reclamation, although the USFWS has assumed the lead role in the development of the AFRP. The Final Restoration Plan for the AFRP was adopted on January 9, 2001 and will be used to guide the long-term development of the AFRP. Additionally, under USFWS direction, technical teams have assisted in the establishment of components of the AFRP. A key element of the program is instream flow recommendations, including objectives for the lower American River and upper Sacramento River.

4.4 Long-Term Central Valley Project and State Water Project Operations Criteria and Plan

The Long-Term CVP and SWP OCAP serves as the operational standard by which Reclamation and DWR operate the integrated CVP/SWP system. The OCAP describes how Reclamation and DWR operate the CVP and the SWP to divert, store, and convey water consistent with applicable law (Reclamation 2008). Reclamation and DWR completed an update to the OCAP in 2008 to reflect recent operational and environmental changes occurring throughout the CVP/SWP system. The terms and conditions identified in the USFWS and NMFS BOs establish the instream habitat conditions and operational requirements that Reclamation and DWR must maintain as part of integrated CVP/SWP operations.

The USFWS OCAP BiOp (2008) concluded that the coordinated operation of the SWP and CVP (including the proposed future action), with implementation of the USFWS reasonable and prudent alternatives (RPAs) would not jeopardize the Delta smelt’s continued existence. Similarly, the NMFS BiOp (2009 and subsequent amendments) concluded that with the inclusion of NMFS’s RPAs the project was not likely to jeopardize the continued existence of endangered and threatened salmon and steelhead or result in the destruction or adverse modification of designated habitat for the endangered and threatened salmon and steelhead. Both the USFWS BiOp and the NMFS BiOp were litigated and subsequently upheld in the courts.

4.5 Freeport Regional Water Project Construction, Operations and Maintenance Biological Opinions

The 2004 USFWS/NMFS Freeport Regional Water Project (FRWP) BiOps on the construction, operations and maintenance of the FRWP, serve as the operational standard by which FRWA operate the FRWP intake facility. Both BiOps identify construction, operation and maintenance-related impacts associated to the facility, and identify mitigation measures to avoid adverse impacts to listed species within the action area.

The USFWS BiOp covers the construction, maintenance and operation of the Freeport diversion facilities, as well as terrestrial effects of water deliveries to FRWP. The BiOp concludes that the effects of the proposed action of the formal and early consultation, including conservation measures, and the cumulative effects, are not likely to jeopardize the continued existence of the listed species within the action area. An incidental take statement with reasonable and prudent measures and non-discretionary terms and conditions necessary and appropriate to minimize incidental take associated with the project is included in the BiOp.

The NMFS BiOp covers the effects of construction, maintenance and operation of the FRWP diversion facilities on listed anadromous species known to exist within the action area. The BiOp concluded that the project is not likely to jeopardize the continued existence of the above listed species or adversely modify designated critical habitat. An incidental take statement with reasonable and prudent measures and non-discretionary terms and conditions necessary and appropriate to minimize incidental take associated with the project is included in the BiOp.

4.6 CALFED Bay-Delta Program

The CALFED Program is a collaborative effort of 23 Federal and State agencies focusing on restoring the ecological health of the Bay-Delta Estuary while ensuring water quality improvements and water supply reliability to all users of the Bay-Delta water resources (CALFED 2000b). The CALFED Program includes a range of balanced actions that can be taken forward to a comprehensive, multi-agency approach to managing Bay-Delta resources. The Bay- Delta watershed includes the Sacramento and San Joaquin rivers and tributaries (e.g., Feather and lower American rivers).

4.7 Environmental Water Account

The Environmental Water Account (EWA), as described in the CALFED Record of Decision (ROD), is a key component of CALFED's water management strategy. Created to address the problems of declining fish populations and water supply reliability, the EWA is an adaptive management tool that aims to protect both fish and water users as it modifies water project operations in the Bay-Delta. The EWA provides water for the protection and recovery of fish beyond that which would be available through the existing baseline of regulatory protection related to project operations. The EWA buys water from willing sellers or diverts surplus water when safe for fish, then banks, stores, transfers and releases it as needed to protect fish and compensate water users for deferred diversions (USFWS 2004b).

To date, EWA actions taken to benefit at-risk native fish species range from CVP/SWP export pumping curtailments, which directly reduce incidental take at the CVP and SWP pumps in the South Delta, to augmenting instream flows and Delta outflows. Beneficial changes in SWP and CVP operations could include changing the timing of water exports from Delta pumping plants to coincide with periods of greater or lesser vulnerability of various fish species to environmental conditions in the Delta. For example, EWA or its functional equivalent might alter the timing of water diversions from the Delta and carry out water transfers to reduce fish entrainment at the pumps and provide for migratory cues for specific anadromous fish species.

5.0 Potential Effects

5.1 Approach

5.1.1 Reservoirs

To evaluate the potential effects of the proposed water transfer on reservoir fisheries, seasonal changes in storage/elevation under the No Action Alternative (i.e., without transfer) and the Proposed Action Alternative (i.e., with transfer) were compared. Reservoir end-of-month storage at French Meadows and Hell Hole reservoirs were determined from PCWA's monthly operations forecast. End-of-month storage at Folsom Reservoir under the No Action Alternative was obtained from Reclamation's May 2015 operations 90% Runoff High and Low Release options and from updated 90% exceedance inflow forecasts from PCWA and SMUD. Differences in end-of-month storages between the No Action Alternative and Proposed Action Alternative were used to evaluate the potential for reduced physical habitat availability and coldwater volume in Action Area reservoirs. Reservoir specific area-capacity curves were also used to translate estimates of storage changes into relative changes in water surface elevations under the alternatives. The estimated values for changes in water surface elevations were used to examine the potential for increases in the frequency of warmwater fish nest-dewatering, where applicable.

Coldwater Fisheries

During the period when Action Area reservoirs are thermally stratified (generally, April to November), coldwater fish in the reservoir reside primarily within the reservoir's metalimnion (middle of the reservoir) and hypolimnion (near bottom) where water temperatures remain suitable. Reduced reservoir storage during this period could reduce the reservoir's coldwater volume, thereby reducing the quantity of habitat available to coldwater fish species during these months. Reservoir coldwater volume generally decreases as reservoir storage decreases, although not always in direct proportion because of the influence of reservoir basin morphomentry. Therefore, to assess potential storage-related effects to coldwater fish habitat availability in French Meadows, Hell Hole, and Folsom reservoirs, end-of-month storage estimates for each reservoir (April–November) was compared between the Proposed Action Alternative and the No Action Alternative. Substantial reductions in reservoir storage were considered to result in substantial reductions in coldwater pool volume and, therefore, habitat availability for coldwater fish.

The criteria used to evaluate potential effects to the coldwater fisheries in Action Area reservoirs are as follows:

- Decrease in reservoir storage, which also would reduce the coldwater volume under the Proposed Action Alternative relative to the No Action

Alternative with sufficient magnitude or duration to adversely affect coldwater fish during the April to November period.

Warmwater Fisheries

Warmwater fish species in reservoirs (including black bass, largemouth bass, smallmouth bass, spotted bass, green sunfish, crappie, and catfish) use the warm upper layer of the reservoirs and nearshore littoral habitats throughout most of the year. Therefore, seasonal changes in reservoir storage, as it affects reservoir water surface elevation (feet msl), and the rates at which the water surface elevation change during specific periods of the year, can directly affect the reservoir's warmwater fish resources. Lower water surface elevations can potentially reduce the availability of nearshore littoral habitats used by warmwater fish for rearing, thereby potentially reducing rearing success and subsequent year-class strength. In addition, decreases in reservoir water surface elevation during the primary spawning and incubation period for warmwater fish may result in reduced initial year-class strength through warmwater fish nest "dewatering." The analysis of impacts to warmwater fishes is limited to Folsom Reservoir as it is the only reservoir within the Action Area to support warmwater fisheries.

Although black bass spawning may begin as early as February, or as late as May, in various California reservoirs, and may possibly extend to July in some waters, the majority of black bass and other centrarchid spawning in California occurs from March through May (Lee 1999; Moyle 2002). For this analysis, the warmwater fish-spawning period is assumed to extend from March through June to determine the potential impact of nest dewatering. The period from April through November was assumed as appropriate for assessing effects on warmwater juvenile fish rearing.

Review of the available literature suggests that, on average, self-sustaining black bass populations in North America experience a nest success (i.e., the nest produces swim-up fry) rate of 60 percent (Friesen 1998; Goff 1986; Hunt and Annett 2002; Hurley 1975; Knotek and Orth 1998; Kramer and Smith 1962; Latta 1956; Lukas and Orth 1995; Neves 1975; Philipp et al. 1997; Raffetto et al. 1990; Ridgway and Shuter 1994; Steinhart 2004; Turner and MacCrimmon 1970). A study by CDFW, which examined the relationship between reservoir water surface elevation fluctuation rates and nesting success for black bass, suggests that a reduction rate of approximately six feet per month or less would result in 60 percent nest success for largemouth bass and smallmouth bass (Lee 1999). Therefore, a decrease in reservoir water surface elevation of six feet or more per month is selected as the threshold beyond which spawning success of nest-building, warmwater fish could potentially result in population declines.

To evaluate potential effects on largemouth bass, smallmouth bass, and other warmwater fish, the frequency of occurrence of month-to-month (March through June) reservoir reductions of six feet or more under the Proposed Action Alternative and the No Action Alternative was compared.

The criteria used to evaluate potential effects on the warmwater fisheries in Folsom Reservoir are as follows:

- Decrease in month-to-month reservoir water surface elevations (March-June) of more than six feet per month under the Proposed Action Alternative relative to the No Action Alternative with sufficient frequency to reduce warmwater fish spawning success.

- Decrease in water surface elevations of sufficient magnitude from April through November to appreciably reduce the availability of nearshore littoral habitats used by warmwater fish for rearing (thereby potentially reducing rearing success and subsequent year-class strength) under the Proposed Action Alternative relative to the No Action Alternative.

5.1.2 Rivers

Instream flow and water temperature are important parameters related to the production and condition of aquatic resources in riverine environments. Instream flow, and the magnitude and duration of flow fluctuation events, may affect fish populations, particularly salmonid populations, by changing the amount of available habitat or altering spawning success. Rapid decreases in flow have the potential to affect the survival of eggs and alevins by exposing redds or strand juveniles in pools and side channels depending on the timing. Changing flows may also influence water temperature and predation thereby affecting overall survival. In addition, water temperatures influence metabolic, physiologic, and behavioral patterns, as well as fecundity and overall spawning success of fish populations (SWRI 2003).

The general criteria used to evaluate potential effects to fisheries and other aquatic resources in the Action Area rivers are as follows:

- Decrease in river flows or increase in water temperatures under the Proposed Action Alternative relative to the No Action Alternative of sufficient magnitude or duration to appreciably reduce the habitat suitability of river fisheries and aquatic resources, or result in redd dewatering or juvenile stranding.

In the lower American and Sacramento rivers, evaluation of potential effects resulting from changes in river flows and water temperature under the Proposed Action Alternative relative to the No Action Alternative was focused on the species of primary management concern namely anadromous salmonids (e.g., winter-run Chinook salmon, spring-run Chinook salmon, fall/late fall-run Chinook salmon, and steelhead) and green sturgeon. The effects analysis focused on determining potential effects to anadromous salmonids because their life history requirements are generally more restrictive than those of other fish species found in the rivers. Thus, if anadromous salmonids are not affected by the Proposed Action Alternative relative to the No Action Alternative, it is unlikely that other, less sensitive fish species (e.g., splittail, American shad, and striped bass) would be affected. In the North Fork and Middle Fork American River, the analysis focused on resident rainbow trout and brown trout.

The criteria used to evaluate potential effects on anadromous salmonids in the lower American and Sacramento rivers and resident salmonids in the North Fork and Middle Fork American rivers are as follows:

- Decrease in river flows or increase in water temperatures under the Proposed Action Alternative relative to the No Action Alternative of sufficient magnitude or duration to notably reduce the suitability of habitat conditions during adult immigration (anadromous salmonids) or adult residency (resident salmonids).

- Decrease in river flows or increase in water temperatures under the Proposed Action Alternative relative to the No Action Alternative with sufficient magnitude or duration to appreciably reduce spawning habitat availability and incubation.

- Decrease in river flow and associated decrease in stage under the Proposed Action Alternative relative to the No Action Alternative of sufficient magnitude or duration to notably increase redd dewatering or juvenile stranding.

- Decrease in flow or increase in water temperature under the Proposed Action Alternative relative to the No Action Alternative of sufficient magnitude or duration to appreciably reduce the suitability of habitat conditions during juvenile rearing.

In the lower American and Sacramento rivers, similar considerations were included in the effects assessment for green sturgeon.

At the Freeport Intake, changes in flows in the lower Sacramento River and increased diversions associated with the water transfer have the potential to impact fisheries and aquatic resources. The criteria used to evaluate potential effects on sensitive species and other aquatic species in the vicinity of the Freeport Intake are as follows:

- Increase in the diversion rate or annual water delivery at the Freeport Intake under the Proposed Action Alternative relative to the No Action Alternative of sufficient magnitude to be inconsistent with the BiOps prepared by USFWS and NMFS for the Freeport Intake in 2008/2009 or ITP issued by CDFW in 2011.

5.2 Impact Analysis

5.2.1 French Meadows and Hell Hole Reservoirs

Under the Proposed Action Alternative, combined storage at French Meadows and Hell Hole reservoirs would be reduced by 12,000 AF in 2015. Under the No Action Alternative, the 2015 carryover storage is expected to be approximately 94,500 AF and 82,500 AF under the Proposed Action Alternative. Under the Proposed Action Alternative, storage in French Meadow and Hell Hole Reservoir would remain above FERC minimum specified storage levels.

Coldwater Fisheries

Hell Hole and French Meadows reservoirs support coldwater recreational salmonid fisheries. The anticipated decreases in storage in these reservoirs would not be expected to notably affect the reservoir's coldwater fisheries because: (1) coldwater habitat would remain available within the reservoirs during all months; (2) physical habitat availability would not be substantively reduced; and (3) anticipated seasonal reductions in storage would not be expected to notably affect the primary prey species utilized by coldwater fishes. Therefore, changes in end-of-month storage under the Proposed Action Alternative would not result in effects to coldwater fish resources in Hell Hole or French Meadows reservoirs.

5.2.2 Middle Fork and North Fork American Rivers

Operations of the MFP under existing conditions currently result in highly variable flows on a daily and weekly basis as a result of peaking operations at Oxbow Powerhouse. Under the Proposed Action Alternative, additional on-peak generation would be produced in MFP powerhouses associated with the 12,000 AF of transfer water. The minimum and maximum flow rates for the day would remain the same as under the No Action Alternative, although the duration of the maximum flow would increase during the daily on-peak generation period. Therefore, the overall increase in flow releases into these river reaches from the MFP under the Proposed Action Alternative would result in only a small increase in the duration of peak (higher) flows when transfer water is released. This is similar to what would occur in hydrologically wetter years. On a daily and monthly basis, the overall variability of flows in the river reaches would remain the same under the Proposed Action Alternative.

Periodic dewatering of the stream margins during hydroelectric peaking operations has been shown to limit the ability of aquatic invertebrates to colonize these areas and achieve the densities that occur in areas that are constantly submerged (Gislason 1985). Differences in flow regime may provide a partial explanation for somewhat higher aquatic invertebrate diversity (taxa richness) in the control reaches where flows are relatively stable during the summer and fall. Aquatic invertebrates such as stoneflies, which may contribute to the forage base for fish, are more likely to successfully colonize and reproduce in an environment with more stable flow conditions.

Flows under the Proposed Action Alternative would not fluctuate beyond existing minimum and maximum ranges. Therefore, no effects to aquatic macroinvertebrate habitat availability are anticipated. The increased flow releases under the Proposed Action Alternative would not increase the magnitude of flows in the Middle Fork American River and therefore, would not affect benthic macroinvertebrate assemblages. Also, the magnitude or velocity of flow releases under the Proposed Action Alternative would not increase above current peaking levels; therefore, there is no additional risk of potentially disrupting or displacing benthic macroinvertebrates or suitable habitat.

Further, the temperature of water released from Oxbow Powerhouse would not change with the implementation of the Proposed Action Alternative. Due to an increase in the duration of higher flows during the water transfer, thermal heating of the water in the river reach would be less under the Proposed Action Alternative and No Action Alternative.

Similar, but slightly less observable changes in flow and water temperature would be expected to occur in the North Fork American River due to flow attenuation. The temperature of water in the lower North Fork American River under the Proposed Action during the July through September releases from the MFP would be 1.6 – 2.2˚F cooler than under the No Action Alternative (Appendix D). During the rest of the year the inflow temperature and the amount of inflow would the same under the Proposed and No Action Alternatives. Therefore, changes in flow and water temperature associated with the Proposed Action Alternative would have a slightly beneficial effect on salmonid fisheries and cold water aquatic resources in Middle Fork and North Fork American rivers and on inflow temperature into Folsom Reservoir.

5.2.3 Folsom Reservoir

Under the Proposed Action Alternative, Folsom Reservoir monthly storage would increase ≤12,000. The transfer water entering Folsom Reservoir from the North Fork American River in July through September would be 1.6 – 2.2˚F colder than the No Action Alternative inflow temperatures (Appendix D). While the inflow would not be cold enough to enter the coldwater hypolimnion, it would be cool enough, ≤70˚F, to increase coldwater volume in the metalimnion and therefore would have a small beneficial effect on salmonids in the reservoir. The daily and monthly changes in Folsom Reservoir storage under the Proposed Action Alternative would not decrease reservoir elevations (<6 ft) and therefore would be protective of warmwater fishery.

5.2.4 Lower American River

The transfer releases into the lower American River under the Proposed Action Alternative would be up to 155 cfs higher in late August through November than the flow releases under the No Action Alternative. The July through September releases from the MFP into Folsom Reservoir and the subsequent release of the water from Folsom Reservoir into the lower American River for delivery to EBMUD in late August through November would have a small beneficial effect on the amount of physical habitat and water temperature in the lower American River for salmonids at the time of the release to EBMUD. Water temperature is a particularly important consideration for the lower American River steelhead and fall-run Chinook salmon. Seasonal releases from Folsom Reservoir's coldwater hypolimnion and blending of those releases with warmer water epi- and metalimnion water via shutter settings and flow volumes through individual powerhouses influence thermal conditions for the lower American River. Folsom Reservoir's coldwater volume oftentimes is not large enough to allow for optimum coldwater releases during the warmest months (i.e., July through September) to provide thermal benefits to steelhead and during October and November to provide thermal benefits for fall-run Chinook salmon immigration, spawning, and incubation. Implementation of the Proposed Action (including increasing July/August Folsom Reservoir inflow 12,000 AF and increasing lower American River August/September outflow) has a small beneficial effect on water temperature in the lower American River (e.g., 1˚F reduction in summer water temperature; Appendix D Table 4). The best lower American River water temperature schedule that can be achieved given Reclamation's reservoir operations will either not be affected or slightly reduced (benefitted) by the Proposed Action.

Adult Fall-run Chinook Salmon/Steelhead Immigration

Adult upstream immigration of fall-run Chinook salmon generally occurs from August through December, whereas steelhead adult immigration generally occurs from December into March. The increased flow rates associated with the Proposed Action Alternative in Julythrough September in the lower American River below Nimbus Dam are not sufficient to affect the attraction of adult fall-run Chinook salmon immigrating into the lower American River. Adult steelhead immigration is unaffected by the Proposed Action because that generally occurs after the proposed transfer would be completed.

Adult Fall-run Chinook Salmon Spawning and Egg Incubation

Fall-run Chinook salmon spawning and incubation in the lower American River generally occurs from October to March, which is potentially when the period when flow changes would occur under the Proposed Action Alternative. It is anticipated that releases would be completed in October before the primary spawning period occurs. If releases extend into November, it would be based on a recommendation from the American River Group (ARG) to release water flows during November to enhance spawning habitat. Therefore, the Proposed Project would have no negative effect on fall-run Chinook salmon spawning.

Adult Steelhead Spawning and Egg Incubation

In the lower American River, steelhead spawning generally extends from late-December to April. Higher flow releases in late August through November under the Proposed Action do not affect the steelhead spawning and egg incubation period.

Juvenile Fall-run Chinook Salmon and Steelhead Rearing and Emigration

The juvenile fall-run Chinook salmon rearing and emigration period extends from late-December into June. The flow increases in late August through under the Proposed Action will not affect rearing habitat for juvenile fall-run Chinook salmon in the lower American River.

The primary period of steelhead smolt emigration occurs from March through June (Castleberry et al. 1991). It has been reported that steelhead move downstream as young-of-the-year (YOY) in the lower American River (Snider and Titus 2000b) from late-spring through summer. Nonetheless, some juvenile steelhead rearing occurs year-round in the lower American River. The increased flow rates associated with the Proposed Action Alternative in the lower American River below Nimbus Dam would slightly increase the amount of habitat available for juvenile steelhead rearing in late August through November. Water temperatures in the lower American River would be slightly cooler (beneficial) with the implementation of the Proposed Action Alternative.

The cessation of water transfer flows in October/November could potentially strand rearing juvenile steelhead. However, the reduction from the transfer flows back to base flows (up to 155 cfs change) corresponds to an average stage reduction in the river upstream of Watt Avenue of 3.1 to 4.0 inches depending on a base flow of 800 or 500 cfs, respectively (base flows of the High and Low Release Reclamation forecasts) and is not of sufficient magnitude to strand rearing juvenile steelhead in the lower American River. Additionally, Reclamation typically implements river flow changes overnight, which has been shown to reduce potential stranding. The Proposed Action Alternative would not have an effect on stranding of juvenile steelhead.

American Shad

American shad immigration generally occurs from April through June, with corresponding spawning and egg incubation occurring from mid-May through June. The flows under the Proposed Action Alternative do not change during the immigration and incubation period for American shad; therefore, no adverse impacts are anticipated.

Striped Bass

Striped bass spawning, embryo incubation, and initial rearing period may begin in April, but generally peaks in May and early-June. Because flows under the Proposed Action Alternative would not change during this time period, striped bass spawning, embryo incubation, and initial rearing period would not be affected under the Proposed Action Alternative. In the lower American River, sub adult and adult striped bass have been observed opportunistically foraging during other months of the year. However, because flows under the Proposed Action Alternative would not appreciably change throughout the year, striped bass would not be notably affected under the Proposed Action Alternative.

Sacramento Splittail

Sacramento splittail spawning, egg incubation, and initial rearing can occur between late February and early July, but peak spawning occurs in March and April. Because flows under the Proposed Action Alternative would not change during this time period, Sacramento splittail spawning, embryo incubation, and initial rearing would not be affected under the Proposed Action Alternative.

Other Fish Species

The life history requirements of anadromous salmonids are generally more restrictive than those of other fish species found in the river. Thus, if anadromous salmonids are not notably affected by the Proposed Action Alternative, it is unlikely that other, less sensitive fish species would be appreciably affected. Because river flow and water temperature do not appreciably change in the lower American River and anadromous salmonids, American shad, striped bass and Sacramento splittail are unaffected by implementation of the Proposed Acton Alternative, other fish species in the lower American River would similarly be unaffected under the Proposed Action Alternative.

5.2.5 Sacramento River

Based on projections from Reclamation and PCWA, flows in the lower Sacramento River (below the confluence with the lower American River to the Freeport Intake) during the transfer would increase by less than 2 percent under the Proposed Action Alternative. Because the change in flow is negligible, fish and aquatic resources in the lower Sacramento River below the confluence with the lower American River would not be affected.

Winter-run Chinook Salmon

Adult winter-run Chinook salmon immigration and holding in the Sacramento River occurs from December through July, with a peak from January through April.

Relatively minor potential changes in flow or water temperature would not be of sufficient magnitude or duration to affect the physical habitat availability or water temperature suitability of winter-run Chinook salmon adult immigration and holding under the Proposed Action Alternative. Winter-run Chinook salmon primarily spawn in the main-stem Sacramento River between Keswick Dam (RM 302) and Red Bluff Diversion Dam (RM 243) between late-April and mid-August, with a peak generally in June. Winter-run Chinook salmon embryo incubation in the Sacramento River can extend into October. Therefore, winter-run Chinook salmon spawning and incubation would not be affected by the Proposed Action Alternative.

Winter-run Chinook salmon fry rearing and emigration in the upper Sacramento River can extend from June through April. Emigration of winter-run Chinook salmon juveniles past Knights Landing, approximately 155.5 river miles downstream of the Red Bluff Diversion Dam, reportedly occurs between November and March, peaking in December, with some emigration continuing through May in some years. Relatively minor potential changes in flow or water temperature would not be of sufficient magnitude or duration to affect the physical habitat availability or water temperature suitability of winter-run Chinook salmon juvenile rearing and emigration. In addition, the slight decrease in flow at the cessation of the water transfer would not result in an appreciable change in stage, and would not be expected to result in juvenile stranding.

Spring-run Chinook Salmon

Adult spring-run Chinook salmon use the lower Sacramento River only as a migration corridor to spawning areas in upstream tributaries. The slight increase in flow in the lower Sacramento River under the Proposed Acton Alternative would not result in an appreciable change in the migration of salmon.

Once incubation is completed and fry emerge from the redds, some portion of an annual year-class may emigrate as post-emergent fry, and some rear in the upper Sacramento River and tributaries during the winter and spring and emigrate as juveniles. The timing of juvenile emigration from the spawning and rearing grounds varies among the tributaries of origin, and can occur during the period extending from October through April. The slight increase in late August through November flows in the lower Sacramento River under the Proposed Action Alternative would not result in a change in outmigration success.

Under the Proposed Action Alternative, critical habitat for the spring-run Chinook salmon in the Sacramento River would not be affected.

Fall-run Chinook Salmon

Adult fall-run Chinook salmon generally begin migrating upstream annually as early as June, with immigration continuing through December in most years. Adult fall-run Chinook salmon immigration generally peaks in October, and typically greater than 90 percent of the run has entered the river by the end of November. Relatively minor changes in flow in the lower American River under the Proposed Action Alternative would not be of sufficient magnitude or duration to appreciably affect adult salmon migration. Fall-run Chinook salmon only use the lower Sacramento River as a migration corridor, therefore implementation of the Proposed Action Alternative would not affect Chinook salmon spawning habitat or incubation success.

Fall-run Chinook salmon fry emergence generally occurs from late-December through March, and juvenile rearing and emigration occurs from January through June. The slight increase in late August through November flows in the lower Sacramento River under the Proposed Action Alternative would not result in a change in outmigration success.

Late Fall-Fun Chinook Salmon

Late fall-run Chinook salmon immigration in the Sacramento River occurs from October through April, with a peak during December. Very minor changes in flow would occur under the Proposed Action Alternative and there would not be an effect on late fall-run Chinook salmon adult immigration. Late fall-run Chinook salmon only use the lower Sacramento River as a migration corridor, therefore implementation of the Proposed Action Alternative would not affect Chinook salmon spawning habitat or incubation success.

Post-emergent fry and juveniles emigrate from their spawning and rearing grounds in the upper Sacramento River and its tributaries during the April through December period. Juvenile rearing can extend from seven to thirteen months in the Sacramento River subsequent to emergence. The slight increase in flows during the water transfer would not result in an appreciable change in outmigration success.

Steelhead

Adult steelhead immigration generally can extend from August into March, with peak immigration during January and February. Relatively minor potential changes in flow under the Proposed Action Alternative in the lower Sacramento River would not be of sufficient magnitude or duration to affect adult steelhead migration. Steelhead only use the lower Sacramento River as a migration corridor, therefore implementation of the Proposed Action Alternative would not affect steelhead spawning habitat or incubation success.

Juvenile steelhead rearing can extend year-round in the Sacramento River, and the primary period of steelhead smolt emigration occurs from March through June. Flows would not change during the emigration period and there would not be change in outmigration success.

Under the Proposed Action Alternative, critical habitat for the Central Valley steelhead in the Sacramento River would not be affected.

Green Sturgeon

Green sturgeon begin their inland migration in late-February, and enter the Sacramento River between February and late-July. Spawning activities occur in the upper Sacramento River from March through July, with peak activity believed to occur between April and June. The lower Sacramento River is primarily used as a migration corridor, therefore, implementation of the Proposed Action Alternative would not affect sturgeon spawning habitat or incubation success. Flow would not change under the Proposed Action Alternative in the lower Sacramento River during the migration period and there would not be an effect on green sturgeon immigration.

Juvenile green sturgeon reportedly rear in their natal streams year-round. It is expected that water temperatures in the lower Sacramento River would not change with the implementation of the Proposed Action Alternative. Relatively minor potential changes in flow or water temperature in the lower American River would not be of sufficient magnitude or duration to affect the physical habitat availability or water temperature suitability of green sturgeon juvenile rearing.

American Shad
American shad immigration and spawning generally occurs from mid-May through June, which is outside the Proposed Action Alternative period. Therefore, American shad immigration and spawning are not expected to change under the Proposed Action Alternative.

Striped Bass
Striped bass spawning, embryo incubation, and initial rearing in the Sacramento River would not be affected by the Proposed Action Alternative because flows during the period of these lifestages would not change under the Proposed Action Alternative.

Sacramento Splittail
Sacramento splittail spawning, egg incubation, and initial rearing can occur between late February and early July, with peak spawning in March and April. Flows in the lower Sacramento River under the Proposed Action Alternative would not change during this time period and there would not be a change in Sacramento splittail habitat.

Other Fish Species
The life history requirements of anadromous salmonids are generally more restrictive than those of other fish species found in the river. Thus, if anadromous salmonids are not notably affected by the Proposed Action Alternative, it is unlikely that other, less sensitive fish species would be appreciably affected. Because river flow and water temperature do not appreciably change in the lower Sacramento River and anadromous salmonids, green sturgeon, American shad, striped bass, and Sacramento splittail are unaffected by implementation of the Proposed Acton Alternative , other fish species in the lower Sacramento River would similarly be unaffected under the Proposed Action Alternative.

5.2.6 Freeport Intake Impacts
The BiOps prepared by USFWS and NMFS for the Freeport Intake (2008/2009) were based on a maximum diversion rate at the Freeport Intake of 185 MGD (286 cfs). The ITP issued by CDFW in 2011 cited this maximum diversion rate and also included a maximum water year delivery (October-September) of 147,000 AF. As described in Section 2, the fish screen installed at the Freeport Intake is in compliance with design criteria and guidelines issued by CDFW, USFWS and NMFS for protection of Delta smelt and salmonids from impingement and entrainment.

Since the maximum diversions at the Freeport Intake, including the PCWA transfer, will be below the values considered in the BiOps for the facility, and are less than the maximums specified in the ITP, the current fish screen will adequately protect fish from impingement and entrainment at the Freeport Intake and effects would be expected to fall within the range of effects already covered by previous BiOps and the Freeport ITP.

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Appendix D:

Technical Memorandum

2015 Placer County Water Agency and East Bay Municipal Utility District Transfer

Effects on Folsom Reservoir and the Lower American River

Placer County Water Agency

July 2015

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List of Acronyms

AF	acre-feet
ATSP	Automated Temperature Selection Procedure
cfs	cubic feet per second
California ISO	California Independent System Operator
CVP	Central Valley Project
Delta	Sacramento-San Joaquin Delta
EBMUD	East Bay Municipal Utility District
F	Fahrenheit
Freeport	Freeport Regional Water Project
LAR	Lower American River
MET	Meteorological
MFP	Middle Fork American River Project
MFAR	Middle Fork American River
NFAR	North Fork American River
PCWA	Placer County Water Agency
Reclamation	U.S. Bureau of Reclamation
SFAR	South Fork American River
SWRCB	State Water Resources Control Board
TCD	Temperature Control Device
WWD	Westlands Water District

EXECUTIVE SUMMARY

Placer County Water Agency (PCWA) and East Bay Municipal Utility District (EBMUD) propose a transfer of 12,000 acre-feet (AF) of surplus PCWA water to EBMUD in 2015 (Transfer). The Transfer water is currently stored in PCWA's Middle Fork American River Project (MFP) reservoirs and would not otherwise be released absent the Transfer. A standard 5% carriage loss (600 AF) of the Transfer water through Folsom Reservoir would result in EBMUD receiving 11,400 AF at the Freeport Regional Water Project (Freeport) Intake. PCWA will enter into a MFP Refill Agreement with the United States Bureau of Reclamation (Reclamation) to ensure non-injury to any downstream legal water users as a result of the Transfer, similar to refill agreements for previous PCWA transfers.

Transfer water would be released July through September from the MFP into the Middle Fork American River (MFAR) and then into the North Fork American River (NFAR) and Folsom Reservoir. Inflow from the NFAR to Folsom Reservoir during the July through September Transfer period would increase 33% (36,369 to 48,369 AF) as a result of the Transfer. Reclamation would provide the Transfer water to EBMUD on a schedule that is mutually agreeable and/or beneficial to Reclamation, EBMUD, and the environment. The Transfer release schedule would be bracketed by a combination of two release options:

- Option 1 (primary): Transfer water released late-August through November from Folsom Reservoir into the Lower American River (LAR) on top of (in addition to) Reclamation's forecasted 2015 LAR releases.

- Option 2 (secondary): Transfer water released from Folsom Reservoir as part of Reclamation's forecasted 2015 LAR releases.

The exact timing of the PCWA transfer into Folsom Reservoir and the release of the water from Folsom Reservoir to EBMUD may change slightly based on the transfer approval process and coordination with Reclamation. Preliminary modeling indicated that the effects of the transfer were relatively insensitive to the exact timing of the transfer window. Modeling of Option 1 and Option 2 based on a PCWA release to Folsom Reservoir in July and August of 6,000 TAF each month and releases from Folsom Reservoir to EBMUD in late-August and September is representative of conditions that would occur if either the PCWA release to Folsom Reservoir or the release of water from Folsom Reservoir to EBMUD were delayed a month or more. Therefore, the schedule outlined above was used to represent the transfer for the broader transfer window.

If Reclamation released the Transfer water in addition to their forecasted releases (Option 1), the Transfer would increase average LAR flows in August by approximately 2% (2,001 to 2040 or 1,641 to 1680 cubic feet per second [cfs], depending on the Reclamation modeling scenario) and average LAR flows in September by 30% (500 to 651 cfs). The increase in Folsom Reservoir outflows would benefit salmonid rearing habitat in the LAR. Alternatively, if Reclamation incorporated the Transfer water into their forecasted LAR releases (Option 2), the Transfer would increase end-of-September storage in Folsom Reservoir by 12,000 AF and could benefit carryover storage, water supply, and/or future flow-related fish habitat in the LAR.

Detailed CE-QUAL-W2 water temperature modeling indicates that the Transfer would decrease the water temperature of the NFAR inflow into Folsom Reservoir by 1.6 – 2.2˚F and aid LAR temperature management to meet downstream temperature targets at Watt Avenue. Depending on the release pattern implemented, modeling results indicate that an approximate 1˚ Fahrenheit (F) reduction of water temperature in the LAR could be achieved during the warmest part of the year. Because of the extreme drought conditions, the Reclamation forecasted Folsom Reservoir storage and LAR flow scenarios result in temperature regimes above the highest Automated Temperature Selection Procedure (ATSP)[1] schedule (78 ATSP schedule; 72˚F summer) at Watt Avenue. The Transfer slightly reduces the temperature, but not enough to meet an existing ATSP schedule.

The Transfer helps meet Water Forum Agreement[2] drier year objectives for the LAR, increases drier year hydropower generation/grid regulation, and enhances MFP white-water rafting opportunities.

1.0 INTRODUCTION

The proposed 12,000 AF Transfer between Placer County Water Agency (PCWA) and East Bay Municipal Utility District (EBMUD) is in response to California's exceptional drought conditions and will assist EBMUD in meeting their consumptive demand consistent with a Stage 4 critical drought declaration pursuant to the EBMUD Drought Management Program.

The Transfer water released to EBMUD under this proposal is surplus to the needs of PCWA's customer base under a Stage 2 Water Warning enacted under PCWA's Water Shortage Contingency Plan and would not otherwise be released this year absent the Transfer. Additionally, all Transfer water was diverted to storage prior to State Water Resources Control Board (SWRCB) May 1, 2015

[1] Automated Temperature Selection Procedure (ATSP) water temperature schedules identified in the Lower American River Flow Management Standard.

[2] 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.

Curtailment Notice. For the purposes of this Transfer, PCWA will be solely exercising Water Right Permit 13856 (Application 18085). PCWA will enter into a Middle Fork American River Project (MFP) Refill Agreement with the United States Bureau of Reclamation (Reclamation) to ensure non-injury to any downstream legal water users.

PCWA has periodically implemented temporary water transfers in drier water years over the past 25 years (Attachment A; Table 1). Drier year water transfers into Folsom Reservoir and the Lower American River (LAR) are part of the environmental release/enhancement objectives in PCWA's purveyor-specific Water Forum Agreement.

This technical memorandum describes the effects of the proposed 12,000 AF Transfer on the American River watershed downstream of the MFP based on the timing, duration, and volume of the proposed Transfer releases described herein. The technical memorandum includes an analysis of the effects of the proposed Transfer on Folsom Reservoir storage, and LAR hydrology and water temperature. Additional effects from the Transfer such as meeting Water Forum Agreement drier year objectives, greater hydropower generation, improved CAISO grid regulation, increased whitewater rafting opportunities, and providing EBMUD supplemental water supplies are also discussed.

2.0 WATER TRANSFER OPERATIONS

2.1. Water Transfer Overview

Under the proposed Transfer, PCWA would release an additional 12,000 AF of stored MFP water July through September of 2015 through MFP hydroelectric facilities into the MFAR then into the NFAR and Folsom Reservoir (Figure 1). Transfer water would be temporarily stored in Folsom Reservoir pursuant to a Warren Act Contract between EBMUD and Reclamation. A carriage loss of 5% is assumed through Folsom Reservoir providing 11,400 AF of Transfer water to EBMUD for re-diversion at the Freeport Regional Water Project (Freeport) Intake. Reclamation would provide the Transfer water to EBMUD on a schedule that is mutually agreeable and/or beneficial to Reclamation, EBMUD, and the environment. The release of Transfer water from Folsom Reservoir could occur on top of (in addition to), as part of Reclamation's forecasted operations (see Section 2.3 Reclamation Operations Forecast), or as a combination of these two options:

Option 1 (primary): Late-August through November up to 155 cubic feet per second (cfs) of water is released from Folsom Reservoir into the LAR on top of (in addition to) Reclamation's forecasted operation releases of water from Folsom Reservoir (total release of 11,400 AF).

Option 2 (secondary): A total of 11,400 AF of water is transferred to EBMUD as part of Reclamation's forecasted operational releases effectively increasing the end-of-September storage in Folsom Reservoir by 12,000 AF.

Following release of the Transfer water by Reclamation, the water would enter the Sacramento River and then the FPWP Facility Intake on the Sacramento River near Clarksburg.

The exact timing of the PCWA transfer into Folsom Reservoir and the release of the water from Folsom Reservoir to EBMUD may change slightly based on the transfer approval process and coordination with Reclamation. Preliminary modeling indicated that the effects of the transfer were relatively insensitive to the exact timing of the transfer window. Modeling of Option 1 and Option 2 based on a PCWA release to Folsom Reservoir in July and August of 6,000 TAF each month and releases from Folsom Reservoir to EBMUD in late-August and September is representative of conditions that would occur if either the PCWA release to Folsom Reservoir or the release of water from Folsom Reservoir to EBMUD were delayed a month or more. Therefore, the schedule outlined above was used to represent the transfer for the broader transfer window.

Table 1. Proposed Schedule of PCWAs MFP Water Transfer Releases into Folsom Reservoir

Month	Volume (AF)
July	2,000
August	7,000
September	3,000
Total	12,000

2.2. PCWA Operations Forecast

PCWA's operations forecast3 for the MFP with and without the Transfer are provided in Table 2. PCWA's forecast indicates that the Transfer would increase average July inflows to Folsom Reservoir by approximately 30% (19,914 to 25,914 AF) and average August inflows by 36% (16,455 to 22,455 AF).

[3] The operations forecast is a model run that incorporates various assumptions (e.g., hydrology, meteorological conditions, water demand, electrical demand, etc.) and is not an exact representation of future MFP operations.

Table 2. Forecasted PCWA Operations of the MFP[1] at the North Fork American River Below the American River Pump Station With and Without the EBMUD Transfer

Operations Scenario	Jun (AF)	Jul (AF)	Aug (AF)	Sep (AF)	Oct (AF)	Nov (AF)	Dec (AF)
NFAR Flow below ARPS[2] / Without Transfer	27,982	19,914	16,455	10,437	9,371	15,653	46,678
NFAR Flow below ARPS / With 12,000 AF Transfer[3]	27,982	25,914	22,455	10,437	9,371	15,653	46,678

[1] June 2015 Inflow projections through September are based on a 90% 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.
[3] Transfer water includes PCWA Water Forum release obligations.

2.3. Reclamation Operations Forecast

Reclamation operations forecasts for Folsom Reservoir and the LAR have been in dynamic flux due to exceptional drought conditions and SWRCB's suspension of the temperature management plan for Shasta Reservoir and the Sacramento River. PCWA used the most recently updated Folsom Reservoir operations forecasts as the Base Case conditions (baseline) to model hydrology and water temperature effects of the Transfer. The latest Reclamation operations forecasts are shown below in Table 34. Both the high release and low release options were used to model Transfer effects (Base Case or no transfer).

[4] The most recent Reclamation forecast of Folsom Reservoir/LAR operations and the basis for the modeling described in the Technical Memorandum was provided by Reclamation to the American River Operations Group on June 9, 2015.

Table 3. Reclamation Draft June 2015 90% Runoff Exceedance Operations Forecasts

DRAFT June 2015

Low Release Bookend - 90% Historical Inflow Oct-Dec
90% Runoff Exceedance Outlook:

90% Inflow based on PCWA/SMUD adjusted inflow Jun-Sep, 90% Histroical inflow Oct-Dec, Keswick releases at 8000 cfs Jun-Aug, minimal Delta project pumping Jun-Aug

Federal End of the Month Storage/Elevation (TAF/Feet)

		Jun	Jul	Aug	Sep	Oct	Nov	Dec
Folsom	535	422	265	187	171	177	189	211
Elev.		406	381	364	360	361	364	370
Monthly River Releases (cfs)								
American		2435	2997	1641	500	500	504	500

High Release Bookend - 90% Historical Inflow Oct-Dec
90% Runoff Exceedance Outlook:

90% Inflow based on PCWA/SMUD adjusted inflow Jun-Sep, 90% Histroical inflow Oct-Dec, Keswick releases at 7000 cfs Jun-Aug, minimal Delta project pumping Jun-Aug

Federal End of the Month Storage/Elevation (TAF/Feet)

		Jun	Jul	Aug	Sep	Oct	Nov	Dec
Folsom	535	397	196	98	83	89	101	123
Elev.		403	366	334	327	330	336	344
Monthly River Releases (cfs)								
American		2864	3702	2001	500	500	504	503

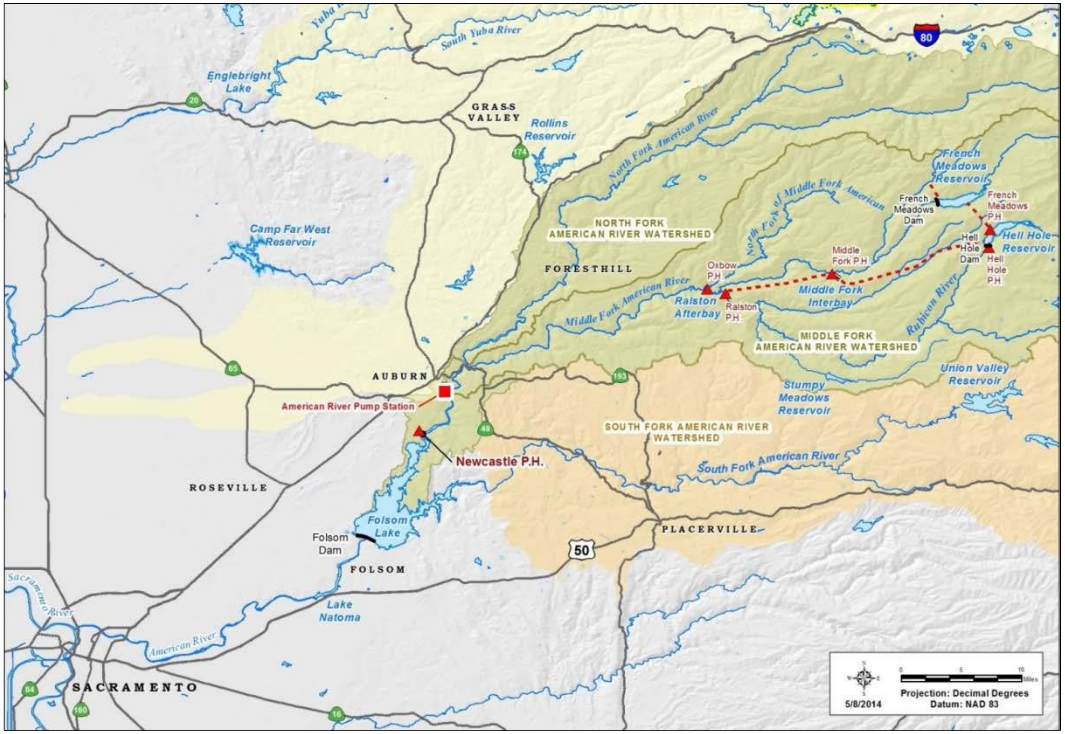


Figure 1. PCWA Middle Fork American River Project, Folsom Reservoir, and Lower American River

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). As a result of the Refill Agreement associated with PCWA water transfers implemented in 2013 and 2014, PCWA's current MFP carryover target for 2015-2016 is 94,500 AF5 (PCWA 2015). Following the proposed Transfer, PCWA would carry an additional 12,000 AF deficit in its carryover target forward in time until conditions identified in the Refill Agreement relieve the deficit (e.g., Folsom Reservoir reaches flood control levels or fills completely). Therefore, the assumed 2015-2016 carryover target would be 82,500 AF instead of the typical 150,000 AF.

3.0 EBMUD WATER SUPPLY EFFECTS

The Transfer would provide EBMUD with water in a year of very critical need6. 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 the Sierra Nevada with a diversion point at Pardee Reservoir in Calaveras and Amador Counties. In dry years, EBMUD supplements its water

[5] The Water Year (WY) 2015 carryover target was 90,000 AF per the 2014 Refill Agreement for the 35,000 AF WWD Transfer, however, with record rainfall occurring in December 2014, PCWA was only able to release enough water to evacuate the MFP reservoirs to 94,500 AF (see June 3, 2015 Memorandum to Ron Milligan, Reclamation).

[6] California is now in its fourth year of drought and the dry conditions are so extreme that water years 2012-2014 now rank as the driest consecutive three-year period on record in terms of statewide precipitation. The continuing drought has severely affected EBMUD's water supply with January 2015 constituting the driest January on record and March 2015 constituting the second driest March on record in the Mokelumne River Basin. Given these conditions, on April 14, 2015, EBMUD's Board of Directors declared a continuing water shortage emergency within EBMUD's service area, declared a Stage 4 critical drought (EBMUD's highest level), adopted a mandatory District-wide water use reduction goal of 20%, declared the need to use the Freeport Facility to deliver supplemental supplies to EBMUD's service area, and increased mandatory restrictions on potable water use.

supplies with 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 are at unprecedented low levels this year and EBMUD's allocation will be just 25%, or 33,250 AF, of the water to which it is entitled under its CVP contract and, in addition, uncertainty exists regarding 2016 water supply conditions. EBMUD is pursuing water transfers in order to prevent or mitigate its existing water supply emergency and ensure its continued ability to provide essential public services. The proposed Transfer is necessary for EBMUD to provide essential public services.

4.0 FOLSOM RESERVOIR STORAGE AND LOWER AMERICAN RIVER FLOW EFFECTS

Depending on how Reclamation releases the Transfer water from Folsom Reservoir, Option 1 or Option 2 (see Section 2.1), the Transfer would increase flows in the LAR and/or storage in Folsom Reservoir. The Option 1 transfer water would increase average August LAR flows by approximately 2% (1,641 to 1,680 cfs or 2,001 to 2,040 cfs, depending on the Reclamation modeling scenario) and average September LAR flows by 30% (500 to 651 cfs) and benefit salmonid rearing habitat in the LAR. The Option 2 transfer would increase September 30th storage in Folsom Reservoir by 12,000 AF and could benefit carryover storage, water supply, or future flow-related habitat in the LAR (Figure 2). Alternatively, some combination of Options 1 and 2 could occur based on system wide operational constraints for the CVP or other factors such as Delta water quality control.

5.0 WATER TEMPERATURE EFFECTS

5.1. Folsom Reservoir Inflow Water Temperature

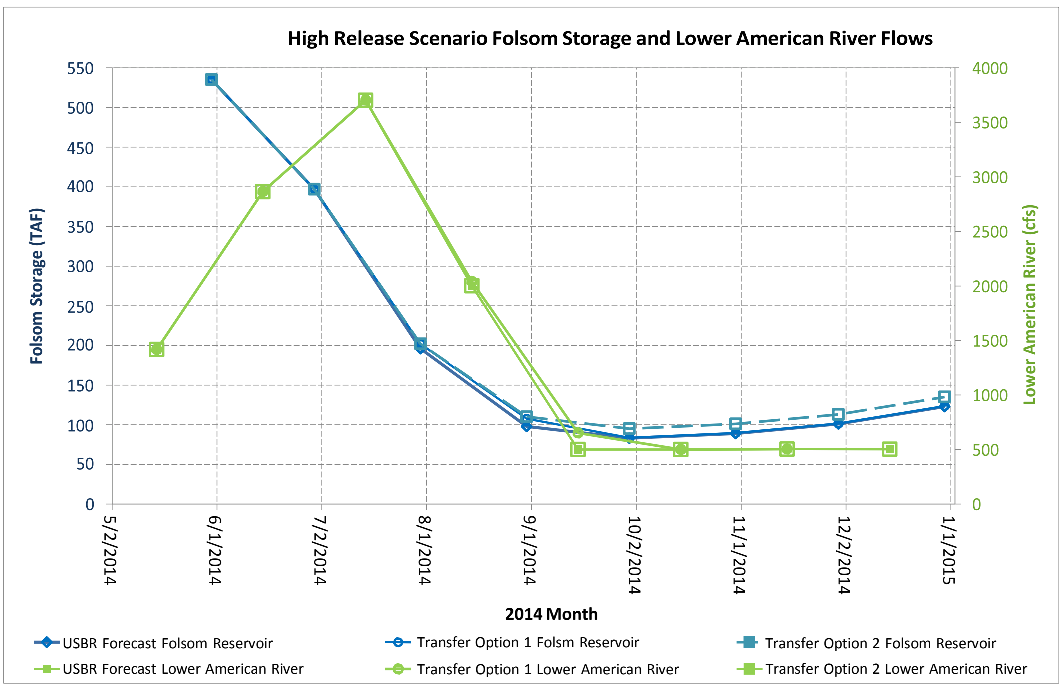
Summer water temperature in the NFAR and South Fork American River (SFAR) decreases with increased flow releases from the upstream hydropower facilities/deep water reservoirs. Inflow water temperature to Folsom Reservoir was determined by using regression models of the inflow water temperature versus flow and air temperature for the two rivers. Details of the regression models are provided in Attachment B of this document. The Base Case (no transfer) amount of inflow in each river was determined by back calculating inflow using the Reclamation 90% exceedance operations forecast for Folsom Reservoir and the LAR (both the High and Low Release options). In the NFAR, the effect of the Transfer water would be to increase NFAR flows into Folsom Reservoir. The Transfer would not affect SFAR inflow to Folsom Reservoir (PCWA does not own or operate any facilities in the SFAR watershed).

5.1.1. North Fork American River

Temperature modeling results for the NFAR just upstream of Folsom Reservoir show a reduction of 1.6 – 2.2˚F in water temperature for July – August as a result of the Transfer (Figure 3). This is a conservative estimate for modeling purposes as the Transfer water was spread evenly over the entire two month inflow period (July – August). It is possible that the water will enter Folsom Reservoir in a more concentrated pattern resulting in cooler inflow temperature than modeled. Attachment C illustrates the accuracy of the temperature modeling based on measured and predicted 2014 inflow temperatures. Also, if the transfer was shifted into September the same type of inflow water temperature cooling would occur.

5.1.2. South Fork American River

SFAR inflow water temperature to Folsom Reservoir is unaffected by the Transfer. The inflow water temperature used for the Folsom Reservoir water temperature modeling is provided in Attachment B. Attachment C illustrates the accuracy of the temperature modeling based on measured and predicted 2014 inflow temperatures.



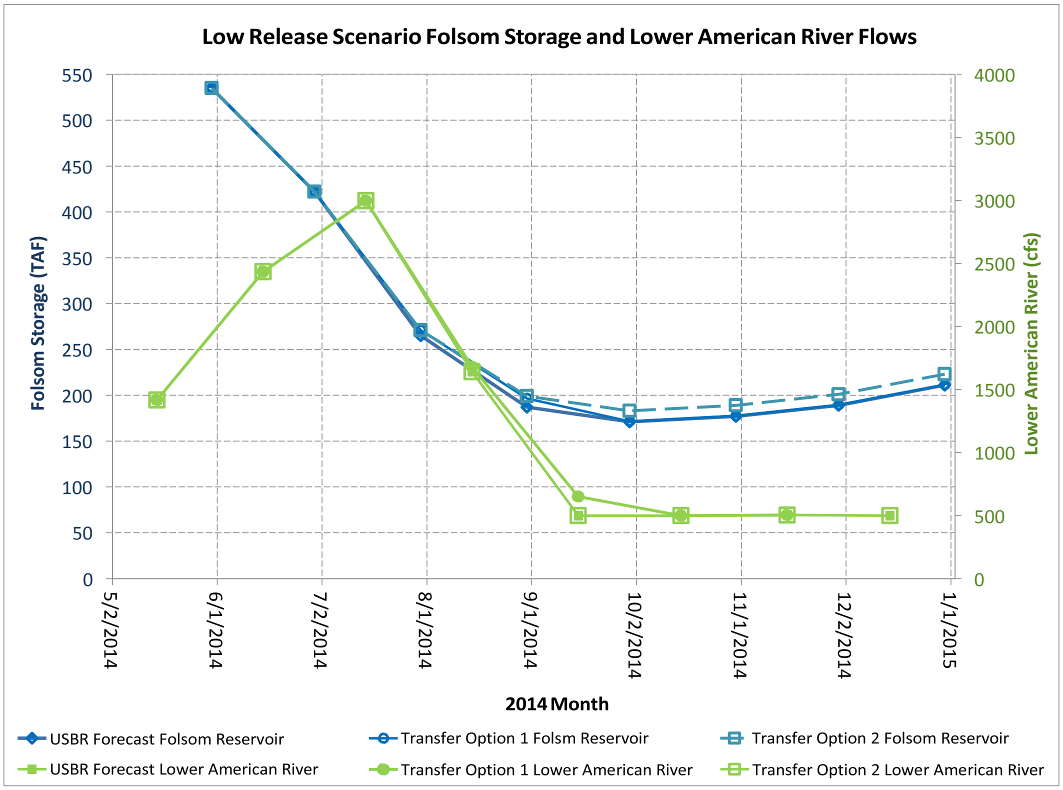
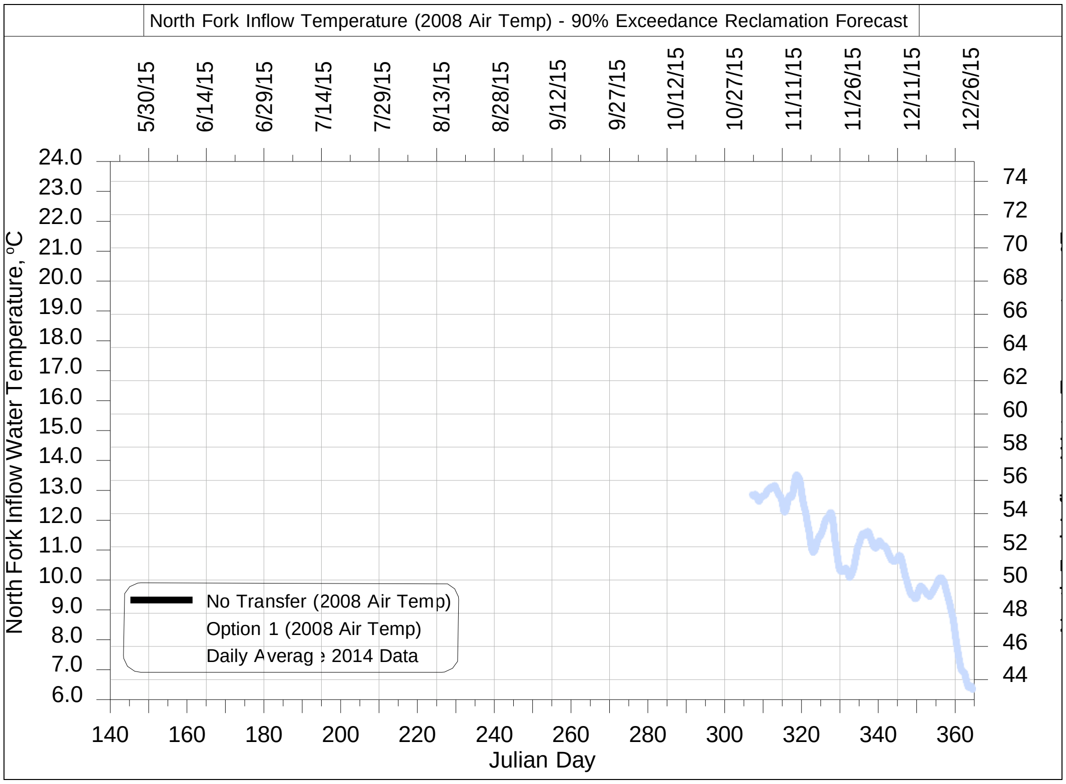


Figure 2. Folsom Reservoir Storage and Lower American River Flow for the Base Case (Reclamation High and Low Release Forecasts) and for the Alternative Water Transfer Release Options 1 and 2.

5.2. Folsom Reservoir and Lower American River Water Temperature Modeling Approach

To model the hydrologic and environmental effects of the Transfer, Reclamation's June 90% exceedance forecast operations scenarios for Folsom Reservoir and the LAR were used as the Base Case. The modeling of the Transfer water releases from Folsom Reservoir was then bracketed using the Option 1 and 2 Folsom Reservoir release scenarios identified above (Section 2.1 Water Transfer Overview).

Water temperature modeling was accomplished with a well-calibrated, state-of-the-art, two-dimensional CE-QUAL-W2 model of Folsom Reservoir (Attachment D) coupled with an accurate regression model of the LAR at Watt Avenue (Attachment E). Meteorological (MET) data from 2008 and 2014, example dry years, was used for the modeling. The 2008 MET data is reasonably representative of average meteorological conditions in recent years (e.g., 2001-2014) and 2014 is representative of a long relatively hot summer (Figure 4).



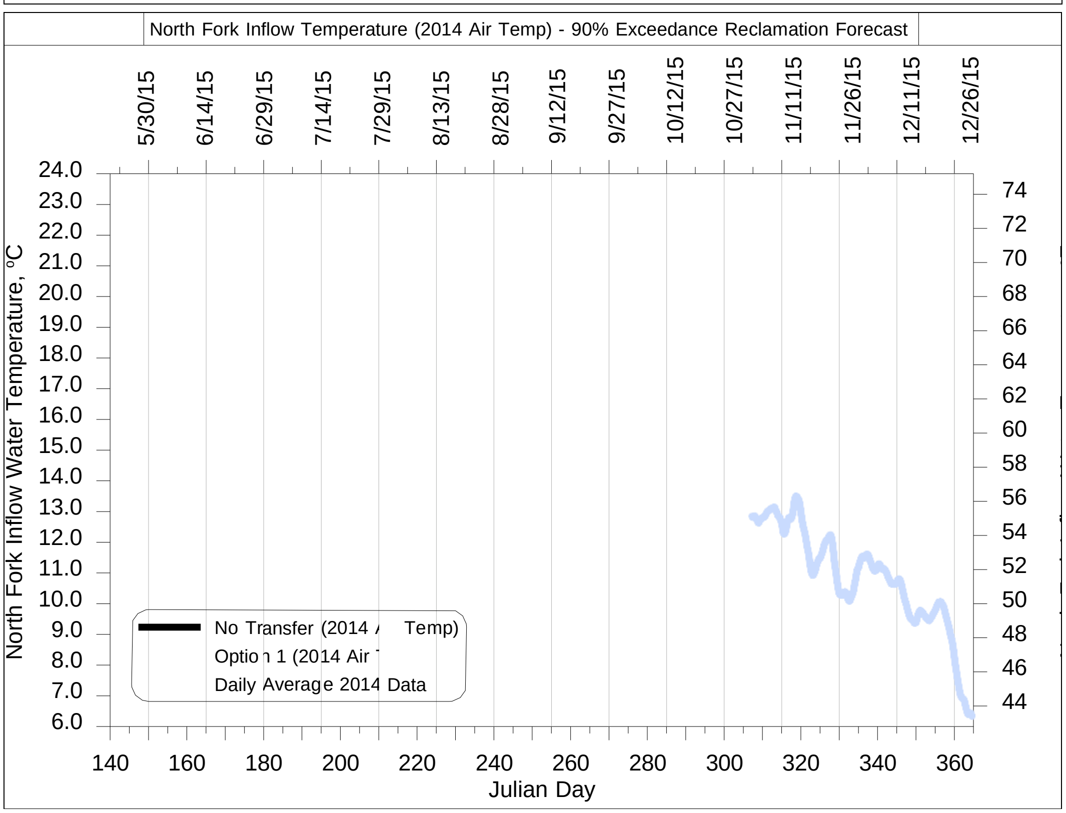
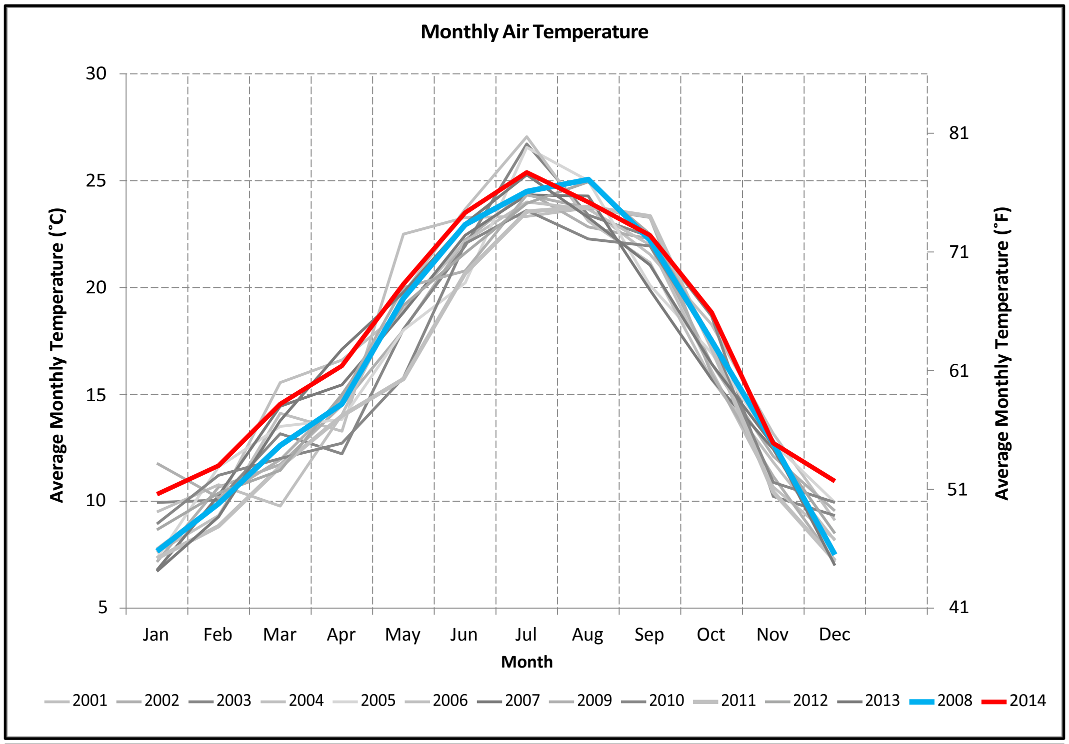


Figure 3. Water Temperature in the North Fork American River upstream of Folsom Reservoir for the Base Case and with the 12,000 AF Water Transfer based on 2008 (top) and 2014 (bottom) Air Temperature



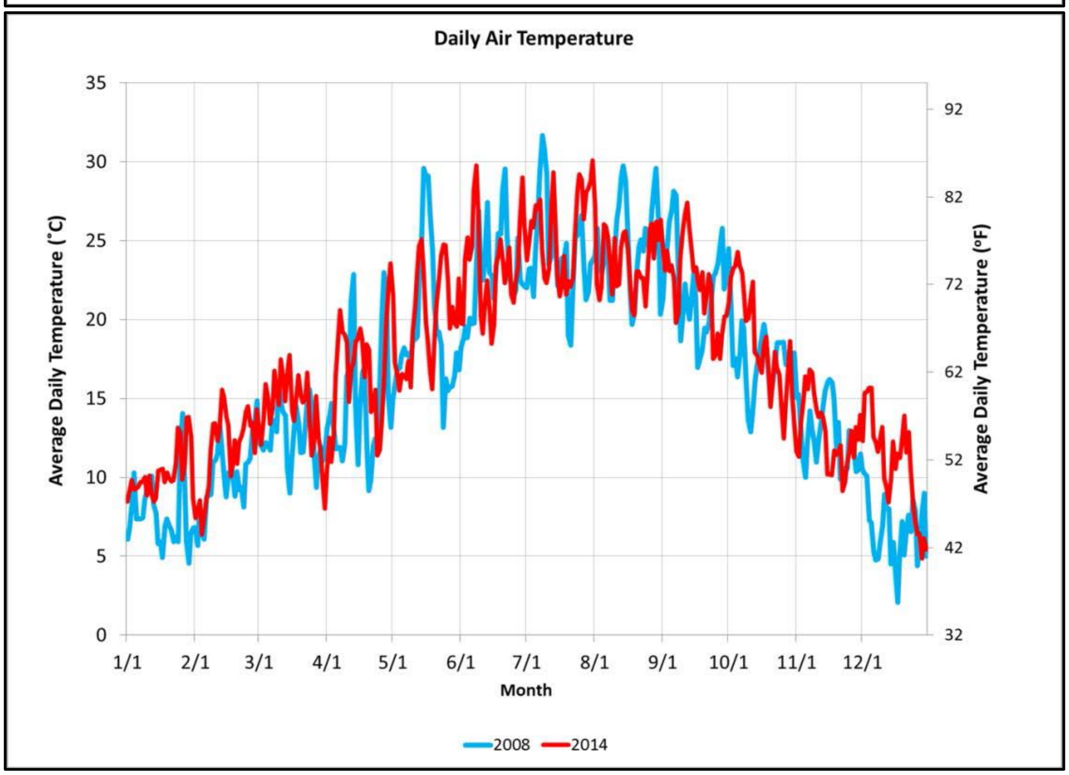


Figure 4. Example of 2008 and 2014 Monthly Meteorolgical (MET) Data (Air Temperature) Compared to Recent (2001-2015) MET Data (top) and Daily 2008 and 2014 Data (bottom).

5.3. Folsom Reservoir and Lower American River Water Temperature Modeling Results

5.3.1. Forecasted Reclamation Operations

Modeling indicates that due to the severe drought the Reclamation forecasted operations in 2015 result in very high water temperature conditions in the LAR for both the High Release and Low Release scenarios. The High Release scenario cannot meet the highest ATSP schedule (Schedule 78), which has a summer temperature target of 72˚F at Watt Avenue (Figure 5). Maximum temperatures at Watt Avenue would be above 78˚F in late August/early September (release temperatures below Folsom Reservoir would be above 72˚F; Figure 6). The low reservoir storage results in the temperature control device (TCD) middle shutters being removed in July and all of the shutters being removed in late August, which limits the opportunity to blend reservoir hypolimnion and metalimnion temperatures to effectively manage the cool water resources.

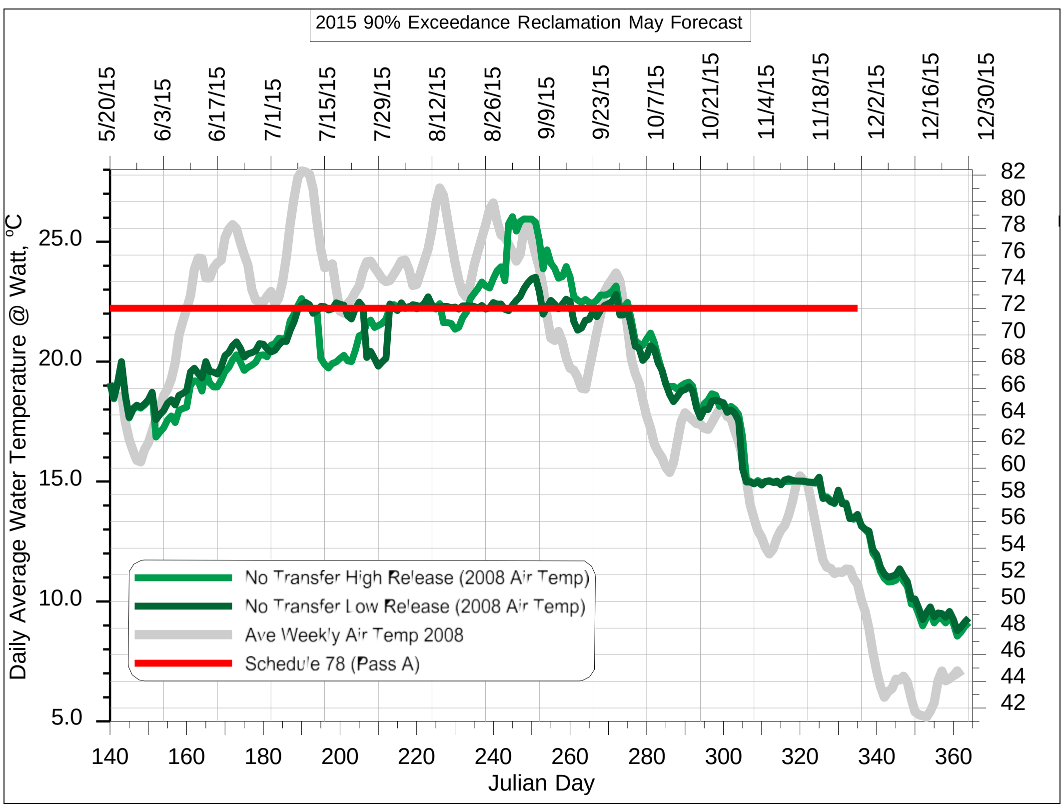
The Reclamation forecasted Low Release scenario results in approximately 2˚F cooler maximum temperatures than the High Release scenario. The Low Release scenario does not meet the highest ATSP schedule using 2014 and 2008 MET data (Figure 5) (release temperatures below Folsom Reservoir would be above 72˚F; Figure 6). The higher reservoir elevations under the Low Release scenario allow the TCDs to remain in place slightly longer and result in slightly better management of temperature than occurs with the High Release scenario.

5.3.2. Forecasted Transfer Operations

Modeling results indicate that the 12,000 AF Transfer Options 1 and 2 would result in a slightly cooler water temperature regime in the LAR for each of the Base Case scenarios (High and Low Release scenarios). For both the High and Low Release scenarios water temperature decreases up to 1˚F during the highest temperature time period (Figures 7 and 8). Option 2 provides less temperature benefit than Option 1, however, it does perform slightly better than the Base Case (No Transfer) Scenarios. Under the Low Release Scenario cool water is managed more effectively because the TCDs can be used slightly longer due to slightly higher water elevations in Folsom Reservoir.

Table 4. Watt Avenue Water Temperature Maximum Water Temperature and ATSP Schedules for the Base Case and Water Transfer Scenarios Options 1 and 2 for 2008 and 2014 MET data (Note: Lower ATSP Schedules Equal Colder Water Temperature).

Model Scenario	Maximum Water Temperature (˚F) 2008 MET	Maximum Water Temperature (˚F) 2014 MET	ATSP Temperature Schedule 2008 MET	ATSP Temperature Schedule 2014 MET
High Release Option				
Base Case	**78.8**	**79.5**	**78+**	**78+**
Transfer Option 1	**78.0**	**78.3**	**78+**	**78+**
Transfer Option 2	**78.6**	**79.2**	**78+**	**78+**
Low Release Option				
Base Case	**74.3**	**74.0**	**78+**	**78+**
Transfer Option 1	**73.0**	**73.2**	**65**	**78+**
Transfer Option 2	**73.2**	**73.5**	**78+**	**78+**



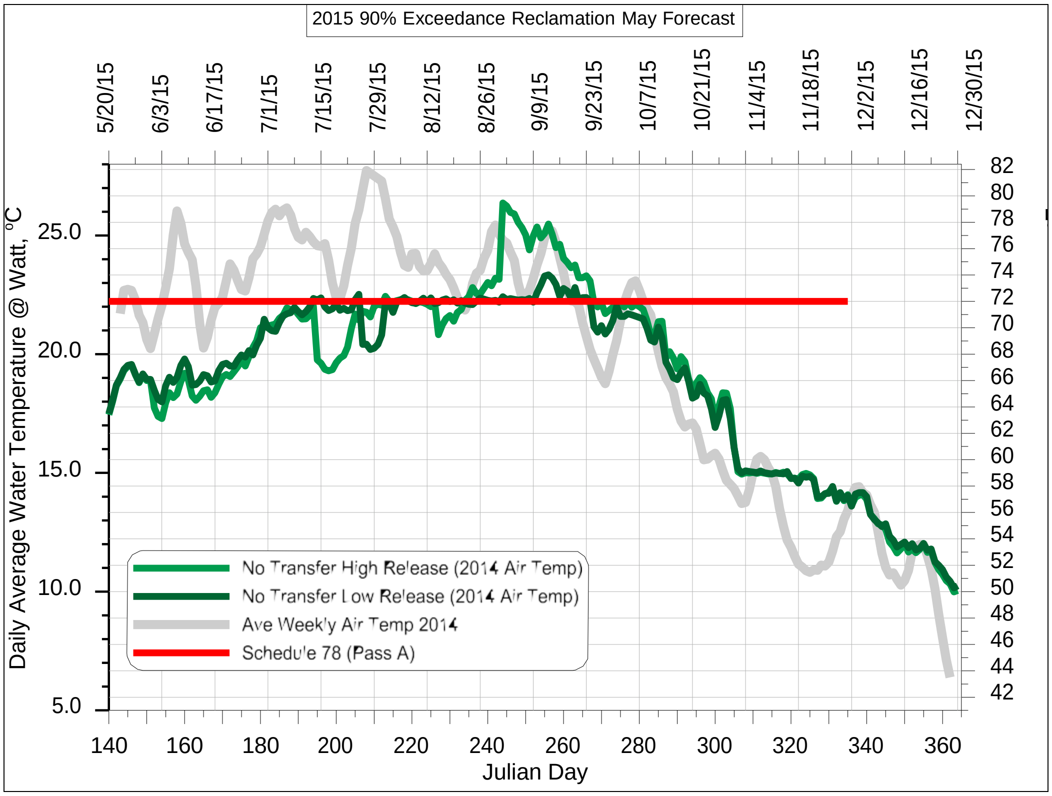
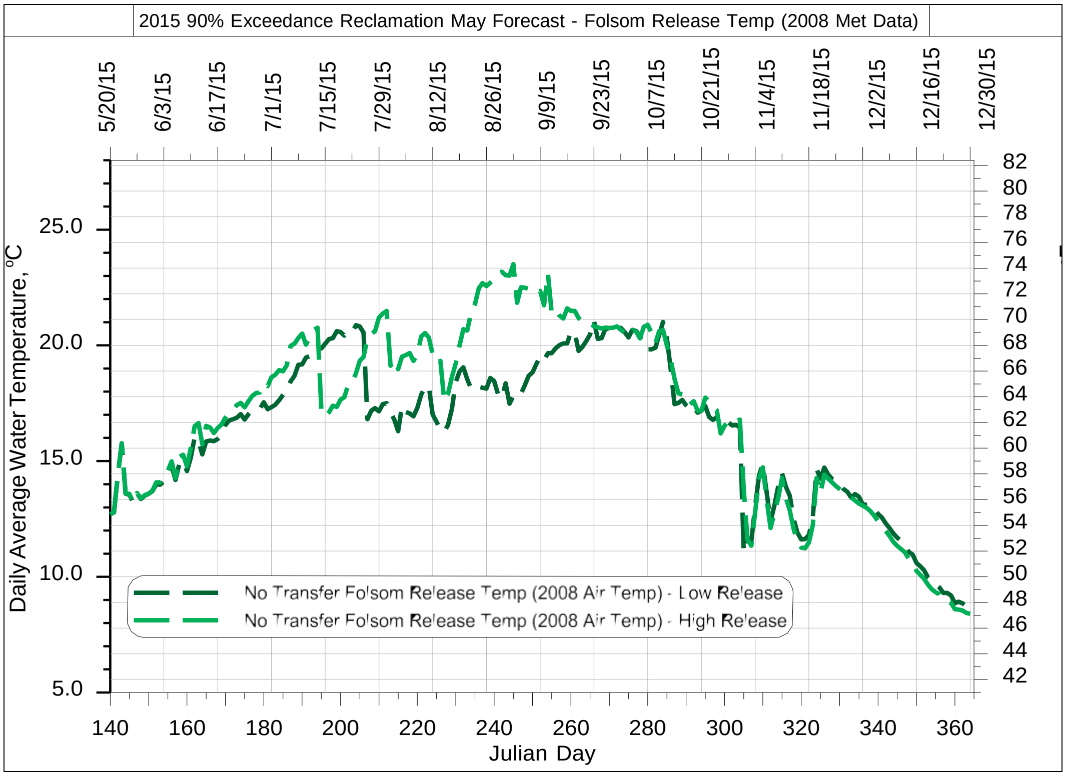


Figure 5. Model Results for Water Temperature in the Lower American River at Watt Avenue using 2008 (top) and 2014 (bottom) Meteorological Data for High and Low Release Scenarios.



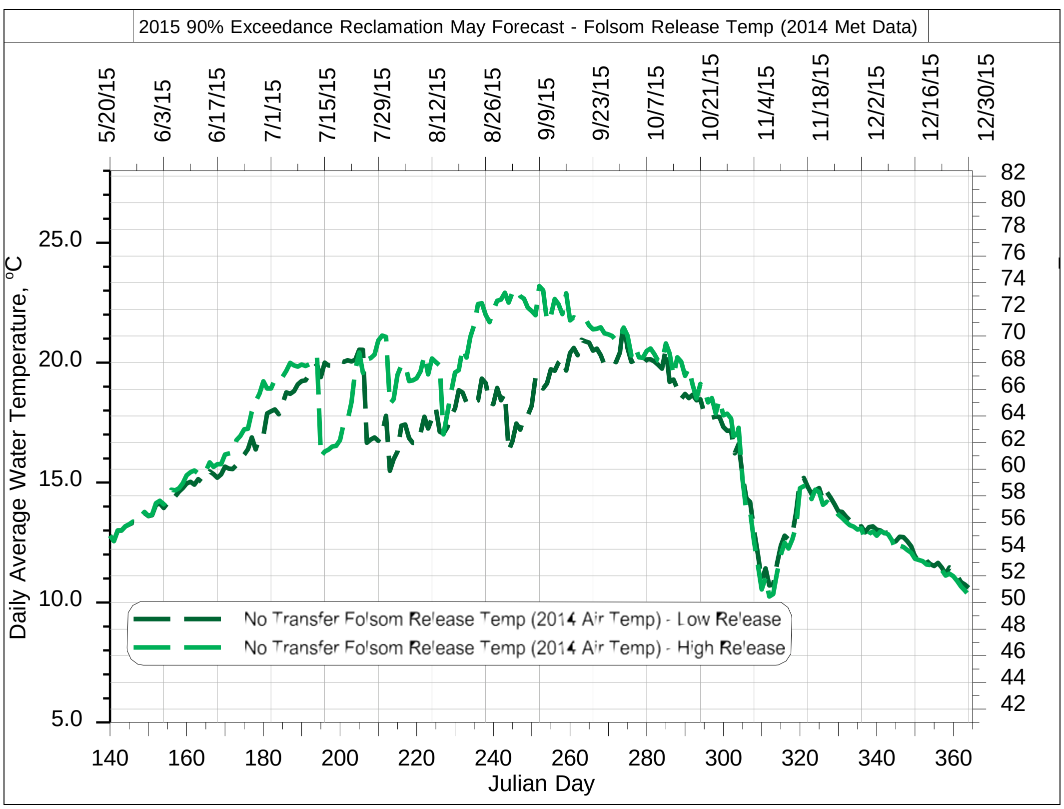
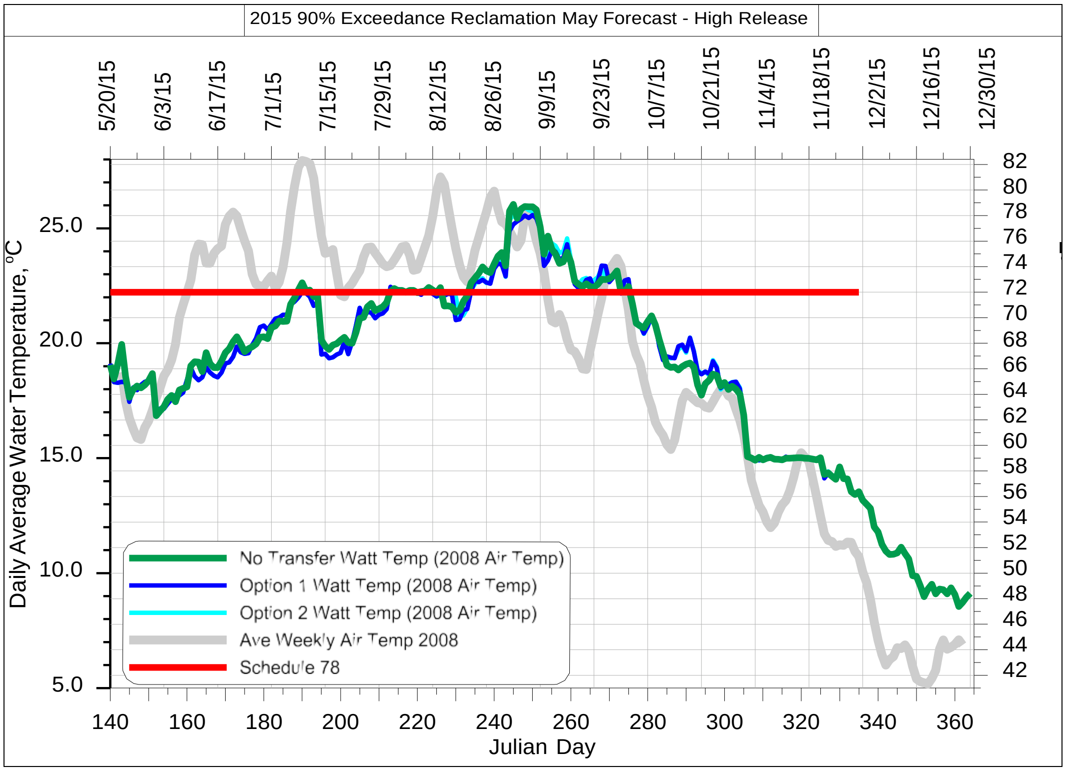


Figure 6. Model Results for Water Temperature below Folsom Reservoir using 2008 (top) and 2014 (bottom) Meteorological Data for High and Low Release Scenarios



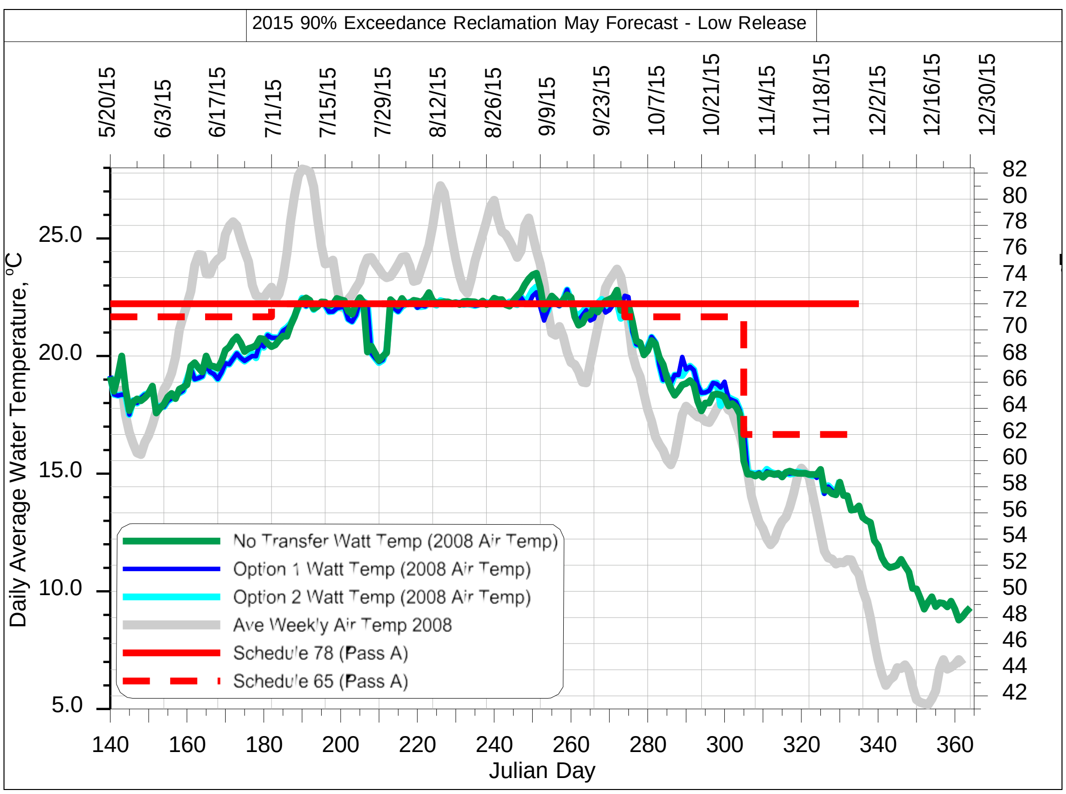
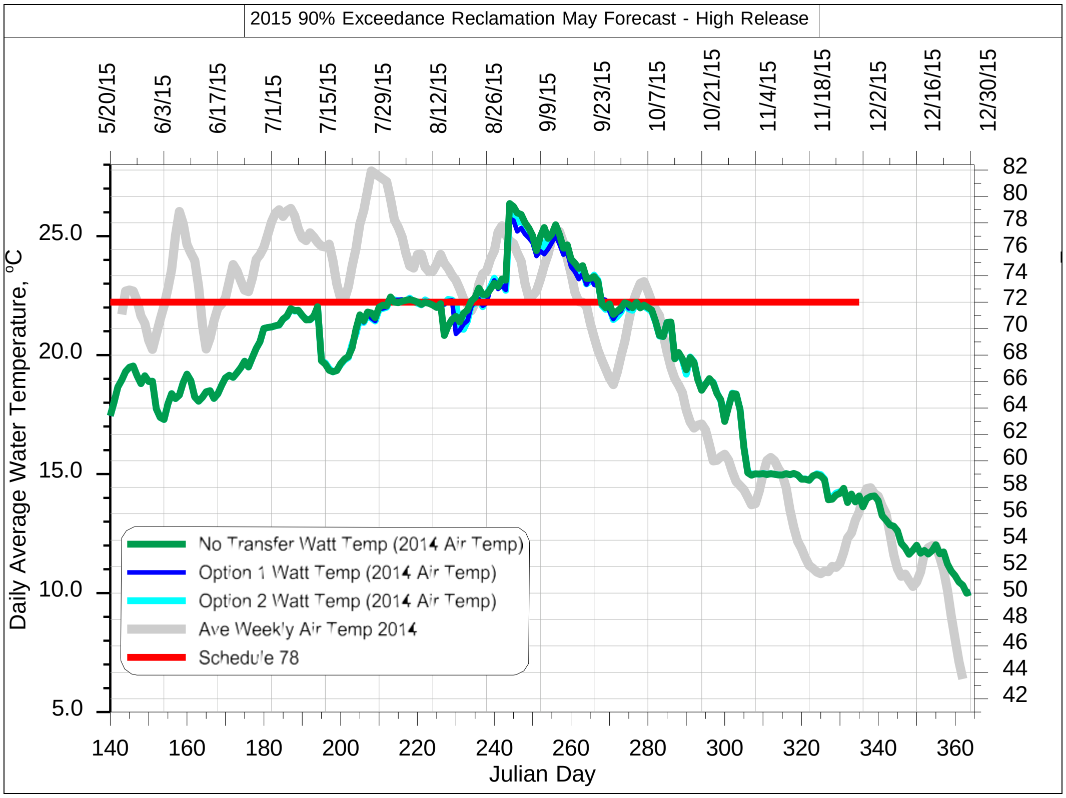


Figure 7. Model Results for Water Temperature in the Lower American River at Watt Avenue using 2008 Meteorological Data for the High (top) and Low Release (bottom) No Transfer, Option 1 and Option 2 Scenarios.



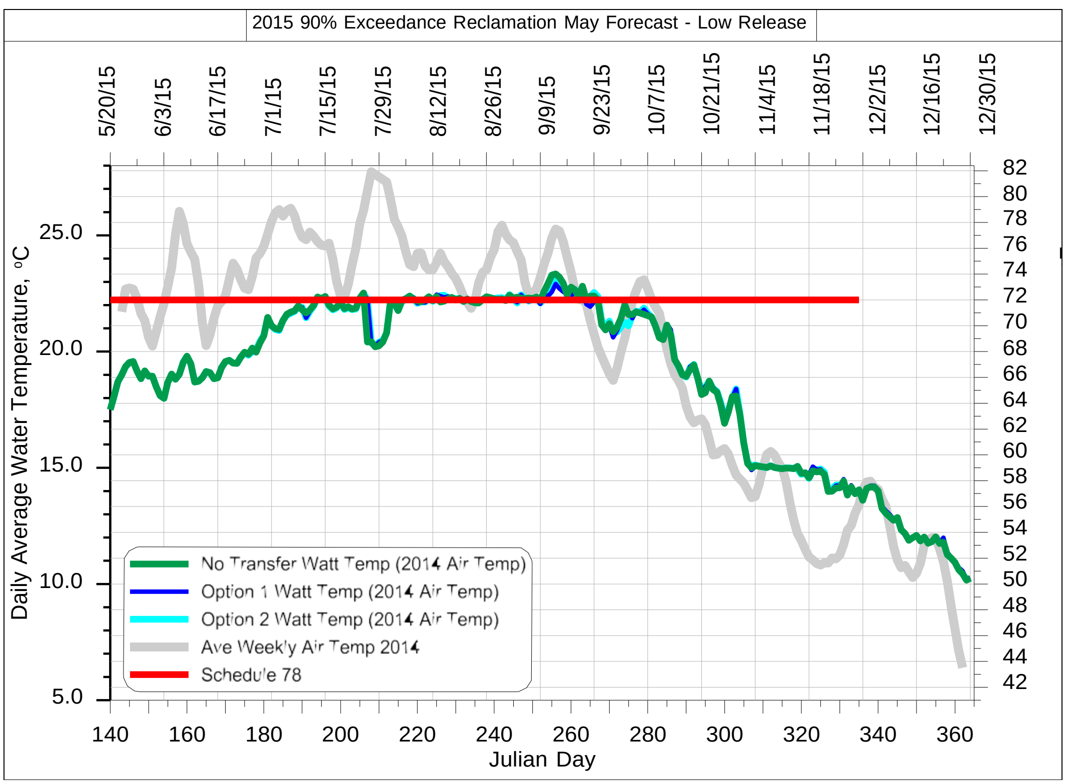


Figure 8. Model Results for Water Temperature in the Lower American River at Watt Avenue using 2014 Meteorological Data for the High (top) and Low Release (bottom) No Transfer Option 1, and Option 2 Scenarios.

6.0 ADDITIONAL DRIER YEAR WATER TRANSFER EFFECTS

Releasing 12,000 AF of 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 MFAR.

PCWA's purveyor-specific Water Forum Agreement includes a commitment to release additional water from the MFP in dry years to preserve and protect the natural resources of the LAR. 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 American rivers. The 2015 Transfer to EBMUD provides certainty that releases will be made into the LAR or 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 drought, there currently is and will continue to be a significant reduction in hydroelectric generation capacity throughout the state until hydrologic conditions stabilize. 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 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). PCWA likely could provide an additional rafting day per week during the peak boating season (July and August) with the Transfer.

7.0 CONCLUSION

The proposed PCWA and EBMUD Transfer would release surplus water from PCWA's MFP reservoirs that would not otherwise be released from the MFP this year and would remain in storage absent the Transfer. The Transfer would not injure any legal user of the water and would benefit fish, wildlife, recreation, and/or other instream beneficial uses.

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

Increased water supply for EBMUD;

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 MFAR whitewater rafting opportunities.

8.0 REFERENCES

Placer County Water Agency. 2015. PCWA's Carryover Storage and Refill Reporting for Dry Year Water Transfers Occurring in 2013 and 2014. Memorandum sent Ron Milligan, Reclamation June 3, 2015.

Attachment A

PCWA Historical Water TRANSFERS (1990-2015)

Attachment A Table 1. PCWA Historical Water Transfers (1990-2015).

Calendar Year	Water Transfer (ac-ft)	MRA* Jan	MRA* Feb	MRA* Mar	MRA* Apr	MRA* May	MRA* Jun	MRA* Jul	MRA* Aug	MRA* Sep	MRA* Oct	MRA* Nov	MRA* Dec	Total Release[1] (ac-ft)	Transfer Recipient
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 (WWD)
2009	20,000								5,209	15,415				20,624	San Diego
2010														0	
2011														0	
2012														0	
2013	20,000					20,000								20,000	WWD
2014	40,000				5,000		8,750	8,750	8,750	8,750					East Bay Municipal District & WWD

[1] In some years, release volumes were greater than the transfer amount.
*** MRA - Monthly Release Amounts (ac-ft)**

Attachment B

Folsom Reservoir Inflow Water Temperature

INTRODUCTION

This attachment documents inflow water temperature into Folsom Reservoir and the relationship between water 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 and water temperatures, and comparisons of empirical versus modelled 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 Attachment B Table 1, and the locations are shown on Attachment B 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, CA (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, CA (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) (Attachment B Table 2). Comparisons of the NFAR empirical and modeled water temperature for the inflows into Folsom Reservoir is provided in Attachment B Figure 1 and a time series plot showing the empirical and modeled water temperature is shown in Attachment B 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) (Attachment B Table 3). Comparison of the SFAR measured and modeled water temperature for the inflows into Folsom Reservoir (November 1999 – June 2014) is provided in Attachment B Figure 3 and a time series plot showing the measured and modeled water temperature is shown in Attachment B Figure 4.

The SFAR water temperature into Folsom Reservoir that was used for the water transfer temperature modeling is shown in Attachment B Figure 5.

ATTACHMENT B

TABLES

Attachment B 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

Attachment B 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 (°F) 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.

Attachment B 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)

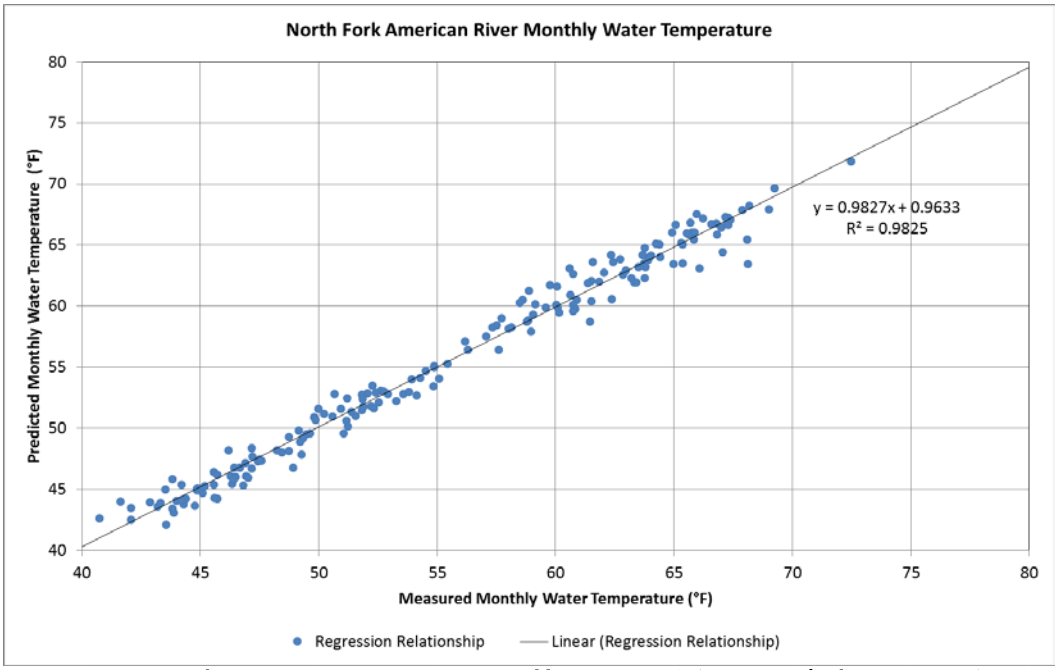
y =South Fork American River Mean Monthly Temperature (°F) near Pilot Hill, CA (USGS gage no. 11446030)

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.

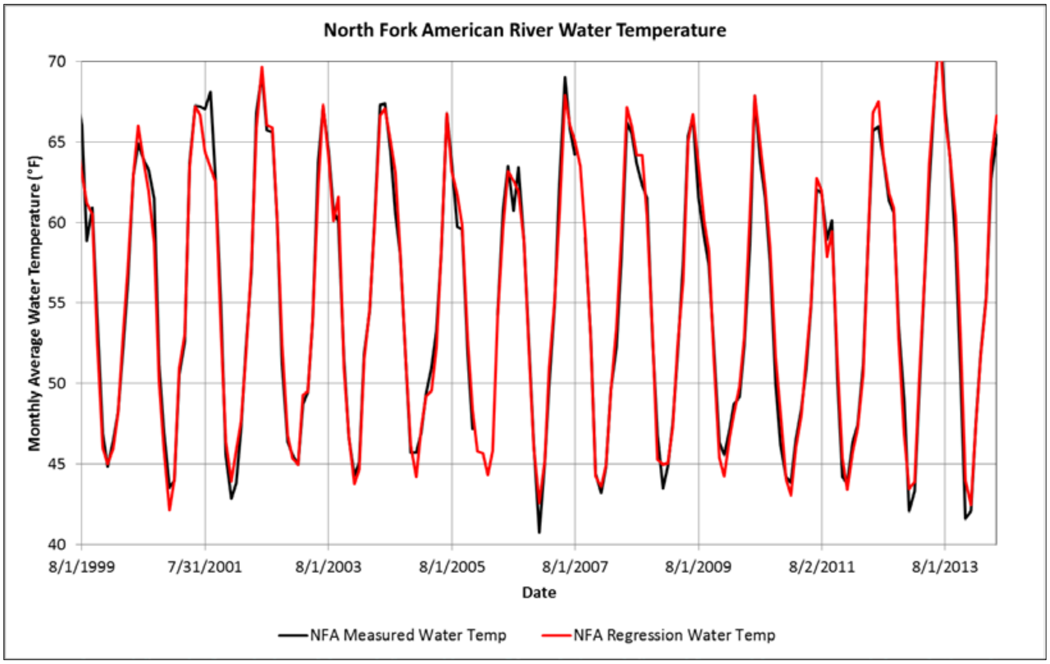
ATTACHMENT B

FIGURES



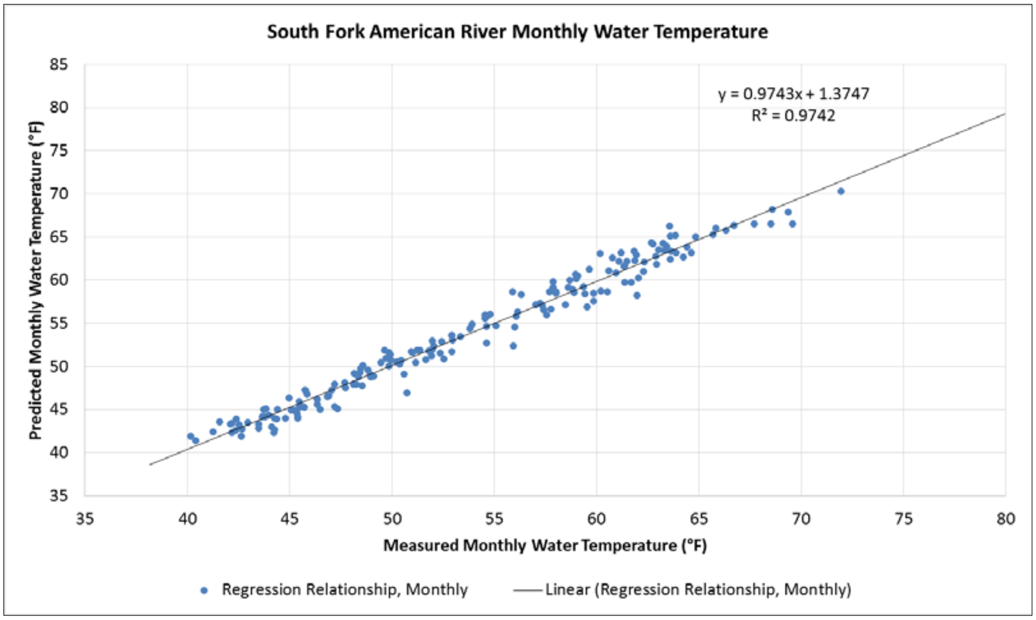
Data sources: Measured water temperature: NFAR mean monthly temperature (°F) upstream of Folsom Reservoir (USGS gage no. 11433790/CDEC station CDEC-NFA); Modeled (regression) water temperature: NFAR monthly flow (cfs) (USGS gage no. 11427000), MFAR mean monthly flow (cfs) (USGS Gage 11433300 until Sept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

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



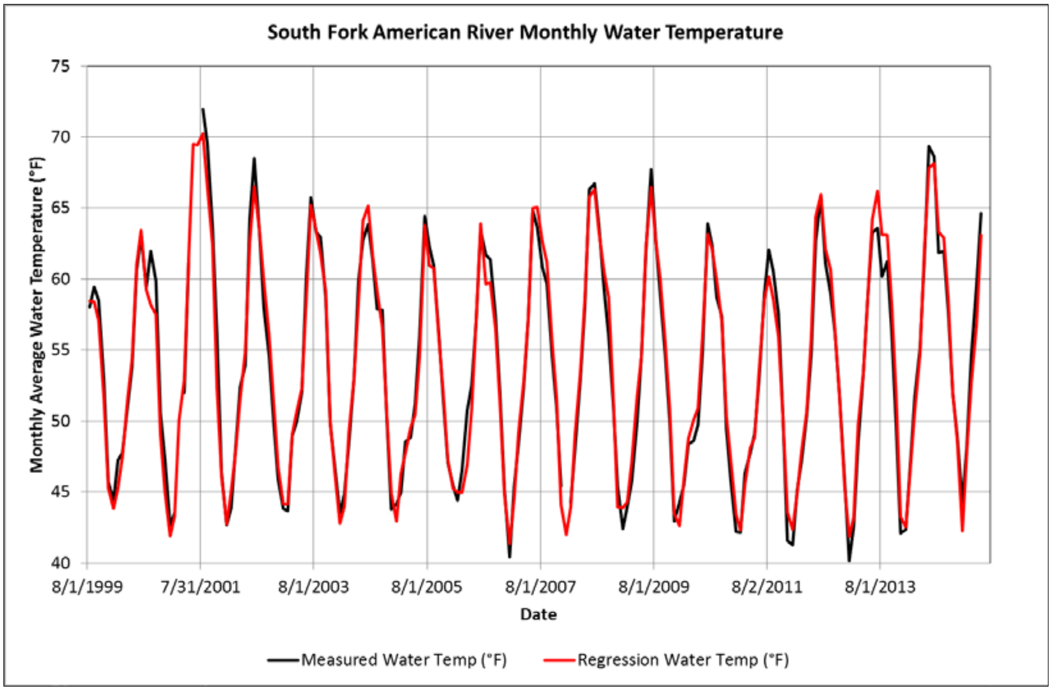
Data sources: Measured water temperature: North Fork American River mean monthly water temperature (°F) upstream of Folsom Reservoir (USGS gage no. 11433790/CDEC station NFA); Modeled (regression) water temperature: NFAR mean monthly flow (cfs) ((USGS gage no. 11427000), MFAR mean monthly flow (cfs)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

Attachment B Figure 2. Time Series of Measured and Modeled North Fork American River Temperature into Folsom Reservoir (July 1999-June 2014).



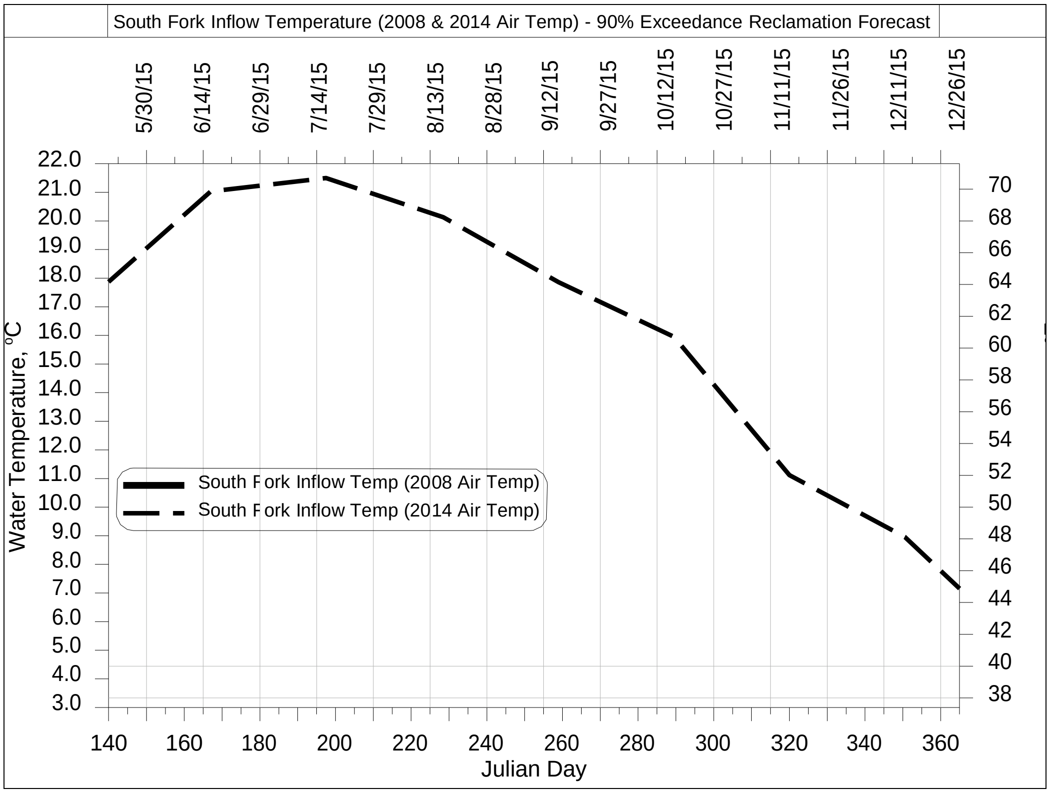
Data sources: Measured water temperature: Monthly average water temperature (°F) (USGS gage no. 11446030). Modeled (regression) water temperature: Monthly average air temperature (°F) (CIMIS-131) and monthly average flow at Chili Bar (cfs) (USGS gage no. USGS/CDEC gage no. 11444500/CDEC-CBR).

Attachment B 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 (ºF) (USGS gage no. 11446030). Modeled (regression) water temperature: Monthly average air temperature (ºF) (CIMIS-131) and monthly average flow at Chili Bar (cfs) (USGS gage no. 11444500).

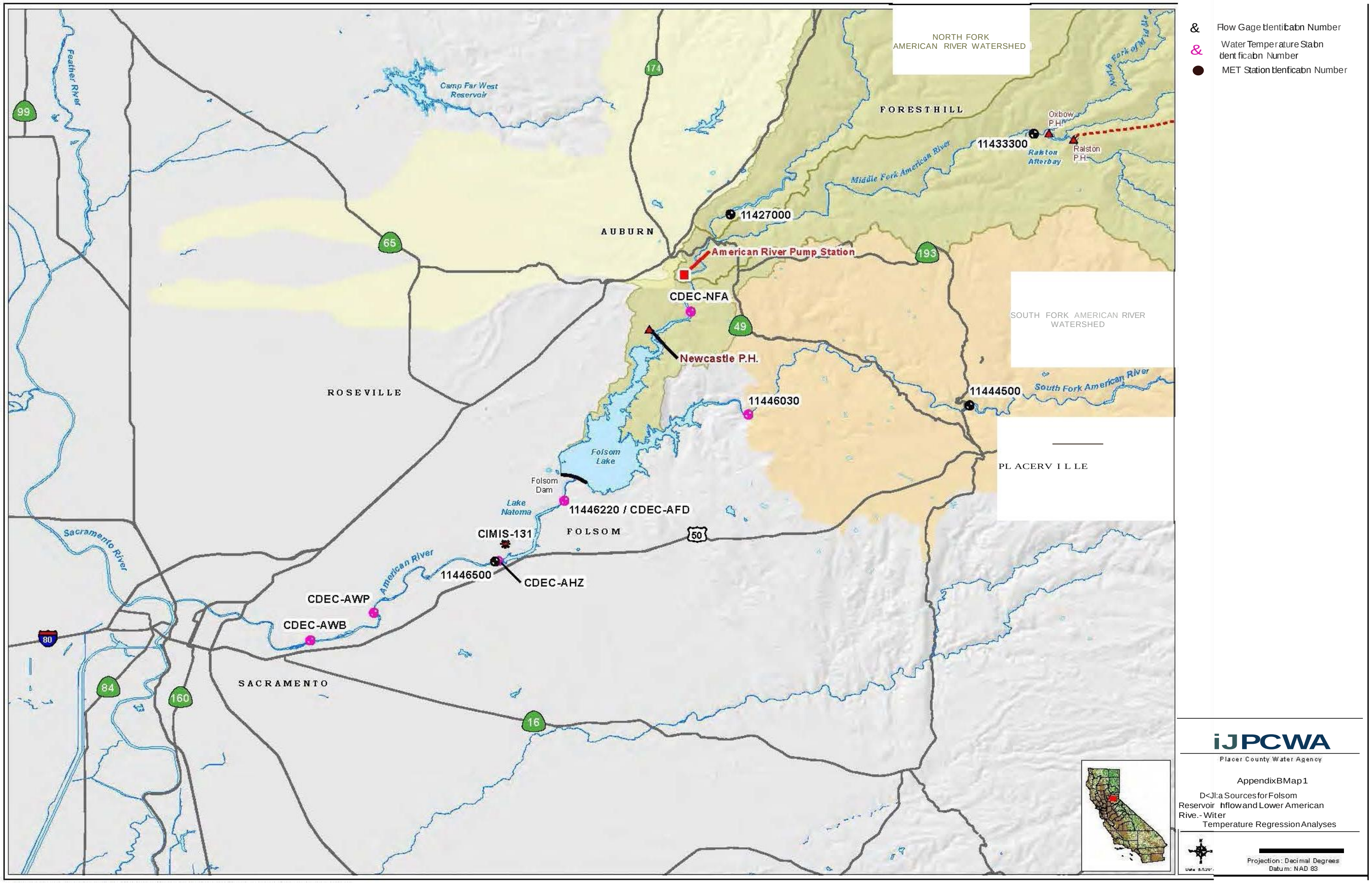
Attachment B Figure 4. Time Series of Measured and Modeled South Fork American River Temperature (August 1999-June 2014).



Attachment B Figure 5. Water Temperature in the South Fork American River upstream of Folsom Reservoir for use in Water Transfer Modeling.

ATTACHMENT B

MAP



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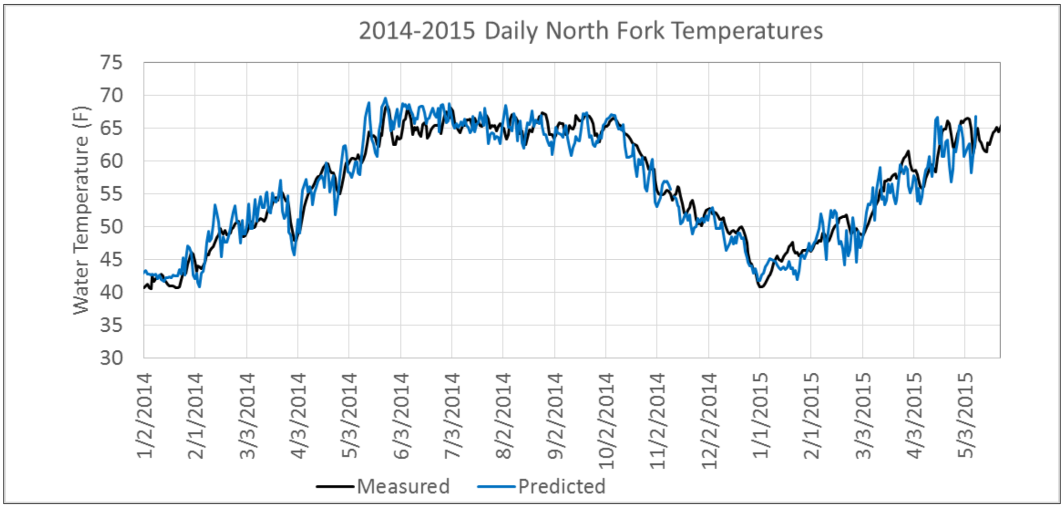
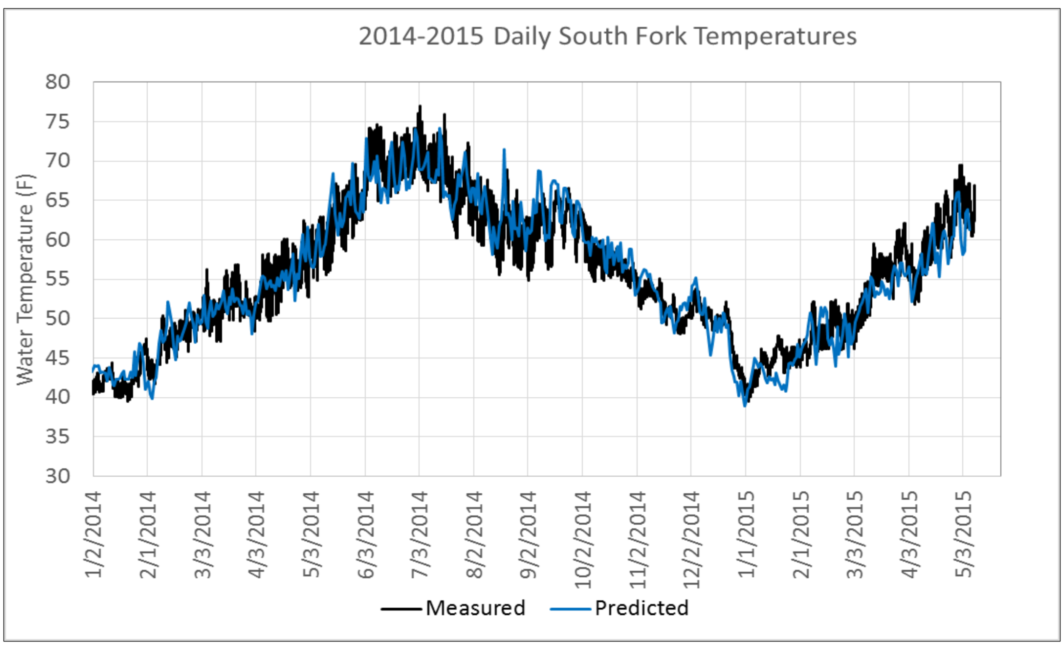
ATTACHMENT C

NORTH FORK, SOUTH FORK, AND LOWER AMERICAN RIVER REGRESSION

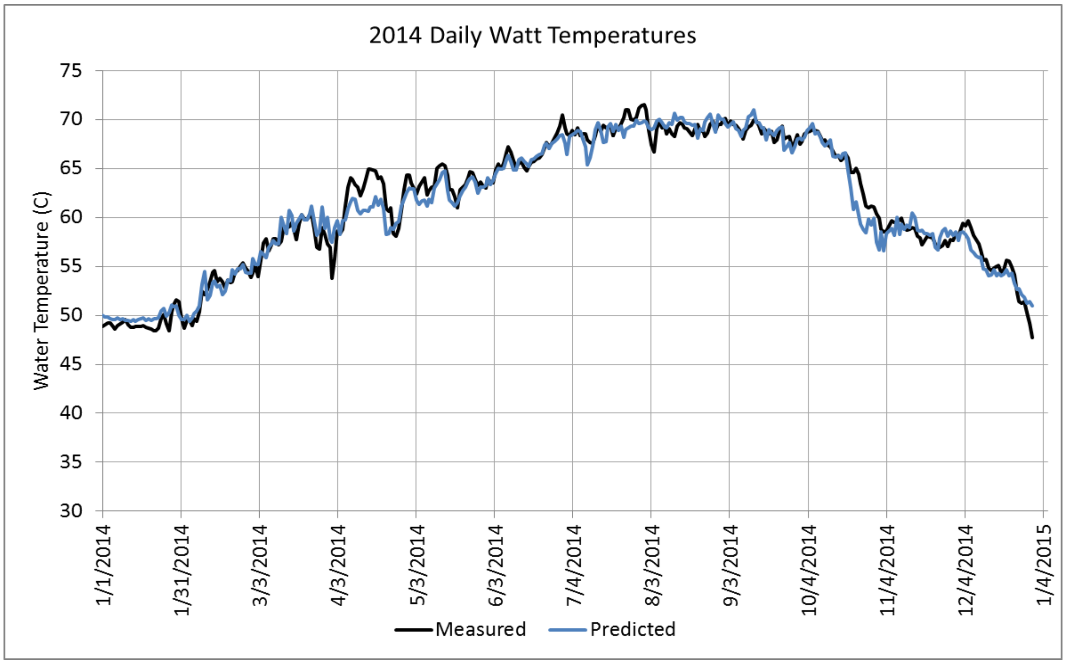
PERFORMANCE FOR 2014



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



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



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

ATTACHMENT D

FOLSOM RESERVOIR WATER TEMPERATURE MODEL

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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^{o}C and 0.58^{o}C, respectively, well less than the target of <1^{o}C. 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

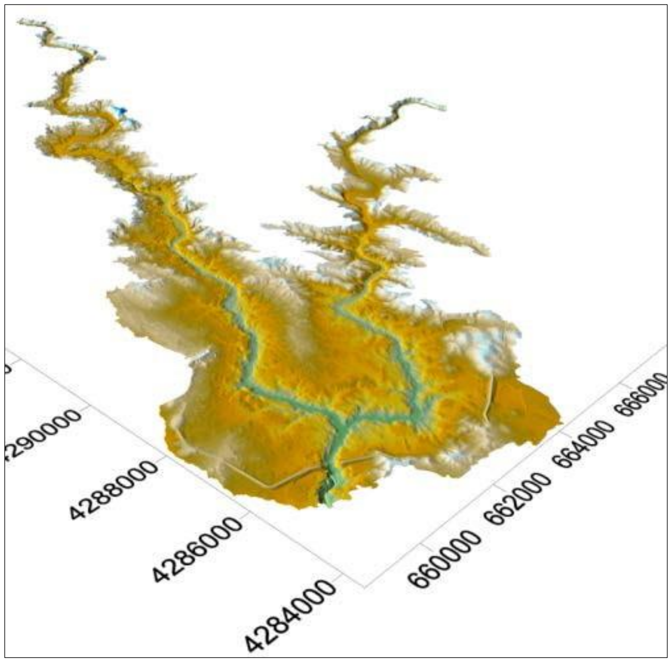
Folsom Dam and reservoir are located approximately 20 miles northeast of the city of Sacramento, California, on the American River. This reservoir has a capacity of 976,000 acre-feet (1,203,878,290 cubic meters) and drains an area of approximately 1,875 square miles (4,856 square kilometers). The dam 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 20 different outlets and outlet structures. Three power generation penstocks are each fitted with discrete, removable/installable shutters that allow for 4 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 8 rectangular river outlets and 8 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 Attachment D 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).

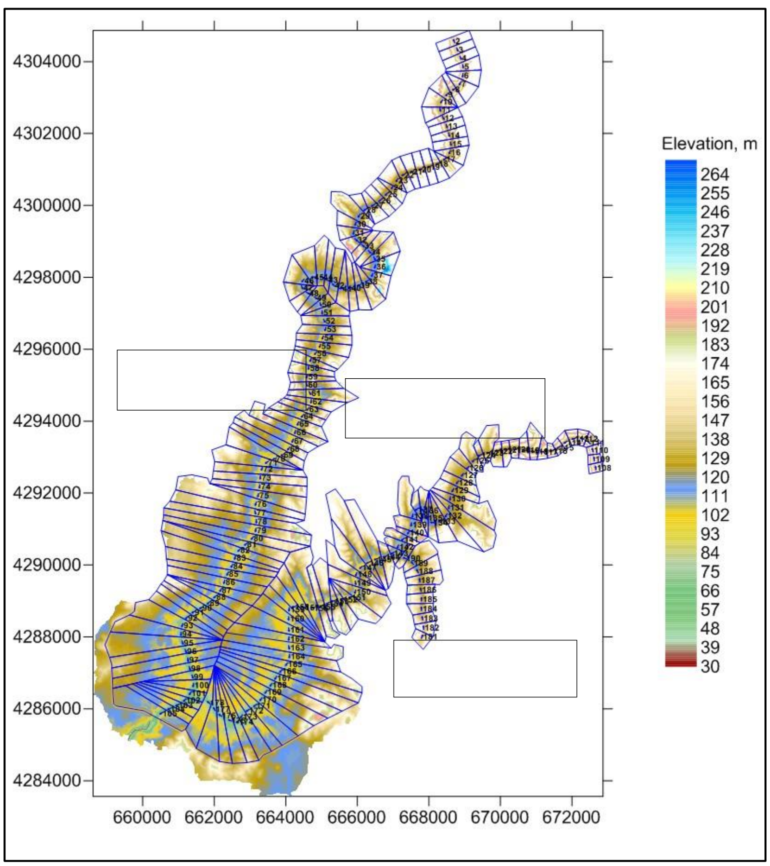
Attachment D Figure 9. Folsom Dam Outlet Structures (Google Maps, 2013)

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 Attachment D Figure 10. This grid was in turn used to develop the CE-QUAL-W2 model grid, shown in Attachment D Figure 11. The grid was divided up into a total of 3 branches with 191 segments each having an average length of 250 meters. The vertical model resolution was 0.61 m or 2 ft. The model grid matched the 2005 Sediment Survey volume elevation and surface area elevation curves (Ferrari, 2007).



Attachment D Figure 10. Folsom Reservoir Bathymetry Showing the North Fork and South Fork of the American River Channels (dimensions are in meters).



Attachment D Figure 11. Model Grid Segment Layout for the Three Model Branches (dimensions are in meters).

HISTORICAL MODEL CALIBRATION

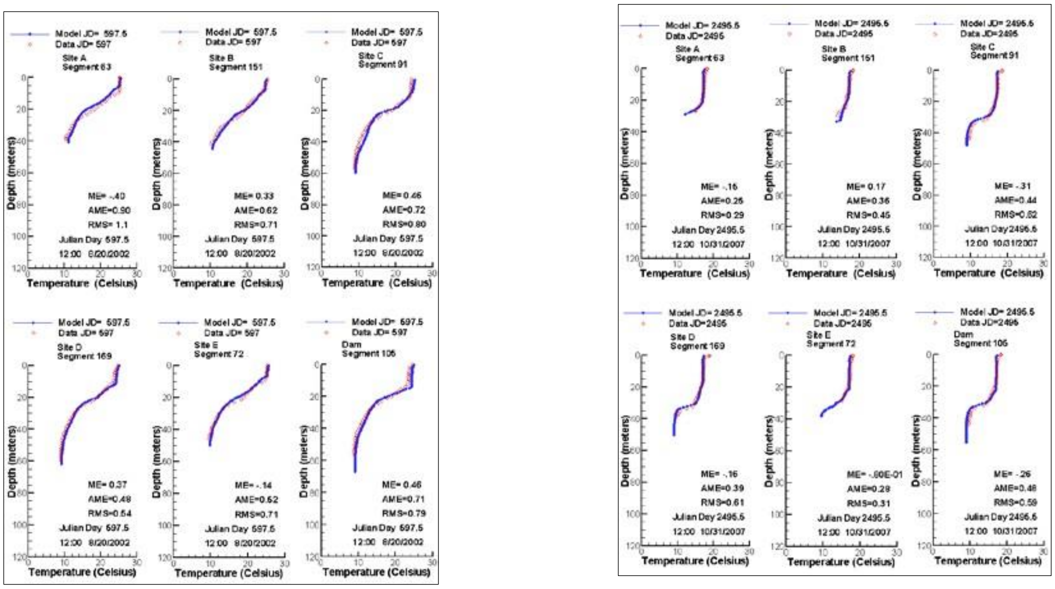
The model was calibrated for a 10-year period between January 1, 2001 and December 31, 2011. Boundary conditions for inflow, meteorological data, and outflow during this period were developed. A very detailed approach for filling in data gaps was undertaken to provide a good set of boundary conditions 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 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 6 stations in Folsom Reservoir with a profile frequency of about once per month (data were collected by Bureau of Reclamation). Attachment D Figure 12 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 Attachment D Table 5.

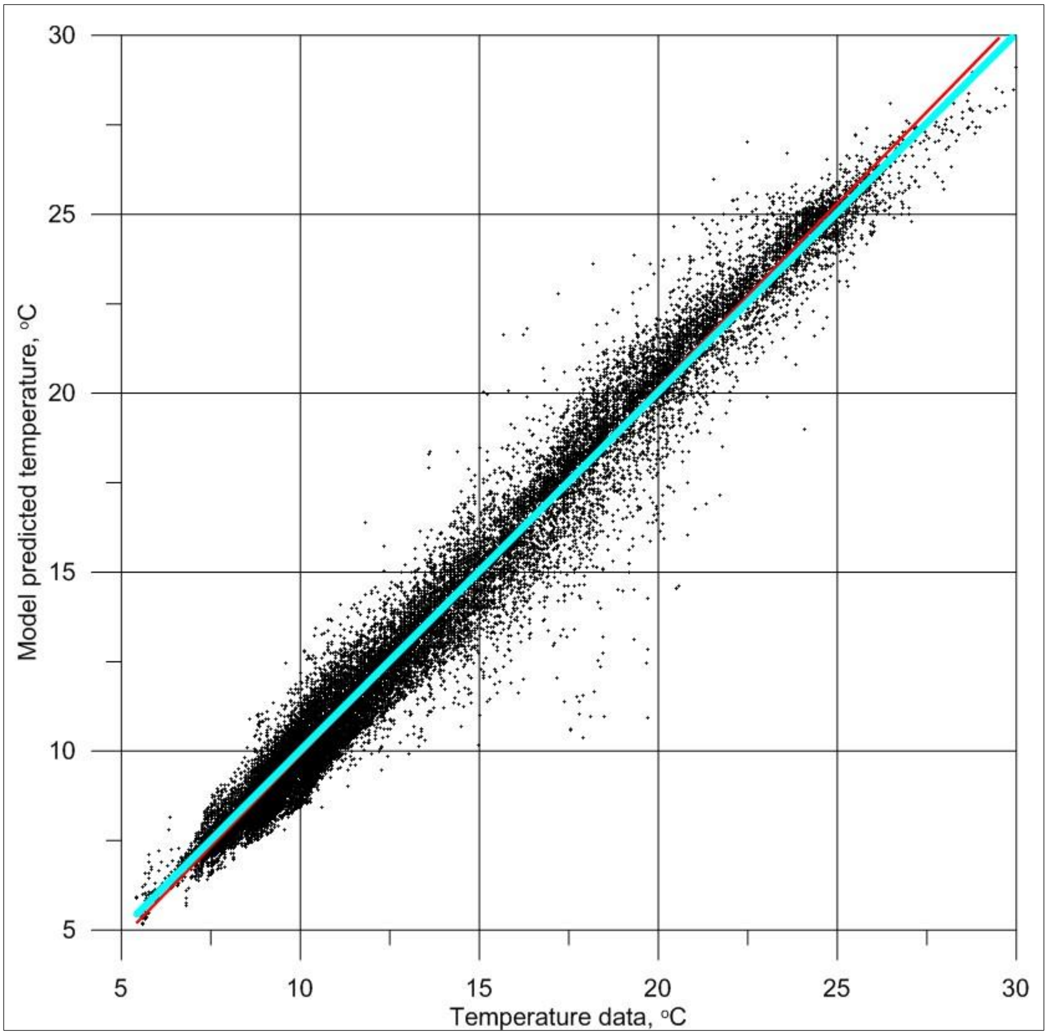


Attachment D Figure 12. Model Temperature Profiles Compared to Measured Temperature Profiles on August 20, 2002 (left) and October 31, 2007 (right) at Six Different Stations in Folsom Reservoir.

Attachment D Table 5. 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**

A comparison of all measured profile data to model profiles over the 10-year period is shown in Attachment D Figure 13.



Attachment D Figure 13. 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 R^2 of 0.996 [red line]; blue line is a 1:1 slope).

Model predicted water temperatures and measured water temperatures immediately downstream of Folsom Dam were also compared (Attachment D Figure 14). Absolute mean errors for downstream temperatures were less than 0.6°C.

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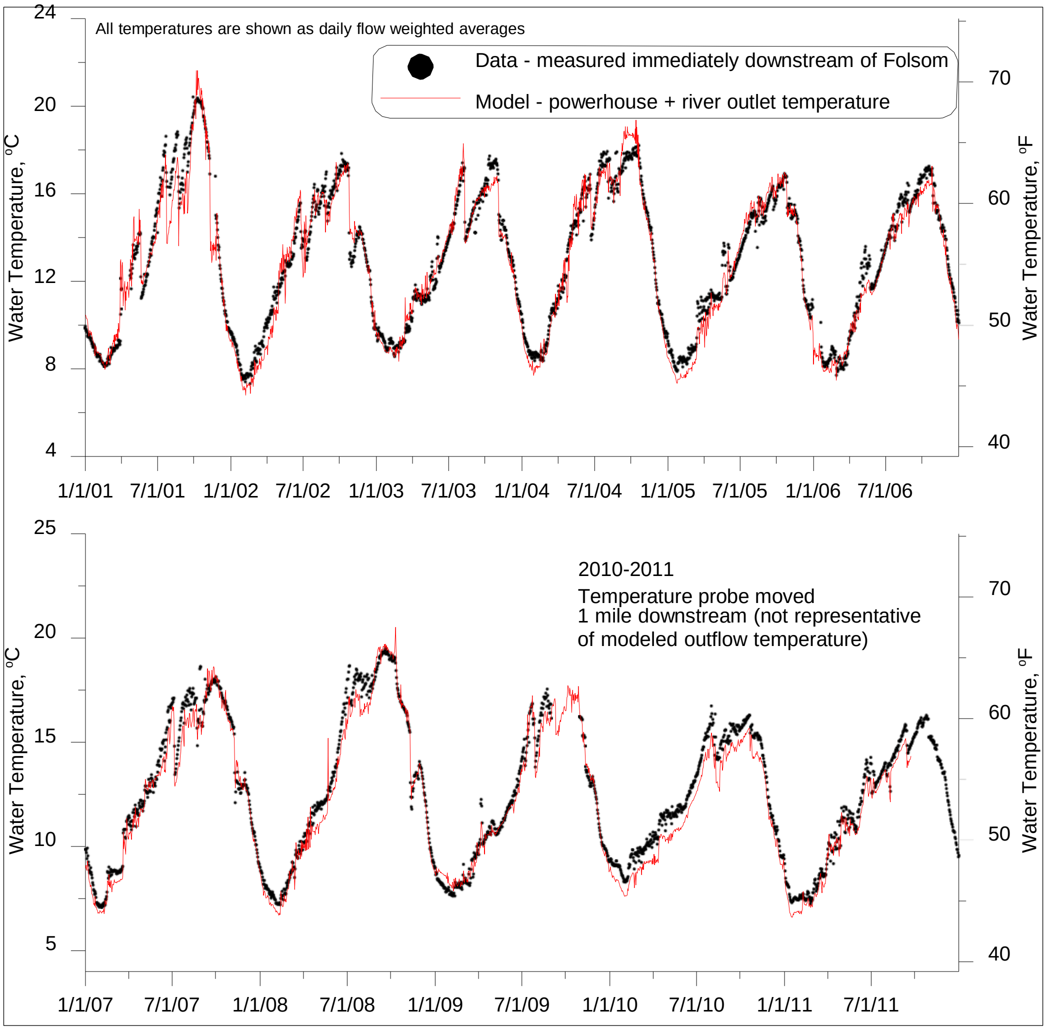


Attachment D Figure 14. Model Predicted Temperatures below Folsom Dam Compared to Measured Temperatures Immediately Downstream of Folsom Dam between 2001 and 2009. For 2010 and 2011, Model Predictions and Observed Data are Shown, but Not Completely Comparable because the Observed Data were Collected 1 mile Downstream of Folsom Dam.

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:

On March 1st of each model year, the elevation of the intake was raised as high as possible given the WSE constraint;

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;

If intake temperature criteria were violated, the intake was lowered in one meter increments until water temperature met criteria; and

The model continued lowering intake elevation as dictated by the temperature criteria until Dec 1st 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 4 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:

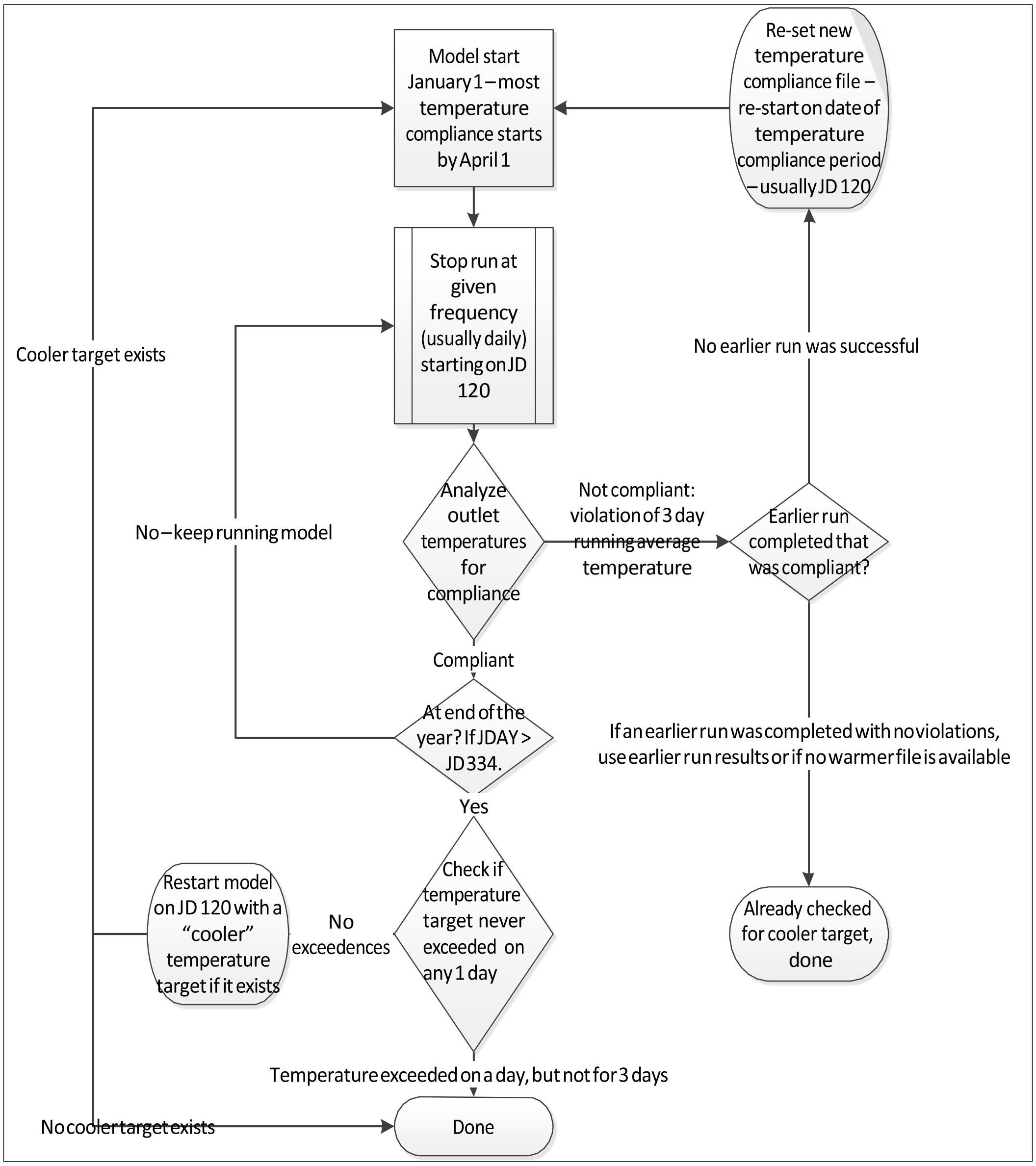
- Minimum and maximum flow through each powerhouse; and
- Shutter minimum elevation below WSE at any time (8.23 meters); otherwise the shutter opening would be lowered to the next lowest level.

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 by-passing 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

10 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 3 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 Attachment D Figure 15.

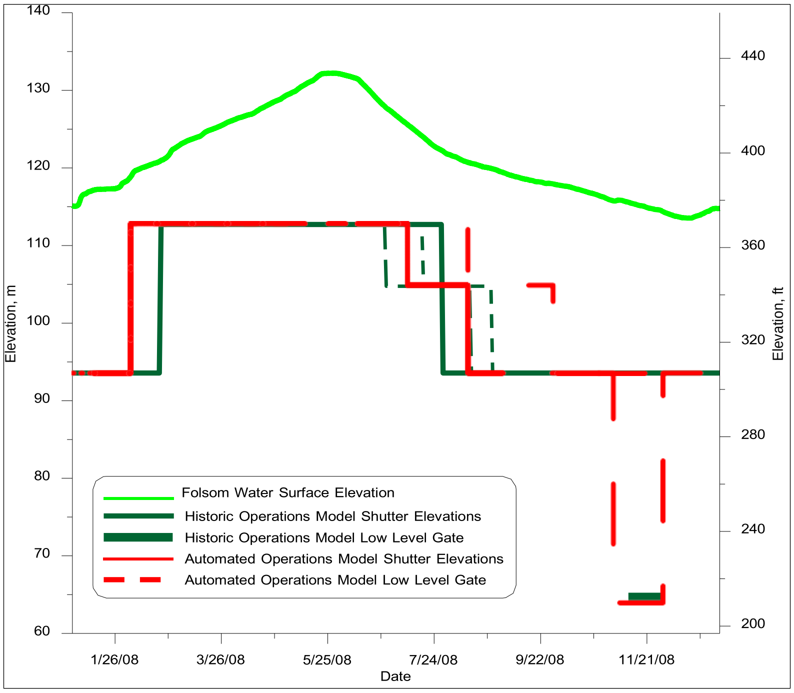


Attachment D Figure 15. Flow Chart for Automatic Model Selection of Optimal Temperature Schedule.

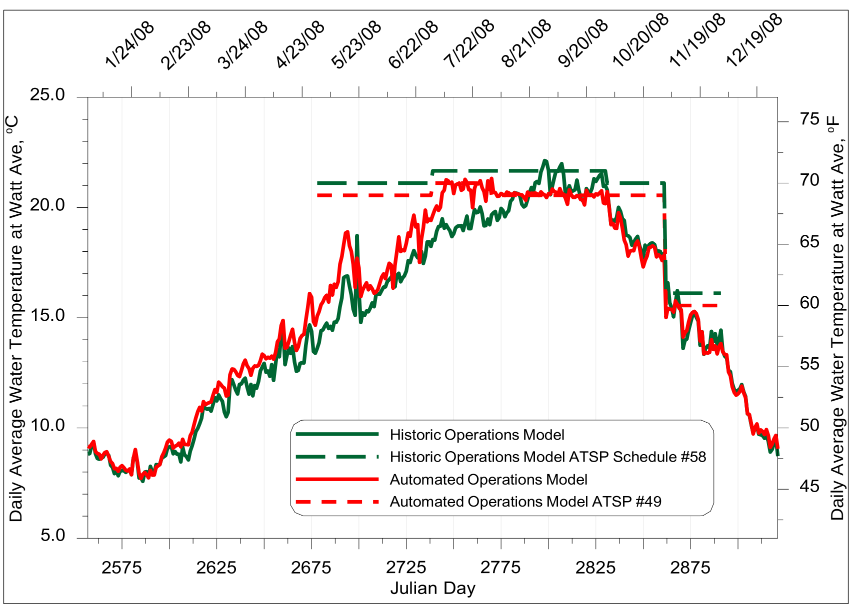
EXAMPLE RESULTS of AUTOMATIC SHUTTER and MUNICIPAL OUTLET SCENARIO

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 Attachment D 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**

Attachment D Figure 9.



Attachment D Figure 16. **Comparison of Historical Versus Automated Water Temperature Model Shutter Operations below Folsom Dam, 2008.**



Attachment D Figure 17. **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).**

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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ATTACHMENT E

Lower American River Water Temperature at Watt Avenue

INTRODUCTION

This attachment documents the regression approach for predicting water temperatures at Watt Avenue.

DATA SOURCES

The sources for flow, water temperature, and other meteorological (MET) data are provided in Attachment E Table 1, and the locations are shown on Attachment E Map 1. The time period used for the regression analyses was 2001-2011. All data were quality controlled prior to use in the analyses.

WATER TEMPERATURE AT WATT AVENUE

Monthly multiple regression relationships were developed to predict water temperatures on the Lower American River at Watt Avenue. The multiple regressions were developed for each month using daily water temperature below Folsom Dam (California Data Exchange Center (CDEC) gage), daily-averaged Folsom Dam outflows (CDEC gage) minus the Folsom South Canal Diversion flows (CDEC gage), and daily air temperature measured near Fair Oaks. Inclusion of solar radiation resulted in minimal improvement to model performance, and was not included in the final regression used. Historical data, 2001-2011, did not include time periods with low summer flows (<1,400 cfs). To add low flow information to the regression, the Lower American River (LAR) HEC-5Q Model was used to develop temperatures at 500 and 1,000 cfs based on MET data from 2008.

The regression relationships (monthly constants and regression coefficients) were then used to predict daily water temperatures at Watt Avenue based on daily flow and air temperature measurements (Attachment E Table 2). The regression coefficients were linearly interpolated between the center of the month values to obtain daily regression coefficients. A comparison of the predicted and measured water temperatures from 2001-2011 at Watt Avenue is shown in Attachment E Figure 1.

ATTACHMENT E

TABLES

Attachment E Table 1. Data Sources for the Lower American River 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
Lower American River						
Daily Average Flow American River below Folsom Dam	US Bureau of Reclamation / CDEC	Folsom Lake outflows	FOL	38.683000°N / 121.183000°W	2/1/1995-present, hourly	1/1/2001-9/23/2011
Folsom South Canal	US Bureau of Reclamation/ CDEC	Folsom South Canal	FSC	38.650000°N/121.183000°W	7/11/2001-present, monthly	7/11/2001-9/23/2011
Daily Water Temperature below Folsom Dam	USGS/ CDEC	American R below Folsom Dam	11446220/ AFD	38.688300°N/121.166700°W	10/24/1998-present, daily	1/1/2001-9/23/2011
Daily Average Air Temperature – Lower American River	CIMIS	CIMIS at Fair Oaks	131	38.65056°N/121.2181°W	4/18/1997-present, daily	1/1/2001-9/23/2011

Abbreviations:

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

Attachment D Table 2. Coefficients Used for the Multiple Regression for Predicting Lower American River Water Temperature at Watt Avenue (2001-2011).

Month	Constant	A	B	C	D	R^2
Predicted Temp = Constant + A(Ave Air Temp) + B(Ave Water Temp below Folsom) + C(Ave Flow) + D(Ave Flow^2)						
Jan	1.9303	0.1141	0.7390	-0.0046	1.438E-05	0.64
Feb	1.6880	0.1771	0.7851	-0.0100	1.470E-05	0.63
Mar	5.9400	0.1291	0.5856	-0.0210	2.656E-05	0.75
Apr	6.5729	0.1232	0.6679	-0.0242	2.413E-05	0.80
May	8.5043	0.1935	0.5898	-0.0462	6.614E-05	0.88
Jun	11.0982	0.0948	0.6151	-0.0603	1.212E-04	0.94
Jul	13.4974	0.0858	0.5903	-0.0938	2.736E-04	0.93
Aug	15.4759	0.1222	0.4923	-0.1611	7.790E-04	0.88
Sep	10.2659	0.1721	0.5021	-0.0825	3.492E-04	0.82
Oct	6.0404	0.2428	0.4855	-0.0041	-1.707E-04	0.70
Nov	5.2172	0.3116	0.4541	-0.0237	1.151E-04	0.65
Dec	1.9128	0.1722	0.6747	0.0012	-1.579E-06	0.89

Regression Variables:

Ave Air Temp = Daily average air temperature at CIMIS at Fair Oaks (station no. 131) (°C)

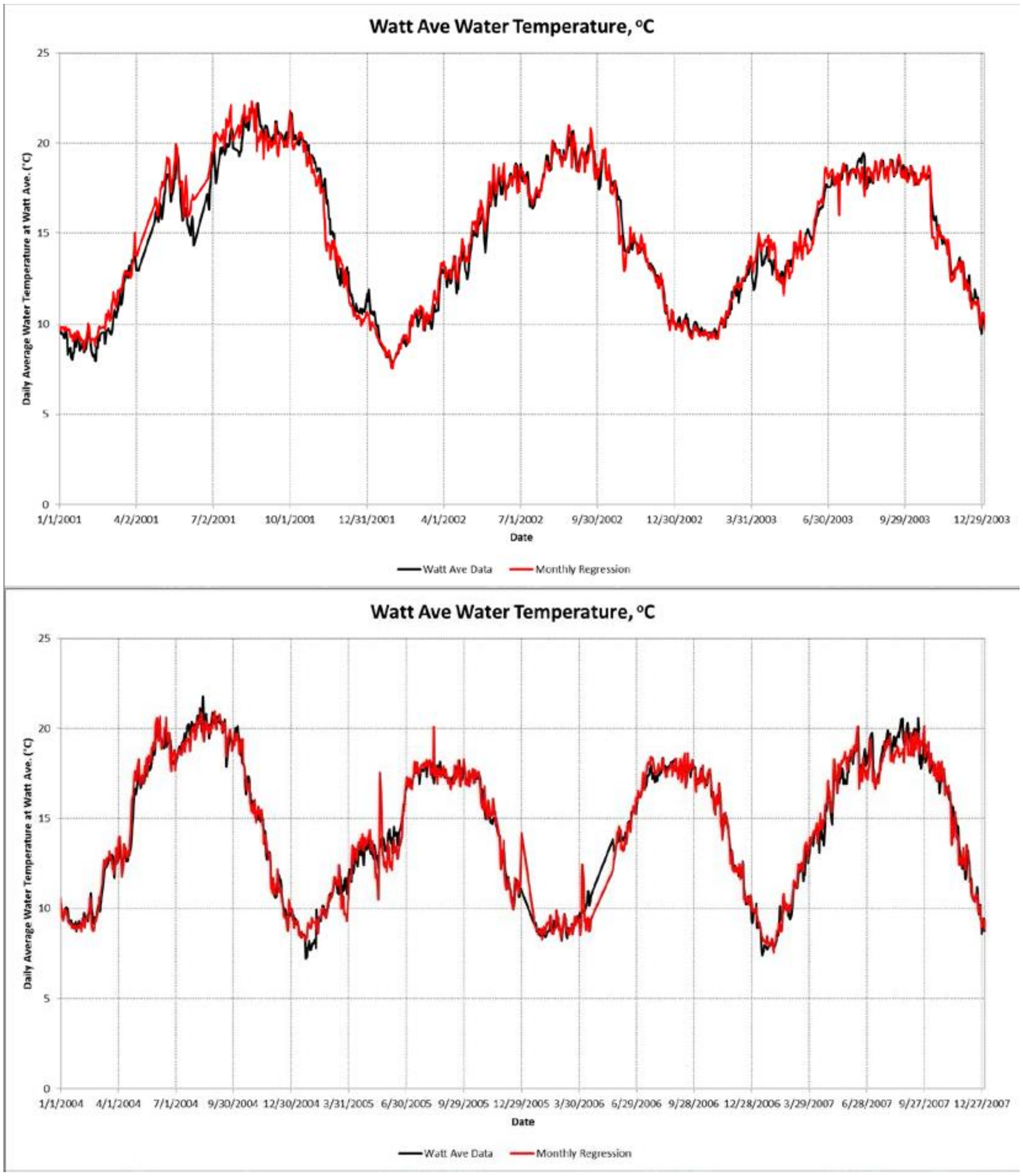
Ave Water Temp below Folsom = Daily water temperature below Folsom Data at USGS/CDEC station (station no. 11446220/AFD) (°C)

Ave Flow = Daily-averaged hourly flow below Folsom Reservoir (CDEC station FOL) – South Canal Diversion (CDEC station FSC) (cfs)

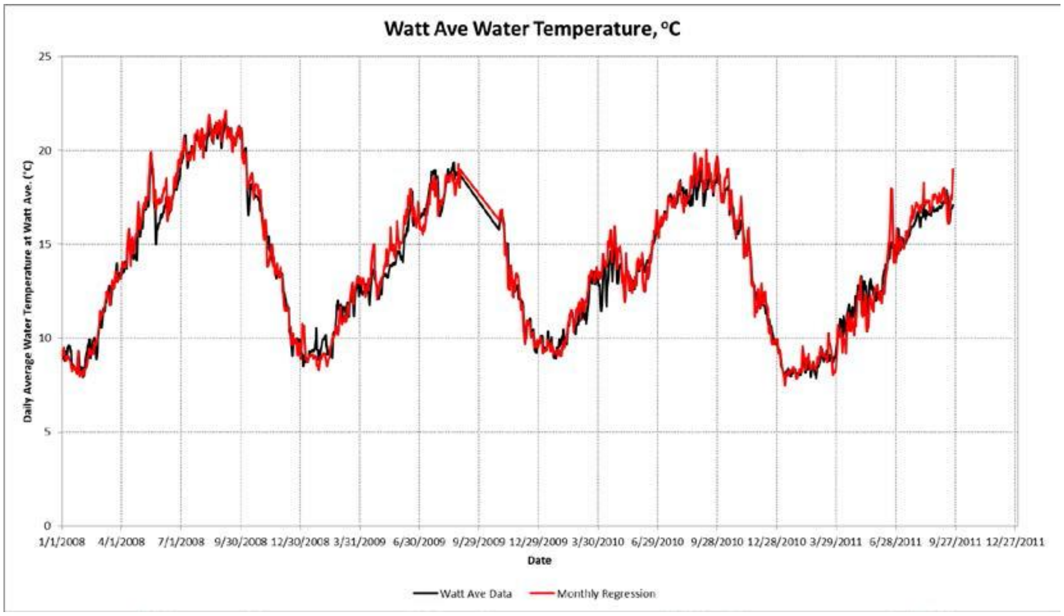
Predicted Temp = Lower American River at Watt Avenue (°C)

ATTACHMENT E

FIGURES



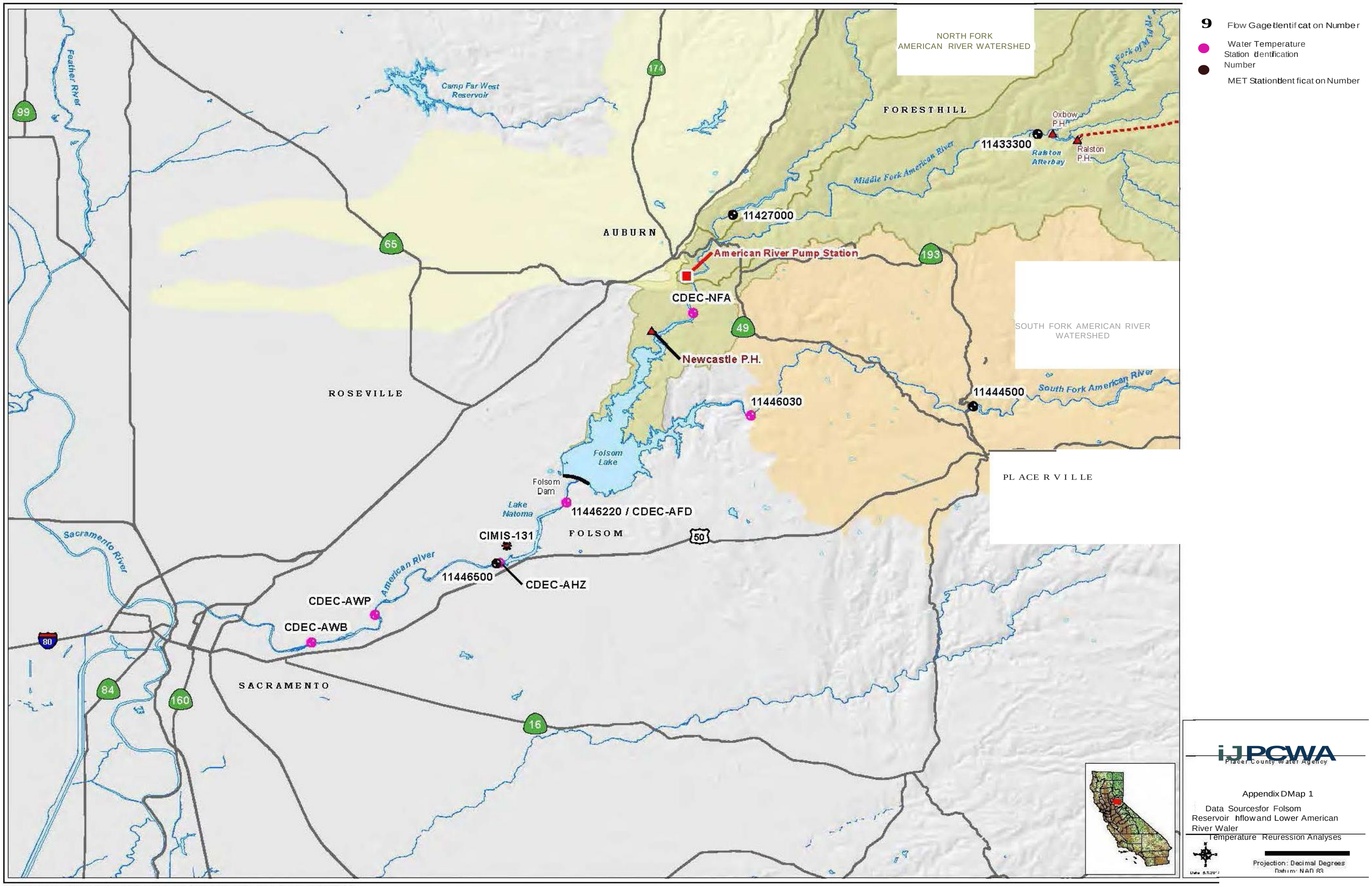
Attachment E Figure 1. Comparison of Measured and Modeled (Regression) Water Temperature on the Lower American River at Watt Avenue (2001-2011): 2001-2004 (top), 2004-2008 (middle), and 2008-2011 (bottom).



Attachment E Figure 1. Comparison of Measured and Modeled (Regression) Water Temperature on the Lower American River at Watt Avenue (2001-2011): 2001-2004 (top), 2004-2008 (middle), and 2008-2011 (bottom) (continued).

ATTACHMENT E

MAP



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