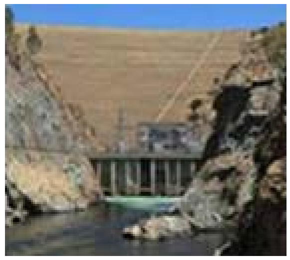
DON PEDRO HYDROELECTRIC PROJECT
FERC NO. 2299

AMENDMENT OF APPLICATION

EXHIBIT E – ENVIRONMENTAL REPORT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List of Acronyms

ac	acres
ACEC	Area of Critical Environmental Concern
ACHP	Advisory Council for Historic Preservation
ACOE	U.S. Army Corps of Engineers
ADA	Americans with Disabilities Act (ADA/ABAAG)
AF	acre-feet
AGS	Annual Grasslands
ALJ	Administrative Law Judge
APE	Area of Potential Effect
APEA	Applicant-Prepared Environmental Assessment
ARMR	Archaeological Resource Management Report
AWQC	Ambient Water Quality Criteria
BA	Biological Assessment
BDCP	Bay-Delta Conservation Plan
BLM	U.S. Department of the Interior, Bureau of Land Management
BLM-S	Bureau of Land Management – Sensitive Species
BMI	Benthic macroinvertebrates
BMP	Best Management Practices
BO	Biological Opinion
BOW	Blue Oak Woodland
ºC	Celsius
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CalEPPC	California Exotic Pest Plant Council
CalSPA	California Sportfishing Protection Alliance
CAS	California Academy of Sciences
CBDA	California Bay-Delta Authority
CCC	Criterion Continuous Concentrations
CCIC	Central California Information Center
CCSF	City and County of San Francisco
CD	Compact Disc
CDBW	California Department of Boating and Waterways

CDEC	California Data Exchange Center
CESA	California Endangered Species Act
CDFA	California Department of Food and Agriculture
CDFG	California Department of Fish and Game (as of January 2013, CDFW)
CDFW	California Department of Fish and Wildlife
CDMG	California Division of Mines and Geology
CDOF	California Department of Finance
CDPH	California Department of Public Health
CDPR	California Department of Parks and Recreation
CDSOD	California Division of Safety of Dams
CDWR	California Department of Water Resources
CE	California Endangered Species
CEC	California Energy Commission
CEII	Critical Energy Infrastructure Information
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CGS	California Geological Survey
cm	centimeters
CMAP	California Monitoring and Assessment Program
CMC	Criterion Maximum Concentrations
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
CORP	California Outdoor Recreation Plan
CPUC	California Public Utilities Commission
CPUE	Catch Per Unit Effort
CRAM	California Rapid Assessment Method
CRC	Chamise-Redshank Chaparral
CRLF	California Red-Legged Frog
CRRF	California Rivers Restoration Fund
CSAS	Central Sierra Audubon Society
CSBP	California Stream Bioassessment Procedure

CSU	California State University
CT	California Threatened Species
CTR	California Toxics Rule
CTS	California Tiger Salamander
CVP	Central Valley Project
CVRWQCB	Central Valley Regional Water Quality Control Board
CWA	Clean Water Act
CWD	Chowchilla Water District
CWHR	California Wildlife Habitat Relationship
CZMA	Coastal Zone Management Act
DDT	dichlorodiphenyltrichloroethane
Districts	Turlock Irrigation District and Modesto Irrigation District
DLA	Draft License Application
DO	Dissolved Oxygen
DOI	Department of Interior
DPRA	Don Pedro Recreation Agency
DPS	Distinct Population Segment
DSE	Chief Dam Safety Engineer
EA	Environmental Assessment
EBMUD	East Bay Municipal Utilities District
EC	Electrical Conductivity
EFH	Essential Fish Habitat
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
Elev or el	Elevation
ENSO	El Niño Southern Oscillation
EPA	U.S. Environmental Protection Agency
ESA	Federal Endangered Species Act
ESRCD	East Stanislaus Resource Conservation District
ESU	Evolutionary Significant Unit
EVC	Existing Visual Condition
EWUA	Effective Weighted Useable Area
°F	Fahrenheit

FERC	Federal Energy Regulatory Commission
FFS	Foothills Fault System
FL	Fork length
FLA	Final License Application
FMP	Fishery Management Plan
FMU	Fire Management Unit
FOT	Friends of the Tuolumne
FPA	Federal Power Act
FPC	Federal Power Commission
FPPA	Federal Plant Protection Act
ft	feet
ft/mi	feet per mile
FWCA	Fish and Wildlife Coordination Act
FWUA	Friant Water Users Authority
FYLF	Foothill Yellow-Legged Frog
g	grams
GIS	Geographic Information System
GLO	General Land Office
GORP	Great Outdoor Recreation Pages
GPS	Global Positioning System
HCP	Habitat Conservation Plan
HSC	Habitat Suitability Criteria
HHWP	Hetch Hetchy Water and Power
HORB	Head of Old River Barrier
hp	horsepower
HPMP	Historic Properties Management Plan
IFIM	Instream Flow Incremental Methodology
ILP	Integrated Licensing Process
in	inches
ISR	Initial Study Report
ITA	Indian Trust Assets
IUCN	International Union for the Conservation of Nature
KOPs	Key Observation Points

kV	kilovolt
kVA	kilovolt-amperes
kW	kilowatt
LWD	large woody debris
m	meters
mm	millimeter
M&I	Municipal and Industrial
MCL	Maximum Contaminant Level
mg/kg	milligrams/kilogram
mg/L	milligrams per liter
mgd	million gallons per day
MGR	Migration of Aquatic Organisms
MHW	Montane Hardwood
mi	miles
mi^2	square miles
MID	Modesto Irrigation District
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MPN	Most Probable Number
MPR	market price referents
MSCS	Multi-Species Conservation Strategy
msl	mean sea level
MUN	municipal and domestic supply
MVA	Megavolt-ampere
MW	megawatt
MWh	megawatt hour
mya	million years ago
NAE	National Academy of Engineering
NAHC	Native American Heritage Commission
NAS	National Academy of Sciences
NAVD 88	North American Vertical Datum of 1988
NAWQA	National Water Quality Assessment
NCCP	Natural Community Conservation Plan

NGVD29	National Geodetic Vertical Datum of 1929
NEPA	National Environmental Policy Act
NERC	North American Electric Reliability Corporation
NGOs	Non-Governmental Organizations
NHI	Natural Heritage Institute
NHPA	National Historic Preservation Act
NISC	National Invasive Species Council
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPS	U.S. Department of the Interior, National Park Service
NRCS	National Resource Conservation Service
NRHP	National Register of Historic Places
NRI	Nationwide Rivers Inventory
NTU	Nephelometric Turbidity Unit
NWI	National Wetland Inventory
NWIS	National Water Information System
NWR	National Wildlife Refuge
O&M	operation and maintenance
OEHHA	Office of Environmental Health Hazard Assessment
OID	Oakdale Irrigation District
ORV	Outstanding Remarkable Value
OSHA	Occupational Safety and Health Administration
PA	Programmatic Agreement
PAD	Pre-Application Document
PDAW	Project Demand of Applied Water
PDO	Pacific Decadal Oscillation
PEIR	Program Environmental Impact Report
PGA	Peak Ground Acceleration
PG&E	Pacific Gas and Electric
PHABSIM	Physical Habitat Simulation System
PHG	Public Health Goal
PM&E	Protection, Mitigation and Enhancement

PMF	Probable Maximum Flood
POAOR	Public Opinions and Attitudes in Outdoor Recreation
ppb	parts per billion
ppm	parts per million
PSP	Proposed Study Plan
PWA	Public Works Administration
QA	Quality Assurance
QC	Quality Control
RA	Recreation Area
RBP	Rapid Bioassessment Protocol
REC-1	water contact recreation
REC-2	water non-contact recreation
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
RM	River Mile
RMP	Resource Management Plan
RP	Relicensing Participant
rpm	Rotations per minute
RPS	Renewable Portfolio Standard
RRMP	Recreation Resource Management Plan
RSP	Revised Study Plan
RST	Rotary Screw Trap
RWG	Resource Work Group
RWQCB	Regional Water Quality Control Board
SC	State candidate for listing under CESA
SCADA	Supervisory Control and Data Acquisition
SCD	State candidate for delisting under CESA
SCE	State candidate for listing as endangered under CESA
SCT	State candidate for listing as threatened under CESA
SD1	Scoping Document 1
SD2	Scoping Document 2
SE	State Endangered Species under the CESA
SEED	U.S. Bureau of Reclamation's Safety Evaluation of Existing Dams
SFP	State Fully Protected Species under CESA

SFPUC	San Francisco Public Utilities Commission
SHPO	State Historic Preservation Officer
SJRA	San Joaquin River Agreement
SJRGA	San Joaquin River Group Authority
SJTA	San Joaquin River Tributaries Authority
SM	Standard Method
SMUD	Sacramento Municipal Utility District
SPAWN	spawning, reproduction and/or early development
SPD	Study Plan Determination
SRA	State Recreation Area
SRMA	Special Recreation Management Area or Sierra Resource Management Area (as per use)
SRMP	Sierra Resource Management Plan
SRP	Special Run Pools
SSC	State species of special concern
ST	California Threatened Species under the CESA
STORET	Storage and Retrieval
SWAMP	Surface Water Ambient Monitoring Program
SWE	Snow-Water Equivalent
SWP	State Water Project
SWRCB	State Water Resources Control Board
TAC	Technical Advisory Committee
TAF	thousand acre-feet
TCP	Traditional Cultural Properties
TCWC	Tuolumne County Water Company
TDS	Total Dissolved Solids
TID	Turlock Irrigation District
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TRT	Tuolumne River Trust
TRTAC	Tuolumne River Technical Advisory Committee
UC	University of California
USBR	U.S. Bureau of Reclamation

USDA	U.S. Department of Agriculture
USDOC	U.S. Department of Commerce
USDOI	U.S. Department of the Interior
USFS	U.S. Department of Agriculture, Forest Service
USFWS	U.S. Department of the Interior, Fish and Wildlife Service
USGS	U.S. Department of the Interior, Geological Survey
USR	Updated Study Report
UTM	Universal Transverse Mercator
VAMP	Vernalis Adaptive Management Plan
VELB	Valley Elderberry Longhorn Beetle
VES	visual encounter surveys
VRO	Visual Resource Objective
WBWG	Western Bat Working Group
WECC	Western Electricity Coordinating Council
WPA	Works Progress Administration
WPT	Western Pond Turtle
WQCP	Water Quality Control Plan
WSA	Wilderness Study Area
WSIP	Water System Improvement Program
WSNMB	Western Sierra Nevada Metamorphic Belt
WUA	weighted usable area
WWTP	Wastewater Treatment Plant
WY	water year
yd^3	cubic yard
yr	year
µS/cm	microSeimens per centimeter
µg/L	micrograms per liter
µmhos	micromhos

PREFACE

On April 28, 2014, the co-licensees of the Don Pedro Hydroelectric Project, Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts), timely filed with the Federal Energy Regulatory Commission (Commission or FERC) the Final License Application (FLA) for the Don Pedro Hydroelectric Project, FERC No. 2299. As noted in the filing and acknowledged by FERC at the time, several studies were ongoing which were likely to inform the development of additional protection, mitigation, and enhancement (PM&E) measures. The Districts have now completed these studies and herein submit this Amendment of Application (Amendment to the Final License Application or AFLA). For ease of review and reference, this AFLA replaces the Districts' April 2014 filing in its entirety.

The Don Pedro Project provides water storage for irrigation and municipal and industrial (M&I) use, flood control, hydroelectric generation, recreation, and natural resource protection (hereinafter, the "Don Pedro Project"). The environmental analysis contained in this AFLA considers all the components, facilities, operations, and maintenance that make up the Don Pedro Project and certain facilities proposed to be included under the new license. The Don Pedro Project is operated to fulfill the following primary purposes and needs: (1) to provide water supply for the Districts for irrigation of over 200,000 acres of Central Valley farmland and M&I use, (2) to provide flood control benefits along the Tuolumne and San Joaquin rivers, and (3) to provide a water banking arrangement for the benefit of the City and County of San Francisco (CCSF) and the 2.6 million people CCSF supplies in the Bay Area. The original license was issued in 1966. In 1995, the Districts entered into an agreement with a number of parties, which resulted in greater flows to the lower Tuolumne River for the protection of aquatic resources.

Hydroelectric generation is a secondary purpose of the Don Pedro Project. Hereinafter, the hydroelectric generation facilities, recreational facilities, and related operations will be referred to as the "Don Pedro Hydroelectric Project," or the "Project". With this AFLA to FERC, the Districts are seeking a new license to continue generating hydroelectric power and implement the Districts' proposed PM&E measures. Based on the information contained in this AFLA, and other sources of information on the record, FERC will consider whether, and under what conditions, to issue a new license for the continued generation of hydropower at the Districts' Don Pedro Project. The Districts are providing a complete description of the facilities and operation of the Don Pedro Project so the effects of the operation and maintenance of the hydroelectric facilities can be distinguished from the effects of the operation and maintenance activities of the overall Don Pedro Project's flood control and water supply/consumptive use purposes.

Being able to differentiate the effects of the hydropower operations from the effects of the flood control and consumptive use purposes and needs of the Don Pedro Project will aid in defining the scope and substance of reasonable PM&E alternatives. As FERC states in Scoping Document 2 in a discussion related to alternative project operation scenarios: "…alternatives that address the consumptive use of water in the Tuolumne River through construction of new structures or methods designed to alter or reduce consumptive use of water are…alternative mitigation strategies that could not replace the Don Pedro *hydroelectric* [emphasis added] project. As such, these recommended alternatives do not satisfy the National Environmental

Policy Act (NEPA) purpose and need for the proposed action and are not reasonable alternatives for the NEPA analysis."

1.0 INTRODUCTION

The Districts are filing with FERC this amendment to the final license application for a new license for the existing Don Pedro Hydroelectric Project (or Project). The Districts initiated relicensing in accordance with regulations governing the Integrated Licensing Process (ILP) promulgated by FERC at 18 Code of Federal Regulations (CFR) Part 5. This Exhibit E, the Environmental Report of the AFLA, is prepared in the form of an Applicant-Prepared Environmental Assessment (APEA) as provided for in 18 CFR §5.18. Exhibit E is supported by data and analysis from more than 35 resource studies and models conducted as part of the relicensing process and numerous prior studies conducted by the Districts in compliance with the terms and conditions of the current Project license.

The 168-megawatt (MW) Don Pedro Hydroelectric Project consists of a single dam and impoundment located on the Tuolumne River in Tuolumne County, California (Figure 1.0-1). The Project is jointly owned by the Districts: MID owns 31.54 percent and TID owns 68.46 percent. Approximately 13,568 acres (ac), or 74 percent, of lands within the current Project Boundary are owned by the Districts. The remaining 26 percent of the Project lands, about 4,802 ac, are federal lands located within the Bureau of Land Management (BLM) Sierra Resource Management Area.

Exhibit E provides environmental analysis by resource area by first describing the existing environment and then evaluating the environmental effects of the Districts' proposal to continue operating the Don Pedro Hydroelectric Project, along with the Districts' proposed resource enhancement measures. The Districts have developed the information on environmental resources contained in this license application in consultation with state and federal fish and wildlife agencies, local governments, Indian Tribes, non-governmental organizations (NGOs) and members of the public. Table 1.0-1 summarizes the studies conducted in support of relicensing.

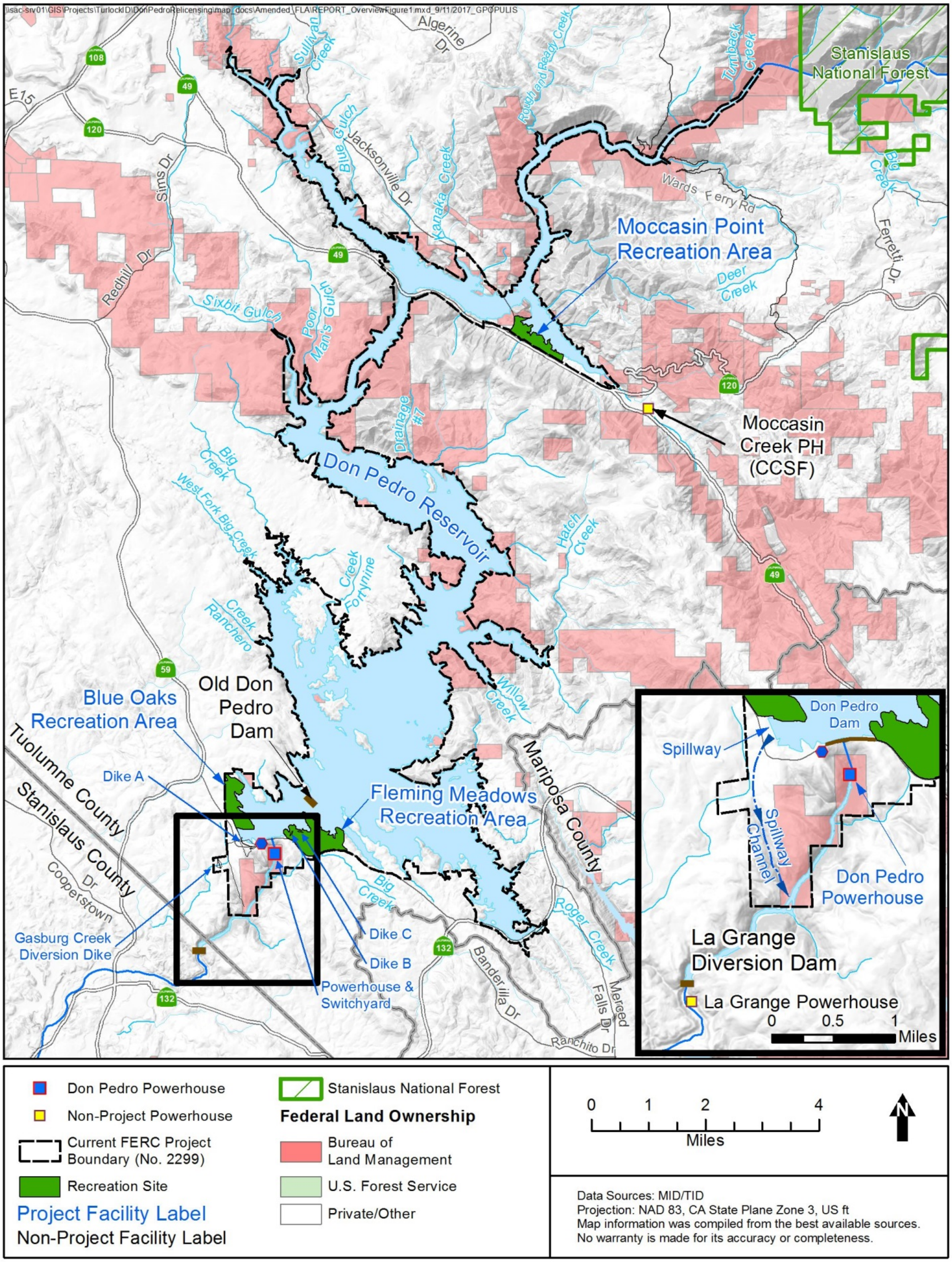

Figure 1.0-1. Don Pedro Project Boundary and major facilities.

Table 1.0-1. Studies conducted in support of the relicensing.

Study Number	Study Title	Final Report
Cultural Resources (CR)		
CR-01	Historic Properties Study	May 2015
CR-02	Native American Traditional Cultural Properties Study	April 2015
Recreation Resources (RR)		
RR-01	Recreation Facility Condition and Public Accessibility Assessment, and Recreation use Assessment	December 2013
RR-02	Whitewater Boating Take Out Improvement Feasibility Study	December 2013
RR-03	Lower Tuolumne River Lowest Boatable Flow Study	December 2013
RR-04	Visual Quality Study	December 2013
Terrestrial Resources (TR)		
TR-01	Special-Status Plants Study	December 2013
TR-02	ESA- and CESA-Listed Plants Study	December 2013
TR-03	Wetland Habitats Associated with Don Pedro Reservoir Study	January 2013
TR-04	Noxious Weed Survey	January 2013
TR-05	ESA-Listed Wildlife - Valley Elderberry Longhorn Beetle Study	December 2013
TR-06	Special-Status Amphibians and Reptiles Study	January 2013
TR-07	ESA-Listed Amphibians - California Red-Legged Frog Study	January 2013
TR-08	ESA-Listed Amphibians - California Tiger Salamander Study	January 2013
TR-09	Special-Status Wildlife - Bats Study	January 2013
TR-10	Bald Eagle Study	December 2013
Water and Aquatic Resources (W&AR)		
W&AR-01	Water Quality Assessment	December 2013
W&AR-02	Project Operations/Water Balance Model	Sepember 2017
W&AR-03	Don Pedro Reservoir Temperature Model	September 2017
W&AR-04	Spawning Gravel in the Lower Tuolumne River Study	December 2013
W&AR-05	Salmonid Population Information Integration and Synthesis Study	January 2013
W&AR-06	Tuolumne River Chinook Salmon Population Model	September 2017
W&AR-07	Predation Study	December 2013
W&AR-07	Mark-Recapture Predation Study[1]	Not applicable
W&AR-08	Salmonid Redd Mapping Study	December 2013
W&AR-10	*Oncorhynchus mykiss* Population Model	September 2017
W&AR-11	Chinook Salmon Otolith Study	February 2016
W&AR-12	*Oncorhynchus mykiss* Habitat Survey	September 2017
W&AR-13	Fish Assemblage and Population Between Don Pedro Dam and La Grange Dam Study	January 2013
W&AR-14	Thermal Performance of Wild Juvenile *Oncorhynchus Mykiss* in the Lower Tuolumne River: A Case for Local Adjustment to High River Temperature	February 2017
W&AR-15	Socioeconomics Study	April 2014
W&AR-16	Lower Tuolumne River Temperature Model	September 2017
W&AR-17	Don Pedro Fish Population Survey	January 2013
W&AR-18	Sturgeon Study	December 2013
W&AR-19	Lower Tuolumne River Riparian Information and Synthesis Study	December 2013
W&AR-20	*Oncorhynchus mykiss* Scale Collection and Age Determination Study	December 2013
W&AR-21	Lower Tuolumne River Floodplain Hydraulic Assessment	February 2017
Response to NMFS Information Request	Districts' Response to NMFS-1, Elements 3 and 6: La Grange Development Affected Environment	January 2014
	Districts' Response to NMFS-4, Element 1 through Element 6 Effects of Don Pedro Project and Related Facilities on Hydrology for Anadromous Fish: Magnitude, Timing, Duration, and Rate of Chage	January 2014

Study Number	Study Title	Final Report
Lower Tuolumne River Instream Flow Study	Pulse Flow Study	June 2012
	Lower Tuolumne River Instream Flow Study	April 2013
	Pacific Lamprey and Sacramento Splittail 1-D PHABSIM Habitat Assessment	April 2014
	Evaluation of Effective Usable Habitat Area for over-summering *O. mykiss*	September 2017
	Non-Native Predatory Bass 1-D PHABSIM Habitat Assessment	September 2017
	In-River Diurnal Temperature Variation Study	April 2014
	Development of Tuolumne River Flow and Temperature Without Dams Model	September 2017

[1] On June 28, 2016, the Districts filed a letter with FERC stating that due to the California Department of Fish and Wildlife's refusal to provide test fish and a Scientific Collection Permit, the Districts will not be able to perform the Mark-Recapture Predation Study.

1.1 Purpose of Action and Need for Power

1.1.1 Purpose of Action

FERC is the federal agency authorized to issue licenses for the construction, operation and maintenance of the nation's non-federal hydroelectric facilities. In accordance with the Federal Power Act (FPA), as amended, FERC is able to issue such licenses for a period not less than 30 years, but no more than 50 years. With submittal of this AFLA, the Districts are requesting a new 50-year license for the Project. Upon expiration of an existing license, FERC must decide whether, and under what terms, to issue a new license. Under the FPA, FERC issues licenses which are best adapted to a comprehensive plan for improving or developing a waterway, and, in so doing, must consider a suite of beneficial public uses including, among others, water supply, flood control, irrigation, recreation, and fish and wildlife. As the federal "action agency", FERC must also comply with the requirements of NEPA. Under NEPA, FERC must clearly define the specific Proposed Action it is considering and state the purpose and need for the Proposed Action.

In the case of the Don Pedro Hydroelectric Project, the Proposed Action under review by FERC is the issuance of a new license to the Districts to authorize the continued generation of hydroelectric power at Don Pedro Dam and Reservoir. As such, and as generally described in FERC's Scoping Document 2 (SD2) issued on July 25, 2011, alternatives to mitigate the Project's effects ("mitigation strategies") must be reasonably related to the purpose and need for the Proposed Action, which in this case is whether, and under what terms, to authorize the continuation of hydropower generation at Don Pedro.

1.1.2 Need for Power

Issuing a new license will allow the Districts to continue generating electricity at the Don Pedro Project for the term of the new license, producing low-cost electric power from an existing, non-polluting, renewable resource.

The electricity generated by the Project is important to the State of California. In January 2016, the California Energy Commission issued the California Energy Demand 2016–2026, Revised Electricity Forecast. The updated forecast presents low, mid, and high forecasts for the state:

average annual growth rates for electricity consumption for 2014–2026 are 0.54 percent, 0.97 percent, and 1.27 percent, respectively (Kavalec 2016).

1.2 Statutory and Regulatory Requirements

1.2.1 Federal Power Act

The issuance of a new license for the Project is subject to numerous requirements under the FPA and other applicable statutes. The major statutes and regulatory requirements are summarized below in chronological order based on date of enactment of the applicable statute. Actions undertaken by the Districts or the agency with jurisdiction related to each requirement are described.

1.2.1.1 Section 18 Fishway Prescriptions

Section 18 of the FPA, 16 U.S.C. § 811, states that FERC shall require construction, maintenance and operation by a licensee of such fishways as the secretaries of the Department of Commerce and the Department of the Interior (DOI) may prescribe. The Districts have consulted with the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) during study plan development and implementation of the ILP. As stated in FERC's July 25, 2011 SD2, the Don Pedro Project does not block the upstream migration of anadromous fish because the upstream extent of anadromous fish in the Tuolumne River is currently limited to areas below La Grange Diversion Dam, located downstream of Don Pedro Dam.

1.2.1.2 Section 4(e) Conditions

The Don Pedro Project occupies approximately 4,802 ac of federal lands which are administered by the BLM. Section 4(e) of the FPA gives the Secretary of the land administering agency authority to prescribe conditions on licenses issued by FERC for hydropower projects located on "reservations" under the Secretary's supervision. See 16 U.S.C. §§ 796(2), 797(e). The Districts have consulted with the BLM during study plan development and implementation of the ILP.

1.2.1.3 Section 10(j) Recommendations

Under the provisions of Section 10(j) of the FPA, each hydroelectric license issued by FERC is required to include conditions based on recommendations of federal and state fish and wildlife agencies for the protection, mitigation, or enhancement of fish and wildlife resources affected by the Project, unless FERC determines they are inconsistent with the purposes and requirements of the FPA or other applicable law. During the relicensing, the Districts have consulted with NMFS, USFWS, and the California Department of Fish and Wildlife (CDFW).

1.2.1.4 Section 30(c) Fish and Wildlife Conditions

This section is applicable to projects that would impound or divert the water of a natural watercourse by means of a new dam or diversion. The Districts are not seeking a license to construct a new dam or diversion; therefore, this section of the FPA is not applicable to the relicensing of the Project.

1.2.2 Clean Water Act

Under Section 401(a)(1) of the Clean Water Act (CWA) of 1970, as amended, 33 USC § 1329(a)(1), a license applicant must obtain certification from the appropriate state pollution control agency verifying compliance with the CWA 33 USC § 1251 *et seq*. In the State of California, the State Water Resources Control Board (SWRCB) is designated to carry out certification requirements prescribed by Section 401. The SWRCB and the State's nine Regional Water Quality Control Boards (RWQCBs) work in a coordinated effort to implement and enforce the CWA, as provided for in the State's Porter-Cologne Water Quality Act.

Within 60 days following FERC's Notice of Acceptance and Ready for Environmental Analysis, the Districts will file the appropriate application to request a Section 401 Water Quality Certificate from the SWRCB.

1.2.3 Endangered Species Act

Section 7 of the Endangered Species Act (ESA) 16 U.S.C. § 1536(a)(2) requires federal agencies to ensure that their actions are "not likely to jeopardize the continued existence of endangered and threatened species or to cause the destruction or adverse modification of the critical habitat of such species...".

FERC is the lead federal agency for relicensing of the Project, and therefore must consult with the USFWS and NMFS to determine whether its actions and authorizations would jeopardize the continued existence of any endangered or threatened species or adversely affect any designated critical habitat. Jeopardy exists when an action would "…appreciably reduce the likelihood of both the survival and recovery of a listed species…" (50 CFR § 402.02). Consultation involves a request to the USFWS and NMFS for an inventory of endangered and threatened species, and species proposed by USFWS or NMFS for listing as endangered or threatened that may be present in the Project Boundary. FERC then prepares a biological assessment (BA) to determine whether these listed species or critical habitat for them is likely to be adversely affected by the federal action, and therefore requires formal consultation. At the end of the consultation process, the USFWS or NMFS issues a biological opinion (BO) that specifies whether or not the action will place an endangered or threatened species or critical habitat in 'jeopardy'. If a jeopardy opinion is issued, the USFWS or NMFS must include reasonable and prudent alternatives to the action. A non-jeopardy opinion may be accompanied by an 'incidental take statement' that specifies impacts of the taking, mitigation measures, and terms and conditions for implementation of the mitigation measures.

On April 8, 2011, FERC initiated informal consultation with the USFWS and the NMFS under Section 7 of the ESA and the joint agency regulations thereunder at 50 CFR, Part 402, and designated the Districts as FERC's non-federal representatives for carrying out informal consultation. The Districts consulted with USFWS and NMFS in developing the aquatic and terrestrial study plans for threatened and endangered species, and implementation of the studies.

One federally-listed fish species, *Oncorhynchus mykiss*,[1] occurs below the Project Boundary. Two federally-listed plant species, Layne's ragwort (*Packera layneae*) and California vervain (*Verbena californica*), are known to occur within the Project Boundary. Habitat for the federally-listed Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*, VELB) is known to occur within the Project Boundary.

A draft BA for federally listed terrestrial species that may occur in the Project Boundary (including Layne's ragwort, California vervain, and VELB) is included in this AFLA. A draft BA for California Central Valley steelhead (*O. mykiss*) is also included in this AFLA.

1.2.4 Coastal Zone Management Act

Under § 307(c)(3)(A) of the Coastal Zone Management Act of 1972, as amended, (16 U.S.C. § 1456(3)(A)), the Commission cannot issue a license for a project within or affecting a state's coastal zone unless the state Coastal Zone Management Act agency concurs with the license applicant's certification of consistency with the state's Coastal Zone Management Act program, or the agency's concurrence is conclusively presumed by its failure to act within 180 days of its receipt of the applicant's certification.

The Project is not located within California's coastal zone boundary and is not subject to California coastal zone program review. No consistency certification is required.

1.2.5 National Historic Preservation Act

FERC licenses may permit activities that may "…cause changes in the character or use of historic properties, if any such historic properties exist…" (36 CFR § 800.16[d]). FERC must therefore comply with Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, (16 U.S. Code § 470 et seq.) and its implementing regulations at 36 CFR Part 800 that requires federal agencies to take into account potential effects of their undertakings on historic properties. As provided at 36 CFR § 800.16(y), a federal undertaking is defined as "a project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a Federal agency, including those carried out by or on behalf of a Federal agency; those carried out with Federal financial assistance; and those requiring a Federal permit, license or approval." In this case, the relicensing of the Project by FERC is considered a federal undertaking and therefore must comply with Section 106.

As defined under 36 CFR 800.16(l), historic properties are prehistoric or historic sites, buildings, structures, objects, districts, *or locations of traditional use or beliefs* that are included in, or eligible for inclusion in, the National Register of Historic Places (NRHP). Historic properties are identified through a process of evaluation against specific criteria found at 36 CFR 60.4. FERC is required to make a good faith effort to identify historic properties that may be affected by the proposed federal undertaking (i.e., the relicensing) (36 CFR § 800).

[1] The term *'O. mykiss'* is used to represent both resident and anadromous life history forms of *Oncorhynchus mykiss*. In circumstances when the discussion is specifically limited to one or the other life history form, the terms 'rainbow trout' or 'resident' will be used to identify resident *O. mykiss*, whereas the terms 'steelhead' or 'anadromous' will be used to denote the anadromous form of *O. mykiss*. However, only steelhead are protected under the ESA.

On April 8, 2011, FERC designated the Districts as its non-federal representatives for purposes of consultation during the relicensing under Section 106 of the NHPA and associated regulations found at 36 CFR § 800.2(c)(4). As FERC's non-federal representatives, the Districts have consulted throughout the relicensing effort with BLM, potentially affected Tribes, and the State Historic Preservation Officer (SHPO), including obtaining the SHPO's concurrence on the Area of Potential Effects (APE). SHPO concurred with the APE in a letter dated January 9, 2012. Since 2012 the APE was expanded slightly to incorporate additional areas where Project activities occur that could affect historic properties. The SHPO concurred on this expanded APE in a letter dated February 23, 2015. Consultation efforts further included nine meetings among the Districts, the Tribes, BLM, and the SHPO that focused on the collaborative development of study plans, discussion of study results, and development of the Historic Properties Management Plan (HPMP). Representatives from five Tribes, BLM, the National Park Service (NPS), the SHPO and FERC routinely participated in these meetings.

To assist FERC in identifying historic properties that may be affected by the Project under a new FERC license, as required by Section 106, the Districts conducted two cultural resources studies: the Historic Properties Study[2] (TID/MID 2015a and TID/MID 2015c) and the Native American Traditional Cultural Properties (TCP) Study (TID/MID 2015b). These studies were conducted in accordance with the Secretary of Interior's Standards and Guidelines for Identification (USDOI 1983) and BLM's Class III/intensive standards, per BLM's 8100 manual series. Tribal monitors from the Tuolumne Band of Me-Wuk Indians and the Southern Sierra Miwuk accompanied the field crew during the cultural resources inventory conducted for the Historic Properties Study.

The Districts submitted a draft HPMP to participating Tribes and agencies on April 30, 2014 for a 90-day review and again on July 11, 2016 for a 30-day review. Copies of the letters transmitting the HPMP to the Tribes and agencies can be found in Attachment N of the HPMP. All comments received from the Tribes and agencies have been considered. A revised HPMP, reflecting the modifications completed to address the comments received, was submitted to the SHPO on August 30, 2016. Comments were received from the SHPO in a letter dated November 10, 2016. The Districts are currently in the process of addressing SHPO comments and revising the HPMP. The Districts expect to file a final HPMP with FERC by February 2018, following additional SHPO consultation efforts.

[2] This study consisted of both an initial cultural resources inventory to document built environment resources and archaeological resources and an addendum inventory to address both expanded APE boundaries and lands newly exposed by low water levels in the reservoir (TID/MID 2015a and TID/MID 2015c). Additionally, reference to this study, as used throughout the HPMP, also includes limited data collected during two ancillary cultural resources surveys within the APE that were not conducted for the relicensing, but were conducted for separate federal undertakings related to compliance with Section 404 of the Clean Water Act. For these ancillary surveys the United States Army Corps of Engineers (USACE) was the lead federal agency. These efforts, that are separate from the Historic Properties Study efforts, were documented in two cultural resources management reports that were prepared and submitted to USACE and local Tribes for review and to the SHPO for review and concurrence (TID/MID 2013 and TID/MID 2014).

1.2.6 Wilderness Act/Wild and Scenic Rivers Act

1.2.6.1 Wild and Scenic Rivers Act

Congress formally designated portions of the upper Tuolumne River, upstream of the Don Pedro Project Boundary, as Wild and Scenic by PL98-425 on September 28, 1984. In May 1988, the US Forest Service (USFS) issued the Tuolumne Wild and Scenic River Management Plan. Among other things, in Chapter 8 of that plan, the USFS identified what it proposed to be the resource management corridor associated with the wild and scenic reach designated by Congress. The management plan generally identified the corridor as encompassing lands within one-quarter mile of the wild and scenic river segments. Chapter 8 also identifies specific parcels of land proposed to be within the corridor and provided five maps showing the corridor boundary. The lands within the USFS wild and scenic management plan (USFS 1988) overlap the 1966 licensed FERC Project Boundary. Specifically, the USFS identifies in the management plan that the lands and waters of T1N R16E, Section 31: S1/2N1/2, N1/2S1/2 are classified as "wild". However, a portion of the area designated as "wild" is within the previously licensed Don Pedro Project Boundary. The more proper designation of the wild and scenic corridor in this area would be Section 31: SE1/4N1/2, NE1/4S1/2.

Congress was clear in PL98-425 that prior authorized uses were not to be affected in any way by the wild and scenic designation. In relevant part, PL98-425 states: "*Nothing in this section is intended or shall be construed to affect any rights, obligations, privileges, or benefits granted under any prior authority of law including chapter 4 of December 19, 1913, commonly referred to as the Raker Act and including any agreement or administrative ruling entered into or made effective* ***before the enactment of this paragraph*** (emphasis added)*.*"

Portions of the Tuolumne River designated as Wild and Scenic include stretches of the river extending 83 miles upstream of the Don Pedro Project Boundary. Of that, a total of 54 miles of the Tuolumne River within Yosemite National Park have been designated as Wild and Scenic. These segments, which are administered by the National Park Service, include the Dana Fork and Lyell Fork at the headwaters of the river; a scenic segment through Tuolumne Meadows; a wild segment from the Grand Canyon of the Tuolumne River to the inlet of Hetch Hetchy Reservoir; a scenic segment from one mile west of O'Shaughnessy Dam; and the remaining five-mile wild segment through Poopenaut Valley to the park boundary. Approximately 13 river miles of the Hetch Hetchy Reservoir were not included in the 1984 Wild and Scenic River designation and thus are not included within the Tuolumne Wild and Scenic River corridor. The remaining segments of the Wild and Scenic Tuolumne River are under the administration of the U.S. Forest Service (USFS) and the BLM.

The Nationwide Rivers Inventory (NRI) is a listing of more than 3,400 river segments in the U.S. that are believed to possess one or more "outstandingly remarkable" natural or cultural values (ORV) judged to be of more than local or regional significance (NPS 1982). The NRI is a source of information for statewide river assessments and federal agencies involved with stream-related projects. Within the Project vicinity, Cherry Creek above Cherry Reservoir and the Clavey River are included in the NRI. Cherry Creek above Cherry Reservoir has potential classification as a wild river and possesses scenery values and geology values. Clavey River has potential classification as wild and scenic river and possesses six ORVs: cultural values, fish values, scenery values, recreation values, wildlife values, and other values, which may include hydrology, paleontology, and/or botany resources.

1.2.6.2 Wilderness Act

There are no Wilderness Areas located within the Project Boundary. The two closest Wilderness Areas to the Project Boundary, Yosemite Wilderness and Emigrant Wilderness, are each located approximately 21 miles away. Within 50 miles of the Project Boundary, there are a total of six Wilderness Areas: Yosemite Wilderness, Emigrant Wilderness, Carson-Iceberg Wilderness, Hoover Wilderness, Mokelumne Wilderness, and Ansel Adams Wilderness.

1.2.7 Magnuson-Stevens Fishery Conservation and Management Act

The purpose of the Magnuson-Stevens Fishery Conservation and Management Act is to conserve and manage, among other resources, anadromous fishery resources of the United States. The Act establishes eight Regional Fisheries Management Councils to prepare, monitor, and revise fishery management plans that will achieve and maintain the optimum yield from each fishery. In California, the Pacific Fisheries Management Council is responsible for achieving the objectives of the statute. The Secretary of Commerce has oversight authority.

The Act was amended in 1996 to establish a new requirement to describe and identify “essential fish habitat” (EFH) in each fishery management plan. EFH is defined as “…those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” EFH has been established by NMFS for waters in California supporting anadromous fish. The Act requires that all federal agencies, including FERC, consult with NMFS on all actions, or proposed actions, permitted, funded, or undertaken by the agency, that may adversely affect EFH. Adversely affect means any impact that reduces the quality and/or quantity of EFH. Comments from NMFS following consultation are advisory only; however, a written explanation must be submitted to NMFS if the implementing federal agency does not agree with NMFS’ recommendations.

The Districts have developed an applicant-prepared EFH Assessment for relevant fisheries managed under the Pacific Salmon Fishery Management Plan (FMP). The FMP identifies freshwater EFH for one species: fall-run Chinook salmon. The EFH Action Area includes the stream reaches below the Project Boundary that are designated as EFH for Chinook salmon. Descriptions of fall-run Chinook abundance, distribution, available habitat, and habitat use are provided in section 3.5 of this Exhibit.

1.3 Public Review and Consultation

1.3.1 Notice of Intent and Pre-Application Document

Prior to filing the Notice of Intent (NOI) and Pre-Application Document (PAD) in February 2011, the Districts commenced relicensing discussions with a series of meetings with resource agencies and the public. The Districts met with NMFS on August 30, 2010, USFWS on August

31, 2010, and CDFW on October 19, 2010. In September 2010, the Districts conducted three public information meetings to seek out additional sources of existing information, familiarize interested parties with the Don Pedro Project facilities, features, and operations, and review the Districts' relicensing plans and the overall relicensing schedule.

The Districts exercised due diligence in acquiring information to be included in the PAD. The Districts contacted governmental agencies, Indian Tribes, and other parties potentially having relevant information, conducted extensive searches of publicly available databases and their own records, and broadly distributed a request for information designed specifically to identify existing, relevant, and available information related to the Don Pedro Hydroelectric Project and any potential effects on resources within the Project Boundary.

Pursuant to 18 C.F.R. §5.6, the Districts prepared a NOI and PAD and filed the documents with FERC on February 11, 2011. The Districts also distributed the PAD to federal and state resource agencies, NGOs, local governments, Indian Tribes, and other relicensing participants. The PAD included information the Districts had gathered to date as well as 10 proposed study plans, which addressed water quality, terrestrial, wildlife, historic properties, and cultural resources.

1.3.2 Scoping and Study Plan Development

Following the Districts' submittal of the PAD, FERC conducted issue scoping to determine what issues and alternatives should be addressed during the relicensing process. The purpose of scoping was to identify the significant environmental issues to be evaluated in the FERC Environmental Impact Statement (EIS). The purposes of the scoping process are as follows:

- invite participation of federal, state, and local resource agencies, Indian Tribes, NGOs, and the public (collectively, relicensing participants) to identify significant environmental and socioeconomic issues related to the proposed Project;
- determine the depth of analysis and significance of issues to be addressed in the environmental document;
- identify how the Project would or would not contribute to cumulative effects in the Project area;
- identify reasonable alternatives to the Proposed Action that should be evaluated in the environmental document;
- solicit available information on the resources at issue, including existing information and study needs; and
- determine the resource areas and potential issues that do not require detailed analysis during review of the Project.

Some resource areas did not require further detailed investigation owing to the fact that extensive studies had been completed as part of ongoing license compliance activities. The Don Pedro Hydroelectric Project and its potential environmental effects have undergone continuous study and evaluation since the initial FERC license was issued. The Districts, in cooperation with state and federal resource agencies and environmental groups, have conducted over 150 individual resource investigations since the Project began commercial operation in 1971. The first 20 years of study led in 1995 to the development of a FERC-mediated Settlement Agreement with resource agencies, interested parties, and NGOs whereby the Districts agreed to modify their operations to increase the flows released to the lower Tuolumne River for the benefit of fisheries, especially fall-run Chinook salmon.

Since the early 1990s to the present time, the Tuolumne River Technical Advisory Committee (TAC) has been actively engaged in developing, reviewing, and participating in activities to improve and protect the fisheries of the lower Tuolumne River downstream of the Don Pedro Project. In addition to the Districts, the TAC consists of state and federal resource agencies, CCSF, and NGOs. On an annual basis, the Districts file with FERC and share with the TAC results of ongoing monitoring in the lower Tuolumne River. The up-to-date record created by the continuous process of environmental investigation and resource monitoring has built a detailed record for the relicensing of the Don Pedro Project. Major studies conducted by the Districts since the 1995 Settlement Agreement are summarized in Table 1.3-1.

Table 1.3-1. Studies conducted by the Districts under the current license.

Study No.	Study Name
Salmon Population Models	
1992 Appendix 1	Population Model Documentation
1992 Appendix 26	Export Mortality Fraction Submodel
1992 Appendix 2	Stock Recruitment Analysis of the Population Dynamics of San Joaquin River System Chinook salmon
Report 1996-5	Stock-Recruitment Analysis Report
Salmon Spawning Surveys	
1992 Appendix 3	Tuolumne River Salmon Spawning Surveys 1971-88
Report 1996-1	Spawning Survey Summary Report
Report 1996-1.1	1986 Spawning Survey Report
Report 1996-1.2	1987 Spawning Survey Report
Report 1996-1.3	1988 Spawning Survey Report
Report 1996-1.4	1989 Spawning Survey Report
Report 1996-1.5	1990 Spawning Survey Report
Report 1996-1.6	1991 Spawning Survey Report
Report 1996-1.7	1992 Spawning Survey Report
Report 1996-1.8	1993 Spawning Survey Report
Report 1996-1.9	1994 Spawning Survey Report
Report 1996-1.10	1995 Spawning Survey Report
Report 1996-1.11	1996 Spawning Survey Report
Report 1996-1.12	Population Estimation Methods
Report 1997-1	1997 Spawning Survey Report and Summary Update
Report 1998-1	Spawning Survey Summary Update
Report 1999-1	1998 Spawning Survey Report
Report 2000-1	1999 and 2000 Spawning Survey Reports
Report 2000-2	Spawning Survey Summary Update
Report 2001-1	2001 Spawning Survey Report
Report 2001-2	Spawning Survey Summary Update
Report 2002-1	2002 Spawning Survey Report
Report 2002-2	Spawning Survey Summary Update
Report 2003-1	Spawning Survey Summary Update
Report 2004-1	2003 and 2004 Spawning Survey Reports
Report 2004-2	Spawning Survey Summary Update

Study No.	Study Name
Report 2006-1	2005 and 2006 Spawning Survey Reports
Report 2006-2	Spawning Survey Summary Update
Report 2007-1	2007 Spawning Survey Report
Report 2007-2	Spawning Survey Summary Update
Report 2008-2	Spawning Survey Summary Update
Report 2009-1	2008 and 2009 Spawning Survey Reports
Report 2009-2	Spawning Survey Summary Update
Report 2009-8	2009 Counting Weir Report
Report 2010-1	2010 Spawning Survey Reports
Report 2010-2	Spawning Survey Summary Update
Report 2010-8	2010 Counting Weir Report
Report 2011-2	Spawning Survey Summary Update
Report 2011-8	2011 Tuolumne River Weir Report
Report 2012-2	Spawning Survey Summary Update
Report 2012-6	2012 Tuolumne River Weir Report
Report 2013-1	2013 Spawning Survey Reports
Report 2013-2	Spawning Survey Summary Update
Report 2013-6	2013 Tuolumne River Weir Report
Report 2014-1	2014 Spawning Survey Reports
Report 2014-2	Spawning Survey Summary Update
Report 2014-6	2014 Tuolumne River Weir Report
Report 2015-1	2015 Spawning Survey Reports
Report 2015-2	Spawning Survey Summary Update
Report 2015-6	2015 Tuolumne River Weir Report
Report 2016-1	2016 Spawning Survey Reports
Report 2016-2	Spawning Survey Summary Update
Report 2016-6	2016 Tuolumne River Weir Report
Seine, Snorkel, Fyke Reports and Various Juvenile Salmon Studies	
1992 Appendix 10	1987 Juvenile Chinook salmon Mark-Recapture Study
1992 Appendix 12	Data Reports: Seining of Juvenile Chinook salmon in the Tuolumne, San Joaquin, and Stanislaus Rivers, 1986-89
1992 Appendix 13	Report on Sampling of Chinook Salmon Fry and Smolts by Fyke Net and Seine in the Lower Tuolumne River, 1973-86
1992 Appendix 20	Juvenile Salmon Pilot Temperature Observation Experiments
Report 1996-2	Juvenile Salmon Summary Report
Report 1996-2.1	1986 Snorkel Survey Report
Report 1996-2.2	1988-89 Pulse Flow Reports
Report 1996-2.3	1990 Juvenile Salmon Report
Report 1996-2.4	1991 Juvenile Salmon Report
Report 1996-2.5	1992 Juvenile Salmon Report
Report 1996-2.6	1993 Juvenile Salmon Report
Report 1996-2.7	1994 Juvenile Salmon Report
Report 1996-2.8	1995 Juvenile Salmon Report
Report 1996-2.9	1996 Juvenile Salmon Report
Report 1996-9	Aquatic Invertebrate Report
Report 1997-2	1997 Juvenile Salmon Report and Summary Update
Report 1998-2	1998 Juvenile Salmon Report and Summary Update
Report 1999-4	1999 Juvenile Salmon Report and Summary Update
Report 2000-3	2000 Seine/Snorkel Report and Summary Update
Report 2001-3	2001 Seine/Snorkel Report and Summary Update
Report 2002-3	2002 Seine/Snorkel Report and Summary Update
Report 2003-2	2003 Seine/Snorkel Report and Summary Update

Study No.	Study Name
Report 2004-3	2004 Seine/Snorkel Report and Summary Update
Report 2005-3	2005 Seine/Snorkel Report and Summary Update
Report 2006-3	2006 Seine/Snorkel Report and Summary Update
Report 2007-3	2007 Seine/Snorkel Report and Summary Update
Report 2008-3	2008 Seine Report and Summary Update
Report2008-5	2008 Snorkel Report and Summary Update
Report 2009-3	2009 Seine Report and Summary Update
Report 2009-5	2009 Snorkel Report and Summary Update
Report 2010-3	2010 Seine Report and Summary Update
Report 2010-5	2010 Snorkel Report and Summary Update
Report 2011-3	2011 Seine Report and Summary Update
Report 2011-5	2011 Snorkel Report and Summary Update
Report 2012-3	2012 Seine Report and Summary Update
Report 2012-5	2012 Snorkel Report and Summary Update
Report 2013-3	2013 Seine Report and Summary Update
Report 2013-5	2013 Snorkel Report and Summary Update
Report 2014-3	2014 Seine Report and Summary Update
Report 2014-5	2014 Snorkel Report and Summary Update
Report 2015-3	2015 Seine Report and Summary Update
Report 2015-5	2015 Snorkel Report and Summary Update
Report 2016-3	2016 Seine Report and Summary Update
Report 2016-5	2016 Snorkel Report and Summary Update
Screw Trap Monitoring	
Report 1996-12	Screw Trap Monitoring Report: 1995-96
Report 1997-3	1997 Screw Trap and Smolt Monitoring Report
Report 1998-3	1998 Tuolumne River Outmigrant Trapping Report
Report 1999-5	1999 Tuolumne River Upper Rotary Screw Trap Report
Report 2000-4	2000 Tuolumne River Smolt Survival and Upper Screw Traps Report
Report 2000-5	1999-2000 Grayson Screw Trap Report
Report 2001-4	2001 Grayson Screw Trap Report
Report 2004-4	1998, 2002, and 2003 Grayson Screw Trap Reports
Report 2004-5	2004 Grayson Screw Trap Report
Report 2005-4	2005 Grayson Screw Trap Report
Report 2005-5	Rotary Screw Trap Summary Update
Report 2006-4	2006 Rotary Screw Trap Report
Report 2006-5	Rotary Screw Trap Summary Update
Report 2007-4	2007 Rotary Screw Trap Report
Report 2008-4	2008 Rotary Screw Trap Report
Report 2009-4	2009 Rotary Screw Trap Report
Report 2010-4	2010 Rotary Screw Trap Report
Report 2011-4	2011 Rotary Screw Trap Report
Report 2012-4	2012 Rotary Screw Trap Report
Report 2013-4	2013 Rotary Screw Trap Report
Report 2014-4	2014 Rotary Screw Trap Report
Report 2015-4	2015 Rotary Screw Trap Report
Report 2016-4	2016 Rotary Screw Trap Report
Flow Fluctuation Assessments	
1992 Appendix 14	Fluctuation Flow Study Report
1992 Appendix 15	Fluctuation Flow Study Plan: Draft
Report 2000-6	Tuolumne River Chinook Salmon Fry and Juvenile Stranding Report
2005 Ten-Year Summary Report Appendix E	Stranding Survey Data (1996-2002)

Study No.	Study Name
Predation Evaluations	
1992 Appendix 22	Lower Tuolumne River Predation Study Report
1992 Appendix 23	Effects of Turbidity on Bass Predation Efficiency
Report 2006-9	Lower Tuolumne River Predation Assessment Final Report
Smolt Monitoring and Survival Evaluations	
1992 Appendix 21	Possible Effects of High Water Temperature on Migrating Salmon Smolts in the San Joaquin River
Report 1996-13	Coded-wire Tag Summary Report
Report 1998-4	1998 Smolt Survival Peer Review Report
Report 1998-5	CWT Summary Update
Report 1999-7	Coded-wire Tag Summary Update
Report 2000-4	2000 Tuolumne River Smolt Survival and Upper Screw Traps Report
Report 2000-8	Coded-wire Tag Summary Update
Report 2001-5	Large CWT Smolt Survival Analysis
Report 2001-6	Coded-wire Tag Summary Update
Report 2002-4	Large CWT Smolt Survival Analysis
Report 2002-5	Coded-wire Tag Summary Update
Report 2003-3	Coded-wire Tag Summary Update
Report 2004-7	Large CWT Smolt Survival Analysis Update
Report 2004-8	Coded-wire Tag Summary Update
Report 2005-6	Coded-wire Tag Summary Update
Report 2006-6	Coded-wire Tag Summary Update
Report 2007-5	Coded-wire Tag Summary Update
Fish Community Assessments	
1992 Appendix 24	Effects of Introduced Species of Fish in the San Joaquin River System
1992 Appendix 27	Summer Flow Study Report 1988-90
Report 1996-3	Summer Flow Fish Study Annual Reports: 1991-94
Report 1996-3.1	1991 Report
Report 1996-3.2	1992 Report
Report 1996-3.3	1993 Report
Report 1996-3.4	1994 Report
Report 2001-8	Distribution and Abundance of Fishes Publication
Report 2002-9	Publication on the Effects of Flow on Fish Communities
Report 2007-7	2007 Rainbow Trout Data Summary Report
Report 2008-6	2008 July *Oncorhynchus mykiss* Population Estimate Report
Report 2010	Tuolumne River *Oncorhynchus mykiss* Monitoring Report (submitted January 15)
Attachment 5	March and July 2009 Population Estimates of *Oncorhynchus mykiss* Report
Report 2011	Tuolumne River *Oncorhynchus mykiss* Monitoring Summary Report (submitted January 15)
Report 2010-6	2010 *Oncorhynchus mykiss* Population Estimate Report
Report 2010-7	2010 *Oncorhynchus mykiss* Acoustic Tracking Report
Report 2011-6	2011 *Oncorhynchus mykiss* Population Estimate Report
Report 2011-7	2011 *Oncorhynchus mykiss* Acoustic Tracking Report
Invertebrate Reports	
1992 Appendix 16	Aquatic Invertebrate Studies Report
1992 Appendix 28	Summer Flow Invertebrate Study
Report 1996-4	Summer Flow Aquatic Invertebrate Annual Reports: 1989-93
Report 1996-4.1	1989 Report
Report 1996-4.2	1990 Report
Report 1996-4.3	1991 Report
Report 1996-4.4	1992 Report

Study No.	Study Name
Report 1996-4.5	1993 Report
Report 1996-9	Aquatic Invertebrate Report
Report 2002-8	Aquatic Invertebrate Report
Report 2004-9	Aquatic Invertebrate Monitoring Report (2003-2004)
Report 2008-7	Aquatic Invertebrate Monitoring (2005, 2007, 2008) and Summary Update
Report 2009-7	2009 Aquatic Invertebrate Monitoring and Summary Update
Delta Salmon Salvage	
Report 1999-6	1993-99 Delta Salmon Salvage Report
Gravel, Incubation, and Redd Studies	
1992 Appendix 6	Spawning Gravel Availability and Superimposition Report (incl. map)
1992 Appendix 7	Salmon Redd Excavation Report
1992 Appendix 8	Spawning Gravel Studies Report
1992 Appendix 9	Spawning Gravel Cleaning Methodologies
1992 Appendix 11	An Evaluation of the Effect of Gravel Ripping on Redd Distribution
Report 1996-6	Redd Superimposition Report
Report 1996-7	Redd Excavation Report
Report 1996-8	Gravel Studies Report: 1987-89
Report 1996-10	Gravel Cleaning Report: 1991-93
Report 2000-7	Tuolumne River Substrate Permeability Assessment and Monitoring Program Report
Report 2006-7	Survival to Emergence Study Report
Report 2008-9	Monitoring of Winter 2008 Runoff Impacts from Peaslee Creek
Water Temperature and Water Quality	
1992 Appendix 17	Preliminary Tuolumne River Water Temperature Report
1992 Appendix 18	Instream Temperature Model Documentation: Description and Calibration
1992 Appendix 19	Modeled Effects of La Grange Releases on Instream Temperatures in the Lower Tuolumne River
Report 1996-11	Intragravel Temperature Report: 1991
Report 1997-5	1987-97 Water Temperature Monitoring Data Report
Report 2002-7	1998-2002 Temperature and Conductivity Data Report
Report 2004-10	2004 Water Quality Report
Report 2007-6	Flow, Delta Export, Weather, and Water Quality Data Report: 2003-2007
IFIM Assessment	
1992Appendix 4	Instream Flow Data Processing, Tuolumne River
1992 Appendix 5	Analysis of 1981 Lower Tuolumne River IFIM Data
	1995 USFWS Report on the Relationship between Instream Flow and Physical Habitat Availability (submitted by Districts to FERC in May 2004)
Flow and Delta Exports	
Report 1997-4	Streamflow and Delta Water Export Data Report
Report 2002-6	1998-2002 Streamflow and Delta Water Export Data Report
Report 2003-4	Review of 2003 Summer Flow Operation
Report 2007-6	Flow, Delta Export, Weather, and Water Quality Data Report: 2003-2007
Report 2008-8	Review of 2008 Summer Flow Operation
Report 2009-6	Review of 2009 Summer Flow Operation
Restoration, Project Monitoring, and Mapping	
Report 1996-14	Tuolumne River GIS Database Report and Map
Report 1999-8	A Summary of the Habitat Restoration Plan for the Lower Tuolumne River Corridor
Report 1999-9	Habitat Restoration Plan for the Lower Tuolumne River Corridor
Report 1999-10	1998 Restoration Project Monitoring Report
Report 1999-11	1999 Restoration Project Monitoring Report
Report 2001-7	Adaptive Management Forum Report

Study No.	Study Name
Report 2004-12	Coarse Sediment Management Plan
Report 2004-13	Tuolumne River Floodway Restoration (Design Manual)
2005 Ten-Year Summary Report Appendix D	Salmonid Habitat Maps
2005 Ten-Year Summary Report Appendix F	GIS Mapping Products
Report 2005-7	Bobcat Flat/River Mile 43: Phase 1 Project Completion Report
Report 2006-8	Special Run Pool 9 and 7/11 Reach: Post-Project Monitoring Synthesis Report
Report 2006-10	Tuolumne River La Grange Gravel Addition, Phase II Annual Report
Report 2006-11	Tuolumne River La Grange Gravel Addition, Phase II Geomorphic Monitoring Report
General Monitoring Information	
Report	1992 Fisheries Studies Report
Report 2002-10	2001-2002 Annual CDFW Sportfish Restoration Report
Report	2005 Ten-Year Summary Report

FERC issued a Scoping Document 1 (SD1) and NOI on April 8, 2011, to solicit comments on the scope of environmental studies in the relicensing process, and to encourage participation in the relicensing process. The SD1 was noticed in the Federal Register on April 14, 2011. FERC staff conducted a public site visit of the Don Pedro Project on May 10, 2011, which included an overview of the Don Pedro Project and its operations and a tour of the Don Pedro Reservoir and adjacent recreation facilities and wildlife areas. On May 11, 2011, FERC staff conducted a daytime public scoping meeting in the city of Turlock, California and an evening public scoping meeting in the city of Modesto, California. Attendees included representatives from federal, state and local agencies, elected officials, business leaders, and community members.

After filing the PAD, the Districts held a series of resource work group (RWG) meetings to solicit input on the relicensing study plans. On July 25, 2011, the Districts filed their Proposed Study Plan (PSP) document with FERC. The PSP presented 30 draft study plans that the Districts proposed in response to study requests received from relicensing participants. On that same day, FERC filed its SD2, incorporating relicensing participant comments received on the SD1, the PAD, and study requests. FERC issued a minor clarification to its SD2 on July 29, 2011.

Between filing the PSP on July 25, 2011 and the October 24, 2011 deadline for filing comments on the PSP, the Districts hosted 13 additional RWG meetings to resolve differences regarding the proposed studies. Through these meetings, all 30 of the Districts' draft study proposals were discussed and two new study plans were formulated. On October 13, 2011, the Districts filed an Updated Study Plan with FERC to provide the most up-to-date version of the PSP. Based on the RWG meetings and comments received on the PSP, the Districts revised many of the original study plans and added five additional studies, bringing the total number of studies to be conducted to 35. On November 22, 2011, the Districts filed a Revised Study Plan containing the 35 study plans.

On December 22, 2011, FERC issued its Study Plan Determination (SPD) for the Don Pedro Project, approving or approving with modifications 33 studies proposed in the RSP, adding one study recommended by the BLM (Bald Eagle Study), and recommending that two studies not be undertaken (the Chinook Salmon Fry Movement Study and the Temperature Criteria Study). As required by the SPD, and after further consultation with the resource agencies and other relicensing participants, the Districts filed three revised study plans with more detailed methodologies on February 28, 2012 and one modified study plan on April 6, 2012. FERC approved or approved with modifications these studies on July 25, 2012. In addition, the Districts chose to conduct the Temperature Criteria Study (W&AR-14), which is included in Attachment C of this AFLA.

Following FERC's issuance of the SPD, a total of seven studies (and associated study elements) that were either not adopted in the SPD or were adopted with modifications, formed the basis of Study Dispute proceedings. On April 17, 2012, in response to study disputes, FERC convened a Dispute Resolution Panel technical conference in Sacramento, California. The Panel issued its findings on May 4, 2012. On May 24, 2012, FERC issued its Formal Study Dispute Determination, with additional clarifications related to the Formal Study Dispute Determination issued on August 17, 2012. The Study Dispute Determination resulted in two modifications to the SPD and six clarifications. Studies were implemented consistent with this determination.

In addition to studies required under the relicensing proceedings, the Districts' instream flow incremental methodology (IFIM) study provides information in support of this license application. On July 16, 2009, FERC directed the Districts to develop and implement an IFIM study to determine instream flows necessary to maximize Chinook salmon and *O. mykiss* production and survival in the Tuolumne River. The lower Tuolumne River Instream Flow Studies – Final Study Plan (Stillwater Sciences 2009) was filed on October 14, 2009 and approved by FERC on May 12, 2010.

In order to examine the broad flow ranges identified in FERC's July 2009 Order, the study plan separated the study into two separate investigations: (1) A conventional 1-D Physical Habitat Simulation (PHABSIM) model (Lower Tuolumne Instream Flow Study), which examines in-channel habitat conditions at flows from approximately 100–1,000 cfs, and (2) a 2-D hydraulic model of overbank areas, as well as adjacent in-channel locations, for flows of 1,000–5,000 cfs, developed as part of the Pulse Flow Study. Following approval of the original Study Plan, in its December 22, 2011 SPD, FERC required the scope of the Lower Tuolumne River Instream Flow Study be expanded to include Pacific lamprey (*Entosphenus tridentatus*) and Sacramento splittail (*Pogonichthys macrolepidotus*), if existing habitat suitability criteria (HSC) were available. In its April 8, 2013 comments on the Draft Lower Tuolumne Instream Flow Study Report, the USFWS provided references to existing criteria, developed for the lower Merced River. More recently, FERC's May 21, 2013 Determination on Requests for Study Modifications and New Studies required the scope of the Lower Tuolumne Instream Flow Study be expanded to assess habitat for non-native predatory fish, including smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*), and striped bass (*Morone saxatilis*) using existing HSC data, where available. All components of the the Lower Tuolumne River Instream Flow Study have now been filed with FERC (Table 1.0-1).

1.3.3 Consultation Workshop Process

The Districts conducted, with FERC concurrence, a series of workshops associated with the studies listed below to share and discuss relevant data with relicensing participants:

- W&AR-02: Project Operations/Water Balance Model,
- W&AR-03: Reservoir Temperature Model,
- W&AR-05: Salmonid Population Information Integration and Synthesis Study,
- W&AR-06: Chinook Population Model,
- W&AR-10: *O. mykiss* Population Model,
- W&AR-16: Lower Tuolumne River Temperature Model, and
- W&AR-21: Lower Tuolumne River Floodplain Hydraulic Assessment.

The purpose of the workshops was to provide an opportunity for relicensing participants and the Districts to discuss relevant data sources, methods of data use and development, and modeling parameters at specific points in the development of these study plans. The goal of the workshop process was for relicensing participants and the Districts to reach agreement where possible after thorough discussion of data and methods. In the December 2011 SPD, FERC directed the Districts to formalize the workshop process. The Districts submitted for review and comment a draft Workshop Consultation Process to relicensing participants in March 2012, and filed the final Workshop Consultation Process with FERC on May 18, 2013.

Throughout 2012, 2013, and 2014, the Districts conducted a total of 18 workshops. In addition, the Districts conducted model training sessions for several of the studies that involved the development of quantitative models. For each workshop, an agenda and materials were provided prior to the meeting date, draft meeting notes were provided for 30-day comment by relicensing participants, and final workshop notes and responses to comments received were filed with FERC to maintain a record of interim study plan decisions. A summary of all consultation documentation related to these Workshops is included as Attachment B to this AFLA.

1.3.4 Initial and Updated Study Reports

On January 17, 2013, the Districts filed their Initial Study Report (ISR). Included in the ISR was the Districts' NOI to file a DLA rather than a Preliminary Licensing Proposal under the ILP. The Districts held the ISR meeting on January 30 and 31, 2013, in Modesto, California. On February 8, 2013, the Districts filed an ISR meeting summary.

Following the ISR meeting, relicensing participants filed requests for new studies and study modifications. The Districts responded to these comments on April 9, 2013, and agreed to a new model and three new studies. On May 21, 2013, FERC issued its Determination on Requests for Study Modifications and New Studies. The determination approved five study modifications and five new studies or study elements. The Districts filed an Updated Study Report (USR) for the Don Pedro Project on January 6, 2014, held a USR Meeting on January 16, 2014, and filed a summary of the meeting on January 27, 2014. On March 28, 2014, the Districts filed a response to USR comments received from relicensing participants.

1.3.5 Draft License Application

The DLA was filed on November 26, 2013, which was followed by a 90-day public comment period. Comments on the DLA were received from FERC, American Whitewater, USFWS, Conservation Groups, NMFS, Restore Hetch Hetchy, Tuolumne County Water Agency, Stanislaus National Forest, ARTA, SWRCB, BLM, CDFW, and OARS Rafting. The Districts' responses to these comments are provided as Attachment A to this AFLA.

1.3.6 Final License Application

On April 28, 2014, the Districts timely filed a Final License Application for the Don Pedro Hydroelectric Project, FERC No. 2299. As noted in the filing and acknowledged by FERC at the time, several studies were ongoing which were likely to inform the development of additional PM&E measures. The Districts have now completed these studies and herein submit this Amendment of Application (Amendment to the Final License Application or AFLA). For ease of review and reference, this AFLA replaces the Districts' April 2014 filing in its entirety.

1.3.7 Post-Filing Consultation and Alternatives Analysis

Since the filing of the FLA in April 2014, the following important studies involving the resources of the lower Tuolumne River were completed. The results of these studies, along with the aforementioned models and existing studies, were used to assess Project impacts on aquatic resources and conduct the analysis of proposed alternative PM&E measures contained in this Exhibit E (see Section 6).

- W&AR-11: Fall-Run Chinook Salmon Otolith Study
- W&AR-14: Thermal Performance of Wild Juvenile *Oncorhynchus Mykiss* in the Lower Tuolumne River: A Case for Local Adjustment to High River Temperature
- W&AR-21: Lower Tuolumne River Floodplain Hydraulic Assessment
- Lower Tuolumne River Instream Flow Study Effective Weighted Usable Area Estimate for *O. mykiss*
- Lower Tuolumne River Instream Flow Study Evaluation of Non-Native Predatory Fish
- Tuolumne River Flow and Water Temperature Model: Without Dams Assessment

On May 18, 2017, the Districts hosted a Modeling Tools Update Meeting with relicensing participants to provide a status update on several models developed to support the relicensing. The following studies were discussed during the meeting:

- W&AR-02: Project Operations/Water Balance Model,
- W&AR-03: Reservoir Temperature Model,

- W&AR-06: Chinook Population Model,
- W&AR-10: *O. mykiss* Population Model,
- W&AR-16: Lower Tuolumne River Temperature Model, and
- W&AR-21: Lower Tuolumne River Floodplain Hydraulic Assessment.

2.0 PROPOSED ACTION AND ALTERNATIVES

This section describes the Districts' licensing proposal for continuing to operate the Don Pedro Hydroelectric Project under a new license. This section also describes the No-Action Alternative and other alternatives considered but eliminated from detailed study.

2.1 No-Action Alternative

Under the No-Action Alternative, the Don Pedro Hydroelectric Project would continue to operate in the future under the terms of the current license (i.e., there would be no change to the existing environment). No new environmental PM&E measures would be implemented under the new license. This alternative constitutes baseline environmental conditions, against which other alternatives can be analyzed.

2.1.1 Existing Don Pedro Project Facilities

The primary Don Pedro Project facilities include: (1) Don Pedro Dam and Reservoir, (2) gated and uncontrolled spillways on the right (west) abutment of the main dam, (3) low-level outlet works located in the diversion tunnel in the left (east) abutment of the main dam, (4) the power intake and tunnel, also in the left abutment, (5) the Don Pedro powerhouse, (6) the Project switchyard located at the powerhouse, and (7) four dikes—the Gasburg Creek Dike and Dikes A, B, and C. Facility specifications are provided below. The Don Pedro Project also includes three developed recreation areas and other small recreation facilities (restrooms and buoys) outside of the developed areas. Detailed descriptions of facilities and features are provided in Exhibit A of this AFLA.

The current Project Boundary encompasses all Don Pedro Project facilities and features as well as all lands needed for operation and maintenance. Approximately 74 percent of all lands within the current Project Boundary, or 13,568 ac, are owned by the Districts. The remaining lands, about 4,802 ac, are public lands located within BLM's Sierra Resource Management Area.

2.1.2 Existing Settlements and Agreements

2.1.2.1 1995 Settlement Agreement

In 1995, the Districts entered into a settlement agreement with CDFW, USFWS, CCSF, California Sportfishing Protection Alliance, Friends of the Tuolumne, Tuolumne River Expeditions, and the Tuolumne River Preservation Trust. Pursuant to this agreement, the Districts agreed, among other things, to increase flows to the lower Tuolumne River for the purpose of enhancing and protecting the fall-run Chinook salmon population. This flow regime remains in effect today. The agreement also formalized the role of the Tuolumne River TAC, provided for multi-party partnership to undertake a series of river restoration projects along the lower Tuolumne River, and defined responsibilities for additional fishery monitoring studies.

2.1.2.2 Fourth Agreement Between the Districts and the City and County of San Francisco

CCSF contributed financially to the construction of the Don Pedro Project to meet its flood control obligations and to obtain water banking privileges in the new Don Pedro Reservoir. This innovative water banking arrangement allows CCSF to pre-release flows from its upstream facilities into the Don Pedro Reservoir where the flows are credited against CCSF's obligation to meet the Districts' water entitlements so that at other times CCSF can divert water that otherwise would have to be released to satisfy the Districts' senior water rights. Both the transfer of flood management and the creation of the water bank provide CCSF and its wholesale customers in the Bay Area with improved reliability of water supply and greater flexibility with its water and power operations. Under certain circumstances, the Districts and CCSF share responsibility for meeting FERC license requirements for the Don Pedro Hydroelectric Project.

2.1.3 Don Pedro Project Safety

The Don Pedro Project has been operating for more than 40 years under the existing license, and during this time FERC staff has conducted operational inspections to evaluate the condition of the structures, the occurrence of any unauthorized modifications, the efficiency and safety of operations, compliance with the terms of the license, and proper maintenance. In addition, the Don Pedro Project has been inspected and evaluated every five years by an independent consultant, and the consultants' safety reports have been submitted for FERC's review. The most recent Dam Safety Surveillance and Monitoring Report was filed with FERC in October 2016.

As part of the relicensing process, FERC staff evaluates the continued adequacy of the Don Pedro Project facilities under a new license. Special articles would be included in any license issued, as appropriate. FERC staff will continue to inspect the Don Pedro Project during the new license term to ensure continued adherence to the FERC-approved plans and specifications, special license articles related to operation and maintenance, and accepted engineering practices and procedures.

2.1.4 Current Don Pedro Project Operation

The Don Pedro Project operates on an annual cycle consistent with managing for and providing a reliable water supply for consumptive use purposes, providing flood flow management, and ensuring delivery of downstream flows to protect aquatic resources. By October 6 of each year, the Don Pedro Reservoir must be lowered to at least elevation 801.9 ft above mean sea level (National Geodetic Vertical Datum (NGVD) 29)[3] to provide the 340,000 AF of flood control benefits acquired by the U.S. Army Corps of Engineers (ACOE) through its financial contribution to the development of the Don Pedro Project. Beginning on October 1 of each year, flows provided by the Don Pedro Project to the lower Tuolumne River, as measured at the USGS streamflow gage at La Grange, are adjusted to meet license requirements to benefit upmigrating adult fall-run Chinook salmon. This includes in certain years providing a pulse flow, the amount of which varies depending on the water year type.

[3] All elevations are NGVD 29.

FERC-required flows to the lower Tuolumne River are adjusted on October 16, the rate of flow dependent on water year type, and these flows are maintained through May 31 of the following year to protect egg incubation, emergence, fry and juvenile rearing, and smolt outmigration of fall-run Chinook salmon. A spring pulse flow is provided each year to aid smolt outmigration, the amount again depending upon water year type. Irrigation deliveries normally begin in early March, but can begin as early as February to provide early growing season soil moisture in dry winters. Irrigation deliveries ramp up considerably by April and normally reach their peak in July and August. Minimum flows to the lower Tuolumne River are adjusted on June 1 and these flows extend through September 30. Irrigation deliveries normally end in late October/early November. Municipal and industrial water supplies are delivered year-round.

Throughout the winter months, Don Pedro Project operators maintain a constant assessment of snow conditions in the upper Tuolumne River watershed and, during years with heavy snow accumulation, may reduce reservoir levels to balance forecasted inflows, outflows, and reservoir storage. The goal of operations is to fill the reservoir by early June; however, greater snowpack volumes can extend this filling into early July if needed for maintenance of the required ACOE flood control space. ACOE flood control guidelines also provide for maintenance of downstream flows on the lower Tuolumne River to less than 9,000 cfs as measured at the USGS gage at Modesto (river mile (RM) 16), located downstream of Dry Creek almost 40 miles below the Don Pedro Project.

2.1.5 Current Don Pedro Project Maintenance

2.1.5.1 Facilities and Road Maintenance

The Districts maintain developed facilities and Don Pedro Project roads using a combination of mechanical mowing and periodic use of pre-emergent herbicides by licensed applicators to manage vegetation growth. Areas maintained by the Districts are typically managed in proportion to their use. Developed facilities (e.g., housing areas near Don Pedro Dam) and associated roads are managed with pre-emergent herbicides annually after the first fall rain (usually in November). Similarly, the perimeters of wastewater treatment facilities are sprayed annually, using herbicides labeled for aquatic use, when appropriate to manage aquatic weeds and algae. Mechanical removal of aquatic weeds is also employed. Main access road shoulders are mowed. No formal management is conducted for unpaved roads leading to Don Pedro Dam from the main road. Additionally, some roads may be treated for specific uses. For example, in 2012 a small access road that is typically unmanaged was mowed to allow access for water quality monitoring efforts.

2.1.5.2 Recreation Area Maintenance

The Districts' three developed recreation areas are managed to minimize the spread of unwanted vegetation and the risk of fire. High-use sections of each recreation area are subject to mowing and trimming on a frequent basis, and pads, road edges, firebreaks, and the immediate area around restrooms and Don Pedro Recreation Agency (DPRA) facilities are sprayed with pre-emergent and/or post-emergent herbicides annually after the first rains.

The Districts use a Gopher X Extermination Machine to conduct rodent control. This machine works by heating a mixture of castor oil and mineral oil to create a smoke, which is then forced into rodent tunnels and nesting areas.

The Districts utilize a ZON Propane Cannon to manage nuisance birds at the Flmeing Meadows Campground swimming lagoon. This device provides a single pressure regulated sonic blast to frighten and disorient pest birds. The Districts use the ZON Propane Cannon daily from about mid-October through early April.

2.1.5.3 Woody Debris Management

Article 52 of the existing FERC license requires the implementation of the Districts' Log and Debris Removal Plan. Under the Plan, the Districts collect and remove floating debris at Don Pedro Dam, in the upper Tuolumne River portion of the reservoir, and in other dispersed areas of the reservoir as needed. Debris is collected in boom rafts, anchored along the reservoir edge, and burned during fall and winter under low reservoir levels.

2.1.6 Existing Resource Measures

The following measures represent ongoing obligations of the Districts as licensees, which affect the quality of the environment and/or Don Pedro Project operations. Under the No-Action Alternative, these obligations would continue during the term of any new license.

2.1.6.1 Public Safety Plan

Last updated in 2014, the Don Pedro Project's Public Safety Plan describes safety devices associated with Don Pedro Project activities, such as signage, buoys, fencing, and floating booms, as well as the locations of these devices. The DPRA Recreation Area Public Safety Plan is a section of the Public Safety Plan.

2.1.6.2 Don Pedro Emergency Action Plan

The Don Pedro Emergency Action Plan identifies potential emergency conditions at Don Pedro Dam and specifies actions to be followed to minimize property damage and loss of life under such conditions. The Districts update the Emergency Action Plan each year.

2.1.6.3 Recreation Facilities

Authorized under Article 45 of the existing license, the Districts built and maintain three developed recreation areas and primitive and semi-primitive lakeshore campsites on Don Pedro Reservoir. The recreation facilities include both floating and shoreline restrooms in addition to those at the developed recreation areas. Facilities include hazard marking, regulatory buoy lines, and other open water-based features including houseboat marinas and a marked water ski slalom course. A full list of recreation facilities is provided in Exhibit A.

2.1.6.4 DPRA Regulations and Ordinances

DPRA Regulations and Ordinances (Exhibit H, Appendix H-4) govern the use of lands and waters within the Project Boundary. In accordance with these rules and regulations, the Districts' land use policy prohibits any placement of improvements along the Don Pedro Reservoir shoreline (e.g., dredging, docks, moorings, piers) and prohibits all vehicular use on undeveloped lands. DPRA Regulations and Ordinances also govern visitor use related to prohibiting, restricting, controlling, and managing as appropriate camping, fires, noise, group size, and other aspects of visitor use that have the potential to impact natural resources and public enjoyment of the recreation facilities.

2.1.6.5 Non-Don Pedro Project Uses of Don Pedro Project Lands

All of the lands within the current Project Boundary are owned by the Districts with the exception of approximately 4,802 acres of federal lands located within the BLM Sierra Resource Management Area. The lands within the Project Boundary are largely undeveloped, with the exception of the recreation areas discussed above. As such, there are few non-Don Pedro Project uses of Don Pedro Project lands. The Districts currently allow limited grazing and apiary uses within the Project Boundary. Under the new license, no apirary or grazing permits will be issued.

2.2 Districts' Proposed Future Don Pedro Hydroelectric Project Operations

The Districts' Preferred Plan, presented in Section 5.0 of this Exhibit E, represents the integration of the data and studies designed to achieve the following interconnected goals:

- protect and improve the natural resources of the lower Tuolumne River, with emphasis on the native fisheries, by applying the wealth of empirical biological and physical data available on the river's resources; and
- protect and sustain the water supplies essential to the welfare and the economies of the communities served by the water resources of the Don Pedro Project, especially during the extended drought periods experienced in the southern Sierra watersheds.

The Districts' Preferred Plan demonstrates that both of these two goals can be achieved, but only by a rigid adherence to being informed by the empirical, site-specific data describing the resources of the Tuolumne River. A brief summary of this Proposed Action is included below.

2.2.1 Proposed New Capital Projects

The Districts are proposing to design and construct certain improvements to the existing whitewater boating take-out at the Ward's Ferry Bridge to improve public safety and efficiency of river egress at this site. A description of proposed improvements is provided in Exhibit B of this application. The Districts are proposing to upgrade the Unit 1, 2, and 3 turbine-generators to increase efficiency and capacity, as described in Exhibit B.

2.2.2 Proposed Resource Enhancement Measures

The Districts have identified a suite of resource enhancement measures that are included as part of the Proposed Action. These measures are described in the following subsections. Also described below are the Districts' proposed management plans to be implemented under the new Project license term.

2.2.2.1 Improve Spawning Gravel Quantity and Quality

Augment Current Gravel Quantities through a Coarse Sediment Management Program

To improve spawning conditions for fall-run Chinook and *O. mykiss*, the Districts propose to conduct coarse sediment augmentation from RM 52 to RM 39 over a 10-year period following issuance of a new license. Because spawning preferences are more heavily weighted towards upstream habitats, the highest priority for the gravel augmentation is upstream of Old La Grange Bridge. Coarse sediment to be added to the river channel would range in size from 0.125 to 5.0 inches in diameter and Stillwater Sciences (2017, provided in Appendix E-1). Taking biological needs, geomorphic needs, and sensitive habitat into consideration, the recommended short-term coarse sediment augmentation sites, in order of priority, would be (1) Riffle A3/4, (2) Riffle A5/6 (3) Basso Pool, and (4) and Riffle A1/2[4] (Stillwater Sciences 2017). Preliminary gravel augmentation designs are provided in Appendix E-1, Attachment A, and estimated gravel volumes and spawning gravel areas are shown in Table 2.2-1.

Table 2.2-1. Preliminary gravel augmentation volumes and spawning gravel areas (at 320 cfs) downstream of La Grange Diversion Dam (RM 52) in the Tuolumne River.

Riffle Location	RM	Volume (yd^3)	Tons	Wetted Area (ft^2)
A2	51.7	450	585	6,450
A3	51.5	4,300	5,590	43,640
A5	51.2	11,500	14,950	120,960
A6	51.0	18,600	24,180	100,460
Basso Upper	46.5	20,500	26,650	190,890
Basso Lower	46.2	2,300	2,990	80,269
Totals		**57,650**	**74,945**	**542,669**

Monitoring associated with this measure would include (1) a spawning gravel evaluation in Year 12 of the augmentation program using methods comparable to those employed for the Spawning Gravel in the Lower Tuolumne River Study (TID/MID 2013d, W&AR-04) and (2) annual surveys of fall-run Chinook and *O. mykiss* spawning use of new gravel patches for five years following completion of gravel augmentation.

Gravel Mobilization Flows of 6,000 to 7,000 cfs

Flows ranging from 6,000-7,000 cfs (measured at USGS gage 11289650 below La Grange Diversion Dam) would be released to mobilize gravel and fines. These flows would be provided for at least two days at an estimated average frequency of once every three to four years, i.e., during years when sufficient spill is projected to occur (see Appendix E-1, Attachment G)

[4] Riffle A1/2 is located just downstream of the confluence of the mainstem Tuolumne River and the La Grange tailrace.

(TID/MID 2017b, W&AR-02). In years when the La Grange gage spring (March through June) spill is projected to exceed 100,000 ac-ft, the Districts would plan to release a flow of 6,500 cfs for two days within the spill period, with down-ramping not to exceed 300 cfs/hr. Because there is the potential for conflicts with downstream interests at these flows, the Districts would publish on their website, with as much notice as is practicable, a notification of the planned flow magnitude, duration, and dates.

Monitoring associated with this measure would consist of conducting substrate surveys at designated test sites located upstream of RM 43 prior to a high-flow event, then examining the same test sites following the flow event to evaluate whether there are corresponding changes in channel morphology or improvements to the quality of spawning gravel, i.e., a reduction in interstitial fines. Flow magnitude and/or duration may be adjusted based on these observations.

Gravel Cleaning

To improve the quality of salmonid spawning gravel, the Districts would conduct a five-year program of experimental gravel cleaning using a gravel ripper and pressure wash operated from a backhoe, or equivalent methodology. Each year of the program would consist of two to three weeks of cleaning select gravel patches. The Districts would conduct *O. mykiss* spawning and redd surveys in areas planned for gravel cleaning prior to commencing any gravel cleaning. Subject to the findings of these surveys, the gravel cleaning might coincide with May pulse flows to benefit Chinook smolt outmigration by providing increased turbidity to reduce predator sight feeding effectiveness.

Monitoring associated with this measure would consist of substrate surveys at designated test sites. Monitoring would be implemented prior to and following gravel cleaning to evaluate changes in substrate composition, particularly reductions in interstitial fines.

2.2.2.2 Instream Habitat Improvement

Boulder-size stone (approximately 0.7-1.5 yd^3) would be placed between RM 42 and RM 50 to provide favorable microhabitats for *O. mykiss* (TID/MID 2017b, W&AR-12). The boulder placement program would take place over four years and proceed by conducting placement in select sub-reaches each summer (after July 15). Placement locations would be selected through collaboration with parties having fisheries and recreational interests in the lower Tuolumne River. A maximum of 200 boulders would be placed. The preferred locations for materials installation would be in run/glide habitats to create velocity diversity and feeding stations. Enhancing an area downstream of a riffle would likely have the greatest benefit. Smaller boulders (12-24 inch) may be placed along stream margins in similar run/glide habitat. This would provide interstitial velocity refuges for rearing juveniles during winter and high flows occurring at other times during the year. Locations between RM 48 and 50 that are run/glide habitats would be tested first. Boulders would be put into place with heavy equipment, and the size of the boulders and their positioning would provide for their stability, i.e., no permanent anchoring, including rebar or cabling, would be used. Boulders would be positioned so that they are completely overtopped during channel-forming flow events. All boulders would be transported, stored, and placed using the existing road network and staging areas along the lower

Tuolumne River, i.e., no new roads or staging areas would be created. There would be no significant modifications to riparian vegetation adjacent to the placement locations. BMPs required by NMFS and other regulatory agencies would be employed to avoid effects on the river and its biota due to the use and storage of heavy equipment. Unlike the placement of large wood in the channel, suitably placed boulders would represent a minimal hazard to recreational boaters using the lower river.

Biological monitoring would consist of bounded *O. mykiss* count estimates in the treatment habitat units and untreated areas nearby that are hydraulically similar to the pre-treatment habitats. The Districts would collect data for at least two years prior to boulder placement and three years after placement. Annual snorkeling surveys would be conducted to assess differences in units with and without bordering boulders, and evaluate changes in fish densities through time in response to boulder placement. In addition, a one-time monitoring event within five years following the completion of the boulder placement program would be conducted to examine the stability of the placed boulders and to map smaller gravel accumulations linked to the placement of the boulders.

2.2.2.3 Contribute to CDBW's Efforts to Remove Water Hyacinth

The Districts would contribute $50,000 per year to the California Division of Boating and Waterways (CDBW, the State agency responsible for implementing an Aquatic Pest Control Program to control hyacinth) to assist with the removal of water hyacinth and other non-native flora. The contribution would be made regardless of the level of water hyacinth infestation occurring in the lower Tuolumne River. The Districts would coordinate with CDBW when water hyacinth infestations occur on the Tuolumne River to schedule removal efforts. There would be no monitoring conducted by the Districts in association with this measure. CDBW employs herbicides to treat water hyacinth and other invasive aquatic plants in Central Valley rivers and the Delta. CDBW uses herbicides that are registered for aquatic use with the EPA and the California Department of Pesticide Regulation.

2.2.2.4 Fall-Run Chinook Spawning Improvement Superimposition Reduction Program

To reduce fall-run Chinook redd superimposition, the Districts propose to develop and install a temporary barrier to encourage spawning on less used, but still suitable, high-quality riffles. The temporary barrier would be installed each year below the new La Grange Bridge (RM 49.9) after November 15 once the number of Chinook passing the proposed RM 25.5 fish counting weir (see below) exceeds 4,000 total spawners. The temporary barrier would be similar to the Alaska-type counting weir currently used on the Tuolumne River at RM 24.5 or a picket-weir type. Final design and configuration of the temporary barrier would be based on consultation with state and federal resource agencies.

2.2.2.5 Predator Control and Suppression Plan

The Districts are proposing to implement a predator control and suppression program to reduce predation on juvenile fall-run Chinook by non-native black bass and striped bass. The predator control and suppression program would consist of two elements: (1) construction and operation of a barrier weir and (2) active predator control and suppression (see descriptions of measures below).

Construct a Fish Counting and Barrier Weir

The Districts are proposing to construct and operate a small barrier weir (less than 5 ft of head at normal flows) at approximately RM 25.5, about 1 mile upriver of the current counting weir. The barrier weir would be a reinforced concrete structure consisting of, from river-right to river-left (looking downstream), the components listed below. A planview of the weir is provided in Section 3.5.

- A concrete abutment merging with natural grade;
- A fishway and counting structure equipped with a viewing window and fish sorting capability;
- An 8-ft long by 5-ft high bottom drop gate with a maximum hydraulic capacity of 75 cfs providing attraction flow to the fishway entrance;
- Spillway section;
- Middle abutment;
- Non-motorized craft (kayak/canoe/raft) bypass structure with flap-gate control and concrete chute; and
- Left concrete abutment merging with natural grade.

The fish counting and barrier weir would serve the following purposes:

- Provide a permanent upstream migrant counting weir to replace the temporary seasonally-operated Alaska-type counting weir located at RM 24.5. The seasonal weir must be removed when flows reach 1,500 cfs; the new counting weir would be capable of being operated year-round and in river flows up to at least 3,000 cfs.
- Provide a Denil-type fishway and counting window to conduct fish counts, fish species separation, and potentially public viewing. The ability to collect fish would also permit broodstock selection, if desired by fisheries agencies.
- Provide a barrier to exclude striped bass from upstream habitats used for rearing by juvenile fall-run Chinook salmon, while at the same time providing a location where striped bass are likely to congregate, which would enable their removal or isolation at key times during smolt outmigration. Striped bass are known to be voracious predators and have been observed in all seasons throughout the entire lower Tuolumne River.
- Provide for elimination of black bass movement into sections of river upstream of RM 25.5 and provide for significant long-term reductions in black bass populations above RM 25.5.

Predator Suppression and Removal

The Districts are proposing to implement a comprehensive predator suppression and control program consisting of the following components.

- Specific incentives and measures to target an annual reduction in the population of black bass and striped bass, based on levels documented in 2012, by approximately 20 percent above the proposed barrier weir (at RM 25.5) and 10 percent below the barrier weir. These measures would include, but would not be limited to, sponsoring and promoting black bass and striped bass derbies and reward-based angling in locations both above and below the barrier weir to substantially diminish the sizes of the bass populations over time.[5] Other removal and/or isolation methods would include electrofishing, seining, fyke netting, and other collection methods. Based on the 2012 population of black bass between the two Tuolumne River rotary screw-traps (RM 30 and RM 5), a 10 percent removal black bass would amount to a total of about 660 fish (roughly equal numbers of smallmouth and largemouth bass).[6] To ensure compliance with this measure, the Districts propose to file an annual report on black bass and striped bass reduction efforts undertaken during the prior calendar year. The Districts propose to conduct a survey every five years to identify the number of fish to be targeted in order to reduce the bass population by 10 percent in succeeding years.
- The Districts will seek and advocate for changes to current fishing regulations for the lower Tuolumne River (e.g., length of season, bag limit, catchable size, requested removal of black bass/striped bass caught, allowing a bounty program) to reduce black and striped bass numbers. In addition, the Districts propose to establish a fund to carry out the activities contemplated above and to educate the public on the adverse effects of introduced piscivores on fall-run Chinook in the Tuolumne River to encourage participation in the removal program and advocacy of changes to fishing regulations that facilitate such removal. Activities could include, but would not be limited to, developing educational materials about the effects of predatory fish, community outreach, or kiosks. To monitor compliance with this measure, the Districts propose to file an annual report describing the specific educational and advocacy measures undertaken during a particular year.

2.2.2.6 Fall-Run Chinook Salmon Restoration Hatchery Program

The Districts are proposing to develop a fall-run Chinook salmon restoration hatchery, with the goal of protecting, improving, and maintaining the Tuolumne River fall-run Chinook population. The Districts propose to build, in cooperation with CDFW, in the general vicinity of the current location of the CDFW offices below La Grange Diversion Dam, a fall-run Chinook restoration hatchery to be operated by CDFW (Appendix E-1, Attachment E). The Districts would pay for hatchery construction and O&M for the first 20 years, after which the success of the hatchery

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[5] Such incentives could include expansion on the Tuolumne River of the current CDFW Free Fishing Days program, which currently allows free fishing on the Labor Day and July 4 holidays, expansion of CDFW's current Fishing in the City program to promote urban youth fishing, promotion of fishing derbies and competitions similar to the Nor-Cal Guides' and Sportsmen's Association (NCGASA) pikeminnow derby on the Feather River, and/or sport-reward program for striped bass and black bass similar to pikeminnow programs currently carried out in Washington and Oregon.

[6] See Districts' *Predator Control and Suppression Plan* (Appendix E-1, Attachment C) for more details. The barrier weir will eliminate striped bass access to important Chinook rearing areas upstream of RM 25.5. Striped bass are estimated to be responsible for approximately 15-20 percent of the total predation on fall-run Chinook juveniles in the lower Tuolumne River.

would be evaluated. The hatchery is not intended to be a permanent facility. The weir described above would allow for the collection of fall-run Chinook broodstock. The proposed supplementation program, like state and federal programs, would be implemented in accordance with procedures that prevent or minimize adverse impacts on the fitness, size, abundance, run-timing, and distribution of wild fish. The proposed supplementation program would be structured to attempt to counter current adverse Chinook population trends to the degree possible in the Tuolumne River through the spawning and rearing of fish selected by CDFW to best represent the wild Tuolumne River stock. The program would allow for the stocking of fish within the basin and as a result produce individuals that are adapted to the extent practicable to conditions in their natal environment.

2.2.2.7 Flow-Related Measures for Fish and Aquatic Resources

The Proposed Action includes flow-related measures during all water-year types. The flow measures include a set of base flows designed for specific salmonid life stages in the Tuolumne River, and a set of pulse flows, which were designed based on 20 years of rotary screw-trapping results and other related studies specific to the Tuolumne River. An adaptive management approach to pulse-flow timing and duration is part of these measures.

For all flow-related measures, the flow schedules are based on five water-year types determined using the 60-20-20 San Joaquin River Index (SJI). The five types are wet (W), above normal (AN), below normal (BN), dry (D), and critical (C). Table 2.2-2 provides the classification of each water year for the 1971–2012 modeling period of record.

All proposed flow-related measures identified below are based on five water-year types determined using the 60-20-20 San Joaquin River Index. The current method used by TID operators to determine the water year type and the required flow release schedule would remain unchanged.[7] There would be two flow monitoring locations for compliance: (1) the existing USGS Tuolumne River at La Grange gage and (2) a new USGS gage measuring the flow in the two infiltration galleries' (see below) pipelines. The La Grange gage would be used to monitor compliance for flows between the La Grange gage and RM 25.5. Subtracting the infiltration gallery pipelines gage from the La Grange gage would yield the instream flows to be provided downstream of RM 25.5, and this difference would constitute the second point of compliance. Compliance would be achieved if flows equaled or exceeded the amounts identified below over monthly timeframes, with no deficit of more than 10 percent below the minimum for more than 60 minutes, and no flow deficit allowed that is greater than 20 percent below the flows described below and shown in Table 2.2-3. With the two compliance points being located about 25 miles apart, during days where scheduled flow changes are to occur, time of travel would be taken into account when determining compliance. Any outage of the infiltration galleries that prevents the planned flow from being withdrawn and lasting for more than three consecutive days would result in the minimum instream flows required at the La Grange gage to be reduced by two-thirds of the amount that would have been withdrawn.

[7] TID operators currently determine the water-year type in early April and issue, after consultation with resource agencies, the schedule of releases for April 15 of the current year through April 14 of the next calendar year.

Table 2.2-2. Classification of each water year for the 1971–2012 modeling period of record.

Water Year	San Joaquin Index	Water Year	San Joaquin Index
1971	BN	1992	C
1972	D	1993	W
1973	AN	1994	C
1974	W	1995	W
1975	W	1996	W
1976	C	1997	W
1977	C	1998	W
1978	W	1999	AN
1979	AN	2000	AN
1980	W	2001	D
1981	D	2002	D
1982	W	2003	BN
1983	W	2004	D
1984	AN	2005	W
1985	D	2006	W
1986	W	2007	C
1987	C	2008	C
1988	C	2009	BN
1989	C	2010	AN
1990	C	2011	W
1991	C	2012	D

Table 2.2.3. Proposed lower Tuolumne River flows to benefit aquatic resources and accommodate recreational boating.

	Flow (cfs)	
Water Year/Time Period	**La Grange Gage**	**Downstream of IGs (RM 25.5)**
Wet, Above Normal, Below Normal		
June 1 – June 30	200	100[1]
July 1 – October 15[3]	350	150[2]
October 15 – December 31	275	275
January 1 – February 28/29	225	225
March 1 – April 15	250	250
April 16 – May 15[4]	275	275
May 16 – May 31[4]	300	300
Dry		
June 1 – June 30	200	75
July 1 – October 15	300	75[2]
October 15 – December 31	225	225
January 1 – February 28/29	200	200
March 1 – April 15	225	225
April 16 – May 15[4]	250	250
May 16 – May 31[4]	275	275
Critical		
June 1 – June 30	200	75
July 1 – October 15	300	75
October 15 – December 31	200	200
January 1 – February 28/29	175	175
March 1 – April 15	200	200

	Flow (cfs)	
Water Year/Time Period	La Grange Gage	Downstream of IGs (RM 25.5)
April 16 – May 15[4]	200	200
May 16 – May 31[4]	225	225

[1] Cease IG withdrawal for one pre-scheduled weekend.
[2] 200 cfs for three-day July 4 holiday, for three-day Labor Day holiday, and for two pre-scheduled additional weekends in either June, July, or August.
[3] The Preferred Plan also includes a flushing flow amounting to 5,950 AF of water for the period October5 through October 7. Ramping of this flow would likely occur on October 4 and 8 as a part of the flushing flow volume.
[4] Fall-run Chinook outmigration pulse flows: 150,000 ac-ft (Wet, Above Normal), 100,000 ac-ft (Below Normal), 75,000 ac-ft (Dry), 45,000 ac-ft (sequential Dry[s]), 35,000 ac-ft (first Critical), and 11,000 ac-ft (sequential Critical[s]).[8]

Infiltration Galleries 1 and 2

The Districts are proposing to complete construction of TID's infiltration gallery (IG1) (RM 25.9) and undertake construction of a second infiltration gallery (IG2) at the same general location. IG1 has a design capacity of approximately 100 cfs, and IG2 would have a capacity of 100-125 cfs. The purpose and operation of the IGs are discussed as appropriate in the following sections that describe proposed lower river flows. The location of the infiltration galleries are provided in Exhibit A and Section 5.0 of this Exhibit.

Early Summer Flows (June 1–June 30)

Except for wet years, when high flows may extend well into June, most fall-run Chinook salmon juveniles have left the Tuolumne River by the end of May (TID/MID 2013b, W&AR-05), so increased summer flows are aimed at enhancing habitat conditions for *O. mykiss*. The Districts are proposing to provide an instream flow of 200 cfs at the La Grange gage from June 1–June 30 of all water-year types to benefit *O. mykiss* fry rearing. Downstream of RM 25.5 (i.e., downstream of the infiltration galleries) instream flows during this period would be 100 cfs during Wet, Above Normal, and Below Normal water years and 75 cfs in Dry and Critical years.

Based on redd surveys, *O. mykiss* in the lower Tuolumne River spawn from late December through early April (TID/MID 2013c, W&AR-08; FISHBIO 2017a). Years of monitoring studies indicate that *O. mykiss* are predominantly found upstream of RM 42, with peak fry densities occurring into June. For the period of June 1 to June 30, base flows would be provided to support *O. mykiss* fry rearing. Flow management for the benefit of *O. mykiss* fry would balance hydraulic habitat suitability and temperature suitability for fry and adult life stages. Flows higher than those proposed by the Districts in June would tend to displace weaker-swimming *O. mykiss* fry to downstream areas with lower quality physical habitat, higher water temperatures, and greater predator densities.

Late Summer Flows (July 1–October 15)

The Districts are proposing to provide an instream flow of 350 cfs at the La Grange gage from July 1–October 15 of Wet, Above Normal, and Below Normal water-year types to benefit *O.*

[8] This reduced pulse flow, while still greater than or equal to Base Case pulse flows, would also occur in a sequence of "D" and "C" years. For example, in a sequence of the years C, D, C, D, C, D, the second and third "critical" years and the second and third "dry" years would each have pulse flows of 11 TAF and 45 TAF, respectively.

mykiss juvenile rearing. During Dry and Critical water years, flow at the La Grange gage would be reduced to 300 cfs. Downstream of RM 25.5 (i.e., downstream of the infiltration galleries) instream flows during this period would be 150 cfs during Wet, Above Normal, and Below Normal water years and 75 cfs in Dry and Critical years.

During this period, the Districts would provide a flushing flow to clean gravels of accumulated algae and fines prior to the onset of substantial spawning. The Districts would provide an instream flow of 1,000 cfs (not to exceed 5,950 AF) on October 5, 6, and 7, with appropriate up and down ramps and IGs shut off. These flows would be provided in Wet, Above Normal, and Below Normal water years only. In Dry and Critical years, the flows at La Grange would continue to be 300 cfs, with withdrawals of 225 cfs at the infiltration galleries, leaving 75 cfs in the river below RM 25.5.

By July, *O. mykiss* in the lower Tuolumne River consist predominantly of juvenile and adult life-stages. Juveniles are stronger swimmers than fry and can maintain position at higher flows. The primary habitat concern during this period is the maintenance of adequate water temperatures from just downstream of the La Grange Project to approximately RM 42.

Fall-run Chinook Spawning Flows (October 16–December 31)

To provide habitat for fall-run Chinook spawning, the Districts propose to provide the following minimum instream flows for the October 16 – December 31 spawning period: 275 cfs (BN, AN, and W water years), 225 cfs (D water years), and 200 cfs (C water years).

Fall-run Chinook Fry Rearing (January 1–February 28/29)

To provide habitat for fall-run Chinook fry rearing, the Districts propose to provide the following minimum instream flows for the period of January 1–February 28/29: (1) 225 cfs (BN, AN, and W water years), (2) 200 cfs (D water years), and (3) 175 cfs (C water years). It is important that flows do not decline substantially following the fall-run Chinook spawning period (see previous section), which would result in the dewatering of established redds. The flows identified here represent a balance between protecting Chinook redds while still providing substantial fry habitat.

Fall-run Chinook Juvenile Rearing (March 1–April 15)

To provide habitat for Chinook juvenile rearing, the Districts propose to provide the following minimum instream flows for the period of March 1–April 15: (1) 250 cfs (BN, AN, and W water years), (2) 225 cfs (D water years), and (3) 200 cfs (C water years).

Outmigration Base Flows (April 16–May 15)

The Districts propose to provide the following outmigration base flows for the period of April 16–May 15: (1) 275 cfs (BN, AN, and W water years), (2) 250 cfs (D water years), and (3) 200 cfs (C water years). Increasing base flows above those in the March 1–April 15 period would maintain favorable water temperatures during the mid-April through mid-May period, which is expected to benefit salmonids. These base flows could be augmented by outmigration pulse flows (see below), depending on the timing of the pulse flows, which would further reduce water temperatures at a given location and extend the plume of colder water farther downstream.

Outmigration Base Flows (May 16–May 31)

To maintain lower water temperatures during the latter half of May, the Districts are proposing the following base flow releases: (1) 300 cfs (BN, AN, and W water years), (2) 275 cfs (D water years), and (3) 225 cfs (C water years). These base flows could be augmented by outmigration pulse flows, as explained below.

Outmigration Pulse Flows (April 16–May 31)

To encourage fall-run Chinook smolt outmigration and increase survival, pulse flows would be provided to coincide with periods when large numbers of parr- or smolt-size fish are occurring in the river. The available pulse flow volumes will be substantially increased over baseline levels, except in the second (and subsequent to the second) Critical water year. The Districts are proposing to allocate the following volumes of water for pulse flow releases: 150,000 ac-ft (AN and W water years), 100,000 ac-ft (BN water years), 75,000 ac-ft (D water years), 45,000 ac-ft (sequential D water years), 35,000 ac-ft (initial C water year), and 11,000 ac-ft (sequential C water years).[9]

Flow Hydrograph Shaping

In spill years, the Districts would make reasonable efforts to shape the descending limb of the snowmelt runoff hydrograph to mimic natural conditions. Floodplain inundation along the lower Tuolumne River is initiated at a flow of approximately 1,100 cfs. Based on flows in the 1971–2012 period, the Proposed Action would result in flows at the La Grange gage greater than 1,500 cfs from February through July in 28 years (or more than 60 percent of the years). Flows exceeding 2,500 cfs would occur in 45 percent of the years in that period.

2.2.2.8 Flows to Enhance Recreational Boating

The Districts propose to provide flows to enhance conditions for canoeing and kayaking on the lower Tuolumne River.

From April 1–May 31 of all water years, a flow of 200 cfs or greater would be provided at the LaGrange gage. During this time period, the infiltration galleries would either be shut off, or additional flows to be withdrawn for water supply purposes would be released to the La Grange gage.

From June 1–June 30, a flow of 200 cfs would be provided at the La Grange gage in all water years. In Wet, Above Normal, and Below Normal water years, withdrawal of water at the

[9] This reduced pulse flow, while still greater than or equal to Base Case pulse flows, would also occur in a sequence of "D" and "C" years. For example, in a sequence of the years C, D, C, D, C, D, the second and third "critical" years and the second and third "dry" years would each have pulse flows of 11 TAF and 45 TAF, respectively.

infiltration galleries would cease for one pre-scheduled weekend in June to provide additional flow to the river downstream of RM 25.5.

From July 1–October 15, a flow of 350 cfs in Wet, Above Normal, and Below Normal water years and 300 cfs in Dry and Critical water years would be provided at the LaGrange gage. In all but Critical water years, the Districts would provide a flow of 200 cfs at RM 25.5 for the three-day July 4 holiday, the three-day Labor Day holiday, and for two pre-scheduled additional weekends in either July or August. In Wet, Above Normal, and Below Normal water years this would represent an incremental increase of 50 cfs downstream of RM 25.5 (over the background of 150 cfs), and in Dry water years this would represent an incremental increase of 125 cfs (over the background of 75 cfs), as measured at the La Grange gage.

2.2.2.9 Whitewater Boating above Ward's Ferry Bridge

Whitewater boaters in the Tuolumne River upstream of Don Pedro Reservoir typically enter the river at the USFS Lumsden campground (≈ RM 97) and take out at Ward's Ferry Bridge, located at about RM 78.5 near the upstream end of Don Pedro Reservoir. Boaters make use of peaking flows discharged from CCSF's Holm powerhouse to traverse the Wild & Scenic section of the upper Tuolumne River. Use of these daily powerhouse flows, which occur from about 7:00 am to about noon, results in many of the boaters arriving at the Ward's Ferry Bridge over a relatively short period. This creates much congestion on and near the bridge, because the commercial whitewater rafting companies position truck cranes on the bridge to lift rafts and other equipment out of the river. The congestion resulting from this process creates significant traffic and related delays at Ward's Ferry Bridge.

The current boating take-out problems experienced at Ward's Ferry are not related to Don Pedro project operations. Nevertheless, the Districts are including in the Preferred Plan the construction of a deck on river left, upstream of the bridge, large enough to accommodate two or three truck cranes and hauling vehicles at one time (depending on final design) thereby eliminating the need to locate truck cranes and other vehicles/equipment on the bridge. The Districts, unless other terms are negotiated with commercial outfitters, would charge a per-head user fee to recover its costs over the period of the new license. While the Districts would pay for the construction of the take-out, the Districts plan to discuss with Tuolumne County plans for the long-term upkeep of the facility as, fundamentally, it acts as an extension of the Ward's Ferry Bridge, and is not affected by any Project operations.

2.2.2.10 Management Plans

Fire Prevention and Response Management Plan

The purpose of the Fire Prevention and Response Management Plan (Appendix E-2) is to provide fire prevention procedures, reporting, and safe fire practices for Project facilities. The Plan will be implemented by the DPRA. The Districts will comply with all applicable codes, regulations, requirements, measures, and activities related to fire management. The Plan addresses the following topics.

- Specific fire prevention and protection requirements applicable to Project-related operations and maintenance on federal lands;
- Project activities requiring the use of fire or burning;
- Protection, applicable codes, and code compliance actions;
- Fire prevention requirements for Project area tool and equipment use;
- Emergency response preparedness;
- Fire safety at recreation facilities;
- Reporting fires;
- Fire control/fire extinguishers;
- Investigation of Project-related fires; and
- Key personnel contact directory.

Spill Prevention Control and Countermeasure Management Plan

The Spill Prevention Control and Countermeasure Management Plan (Appendix E-3) identifies relevant federal, state, and local regulations and consists of three primary components: (1) Don Pedro Hydroelectric Project Spill Prevention, Control, and Countermeasure Plan, (2) Don Pedro Recreation Agency Spill Prevention, Control, and Countermeasure Plan, and (3) Don Pedro Recreation Agency HAZMAT Plan.

Aquatic Invasive Species Management Plan

The Districts propose to implement an Aquatic Invasive Species (AIS) Management Plan (Appendix E-4), which would involve the following activities.

- Providing information to recreational users on ways to reduce the spread of invasive species;
- Continuation of the boater self-inspection permit program;
- Routine operation and management activities, including the following best management practices:
  - Identifying AIS that may be introduced by a given activity;
  - Implementing preventive measures;
  - Identifying critical control points (locations and times) for preventing the spread of AIS; and
  - Identifying actions to be taken if an AIS introduction occurs.

Woody Debris Management Plan

The Proposed Action includes a Woody Debris Management Plan (Attachment E-5). To limit the hazards to recreational users of Don Pedro Reservoir, woody debris is collected in boom rafts, anchored along the reservoir's edge, and burned during fall and winter when reservoir levels are low. During the term of the new license, the Districts would continue to manage woody debris as described above. The Districts will obtain a burn permit from CALFIRE and an Air Quality permit from the Tuolumne County Air Pollution Control District before any woody debris is burned. The Districts will file a Fire Management Plan (see below) with the BLM before woody debris is burned on lands managed by BLM. No staging or burning of wood will occur within 0.5 mile of active bald eagle nests or in areas known to support special-status species.

Terrestrial Resources Management Plan

The Districts propose to implement a Terrestrial Resources Management Plan (Appendix E-6), which would include the components described below.

- Vegetation management
  - Noxious-weed proliferation prevention guidelines for the Don Pedro Project and noxious weed management efforts;
  - Special-status plant species protection and monitoring efforts;
  - Guidelines regarding valley elderberry longhorn beetle host plants;
  - Descriptions of bi-annual employee trainings; and
  - Procedures for revegetation following ground-disturbing activities.
- Bat protection guidelines, including the appropriate use of humane exclusion devices at Project facilities; this would be done in coordination with CDFW and the BLM if the facility is located on BLM-administered land.
- Bald eagle management
  - Bald eagle surveys and monitoring, including (1) determining occupancy of territories, (2) identifying new nests, and (3) assessment of early incubation and nest success;
  - Bald eagle protection measures, including (1) establishment of buffers, (2) protection of nests, and (3) consultation with CDFW, BLM, and USFWS prior to application regarding the type and location of any use of rodenticides within the Project Boundary in accordance with federal and state law, consulting with;
- Western Pond Turtle (WPT) management
  - Continued monitoring and recording of incidental observations of western pond turtles within the Project Boundary; and
  - Training employees to recognize WPT.

Recreation Resource Management Plan

The Proposed Action includes the implementation of the Recreation Resource Management Plan (Appendix E-7), which includes the following elements.

- Address existing recreation resource needs within the Project Boundary;

- Address future recreation resource needs within the Project Boundary;
- Provide adequate and safe public access for recreation purposes;
- Preserve and enhance recreation resources; and
- Promote timely recreation planning over the term of the new Don Pedro Hydroelectric Project license.

Draft Historic Properties Management Plan

The Proposed Action includes the implementation of the Don Pedro Project Historic Properties Management Plan (HPMP) (Appendix E-8) to protect cultural resources. The draft plan includes the following elements.

- General management measures;
- Program for cultural resource evaluations;
- Avoidance measures for known cultural resources;
- Program for mitigating adverse effects on cultural resources;
- Protocols for proposed future actions;
- Program for future cultural resources inventory;
- Public education and information program
- Personnel training;
- Procedures for unanticipated discovery of cultural resources
- Roles and responsibilities;
- Reporting requirements; and
- Procedures for HPMP reviews and updates.

The Districts are currently in the process of addressing SHPO comments and revising the draft HPMP submitted with this AFLA. The Districts expect to file a final HPMP with FERC by February 2018, following additional SHPO consultation efforts.

Transportation Management Plan

Article 17 of the existing license has worked well and will be continued. The Districts propose that the new license continues the Districts' current practices under Article 17:

> In the construction and maintenance of the project, the location and standards of roads and trails, and other land uses, including the location and condition of quarries, borrow pits, and spoil disposal areas, and sanitary facilities, shall be subject to the approval of the department or agency of the United States having supervision over the lands involved.

The Districts currently conduct maintenance on existing roads within the Project Boundary, with emphasis on the 14.25 miles of roads within Project developed recreation areas. Under the new license, the Districts propose to annually notify the BLM of the location and type of any road maintenance projects on BLM lands, and to convene a meeting to confer on project details if requested by the BLM.

2.3 Alternative Measures and Operations Proposed by Others

The great majority of the comments received on the DLA were general in nature, and did not propose specific resource PM&E measures. Specific measures not directly involving flow have been put forth by the BLM, USFWS, the Lower Tuolumne Farmers, and whitewater boating interests and are addressed herein and in the Districts Response to Comments on the DLA in Attachment A of this AFLA. The BLM recommended the adoption of a number of resource management plans which the Districts have largely incorporated within the proposed management plans identified above and included in this AFLA. A number of requests for improved river-egress facilities at the Ward's Ferry Bridge were included in comments to the DLA, and the Districts have addressed these comments and provided a proposal in Section 5.0 of this Exhibit E. Several flow proposals that have been made by others are also analyzed in Section 5.0 of this Exhibit E.

2.4 Alternatives Considered but Eliminated from Detailed Study

2.4.1 Federal Government Takeover of the Project

FERC's SD2 noted that no governmental agency has suggested a willingness or ability to take over the Project. Therefore, this alternative has not been considered. Also, as the Districts are public entities, the Project is not subject to federal takeover.

2.4.2 Issuing a Non-Power License

A non-power license is a temporary license FERC would terminate whenever it determines that another governmental agency is authorized and willing to assume regulatory authority and supervision over the lands and facilities covered by the non-power license. The Districts are public entities authorized to own and operate dams in the State of California. At this time, no other governmental agency has suggested a willingness or ability to take over the Project. No party has sought a non-power license for the Don Pedro Project. Therefore, a non-power license has not been considered.

2.4.3 Retiring the Don Pedro Hydroelectric Project

Decommissioning of the Don Pedro Hydroelectric Project could be accomplished without removal of Project facilities. This alternative could potentially occur if FERC denied issuance of a new license to continue hydropower generation or if the Districts were not to accept the new license issued by FERC. Under the decommissioning alternative, the Project would no longer be authorized to generate power; however, the primary purposes and needs for the Don Pedro

Project of water supply and flood control would continue. No entity has recommended retirement of the Project.

3.0 ENVIRONMENTAL ANALYSIS

The Don Pedro Project provides water storage for irrigation and municipal and industrial (M&I) use, flood control, hydroelectric generation, recreation, and natural resource protection (hereinafter, the "Don Pedro Project"). The environmental analysis contained in this AFLA considers all the components, facilities, operations, and maintenance that make up the Don Pedro Project and certain facilities proposed to be included under the new license. The Don Pedro Project is operated to fulfill the following primary purposes and needs: (1) to provide water supply for the Districts for irrigation of over 200,000 acres of Central Valley farmland and M&I use, (2) to provide flood control benefits along the Tuolumne and San Joaquin rivers, and (3) to provide a water banking arrangement for the benefit of the City and County of San Francisco (CCSF) and 2.6 million people who reside in the Bay Area. The original license was issued in 1966. In 1995, the Districts entered into an agreement with a number of parties, which resulted in greater flows to the lower Tuolumne River for the protection of aquatic resources.

Hydroelectric generation is a secondary purpose of the Don Pedro Project. Hereinafter, the hydroelectric generation facilities, recreational facilities, and related operations will be referred to as the "Don Pedro Hydroelectric Project," or the "Project". With this AFLA to FERC, the Districts are seeking a new license to continue generating hydroelectric power and implement the Districts' proposed PM&E measures. Based on the information contained in this application, and other sources of information on the record, FERC will consider whether, and under what conditions, to issue a new license for the continued generation of hydropower at the Districts' Don Pedro Project. The Districts are providing a complete description of the facilities and operation of the Don Pedro Project so the effects of the operation and maintenance of the hydroelectric facilities can be distinguished from the effects of the operation and maintenance activities of the overall Don Pedro Project's flood control and water supply/consumptive use purposes.

Being able to differentiate the effects of the hydropower operations from the effects of the flood control and consumptive use purposes and needs of the Don Pedro Project will aid in defining the scope and substance of reasonable PM&E alternatives. As FERC states in Scoping Document 2 in a discussion related to alternative project operation scenarios: "…alternatives that address the consumptive use of water in the Tuolumne River through construction of new structures or methods designed to alter or reduce consumptive use of water are…alternative mitigation strategies that could not replace the Don Pedro *hydroelectric* [emphasis added] project. As such, these recommended alternatives do not satisfy the National Environmental Policy Act (NEPA) purpose and need for the proposed action and are not reasonable alternatives for the NEPA analysis."

3.1 General Description of the Tuolumne River Basin and Don Pedro Project

The 150-mile-long Tuolumne River originates in the Sierra Nevada in Yosemite National Park. At Tuolumne Meadows, streams flowing down the slopes of Mount Lyell and Mount Dana join to form the river's headwaters. After nearly 8,600 ft of elevation drop, the Tuolumne River converges with the San Joaquin River. Don Pedro Dam is located at RM 54.8 of the Tuolumne

River. The upstream extent of the Project Boundary is at RM 80.8 and the current downstream extent of the Project Boundary is at RM 53.2.

There are 23 tributaries to the Tuolumne River (Table 3.1-1 and Figure 3.1-1), primarily located upstream of the Project Boundary. Only Twin Gulch and Dry Creek converge with the Tuolumne River below the Project Boundary. The hydrologic characteristics of the tributaries vary significantly. East of Don Pedro Reservoir, especially in areas above approximately 5,000 ft where snow accumulation is significant, the upper Tuolumne River and its tributaries are snowmelt-dominated. Runoff from tributaries in the lower elevations is primarily rain-driven.

Table 3.1-1. Primary tributaries to the Tuolumne River.

Major Tributary (listed upstream to downstream)
Above the Project Boundary
Lyell Fork
Dana Fork
Cathedral Creek
Falls Creek
Return Creek
South Fork Tuolumne
Eleanor Creek
Cherry Creek
Jawbone Creek
Clavey River
Indian Springs Creek
Big Creek
North Fork
Turnback Creek
Project Boundary
Hatch Creek
Moccasin Creek
Grizzly Creek
Rough and Ready Creek
Sullivan Creek
Woods Creek
Big Creek
West Fork Creek
Below the Project Boundary
Twin Gulch
Dry Creek

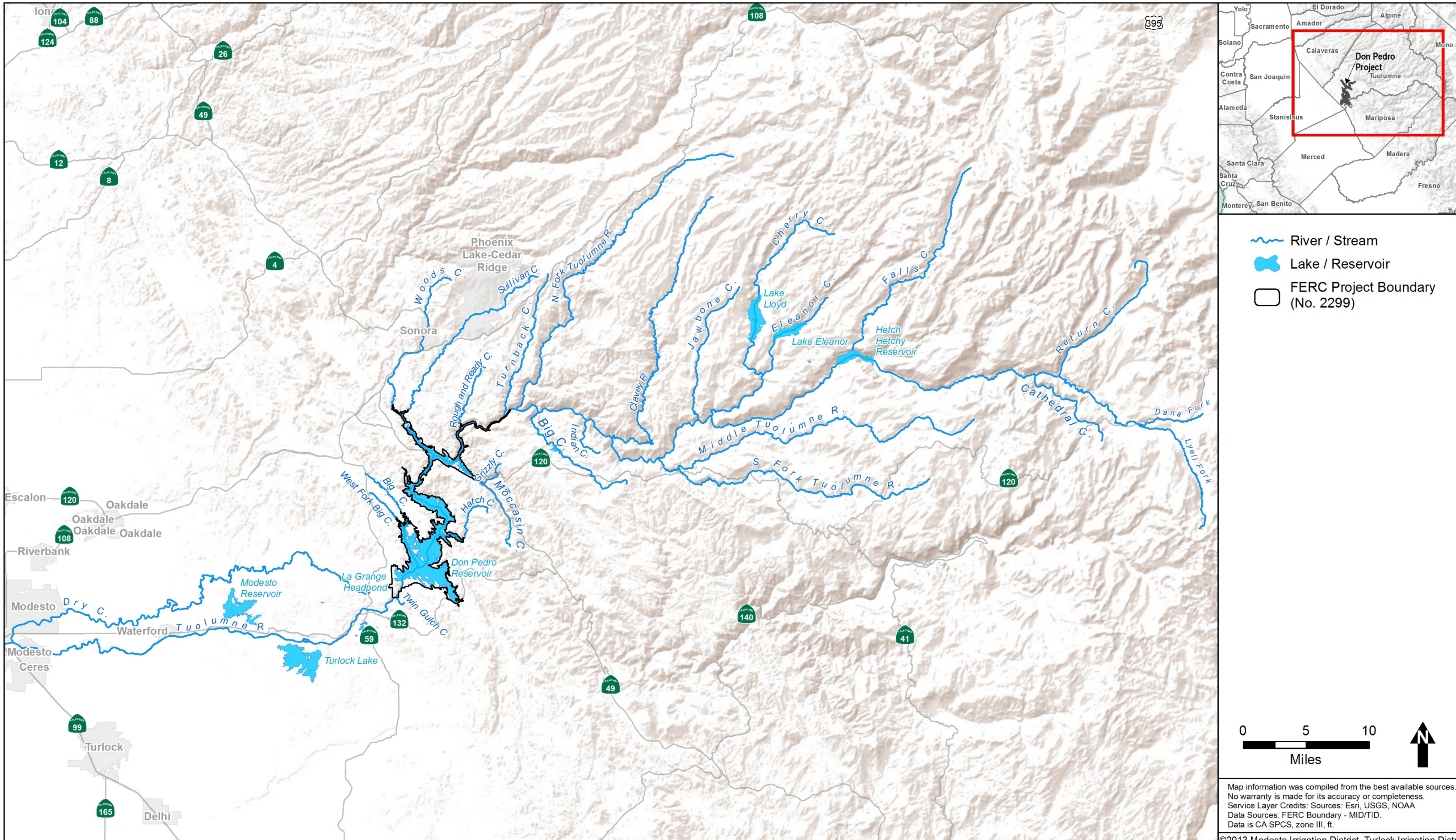

Figure 3.1-1. **Location of tributaries to the Tuolumne River.**

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There are three major water diversions from the Tuolumne River. First, upstream of the Don Pedro Project at RM 118, O'Shaughnessy Dam impounds Hetch Hetchy Reservoir and diverts water to the Bay Area through the Canyon, Mountain, and Foothill tunnels, and San Joaquin Pipelines. Owned and operated by CCSF, the 360,400 AF Hetch Hetchy Reservoir is an integral component of CCSF's Hetch Hetchy Water and Power System, which provides approximately 85 percent of CCSF's Bay Area municipal and industrial ("M&I") water supply and generates on average 1,700,000 megawatt-hours (MWh) of electricity each year. Second, CCSF owns and operates Early Intake Diversion Dam, located at RM 105. This facility is used to divert water supplied by CCSF's Cherry Creek facilities through the Mountain and Foothill tunnels to its San Joaquin Pipelines during emergency and extreme drought conditions. Third, located below the current Project Boundary at RM 52.2, La Grange Diversion Dam, owned by the Districts, diverts flows from the Tuolumne River for irrigation and M&I water supply purposes.

The mainstem Tuolumne River forms at an elevation just above 8,600 ft in the high alpine Tuolumne Meadows located in Yosemite National Park. At this point, the eight mile-long Dana Fork and the 13-mile-long Lyell Fork converge (NPS 2010), draining the south-facing slopes of the mountains near Tioga Pass and the north-facing slopes of the Cathedral Range. From Tuolumne Meadows, the Tuolumne River winds and plunges generally westward through a number of waterfalls, including Tuolumne, California, Le Conte, and Waterwheel falls (DeLorme 2003), before entering the steep-sided and rocky Grand Canyon of the Tuolumne.

The river continues down the canyon and into Don Pedro Reservoir, at which point the canyon transitions into the low Sierra foothills and wider Tuolumne River valley. Downstream of the reservoir, the rolling hills of the eastern Central Valley gradually flatten to become a terraced floodplain. From here, the river flows to its confluence with the San Joaquin River.

The Tuolumne River watershed covers 1,960 mi^2 and encompasses a wide range of climates and hydrologic conditions. Annual precipitation within the watershed ranges from over 60 inches in the high mountain areas to 12 inches in the Central Valley (Western Regional Climate Center 2010). Within the Project Boundary, annual precipitation ranges from 25 to 40 inches (ACOE 1972). At its headwaters in the Sierra Nevada, the Tuolumne River area experiences significant snow accumulation from December to April. Downstream in the Sierra Nevada foothills where the Don Pedro Project is located, the climate is often described as Mediterranean. Winters are wet and cool, with most precipitation occurring in the form of rain. The summers are hot and dry.

Runoff in the Tuolumne River watershed is produced by rainfall and snowmelt. Runoff from the upper basin occurs from April to July, when snowpack from the winter melts (ACOE 1972). In the Sierra foothills and valley floor, runoff occurs from December to March, coinciding with the rainy season. The long-term mean annual natural runoff of the Tuolumne River at Don Pedro Dam is approximately 1.9 million AF. The observed mean annual runoff into the reservoir (based on the period 1975 to 2009) is 1.6 million AF, with the bulk of the difference being the out-of-basin diversions by CCSF for its M&I water customers. However, the annual runoff of the Tuolumne River is subject to considerable variability. For example, during that same time period, the annual unimpaired runoff of the Tuolumne River has varied from 382,000 AF (WY 1977) to 4.6 million AF (WY 1983).

Lands within the Tuolumne basin have a number of uses and a variety of ownership types. Above the Don Pedro Project area, lands in the Tuolumne River watershed are primarily federally owned, with NPS managing Yosemite National Park and the USFS managing the Stanislaus National Forest. Developed land in this stretch of the subbasin is largely limited to small communities, such as Groveland and Smith Station, as well as dispersed individual residences and small tracts of non-irrigated farmland. Much of the land immediately upstream of the Project Boundary is managed by the BLM, including lands adjacent to the Tuolumne River.

Surrounding the Project, lands are a mix of publicly owned lands administered by the BLM and private property. Approximately 74 percent of lands within the current Project Boundary, or 13,568 ac, are owned by the Districts. The remaining lands, about 4,802 ac, are public lands located within BLM's Sierra Resource Management Area.

Downstream of the current Project Boundary, in the Central Valley area of the Tuolumne River watershed, land is primarily privately owned and used for agriculture, grazing, rural residential purposes, and denser residential purposes, such as in the communities of Waterford and Modesto (Stanislaus County 2006). A small portion of land downstream of the Project is under state ownership; Turlock Lake State Recreation Area (SRA) is a small state park spanning from the southern bank of the Tuolumne River to the north shore of Turlock Lake.

Tuolumne County, where the Don Pedro Project is located, has a diverse economic base. From 2007 to 2011, the four largest employment sectors were (1) educational services, health care, and social assistance; (2) arts, entertainment, recreation, and accommodation and food services; (3) retail trade; and (4) construction (U.S. Department of Commerce (USDOC) 2013). During this time period, agriculture, forestry, fishing, hunting, and mining constituted the eleventh largest employment sector in Tuolumne County. Major employers in the county include the Corrections Department, Sonora Regional Convalescent Home, and Sonora Regional Hospital (State of California 2013). A more thorough discussion of the economic activity in the vicinity of the Don Pedro Project is included in Section 3.12.

3.1.1 Historical Perspective of Tuolumne River Water Uses

The waters of the Tuolumne River have been the source of competing needs, uses, and claims dating back to the late 1800s. Because the history of these competing interests continues to be relevant to Don Pedro Project operations today, a historical perspective of the water use issues is valuable.

In 1887, the California legislature authorized a new form of popularly-elected local government, the irrigation district, based on the idea that since irrigation would be a community benefit, its finance and governance should be community-based rather than be controlled by individual landowners or irrigators. In June of that year, TID became the first to organize under the new law, followed in July by MID. Three years later, in August 1890, the two pioneer districts signed an agreement to build a joint diversion dam, La Grange Diversion Dam (located about two miles below the present Don Pedro Dam), and to divide such flow as the Districts had rights to in proportion to the total acreage in each district. The agreement also provided an option to share future projects upstream from La Grange Diversion Dam on the same acreage formula, putting in place a partnership for the development of the river that has lasted for 120 years. La Grange Diversion Dam, however, was not the first dam to be built on the Tuolumne River. The first major dam built on the Tuolumne River was Wheaton Dam constructed in 1871, before the Districts were formed, by a small private company, the Tuolumne Water Co., near the present location of La Grange Diversion Dam (RM 52.2).

La Grange Diversion Dam was built of boulders set in concrete and faced with roughly dressed stones quarried nearby. Its sole purpose was to raise the elevation of the river behind it to the level necessary to divert water into the Districts' irrigation canals, and any water not diverted into the canals simply passed safely over the top of the dam. At 127 feet high and 90 feet thick at the base, it was the highest dam of its kind when it was completed in 1893.

The Districts' position as the only users of the Tuolumne River was challenged in 1901 when the City of San Francisco announced plans to construct dams at Hetch Hetchy Valley and on Eleanor Creek to create a new municipal water supply. At first San Francisco's applications for rights-of-way over federal park and forest lands were rejected, but in 1908, Secretary of the Interior James Garfield granted a permit. The Garfield Permit recognized specific senior water rights of the Districts. The permit also required San Francisco to sell surplus water to the Districts at cost and to sell electricity to the Districts for irrigation and drainage pumping at cost.

Between 1908 and 1912, San Francisco engineers developed plans for diverting water for municipal supply and generating hydroelectric power from the Tuolumne watershed — including an additional dam in Cherry Valley — that would be capable of supplying up to 400 million gallons per day to San Francisco and other cities around the bay. In 1910, Garfield's successors reopened the controversy when they threatened to revoke San Francisco's right to use Hetch Hetchy Valley. In 1913, Secretary of Interior Fisher concluded he could not allow San Francisco to build the Hetch Hetchy Project without clearer authorization from Congress. As a bill authorizing San Francisco's plan worked its way through Congress, the Districts negotiated terms with San Francisco. The Raker Act passed by Congress in 1913 recognized and protected the senior priority water diversions by TID and MID named in the previous Garfield Permit—a total of 2,350 cfs or natural flow, whichever is less, year-round and 4,000 cfs for 60 days each spring.

While the Hetch Hetchy project was being debated, the Districts were moving forward with plans for storage reservoirs because the natural flow and absence of storage at La Grange Diversion Dam made it impossible to irrigate any substantial acreage after the snow-melt ended in early summer. Both Districts first built small foothill reservoirs along their main canals—Modesto Reservoir in 1911 and Turlock Lake in 1914—and in 1915, they agreed to cooperate on a larger dam upstream of the La Grange Diversion Dam.

The construction agreement for the original Don Pedro Project signed in April 1919 allocated costs and benefits according to acreage, fixing TID's share of the Don Pedro Project, and subsequent water supply facilities on the river, at 68.46 percent and MID's share at 31.54 percent. When the original Don Pedro Dam was finished in 1923, the 284-foot-high arched dam was the highest in the world and had a maximum storage of 289,000 AF, which expanded the Districts' irrigation season beyond just the spring runoff season.

The original Don Pedro Project also put the Districts in the power business. Because in the 1920s electric lines rarely extended into rural areas, there had long been an interest in having the Districts distribute the power produced at Don Pedro. TID built its own transmission line and began retail distribution in 1923, with a branch to supply MID until it could build its own line from the dam. Growth was rapid, and in 1928, the generation capacity of Don Pedro was doubled to 30 MW. Private utilities found it impossible to compete with the Districts' low rates and expanding network of distribution lines; TID took full control of electric service within its boundaries in 1931, and MID did so in 1940. The Districts' hydroelectric power development kept them solvent during the Depression while also helping to lower property tax rates to help cash-strapped residents.

To maintain a minimum power pool at Don Pedro and increase irrigation storage, the Districts added gates to the spillway. The nine-foot increase in reservoir elevation flooded federal land above the 1916 reservation of public lands, resulting in the issuance of a Federal Power Commission (FPC) minor part license for the original Don Pedro Project in 1930.

San Francisco and the Districts continued to discuss their respective needs and rights to the Tuolumne River. In 1933, the Districts filed suit as San Francisco neared completion of the Hetch Hetchy Aqueduct, arguing that their rights under state law exceeded the flow San Francisco was required to release to the Districts under the Raker Act. Negotiations soon developed on a cooperative solution. The result was what became known as the First Agreement, a brief document that suspended litigation and committed San Francisco and the Districts to continued cooperation that would "recognize the provisions of the Raker Act as applying to the Districts and to the City without waiving any of their rights."

To satisfy the needs of those depending on the Districts and San Francisco to provide water, the Districts and San Francisco began a cooperative program, which included discussions of building additional storage on the Tuolumne River. However, planning was complicated by the efforts of the ACOE to construct a flood control reservoir at Jacksonville, just upstream of old Don Pedro. That prompted the Second Agreement in 1943, which proclaimed that a dam on Cherry Creek in the upper watershed and a larger Don Pedro dam were part of a coordinated and comprehensive watershed plan for developing the river. The next year the Districts and San Francisco took their case to Congress, and succeeded in stopping the federal dam and substituting a federal financial contribution to their projects to provide flood control.

In 1949, the Third Agreement between the Districts and San Francisco spelled out the terms of the comprehensive plan. New Don Pedro would be built with a financial contribution by San Francisco providing it with use of storage in the new reservoir. San Francisco's junior rights on the Tuolumne River would entitle it to relatively little or no water in dry years, which meant that it needed significant year-to-year carry-over storage to turn those junior rights into a reliable water supply.

Rather than building a number of additional small, uneconomical reservoirs in the upper watershed, new Don Pedro allowed San Francisco to acquire storage on terms that were more favorable. New Don Pedro would be owned and operated exclusively by the Districts, so the

Third Agreement introduced the concept of a "water bank"; San Francisco would receive credit for inflow in excess of the Districts' priorities as listed in the Raker Act, and could use those credits to offset the subsequent upstream diversion of water that would otherwise have had to flow to the Districts. In essence, the agreement allows San Francisco to pre-release water from its upstream facilities into a water bank in the Don Pedro Reservoir so at other times it can hold back an equivalent amount of water that otherwise would have had to be released to satisfy the Districts' senior water rights. Once the water enters the Don Pedro Reservoir, it belongs to the Districts and the Districts have unrestricted entitlement to its use.

To pay for its water bank space, and to relieve its reservoirs of any federal flood control obligations, San Francisco agreed to pay for a portion of the construction of a new dam capable of storing a total of 1.2 million AF, including 290,000 AF to replace the original Don Pedro Project, 340,000 AF of flood control storage requested by ACOE, and 570,000 AF for water bank storage. ACOE flood control space would be kept empty during the rainy season to absorb storm inflows. When not obligated for ACOE flood control space, San Francisco could obtain water bank credits for up to 50 percent of the flood control storage space. All water in the reservoir belongs to the Districts, and San Francisco agreed to not construct or install facilities to divert water from the reservoir. The Districts would provide the land for the Don Pedro Project and pay for the new, and much larger, power plant. They also had the right to create additional storage for themselves by paying the marginal cost of a higher dam.

The Districts opted to increase new Don Pedro to its current maximum capacity of 2,030,000 AF. As part of the FERC licensing process, the California Department of Fish and Wildlife (CDFW) asked the FPC, predecessor agency to FERC, to require a set of scheduled minimum flows below La Grange Diversion Dam to protect fall-run Chinook Salmon that spawned in the Tuolumne River. There was a general recognition that new Don Pedro was a necessary prerequisite for protection of the Tuolumne fall-run Chinook Salmon since the existing dam had no downstream release requirement. FPC also recognized that fishery releases, when combined with rising San Francisco diversions, could ultimately undermine the economic feasibility of the Don Pedro Project. To balance those factors, FPC's 1964 (FPC 1964) decision set normal year releases of 123,000 AF and dry year releases at 64,000 AF for the first 20 years, and required the Districts to conduct studies that could be used to develop future fishery requirements.

The overall allocation of costs and benefits—the basic New Don Pedro bargain—had been defined by the Third Agreement but implementation still had details to be finalized. San Francisco and the Districts negotiated such further details in the Fourth Agreement, which was executed by the parties in 1966. Key provisions of the Fourth Agreement include the following:

- The Water Bank Account is to be maintained on a daily basis based upon the computed daily natural flow at La Grange Diversion Dam. "Daily natural flow" is defined as that flow which would have occurred at La Grange Diversion Dam had no facilities been constructed by any party in the Tuolumne River watershed. San Francisco receives a credit of advance releases whenever the inflow to the reservoir from all sources exceeds 2,416 cfs or natural flow, whichever is smaller, year-round, and 4,066 cfs or natural flow, whichever is smaller, for 60 days following and inclusive of April 15. The additional 66 cfs was for an 1871 mining ditch right acquired during the construction of the original Don Pedro Dam. A major portion of the mining ditch right served the Waterford Irrigation District which was later annexed by MID.

- Except with the prior consent of the Districts, San Francisco is not entitled to have a debit balance in the Water Bank Account.
- The parties agree to share in certain costs based on a ratio of 51.7121 percent to San Francisco and 48.2875 percent to the Districts. These costs included (1) continuing costs for deficit operation of recreation facilities required under a FERC license and (2) the costs of (a) fishery studies required by FERC, (b) any resulting proceedings, and (c) any facilities or programs instituted as a consequence of such fishery studies or proceedings.
- Future responsibility for fishery releases in Article 8, which provides:

The Districts and City recognize that Districts, as licensees under the [FERC] license for the New Don Pedro project, have certain responsibilities regarding the water release conditions contained in said license, and that such responsibilities may be changed pursuant to further proceedings before the [FERC]. As to these responsibilities, as they exist under the terms of the proposed license or as they may be changed pursuant to further proceedings before the [FERC], Districts and City agree:

(a) That any burdens or changes in conditions imposed on account of benefits accruing to City shall be borne by City.

(b) That at any time Districts demonstrate that their water entitlements, as they are presently recognized by the parties, are being adversely affected by making water releases that are made to comply with [FERC] license requirements, and that the [FERC] has not relieved them of such burdens, City and Districts agree that there will be a re-allocation of storage credits so as to apportion such burdens on the following basis: 51.7121% to City and 48.2879% to Districts.

In the event City and Districts cannot agree that there has been such an adverse effect and the extent thereof, these issues shall be determined by arbitration as provided in [this Agreement].

(c) That in the event of such adverse effects on Districts' water entitlements, and the consequent necessity for distribution of burden therefor as provided in subparagraph b, Districts shall forthwith seek modifications by the [FERC] of the water release conditions of said license.

Article 37 of the Project license established minimum flow releases for the first 20 years of operation (1971 to 1991) and reserved FPC's authority to revise the minimum flow requirements after 20 years. Article 39 of the license required the Districts, in cooperation with CDFW, to study the Tuolumne River fishery and how it could feasibly be sustained (see Appendix B-1 of this Exhibit for current license articles). The Districts subsequently commenced 18 years of fishery studies.

In 1985, the Districts applied to FERC to amend their license to add a fourth generating unit. While the amendment proceeding was underway, the Districts, CDFW, and the U.S. Department of the Interior, Fish and Wildlife Service (USFWS) entered into an agreement to amend the approved fish study plan provided for in Article 39 of the license. Among other things, the agreement contemplated extending the existing study and maintaining the existing flows until 1998. In 1987, FERC granted the license amendment and included the revised study plan in the license. FERC added Article 58 to the license, making the Districts' amended fish study plan a condition of the license and requiring the Districts to file a report on the results, with recommendations for changes in the existing flow releases and ramping rates for the Project. In doing so, however, FERC found that it was beyond the scope of the amendment request to extend the ongoing study or minimum flows beyond the initial 20-year period provided for in the existing license. As a result, the requirement to revisit the Project's minimum flows after 20 years, and to provide the results of the ongoing fish study, remained intact.

In 1995, the Districts entered into a FERC-mediated settlement agreement (1995 Settlement Agreement) with CDFW, USFWS, CCSF, California Sportfishing Protection Alliance, Friends of the Tuolumne, Tuolumne River Expeditions, and the Tuolumne River Preservation Trust. Pursuant to this agreement, in 1996, FERC amended Articles 37 and 58 of the license to implement new minimum flows and fishery monitoring studies. Before approving the license amendment, FERC completed formal consultation with the USFWS pursuant to Section 7 of the federal Endangered Species Act on two listed fish species, the Delta Smelt and Sacramento Splittail. FERC also prepared an Environmental Impact Statement (EIS) that examined the effects of various alternative flow regimes. As amended in 1996, Article 37 required a modified minimum flow regime to protect fishery resources in the Tuolumne River. This flow regime remains in effect today.

3.1.2 Water Rights Owned by TID and MID

The Districts have a number of individual water rights on the Tuolumne River including certain appropriative water rights acquired in 1855, riparian water rights, additional pre-1914 appropriative water rights, and post-1914 appropriative water right licenses issued by the State of California (License Numbers 11057 and 11058).

Section 3.1.1 above provides a description of the Raker Act and the Fourth Agreement between the Districts and CCSF. The Fourth Agreement defines the allocation of the waters of the river between CCSF and the Districts, the primary holders of water rights on the Tuolumne River. The Districts also have storage water rights in the original and existing Don Pedro Reservoir licensed by the State Water Resources Control Board (SWRCB). The water rights recognized under License Numbers 11057 and 11058 permit the use of water for irrigation, power generation, and recreation. The licenses also allow the storage, withdrawal from storage, diversion, and re-diversion of Tuolumne River water. Specifically, License Numbers 11057 and 11058 permits the Districts to store 1,046,800 AF of water per year to be collected from November 1 to July 31 of the succeeding year, to divert and re-divert a maximum of 1,371,800 AF per year, and withdraw 951,100 AF of water per year.

3.2 Scope of Cumulative Effects Analysis

As described in FERC's SD2 (FERC 2011), the scope of FERC's environmental assessment for the Don Pedro Hydroelectric Project relicensing must include an analysis of how the Proposed Action would or would not contribute to cumulative effects. According to the Council on Environmental Quality's regulations for implementing NEPA (50 CFR. §1508.7), cumulative effects on a resource are the result of the combined influence of past, present, and reasonably foreseeable future actions within a specified geographical range (FERC 2008), regardless of which agency (federal or non-federal) or entity undertakes such actions. Related specifically to the Tuolumne River basin, cumulative effects can result from individually minor but collectively significant actions taking place over a prolonged period of time, including hydropower operations, diversions for irrigation and drinking water supply, past gravel and gold mining activities, other land and water development activities, and the introduction of non-native species to the watershed.

Based on FERC's scoping meetings, comments received during scoping, and information in the PAD, FERC identified the following resources as having the potential to be cumulatively affected by the continued operation and maintenance (O&M) of the Don Pedro Hydroelectric Project: water; geomorphology; fish and aquatic, including anadromous fish and their habitat; and socioeconomic resources.

Section 4 of this Exhibit E describes each of the aforementioned resources and identifies relevant actions inside and outside[10] the Tuolumne River basin that influence the environmental baseline for the Proposed Action, in accordance with guidance issued by FERC in its SD2 for the Project. Government and private actions are addressed, as appropriate, in this assessment. Actions undertaken by the government and/or other private entities which have occurred, or may occur, independently of the Districts' Proposed Action, are neither direct nor indirect effects of Don Pedro Project operations. Following the description of relevant actions potentially affecting a given resource (i.e., water, geomorphology, fish and aquatic, and socioeconomic), Section 4 of Exhibit E includes an assessment of cumulative effects on that resource.

The effects of the Don Pedro Project are attenuated with increasing distance downstream in the Tuolumne River and into the San Joaquin River basin, Sacramento-San Joaquin River Delta, and the San Francisco Bay. With increased distance downstream of the Don Pedro Project, the number and complexity of co-occurring past, current, and future actions make it exceedingly difficult, if not impossible, to meaningfully isolate specific effects of the numerous individual actions on the resources of concern.

3.3 Geology and Soils

This discussion of geology and soils considers the geologic setting of the Don Pedro Project, in addition to seismicity, physiography, soils, and erosion information. Existing, relevant, and reasonably available information regarding each of these is also presented in the PAD (TID/MID

[10] For geomorphology, out-of-basin actions are not considered relevant in the context of cumulative effects (see Geographic Scope).

2011) and summarized here. Consultation with agencies and relicensing participants did not result in the identification of any potential effects to resources due to erosion except as related to cultural resources within the Don Pedro Reservoir, nor were any studies requested or required related directly to geology and soils.

3.3.1 Existing Environment

3.3.1.1 Geologic Setting and Site Specific Geology

The Don Pedro Project is located in the Western Sierra Nevada Metamorphic Belt (WSNMB), which is contained within the Sierra Nevada Block, a tilted fault block approximately 400 miles long that trends north-northwest, is 40 to 80 miles wide, and includes a broad region of foothills along the western slope of the Sierra Nevada Range (Harden 2004). The eastern face of the tilted Sierra Nevada Block is high and rugged, consisting of multiple fault scarps (Eastern Sierra Nevada Frontal Shear Zone) separating it from the Basin and Range Province. This contrasts with the gentle western slope that disappears under sediments of the Great Valley. The Sierra Nevada block continues under the Great Valley and is bounded on the west by an active fold and thrust belt that marks the eastern boundary of the Coast Range Province (Wentworth and Zoback 1989). The northern boundary of the tilted fault block is marked by the disappearance of typical Sierra bedrock under the volcanic cover of the Cascade Range. The southern boundary of the fault block is along the Garlock Fault located in the Tehachapi Mountains 210 miles southeast of the Project Boundary where characteristic rocks of the Sierra Nevada are abruptly truncated by this east-west fault system. The Don Pedro Project is located a few miles east of the surficial boundary with the Great Valley geomorphic province (Figure 3.3-1).

The WSNMB is divided into three lithotectonic subunits, designated the Western, Central, and Eastern belts (Day et al. 1985). The Project Boundary is situated within the Central Belt. The Western and Central belts are composed of Paleozoic and Mesozoic serpentinized peridotite (ultramafic rock) and metamorphosed volcanic and sedimentary sequences. Both belts represent oceanic terranes (Schweickert and Cowan 1975; Bogen 1985; Tobisch et al. 1987). The Eastern Belt is composed of Paleozoic and Mesozoic sedimentary and volcanic rocks and is generally accepted to have formed in near-continental to continental arc environments (Hannah and Moores 1986; Harwood 1988).

The Central Belt consists of a Paleozoic ophiolite complex (a sequence of former sea floor to upper mantle strata, here known as the Tuolumne Ultramafic Complex), middle Triassic to early Jurassic volcanic rocks (Jasper Point and Peñon Blanco formations) and sedimentary rocks (Mariposa Formation) intruded by lower Jurassic plutons (Clark 1964; Morgan 1977; Bogen 1985). The lowest stratigraphic unit at the site is the above-mentioned Tuolumne Ultramafic Complex of late Paleozoic (about 300 million years ago (mya)) age (Saleeby et al. 1982). It is overlain structurally and stratigraphically by the metavolcanic rocks of the Peñon Blanco Formation of middle Triassic to early Jurassic age. Overlying all the above rock units in places are several types of surficial deposits, primarily colluvial soils and local alluvium in drainage courses.

3.3.1.2 Faulting and Seismicity

The Project Boundary is located near the western margin of the Sierra Nevada range, where the Foothills Fault System is a dominant structural feature. This fault system, developed during the Nevadan orogeny (mountain building) episode approximately 123 to 160 mya, is a braided complex of north-northwest-striking fault structures with mineralized zones (Clark 1960). Nearby fault segments were reactivated during the Cenozoic Era (less than 65 mya), and some were reactivated as recently as during the Quaternary Period (1.8 mya to present day). The Cleveland Hills Fault, located about 134 miles northwest of the Project Boundary, was active during the Lake Oroville earthquake on August 1, 1975.

The Foothills Fault System contains two major fault zones, the Bear Mountains Fault Zone and the Melones Fault Zone, that cross the Tuolumne River. The California Division of Mines and Geology (CDMG) Open-File Report 84-52 (USGS 1984) states that the Bear Mountains and Melones Fault zones did not warrant zoning as active faults because they "either are poorly defined at the surface or lack evidence of Holocene (recent) displacement" (Hart et al. 1984). The Bowie Flat Fault is a relatively minor fault within the Foothills Fault System and is also located in the vicinity of the Don Pedro Project.

A seismicity and ground motion study performed for Don Pedro Dam in November 1992 showed that earthquakes from faults less than six miles from the dam control the maximum ground motion observed, rather than more distant (greater than 50 miles from the dam) active regional faults such as the San Andreas and Sierra Nevada Frontal faults (Bechtel Corporation 1992). A subsequent review of the 1992 study agreed with that assessment, but recommended that a maximum earthquake of magnitude 6.5 (compared to magnitude 6.25 in the 1992 Bechtel Corporation report) be assigned to the fault traces in the Foothills Fault System. The report classified all the faults in the system as "conditionally active" (HDR Engineering and Geomatrix Consultants 2000). Earthquake ground motions were estimated assuming a maximum earthquake of Magnitude 6.5. Median bedrock peak ground accelerations (PGA) were estimated using two available ground motion attenuation models (Sadigh et al. 1997; Abrahamson and Silva 1997). Using those models, the reported PGA for the Don Pedro Project ranges from 0.50g to 0.60g.

3.3.1.3 Recent Seismic Activity

Figure 3.3-2 illustrates seismic events in the vicinity of the Don Pedro Project from 1769 through the 2013. The source of information on historical seismic events (magnitude and epicentral location) prior to the year 2000 were obtained from the CGS (2013). For events from the year 2000 to 2013, the source of information was the USGS (USGS 2013). There have been no earthquakes within approximately 60 miles of the Project Boundary in recorded history.

3.3.1.4 Mineral Resources

Tuolumne County and lands within the Project Boundary include considerable mineral resources, chiefly gold, and have been subject to extensive mining activity (Figure 3.3-3). The placers of Columbia and Springfield northwest of the Don Pedro Project produced approximately $55,000,000 in gold prior to 1899. The pocket mines of Sonora, Bald Mountain, and vicinity have also been highly productive and exceptionally long-lived. Marble and limestone products have been next to gold in value. The Columbia marble beds northwest of the Project Boundary had a long history of production prior to 1941, and two plants are presently processing the stone from these deposits. Tuolumne County also contains deposits of copper, soapstone, scheelite (an ore of tungsten), limestone, marble, platinum, silver, sulphur, decorative stone, slate, sand, and gravel (TID/MID 2011).

California leads the nation in aggregate production, virtually all of which is removed from alluvial deposits (Kondolf 1995). As of 1994 sand and gravel mining exceeded the economic importance of gold mining in the state. Large-scale in-channel aggregate mining began in the Tuolumne River corridor in the 1940s, when aggregate mines extracted sand and gravel directly from large pits located within the active river channel. Off-channel aggregate mining along the Tuolumne River has also been extensive. For example, the Gravel Mining Reach of the lower Tuolumne (RM 34.2 to 40.3) is currently the focus of development by commercial aggregate producers.

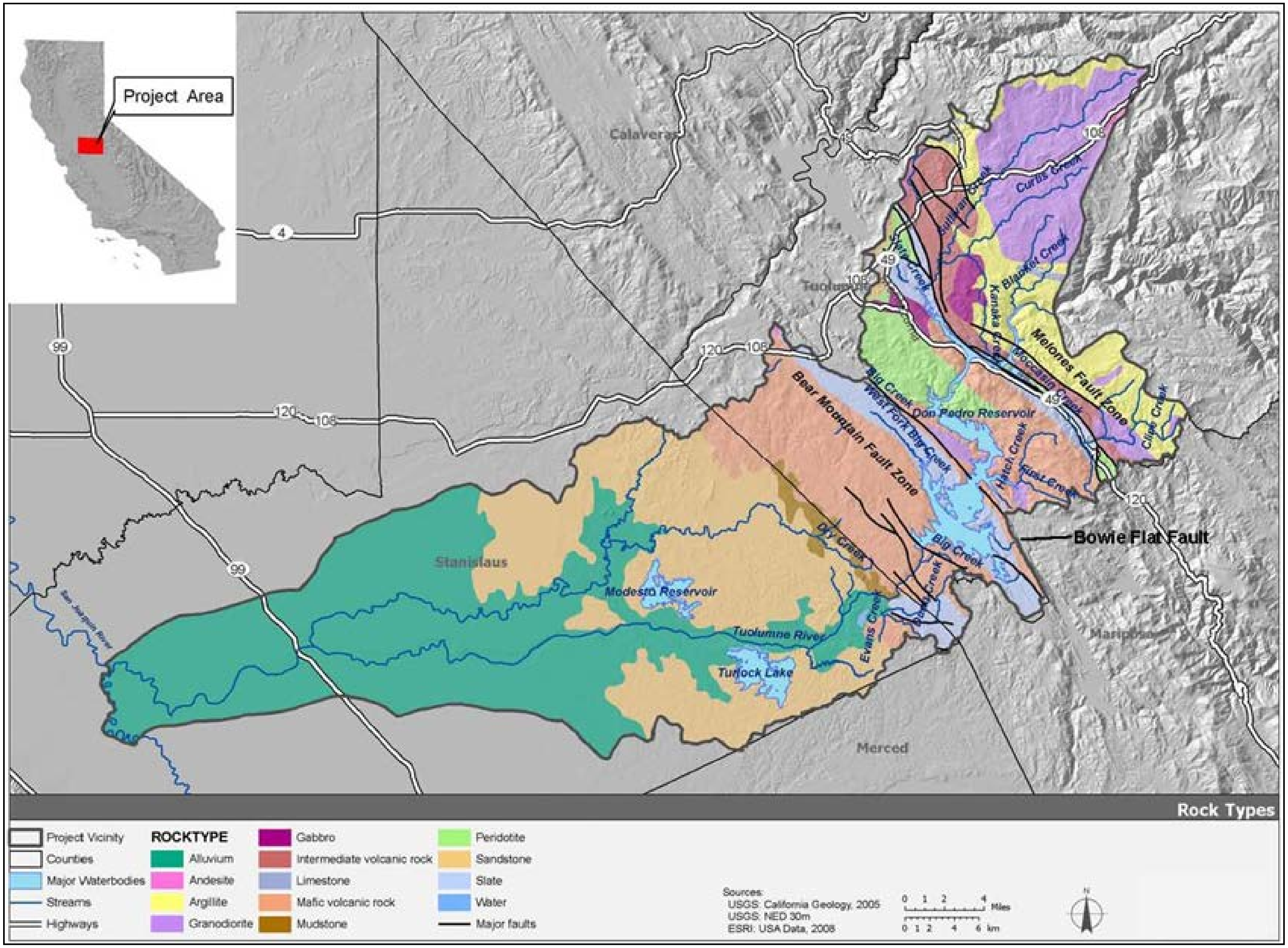

Figure 3.3-1. Rock types in the Don Pedro Project vicinity.

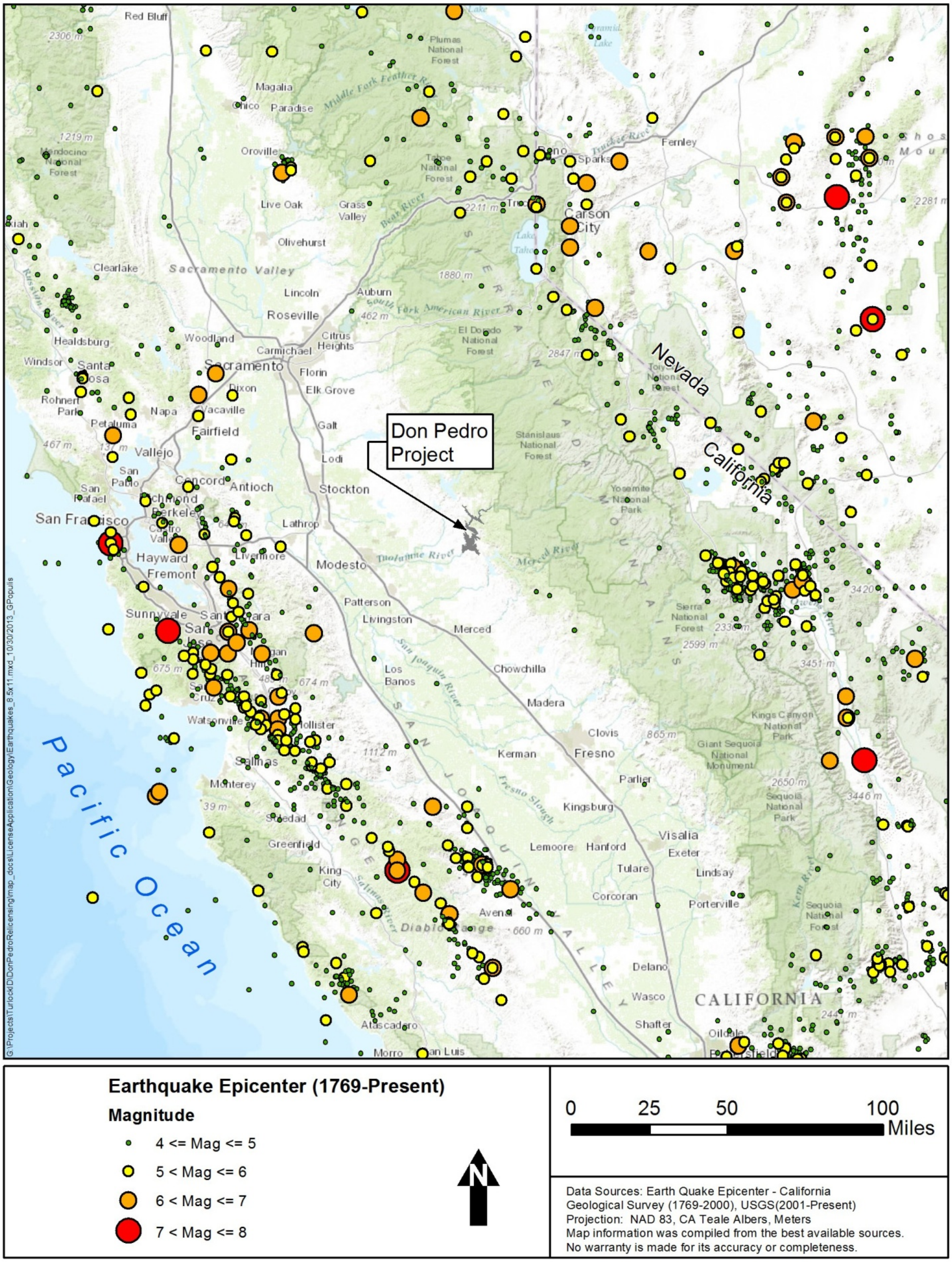

Figure 3.3-2. Historical Seismicity 1769 to 2013.

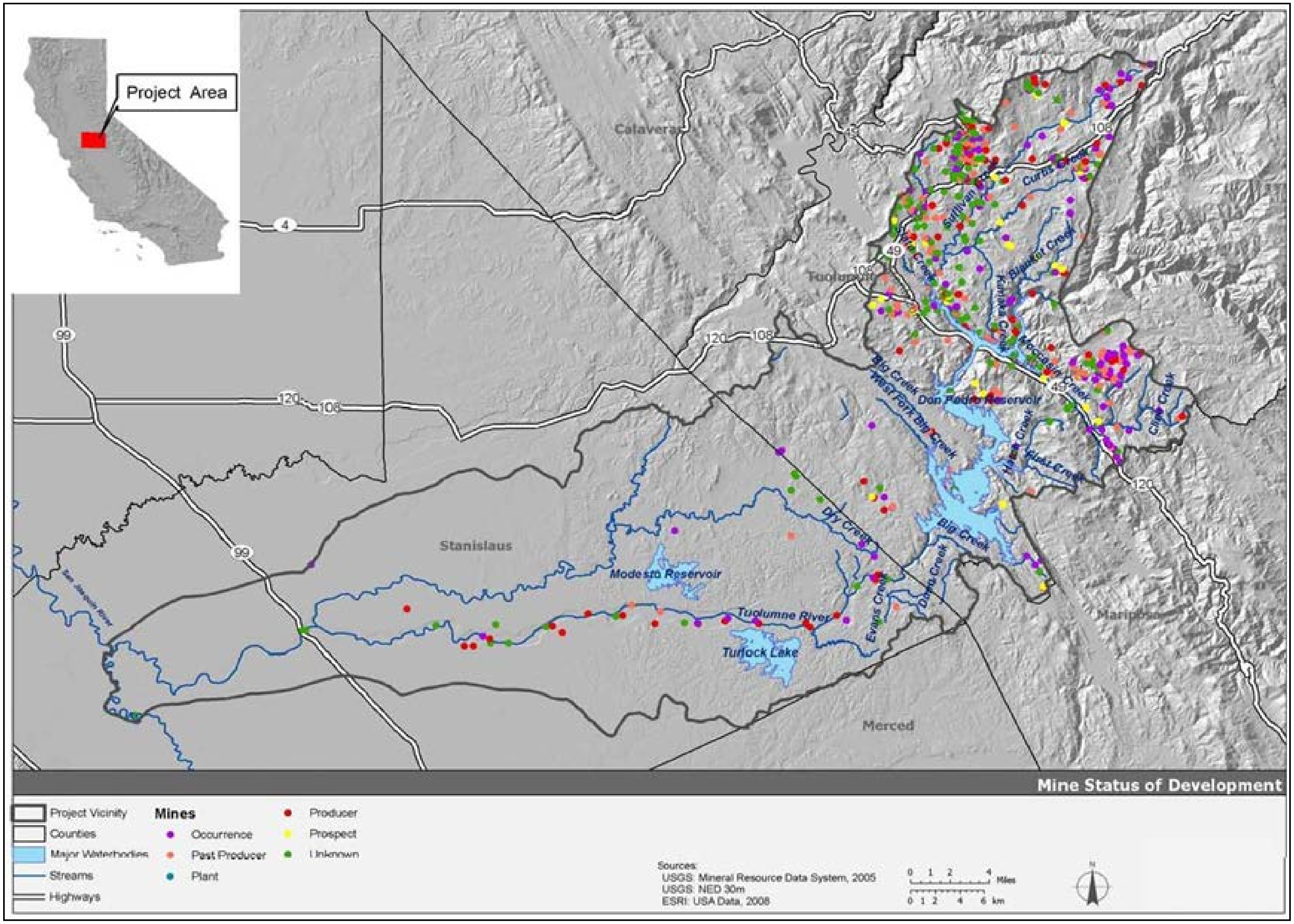

Figure 3.3-3. Past and present mines in the general vicinity of the Project Boundary.

3.3.1.5 Soil Resources

Soil Associations

Two soil associations cover nearly 90 percent of the Project Boundary, Whiterock-rock outcrop-Auburn covers 70.6 percent and rock outcrop-Henneke-Delpiedra covers 18.2 percent (Table 3.3-1). The areas to the southwest and northeast of Don Pedro Reservoir are dominated by soils of the Whiterock-rock outcrop-Auburn association, with bands of the rock outcrop-Henneke-Delpiedra and Sierra-Rock outcrop-Auberry-Ahwahnee associations bisecting the lake in a northwest to southeast direction. The area to the south of the Tuolumne River in the upper few river miles of the Project Boundary is rock outcrop-Friant-Coarsegold association, and there are very small areas of Sites-rock outcrop-Mariposa-Diamond Springs and Maymen-Mariposa associations in the uppermost Project Boundary (TID/MID 2011).

Table 3.3-1. Soil associations within the Don Pedro Project Boundary.

Soil No.	Soil Association	Acres	% of Total
s818	Whiterock-Rock outcrop-Auburn	4,556.9	70.6
s838	Rock outcrop-Henneke-Delpiedra	664.2	18.2
s841	Sierra-Rock outcrop-Auberry-Ahwahnee	488.6	7.8
s751	Rock outcrop-Friant-Coarsegold	281.1	3.2
s757	Maymen-Mariposa	13.7	Trace
s846	Sites-Rock outcrop-Mariposa-Diamond Springs	5.5	Trace
	Total	**6,009.9**	**100**

The Whiterock-rock outcrop-Auburn association is one of the more extensive associations in the foothills of the Sierra Nevada, and it typically develops in tilted slate, amphibolite schist, and partially metamorphosed sandstone formations. Whiterock soils tend to be shallower and less weathered than those of the Auburn series. The Bear Mountains Fault Zone, which runs northwest to southeast, has serpentinized ultramafic rock in many areas along the zone. The areas underlain by these ultramafic rocks are reflected by the presence of the Henneke and Delpiedra series, which are often shallow and poorly developed as shown by the large amount of "rock outcrop" in the association.

Shoreline and Reservoir Conditions

Much of the Don Pedro Reservoir shoreline is intact rock or rock/rubble/boulder not prone to erosion (Figure 3.3-4). Slopes less than eight percent are generally soil (Figure 3.3-5). There have been no large movements or mass movements of soil along the reservoir shoreline since the Don Pedro Project commenced operation. Within the reservoir, the 1997 flood resulted in substantial accumulation of sediment (approximately 30 ft deep) near Ward's Ferry Bridge; this material is slowly migrating downstream and has recently accumulated near Rough and Ready Creek.

Sediment resulting from eroded material is contained within Don Pedro Reservoir, as Don Pedro Dam traps coarse sediment and much of the fine sediment. An assessment of bathymetry data collected in 2011 determined the reservoir to have a total current storage capacity of 2,014,306 AF at elevation 830 ft. The original elevation-storage curve for Don Pedro Reservoir at the time of its construction indicated a total storage capacity of 2,030,000 AF, a difference of less than one percent (TID/MID 2017).

Figure 3.3-4. Photograph of the Three Springs Gulch shows steep, vertical, rocky slopes typical of the Railroad Canyon area. Photograph taken on June 11, 2012.

Figure 3.3-5. Typical shoreline condition along the Don Pedro Reservoir. Photograph shows the east side of the South Bay on May 4, 2011.

Observations of soil and reservoir conditions were components of the extensive relicensing studies conducted within the Project Boundary during 2012. In particular, 11 terrestrial and cultural resource studies conducted field surveys and reconnaissance efforts that included the entirety of the Don Pedro Reservoir shoreline, Don Pedro Project facilities, and surrounding areas (Table 3.3-2). Each study included observation of potential disturbances to targeted resources, as well as general habitat conditions within the study areas. Study leads reported that no substantial erosion was observed. Erosion was observed in the larger drainages entering the reservoir where seasonal flows would result in bank erosion of soils along the stream (e.g., Hatch Creek and Big Creek). Steep soil slopes in excess of 30 degrees also showed some signs of erosion, likely due to overland flow. In no case was erosion above the normal maximum water surface elevation observed to affect non-geologic resources, including special-status species or cultural resource sites.

DPRA personnel are tasked with constant observation of soil and reservoir conditions, and reporting major instances of erosion and soil movement. DPRA personnel patrol Don Pedro Reservoir daily during the recreation season, and all areas of the reservoir at weekly intervals during the off-season. Any observations potentially affecting sensitive resources or Don Pedro Project uses are designated for monitoring and/or management. However, no instances of substantial erosion or large/mass movement of soil are currently reported within the Project Boundary, and none have been observed in recent years (Russell 2013).

Table 3.3-2. Relicensing studies observing shoreline habitats.

Study	Study Name	Study Scope and Area[1]
CR-01	Historic Properties	Field survey. All lands within the Project Boundary that are (1) within 100 ft beyond the normal maximum water surface elevation (830 ft), (2) within designated facilities and formal recreation use areas, (3) within informal recreation use areas identified by the DPRA, (4) within the Red Hills ACEC, or (5) along the reservoir edge.
TR-01	Special-Status Plants	Field survey. Lands within the Project Boundary that are subject to O&M or recreation activities, including high-use shoreline areas, the Red Hills ACEC, and all facilities.
TR-02	ESA and CESA-listed Plants	Field survey. Lands within the Project Boundary that are subject to O&M or recreation activities, including high-use shoreline areas, the Red Hills ACEC, and all facilities.
TR-03	Wetlands	Field survey. Wetland and riparian habitats within ten drainages to Don Pedro Reservoir.
TR-04	Noxious Weeds	Field survey. Lands within the Project Boundary that are subject to O&M or recreation activities, including high-use shoreline areas, the Red Hills ACEC, and all facilities.
TR-05	ESA-listed Wildlife - VELB	Field survey. Lands within the Project Boundary that are subject to O&M or recreation activities, including high-use shoreline areas, the Red Hills ACEC, and all facilities, as well as wetland and riparian habitats within ten tributaries to Don Pedro Reservoir.
TR-06	Special-Status Amphibians and Reptiles	Field reconnaissance. Suitable aquatic habitats within the Project Boundary within 0.5 mi from the normal maximum water surface elevation of Don Pedro Reservoir, including accessible sections of the Tuolumne River, and tributaries up to 1.0 mi upstream of the reservoir.
TR-07	California Red-Legged Frog	Field reconnaissance. Suitable habitats within the Project Boundary and 1-mile surrounding radius.
TR-08	California Tiger Salamander	Field reconnaissance. Suitable habitats within the Project Boundary and 1.24-mile surrounding radius.
TR-09	Special-Status Bats	Field reconnaissance. All facilities and recreation areas.
TR-10	Bald Eagle	Project Boundary and 1000 ft buffer surrounding.

[1] Field surveys covered all lands within the study area using pedestrian survey methods. Reconnaissance surveys sampled the study area, targeting individual habitats.

3.3.2 Resource Effects

Page 35 of FERC's SD2 specifically identifies the following potential issues associated with geologic and soils resources:

- Effects of project operation and maintenance on soil erosion and shoreline erosion at the project reservoir and stream reaches
- Potential effects of any project-related changes in streamflow and sediment delivery to project stream reaches on stream geomorphic processes or reservoir bathymetry
- Potential effects of runoff from project roads and other hard surface runoff on erosion and sediment transport
- Potential effects of the use of project spillways and dam outlet facilities on soil erosion

- Potential effects of project operations on large woody debris distribution and recruitment
- Effects of project-related recreation to soil compaction or erosion

The Proposed Action would have no measureable impact on geology and soil resources in the Project Boundary. As a part of the Proposed Action, the Districts have proposed to lower the minimum pool from the current elevation of 600 ft. to 550 ft. The Districts would extend the existing riprap protection on the upstream face of Don Pedro Dam from the current elevation of 585 ft to elevation 535 ft. Bathymetric data do not indicate increased slope angles in these lower pool elevations; as a result no new soil movements or other effects to soils or geology are expected.

Don Pedro Project operations have the potential to directly affect resources within the Project Boundary; those effects related to geology and soils are discussed below. Additionally, the Don Pedro Project is one among many influences affecting resources of the lower Tuolumne River downstream of the Project Boundary. These potential cumulative effects, including those related to streamflow, sediment delivery, and woody debris, are addressed in Section 4 of this Exhibit E.

3.3.2.1 Shoreline Erosion, Spillway, and Outlet Works

The Proposed Action would have no measureable impact on erosion or shoreline resources. Water storage level changes over the water year can exceed 1 million AF, although they are normally less than about 700,000 AF from the normal low level, which occurs in October/November, to the normal high, which may occur in May, June, or July depending on the water year type. The effect of hydropower operations on reservoir water levels is limited to the daily shaping of flows. At the median reservoir level of 780 ft, a change in reservoir level of 0.15 ft (1.8 inches) would occur over a 16-hour summer day operating period, when compared to the off-peak flow occurring all day, and assuming no inflow to the reservoir.

The effects of the Don Pedro Project on erosion and shoreline resources are minor, limited in scope and degree, and do not affect other resources. Based on observations by DPRA staff and extensive relicensing studies covering the entirety of the reservoir shoreline, indicators of active shoreline erosion above the normal maximum water line are few within the Project Boundary, including at the three developed recreation sites. During completion of relicensing studies, no substantial erosion was observed above the normal maximum water line. Erosion was observed in the larger drainages entering the reservoir where seasonal flows result in bank erosion of soils along the stream (e.g., Hatch Creek and Big Creek). Steep soil slopes in excess of 30 degrees also showed some signs of erosion likely due to overland flow. In no case was erosion observed to be affecting any non-geologic resources, including special-status species or cultural resource sites, above the normal maximum water surface elevation.

Additionally, over 90% of the Don Pedro Reservoir shoreline is undeveloped, and geographically removed from any O&M activity. The reservoir shoreline is either federal land administered by the BLM or lands owned in fee and managed by the Districts; no development is permitted within the current Project Boundary except at the three developed recreation areas. DPRA strictly regulates shoreline uses and prohibits shoreline disturbances such as dredging, ORV use, and camping outside designated areas (DPRA 2001).

During daily operations, erosion related to the use of the spillway and dam outlet facilities is minimal, and not likely to result in any environmental effects. The spillway, founded on rock, discharges directly to a bedrock-confined channel, and the outlet works tunnel discharges into a bedrock-lined channel approximately 400 ft downstream of the powerhouse. The gulch downstream of the spillway channel is dry, except occasionally during seasonal rainy periods. Since the Don Pedro Project went into service, there have been two spill events, which occurred in January 1997, and February 2017. Outflows at the spillway in January 1997 exceeded 50,000 cfs. The use of the spillway in January 1997 resulted in considerable scour and erosion in Twin Gulch, the eventual receiving channel of flows released at the spillway. This event eroded approximately 500,000 yd^3 of sediment from the Twin Gulch channel below the spillway chute (McBain & Trush 2004). The effects to resources of this event and subsequent use of the spillway in February 2017 are unknown, but are believed to have been minor, as there were no known occurrences of special-status species in the vicinity of Twin Gulch Channel. Current terrestrial habitat assessments indicate poor habitat in the Twin Gulch channel and near the dam outlet works facilities.

3.3.2.2 Effects of Local Runoff and Recreation

Based on observations by DPRA staff and extensive relicensing studies covering the entirety of the reservoir shoreline, runoff related to road use and hard surfaces is minimal and not likely to result in any environmental effects. During completion of relicensing studies, no observations were made of detrimental effects of runoff to any resource study area. Additionally, the bulk of the roads within the Project Boundary are county roads not managed by the Districts. Roads and hard surfaces related to facilities and recreation sites are removed from streams and waterways, and no observations of runoff-related damage or erosion have been reported or were noted during relicensing consultations.

The Don Pedro Project includes three developed recreation areas that receive substantial use during much of the year. The recreation areas are largely unpaved, and the soils are typically compacted under existing conditions. Additionally, DPRA maintains a trail system in parts of the Project Boundary; these trails serve to focus recreational use on already-compacted lands. Outside these areas, Don Pedro Project lands receive little foot traffic and the majority of dispersed recreational uses are boat-based.

3.3.3 Proposed Resource Measures

No environmental measures are proposed related directly to geology and soil resources as there is no evidence of Project effects to sensitive resources due to erosion or soil/rock movement.

3.3.4 Unavoidable Adverse Impacts

Use of the Don Pedro Project spillway during flood conditions is an unavoidable effect that has occurred only twice since dam construction, but could occur in the future. Erosion in Twin Gulch downstream of the spillway channel is an unavoidable effect of the primary purposes of the Don Pedro Project, with little to no adverse impact because spill only occurs during extreme high water events and due to the lack of sensitive resources in Twin Gulch and the reach of the Tuolumne River between Don Pedro Dam and the La Grange Diversion Dam.

3.4 Water Resources

3.4.1 Existing Environment

The Tuolumne River originates in Tuolumne Meadows in Yosemite National Park from the confluence of headwater streams running off the slopes of Mount Lyell and Mount Dana, both over 13,000 ft in elevation. From there it flows roughly 140 miles–and loses about 8,000 ft in elevation–to its confluence with the San Joaquin River. Like other rivers of the Sierra Nevada that flow west to the Central Valley, the Tuolumne River has a long history of development and use, dating back to the mid-1800s. Many small dams were built on the river as early as the 1850s, such as those built by the Jacksonville Damming Company formed in 1850 "[t]o change the present course of the Tuolumne River, above and below Wood's Creek"[11] to facilitate in-channel gold mining operations. The first major dam constructed on the Tuolumne River–Wheaton Dam–was completed in 1871 near the location of the current La Grange Diversion Dam. Wheaton Dam was used to divert flow for irrigation and domestic use (see Section 4.0 of this AFLA for a detailed account of the history of water management in the Tuolumne River basin).

Community interest in developing the water resources of the Tuolumne River extends back to 1887, when TID and MID became the first two entities in California to organize as irrigation districts under the 1887 Wright Act. Three years later, in 1890, the Districts agreed to build a jointly-owned diversion dam, La Grange Diversion Dam, which was put into service in 1893. The Districts completed construction of the original Don Pedro Dam in 1923 at a location approximately 1.5 miles upstream of the present Don Pedro Dam.

The City of San Francisco's interests in using the waters of the Tuolumne River date back to 1901 when the city first announced plans to build a dam in Hetch Hetchy Valley, culminating in the construction of O'Shaughnessy Dam in 1923. Major water resource projects continued to be built in the watershed through the 1970s (e.g., Cherry Dam in 1955; Kirkwood powerhouse in 1967; new Don Pedro Dam in 1971). TID, MID, and CCSF have been involved in managing the waters of the Tuolumne River for over 100 years.

The Don Pedro Project Boundary extends from RM 53.2 to RM 80.8. Don Pedro Reservoir extends upstream from Don Pedro Dam (located at RM 54.8) for approximately 24 miles at the normal maximum water surface elevation of 830 ft. The surface area of the reservoir at this elevation is approximately 12,960 ac, and the reservoir shoreline, including the numerous islands within the lake, is approximately 160 miles long. The watershed upstream of Don Pedro Dam is approximately 1,533 mi^2.

[11] A History of Tuolumne County, 1882, p. 51.

3.4.1.1 Water Resources Studies Conducted During Relicensing

Water Quality Study

The goals of the Water Quality Assessment Study (TID/MID 2013a) were to (1) characterize existing water quality conditions within Don Pedro Reservoir, downstream of Don Pedro Dam at the point of the Don Pedro Project discharge, and just downstream of La Grange Diversion Dam, and (2) evaluate the consistency of existing water quality conditions with the CVRWQCB's Basin Plan Objectives (CVRWQCB 1998).

Tuolumne River Operations Model

The Tuolumne River Operations Model (Operations Model) (TID/MID 2017d) was developed to simulate (1) Don Pedro Project operations and Hetch Hetchy water supply operations for a period of analysis that covers a range of historical hydrologic conditions and (2) alternative operating scenarios and their effects on hydropower generation, downstream flows, and water supplies to the Districts and CCSF's Bay Area customers. The Operations Model is able to simulate basic decisions made which affect Don Pedro flood management, water supply, lower river releases, reservoir levels, and hydropower generation. More specifically, objectives for the Operations Model include, (1) adequate reproduction of observed Don Pedro reservoir levels, reservoir releases, and hydropower generation, within acceptable calibration standards over a range of hydrologic conditions, (2) providing output to inform other studies, analyses, and models, and (3) evaluating alternative operations scenarios to estimate effects on reservoir levels, reservoir releases, and hydropower generation.

The geographic scope of the Operations Model on the Tuolumne River extends from CCSF's Hetch Hetchy system through the Districts' Don Pedro Reservoir, and then from Don Pedro Dam to the Tuolumne River's confluence with the San Joaquin River. Hydrologic records of Tuolumne River flows at the La Grange gage have been recorded by the Districts and CCSF dating back to the early 1900s to implement and monitor the provisions of the Raker Act and 4th Agreement between the Districts and CCSF regarding the allocation of Tuolumne River flows.

Within this scope, the Operations Model also depicts the water supply operations of the Hetch Hetchy system including reservoir levels, outflows, and flows in the San Joaquin Pipeline providing water to the Bay Area. Under certain circumstances, the Districts and CCSF share responsibility for meeting FERC license requirements in the lower Tuolumne River downstream of the Don Pedro Project. Further information about shared responsibility for instream flows is provided in Section 5.0 of this Exhibit.

Reservoir Temperature Model

The goal of the Reservoir Temperature Model Study (TID/MID 2017e) is to develop a model that simulates and characterizes the seasonal water temperature dynamics experienced in Don Pedro Reservoir under current and alternative future conditions. The model (1) reproduces observed reservoir temperatures, within acceptable calibration standards, over a range of hydrologic conditions, (2) provides output that can inform other studies, analyses, and models, and (3) predicts potential changes in reservoir thermal conditions under alternative operating scenarios. The study area for the reservoir temperature model consists of Don Pedro Reservoir, extending from about elevation 300 ft to about elevation 850 ft, or from the tailwater of Don Pedro powerhouse to about 20 ft above the Don Pedro Reservoir normal maximum reservoir elevation of 830 ft. The complex physical geometry and setting of the reservoir, including the continued existence of the old Don Pedro Dam, required the use of a three-dimensional representation of the reservoir and its behavior over a full range of conditions.

Lower Tuolumne River Temperature Model

The Lower Tuolumne River Temperature Model (TID/MID 2017b) simulates existing water temperature conditions in the lower Tuolumne River from below Don Pedro Dam (RM 54.8) to the confluence with the San Joaquin River (RM 0). The model is also able to estimate river temperature conditions under alternative Don Pedro Project operations scenarios. The model simulates the temperature regime of the lower river for the 1971-2012 period, consistent with the period of record of the Tuolumne River Operations Model. The lower river temperature model was developed to address the following specific objectives: (1) reproduce observed river water temperatures, within reasonable calibration standards, over the range of hydrologic conditions, (2) evaluate sensitivity of water temperatures to Tuolumne River-specific flow and meteorological conditions, (3) provide output to inform other studies, analyses, and models, and (4) predict potential changes in river temperature under alternative operating scenarios. The study area includes the Tuolumne River from the outlet of the Don Pedro Project at an elevation of approximately 300 ft to the Tuolumne River's confluence with the San Joaquin River at elevation 35 ft. The total drainage area and reach length of the study area are approximately 430 mi^2 and 54 river miles, respectively. There is one major tributary in this reach, Dry Creek, which joins the lower Tuolumne River at RM 16. Dry Creek has a drainage area of approximately 204 mi^2, accounting for nearly half of the total drainage area encompassed by the model.

In 2013, the Districts supplemented the already-extensive water temperature data collection activities with additional temperature data collection. This study, entitled *In-River Diurnal Temperature Variation Study*, was conducted to investigate the occurrence of large changes in diurnal temperature variation which were observed to occur over very short distances at certain locations along the lower Tuolumne River. The study involved establishment of a high-density network of thermologgers at specific locations along the river, and monitoring river temperatures from July 1 through at least September 30, 2013. The report on this study is being issued with this license application.

Development of Tuolumne River Flow and Temperature Without Dams Model (Jayasundara et al. 2017)

The purpose of the Development of Tuolumne River Flow and Temperature Without Dams Model (Jayasundara et al. 2017) is to develop a flow and water temperature model to simulate water temperatures in the Tuolumne River without the existing Hetch Hetchy (including Cherry and Eleanor reservoirs), Don Pedro, and La Grange projects in place. The model was developed to complement detailed models developed for Don Pedro Reservoir and La Grange headpond (TID/MID 2017d) and the lower Tuolumne River (TID/MID 2017b). Supporting data included the development of long-term flow and meteorological conditions to assess flow and water temperatures over a multi-decade period, i.e., 1970 to 2012. In its December 2011 Study Plan Determination, FERC indicated that EPA (2003) temperature guidelines would apply to the lower Tuolumne River, unless empirical information could be developed specific to the Tuolumne River to inform potential alternative water temperature considerations. The "without dams" model developed by this study provides such information, as do other studies completed during the relicensing process.

Model Integration

The Tuolumne River Operations Model, Don Pedro Reservoir Temperature Model, and Lower Tuolumne River Temperature Model form an integrated system of river- and reservoir-specific models for developing "Base Case" conditions (i.e., existing baseline as defined by FERC) and evaluating alternative Don Pedro Project operation scenarios. The Operations Model establishes reservoir inflows, outflows, and water levels. Output from the Operations Model acts as input to the reservoir temperature model, which in turn provides reservoir outflow temperatures as an input to the river temperature model. The operations model and the river temperature model also provide input to the Tuolumne River Chinook (TID/MID 2017a) and *Oncorhynchus mykiss* (TID/MID 2017c) population models. The population models are described in detail in Section 3.5 of this Exhibit E.

3.4.1.2 Water Quantity

Drainage Area

The Tuolumne River can be divided into three subbasins: the upper Tuolumne River, the Project Boundary, and the lower Tuolumne River. Table 3.4-1 provides the approximate drainage areas and lengths of reaches in these subbasins.

Table 3.4-1. Drainage areas and lengths of Tuolumne River subbasins.

Subbasin	Length of Reach (miles)	Drainage Area (mi^2)	Total Upstream Drainage Area (mi^2)
Upper Tuolumne River	60	1,300	1,300
Project Boundary	28	230	1,530
Lower Tuolumne River	53	430	1,960
Total	141	1,960	NA

The upper Tuolumne River includes the Hetch Hetchy Reservoir watershed (459 mi^2) and the Cherry Lake/Lake Eleanor Reservoir (Cherry/Eleanor) watershed (193 mi^2). Hetch Hetchy Reservoir has a normal pool elevation of about 3,800 ft, Cherry Lake has a normal pool elevation of 4,700 ft, and Lake Eleanor has a normal pool elevation of 4,657 ft. The Don Pedro Project Boundary is at elevation 845 ft.

Climate

The climate and hydrology of the Tuolumne River basin varies considerably over the river's length. Annual precipitation in the high elevations of the watershed, above 10,000 ft, exceeds 60 inches per year, occurring mostly as snow, while less than 100 miles away in the Central Valley, the annual precipitation is less than 12 inches. In addition to the geographic variation in precipitation, the seasonal and annual variations are also extreme. In the lower reaches of the river, the average precipitation from May through September, inclusive, is less than 1 inch. Year-to-year variation is also dramatic. During the period of WY 1971–2012, the lowest estimated unimpaired flow at the La Grange gage was 382,000 AF (WY 1977) compared to a high of 4.6 million AF (WY 1983), i.e., an inter-annual range that varies by a factor of 12. Another characteristic of the basin's hydrology is that dry and wet years often come in multi-year, back-to-back periods. The third driest year in the WY 1971–2012 period was WY 1976 (672,000 AF), the year before the driest year of WY 1977, and the third wettest year was WY 1982 (3.8 million AF), the year before the wettest year of WY 1983.

Temperature and precipitation statistics for the Tuolumne River basin are provided in Table 3.4-2, and evapotranspiration rates along the lower Tuolumne River are shown in Figure 3.4-1. About 88 percent of the annual precipitation occurs from November through April. Precipitation usually occurs as rain at elevations below 4,000 ft and as snow at higher elevations. Snow cover below 5,000 ft is generally transient and may accumulate and melt several times during a winter season. Normally snow accumulates at higher elevations until about April 1, when the melt rate begins to exceed snowfall. The statistics in Table 3.4-2 also demonstrate why agriculture in the Central Valley is dependent upon irrigation. Average precipitation during the hot summer months of May through September is less than one inch.

Table 3.4-2. Monthly climatological data for the Tuolumne River watershed.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Downstream of Don Pedro Project MODESTO, CALIFORNIA (WRCC Station No. 045738) Period of Record : 1/ 1/1931 to 12/31/2005, Approx. Elevation: 90 ft												
Avg. High (°F)	54°	61°	67°	73°	81°	88°	94°	92°	88°	78°	64°	54°
Avg. Low (°F)	38°	41°	44°	47°	52°	56°	60°	59°	56°	50°	42°	38°
Mean (°F)	46°	51°	55°	60°	66°	72°	77°	75°	72°	64°	53°	46°
Avg. Rainfall (in)	2.4	2.1	2.0	1.1	0.5	0.1	0	0	0.2	0.6	1.3	2.1
Avg. snowfall (in)	0	0	0	0	0	0	0	0	0	0	0	0
Near Don Pedro Project Boundary SONORA Ranger Station, CALIFORNIA (WRCC Station No. 048353) Period of Record : 1/11/1931 to 12/31/2005, Approx. Elevation: 1,750 ft												
Avg. High (°F)	55°	58°	62°	68°	77°	87°	95°	94°	88°	77°	64°	56°
Avg. Low (°F)	33°	35°	38°	41°	47°	52°	58°	57°	53°	45°	37°	33°
Mean (°F)	44°	47°	50°	55°	62°	69°	77°	75°	70°	61°	51°	45°
Avg. Precipitation (in)	6.1	5.7	4.8	2.7	1.2	0.3	0.1	0.1	0.5	1.7	3.6	5.5
Avg. Snowfall (in)	1.6	0.8	0.4	0.2	0	0	0	0	0	0	0	0.5
Upper Tuolumne River Basin HETCH HETCHY, CALIFORNIA (WRCC Station No. 043939) Period of Record : 1/ 7/1931 to 12/31/2005, Approx. Elevation: 3,780 ft												
Avg. High (°F)	48°	52°	57°	63°	70°	78°	86°	86°	81°	71°	58°	49°
Avg. Low (°F)	29°	30°	33°	37°	43°	50°	56°	55°	51°	42°	34°	30°
Mean (°F)	38°	41°	45°	50°	57°	64°	71°	71°	66°	57°	46°	39°
Avg. Precipitation (in)	6.0	5.7	5.2	3.3	1.9	0.8	0.2	0.2	0.7	2.0	4.2	5.9
Avg. Snowfall (in)	15.2	12.9	14.7	6.3	0.3	0	0	0	0	0.1	2.7	11.7

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
High-Sierra Nevada Climate (north of Tuolumne River watershed) TWIN LAKES, CALIFORNIA (WRCC Station No. 049105) Period of Record : 7/ 1/1948 to 8/31/2000, Approx. Elevation: 8,000 feet												
Avg. High (°F)	38°	40°	41°	47°	54°	63°	71°	70°	65°	56°	45°	39°
Avg. Low (°F)	16°	16°	18°	22°	29°	36°	43°	42°	39°	31°	23°	18°
Mean (°F)	27°	28°	30°	34°	42°	49°	57°	56°	52°	44°	34°	29°
Avg. Precipitation (in)	9.0	7.3	6.7	3.9	2.5	1.1	0.7	0.7	1.2	2.6	6.1	7.8
Avg. Snowfall (in)	79.5	73.3	75.9	36.6	14.5	2.3	0	0.2	1.1	10.3	40.9	66.4

Source: Western Regional Climate Center 2006 - http://www.wrcc.dri.edu/summary/climsmnca.html.

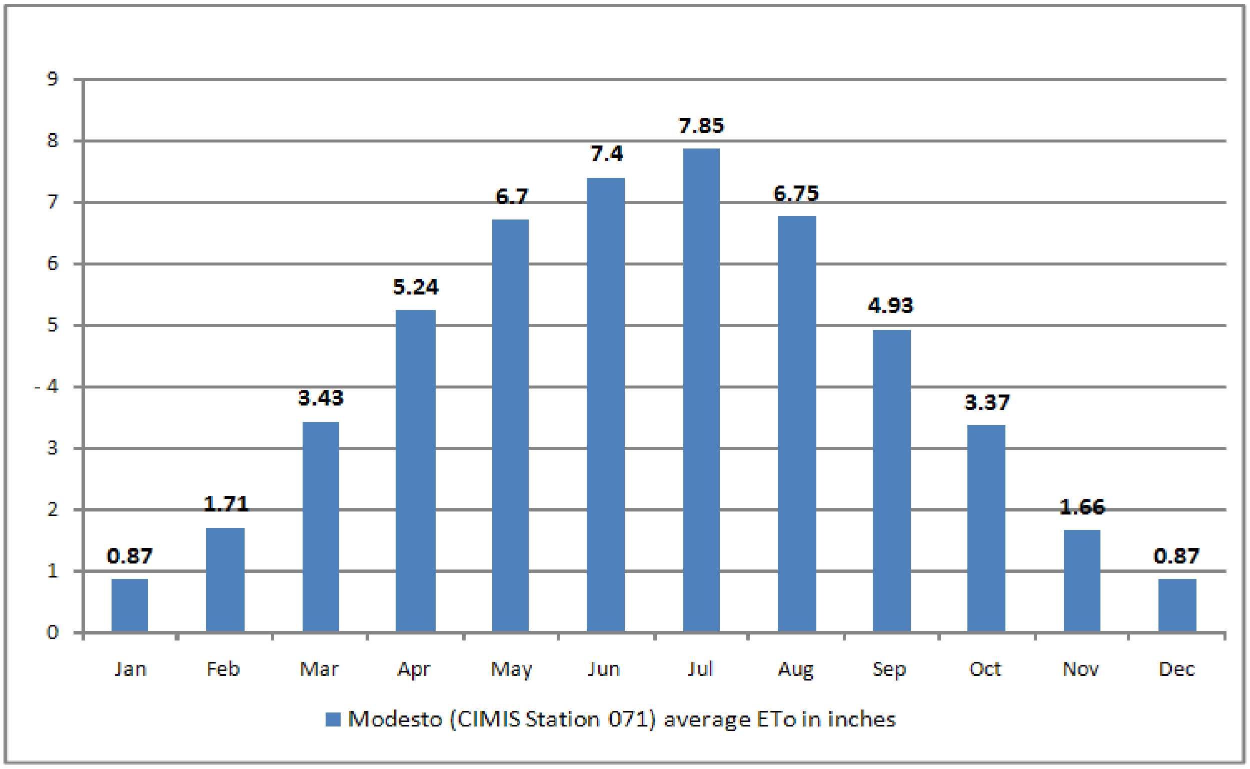

Figure 3.4-1. Modesto monthly average evapotranspiration rates (ETo in inches), June 1987 to present.

Source: California Department of Water Resources (CDWR) 2013

General Description of Basin Hydrology

The hydrologic characteristics of the Tuolumne River and its tributaries vary significantly from its headwaters to its terminus at the San Joaquin River. Above about 5,000 ft, the Tuolumne River and its tributaries are snowmelt-dominated. Smaller streams in this area may have extremely low summer flows, although groundwater and interflow may continue to provide small amounts of late summer flows. Approximately 75 percent of the runoff in these areas occurs between April and July, with 20 percent or less occurring from December through March, and as little as 5 percent occurring from August through November (ACOE 1972).

In the middle elevations, more precipitation occurs as rainfall, and there can be multiple rain-on-snow periods each year. Several reservoirs are located in this middle-elevation band upstream of the Don Pedro Project, from 3,000 to 5,000 ft elevation (Hetch Hetchy Water and Power [HHWP] 2006 [San Francisco Public Utilities Commission (SFPUC), HHWP, MAH 010721, BJM Rev 070626, undated]). Much of the runoff in these elevations occurs from December through March during winter rains, with much of the remaining runoff occurring from April through July (ACOE 1972).

The Tuolumne River derives much of its flow from snowmelt. Using estimates of natural flow, Don Pedro Reservoir would normally receive about 88 percent of its inflow from January through July. However, because of upstream regulation, the pattern of inflow does not reflect a typical snow-melt driven hydrograph. Some low-elevation, unregulated, rain-driven tributaries flow directly into Don Pedro Reservoir, but these streams provide only a small fraction of the annual flow to the reservoir. The average annual flow of the Tuolumne River at Don Pedro Reservoir is approximately 1.7 million AF. Flood flows in the Don Pedro Project area can be the result of heavy rains, rain-on-snow (mainly in winter and early spring), and/or snowmelt-floods (mostly in spring through early summer). Consequently, the ACOE Flood Control Manual for the Don Pedro Project requires the maintenance of a flood envelope of 340,000 AF from October 7 through April 27 and conditional flood space thereafter depending on the anticipated snowmelt runoff during April, May, and June (ACOE 1972). Details on flood control operations are provided in Exhibit B of this AFLA.

Downstream of the Don Pedro Project, water flows from the Don Pedro powerhouse or outlet works tunnel into the Tuolumne River and then into the impoundment formed by La Grange Diversion Dam, a non-project diversion dam owned by the Districts[12]. Downstream of La Grange Diversion Dam, the Tuolumne River becomes a meandering stream, with an average gradient of about 2 ft/mile, in contrast to the upper Tuolumne where gradients can exceed 100 ft/mile. In the lower Tuolumne River valley, around 75 percent of the annual runoff occurs during rainstorms between December and March (ACOE 1972). Some flow in this area is derived from groundwater, but the groundwater contribution has not been well quantified. Based on accretion flow measurements taken during the relicensing process, the lower Tuolumne River is considered to be generally a gaining stream (TID/MID 2017d, Attachment A, Appendix B).

Hydrology Upstream of Don Pedro Reservoir

There are a number of streamflow gages on the upper Tuolumne River, either presently maintained or historical that account for much of the data about the contributing watershed to the Don Pedro Reservoir (Table 3.4-3). In particular, there are four locations of streamflow measurement below the last points of regulation on the mainstem Tuolumne or its larger tributaries upstream of the Project Boundary. The sum of these four gages constitutes the flow from the majority of the Tuolumne River watershed. Approximately 875 mi^2 of the 1,300 mi^2 of the watershed upstream of Don Pedro Reservoir is accounted for by these four gages: Tuolumne River Below Early Intake Near Mather, Cherry Creek Below Dion R Holm PH, South Fork

[12] In its SD2, FERC states that "The Districts' powerhouse, pipeline, canals and other facilities associated with La Grange dam are not part of the existing license for the Don Pedro Project nor are they included within the project boundary of the existing license." And, "…the Don Pedro Project is a complete unit of development, separate and distinct from La Grange Dam. Since the Districts have all the rights necessary or appropriate for the operation and maintenance of the project, there is no basis for requiring that La Grange Dam be included in the new license for the Don Pedro Project." On December 19, 2012, FERC staff issued an order finding licensing required for the unlicensed La Grange Hydroelectric Project (141 FERC 62,211 (2012)).

Tuolumne River Near Oakland Recreation Camp, and Middle Tuolumne River At Oakland Recreation Camp. Some regulation by smaller reservoirs occurs on Sullivan Creek and Big Creek (USGS 2008), but the regulation of Cherry and Eleanor creeks and the upper mainstem Tuolumne River constitutes the majority of regulation on the upper Tuolumne River.

Table 3.4-3. Flow and storage gages in the Tuolumne River watershed.[1]

Gage Number	Gage Name	Period of Record[2]	Notes
Relevant Streamflow Gages Upstream of Don Pedro Reservoir			
11276500	Tuolumne River Near Hetch Hetchy CA	10/1/1910-present	Located downstream of CCSF's Hetch Hetchy Reservoir. Period of record spans period of construction of O'Shaughnessy Dam
11276900	Tuolumne River Below Early Intake Near Mather CA	10/1/1966-present	Downstream of Hetch Hetchy and Kirkwood Powerhouse
11278400	Cherry Creek Below Dion R Holm PH, Near Mather CA	4/1/1963-present	--
11281000	South Fork Tuolumne River Near Oakland Recreation Camp CA	4/1/1923-9/30/2002; 1/27/2009-present	Gage re-installed in 2006 by CCSF HHWP, but data after 2002 are not reported on USGS. Recent data available through CDEC
11282000	Middle Tuolumne River At Oakland Recreation Camp CA	10/1/1916-9/30/2002; 1/28/2009-present	Gage re-installed in 2009 by CCSF HHWP, but data after 2002 are not reported on USGS. Recent data available through CDEC
Don Pedro Reservoir Gage			
11287500	Don Pedro Reservoir Near La Grange CA	1923-present	The period 1923-1970 reflects original Don Pedro Reservoir storage (max. 290,400 AF)
Relevant Streamflow Gages Downstream of Don Pedro Reservoir			
11289650	Tuolumne River Below La Grange Diversion Dam Near La Grange CA	12/1/1970-present	Flow and temperature (from 11/10/1970)
11289000	Modesto Canal Near La Grange CA	12/1/1970-present	--
11289500	Turlock Canal Near La Grange CA	12/1/1970-present	--
11289651	Combined Flow Tuolumne River, Modesto Canal + Turlock Canal CA	10/1/1970-present	--
11290000	Tuolumne River At Modesto CA	present	Location of 9,000 cfs restriction

1 All gage information is taken from the USGS National Water Information System (NWIS), and data from these locations is available to the public at: http://waterdata.usgs.gov.
2 Note that some gages, particularly those with long-term records, may have missing data.

Relevant data from US Geological Survey (USGS) are presented below for the Tuolumne River below CCSF's Early Intake and Kirkwood powerhouse; Cherry Creek below CCSF's Cherry Lake, Lake Eleanor, and Holm Powerhouse; and the South Fork and Middle Fork Tuolumne rivers near their confluences with the mainstem Tuolumne River.

Tuolumne River Below Early Intake, Near Mather, California (USGS Gage No. 11276900)

This location represents the flow in the mainstem Tuolumne River below Hetch Hetchy Reservoir plus discharges from Robert C. Kirkwood Powerhouse that is not diverted to CCSF's Mountain Tunnel (Table 3.4-4).

Table 3.4-4. Mean monthly flows for the 1975-2012 period for Tuolumne River below Early Intake (RM 105.5).

Month	Mean Monthly Flow (cfs)	Lowest Mean Monthly Flow (cfs)	Highest Mean Monthly Flow (cfs)
Jan	264	31	2917
Feb	314	35	1039
Mar	436	38	1145
Apr	597	34	1694
May	1619	52	4028
Jun	2077	37	6260
Jul	1006	30	5530
Aug	227	31	1726
Sep	114	29	370
Oct	77	30	247
Nov	95	35	313
Dec	168	29	1169

Source: USGS 11276900.

Cherry Creek below Dion R. Holm Powerhouse, Near Mather, California (USGS Gage No. 11278400)

This gage is located immediately downstream of the Dion R. Holm powerhouse about 600 ft upstream of the confluence of Cherry Creek with the Tuolumne River and represents nearly the full regulated flow of Cherry Creek (Table 3.4-5). Cherry Creek and its tributary, Eleanor Creek, both have regulating reservoirs upstream of this point. Cherry Creek enters the Tuolumne River at RM 104.

Table 3.4-5. Mean monthly flows for the 1975-2012 period for Cherry Creek below Dion R. Holm powerhouse.

Month	Mean Monthly Flow (cfs)	Lowest Mean Monthly Flow (cfs)	Highest Mean Monthly Flow (cfs)
Jan	610	4	3266
Feb	703	4	1528
Mar	834	4	1497
Apr	1008	3	2199
May	1321	3	3768
Jun	1257	4	3728
Jul	746	11	2643
Aug	467	26	1161
Sep	380	20	898
Oct	341	13	962
Nov	365	15	1445
Dec	473	6	1394

Source: USGS 11278400.

South Fork Tuolumne River near Oakland Recreation Camp, CA (USGS Gage No. 11281000)

Historical data are available at this USGS gage for the period of 1923–2002 (Table 3.4-6). Measurement at this gage was discontinued at the end of September 2002, but the gage was reinstalled by CCSF in 2006. Data are now reported on the California Data Exchange Center (CDEC) website. There are no known diversions in this watershed. The South Fork enters the Tuolumne River at RM 97.5.

Table 3.4-6. Mean monthly flows for the 1975-2012 period for South Fork Tuolumne River near Oakland Recreation Camp.

Month	Mean Monthly Flow (cfs)	Lowest Mean Monthly Flow (cfs)	Highest Mean Monthly Flow (cfs)
Jan	98	8	429
Feb	164	9	725
Mar	207	11	750
Apr	222	16	730
May	246	26	654
Jun	143	13	656
Jul	44	3	242
Aug	14	0	58
Sep	11	1	39
Oct	14	2	51
Nov	32	6	211
Dec	52	6	416

Source: USGS 11281000; CCSF HHWP.

Middle Fork Tuolumne River at Oakland Recreation Camp, CA (USGS Gage No. 11282000)

Historical data are available at this USGS gage for the period of 1923–2002 (Table 3.4-7). Measurement at this gage was discontinued at the end of September 2002, but the gage was reinstalled by CCSF in 2006. Data are now reported on the CDEC website. There are no known diversions on this stream.

Table 3.4-7. Mean monthly flows for the 1975-2012 period for Middle Fork Tuolumne River at Oakland Recreation Camp.

Month	Mean Monthly Flow (cfs)	Lowest Mean Monthly Flow (cfs)	Highest Mean Monthly Flow (cfs)
Jan	51	2	218
Feb	87	4	345
Mar	115	5	354
Apr	170	17	476
May	285	24	598
Jun	205	11	875
Jul	57	1	361
Aug	10	0	61
Sep	6	0	27
Oct	7	0	37
Nov	18	2	138
Dec	27	2	234

Source: USGS 11282000; CCSF HHWP.

Hydrology within the Project Boundary

Inflows to Don Pedro Reservoir are affected by upstream water management, particularly that associated with CCSF's Hetch Hetchy development. Outflows from Don Pedro Dam reflect real-time operations by the Districts to manage flows in accordance with storage requirements, ACOE flood control guidelines, and diversions for irrigation and M&I uses (i.e., the primary Don Pedro Project purposes, as described in Exhibit B of this AFLA). Water releases are also provided to benefit fish and aquatic resources in the lower Tuolumne River, as contained in the current FERC license. Table 3.4-8 shows Don Pedro outflows since the first full calendar year following the 1996 FERC order incorporating terms of the 1995 Settlement Agreement.

Hydrology of the Lower Tuolumne River

Flows in the lower Tuolumne River above La Grange Diversion Dam are reported at three USGS gages: nos. 11289650, 11289000, and 11289500 (Table 3.4-8). The data are combined to estimate total flow releases from the Don Pedro Project (Table 3.4-9). Records for these locations are available from the USGS NWIS website for October 1, 1970 to September 30, 2012. Flow data continue to be reported by USGS and are updated at least annually. The mean annual flow at this location since completion of reservoir filling is 2,300 cfs (WY 1975-2012).

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Table 3.4-8. Don Pedro Project mean monthly outflows (cfs) 1997-2012.

	Monthly mean flow (cfs)[1]																		
Month	**1997[2]**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Mean monthly flow (cfs)**	**Highest mean monthly flow (cfs)**	**Lowest mean monthly flow (cfs)**
USGS 11289650 - Tuolumne River Below La Grange Diversion Dam Near La Grange, CA (cfs)																			
Jan	13,070	2,114	1,247	324	325	177	184	223	187	4,456	353	171	165	232	4,096	342	1,729	13,070***	165
Feb	8,116	6,168	4,903	2,284	1,273	172	185	220	1,823	2,373	358	173	168	225	3,176	340	1,997	8,116***	168
Mar	2,443	5,407	3,285	4,602	615	165	182	1,098	3,875	4,234	357	172	169	284	5,142	323	2,022	5,407	165
Apr	1,457	5,392	2,034	1,548	558	665	685	1,010	4,524	7,436	487	533	372	1,342	7,400	271	2,232	7,436	271
May	953	3,621	1,697	1,164	706	419	477	412	4,868	7,847	385	680	687	2,706	3,396	798	1,926	7,847	385
Jun	269	4,433	284	340	54	97	234	127	3,809	4,657	127	95	149	2,555	5,027	134	1,399	5,027	54
Jul	290	2,845	287	421	89	88	243	108	1,913	834	114	93	107	813	2,132	107	655	2,845	88
Aug	287	1,019	259	603	110	86	236	106	773	584	110	99	102	316	2,498	104	467	2,498	86
Sep	285	1,423	294	473	112	68	250	110	328	412	89	97	106	308	1,197	102	365	1,423	68
Oct	465	628	424	412	189	202	297	209	464	449	141	174	385	491	491		367	628	141
Nov	380	316	338	347	184	191	231	186	369	379	174	161	255	399	366	In WY	292	399	161
Dec	330	1,321	336	334	177	187	226	178	1,285	352	169	164	256	4,152	366	2013	904	4,625	164
USGS 11289000 - Modesto Canal Near La Grange, CA (cfs)																			
Jan	6	117	66	237	72	40	76	87	83	143	9	27	31	16	34	358	88	358	6
Feb	168	56	47	72	142	67	58	44	204	135	113	45	29	11	93	69	84	204	11
Mar	642	121	301	231	213	434	328	355	260	142	348	346	219	253	96	340	289	642	96
Apr	601	250	630	586	607	720	325	720	450	249	483	575	474	337	453	275	483	720	249
May	872	310	697	659	773	724	605	653	665	716	682	656	573	533	674	736	658	872	310
Jun	701	655	769	733	802	791	801	751	695	802	763	646	716	769	708	767	742	802	646
Jul	962	787	781	915	905	891	894	825	1,043	846	803	748	791	704	761	869	845	1,043	704
Aug	813	869	927	878	767	707	825	704	827	824	781	793	721	754	858	764	801	927	704
Sep	550	482	566	474	567	583	525	461	604	594	411	506	474	482	589	453	520	604	411
Oct	347	344	334	293	387	358	380	270	299	304	321	301	266	271	233		314	387	233
Nov	78	73	195	44	36	105	172	84	141	173	162	100	112	184	169	In WY	122	195	36
Dec	26	86	72	75	72	58	13	43	126	8	9	18	2	0	0	2013	40	126	0
USGS 11289500 - Turlock Canal Near La Grange, CA (cfs)																			
Jan	387	69	506	0	91	27	6	25	316	299	164	4	82	108	301	581	185	581	0
Feb	599	326	313	0	8	6	323	302	339	529	257	101	151	180	190	202	239	599	0
Mar	1,457	454	623	603	595	1,023	637	1,035	872	644	1,113	1,132	601	601	581	477	778	1,457	454
Apr	1,222	699	1,304	1,135	1,110	1,249	771	1,272	1,184	529	1,082	866	1,013	712	1,070	623	990	1,304	529
May	1,710	800	1,321	1,246	1,455	1,121	1,073	1,336	1,256	1,339	1,166	1,136	1,021	1,171	1,145	1,248	1,222	1,710	800
Jun	1,445	1,243	1,525	1,725	1,664	1,483	1,639	1,552	1,504	1,624	1,599	1,310	1,525	1,569	1,398	1,425	1,514	1,725	1,243

Month	Monthly mean flow (cfs)[1]																Mean monthly flow (cfs)	Highest mean monthly flow (cfs)	Lowest mean monthly flow (cfs)
	1997[2]	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012			
Jul	2,081	1,817	1,938	1,898	1,805	1,817	1,883	1,840	1,917	2,000	1,816	1,572	1,899	1,846	1,845	1,788	1,860	2,081	1,572
Aug	1,587	1,681	1,796	1,784	1,526	1,489	1,516	1,510	1,706	1,674	1,494	1,314	1,482	1,656	1,718	1,510	1,597	1,796	1,314
Sep	812	977	952	1,063	825	736	714	617	991	936	631	571	793	1,097	1,069	953	847	1,097	571
Oct	505	613	566	527	445	358	742	577	259	379	305	129	180	430	533	In WY 2013	442	742	129
Nov	30	0	59	24	4	22	1	1	3	8	35	2	27	279	95		37	279	0
Dec	109	0	301	173	12	94	36	12	27	1	45	149	20	600	29		102	600	0
USGS 11289651 - Combined Flow Tuolumne River + Modesto Canal + Turlock Canal (~ total Don Pedro Project outflow)[3] (cfs)																			
Jan	13,630	2,301	1,818	561	489	244	266	335	585	4,897	525	203	278	355	4,430	1,282	2,012	13,630	203
Feb	8,885	6,551	5,262	2,355	1,424	245	565	566	2,365	3,038	728	320	348	415	3,458	611	2,321	8,885	245
Mar	4,544	5,983	4,210	5,435	1,423	1,622	1,146	2,487	5,005	5,020	1,818	1,651	989	1,139	5,818	1,142	3,090	5,983	989
Apr	3,280	6,341	3,968	3,269	2,276	2,634	1,781	3,001	6,158	8,211	2,052	1,973	1,860	2,392	8,922	1,168	3,705	8,922	1,168
May	3,535	4,732	3,714	3,067	2,935	2,263	2,155	2,402	6,790	9,902	2,234	2,472	2,280	4,408	5,216	2,783	3,806	9,902	2,155
Jun	2,415	6,332	2,579	2,796	2,519	2,371	2,672	2,430	6,009	7,083	2,488	2,049	2,391	4,894	7,134	2,328	3,656	7,134	2,049
Jul	3,333	5,448	3,006	3,234	2,798	2,795	3,021	2,772	4,872	3,678	2,732	2,414	2,798	3,363	4,738	2,766	3,361	5,448	2,414
Aug	2,687	3,569	2,982	3,264	2,403	2,281	2,578	2,319	3,305	3,082	2,385	2,205	2,304	2,725	5,074	2,377	2,846	5,074	2,205
Sep	1,647	2,882	1,812	2,009	1,504	1,386	1,489	1,188	1,922	1,942	1,130	1,175	1,371	1,888	2,855	1,509	1,732	2,882	1,130
Oct	1,318	1,584	1,324	1,231	1,021	917	1,419	1,055	1,021	1,133	766	604	832	1,193	1,258	In WY 2013	1,141	1,587	604
Nov	489	389	592	415	224	318	404	270	513	559	371	263	394	862	630		443	862	224
Dec	466	1,407	709	582	261	339	275	233	1,437	361	223	330	277	4,752	394		1,043	4,752	223

[1] Values Calculated using USGS NWIS monthly statistics module: http://waterdata.usgs.gov/nwis/nwisman/?site_no=11289650&agency_cd=USGS, http://waterdata.usgs.gov/nwis/nwisman/?site_no=11289000&agency_cd=USGS, http://waterdata.usgs.gov/nwis/nwisman/?site_no=11289500&agency_cd=USGS, and http://waterdata.usgs.gov/nwis/nwisman/?site_no=11289651&agency_cd=USGS

[2] The flood of record occurred in January, 1997, with high reservoir releases continuing on into February, 1997. These values skew the January and February mean monthly flow averages for the 1997 to 2012 period. Without 1997 values, the mean monthly flow in January is 973 cfs and February is 1,589, compared to 1,729 and 1,997 cfs, respectively.

[3] Some values rounded by USGS - sum of individual gage monthly mean flows may not precisely equal combined gage monthly mean flows.

Table 3.4-9. Mean monthly flows for the 1975-2012 period for lower Tuolumne River above La Grange Diversion Dam

Month	Below La Grange Diversion Dam (cfs)	Modesto Canal near La Grange (cfs)	Turlock Canal near La Grange (cfs)	Don Pedro Project Release (cfs)
Jan	1491	74	140	1705
Feb	1812	66	183	2061
Mar	1952	267	604	2823
Apr	1962	543	1069	3574
May	1790	660	1211	3661
Jun	1034	786	1474	3294
Jul	537	878	1798	3213
Aug	327	782	1568	2677
Sep	481	513	786	1780
Oct	618	288	400	1306
Nov	348	174	196	718
Dec	881	122	208	1211

Source: USGS 11289650, USGS 11289000, USGS 11289500, and USGS 11289651.

Tuolumne River at 9th Street Bridge in Modesto, California (USGS Gage No. 11290000)

USGS also reports flows for a gage located farther downstream near the City of Modesto (Table 3.4-10). This gage has relevance to the operation of the Don Pedro Project through implementation of the ACOE 1972 Flood Control Manual. Flows measured at this gage can affect operations because the Flood Control Manual calls for maintaining Tuolumne River flows below 9,000 cfs at the 9th Street Bridge (below the Dry Creek confluence) to minimize significant property damage. This restriction has the greatest potential to affect operation during the wet winter and early spring snowmelt months when diversions for irrigation or M&I use may be relatively low and maintenance of flood control space in Don Pedro Reservoir is vital.

Unimpaired Flow

The unimpaired flow of the Tuolumne River is calculated on a daily basis by the California Department of Water Resources (CDWR) for the Tuolumne River at La Grange Diversion Dam (Station ID TLG.) The drainage area at this location, according to the CDWR's CDEC system, is approximately 1,548 mi^2. Historical computed flows are available from CDEC on a daily basis beginning in April 1986, and on a monthly basis from October 1900 through the present. Because these data are computed on a daily basis using a number of different gages for an arithmetic water-balance (including changes in storage at Don Pedro Reservoir), CDWR's estimate of unimpaired flows for the Tuolumne River can vary considerably from day to day and occasionally show negative flows. Table 3.4-11 presents a summary of average monthly unimpaired flow for 1975–2012.

Annual unimpaired flow of the Tuolumne River above Don Pedro Reservoir has averaged about 1.97 million AF since 1975, or about 1.8 cfs/mi^2. The maximum annual unimpaired runoff since 1975 occurred in WY 1983, at 4.6 million AF (4.1 cfs/mi^2), and the minimum occurred in WY 1977, at 0.38 million AF (0.34 cfs/mi^2), or just 19 percent of the mean flow.[13]

[13] Preliminary total runoff estimate from WY 2017 is 4.8 million AF.

Table 3.4-10. Mean monthly flows for the 1975-2012 period for Tuolumne River at Modesto, below Dry Creek.

Month	Mean Monthly Flow (cfs)	Lowest Mean Monthly Flow (cfs)	Highest Mean Monthly Flow (cfs)
Jan	1837	154	15500
Feb	2138	166	8782
Mar	2293	239	7658
Apr	2192	169	9268
May	1992	138	10420
Jun	1216	95	5683
Jul	716	79	4244
Aug	501	68	2415
Sep	680	73	4041
Oct	848	78	4760
Nov	647	93	2089
Dec	1129	110	5431

Source: USGS 11290000.

Table 3.4-11. Tuolumne River at La Grange Diversion Dam mean monthly unimpaired flow, 1975-2012.

Month	Unimpaired Flow Monthly Average (AF)
January	146,465
February	156,184
March	227,960
April	279,811
May	449,940
June	354,796
July	143,172
August	33,145
September	16,926
October	24,289
November	46,374
December	83,581
Total	**1,946,116**

Source: TID/MID 2013.

Flood Hydrology

The ACOE participated financially in the construction of the Don Pedro Project to acquire 340,000 AF of flood storage space in the Don Pedro Reservoir. This storage is to be provided each year from October 7 to at least April 27. Depending on runoff forecasts, the flood storage space can be reduced to zero as early as the first week in June. Under current operations, the flood storage volume of 340,000 AF lies between elevations 801.9 ft and 830 ft. The flood storage space may be encroached upon during the annual flood management period as long as such encroachment is subsequently reduced. Details on the seasonal and inter-annual variability of operations and flood control can be found in Exhibit B of this AFLA.

Since completion of the new Don Pedro Dam in 1971, the flood of record occurred in January 1997 (the "1997 New Year's Flood"); this was the first time water was discharged at the Don Pedro spillway. The peak inflow was estimated to be 120,935 cfs, and peak outflow was 59,462 cfs, as measured at the La Grange gage. On February 20, 2017, the reservoir level reached 830 feet and the Don Pedro Project spilled for just the second time, with the maximum release being 19,100 cfs.

Prior to 1971, the unregulated historical flood of record occurred in January 1862, with an estimated discharge of 130,000 cfs. A more recent flood (post-original Don Pedro Dam construction) occurred in December 1950, with an estimated discharge of 61,000 cfs.

The design flood for the Don Pedro Project is the Probable Maximum Flood (PMF), which was recomputed in 2006 during the Don Pedro Project's Potential Failure Mode Analysis. Peak inflow and outflow were estimated to be 706,900 cfs and 525,600 cfs, respectively. The PMF would be passed at the reservoir elevation 852 ft, or 3 ft below top of dam.

Drought Hydrology

As noted above, the minimum annual unimpaired flow of the Tuolumne River above Don Pedro Reservoir occurred in WY 1977, at 0.38 million AF (0.34 cfs/mi^2), or just 19 percent of the mean flow. The current normal year Tuolumne River water demand exceeds 1.4 million AF, consisting of 900,000 AF for the Districts irrigation and M&I use, 300,000 AF for protection of aquatic resources in the lower Tuolumne River, and 250,000 AF of M&I water for CCSF's Bay Area customers. Annual unimpaired flow since 1975 at Don Pedro Dam has been less than 1.4 million AF in more than 40 percent of the years.

Successive dry years are challenging for water supply management. Drought planning is based on supplying adequate amounts of water to meet demands through a sequence of dry years. Since 1971, several drought periods have occurred: WYs 1976–1977, 1987–1992, 2001–2004, and 2012–2013 were all periods of drought. During the 1976–1977 drought, the combined two-year unimpaired flow was 1 million AF or only 26 percent of the two-year mean of 3.9 million AF. These two years are the driest two consecutive years in recorded history. The longest drought occurred during the WYs 1987–1992. The unimpaired flow over these six years averaged 0.9 million AF, or just 48 percent of the mean. In the entire WY 1987–1992 period, not a single year exceeded 70 percent of the long-term mean annual flow. The successive four-year low-flow period from WY 2001–2004 had a mean unimpaired flow of 1.35 million AF, or 69 percent of the mean, without a single-year's flow being above the mean. The most recent drought extended through WY 2015, making the WYs 2012-2015 the driest four consecutive years on record at approximately 3.2 million AF.

Demand for irrigation water during drought years is greater than during normal or wet years due to reduced winter moisture. Use of groundwater during drought periods can offer only temporary relief from droughts. The majority of groundwater recharge in both the Turlock and Modesto groundwater basins comes from applied irrigation water during wet years. Recent studies indicate that groundwater storage has been reduced and may no longer be in a state of equilibrium as had existed in the 1990s (TID 2008).

Development of Hydrology for the Tuolumne River Operations Model

As noted above, the Districts have developed a detailed river-specific computer model (TID/MID 2017d) to simulate the operations of the Don Pedro Project and the water supply operations of CCSF's Hetch Hetchy water system. The geographic scope of the model extends from Hetch Hetchy Reservoir, Cherry Lake, and Eleanor Lake in the upper watershed to the USGS La Grange and Modesto streamflow gages in the lower Tuolumne River, and on to the confluence of the Tuolumne and San Joaquin rivers. The model Version 3.0 provides a simulation of the "Base Case" for the Don Pedro Project, reflecting existing conditions, including the influence of the Don Pedro Project's primary purposes (i.e., irrigation and M&I uses and flood control) on hydrology. The model may also be used to simulate alternative operations scenarios and can be used to compare the effects of alternative scenarios with the Base Case.

The hydrology associated with the model's Base Case contains simulated inflows to Don Pedro Reservoir for the WY 1971–2012 period. Inflows consist of two basic components: (1) a fluctuating unregulated inflow to Don Pedro Reservoir from the portion of the watershed that contains no water regulation, and (2) the regulated releases from the CCSF system. The inflow reflects a daily fluctuating pattern mostly associated with the unregulated component of runoff, which amounts to approximately 40 percent of the total runoff in the basin upstream of the Don Pedro Project. The unregulated component of inflow to Don Pedro Reservoir remains the same among all operation simulations. The regulated inflow to Don Pedro is based on the simulated operations of the CCSF system, which may change among operation simulations due to changed flow requirements for CCSF system demands or user-controlled parameters.

The unimpaired hydrology of the final model was based on collaboration among the Districts and relicensing participants. The selected approach was to develop a flow record for the Tuolumne River using gage proration to develop daily flows, while conforming to the underlying monthly mass balances developed using existing, reliable reservoir level and outflow data. This approach allowed conservation of mass principles to be maintained over the monthly time steps. Gaged data from both the Tuolumne River and nearby drainages were included in the gage proration. To prorate the gaged data to a larger ungaged area, three physical variables were considered: elevation, drainage area, and average annual precipitation (precipitation). Each gaged basin, along with each application basin (Hetch Hetchy, Cherry/Eleanor, and Unregulated), was divided into 100-ft "elevation bands" for its entire drainage area. This was done using USGS National Elevation Dataset, 1/3 arc-second (USGS 2009), which equates to about a 30-ft pixel size. Each elevation band for each gage had attributes added for the drainage area within this band (e.g., the number of mi^2 of the Tuolumne River drainage that exists between elevation 500 and 600 ft) and precipitation (e.g., the average annual precipitation for the drainage area between elevation 500 and 600 ft).

The Oregon Climate Service's Probabilistic Symbolic Model Checker (PRISM) was employed to estimate average annual precipitation from 1971–2000 (PRISM 2006) for each of the elevation bands represented by the basins being evaluated (elevation 100–13,000 ft). PRISM uses the observed precipitation gage and radar data network, in conjunction with an orographic precipitation and atmospheric model, to develop an estimate of average annual precipitation for the contiguous United States at a pixel size resolution of 2,500 ft. Bi-linear interpolation was used to resample the PRISM values to the same pixel size as the elevation model.

Areas at low elevations and high elevations in each of the application basins, which were poorly represented or not represented at all by the reference gages, were added into the elevation distributions of the most representative gages to provide some amount of coverage for those elevation ranges. The proration calculation includes two main steps. First, the daily flow for a given gage is divided across the elevation range that the gage represents, in equal proportion to the drainage area represented within each 100-ft elevation band. Second, the sum of each of the individual "elevation band flows" for each gage is scaled up to the area of that elevation band in the application basin. Each of these steps includes a scaling factor for both area and precipitation.

This method and its results are explained in detail in Appendix B-2 of Exhibit B of this AFLA and were described to relicensing participants in a March 27, 2013 Workshop and again in the Districts' April 9, 2013 submittal to FERC titled *Districts' Response to Relicensing Participants Comments on the Initial Study Report (Attachment 2).*

3.4.1.3 State Designated Beneficial Uses

Beneficial use designations for the Tuolumne River are established by the Central Valley Regional Water Quality Control Board (CVRWQCB) through the issuance of the Water Quality Control Plan (Basin Plan). The Don Pedro Project and the areas upstream and downstream of the Project Boundary fall within three Basin Plan units (HUs): (1) HU 536, which includes the Tuolumne River upstream of the Don Pedro Project; (2) HU 536.32, which includes Don Pedro Reservoir; and (3) HU 535, which includes the Tuolumne River from Don Pedro Dam to the San Joaquin River. Table 3.4-12 lists the designated beneficial uses for these units. As provided in the Basin Plan, existing beneficial uses of Don Pedro Reservoir water include (1) Industrial Service Supply (power generation), (2) Water Contact Recreation, (3) Non-Water Contact Recreation, (4) Warm Freshwater Habitat, (5) Cold Freshwater Habitat, and (6) Wildlife Habitat. Although Municipal and Domestic Supply is listed only as a potential use, in actuality Don Pedro Reservoir is currently providing a portion of the drinking water supply for the City of Modesto, as well as the DPRA campgrounds and facilities. The agricultural supply, municipal water supply, and fish habitat enhancement beneficial uses are elaborated on below.

Table 3.4-12. Designated beneficial uses of the Tuolumne River from the Basin Plan.

Designated Beneficial Use Description from Basin Plan, Section II		Designated Beneficial Use by HU from Basin Plan Table II-1			
		Use	Source to Don Pedro Reservoir HU 536	Don Pedro Reservoir HU 536.32	Don Pedro Dam to San Joaquin River HU 535
Municipal and Domestic Supply (MUN)	Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.	MUNICIPAL AND DOMESTIC SUPPLY	Existing	Potential	Potential
Agricultural Supply (AGR)	Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation (including leaching of salts), stock watering, or support of vegetation for range grazing.	IRRIGATION	Existing	--	Existing
		STOCK WATERING	Existing	--	Existing
Industrial Process Supply (PRO)	Uses of water for industrial activities that depend primarily on water quality.	PROCESS	--	--	--
Industrial Service Supply (IND)	Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well repressurization.	SERVICE SUPPLY	--	--	--
		POWER	Existing	Existing	--
Water Contact Recreation (REC-1)	Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.	CONTACT	Existing	Existing	Existing
		CANOEING AND RAFTING[1]	Existing	--	Existing
Non-Contact Water Recreation (REC-2)	Uses of water for recreational activities involving proximity to water, but where there is generally no body contact with water, nor any likelihood of ingestion of water. These uses include, but are not limited to, picnicking, sunbathing, hiking, beach-combing, camping, boating, tide-pool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.	OTHER NON-CONTACT	Existing	Existing	Existing
Warm	Uses of water that support warm	WARM[2]	Existing	Existing	Existing

Designated Beneficial Use Description from Basin Plan, Section II		Designated Beneficial Use by HU from Basin Plan Table II-1			
		Use	Source to Don Pedro Reservoir HU 536	Don Pedro Reservoir HU 536.32	Don Pedro Dam to San Joaquin River HU 535
Freshwater Habitat (WARM)	water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.				
Cold Freshwater Habitat (COLD)	Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.	COLD[2]	Existing	Existing	Existing
Migration of Aquatic Organisms (MGR)	Uses of water that supports habitats necessary for migration or other temporary activities by aquatic organisms, such as anadromous fish.	WARM[3]	--	--	--
		COLD[4]	--	--	Existing
Spawning (SPWN)	Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.	WARM[3]	--	--	Existing
		COLD[4]	--	--	Existing
Wildlife Habitat (WILD)	Uses of water that support terrestrial or wetland ecosystems including, but not limited to, preservation or enhancement of terrestrial habitats or wetlands, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, or invertebrates), or wildlife water and food sources.	WILDLIFE HABITAT	Existing	Existing	Existing

1 Applies to streams and rivers only.
2 Resident does not include anadromous. Any hydrologic unit with both WARM and COLD beneficial use designations is considered a COLD water body by the SWRCB for the application of WQOs.
3 Warm water fish species include striped bass, sturgeon, and shad.
4 Cold water fish species include salmon and steelhead.
Source: CVRWQCB 1998 and amendments.

Irrigated Agriculture

Water for irrigated agriculture is a designated beneficial use of Tuolumne River waters. TID and MID use a combined average of 850,000 AF per year to serve over 200,000 ac of highly productive farmland north and south of the Tuolumne River. For annual crops (e.g., grains, pasture, and vegetables), initial decisions and financial commitments to the number of acres to plant must be made by late January or early February, at which time total water year precipitation levels and runoff are largely unknown. Many of these annual crops are grown to support the large regional dairy industry. Growing annual crops provides a source of feed for cows as well as a means by which to dispose of nutrients created by the herds. Other important irrigated crops in the Districts' service areas are nut and fruit orchards, which are permanent crops requiring significant initial and continuing investment. A reliable year-over-year water supply is necessary to sustain the yield and health of permanent crops.

Municipal and Industrial Water Supply

The Project contributes substantially to the water supplies of the City of Modesto (population: 210,000) and 2.6 million people in the San Francisco Bay Area. The CCSF contributed financially to the construction of the Don Pedro Project in exchange for water banking privileges that benefit CCSF's Bay Area water customers.[14] Protecting the primary purpose of the Don Pedro Project--providing reliable water supplies, especially during drought periods--is essential not only to the welfare and economies of the Districts' service territory, but to the Central Valley region and the Bay Area.

Fish Habitat Enhancement Flows

Under the current FERC license, Don Pedro Reservoir provides up to 300,000 AF of water to the lower Tuolumne River to protect and enhance aquatic resources, including spawning, rearing and migration flows for Chinook salmon and *O. mykiss* (flow releases made for the benefit of fish and aquatic resources in the lower river are described in Section 4.1 of this AFLA).

3.4.1.4 Water Quality

Water Quality Objectives

The CVRWQCB has adopted WQOs to protect the beneficial uses listed in Table 3.4-12. These WQOs are described in Table 3.4-13. The objectives are primarily narrative, incorporating California's numeric Title 22 drinking water standards by reference, although some (i.e., bacteria, dissolved oxygen [DO], pH, temperature, and turbidity), are numeric.

[14] CCSF provides the potable water supply for 2.6 million people in the Bay Area. The Hetch Hetchy System provides 85% of the supply to San Francisco's Regional Water System. The Regional Water System meets 98% of CCSF's needs (800,000 people) and about 65% of CCSF's wholesale customers' needs (population: 1.8 million).

Table 3.4-13. Water quality objectives to support beneficial uses in the vicinity of the Don Pedro Project as designated by the Central Valley Regional Water Quality Control Board and listed in the Basin Plan.

Water Quality Objective	Description
Bacteria	In terms of fecal coliform. Less than a geometric average of 200/100 ml on five samples collected in any 30-day period and less than 400/100 ml on ten percent of all samples taken in a 30-day period.
Biostimulatory Substances	Water shall not contain biostimulatory substances that promote aquatic growth in concentrations that cause nuisance or adversely affect beneficial uses.
Chemical Constituents	Waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses. Specific trace element levels are given for certain surface waters, none of which include the waters in the vicinity of the Don Pedro Project. Other limits for organic, inorganic and trace metals are provided for surface waters that are designated for domestic or municipal water supply. In addition, waters designated for municipal or domestic use must comply with portions of Title 22 of the California Code of Regulations. For protection of aquatic life, surface water in California must also comply with the California Toxics Rule (40 CFR Part 131).
Color	Water shall be free of discoloration that causes a nuisance or adversely affects beneficial uses.
Dissolved Oxygen (DO)	The DO concentrations shall not be reduced below the following minimum levels at any time. Waters designated WARM.....5.0 mg/L Waters designated COLD.......7.0 mg/L Waters designated SPWN 7.0 mg/L The Tuolumne River also has a water body specific DO objective (Table III-2). DO concentrations shall not be reduced below 8.0 mg/L from October 15 – June 15 from Waterford to La Grange.
Floating Material	Water shall not contain floating material in amounts that cause a nuisance or adversely affect beneficial uses.
Oil & Grease	Water shall not contain oils, greases, waxes or other material in concentrations that cause a nuisance, result in visible film or coating on the surface of the water or on objects in the water, or otherwise adversely affect beneficial uses.
pH	The pH of surface waters will remain between 6.5 and 8.5, and cause changes of less than 0.5 in receiving water bodies.
Pesticides	Waters shall not contain pesticides or a combination of pesticides in concentrations that adversely affect beneficial uses. Other limits established as well.
Radioactivity	Radionuclides shall not be present in concentrations that are harmful to human, plant, animal or aquatic life nor that result in the accumulation of radionuclides in the food web to an extent that presents a hazard to human, plant, animal or aquatic life.
Sediment	The suspended sediment load and suspended-sediment discharge rate of surface waters shall not be altered in such a manner as to cause a nuisance or adversely affect beneficial uses.
Settleable Material	Waters shall not contain substances in concentrations that result in the deposition of material that causes a nuisance or adversely affects beneficial uses.
Suspended Material	Waters shall not contain suspended material in concentrations that cause a nuisance or adversely affect beneficial uses.

Water Quality Objective	Description
Tastes and Odor	Water shall not contain taste- or odor-producing substances in concentrations that impart undesirable tastes and odors to domestic or municipal water supplies or to fish flesh or other edible products of aquatic origin, or that cause nuisance, or otherwise adversely affect beneficial uses.
Temperature	The natural receiving water temperature of interstate waters shall not be altered unless it can be demonstrated to the satisfaction of the RWQCB that such alteration in temperature does not adversely affect beneficial uses. Increases in water temperatures must be less than 5 ºF above natural receiving-water temperature.
Toxicity	All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life. Compliance with this objective will be determined by analyses of indicator organisms, species diversity, population density, growth anomalies, and biotoxicity tests as specified by the RWQCB.
Turbidity	In terms of changes in turbidity (NTU) in the receiving water body: where natural turbidity is 0 to 5 NTUs, increases shall not exceed 1 NTU; where 5 to 50 NTUs, increases shall not exceed 20 percent; where 50 to 100 NTUs, increases shall not exceed 10 NTUs; and where natural turbidity is greater than 100 NTUs, increase shall not exceed 10 percent.

[1] Methylmercury objectives in the Basin Plan do not apply to the vicinity of the Don Pedro Project. The radioactivity and suspended material objectives do not apply to the Don Pedro Project; Don Pedro Project O&M does not contribute radioactive or suspended material into the Tuolumne River or its impoundments.
[2] There is no waterbody specific salinity objective that applies to the vicinity of the Don Pedro Project. Salinity is therefore addressed thorough the chemical constituents objective.
[3] Table 3.4-15 lists numeric standards, criteria, and benchmarks selected for interpreting water quality constituent concentrations that do not have numeric Basin Plan objectives.
[4] Tastes and Odors limits for drinking water are provided as secondary MCLs in Title 22 of the California Code of Regulations.
Source: CVRWQCB 1998 and amendments.

Two of the Basin Plan WQOs, temperature and turbidity, include, at least in part, a criterion limiting changes to receiving water. The temperature objective states that "natural receiving waters" should not be warmed by more than 5°F (approximately 2.8°C), and the turbidity objective provides restrictions for percentage increases in turbidity. The turbidity standard cannot be evaluated based on directly applicable information, because no information exists to characterize the natural receiving water turbidity levels.

However, simulation modeling can be used to estimate natural receiving water temperatures with reasonable certainty. With respect to the temperature regime of the natural receiving water of the Tuolumne River, the Districts have developed an estimate of the unimpaired flow and temperature regime of the Tuolumne River from above Hetch Hetchy Reservoir to its confluence with the San Joaquin River. The model and the comparison of with- and without-dams temperature conditions are discussed further below.

Application of the Basin Plan's temperature and DO WQO to reservoirs is also difficult due to seasonal reservoir stratification, especially in a physically complex reservoir such as Don Pedro. However, advancements in computer modeling have also made possible the simulation of temperature dynamics in reservoirs.

California List of Impaired Waters

Section 303(d) of the federal Clean Water Act (CWA) requires that every two years each state submit to the Environmental Protection Agency (EPA) a list of rivers, lakes, and reservoirs for which pollution control and/or requirements have failed to provide adequate water quality. The SWRCB and CVRWQCB work together to research and update the list for the State of California. Based on a review of this list and its associated Total Maximum Daily Load (TMDL) Priority Schedule, the surface water bodies identified by the SWRCB as CWA § 303(d) State Impaired in the vicinity of the Don Pedro Project are listed in Table 3.4-14 (SWRCB 2010). There are currently no approved TMDL plans for the Tuolumne River.

Table 3.4-14. 2010 CWA Section 303(d) list of water quality limited segments for the Don Pedro Project Boundary and upstream and downstream of the Project Boundary.

Waterbody Segment	Pollutant/Stressor	Potential Sources	Expected TMDL Completion Date
Upstream of the Project Boundary			
Tuolumne River	None	--	--
Sullivan Creek (Phoenix Reservoir to Don Pedro Reservoir)	*Escherichia coli* (*E. coli*)	unknown	2021
Woods Creek (north side of Don Pedro Reservoir)	*E. coli*	unknown	2021
Project Boundary			
Don Pedro Reservoir	Mercury	Resource Extraction	2020
Downstream of the Project Boundary			
Lower Tuolumne River (Don Pedro Reservoir to San Joaquin River)	Chlorpyrifos	Agriculture	2021
	Diazinon	Agriculture	TBD
	E. coli	unknown	TBD
	Group A Pesticides[1]	Agriculture	TBD
	Mercury	Resource Extraction	2021
	Temperature	unknown	2021
	Unknown Toxicity	unknown	2021
Turlock Lake	Mercury	unknown	2021
Modesto Reservoir	Mercury	unknown	TBD
Dry Creek (tributary to Tuolumne River at Modesto)	Chlorpyrifos	Agriculture	2021
	Diazinon	Agriculture	2021
	E. coli	unknown	2021
	Unknown Toxicity	unknown	2021

[1] The Group A Pesticides consist of aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexanes (including lindane), endosulfan, and toxaphene.

Source: SWRCB 2010.

Water Quality Information and Studies

In addition to water quality investigations performed as part of relicensing studies, existing water quality information for waters in the vicinity of the Don Pedro Project was documented in Section 5.2.1 of the PAD and included data collected from 1970 through 2009 from the following sources:

- EPA Storage and Retrieval (STORET) data and reports,
- USGS Water Resources Data Reports and data collected for the National Water Quality Assessment (NAWQA) Program,
- CVRWQCB reports prepared for the Surface Water Ambient Monitoring Program (SWAMP),
- Environmental Defense Fund's Paradise Regained: Solutions for Restoring Yosemite's Hetch Hetchy Valley, Appendix B,
- NPS report on Yosemite National Park,
- CDWR data,
- Districts' water quality monitoring data from Don Pedro Reservoir and the lower Tuolumne River, and
- Various CCSF reports.

When developing the PAD, the Districts found that water samples collected within the Don Pedro Project Boundary, while limited, indicated that surface waters are of low specific conductivity and hardness, prone to acidification, and had limited potential sources of local contamination. However, Don Pedro Reservoir's minor tributaries and recreation related infrastructure were identified as potential sources of water quality degradation.

The Districts conducted a study in summer of 2012 to characterize current water quality just upstream, within, and immediately downstream of Don Pedro Reservoir (TID/MID 2013). Surface water samples were collected at five locations and analyzed for 55 physical and chemical characteristics. In-reservoir sites were sampled at two depths: within 1-2 meters of the reservoir's surface and within 1-2 meters of the bottom. During the 30 days surrounding and including the 2012 Independence Day holiday, surface water samples were collected five times adjacent to 12 reservoir recreation sites. These were analyzed for bacteria and hydrocarbons.

Data collected in 2012 indicate that water quality is good upstream, within, and downstream of the Don Pedro Project Boundary. Water is clear, DO is near saturation at riverine sites and in the epilimnion of the reservoir, alkalinity is low (<16 mg/L in all samples), and pH is near neutral. Fecal coliform bacteria are below or near detection limits near potential sources. Nitrogen and phosphorous occur at concentrations generally less than 1 mg/L, and algae blooms are not observed. Eilers et al. (1987) defined Don Pedro Reservoir as mesotrophic, which is consistent with the nutrient concentrations observed in 2012. Hardness (i.e., 6 to 15 mg/L), turbidity (i.e., 0 to 8 NTU[15]), and nutrient concentrations remain generally constant as water flows downstream through the Project Boundary (TID/MID 2013).

[15] In 2012, the sample collected between Don Pedro Reservoir's upper and middle bay was 282 NTU. Review of temperature profiles indicated that this reading was near the metalimnion, a location where plankton can accumulate. All other samples exhibited turbidity between 8 NTU (most upstream sample) and 0 NTU (near dam and downstream samples).

Consistency with Basin Plan Water Quality Objectives

Water quality data were evaluated relative to 15 applicable (see following sections) Basin Plan WQOs[16,17] (see Table 3.4-13) (TID/MID 2013). As prescribed by the FERC-approved study plan, for narrative WQOs (i.e., non-numeric objectives), data were compared to relevant guidelines and benchmarks, including EPA's (EPA 2000) California Toxics Rule (CTR) aquatic-life protective criteria (TID/MID 2013). Numeric WQOs and the benchmarks used for evaluating the protection of designated beneficial uses of Don Pedro Project waters are provided in Table 3.4-15.

Table 3.4-15. Benchmark values used for evaluating the protection of designated beneficial uses of Don Pedro Project waters.[1]

Basin Plan Water Quality Objective (Potentially Affected Beneficial Uses)	Symbol or Abbreviation	Benchmark Values	Reference	Notes
Bacteria (MUN, REC-1)				
Total coliform	--	< 10,000 MPN per 100 mL < 240 MPN per 100 mL (geometric mean);	EPA 2003	Water contact recreation, single-day sample; Water contact recreation, 30-day geometric mean
Fecal coliform	--	< 200 MPN per 100 mL (geometric mean); < 10% of samples > 400 MPN per 100 mL	CVRWQCB 1998	Water contact recreation, 30-day geometric mean; with individual samples not > 400 MPN/100 mL
Escherichia coli	E. coli	<126 MPN per 100 mL (geometric mean) <235 MPN per 100 mL in any single sample	EPA 2003	Water contact recreation, 30-day geometric mean
Biostimulatory Substances (COLD, SPAWN)				
Total Kjeldahl Nitrogen	TKN	None	--	--
Total Phosphorous	TP	None	--	--
Chemical Constituents (AGR, COLD, MUN)				
Alkalinity	--	20 mg/L (minimum)	Marshack 2008	EPA AWQC; low alkalinity can affect water treatment
Arsenic	As	0.010 mg/L	CDPH 2010 cited in CVRWQCB 1998	Title 22 Primary MCL[2]
Cadmium	Cd	5 µ/L	CDPH 2010 cited in CVRWQCB 1998	Title 22 Primary MCL[2]
Calcium	Ca	None	--	--
Chloride	Cl	250 mg/L	CDPH 2010 cited in CVRWQCB 1998	Title 22 Secondary MCL[2]
Chromium (total)	Cr (total)	50 µg/L	CDPH 2010 cited in CVRWQCB 1998	Title 22 Primary MCL[2]

[16] The radioactivity WQO does not apply to the Don Pedro Project.
[17] Temperature was evaluated separately and is discussed below, in Section 3.4.5.

Basin Plan Water Quality Objective (Potentially Affected Beneficial Uses)	Symbol or Abbreviation	Benchmark Values	Reference	Notes
Copper	Cu	1 mg/L	CDPH 2010 cited in CVRWQCB 1998	Title 22 Secondary MCL[2]
Lead	Pb	15 µg/L	CDPH 2010 cited in CVRWQCB 1998	Title 22 Primary MCL[2]
Mercury (inorganic)	Hg	0.002 mg/L	CDPH 2010 cited in CVRWQCB 1998	Title 22 Primary MCL[2]
Nickel	Ni	0.1 mg/L	CDPH 2010 cited in CVRWQCB 1998	Title 22 Primary MCL[2]
Nitrate	NO_3	45 mg/L	CDPH 2010 cited in CVRWQCB 1998	Title 22 Primary MCL[2]
Nitrite	NO_2	1 mg/L	CDPH 2010 cited in CVRWQCB 1998	Title 22 Primary MCL[2]
Nitrate + Nitrite	$NO_3 + NO_2$	10 mg/L (combined total)	CDPH 2010 cited in CVRWQCB 1998	Title 22 Primary MCL[2]
Potassium	K	None	--	--
Selenium	Se	0.05 mg/L	CDPH 2010 cited in CVRWQCB 1998	Title 22 Primary MCL[2]
Sodium	Na	20 mg/L	Marshack 2008	Sodium Restricted Diet[3]
Specific conductance	--	150 µmhos	CVRWQCB 1998	Aquatic Life Protection
Zinc	Zn	5 mg/L	CDPH 2010 cited in CVRWQCB 1998	Title 22 Secondary MCL[2]
Dissolved Oxygen (COLD, SPAWN)				
Dissolved Oxygen	DO	7.0 mg/L (minimum)	CVRWQCB 1998	Aquatic life protection
Floating Material (REC-1, REC-2)				
Floating Material	--	Narrative Criteria	CVRWQCB 1998	Aesthetics - Absent by visual observation
Oil and Grease (REC-1, REC-2)				
Oil & Grease	--	Narrative Criteria	CVRWQCB 1998	Aesthetics - Absent by visual observation
Total Petroleum Hydrocarbons	TPH	None	--	--
pH (COLD, SPAWN, WILD)				
pH	--	6.5-8.5	CVRWQCB 1998	Aquatic life protection
Sediment and Settleable Solids (REC-2, SPAWN, WILD)				
Sediment	--	Narrative Criteria	CVRWQCB 1998	--
Tastes and Odors (MUN)				
Aluminum	Al	0.2 mg/L	CDPH 2010 cited in CVRWQCB 1998	Title 22 Secondary MCL[2]

Basin Plan Water Quality Objective (Potentially Affected Beneficial Uses)	Symbol or Abbreviation	Benchmark Values	Reference	Notes
Chloride	Cl	250 mg/L	CDPH 2010 cited in CVRWQCB 1998	Title 22 Secondary MCL[2]
Copper	Cu	1.3 mg/L	CDPH 2010 cited in CVRWQCB 1998	Title 22 Secondary MCL[2]
Iron	Fe	0.3 mg/L	CDPH 2010 cited in CVRWQCB 1998	Title 22 Secondary MCL[2]
Silver	Ag	0.1 mg/L	CDPH 2010 cited in CVRWQCB 1998	Title 22 Secondary MCL[2]
Specific Conductance	--	900 umhos	CDPH 2010 cited in CVRWQCB 1998	Title 22 Secondary MCL[2]
Sulfate	SO_4	250 mg/L	CDPH 2010 cited in CVRWQCB 1998	Title 22 Secondary MCL[2]
Total Dissolved Solids	TDS	500 mg/L	CDPH 2010 cited in CVRWQCB 1998	Title 22 Secondary MCL[2]
Zinc	Zn	5 mg/L	CDPH 2010 cited in CVRWQCB 1998	Title 22 Secondary MCL[2]
Toxicity (COLD, SPAWN, MUN) CTR values listed below generally assume Total Recoverable Concentrations (unfiltered)[4,5]				
Ammonia as N (pH and Temp dependent)	NH_3-N	24.1 mg/L (CMC); 4.1-5.9 mg/L (CCC)	EPA 2000	CTR criteria over 0-20°C assuming pH 7.0
		5.6 mg/L (CMC); 1.7-2.4 mg/L (CCC)	EPA 2000	CTR criteria over 0-20°C assuming pH 8.0
		0.9 mg/L (CMC); 0.3-0.5 mg/L (CCC)	EPA 2000	CTR criteria over 0-20°C assuming pH 9.0
Arsenic	As	0.34 mg/L (CMC); 0.15 mg/L (CCC)	EPA 2000	CTR criteria
Cadmium (hardness dependent)	Cd	0.23 µg/L (CMC); 0.15 µg/L (CCC)	EPA 2000	CTR for unfiltered sample assuming hardness of 5 mg/L as $CaCO_3$
		0.4 µg/L (CMC); 0.34 µg/L (CCC)	EPA 2000	CTR for unfiltered sample assuming hardness of 10 mg/L as $CaCO_3$
		0.56 µg/L (CMC); 0.53 µg/L (CCC)	EPA 2000	CTR for unfiltered sample assuming hardness of 15 mg/L as $CaCO_3$
		0.83 µg/L (CMC); 0.95 µg/L (CCC)	EPA 2000	CTR for unfiltered sample assuming hardness of 25 mg/L as $CaCO_3$

Basin Plan Water Quality Objective (Potentially Affected Beneficial Uses)	**Symbol or Abbreviation**	**Benchmark Values**	**Reference**	**Notes**
Copper (hardness dependent)	Cu	0.83 µg/L (CMC); 0.72 µg/L (CCC)	EPA 2000	CTR for unfiltered sample assuming hardness of 5 mg/L as $CaCO_3$
		1.6 µg/L (CMC); 1.3 µg/L (CCC)	EPA 2000	CTR for unfiltered sample assuming hardness of 10 mg/L as $CaCO_3$
		2.34 µg/L (CMC); 1.84 µg/L (CCC)	EPA 2000	CTR for unfiltered sample assuming hardness of 15 mg/L as $CaCO_3$
		3.79 µg/L (CMC); 2.85 µg/L (CCC)	EPA 2000	CTR for unfiltered sample assuming hardness of 25 mg/L as $CaCO_3$
Lead (hardness dependent)	Pb	0.54 µg/L (CCC) 14 µg/L (CMC)	EPA 2000	CTR for unfiltered sample assuming hardness of 25 mg/L as $CaCO_3$
Mercury	Hg	0.050 µg/L	EPA 2000 40 CFR 131.38	CTR/Federal Register 5/18/00
Nitrate-Nitrite	NO_3-N+NO_2-N	10 mg/L (combined total)	CDPH 2010 cited in CVRWQCB 1998	Title 22 Primary MCL (“Blue baby Syndrome”)
Silver (hardness dependent)	Ag	0.02 µg/L (CMC) instantaneous	EPA 2000	CTR for unfiltered sample assuming hardness of 5 mg/L as $CaCO_3$
		0.08 µg/L (CMC) instantaneous	EPA 2000	CTR for unfiltered sample assuming hardness of 10 mg/L as $CaCO_3$
		0.16 µg/L (CMC) instantaneous	EPA 2000	CTR for unfiltered sample assuming hardness of 15 mg/L as $CaCO_3$
		0.37 µg/L (CMC) instantaneous	EPA 2000	CTR for unfiltered sample assuming hardness of 25 mg/L as $CaCO_3$
Zinc (hardness dependent)	Zn	9.47 µg/L	EPA 2000	CTR for unfiltered sample assuming hardness of 5 mg/L as $CaCO_3$
		17.03 µg/L	EPA 2000	CTR for unfiltered sample assuming hardness of 10 mg/L as $CaCO_3$

Basin Plan Water Quality Objective (Potentially Affected Beneficial Uses)	Symbol or Abbreviation	Benchmark Values	Reference	Notes
		24.01 µg/L	EPA 2000	CTR for unfiltered sample assuming hardness of 15 mg/L as $CaCO_3$
		37.02 µg/L	EPA 2000	CTR for unfiltered sample assuming hardness of 25 mg/L as $CaCO_3$
Aldrin	--	3.0 µg/L	Marshack 2008	AWQC
Chlordane	--	0.0043 µg/L	Marshack 2008	AWQC
Chlorpyrifos	--	0.014 µg/L	Marshack 2008	AWQC
Diazinon	--	0.05 µg/L[5]	Marshack 2008	AWQC
Dieldrin	--	0.056 µg/L	Marshack 2008	AWQC
Endosulfan	--	0.056 µg/L	Marshack 2008	AWQC
Endrin	--	0.036 µg/L	Marshack 2008	AWQC
Heptachlor	--	0.0038 µg/L	Marshack 2008	AWQC
Heptachlor epoxide	--	0.0038 µg/L	Marshack 2008	AWQC
alpha-Hexachlorocyclohexane	--	0.08 µg/L	Marshack 2008	AWQC
beta-Hexachlorocyclohexane	--	0.08 µg/L[6]	Marshack 2008	AWQC
delta-Hexachlorocyclohexane	--	0.08 µg/L[6]	Marshack 2008	AWQC
gamma-Hexachlorocyclohexane	--	0.08 µg/L	Marshack 2008	AWQC
Toxaphene	--	0.0002 µg/L	Marshack 2008	AWQC
Turbidity (COLD, SPAWN, WILD, MUN)				
Turbidity	NTU	increase < 1 NTU for 1-5 NTU background; increase < 20% for 5-50 NTU background	CVRWQCB 1998	Aesthetics, disinfection, egg incubation

[1] Note a chemical may be listed under more than one beneficial use.
[2] CDPH Title 22 identified as minimum water quality thresholds, but acknowledged as insufficiently protective in some cases (CVRWQCB 1998).
[3] Guidance level to protect those individuals restricted to a total sodium intake of 500 mg/day (Marshack 2008).
[4] CMC: Criterion Maximum Concentration (one-hour acute exposure) for aquatic toxicity as defined by EPA (2000).
[5] CCC: Criterion Continuous Concentration (four-day chronic exposure) for aquatic toxicity as defined by EPA (2000).
[6] Value is for gama-hexachlorocyclohexane.

Key:
AGR = agricultural supply
AWQC = Ambient Water Quality Criteria
EPA = Environmental Protection Agency
$CaCO_3$ = Calcium carbonate
CMC = Criterion Maximum Concentration (1-hour acute exposure) for aquatic toxicity as defined by EPA (2000)
CCC = Criterion Continuous Concentration (4-day chronic exposure) for aquatic toxicity as defined by EPA (2000)
COLD = cold freshwater habitat
CTR = California Toxics Rule
MCL = Maximum Contaminant Level
MUN = municipal and domestic supply
REC-1 = water contact recreation
REC-2 = water non-contact recreation
µmhos = micromhos
µg/L = micrograms per liter
mg/L = milligrams per liter
MPN = Most Probable Number
NTU = Nephelometric turbidity units
SM = Standard Method
SPAWN = spawning, reproduction and/or early development
WILD = wildlife habitat

The Districts observed no inconsistencies for 13 of the 15 applicable Basin Plan WQOs, including: (1) Biostimulatory Substances, (2) Chemical Constituents, (3) Color, (4) pH, (5) Pesticides, (6) Sediment (7) Settleable Material, (8) Taste and Odor, (9) Toxicity, including mercury and methylmercury, (10) Turbidity, (11) Bacteria, (12) Floating Material, and (13) Oil and Grease. Some inconsistencies were observed for two objectives: (1) Toxicity and (2) DO.

Biostimulatory Substances

The Basin Plan requires that water shall not contain biostimulatory substances that promote aquatic growth in concentrations that cause nuisance or adversely affect designated beneficial uses.

In August 2012, nitrate concentrations ranged between 0.037 mg/L (estimated[18]) and 0.11 mg/L, and nitrite concentrations and total Kjeldahl Nitrogen were not detectable. Total phosphorous levels were similarly low, ranging between 0.025 mg/L (estimated) and the reporting limit of 0.10 mg/L. Orthophosphate concentrations were only detected in one sample at 0.051 mg/L (estimated). These low nutrient levels suggest that biostimulatory substances are not currently present in sufficient quantities to cause nuisance conditions related to algal blooms or decreased water clarity. The Districts are unaware of any instances where algal blooms or decreased water clarity have been reported as a nuisance.

Chemical Constituents

The Basin Plan requires that water shall not contain chemical constituents in concentrations that adversely affect designated beneficial uses. The Basin Plan requires that water designated for use as domestic or municipal supply shall not contain concentrations of chemical constituents in excess of the maximum contaminant levels (MCLs) specified in the provisions of Title 22 of the CCR (CDPH 2010).

MCLs are intended to be applied to finished tap water, but were conservatively applied to untreated water in this study. Samples collected in August 2012 had concentrations less than the primary MCLs for all analytes, i.e. water quality at the sampled locations was found to be consistent with drinking water standards (TID/MID 2013). Analytes with secondary MCLs for tastes and odors and aquatic toxicity are discussed below.

Color

The Basin Plan includes a narrative WQO regarding color. The FERC-approved study plan did not require sampling for color. The Districts are aware of no instances where the color of the water in the vicinity of the Don Pedro Project has been reported as a nuisance or has adversely affected designated beneficial uses.

[18] If an analyte was detected at a concentration below the reporting limit, but above the laboratory method detection limit, its concentration was reported by the laboratory as estimated.

pH

The Basin Plan requires that pH shall neither be depressed below 6.5 nor raised above 8.5. During August 2012 sampling, three locations had a pH value outside these limits: the inflow sample of the Tuolumne River above Don Pedro Reservoir (6.40 su), the mid-reservoir hypolimnion of Don Pedro Reservoir (6.47 su), and the near-dam hypolimnion of Don Pedro Reservoir (6.43 su). For a low nutrient, snow-melt derived reservoir, these values are within the sonde's measurement error of ± 0.1 mg/L and are therefore considered to be consistent with the objective. Also, the lowest value (6.40 su) was measured in the Tuolumne River upstream of the reservoir, i.e., above the influence of the Don Pedro Project.

Pesticides

Significant pesticide use does not occur within the Don Pedro Project Boundary or in association with Don Pedro Project O&M activities. Furthermore, the Districts are aware of no instances where pesticide use in the vicinity of the Project Boundary has been reported to cause a nuisance or adversely affect designated beneficial uses.

Downstream of the Project Boundary, the section of the Tuolumne River from Don Pedro Reservoir to the San Joaquin River is included in the State of California's CWA § 303(d) list in relation to the non-point discharge of some agricultural pesticides (SWRCB 2010). Agricultural chemicals on the 303(d) list are chlorpyrifos, diazinon, and the Group A Pesticides—aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexanes (including lindane), endosulfan, and toxaphene. Pesticides on the 303(d) list for the lower Tuolumne River were not detected in any of the August 2012 samples (TID/MID 2013) analyzed at the commercially available reporting limits. However, because the detection limits for chlordane and toxaphene exceeded the reporting limits for those analytes, consistency with benchmarks could not be determined irrefutably. Nonetheless, as stated above, because significant pesticide use does not occur in association with the Don Pedro Project, these non-detects are considered applicable–chlordane and toxaphene are not present in Don Pedro Project waters.

Sediment

The Basin Plan requires that suspended sediment load and suspended sediment discharge to surface waters shall not alter surface waters in such a manner as to cause a nuisance or adversely affect beneficial uses of water within the Project Boundary or other water. Total dissolved solids and total suspended solids were low in August 2012 (10 to 38 mg/L and 1.0 to 3.1 mg/L, respectively). The Districts are aware of no sediment discharges to surface water related to the Don Pedro Project. Additionally, the Districts are aware of no suspended sediment levels or discharges that cause a nuisance or adversely affect any designated beneficial uses of water within the Project Boundary or other nearby water.

Settleable Material

The Basin Plan requires that waters shall not contain substances in concentrations that result in the deposition of material that causes nuisance or adversely affects beneficial uses. The FERC-approved study (TID/MID 2013) did not include a provision for evaluating settleable material. The Districts are aware of no settleable material present in Don Pedro Project water or settleable material that causes a nuisance or adversely affects any designated beneficial uses of Don Pedro Project or other nearby water.

Tastes and Odor

The Basin Plan requires that waters shall not contain taste- or odor-producing substances in concentrations that impart undesirable tastes or odors to domestic or municipal water supplies or to fish flesh or other edible products of aquatic origin, or that cause nuisance, or otherwise adversely affect beneficial uses of Don Pedro Project or other nearby water.

During the 2012 sampling, iron was measured at a level less than its secondary MCL of 0.3 mg/L for taste and odors at all locations, but one. Above Don Pedro, the inflow sample had an iron concentration of 3.14 mg/L. Secondary MCLs are routinely applied at the point of use (i.e., "at the tap") and existing water treatment methods appear to be adequate to meet these secondary water quality criteria. Furthermore, the 3.14 mg/L measurement reflects conditions upstream of the reservoir and therefore outside the influence of the Don Pedro Project. The Districts are aware of no reports that taste or odor of water or fish caught in Don Pedro Reservoir cause a nuisance or otherwise adversely affect designated beneficial uses of Don Pedro Project or other nearby water.

Toxicity

The Basin Plan requires that waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life. The FERC-approved study plan states that water quality data collected as part of the study would be compared to the aquatic life protective benchmarks from EPA (2000) CTR or benchmarks excerpted from Marshack (2008) *A Compilation of Water Quality Goals*. The low levels of hardness found throughout the study area are expected to increase the aquatic toxicity of some metals due to the greater proportion of free ions found in many trace metals. At the low hardness levels found in the study (i.e., 6 to 15 mg/L), sample-specific dissolved cadmium, copper, lead, silver, and zinc CTR criteria were calculated (see Attachment C, Table C-2 of TID/MID 2013). Of these five metals, only copper exhibited a concentration greater than its sample specific CTR– and only in two samples. The mid-reservoir hypolimnion of Don Pedro Reservoir had a copper (dissolved) concentration of 6.25 micrograms per liter (µg/L), as compared to a CTR guideline of 1.8 µg/L, and the near-dam hypolimnion of Don Pedro Reservoir had a copper (dissolved) concentration of 8.16 µg/L. The Districts are aware of no O&M activity that may affect levels of copper. As reported in the PAD (TID/MID 2011), algaecides are not used to manage algae in Don Pedro Reservoir.

Mercury and Methylmercury

The section of the Tuolumne River from the outlet of Don Pedro Reservoir to the San Joaquin River is included in the State of California's CWA Section 303(d) list of impaired and threatened waters. The pollutant stressors identified in the 303(d) list are primarily related to agriculture, but the list also includes mercury, a legacy contaminant of the gold mining era (SWRCB 2010). Mercury is bioaccumulated by transfer through the food-web to organisms at higher trophic levels, such as piscivorous fish, which can lead to adverse effects on the nervous systems of these higher trophic organisms.

In August 2012, mercury was detected at all locations at concentrations that ranged between 0.08 and 4.57 nanograms per liter (ng/L). These total mercury concentrations are far less than the MCL of 0.002 mg/L (2,000 ng/L), indicating that the drinking water beneficial use is being met everywhere in the Don Pedro Project Boundary for mercury. In addition, the samples were below the CTR benchmark of 50 ng/L.

Samples were also analyzed for total methylmercury and dissolved methylmercury. Methylmercury (total) was detected in three of the eight samples. Samples that contained methylmercury were collected from the Tuolumne River inflow above Don Pedro Reservoir (0.029 ng/L), the mid-reservoir hypolimnion of Don Pedro Reservoir (0.042 ng/L, estimated), and the near-dam hypolimnion of Don Pedro Reservoir (0.053 ng/L). Methylmercury (dissolved) was detected in the mid-reservoir hypolimnion of Don Pedro Reservoir (0.293 ng/L), and the near-dam hypolimnion of Don Pedro Reservoir (0.394 ng/L). These data show that methylmercury is present; however, the exact concentration is uncertain. The reported dissolved concentrations are greater than total concentrations, and the laboratory cannot explain why, other than the results reflect the difficulty of measuring methylmercury near its reporting limits.

These data are consistent with reports of water quality and fish tissue data collected between fall 2008 and spring 2009 in which water quality samples and higher trophic level fish species were collected from nine sites within, upstream of, and downstream of Don Pedro Reservoir (TID/MID 2009). Like this study, methylmercury was not detected below either the Don Pedro Dam or La Grange Diversion Dam, but methylmercury was detected in hypolimnetic samples in the Moccasin Creek arm (0.15 ng/L) and Woods Creek (0.145 ng/L) arm of Don Pedro Reservoir. However, unlike the 2012 study, no mercury was detected in water samples collected from the Tuolumne River upstream of Don Pedro Reservoir.

Stillwater Sciences (TID/MID 2009) found evidence of fish mercury bioaccumulation. Concentrations in excess of the EPA (2001) fish tissue residue criterion (0.3 milligrams/kilogram (mg/kg)) were found at all sites within Don Pedro Reservoir, as well as downstream of La Grange Diversion Dam in the lower Tuolumne River, with the highest fish tissue mercury concentrations (0.29 to 0.99 mg/kg) observed in largemouth bass sampled from the shallow Moccasin Creek and Woods Creek arms of Don Pedro Reservoir. The Office of Environmental Health Hazard Assessment (OEHHA) has not issued a fish ingestion advisory for Don Pedro Reservoir (OEHHA 2009).

The Districts are aware of no Don Pedro Project O&M activity that may affect mercury methylation and do not propose any activities that may be associated with the release or mobilization of mercury.

Turbidity

The Basin Plan requires that waters be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. This objective is expressed in terms of changes in turbidity (NTU) in the receiving water body: where natural turbidity is 0 to 5 NTUs, increases shall not exceed 1 NTU; where natural turbidity is 5 to 50 NTUs, increases shall not exceed 20 percent; where natural turbidity is 50 to 100 NTUs, increases shall not exceed 10 NTUs; and where natural turbidity is greater than 100 NTUs, increase shall not exceed 10 percent.

Spatial upstream-to-downstream turbidity trends are best seen in the data as presented in Attachment C of the Water Quality study report, which provides sample results by location (TID/MID 2013). In August 2012, turbidity was 8.6 NTU upstream of the Don Pedro Project (Tuolumne River above the Project Boundary) and 0 NTU downstream of the Project Boundary (below Don Pedro Dam). Three of the four intermediate locations also exhibited no turbidity. The mid-reservoir (surface) sample had a turbidity reading of 283 NTU. Review of temperature profiles indicated that this reading was near the metalimnion,[19] a location where plankton can accumulate. Turbidity was not recorded downstream of La Grange Diversion Dam.

There is no evidence to suggest that turbidity levels cause a nuisance or any adverse effects on beneficial uses in the study area or immediately downstream of the Don Pedro Project.

Bacteria

The Basin Plan includes a WQO (<200 MPN per 100 mL) for fecal coliform in waters designated for contact recreation (Table 3.4-2), but does not provide a WQO for total coliform or *Escherichia coli* (*E. coli*).

In 2012, all 12 recreation sites sampled had fecal coliform counts below the WQO for the time surrounding and including Independence Day (i.e., a period of intense recreational use of the Don Pedro Project area). The total coliform and *E. coli* benchmarks used to evaluate the bacteria counts are shown in Table 3.4-15. All total coliform counts and *E. coli* levels were below their respective benchmarks.

Floating Material

The Basin Plan's narrative WQO regarding floating material states that water shall be free of floating material in amounts that cause nuisance or adversely affect beneficial uses. The FERC-approved study did not include a provision for measuring floating material. The Districts are aware of no instances where floating material in Don Pedro Project waters has been reported as a potential problem.

Oil and Grease

The Basin Plan requires that water not contain oils, greases, waxes, or other material in concentrations that cause nuisance, result in visible film or coating on the surface of the water or

[19] The boundary between the thermal layers is the metalimnion, a zone of abrupt temperature change.

on objects in the water, or otherwise adversely affect beneficial uses. In 2012, the Districts looked for and did not observe any oil and grease in Don Pedro Reservoir. Samples collected adjacent to 12 recreation sites on and around Independence Day were analyzed for total petroleum hydrocarbons. At all sites, total petroleum hydrocarbon levels were below the reporting limit of 50 µ/L.

Dissolved Oxygen

The general DO WQO of 7.0 mg/L applies to the Tuolumne River and its tributaries (CVRWQCB 1998). Synoptic measurements of DO in August 2012 were all above Basin Plan numerical limits (i.e., satisfying the WQO) except in the mid-reservoir hypolimnion (3.2 mg/L), and near-dam hypolimnion (4.8 mg/L) of Don Pedro Reservoir. These results were expected, because large, deep reservoirs and lakes generally form strong thermoclines[20] with oxygen poor hypolimnia in the late summer/fall period. DO concentrations were above the Basin Plan objective at all surface sites (TID/MID 2013).

In addition to the 2012 Water Quality study data collection, the Districts have collected DO profiles since June 2011 in Don Pedro Reservoir. Tables 3.4-16 and 3.4-17 provide a summary of data collected from two of the eight locations, which are representative of conditions in the reservoir: (1) near the dam and (2) near the Highway 49 Bridge (approximately 13 miles upstream from the dam). Associated depths are shown in Figure 3.4-2.

Table 3.4-16. Monthly minimum, average and maximum dissolved oxygen (DO) concentrations (mg/L) in Don Pedro Reservoir near the dam for select months from June 2011 to September 2013.

Month	Minimum DO (mg/L)	Average DO (mg/L)	Maximum DO (mg/L)
2011			
June	7.7	8.4	9.3
July	7.0	8.0	9.8
August	6.6	7.5	8.4
September	6.2	7.1	8.1
October	5.7	7.0	8.4
November	5.9	6.9	8.1
2012			
March	5.0	6.8	10.5
April	3.7	7.0	11.0
May	4.1	6.6	9.6
June	4.0	5.9	8.2
July	4.2	6.3	8.9
August	4.6	6.6	8.1
September	3.3	5.6	7.9
October	3.3	5.5	8.0
November	3.4	5.7	8.2
2013			
February	2.6	4.7	7.5
March	0.7	5.4	7.8
April	5.1	5.7	6.9
May	5.7	6.8	8.5

[20] The thermocline is the location where the rate of temperature decrease with increasing depth is greatest.

Month	Minimum DO (mg/L)	Average DO (mg/L)	Maximum DO (mg/L)
June	5.7	6.7	8.9
July	5.1	6.1	7.8
August	No Data	No Data	No Data
September	5.7	6.7	8.5

Key: DO = Dissolved Oxygen
mg/L = milligram per Liter

Table 3.4-17. Monthly minimum, average and maximum dissolved oxygen (DO) concentrations (mg/L) in Don Pedro Reservoir near the Highway 49 Bridge for select months from June 2011 to September 2013.

Month	Minimum DO (mg/L)	Average DO (mg/L)	Maximum DO (mg/L)
2011			
June	5.7	9.3	10.6
July	6.8	8.4	9.4
August	0.8	6.8	8.4
September	2.1	6.3	8.0
October	0.8	6.3	8.1
November	5.4	7.0	8.0
2012			
March	8.6	9.0	9.9
April	No Data	No Data	No Data
May	7.8	8.7	9.5
June	5.9	6.9	7.4
July	5.5	6.6	7.2
August	No Data	No Data	No Data
September	0.6	4.4	7.9
October	No Data	No Data	No Data
November	0.0	4.7	8.3
2013			
February	7.5	8.0	8.7
March	6.9	7.8	8.3
April	6.6	7.2	7.6
May	6.6	7.8	8.4
June	5.8	7.5	8.5
July	4.5	5.9	6.8
August	No Data	No Data	No Data
September	1.4	4.3	8.4

Key: DO = Dissolved Oxygen
mg/L = milligram per Liter

DO concentrations in Don Pedro Reservoir are consistent with what is expected in deeper reservoirs and natural lakes of inland northern California. The profile is a positive heterograde curve indicating a metalimnetic[21] oxygen maxima. This occurs whenever a reservoir is stratified but most strongly in the summer. Increasing temperatures in the epilimnion result in decreased oxygen solubility, whereas typical oxygen consumption in the hypolimnion also results in a decrease in DO with depth. These metalimnetic oxygen maxima are almost always caused by algae populations producing oxygen in the metalimnion faster than they sink into the hypolimnion. The depth at which this occurs is often directly related to the transparency of water (Wetzel 1983). Figure 3.4-2 shows four reservoir DO profiles in Don Pedro Reservoir that

[21] Near or around the metalimnion.

demonstrate this condition. In the June, August, and October profiles, when the reservoir was stratified, the metalimnetic oxygen maxima are evident. Figure 3.4-3 provides the corresponding water temperature profiles.

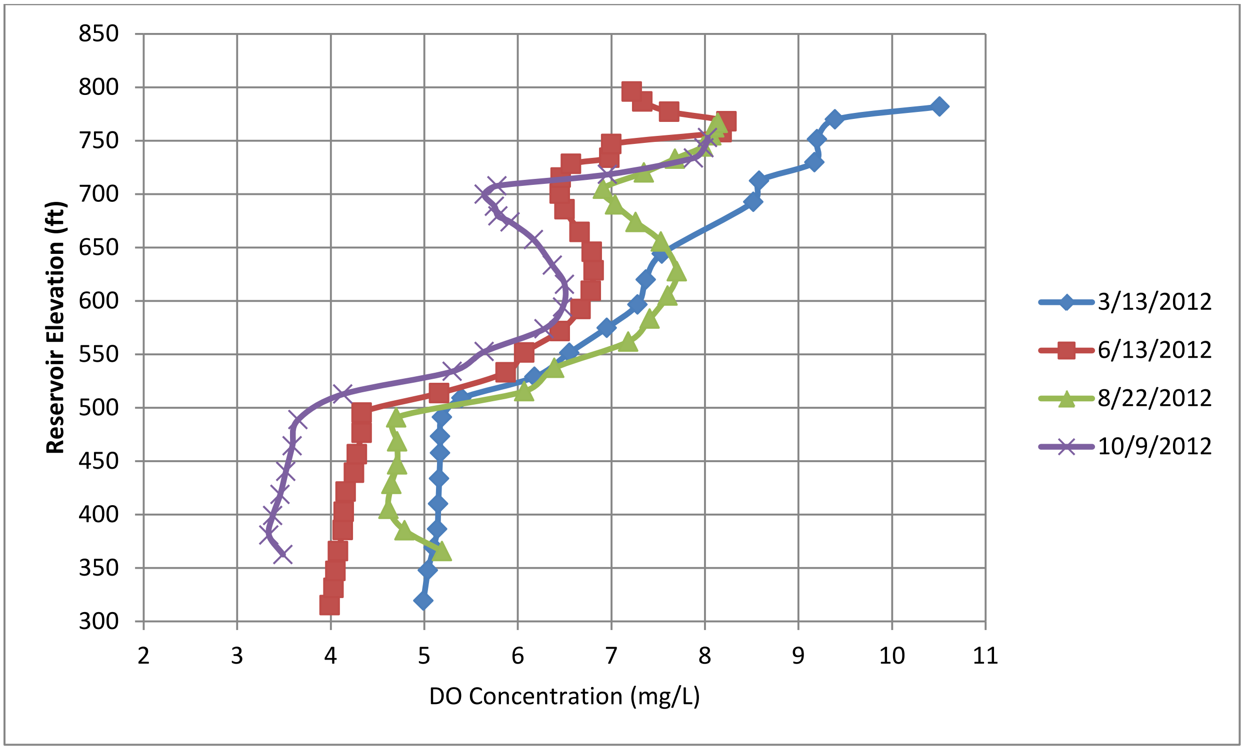

Figure 3.4-2. Dissolved oxygen profiles collected in Don Pedro Reservoir near the dam during 2012.

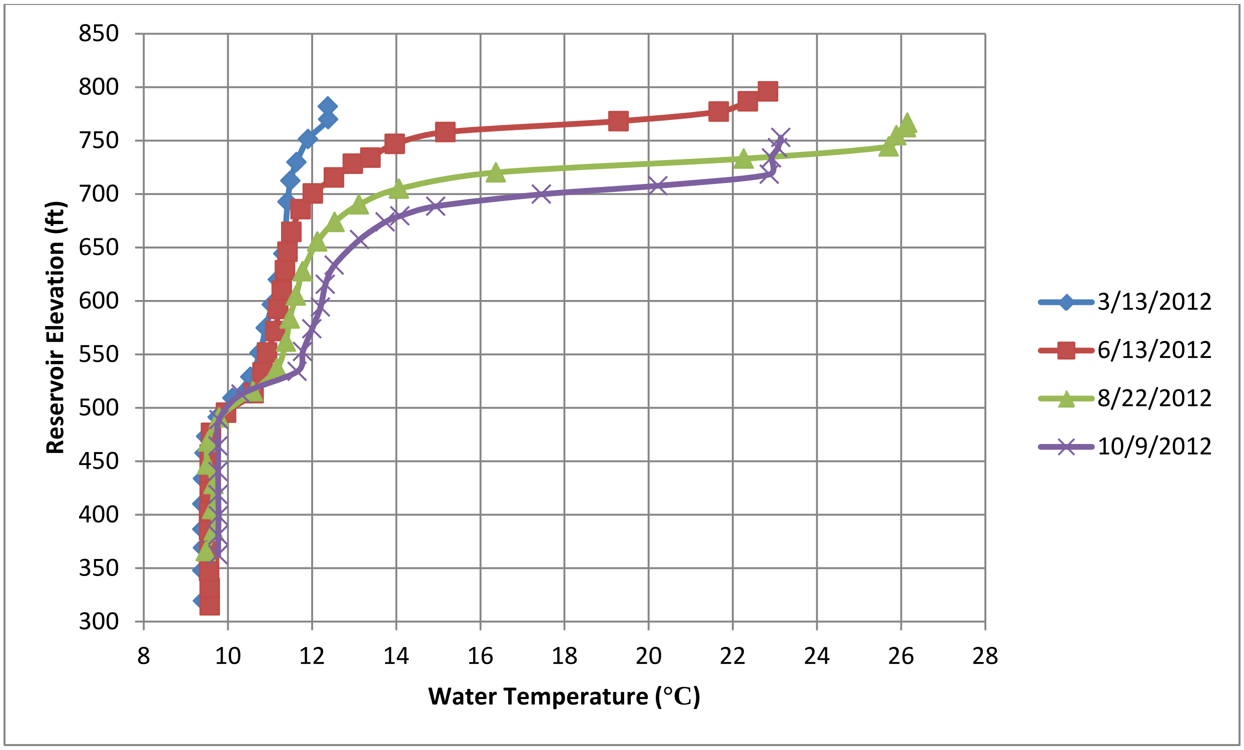

Figure 3.4-3. Water temperature profiles collected in Don Pedro Reservoir near the dam during 2012.

The Districts have also collected hourly DO data in the Tuolumne River downstream of Don Pedro Dam and powerhouse since late 2011. Table 3.4-18 shows the monthly minimum, maximum, and average hourly DO concentrations for 2012. In all but two months, October and November, each hour's DO concentration measured downstream of the dam is above the Basin Plan WQO of 7 mg/L. In October and November there were 17 days when at least one hourly recording was below 7 mg/L, with the lowest concentration being 5.8 mg/L. However, there were zero days in 2012 when the average of the day's 24 hourly DO measurements was below 7 mg/L.[22]

Table 3.4-18. Monthly minimum, average and maximum dissolved oxygen (DO) concentrations (mg/L) in the Tuolumne River downstream of Don Pedro Dam and powerhouse in 2012.

Month	Minimum DO (mg/L)	Average DO (mg/L)	Maximum DO (mg/L)
2012			
January	8.6	10.1	11.4
February	8.2	10.0	12.4
March	8.4	9.2	12.1
April	8.4	9.3	10.9
May	8.8	9.6	10.6

[22] The Districts collected DO data in the La Grange Powerhouse tailrace channel as part of the Fish Barrier Assessment (FISHBIO 2017x) conducted in support of the La Grange Hydroelectric Project licensing. Data generally indicate satisfactory conditions for aquatic life. However, during the first year of the assessment (2015), there was a brief period from late September through October during which daily instantaneous measurements of DO as low as 4.3 mg/L were recorded at the La Grange Powerhouse tailrace channel weir location. The low instantaneous DO levels appeared to be a localized event because DO levels at the main channel weir ranged from 9.1-11.1 mg/L during the same time period.

Month	Minimum DO (mg/L)	Average DO (mg/L)	Maximum DO (mg/L)
June	8.6	9.6	10.7
July	8.3	9.2	10.3
August	8.2	9.1	10.4
September	7.4	8.8	10.3
October	6.8	8.4	10.7
November	5.8	8.7	11.0
December	8.6	8.9	9.1

Key: DO = Dissolved Oxygen
mg/L = milligram per Liter

3.4.1.5 Water Temperature Regime of Don Pedro Reservoir

A comprehensive set of water temperature data for Don Pedro Reservoir has been collected by both CDFW and the Districts. Since 2004, CDFW has collected monthly temperature profiles at six stations in Don Pedro Reservoir and, since 2010, the Districts' have collected monthly temperature profiles at eight locations (Table 3.4-19; Figure 3.4-4). The eight locations measured by the Districts consist of the six CDFW sites, a site upstream of old Don Pedro Dam, and a site downstream of old Don Pedro Dam.

Table 3.4-19. Don Pedro Reservoir temperature measurement locations with period of record.

Site Location[1]	Approximate River Mile	Latitude	Longitude	Period of Record
Inflow Temperature				
Tuolumne River at Indian Creek Trail	83.0	37.88383	-120.15361	10/2010 - 11/2012
Reservoir Temperature				
At Ward's Ferry[2]	78.4	37.87744	-120.295	8/2004 – 11/2012
At Woods Creek Arm	--	37.88127	-120.415361	8/2004 – 11/2012
At Jacksonville Bridge	72.3	37.83733	-120.34525	8/2004 – 11/2012
At Highway 49 Bridge	70.1	37.83955	-120.378305	8/2004 – 11/2012
At Middle Bay	62.0	37.76794	-120.357	8/2004 – 11/2012
Upstream of Old Don Pedro Dam[3,4]	56.4	37.71316	-120.4005	7/2011 – 11/2012
Downstream of Old Don Pedro Dam[3,4]	56.3	37.712083	-120.405	7/2011 – 11/2012
Upstream of Don Pedro Dam	55.1	37.702638	-120.421722	8/2004 – 11/2012
Outflow Temperature				
Tuolumne River below Don Pedro Powerhouse[6]	54.3	37.6929	-120.421616	10/2010 - 11/2012

1 Upstream and downstream data collection sites used to validate and calibrate the Reservoir Temperature Model are also listed herein (TID/MID 2013b).
2 CCSF's site is located approximately at 763 msl and is riverine at reservoir elevations below that level. In recent years, CDFW started to collect the Ward's Ferry profiles at an alternative in-reservoir site.
3 Old Don Pedro Dam at RM 56.4 was submerged in 1971 with the filling of Don Pedro Reservoir
4 The Old Don Pedro Dam had 12 gated outlets arranged in two rows of six gates. Each outlet was 52-inches in diameter; the lower row of six have a centerline at elevation 421 ft and the upper row of six has a centerline of elevation 511 ft. All of these gates were left in the open position when Old Don Pedro Dam was inundated by the new Don Pedro Dam. There are also three 5-ft diameter sluiceway gates, each with a centerline at 355 ft; these gates are believed to be closed.
5 Outflows from Don Pedro Reservoir are provided by the powerhouse intake tunnel with a centerline elevation of 534 ft.

Water temperatures in Don Pedro Reservoir are consistent with warm monomictic[23] lakes; temperatures do not drop below approximately 10º C and the reservoir circulates freely in winter

23 A lake or reservoir that mixes one time each year.

and stratifies in summer. Ice does not form on the reservoir, and the reservoir mixes once in winter.

With respect to temperature patterns, the three years of data collection (2011, 2012, and 2013) represent a range of hydrologic conditions, with 2011 being a wet year, and 2012 and 2013 being dry years. Water temperature profiles for the Don Pedro Dam forebay are provided in Figure 3.4-5, Figure 3.4-6, and Figure 3.4-7, respectively. The 2011 vertical temperature profiles indicate that from January through March the reservoir was not stratified and equilibrium temperatures were around 10^{o} C. In April the data indicate significant warming at the surface, with temperatures around 18^{o} C, and initial reservoir stratification beginning to occur. The data for May and June look similar to April, but with the surface heat penetrating to some considerable depth. By July the surface temperatures have risen above 25^{o} C and the reservoir temperature stratification is well-defined.

The profiles show a decrease in temperature with depth that extends some 200 ft until the temperature stabilizes around 10–12^{o} C. The temperature stratification remains strong through July, August, and September. At the end of September the reservoir is still strongly stratified, but surface temperatures have dropped by a couple of degrees and were just below 25^{o} C. When the last profiles were measured on October 13 of 2011 the reservoir remained stratified. Surface temperatures had continued to drop and were around 20^{o} C. The 2012 and 2013 years showed similar characteristics, but with some alteration probably due to being drier hydrologic years.

The Districts continued to measure temperature at the locations shown in Figure 3.4-4 during 2014, 2015, and 2016. Temperature profiles for the Don Pedro Dam forebay based on these years (Figures 3.4-8, 3.4-9, and 3.4-10) show that minimum and maximum reservoir temperatures, and seasonal patterns of stratification, were similar to those observed 2011–2013.

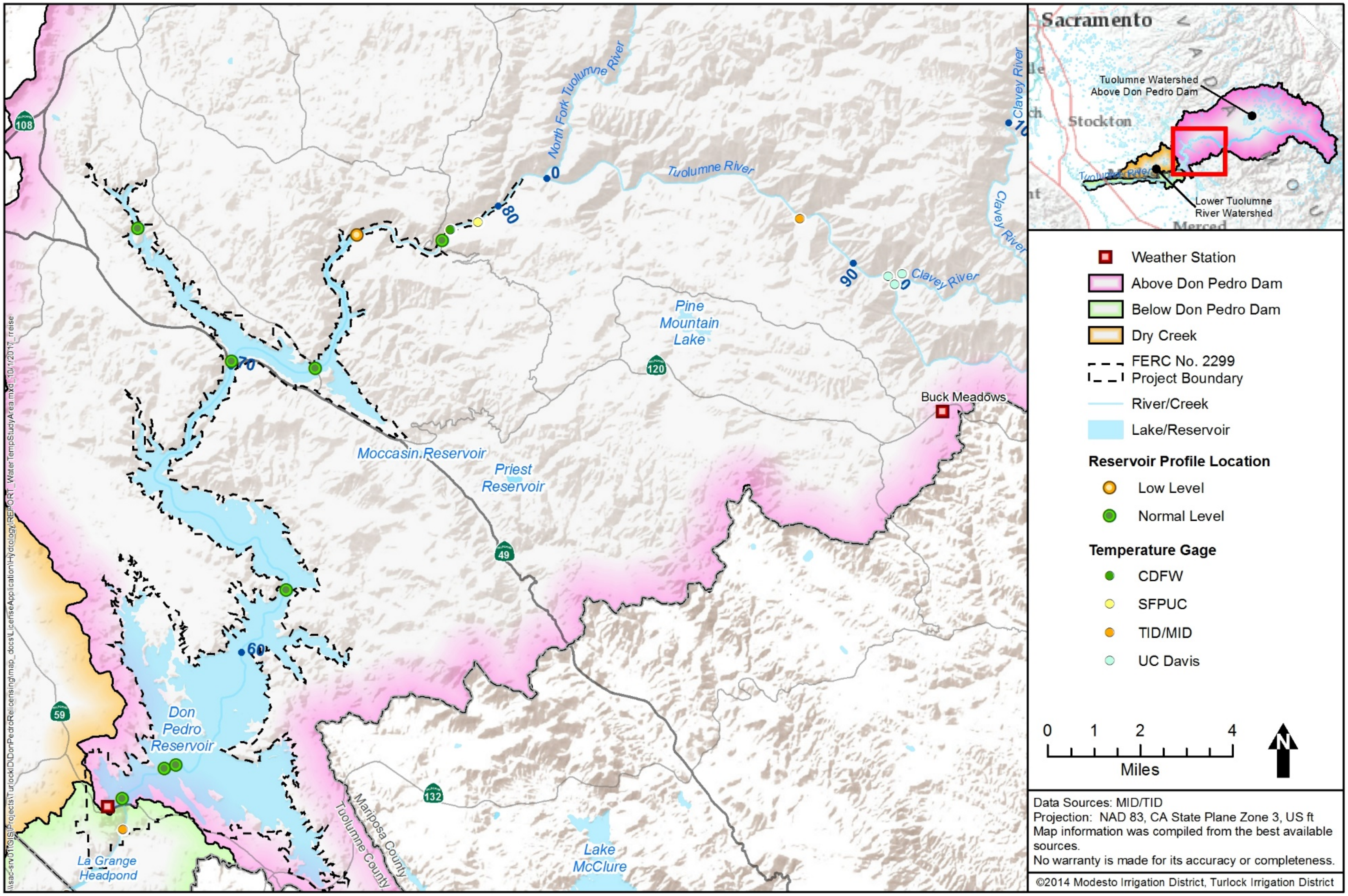

Figure 3.4-4. Don Pedro Reservoir temperature profile locations.

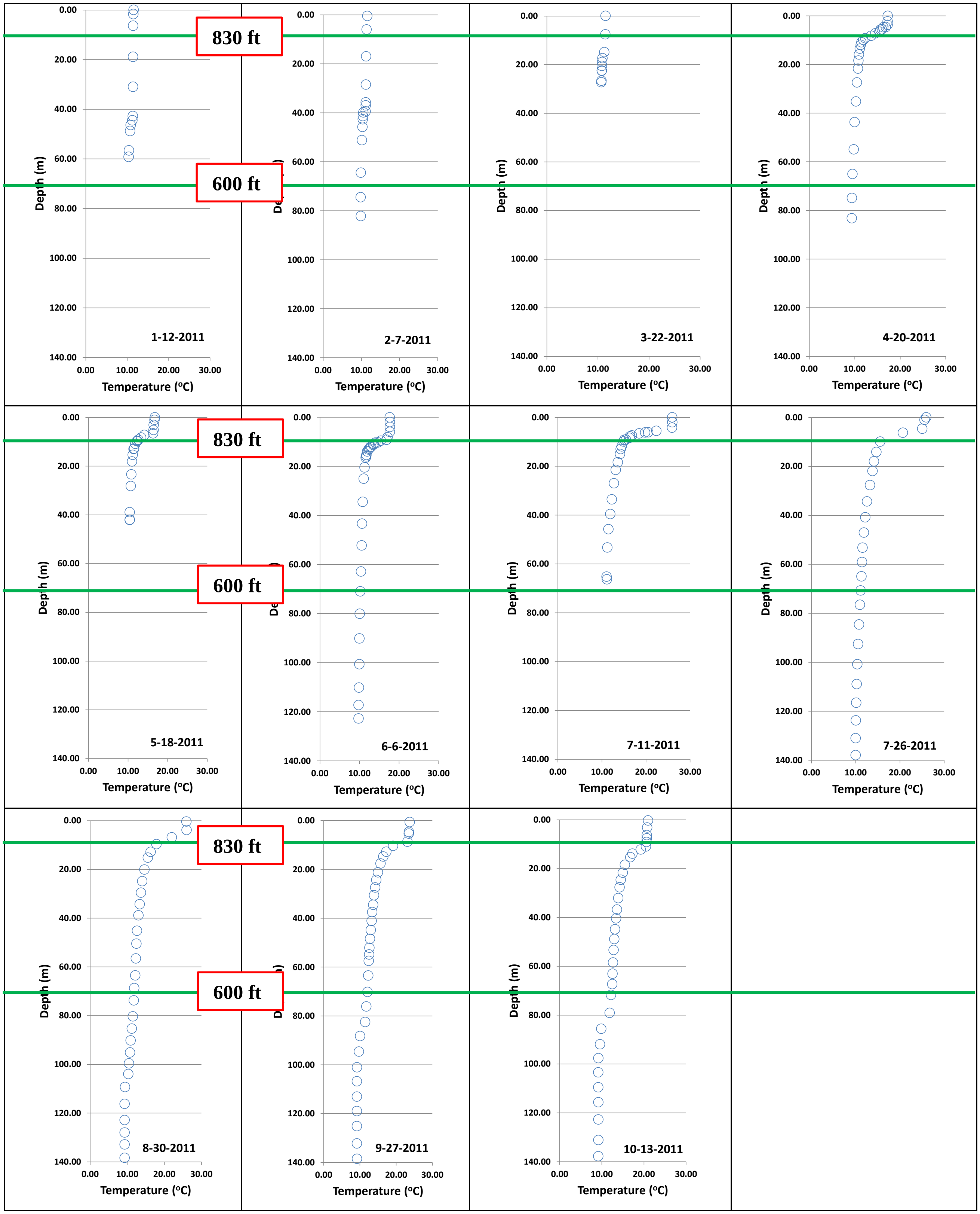

Figure 3.4-5. Water temperature profiles recorded in the Don Pedro Dam forebay in 2011; green lines indicate elevation.

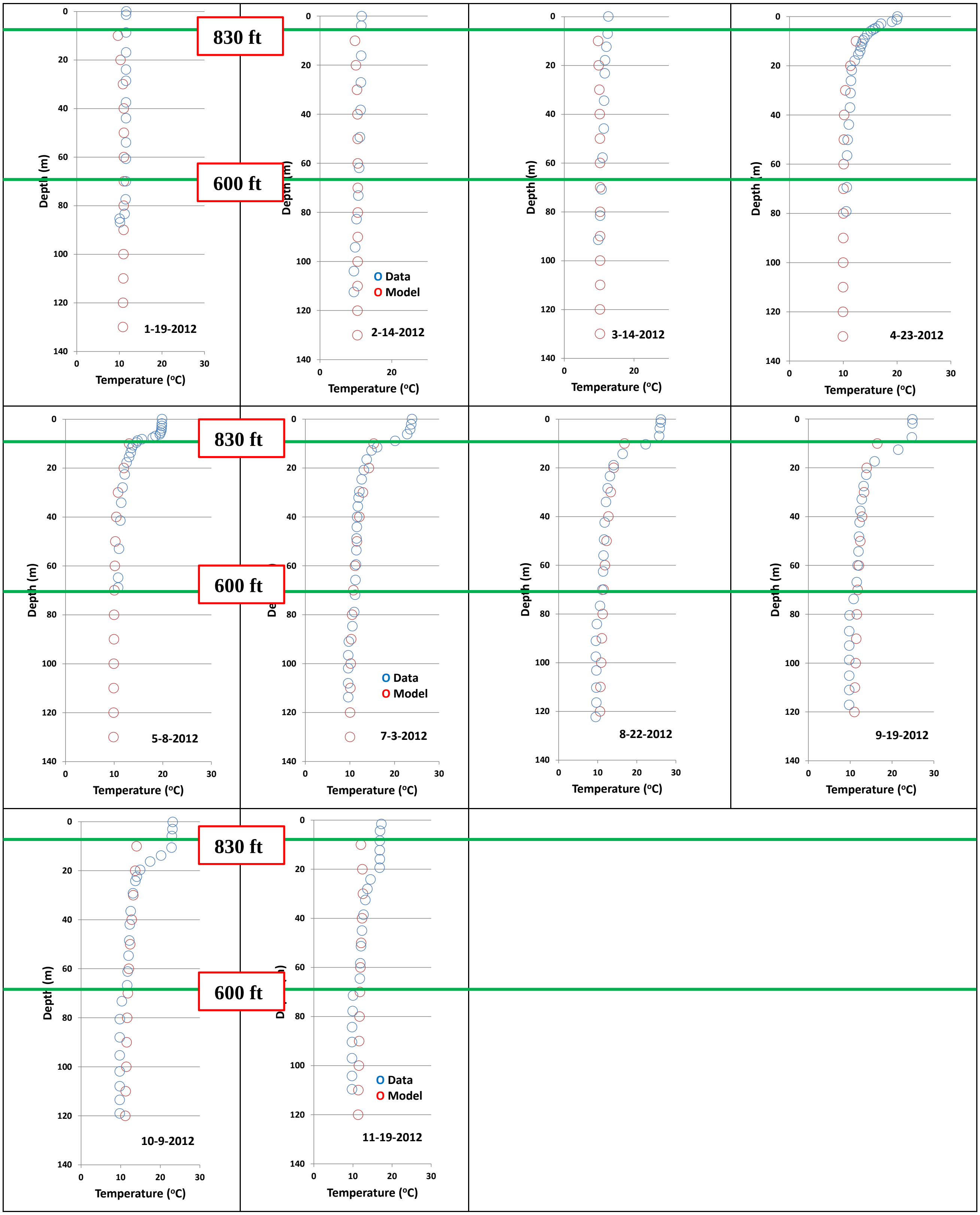

Figure 3.4-6. Water temperature profiles recorded in the Don Pedro Dam forebay in 2012; green lines indicate elevation.

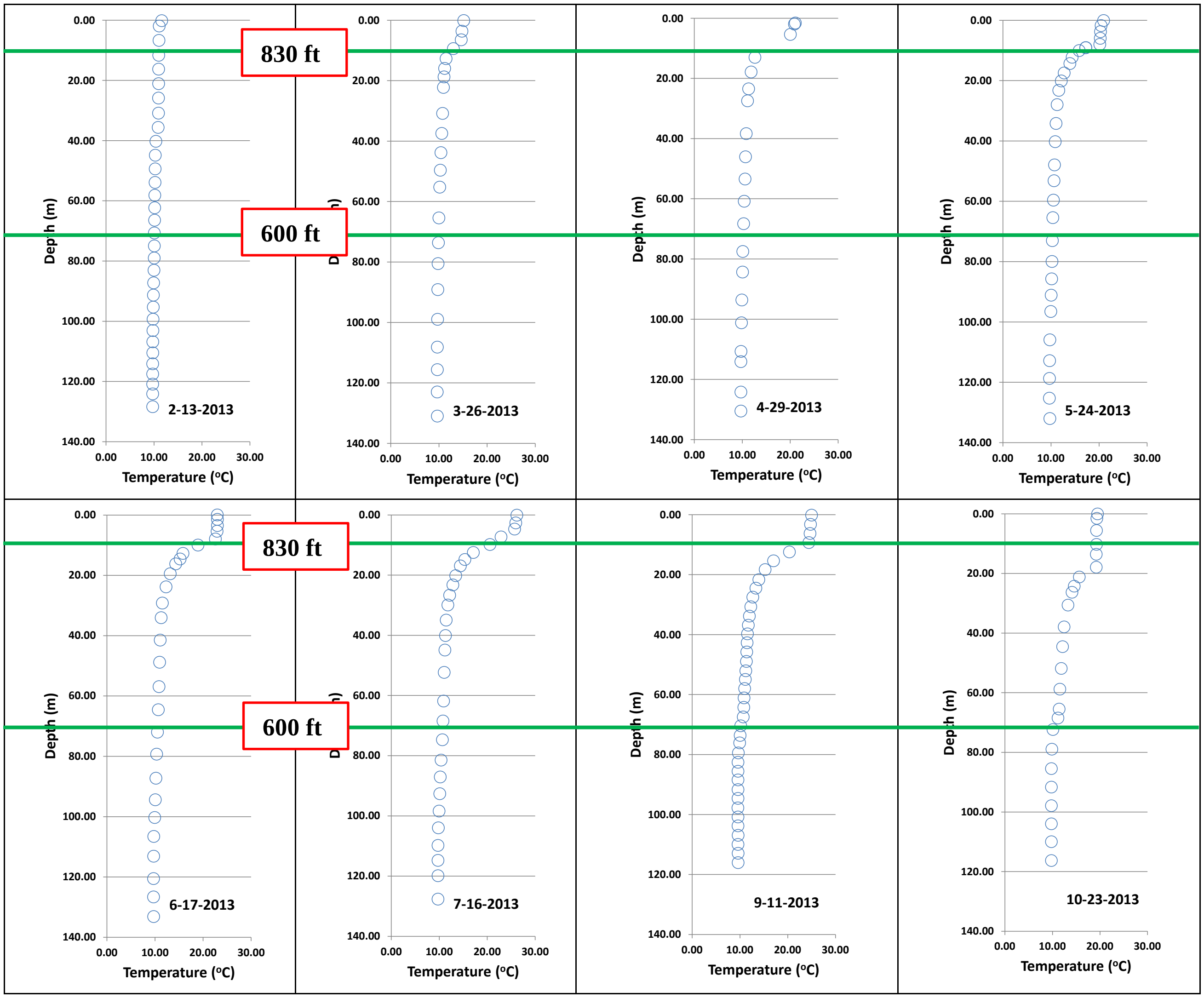

Figure 3.4-7. Water temperature profiles recorded in the Don Pedro Dam forebay in 2013; green lines indicate elevation.

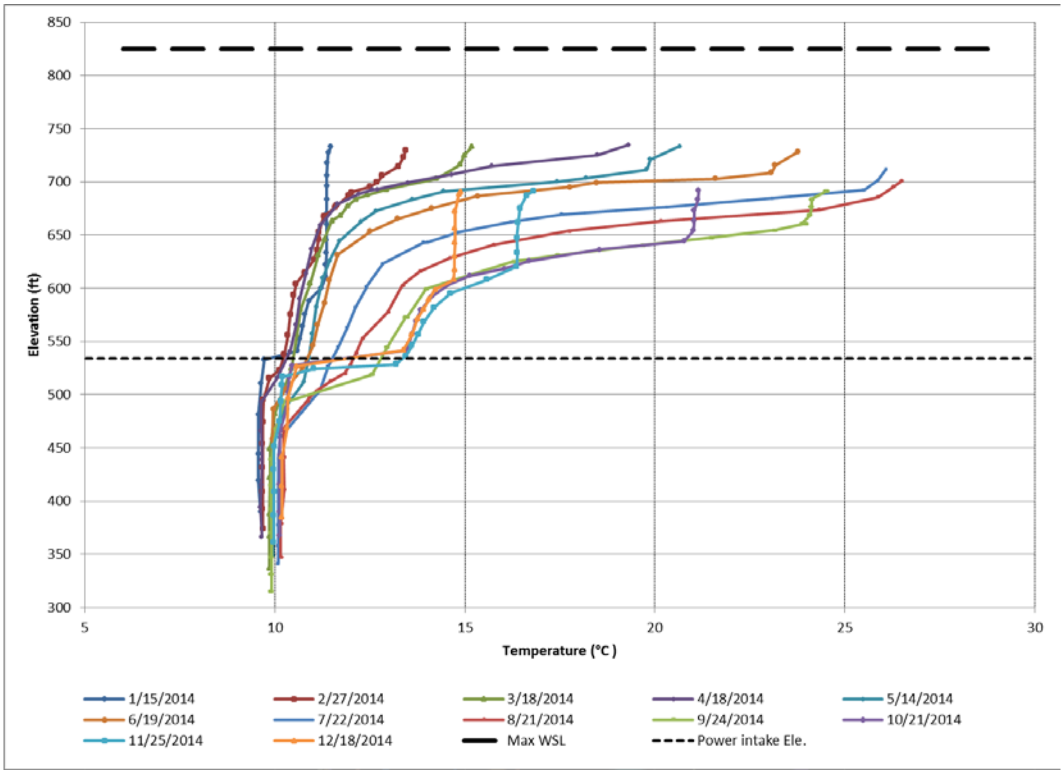

Figure 3.4-8. Water temperature profiles recorded in the Don Pedro Dam forebay in 2014.

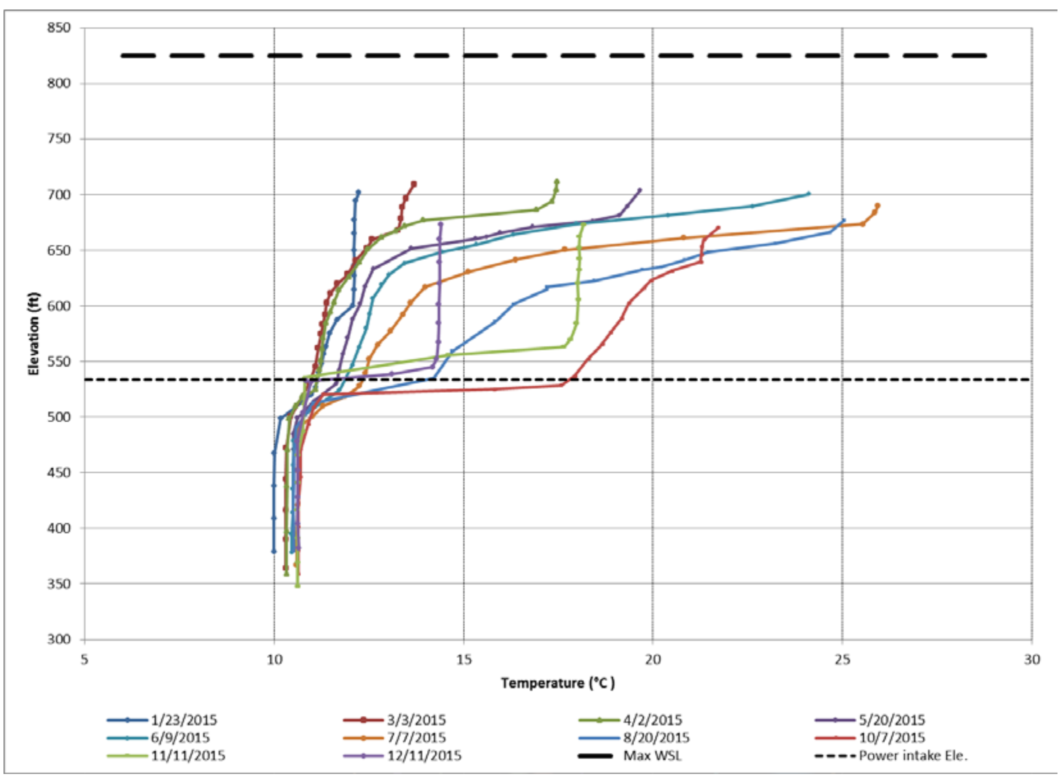

Figure 3.4-9. Water temperature profiles recorded in the Don Pedro Dam forebay in 2015.

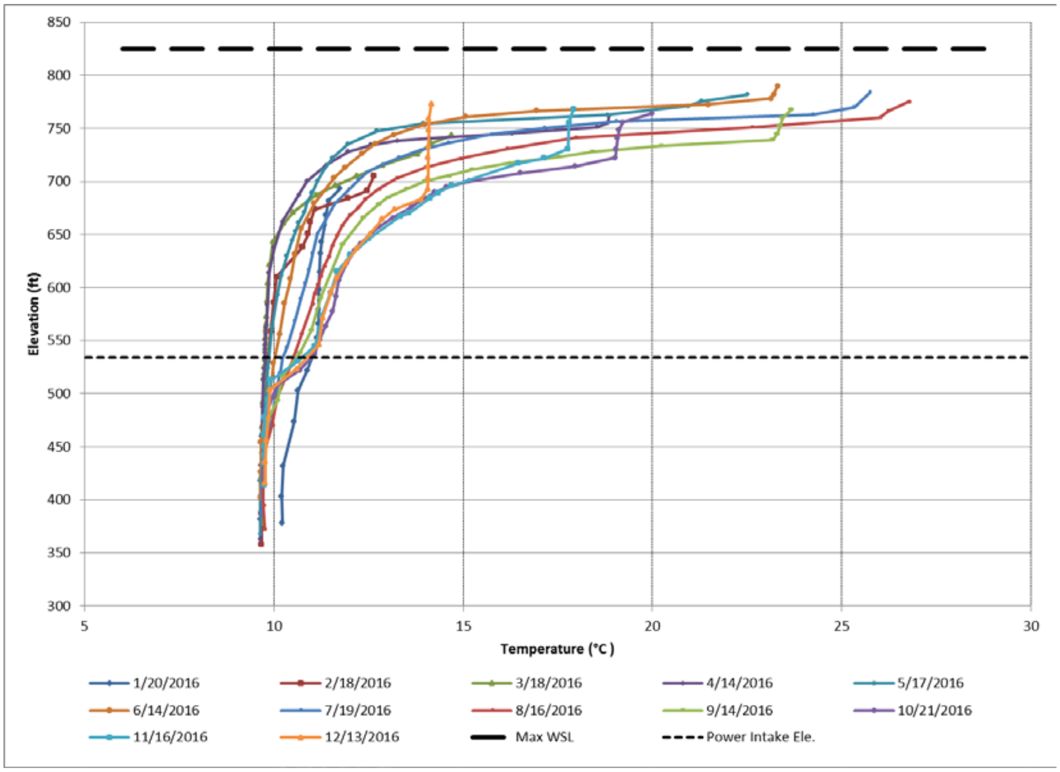

Figure 3.4-10. Water temperature profiles recorded in the Don Pedro Dam forebay in 2016.

3.4.1.6 Water Temperature between Don Pedro Dam and La Grange Diversion Dam

Temperatures in the Tuolumne River between Don Pedro Dam and La Grange Diversion Dam reflect the temperature of discharges released from the Don Pedro Project. Releases from Don Pedro Dam reflect hypolimnion temperatures in Don Pedro Reservoir and generally have not exceeded 13 ºC (55.4º F) and are often much cooler, being between 9, 5 degrees and 11.5 degrees most of the time (Table 3.4-20). The La Grange headpond does not stratify because of its small size and low depths relative to the flow passing through it. By the time Don Pedro discharges reach La Grange Diversion Dam, water temperatures have warmed slightly, about 1ºC or less.

Table 3.4-20. Don Pedro hypolimnion, Don Pedro Project outflow, and La Grange headpond temperature comparison.

Month	Average Temperature (°C)								
	Don Pedro Hypolimnion Upstream of Don Pedro Dam (DPDAM) Elevation 535 ft msl[1]; approx. RM 55.1			Don Pedro Project Outflow RM 54.3			Tuolumne River above La Grange Diversion Dam RM 52.2		
	8/2004 – 11/2012 (most of 2009 missing)			1/1987 - 9/1988 and 5/2010 - 2/2013			8/2011 – 12/2012		
	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest
January	10.8	11.4	10.2	10.5	11.7	8.9	11.3	11.3	11.3
February	10.1	11.0	9.5	9.7	11.4	8.5	10.8	10.8	10.8
March	10.1	10.7	9.3	9.3	11.1	7.8	10.8	10.8	10.8
April	10.2	11.4	9.3	9.4	10.9	8.3	10.9	10.9	10.9
May	10.4	10.8	9.8	9.8	11.1	8.6	11.0	11.0	11.0
June	10.7	11.6	10.0	10.2	11.7	9.0	11.2	11.2	11.2
July	11.0	12.1	10.4	10.6	11.7	9.4	11.5	11.5	11.5
August	11.3	12.2	10.6	10.9	12.2	9.4	11.8	11.8	11.8
September	11.4	11.9	10.8	11.1	12.2	10.0	12.0	12.0	12.0
October	11.5	11.9	11.0	11.3	12.2	10.0	12.1	12.1	12.1
November	11.4	12.0	10.7	11.3	13.3	9.3	11.2	11.2	11.2
December	11.5	12.3	11.1	11.2	12.2	10.1	11.2	11.2	11.2

[1] When profile did not extend down to 535 ft msl, the temperature measured at the bottom of the Don Pedro Reservoir profile was used for calculating averages.

Key: ft = feet, msl = mean sea level, RM = River Mile

The Basin Plan WQO for temperature states that "at no time or place shall the temperature of any COLD water be increased by more than 5°F above natural receiving water temperature" (CVRWQCB 1998, as amended). Temperatures in the reach downstream of the Project Boundary are dominated by the cold water released from the Don Pedro Project.

3.4.1.7 With- and Without-Dam Temperature Conditions

As explained previously, the focus of the Jayasundara et al. (2017) was to develop a flow and water temperature model to simulate water temperature conditions in the Tuolumne River without the existing Hetch Hetchy (including Cherry and Eleanor reservoirs), Don Pedro, and La Grange projects. The model was developed to complement detailed models developed for Don Pedro Reservoir and La Grange headpond (TID/MID 2017e) and the lower Tuolumne River (TID/MID 2017b). Supporting data included the development of long-term flow and meteorological conditions to assess flow and water temperatures over a multi-decade period, i.e., 1970 to 2012.

Figures 3.4-11 through 3.4-20 provide a comparison of simulated without-dams 7DADM temperatures to simulated (below the Don Pedro Project) and empirically derived (above the Don Pedro Project) with-dams temperatures at the following locations: (1) below the South Fork Tuolumne River (≈ RM 98), (2) the Tuolumne River below Indian Creek (≈ RM 88), (3) immediately below Don Pedro Dam (≈ RM 54), (4) RM 51.5, 46, 40, 34, and 24 in the lower Tuolumne River above Dry Creek (5) and RM 10 and RM 1 on the lower Tuolumne River below Dry Creek.

Comparison of the 7DADM temperatures under with- and without-dams conditions upstream of the Don Pedro Project indicates that summer 7DADM water temperatures would be substantially warmer, up to 7°C, in the absence of the upstream Hetch Hetchy impoundments than they are under existing conditions, particularly at RM 98 (Figures 3.4-11 and 3.4-12). With-dams temperatures are nearly the same to slightly warmer, up to 2°C, than without-dams temperatures during much of the remainder of the year (Figures 3.4-11 and 3.4-12). As noted in the figure captions, plots for RM 98 and RM 88 compare simulated without-dams temperatures to empirically derived with-dams temperatures.

The without-dams simulation reveals that 7DADM water temperatures in the Tuolumne River mainstem, in the absence of impoundments, would approach thermal equilibrium well upstream of the current location of the Don Pedro Project, that is, without-dams temperature profiles at RMs 88 and 98 are essentially the same (Figures 3.4-11 and 3.4-12). Moreover, high without-dams 7DADM temperatures at RMs 88 and 98 (≈ 24°C) are similar to the high without-dams temperatures in the lower river (≈ 25°C) (compare Figures 3.4-11 and 3.4-12 to Figures 3.4-13–3.4-17).

Immediately below Don Pedro Dam (RM 54), with-dams 7DADM temperatures are relatively cool year-round, with little variability (Figure 3.4-13), because water is released from the reservoir's hypolimnion. Because of the thermal mass of the reservoir, water at depth is to a large degree buffered from the influence of seasonal and diel variability in air temperature and other climatic factors, at least when reservoir levels remain high. With-dams 7DADM temperatures are much cooler than without-dams temperatures in summer but are slightly warmer from November through February (Figure 3.4-13).

With-dams temperatures during summer rise significantly with increasing distance downstream of the current Project Boundary. Under Base Case conditions, by RM 46, summer 7DADM temperatures have climbed back to 20°C, very close to the 7DADM temperatures experienced above Don Pedro Reservoir (Figure 3.4-15). However, this is still 5°C below without-dam conditions. By RM 40 (near Roberts Ferry Bridge), average with-dam 7DADM temperatures in July reach 22°C (Figure 3.4-16). By RM 34, thermal equilibrium has largely been restored under with-dams conditions, i.e., the highest 7DADM temperatures in summer are around 24°C, very close to the 7DADM without-dams conditions (Figure 3.4-17). From this point downstream to the confluence with the San Joaquin River (Figures 3.4-18 - 3.4-20), with-dam 7DADM summer temperatures exceed without-dam temperatures by 2 to 3°C. Also, at all locations in the lower river, except immediately below Don Pedro Dam, there is a decrease in daily average water temperatures from mid-April to mid-May under the with-dams condition, which is the result of pulse flow releases scheduled to benefit fish downstream of La Grange Diversion Dam contained in the Base Case.

Without-dams temperatures are measurably cooler from mid-May (following the Base Case pulse flow) through the end of June downstream of about RM 40 under the Base Case.

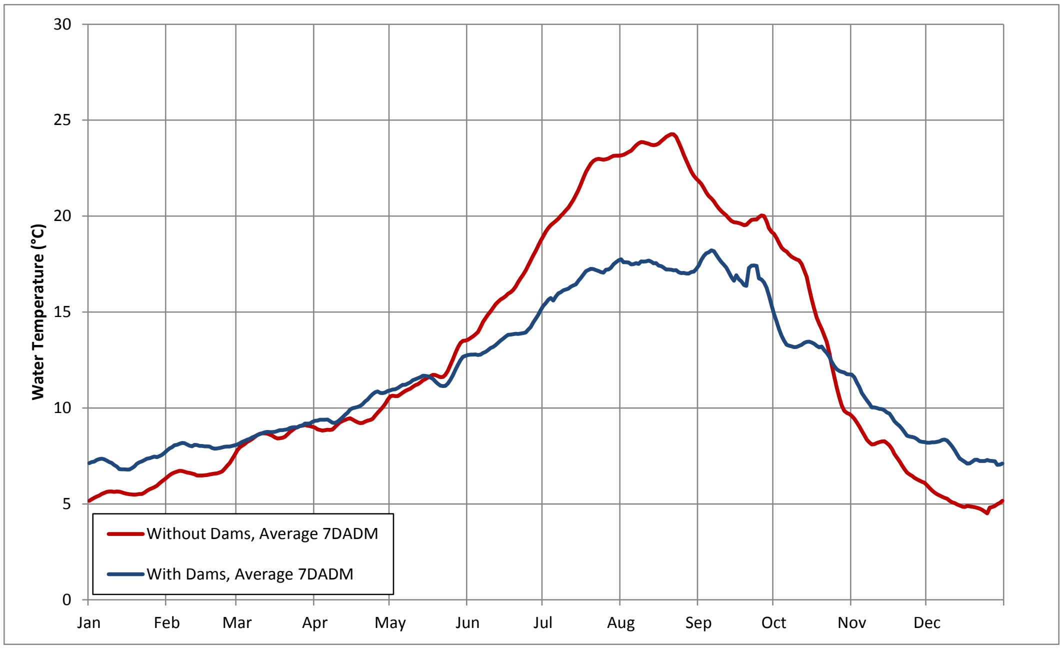

Figure 3.4-11. Comparison of 7DADM water temperatures under with- and without-dams conditions in the Tuolumne River below the South Fork Tuolumne River (≈RM 98). Without-dams temperatures are simulated based on the period 1970 - 2012 (Jayasundara et al. 2017), and with-dams temperatures are based on data collected by temperature loggers from 2005 - 2012.

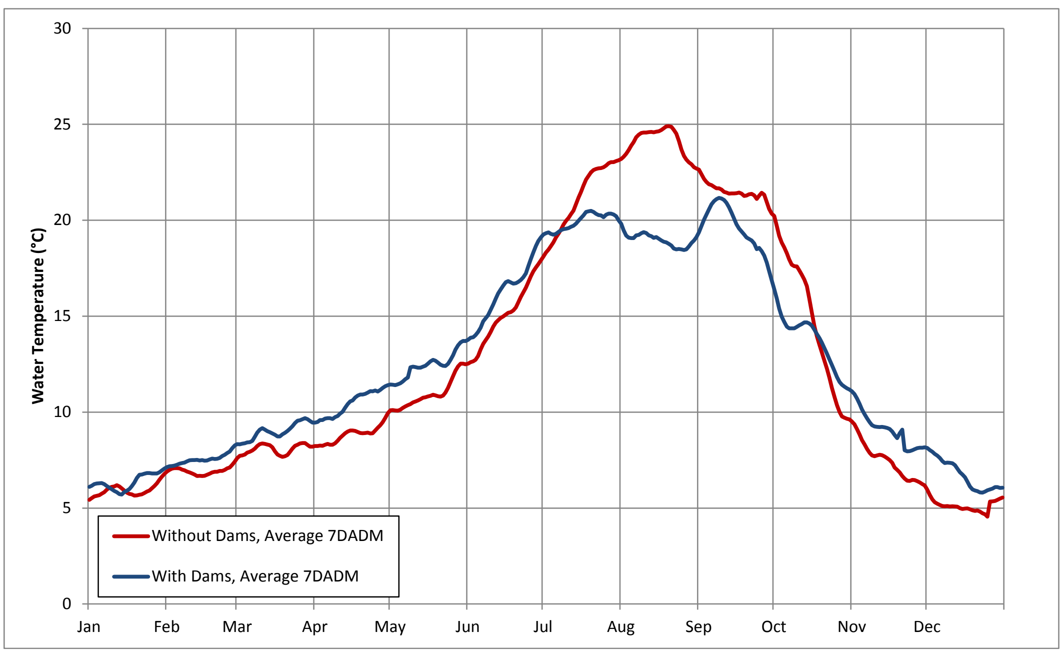

Figure 3.4-12. Comparison of 7DADM water temperatures under with- and without-dams conditions in the Tuolumne River below Indian Creek (≈RM 88). Without-dams temperatures are simulated based on the period 1970 - 2012 (Jayasundara et al. 20174), and with-dams temperatures are based on data collected by temperature loggers from 2009 – 2012.

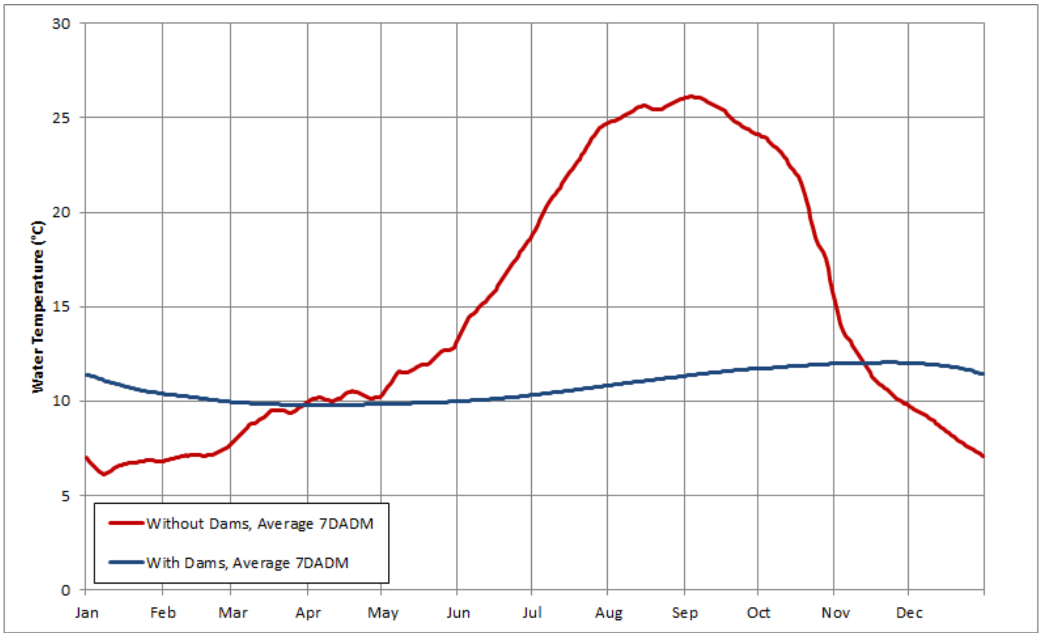

Figure 3.4-13. Comparison of 7DADM water temperatures under with- and without-dams conditions in the Tuolumne River below Don Pedro Dam (≈RM 54). Without-dams temperatures (Jayasundara et al. 2017) and with-dams (Base Case) temperatures (TID/MID 2013d) are simulated based on the period 1970 - 2012.

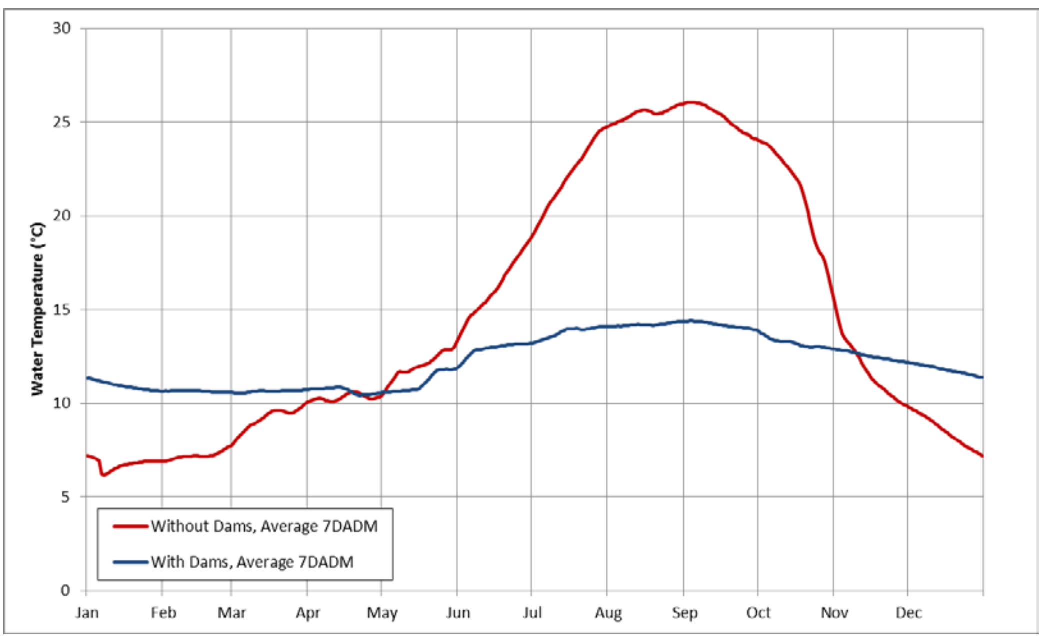

Figure 3.4-14. Comparison of 7DADM water temperatures under with- and without-dams conditions in the lower Tuolumne River at RM 51.5. Without-dams temperatures (Jayasundara et al. 2017) and with-dams (Base Case) temperatures (TID/MID 2013d) are simulated based on the period 1970 – 2012.

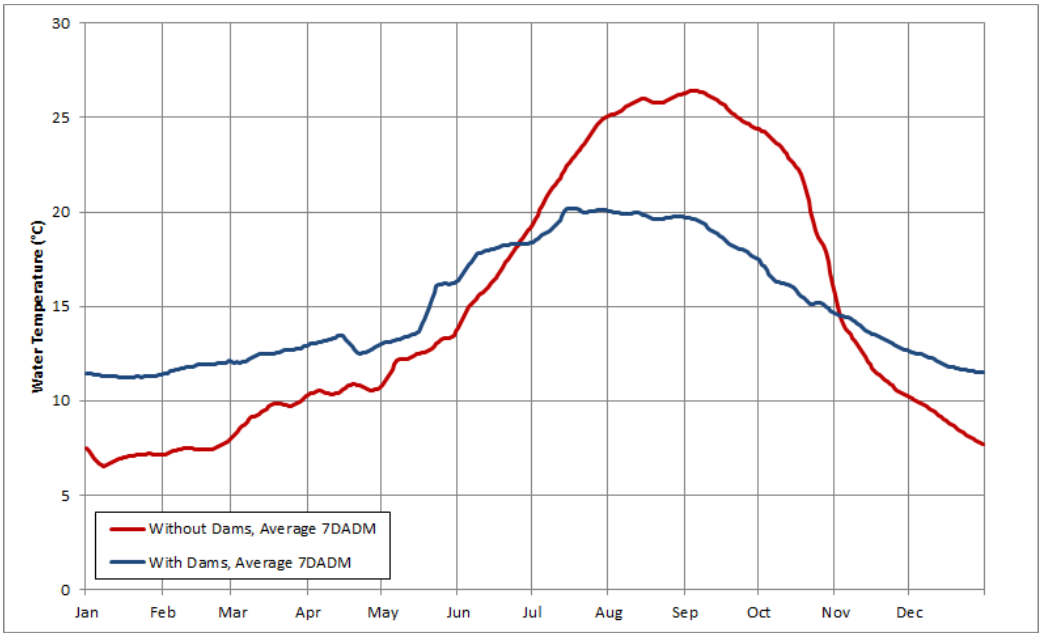

Figure 3.4-15. Comparison of 7DADM water temperatures under with- and without-dams conditions in the lower Tuolumne River at RM 46. Without-dams temperatures (Jayasundara et al. 2017) and with-dams (Base Case) temperatures (TID/MID 2013d) are simulated based on the period 1970 - 2012.

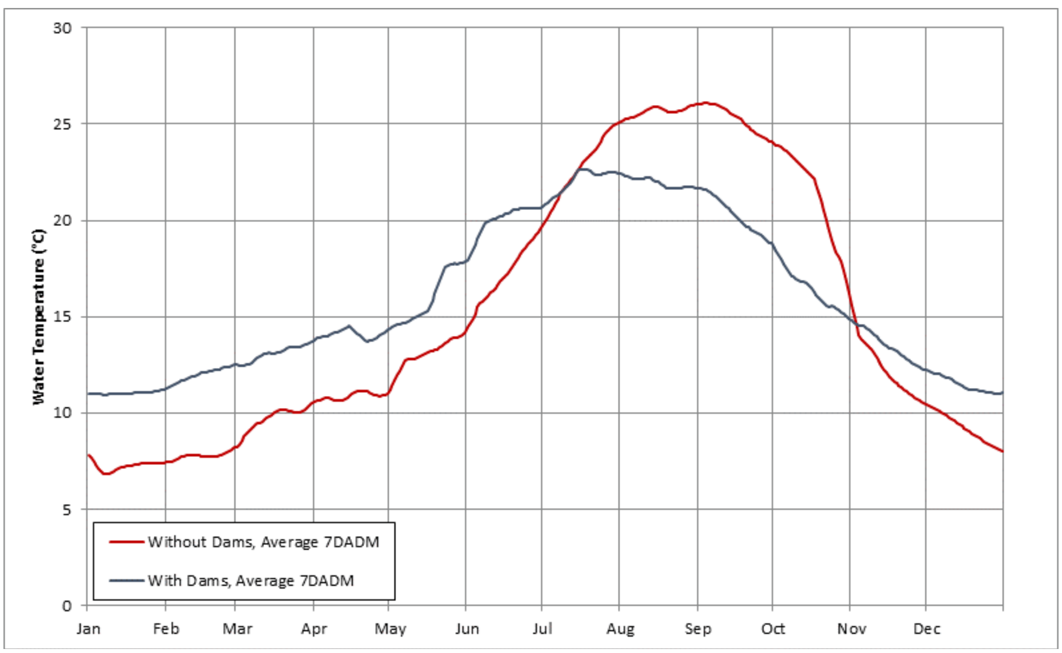

Figure 3.4-16. Comparison of 7DADM water temperatures under with- and without-dams conditions in the lower Tuolumne River at RM 40. Without-dams temperatures (Jayasundara et al. 2017) and with-dams (Base Case) temperatures (TID/MID 2013d) are simulated based on the period 1970 - 2012.

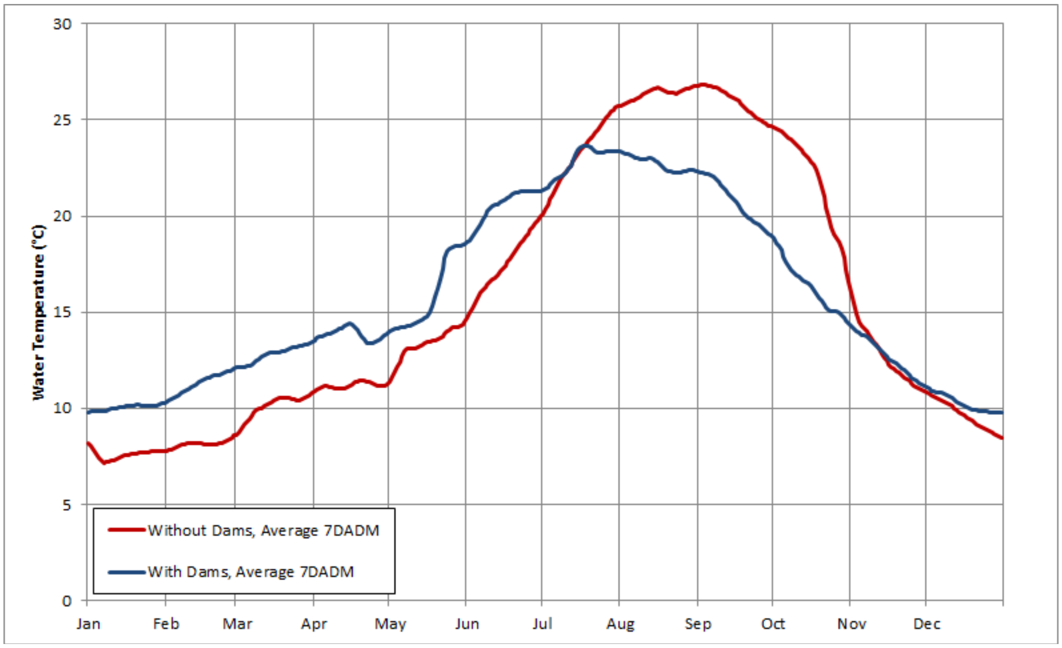

Figure 3.4-17. Comparison of 7DADM water temperatures under with- and without-dams conditions in the lower Tuolumne River at RM 34. Without-dams temperatures (Jayasundara et al. 2017) and with-dams (Base Case) temperatures (TID/MID 2013d) are simulated based on the period 1970 - 2012.

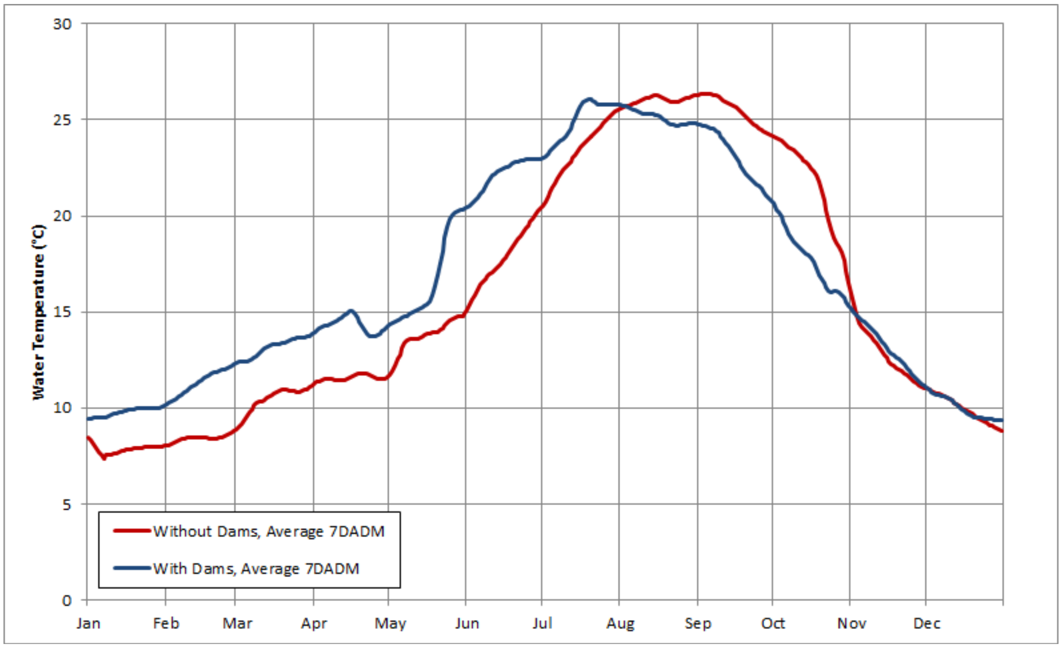

Figure 3.4-18. Comparison of 7DADM water temperatures under with- and without-dams conditions in the lower Tuolumne River at RM 24. Without-dams temperatures (Jayasundara et al. 2017) and with-dams (Base Case) temperatures (TID/MID 2013d) are simulated based on the period 1970 - 2012.

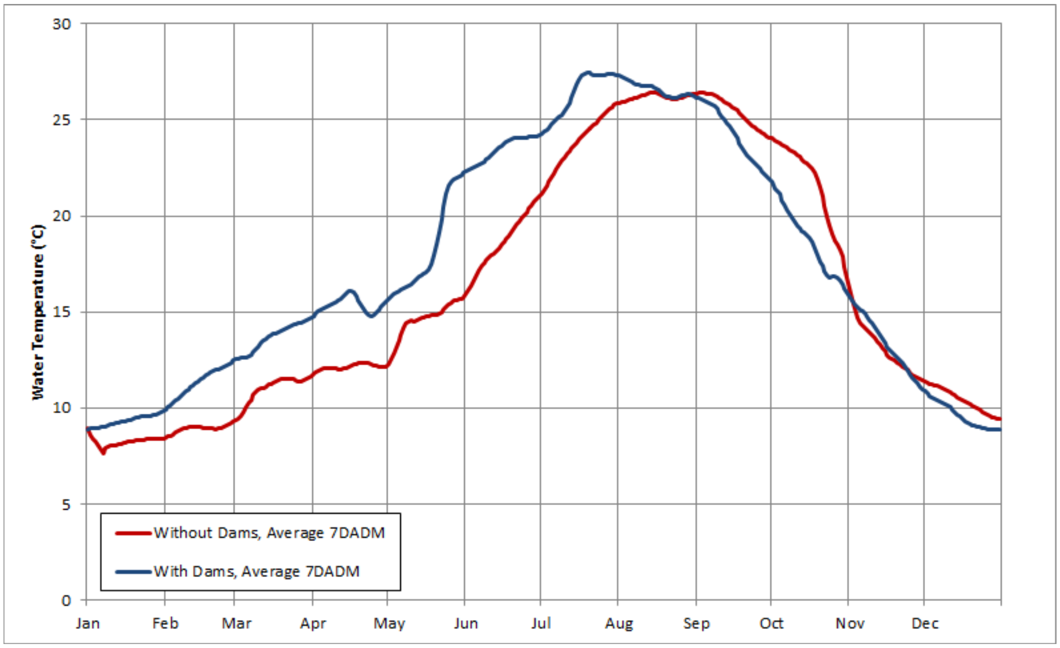

Figure 3.4-19. **Comparison of 7DADM water temperatures under with- and without-dams conditions in the lower Tuolumne River at RM 10. Without-dams temperatures (Jayasundara et al. 2017) and with-dams (Base Case) temperatures (TID/MID 2013d) are simulated based on the period 1970 - 2012.**

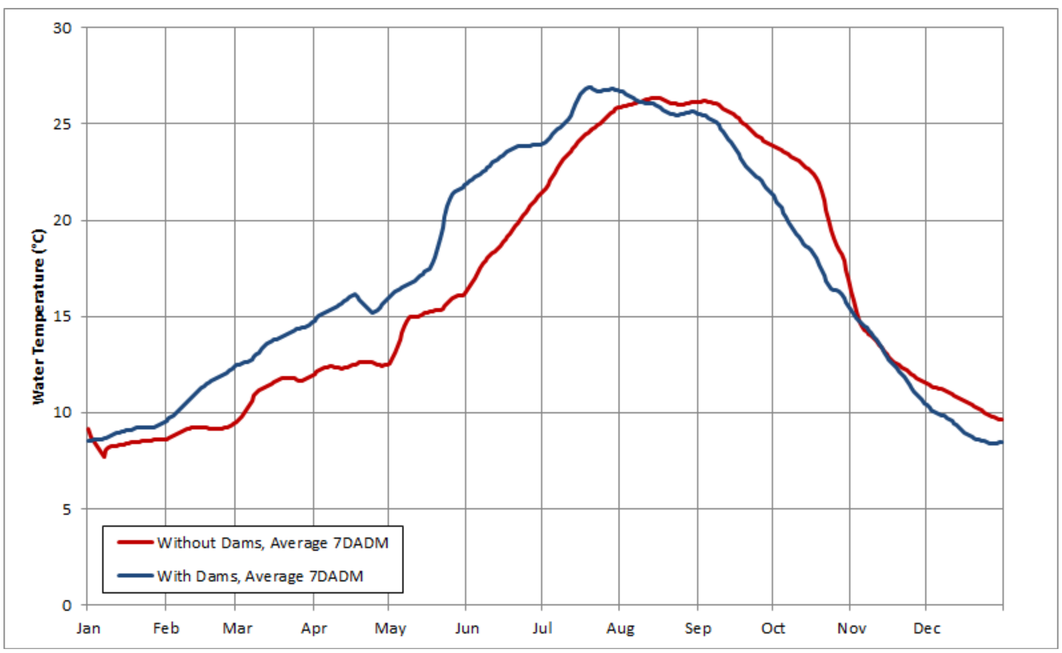

Figure 3.4-20. **Comparison of 7DADM water temperatures under with- and without-dams conditions in the lower Tuolumne River at RM 1. Without-dams temperatures (Jayasundara et al. 2017) and with-dams (Base Case) temperatures (TID/MID 2013d) are simulated based on the period 1970 - 2012.**

3.4.2 Resource Effects of the Proposed Action

FERC's SD2 (page 35) identifies the following issues related to water resources:

- Effects of project operation on the quantity and timing of streamflow in the project-affected downstream reach, including water storage, peaking operations, and ramping rates.
- Potential effects of project operation and maintenance on water quality, water temperature, and water quantity in the project reservoir and the project-affected downstream reach.

The following paragraphs address the issues identified by FERC in its SD2, but in the context of what can be expected to occur under an extension into the future of existing Don Pedro Project baseline conditions. As explained above, water management is driven by the primary Don Pedro Project purposes; hydropower generation is a consequence of flows scheduled for release to satisfy the primary purposes of the Don Pedro Project.

3.4.2.1 Effects of the Proposed Action on Don Pedro Reservoir

The Proposed Action under review by FERC is the issuance of a new license to the Districts to authorize the continued generation of hydroelectric power at Don Pedro Dam and implementation of the Districts' proposed resource measures. As such, and as generally described in FERC's SD2 issued on July 25, 2011, any alternatives to mitigate the Don Pedro Project's effects ("mitigation strategies") must be reasonably related to the purpose and need for the Proposed Action, which in this case is whether, and under what terms, to authorize the continuation of hydropower generation at the Don Pedro Project.

As explained in Exhibit B of this AFLA, flows are released from Don Pedro Reservoir to satisfy the following requirements: (1) flood flow management, including pre-releases in advance of anticipated high flows during wet years to maintain river flows at the Modesto gage below 9,000 cfs, (2) the Districts' irrigation and M&I demands, including flows to maintain water storage in Turlock Lake and Modesto Reservoir, and (3) protection of aquatic resources in the lower Tuolumne River in accordance with the terms of the FERC license. The first two of these, i.e., flood control and water supply for irrigation and M&I uses, are primary purposes of the Don Pedro Project. Once the weekly and daily flow schedules are established based on these demands, outflows from the Don Pedro powerhouse are scheduled to deliver these flows. During on-peak periods of electric energy demand, outflows may be shaped to generate more electricity during on-peak periods and less during off-peak periods, subject to meeting the requirements of the pre-established flow schedule and the physical constraints of the Districts' irrigation system. In accordance with the Districts' "water-first" policy, flow releases are scheduled around the three requirements listed above, then delivered via the generation units up to their capacity and availability. Hydropower generation at the Don Pedro Project is a secondary consideration with respect to flow scheduling.

Both TID and MID experience their greatest on-peak demands during the summer months. As demonstrated in Exhibit B, the change in Don Pedro generation from off-peak to on-peak periods is relatively small on average. This change in generation from on-peak to off-peak periods reflects the minor degree of hourly shaping of daily flows that occurs. The amount of daily shaping that can be achieved is not only limited by the water supply scheduling consistent with the primary purposes of the Don Pedro Project, but also other physical and operational constraints. First, the volume of usable storage in La Grange headpond is not sufficient to allow it to act as a re-regulating reservoir and flows released by the Don Pedro hydropower units simply pass through the La Grange pool virtually unchanged. Second, while the TID main canal, the larger of the two main canals, has a design hydraulic capacity of 3,400 cfs, flow may be restricted to a maximum of approximately 2,500 cfs for safety reasons and ramping rates in the main canal are constrained to about 300 cfs per hour, or 10 MW/hr, hardly conducive to a peaking or load-following operation. Also, the operation of the Districts' irrigation water storage reservoirs – Turlock Lake and Modesto Reservoir – have limited storage capacities, the use of which are driven by irrigation purposes and needs. Winter hydropower generation at Don Pedro is very limited because of the Don Pedro Project's "water first" operation. Except for minimum flows to the lower Tuolumne River, water is either being stored for water supply purposes, released for filling of the irrigation storage reservoirs, or released for flood management purposes without regard to on-peak/off-peak shaping. Exhibit B of this application provides more detailed information on each Districts' typical hydropower generation during the summer peak season.

As explained previously, the Don Pedro Project was constructed for the purposes of providing water storage for water supply and flood flow management. The Don Pedro Project is operated to provide water storage sufficient to satisfy annual flow requirements while considering the need for carry-over storage that may be necessary to satisfy consumptive use driven water demands over successive dry years. Achieving these primary purposes results in substantial annual and multi-year changes in Don Pedro Reservoir water levels. Based on examining water level changes by Water Year (versus the calendar year), the minimum annual reservoir water level generally occurs in the October/November time period, and the maximum water level generally occurs in the May/June time period. Reservoir storage changes over a Water Year can be as small as 100,000 AF to as high as 1 million AF or more, driven by the combination of hydrology and satisfying the Don Pedro Project's primary purposes. Hydropower generation is not a cause of, nor does it contribute to, these large scale changes in reservoir levels.

The effect of hydropower operations on reservoir water levels would be limited to the daily shaping of flows discussed previously. Using the data provided in Exhibit B (see Table 2.4-4); the greatest on-peak/off-peak change in generation was roughly 40 MW. If it is assumed that the on-peak period lasts for 16 hours during the summer, this equates to a flow of roughly 1,200 cfs more during on-peak periods than during off-peak periods. Over a 16-hour period, this amounts to a volume of 1,600 acre-feet. At the median reservoir level of 780 ft, this represents a change in reservoir level of 0.15 ft, or 1.8 inches occurring over a 16 hour period, compared to the off-peak flow occurring all day. This also assumes that there was zero inflow to the reservoir during the day. Flow-shaping for hydroelectric generation has only very minor, if any, effects on conditions in the Don Pedro Reservoir. Similarly, in nearly all years, the Districts' proposed resource enhancements, including the proposed flow regime to benefit aquatic resources in the lower Tuolumne River, would have negligible effects on water surface elevations and undetectable, if any, effects on water quality in Don Pedro Reservoir. Therefore, in nearly all years, the Proposed Action would have no measurable effects on variation in reservoir water surface elevation or water quality, or any other environmental conditions in the reservoir.

As part of the Proposed Action the Districts are proposing to lower the minimum pool from the current lowest operating elevation of 600 ft. to 550 ft. The use of the water below the current 600 ft. elevation would most likely occur during successive dry years, so the frequency of use would be low. Any such use would most likely occur between mid-November and mid-March when ambient air and water temperatures are low; water temperatures during this period are typically less than 18°C and usually less than 15°C (see Figures 3.4-8 through 3.4-10). Also, during most of this period the reservoir is not thermally stratified or only weakly stratified. Given the time of year when potential drawdown below 600 ft would occur, and water quality conditions in the forebay at that time, no significant changes in water quality in Don Pedro Reservoir would be expected when compared to baseline conditions, that is, operating the Project with a 600 ft elevation minimum operating level.

3.4.2.2 Effects of the Proposed Action between Don Pedro Dam and La Grange Diversion Dam

Unlike Don Pedro Reservoir and the lower Tuolumne River, where the Proposed Action would have no effect on environmental conditions (see sections 3.4.2.1 and 4.0, respectively), the secondary Don Pedro Project purpose of hydroelectric power generation, and flow releases conducted to implement the Districts' proposed lower river resource measures, would have a minor effect on water velocities in the reach between Don Pedro Reservoir and La Grange Diversion Dam. As explained previously, outflows through the powerhouse may be shaped to generate more electricity during on-peak periods and less during off-peak periods, subject to meeting the requirements of the pre-established flow schedule associated with the Don Pedro Project's primary purposes (i.e., deliveries for irrigation and M&I uses, water management for flood control) and releases for fish protection downstream of La Grange Diversion Dam. An increase of 40 MW during on-peak hours results in a change in flow of approximately 1,200 cfs. Using an average width of 250 ft and a minimum average transect depth of 3 feet, the maximum velocity change over this 1,000 cfs range in the reach between Don Pedro Dam and La Grange Diversion Dam would be about 1.3 fps. There would be very little change in water depth associated with a 1,000 cfs change in flow because the riverine reach just below Don Pedro Dam is quite deep and maximum water surface elevation is limited by the crest elevation of the La Grange Diversion Dam spillway.

The magnitude of flow variability within this reach that would result from the Proposed Action would have insignificant effects on temperature and water quality. The Don Pedro Project's primary purposes dictate the overall magnitude and timing of flows passed downstream, and these are the flows that influence conditions in the reach between the dams, not the relatively small variation that would be caused by the Proposed Action. Reducing the current minimum operating elevation from 600 ft to 500 ft is not expected to have any effects on water quality in this reach, relative to baseline conditions.

3.4.2.3 Effects of the Proposed Action in the Lower Tuolumne River

There would be no direct or indirect adverse effects on water quality resources in the lower Tuolumne River as the result of continued hydroelectric power generation at the Project or changing the operating elevation from 600 ft to 550 ft. Continuance of existing hydropower operations at Don Pedro Dam would have no adverse effect on flows, temperature, water quality, or any other environmental conditions in the lower Tuolumne River, because the lower river flow regime is dictated by the independent, non-interrelated primary purposes of the Don Pedro Project (i.e., water supply, flood control, CCSF's water bank) and flow releases to protect aquatic resources. The effects of the primary Project purposes are addressed in Section 4.0 (Cumulative Effects) of this AFLA.

There would, however, be minor, short-term effects on water quality as the result of measures proposed by the Districts, as part of the Proposed Action, to benefit aquatic resources, fall-run Chinook and *O. mykiss* in particular, in the lower Tuolumne River. The anticipated effects of the Districts' proposed resource measures on lower river water quality are discussed in Section 3.4.3 and referenced as appropriate in Section 4.0, *Cumulative Effects*.

3.4.3 Proposed Resource Measures

Because the Proposed Action of issuing a new license to continue hydroelectric power generation would have no adverse effects on water resources in Don Pedro Reservoir, in the reach of the Tuolumne River between Don Pedro Dam and La Grange Diversion Dam, or in the lower Tuolumne River downstream of La Grange Diversion Dam, the Districts are proposing no water resources related environmental measures. The effects of the measures proposed by the Districts to benefit aquatic resources in the lower river are discussed in the following sections. These measures are addressed in greater detail in Section 3.5.4 of this AFLA, and supporting documentation as referenced in Section 3.5.4.

3.4.3.1 Gravel Mobilization Flows of 6,000 to 7,000 cfs

Flows ranging from 6,000-7,000 cfs (measured at USGS gage 11289650 below La Grange Diversion Dam) would be released to mobilize gravel and fines. These flows would be provided for at least two days at an estimated average frequency of once every three to four years, i.e., during years when sufficient spill is projected to occur (Appendix E-1, Attachment G) (TID/MID 2017d, W&AR-02). In years when the La Grange gage spring (March through June) spill is projected to exceed 100,000 ac-ft, the Districts would plan to release a flow of 6,500 cfs for two days within the spill period, with down-ramping not to exceed 300 cfs/hr.

This measure could cause localized, short-duration pulses in turbidity, but no significant effects on water quality are anticipated. These flows would be released at a time when high-flows naturally occur (i.e., March–June of Wet and Above Normal water years), and would have effects similar to what would take place in a natural system during a minor channel-forming event.

3.4.3.2 Gravel Cleaning

The Districts would conduct a five-year program of experimental gravel cleaning using a gravel ripper and pressure wash operated from a backhoe, or equivalent methodology. Each year of the program would consist of two to three weeks of cleaning select gravel patches. The Districts would conduct *O. mykiss* spawning and redd surveys in areas planned for gravel cleaning prior to commencing any gravel cleaning. Subject to the findings of these surveys, the gravel cleaning may coincide with May pulse flows to benefit Chinook smolt outmigration by providing increased turbidity to reduce predator sight feeding effectiveness.

During short periods, localized increases in turbidity might exceed state water quality standards (see Section 3.4, *Water Resources*, of this AFLA), but the improvements in spawning gravel quality and potential increases in fall-run Chinook outmigrant survival due to short-duration reductions in predator efficiency are likely to significantly outweigh any short-term effects of increased turbidity. The Districts would coordinate with the SWRCB to secure necessary permits and conduct any required turbidity monitoring. If gravel cleaning is judged to be successful, the program would continue, adjusted as needed to comply with any water-quality related concerns of the SWRCB.

3.4.3.3 Matching Funds for Water Hyacinth Removal

The Districts would contribute $50,000 per year to the California Division of Boating and Waterways (CDBW, the State agency responsible for implementing an Aquatic Pest Control Program to control hyacinth) to assist with the removal of water hyacinth and other non-native flora. The contribution would be made regardless of the level of water hyacinth infestation occurring in the lower Tuolumne River.

Water hyacinth can increase water losses from lakes and rivers because of the plant's high transpiration rate (Parsons 1992, as cited in Cal-IPC 2014) and can alter water quality beneath dense vegetation mats by reducing dissolved oxygen and affecting pH and turbidity (Penfound and Earle 1948; Center and Spencer 1981, as cited in Cal-IPC 2014). Alterations in water quality can lead to adverse effects on aquatic biota, and decaying water hyacinth beds can make water unsuitable for drinking by humans, wildlife, and livestock.

Because of the adverse effects of water hyacinth infestations on aquatic systems, removal of these introduced plants could improve water quality in the lower river, particularly during the warmer months when plant densities and background water temperatures are higher. CDBW uses herbicides that are registered for aquatic use with EPA and the California Department of Pesticide Regulation. CDBW applies herbicide at levels that do not exceed allowable limits, and treated areas are typically monitored weekly by CDBW to ensure that herbicide levels do not exceed these limits and that treatments have no adverse environmental impacts.

3.4.3.4 Flow-Related Measures for Fish and Aquatic Resources

The District's proposed flow regime for the lower Tuolumne River is summarized in Table 3.4.21. Some of the releases proposed by the Districts would reduce water temperatures (see following sections) relative to baseline conditions, and as a result could increase dissolved oxygen concentrations.

Table 3.4-21. Proposed lower Tuolumne River flows to benefit aquatic resources and accommodate recreational boating.

	Flow (cfs)	
Water Year/Time Period	**La Grange Gage**	**Downstream of RM 25.5**
Wet, Above Normal, Below Normal		
June 1 – June 30	200	100[1]
July 1 – October 15	350	150[2]
October 15 – December 31	275	275
January 1 – February 28/29	225	225
March 1 – April 15	250	250
April 16 – May 15[3]	275	275
May 16 – May 31[3]	300	300
Dry		
June 1 – June 30	200	75
July 1 – October 15	300	75[2]
October 15 – December 31	225	225
January 1 – February 28/29	200	200
March 1 – April 15	225	225
April 16 – May 15	250	250
May 16 – May 31	275	275
Critical		
June 1 – June 30	200	75
July 1 – October 15	300	75
October 15 – December 31	200	200
January 1 – February 28/29	175	175
March 1 – April 15	200	200
April 16 – May 15	200	200
May 16 – May 31	225	225

[1] Cease IG withdrawal for one pre-scheduled weekend.
[2] 200 cfs for three-day July 4 holiday, for three-day Labor Day holiday, and for two pre-scheduled additional weekends in either June, July, or August.
[3] Fall-run Chinook outmigration pulse flows: 150,000 ac-ft (Wet, Above Normal), 100,000 ac-ft (Below Normal), 75,000 ac-ft (Dry), 45,000 ac-ft (sequential Dry[s]), 35,000 ac-ft (first Critical), and 11,000 ac-ft (sequential Critical[s]).[24]

Early Summer Flows (June 1–June 30)

The Districts are proposing to provide an instream flow of 200 cfs (as measured at the La Grange gage) upstream of RM 25.7 from June 1–June 30 of all water year types to benefit *O. mykiss* fry rearing. Downstream of RM 25.5 (i.e., downstream of the infiltration galleries) instream flows during this period would be 100 cfs during Wet, Above Normal, and Below Normal water years and 75 cfs in Dry and Critical years. These flows were selected to balance hydraulic habitat suitability and temperature suitability for *O. mykiss* fry and adult life stages.

Water temperature modeling shows that at RM 47, a flow of 200 cfs would maintain average daily water temperatures at less than 18°C, and at RM 43, a flow of 200 cfs would maintain average daily water temperatures at less than 20°C, except when maximum daily ambient air temperatures exceed 100°F (38°C) (Figure 3.4-21), which on average occurs only one day in June (Figure 3.4-22). At 150 cfs, average daily water temperatures at RM 43 would be less than

[24] This reduced pulse flow, while still greater than or equal to Base Case pulse flows, would also occur in a sequence of “D” and “C” years. For example, in a sequence of the years C, D, C, D, C, D, the second and third “critical” years and the second and third “dry” years would each have pulse flows of 11 TAF and 45 TAF, respectively.

20°C until maximum daily air temperature exceeds 95°F (Figure 3.4-21), which occurs on average three days in June (Figure 3.4-22).

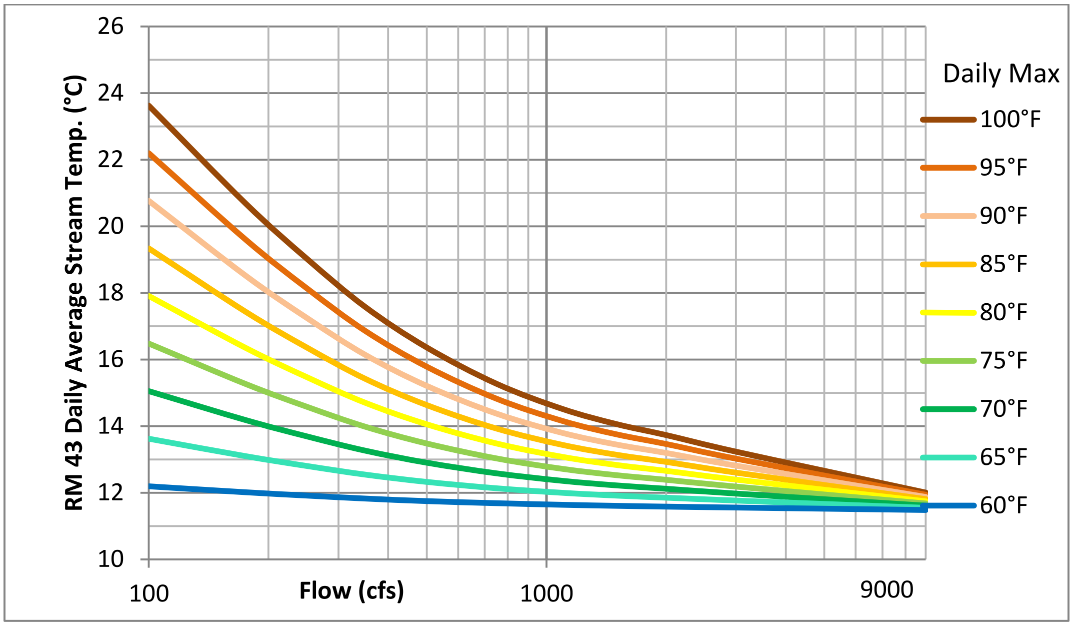

Figure 3.4-21. RM 43 daily average water temperatures versus flow and maximum air temperatures.

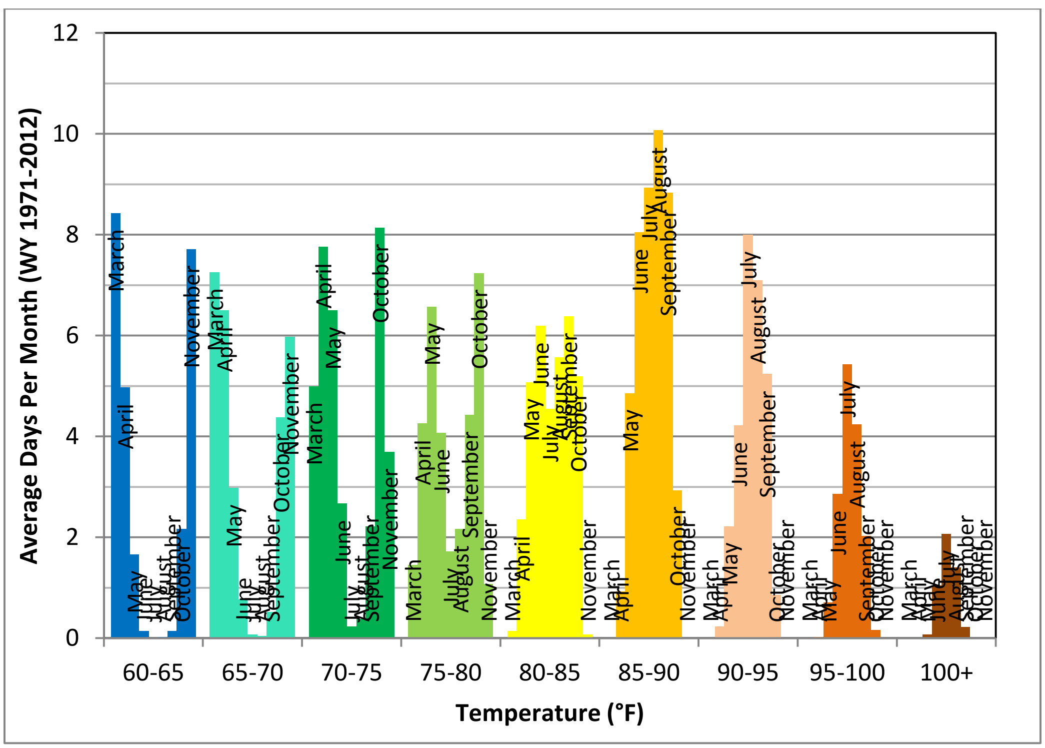

Figure 3.4-22. Frequency of occurrence of maximum daily air temperatures by month for the lower Tuolumne River (estimated for approximately RM 40).

Late Summer Flows (July 1–October 15)

The Districts are proposing to provide an instream flow of 350 cfs (as measured at the La Grange gage) upstream of RM 25.7 from July 1–October 15 of Wet, Above Normal, and Below Normal water year types to benefit *O. mykiss* juvenile rearing. During Dry and Critical water years, flow at the La Grange gage would be reduced to 300 cfs. Downstream of RM 25.5 (i.e., downstream of the IGs) instream flows during this period would be 150 cfs during Wet, Above Normal, and Below Normal water years and 75 cfs in Dry and Critical years.

A flow of 350 cfs would maintain average daily water temperatures below 18°C at RM 43 until daily maximum air temperatures exceed 105°F (40.6°C) (Figure 3.4-21). During Dry and Critical years, flow at the La Grange gage would be reduced to 300 cfs. Under these flows, average daily water temperatures would be maintained below 19°C at RM 43 until daily maximum air temperatures exceed 100°F (38°C) (Figure 3.4-21).

During this period, the Districts will provide a flushing flow to clean gravels of accumulated algae and fines prior to the onset of substantial spawning. The Districts would provide an instream flow of 1,000 cfs (not to exceed 5,950 AF) on October 5, 6 and 7, with appropriate up and down ramps and IGs turned off. These flows would be provided in Wet, Above Normal, and Below Normal water years only. In Dry and Critical years, the flows at La Grange would continue to be 300 cfs, with withdrawals of 225 cfs at the IGs leaving 75 cfs in the river below RM 25.5. These flushing flows would not be expected to have significant effects on water quality.

Fall-Run Chinook Spawning Flows (October 16–December 31)

To provide habitat for fall-run Chinook spawning, the Districts propose to provide the following minimum instream flows for the October 16–December 31 spawning period: 275 cfs (BN, AN, and W water years), 225 cfs (D water years), and 200 cfs (C water years). At 275 cfs, average daily water temperatures at RM 43 would be less than 14.5°C until daily maximum air temperatures exceed 75°F, which is estimated to occur about one day in November on average (see Figures 3.4-21 and 3.4-22). Average daily water temperatures would generally remain below 14°C in December throughout the entire gravel-bedded reach of the lower Tuolumne River.

Fall-Run Chinook Juvenile Rearing (March 1–April 15)

To provide habitat for Chinook juvenile rearing, the Districts propose to provide the following minimum instream flows for the period of March 1–April 15: (1) 250 cfs (BN, AN, and W water years), (2) 225 cfs (D water years), and (3) 200 cfs (C water years). At 250 cfs, average daily water temperatures would remain below 18°C at RM 39.5 until maximum daily air temperatures exceed about 80°F (Figure 3.4-23), which occurs on average between three and four days in April (Figure 3.4-22), and would remain below 20°C at RM 39.5 until maximum daily air temperature exceeds 85°F (Figure 3.4-23), which occurs about one day in April on average (Figure 3.4-22).

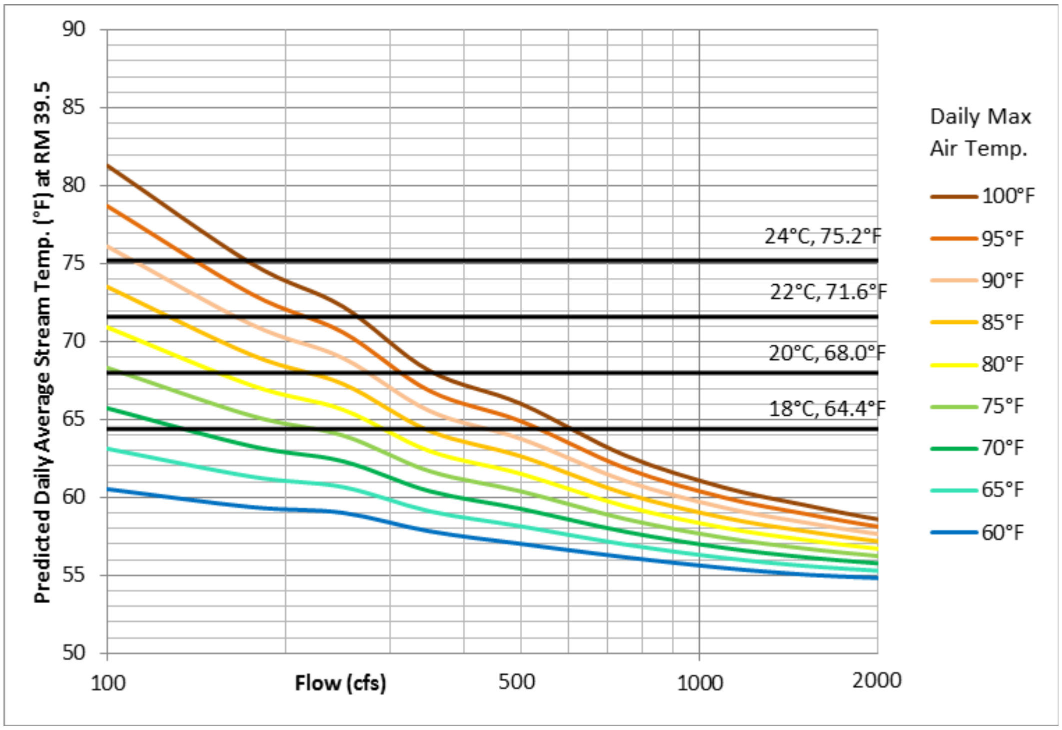

Figure 3.4-223. RM 39.5 daily average water temperatures versus flow and maximum air temperatures.

Outmigration Base Flows (April 16–May 15)

The Districts propose to provide the following outmigration baseflows for the period of April 16–May 15: (1) 275 cfs (BN, AN, and W water years), (2) 250 cfs (D water years), and 200 cfs (C water years). Increasing baseflows above those in the March 1–April 15 period would maintain favorable water temperatures during the mid-April through mid-May period, which is expected to benefit smolts. Water temperature modeling shows that at RM 43, a flow of 275 cfs would maintain average daily water temperatures at less than 20°C, even at maximum daily ambient air temperatures that exceed 100°F (38°C) (Figure 3.4-21). At RM 43, a flow of 275 cfs would maintain average daily water temperatures below 15°C until maximum daily air temperatures exceed 80°F (Figure 3.4-21), which, on average, occurs about three to four days in April and 15 in May (Figure 3.4-22). At RM 39.5, a flow of 275 cfs would maintain average daily water temperatures below 21°C until maximum daily air temperatures exceed 100°F (35°C) (Figure 3.4-23), which occurs one day on average in May (Figure 3.4-22). At RM 39.5, a flow of 225 cfs would maintain average daily water temperatures below 21°C until maximum air temperatures exceed 95°F (32°C) (Figure 3.4-23), which occurs on average about two days in May (Figure 3.4-22). Baseflows would at times be augmented by outmigration pulse flows, which would further reduce water temperature at a given location and extend the plume of colder water farther downstream.

Outmigration Base Flows (May 16–May 31)

To maintain lower water temperatures during this period, the Districts are proposing the following base-flow releases: (1) 300 cfs (BN, AN, and W water years), (2) 275 cfs (D water years), and 225 cfs (C water years). These base flows could be augmented by outmigration pulse flows, as explained below.

Outmigration Pulse Flows (April 16–May 31)

To encourage fall-run Chinook smolt outmigration and increase survival, pulse flows would be provided to coincide with periods when large numbers of parr- or smolt-size fish are occurring in the river. The available pulse flow volumes would be substantially increased over baseline levels, except in the second (and subsequent to the second) Critical water years. The Districts are proposing to allocate the following volumes of water for pulse flow releases: 150,000 ac-ft (AN and W water years), 100,000 ac-ft (BN water years), 75,000 ac-ft (D water years), 45,000 ac-ft (sequential D water years), 35,000 ac-ft (initial C water year), and 11,000 ac-ft (sequential C water years).[25] These pulse flows would augment outmigration base flows (see above), which would further reduce water temperatures at a given location and extend the beneficial plume of colder water farther downstream relative to that provided by the base flows alone.

3.4.3.5 Flow Hydrograph Shaping

In spill years, the Districts would make reasonable efforts to shape the descending limb of the snowmelt runoff hydrograph to mimic natural conditions to promote seed dispersal and germination of cottonwoods and native willows. Increasing natural recruitment of snowmelt-dependent hardwoods would increase stands of trees that would eventually provide shade, which could over the long-term contribute to water temperature reduction.

3.4.4 Unavoidable Adverse Impacts

The Proposed Action would have no unavoidable adverse effects on water resources in Don Pedro Reservoir, in the reach of the Tuolumne River between Don Pedro Dam and La Grange Diversion Dam, or in the lower Tuolumne River downstream of La Grange Diversion Dam.

3.5 Fish and Aquatic Resources

3.5.1 Historical Distribution of Fishes in the San Joaquin Valley and Tuolumne River

The Tuolumne River is located within a region referred to as the Central Valley Zoogeographic Subprovince, which is characterized by a distinctive fish fauna (Moyle 2002). Species native to this region are adapted to a climate characterized by extended droughts and large floods (Moyle 2002). The four main native fish assemblages in the Central Valley Zoogeographic Subprovince are the (1) rainbow trout assemblage, (2) California roach assemblage, (3) Sacramento pikeminnow-hardhead-sucker assemblage, and (4) deep-bodied fish assemblage.

[25] This reduced pulse flow, while still greater than or equal to Base Case pulse flows, would also occur in a sequence of "D" and "C" years. For example, in a sequence of the years C, D, C, D, C, D, the second and third "critical" years and the second and third "dry" years would each have pulse flows of 11 TAF and 45 TAF, respectively.

The San Joaquin River and its tributaries below an elevation of about 80 ft[26] are typically characterized by warm sluggish channels, swamps, and sloughs (Moyle 2002). Historically, the native fish fauna of the Central Valley floor was composed primarily of species from the deep-bodied fish assemblage, such as Sacramento perch (*Archoplites interruptus*), tule perch (*Hysterocarpus traskii*), hitch (*Lavinia exilcauda*), Sacramento blackfish (*Orthodon microlepidotus*), and Sacramento splittail (*Pogonichthys macrolepidotus*). Large Sacramento pikeminnow (*Ptychocheilus grandis)* and Sacramento sucker (*Catostomus occidentalis*) were also abundant, migrating upstream to spawn in tributaries to the San Joaquin River, including the Tuolumne River. Anadromous fish passed through the river reaches of the Central Valley floor on their way upstream to spawn (Moyle 2002).

Central Valley foothill streams and rivers, which extend from the valley floor to the Sierra Nevada and Coast Range mountains, were occupied by, from lowest to highest elevation, the pikeminnow-hardhead-sucker assemblage, the California roach assemblage, and the rainbow trout assemblage. The pikeminnow-hardhead-sucker assemblage occurred just above the valley floor at elevations of 80–1,500 ft and included Sacramento pikeminnow, Sacramento sucker, and hardhead (*Mylopharodon conocephalus*), among other species. The California roach assemblage, which overlapped in elevation with the pikeminnow-hardhead-sucker assemblage, included species that occurred in small, warm tributaries and larger streams that flowed through open foothill woodlands. Many of these streams were intermittent during summer and flood-prone during winter and spring. In the Tuolumne River watershed, the California roach assemblage included the endemic Red Hills roach (*Hesperoleucus symmetricus*). The rainbow trout assemblage overlapped with the upper extents of the pikeminnow-hardhead-sucker and California roach assemblages and extended to the highest elevations occupied by fish (i.e., about 3,600 ft). Species in this assemblage occurred in streams characterized by swift, perennial flows, steep gradients, cool temperatures, high dissolved oxygen concentrations, and abundant cover. Rainbow trout, sculpin, Sacramento sucker, and speckled dace (*Rhinichthys osculus*) are members of this assemblage.

Historically, three anadromous fish species occurred in the Tuolumne River: fall- and spring-run Chinook salmon (*Oncorhynchus tshawytscha*), steelhead (*O. mykiss*), and Pacific lamprey (*Entosphenus tridentatus).* Fall-run Chinook salmon spawning escapement to the Tuolumne River has varied over a wide range. During some years it was larger than the escapement to any other Central Valley river, except for the mainstem Sacramento River, and was estimated at 122,000 spawners in 1940 and 130,000 spawners in 1944 (California Department of Fish and Game [CDFG] 1946; Fry 1961, as cited in Yoshiyama et al. 1996). In contrast, escapement was as low as 500, 200, and 100 returning adults in 1961, 1962, and 1963, respectively.

According to Moyle et al. (1996), anadromous species did not reach Hetch Hetchy Valley (elevation 3,600 ft). The waterfalls just below Hetch Hetchy Dam on the mainstem, about 10 miles above Preston Falls, evidently stopped all fish that might have ascended that far. John Muir wrote that the river was barren of fish above these falls (Muir 1902, as cited in Yoshiyama et al. 1996). There is no indication that salmon reached Poopenaut Valley, which is located 3 miles downstream of Hetch Hetchy Valley (Yoshiyama et al. 1996). In addition, there is no archaeological or ethnographic evidence indicating that salmon were part of the subsistence

[26] All elevations are NGVD 29.

economies of the native inhabitants along the Tuolumne River in the Yosemite region (Snyder 1993 unpublished memorandum, as cited in Yoshiyama et al. 1996). According to Weaver and Mehalick (2009), no trout species are native to the Tuolumne River upstream of Preston Falls, so "the NPS [National Park Service] does not support a Wild Trout designation in this portion of the river [i.e., above the falls]."

Clavey Falls, at the confluence of the Tuolumne and Clavey rivers, may have also obstructed upstream migration of salmon at certain flows. Chinook salmon most likely did not pass over Preston Falls, located 4 miles above the current location of Early Intake Dam near the boundary of Yosemite National Park (about 51 miles upstream of Don Pedro Dam) (Yoshiyama et al.1996). Steep sections of stream in the Clavey River and in the South and Middle forks of the Tuolumne River most likely obstructed salmon migration. In the lower South Fork Tuolumne River, a 25–30-foot-high waterfall probably prevented upstream access (Stanley and Holbek 1984, as cited in Yoshiyama et al. 1996). The North Fork Tuolumne River, with a 12-ft waterfall located about 1 mile above its mouth, likewise had limited access. Yoshiyama et al. (1996) reported that steelhead may have ascended several miles into Cherry Creek, which is a tributary to the mainstem Tuolumne River located about 1 mile below Early Intake Dam. Large runs of Pacific lamprey once spawned in most of the same places as Chinook salmon (Moyle et al. 1996).

Results of the Upper Tuolumne River Basin Fish Migration Barriers Study (TID/MID 2017d) suggest that the mainstem Tuolumne River would be accessible by anadromous fish to Lumsden Falls (RM 97.3). The North Fork Tuolumne River upstream of RM 1.69 would not be accessible to anadromous fish. The Clavey River upstream of RM 2.05 would not be accessible to anadromous fish. The South Fork Tuolumne River upstream of RM 1.9 would not be accessible. The Middle Fork Tuolumne River originates upstream of RM 1.9 of the South Fork and therefore would not be accessible to anadromous fish, and Cherry Creek upstream of RM 1.62 would not be accessible.

Anadromous fish abundance in the lower Tuolumne River downstream of La Grange Diversion Dam has been reduced by habitat degradation due to extensive instream and floodplain mining that began in the mid-1800s as well as other land uses. Dams and water diversions associated with mining had affected fish migration as early as 1852 (Snyder 1993 unpublished memorandum, as cited in Yoshiyama et al.1996). Access to historical spawning and rearing habitat was significantly restricted beginning in the 1870s, when a number of dams and irrigation diversion projects were constructed. Wheaton Dam, built in 1871 near the site of the La Grange Diversion Dam, ranged from 16 – 30 ft high (USGS 1899), and was a barrier to upstream fish migration. In 1884, three years before the existence of either District, the California Fish and Game Commission reported that the Tuolumne River was "dammed in such a way to prevent the fish from ascending" (California Fish and Game Commission 1884, as cited in Yoshiyama et al. 1996).

As noted above, gravel and gold mining adversely affected salmon runs prior to dam construction on the Tuolumne River (TID/MID 2005). These activities left large pits in the river and floodplain that altered the river's morphology and flow patterns and harbored predators, such as largemouth and smallmouth bass (both species were introduced by CDFW in the late 1800s and early 1900s for recreational fisheries). Introduced predators were, and continue to be, most abundant in the slow-water areas prevalent in the middle section of the lower Tuolumne River, downstream of the major Chinook spawning areas (Orr 1997). Much of this type of habitat was created by instream sand and gravel mining, making it likely that the present pattern and degree of predation mortality in the Tuolumne River is to a large extent a result of past sand and gravel mining coupled with the introduction of non-native piscivorous fish species (Orr 1997).

TID/MID (2005) noted that water management, riparian diversions, Delta and San Francisco Bay development activities, state and federal Delta water exports, water quality issues, hatchery programs, commercial and recreational harvest, and poaching, all affected historical patterns of anadromous salmonid abundance in the Tuolumne River. Pacific lamprey populations appear to have declined for reasons similar to those of salmon, e.g., dams, water management, habitat alteration (Moyle et al. 1996). The decline in major host species, i.e., salmon and steelhead, may have been an additional contributing factor (Moyle et al. 1996).

3.5.2 Fish and Aquatic Resources in Don Pedro Reservoir

3.5.2.1 Existing Environment

Don Pedro Reservoir extends upstream from Don Pedro Dam (located at RM 54.8) for approximately 24 miles at the normal maximum water surface elevation of 830 ft. The surface area of the reservoir at this elevation is approximately 12,960 ac, and the reservoir shoreline, including the numerous islands within the lake, is approximately 160 miles long. The watershed upstream of Don Pedro Dam is approximately 1,533 mi^2. The reservoir contains both native and non-native and game and non-game fish species (Table 3.5-1), and because it thermally stratifies, supports viable warm-water and cold-water fisheries.

Within the Don Pedro Project vicinity, there are a number of tributaries that flow into Don Pedro Reservoir (see Section 3.1, General Description of the Tuolumne River Basin and Don Pedro Project). Because of their relatively low elevation, most of the streams contributing flow to the reservoir are ephemeral and rain-driven; in late summer and fall they contribute only a trickle of water, if any, to the reservoir. Regardless of the season, each of these tributary streams has a relatively small immediate watershed and thus contributes comparatively little water when compared to the mainstem Tuolumne River.

CDFW manages the Don Pedro Reservoir fishery as a put-and-take resource with substantial stocking and related fishing regulations, and has characterized the resident trout and inland salmon fisheries of Don Pedro Reservoir as being totally dependent on hatchery supplementation (CDFG and USFWS 2010). As part of its Inland Salmon Program, CDFW generally plants rainbow trout (*O. mykiss*), kokanee (*O. nerka*), and Chinook salmon in Don Pedro Reservoir annually. Don Pedro Reservoir is also managed by CDFW as a year-round fishery for black bass. In the past, CDFW planted brook trout (*Salvelinus fontinalis*) (beginning in 1959) and brown trout (*Salmo trutta*) (beginning in 1979) in Don Pedro Reservoir. The trout and salmon fisheries of Don Pedro Reservoir recovered from a copepod infestation that affected them during the early 1990s. CDFW stocked only brook trout and brown trout during the infestation years, because these species are not susceptible to the parasites. Rainbow trout stocking resumed in 1997, which resulted in a rebound of the trout fishery. The DPRA has been stocking black bass in the reservoir on an annual basis since the early 1980s (TID/MID 2013a, W&AR-17), and because of the robust bass population supported by the reservoir, multiple fishing contests, permitted by CDFW, are held during most years (see Angler Use section below).

Fish Studies Conducted in Don Pedro Reservoir

In 2012, the Districts conducted a study to provide information concerning the distribution and occurrence of fish in Don Pedro Reservoir (TID/MID 2013a, W&AR-17). The objectives of the study were to document fish species composition, relative abundance, age and size composition, and characterize the influence of existing operations on fish habitat. To address the objectives, integrated sampling was conducted, including: (1) reservoir boat electrofishing, (2) reservoir gillnet sampling, (3) creel surveys, (4) bass nesting assessments, (5) tributary access assessments, and (6) age-scale assessments. Boat electrofishing and gill net sampling locations are shown in Figure 3.5-1.

Fish Species Composition in Don Pedro Reservoir

Fourteen fish species were captured during the 2012 Reservoir Fish Population Study (Table 3.5-1) (TID/MID 2013a, W&AR-17). Table 3.5-1 also includes information on fish size by species and fish condition (Kn) for select species. Figure 3.5-2 presents a summary of the proportion of species by raw catch (i.e., number) and measured biomass. Threadfin shad (*Dorosoma petenense*) was the most abundant species by number (20.8% of the catch). Most game fish were sunfishes (Family Centrarchidae), primarily largemouth bass (*Micropterus salmoides*). Other frequently collected centrarchids included green sunfish (*Lepomis cyanellus*), bluegill (*Lepomis macrochirus*), spotted bass (*M. punctulatus*), and smallmouth bass (*M. dolomieu*). Trout and salmon (Family Salmonidae) included kokanee and rainbow trout. Other commonly collected species included channel catfish (*Ictalurus punctatus*) and common carp (*Cyprinus carpio*). One species captured during 2012, i.e., golden shiner (*Notemigonus crysoleucas*), had not been previously collected in Don Pedro Reservoir (TID/MID 2013a, W&AR-17). Overall, fish species composition in the reservoir in 2012 was similar to that documented by CDFW in past studies (Houk 2002, 2003). Fish species not collected during the 2012 study, yet known to occur in Don Pedro Reservoir, include brown trout, brook trout, Chinook salmon, coho salmon (*O. kisutch*), black bullhead (*Ameiurus melas*), Sacramento pikeminnow, and whitefish (*Prosopium williamsonii*) (*http://www.donpedrolake.com/recreation/fishing*).

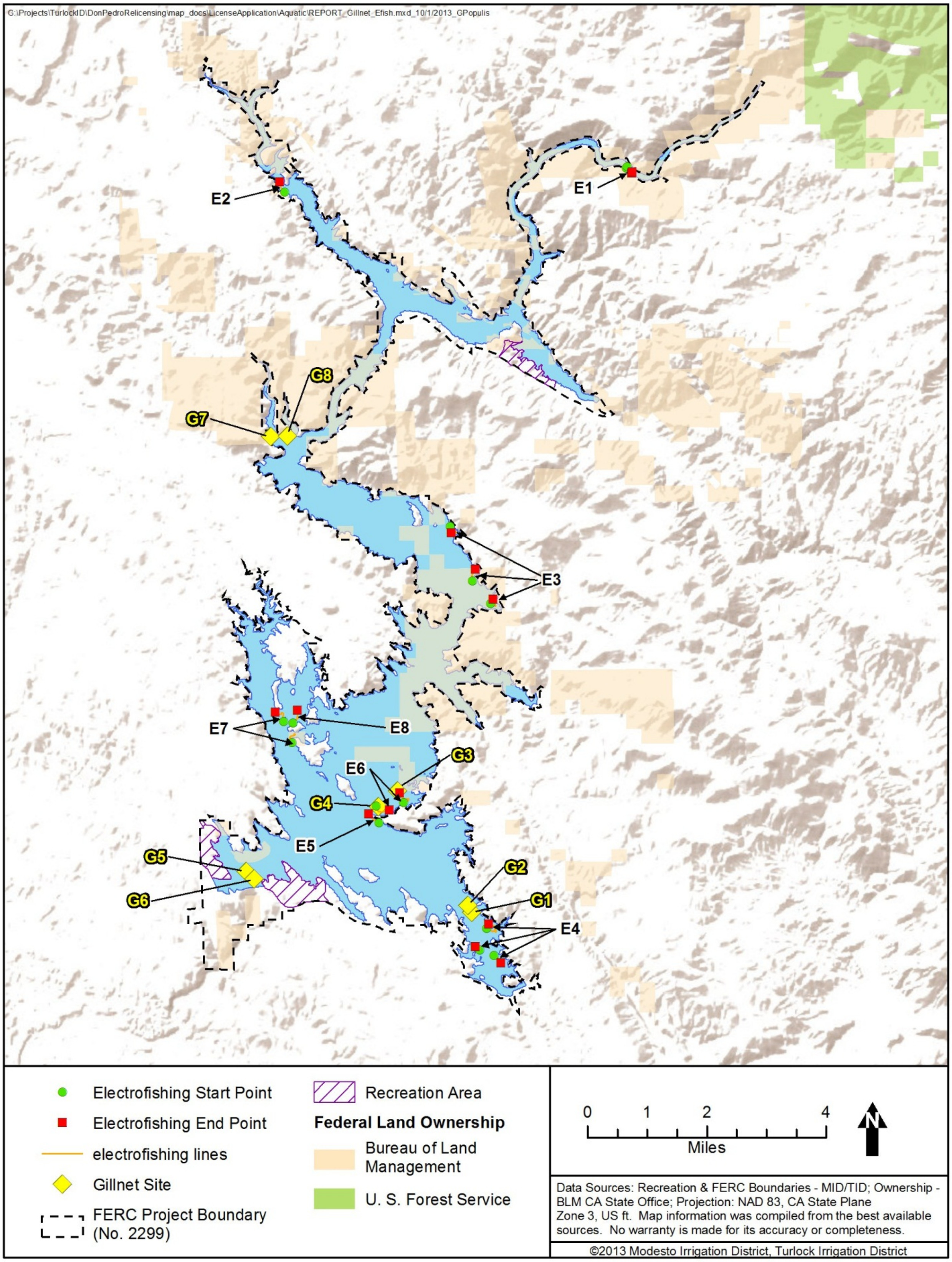

Figure 3.5-1. Location of fish population survey sites sampled using boat electrofishing and gill nets during the Don Pedro Reservoir fish population survey, October 2012.

Table 3.5-1. Summary of relative abundance, length, and weight of all fish species collected at Don Pedro Reservoir in 2012.

Species	Native Species (N)	Composition		Length (mm)			Weight (g)			Mean (Kn)[1]
		N	%	Min	Max	Mean	Min	Max	Mean	
Black bass (unidentified[2])	--	76	11.7	52	98	68.8	1.2	11.2	4.1	--
Bluegill sunfish (*Lepomis macrochirus*)	--	78	12.0	37	138	80.7	1.0	60.0	12.8	1.00
Channel catfish (*Ictalurus punctatus*)	--	30	4.6	60	575	326.1	3.3	2,350	760.8	0.99
Common carp (*Cyprinus carpio*)	--	8	1.2	450	686	578.0	1,420	4,678	2,910	--
Crappie (*Pomoxis* spp.)	--	1	0.2	57	57	57.0	2.2	2.2	2.2	--
Golden Shiner (*Notemigonus crysoleucas*)	--	5	0.8	53	90	70.6	2.6	11.5	6.0	--
Green sunfish (*Lepomis cyanellus*)	--	95	14.6	32	102	67.1	0.5	19.0	5.2	1.04
Kokanee (*Oncorhynchus nerka*)	--	18	2.8	308	412	332.3	172.0	965.0	380.6	0.92
Largemouth bass (*Micropterus salmoides*)	--	116	17.8	45	465	252.3	1.1	1,723	361.2	1.06
Rainbow trout (*Oncorhynchus mykiss*)	N	1	0.2	422	422	422.0	683.0	683.0	683.0	--
Sacramento sucker (*Catostomus occidentalis*)	N	9	1.4	322	495	406.9	322.0	1310	785.0	--
Smallmouth bass (*Micropterus dolomieu*)	--	20	3.1	54	410	201.7	2.1	1,107	285.3	1.04
Spotted bass (*Micropterus punctulatus*)	--	57	8.8	100	403	276.8	11.9	992.2	377.1	0.95
Threadfin shad *(Dorosoma petenense)*	--	135	20.8	58	111	76.3	1.0	18.7	6.0	0.99
White catfish (*Ameiurus catus*)	--	1	0.2	295	295	295	368.5	368.5	368.5	--
	Total	650	100.0							

1 Species with 10 or fewer individuals or poor fit regressions did not have a reportable condition factor.
2 Small-sized black bass were not identified to species.

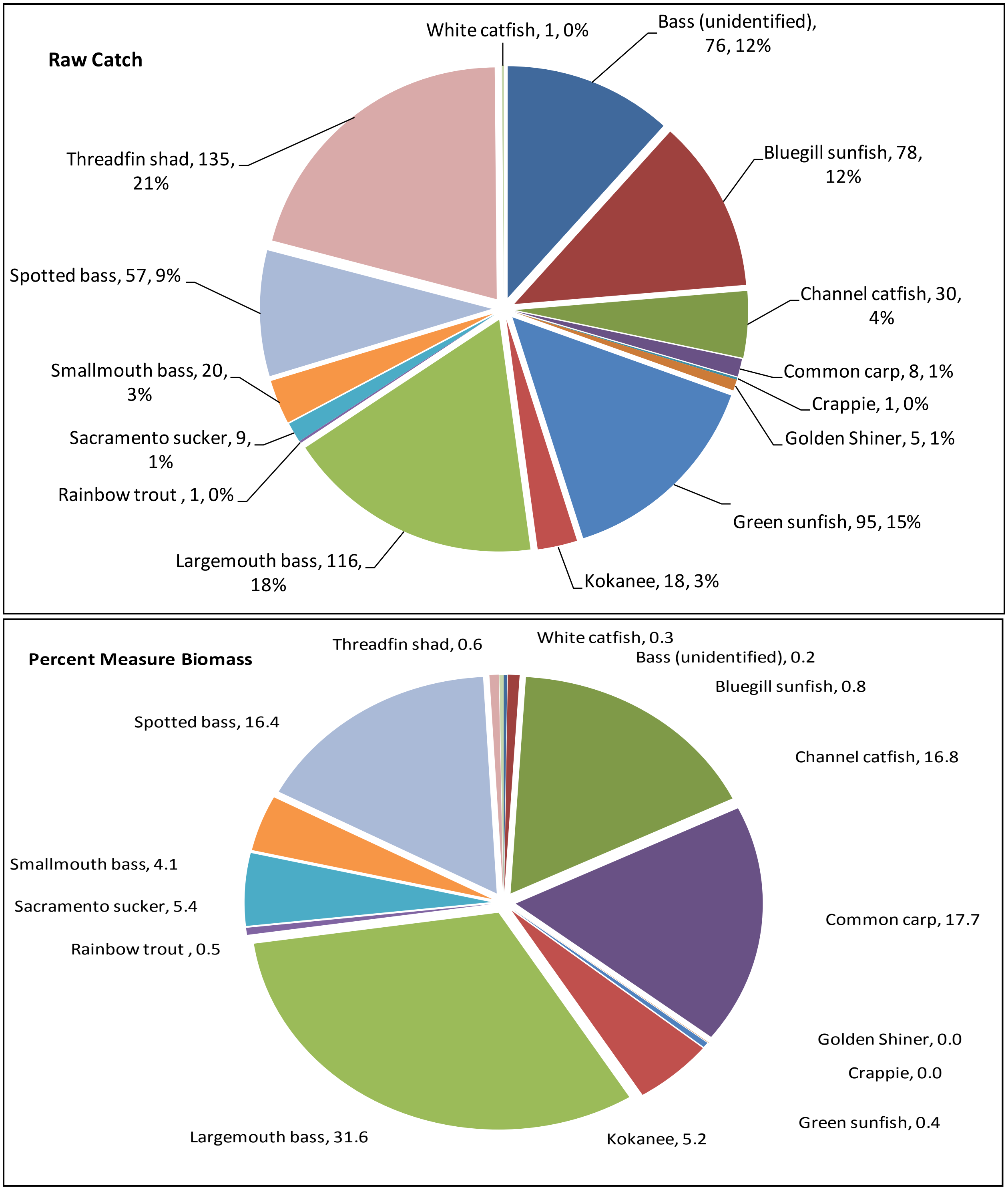

Figure 3.5-2. Relative numbers of fish (top) and percent measured biomass (bottom) by species, combined from gillnet and boat electrofishing activities during the Don Pedro Reservoir fish population survey conducted in October 2012.

Species that were well represented were generally present in multiple size classes. Largemouth bass ranged in length from 45 to 465 mm (mean 252.3 mm), and spotted bass ranged from 100 to 403 mm (mean 276.8 mm). Mean length for kokanee was 332.3 mm. No juvenile kokanee were collected during the study. Although largemouth bass were not the most numerically common species, they accounted for 31.6% of fish biomass (weight), the highest of all species. Common carp (17.7%), channel catfish (16.8%), and spotted bass (16.4%) also represented a significant proportion of biomass. Fish condition indicated that fish were healthy: average Kn ranged from 0.92 for kokanee to 1.06 for largemouth bass (Table 3.5-1).

Scales collected from black bass in the reservoir were used for age analysis (TID/MID 2013a, W&AR-17). The number of salmonid (rainbow trout and kokanee) scales collected was insufficient to allow for meaningful scale aging, so no analysis was conducted for these species. Largemouth bass, smallmouth bass, and spotted bass length-frequency distributions and age classes are shown in Figure 3.5-3, Figure 3.5-4, and Figure 3.5-5, respectively. The presence of multiple age classes, including young-of-the-year fish, demonstrates that black bass reproduce successfully in the reservoir.

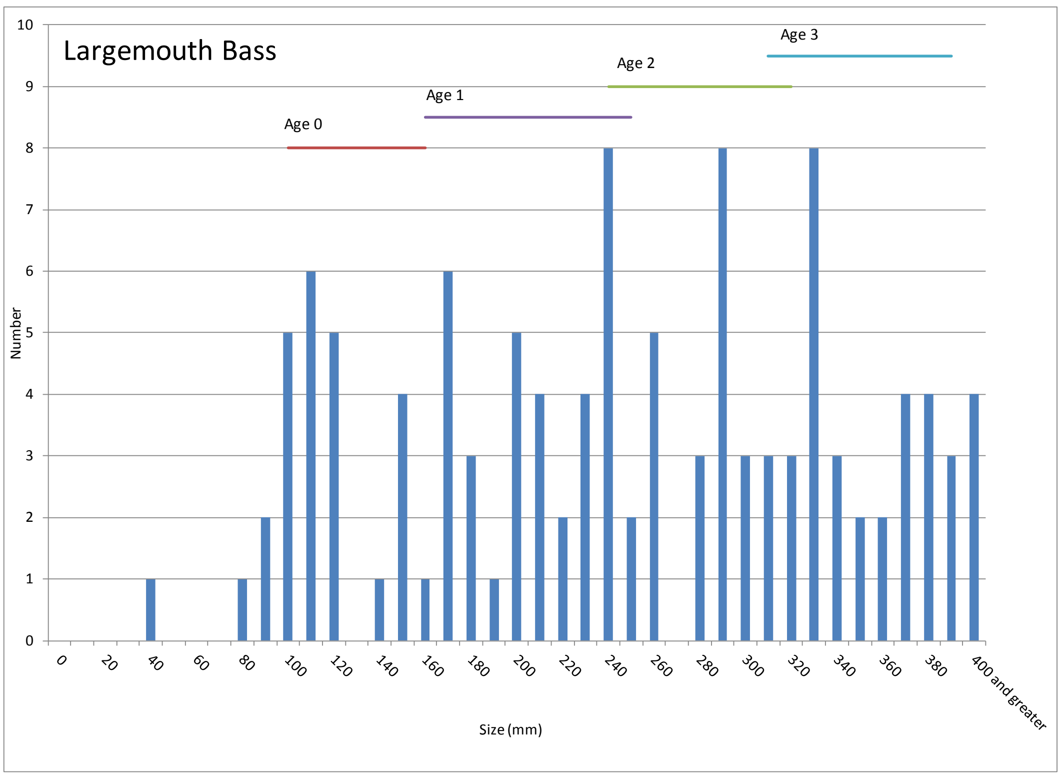

Figure 3.5-3. Length-frequency distribution of largemouth bass sampled during the Don Pedro Reservoir fish population survey, October 2012.

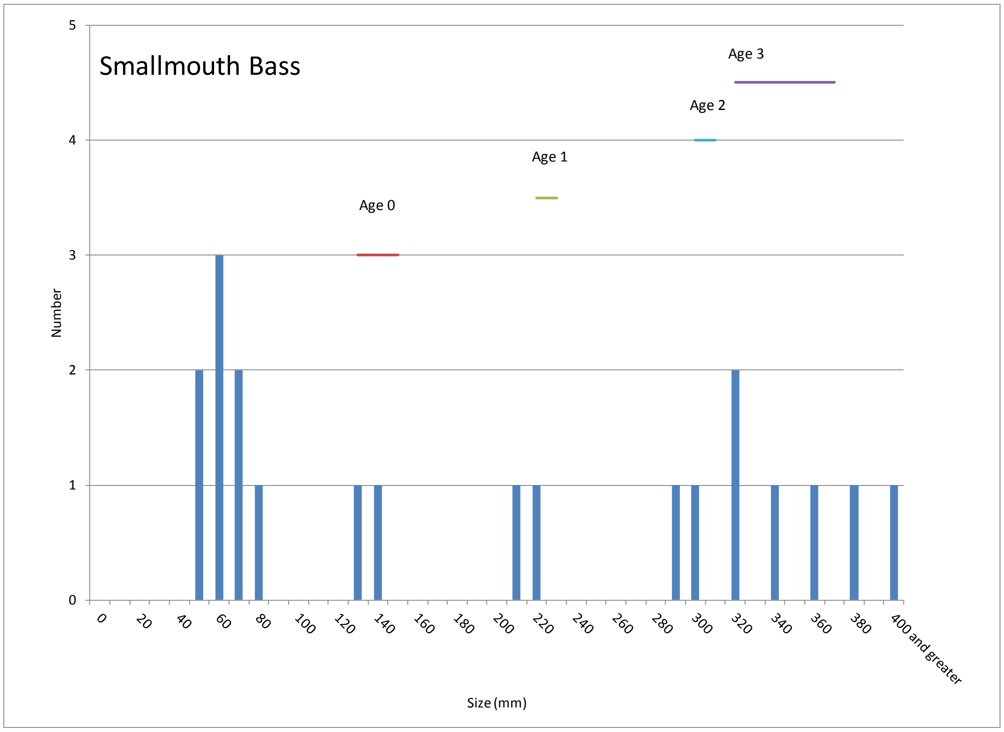

Figure 3.5-4. Length-frequency distribution of smallmouth bass sampled during the Don Pedro Reservoir fish population survey, October 2012.

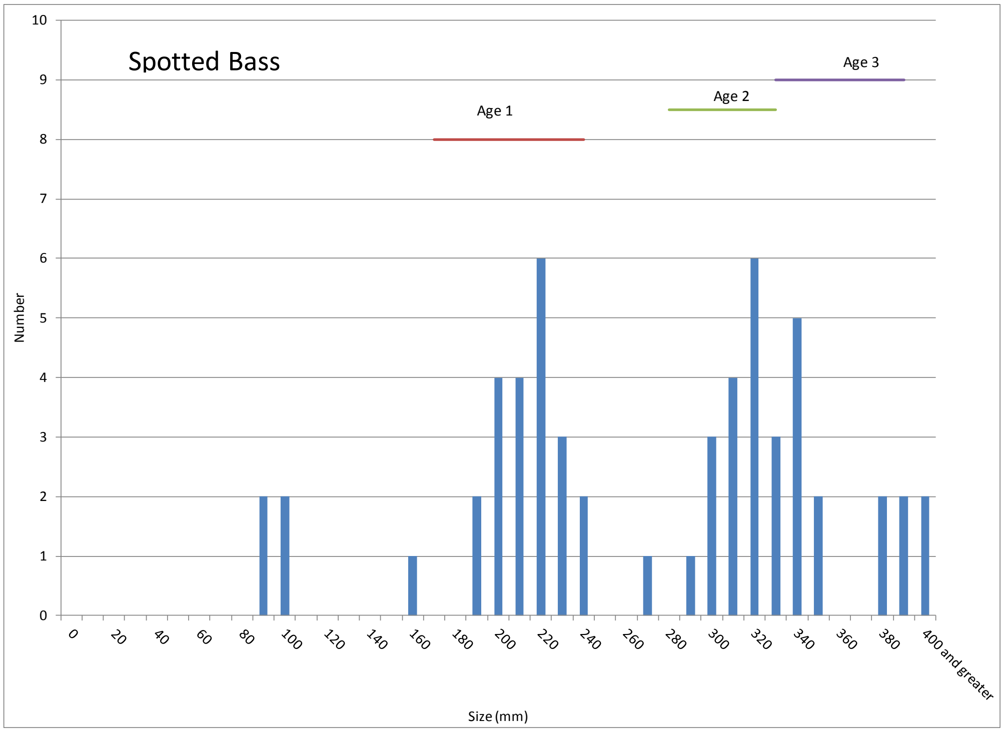

Figure 3.5-5. Length-frequency distribution of spotted bass sampled during the Don Pedro Reservoir fish population survey, October 2012.

There are three special status fish species–hardhead, Red Hills roach, and Sacramento-San Joaquin roach–that occur in tributaries to Don Pedro Reservoir or the mainstem Tuolumne River upstream and downstream of the reservoir (discussed below). However, these species have not been found within the Project Boundary.

Hardhead

The hardhead (*M. conocephalus*), which is included on the California Species of Special Concern watch list, is a large (up to 580 mm long) cyprinid (minnow) that generally occurs in large, undisturbed reaches of low- to mid-elevation rivers and streams (Moyle 2002). Hardhead mature following their second year, and spring spawning migrations into smaller tributary streams are common. The spawning season may extend into August in the foothill streams of the San Joaquin River basin. Spawning behavior has not been well documented, but hardhead appear to spawn in gravel riffles (Moyle 2002). Little is known about life-stage-specific water temperature requirements of hardhead, but temperatures ranging from approximately 18–24°C are believed to be suitable (Moyle 2002). Hardhead are omnivores, feeding primarily on benthic invertebrates and aquatic plants (Moyle 2002).

Historically, hardhead were widely distributed and locally abundant in the Central Valley. Their specialized habitat requirements, widespread alteration of lower elevation riverine habitats, and predation by bass have resulted in population declines and isolation of populations (Moyle 2002). Hardhead also have at times been abundant in reservoirs, but most of these reservoir populations have proved to be transitory, presumably extirpated after predators became established. Brown and Moyle (2004) found that hardhead disappeared from the upper Kings River when the reach was invaded by bass. Hardhead occur in the Tuolumne River both upstream and downstream of the Don Pedro Project, but no hardhead were collected or observed during the 2012 Reservoir Fish Population Study (Table 3.5-1) (TID/MID 2013a, W&AR-17).

Red Hills Roach

The Red Hills roach (*Hesperoleucus symmetricus*), which is listed as endangered under the California Endangered Species Act, is also a cyprinid and part of the California roach complex. There is a recently discovered population of California roach (Brown et al. 1992, as cited in Jones et al. 2002); individuals within this population are abundant in several permanent pools located along the intermittent streams that drain into Six Bit Gulch and Poor Man's Gulch, both of which are tributaries to Don Pedro Reservoir (Brown et al.1992, as cited in Jones et al. 2002; Moyle et al. 1995, as cited in Jones et al. 2002; USDOI BLM 2009). It is thought that these permanent pools are spring-fed (USDOI BLM 2009). During the dry part of the year, the fish are confined to these pools, surviving in warm shallow water until spring when they move upstream to spawn (USDOI BLM 2009). The Red Hills roach is specifically found in areas characterized by serpentine soils and stunted vegetation (Moyle 2002). The Red Hills variety of California roach has unique morphologic characteristics, primarily a chisel lip, which make it noticeably different from individuals of other roach populations. The chisel lip is used to scrape algae, a major food source, off submerged rocks (USDOI BLM 2009). The Red Hills region is currently listed as an Area of Critical Environmental Concern (ACEC) by the BLM and an Aquatic Diversity Management Area (Moyle 1996). No Red Hills roach were collected or observed during the 2012 Reservoir Fish Population Study (Table 3.5-1) (TID/MID 2013a, W&AR-17).

Sacramento-San Joaquin Roach

The Sacramento-San Joaquin roach (*Lavinius symmetricus symmetricus*), which is included on the California Species of Special Concern watch list, is also part of the California roach complex. The Sacramento-San Joaquin roach is found in the Sacramento and San Joaquin River drainages, except the Pit River, as well as other tributaries to San Francisco Bay. Sacramento-San Joaquin roach are generally found in small, warm, intermittent streams, and are most abundant in mid-elevation streams in the Sierra foothills and in the lower reaches of some coastal streams (Moyle 2002). The species tolerates relatively high temperatures (30–35°C) and low dissolved oxygen levels (1–2 mg/L) (Taylor et al. 1982). However, they are habitat generalists, also being found in cold, well aerated and clear "trout streams" (Taylor et al. 1982), in human-modified habitats (Moyle 2002), and in the main channels of rivers. Assuming that the Sacramento-San Joaquin roach is indeed a single taxon (which is considered unlikely), it is abundant in a large number of streams, although it is now absent from a number of streams and stream reaches where it once occurred (Moyle 2002). Adult Sacramento-San Joaquin roach have been observed and documented in the general vicinity of the Don Pedro Project, i.e., in Hatch and Second creeks, and Rough and Ready Creek, but not in the Tuolumne River mainstem. During the 2012 Reservoir Fish Population Study, no Sacramento-San Joaquin roach were collected or observed (Table 3.5-1) (TID/MID 2013a, W&AR-17).

Bass Nesting

CDFW has concluded that a spawning nest survival rate of at least 20 percent is necessary to maintain long-term population levels of highly fecund, warm-water fish, such as black bass. The reservoir fish evaluation conducted by the Districts in 2012 shows that water surface elevation changes occurring in Don Pedro Reservoir during the past 27 years have been within a range that has maintained bass nest survival at or above the 20 percent criterion identified by CDFW (Lee 1999; TID/MID 2013a, W&AR-17). The frequency with which monthly reservoir elevations decreased during the nesting period of March through June (estimated by comparing first-of-the-month and end-of-the-month water surface elevations from 1984 through 2012) is summarized in Table 3.5-2. The number of months that largemouth, smallmouth, and spotted bass nest survival equaled or exceeded the CDFW 20 percent survival rate, based on water surface elevation reductions in Don Pedro Reservoir from 1984 to 2010, is shown in Table 3.5-3 (TID/MID 2013a, W&AR-17).

During the Districts' 2012 study, 14 bass nests were observed at depths ranging from 2.2 ft to 8.0 ft, with an average depth of 5.1 ft (TID/MID 2013a, W&AR-17). Nest diameters ranged from 0.6 ft to 6.5 ft, with an average diameter of 3.0 ft. Most nests were located close to cover and within 30 ft of shore.

Table 3.5-2. Don Pedro Reservoir water surface elevation monthly reduction from 1984 to 2010.

Month	No. of Months Evaluated	Frequency of Monthly Elevation Reduction	Percent of Months with elevation reduction
March	27	9	33.3
April	27	12	44.4
May	27	6	22.2
June	27	4	14.8

Table 3.5-3. Number of months that largemouth, smallmouth, and spotted bass nest survival equaled or exceeded the CDFW 20 percent survival rate based on water surface elevation reductions in Don Pedro Reservoir from 1984 to 2010.

Month	No. of Months Analyzed	No. Months ≥20% Survival	Percent Total Months
Largemouth bass			
March	27	27	100
April	27	26	96.3
May	27	27	100
June	27	26	96.3
Smallmouth bass			
March	27	27	100
April	27	26	96.3
May	27	27	100
June	27	26	96.3
Spotted bass			
March	27	27	100
April	27	27	100
May	27	27	100
June	27	27	100

Potential Salmonid Spawning Tributaries

Streams that typically contain surface flows during spring and, in some cases, fall salmonid spawning periods are shown in Table 3.5-4 (TID/MID 2013a, W&AR-17). Perennial tributary streams within the Don Pedro Project vicinity were identified as those that could potentially support fall spawning. Tributaries that potentially could attract salmonid spawners were evaluated by conducting an assessment of gradient within the inundation zone. Under existing operations, slopes at the locations where tributaries enter the reservoir are well below the 10 percent criterion defining a fish impediment (TID/MID 2013a, W&AR-17). Potential fish passage impediments were identified only in Deer Creek, which is not considered a salmonid spawning stream (TID/MID 2013a, W&AR-17). Cold-water fisheries in the reservoir are primarily supported by stocking; nonetheless, existing Don Pedro Project operations during the potential spring and fall fish migration periods accommodate fish access to possible cold-water spawning tributaries (TID/MID 2013a, W&AR-17).

Table 3.5-4. Tributaries to Don Pedro Reservoir evaluated for potential fish passage impediments during the fall and spring salmonid spawning periods. A designation of "yes" indicates that flows are present in a given tributary during the respective spawning period.

Stream	Spring Spawning	Fall Spawning
Tuolumne River	Yes	Yes
Deer Creek	Yes	No
Moccasin Creek	Yes	Yes
Hatch and First Creeks	Yes	No
Willow Creek	Yes	No
Fleming Creek	Yes	No
Rogers Creek	Yes	Yes
Lucas Gulch	Yes	No
Ranchero Creek	Yes	No
West Fork Creek	Yes	No
Big Creek	Yes	Yes
Fortynine Creek	Yes	No
Sixbit Gulch	Yes	No
Poormans Gulch	Yes	No
Woods Creek	Yes	Yes
Sullivan Creek	Yes	No
Kanaka Creek	Yes	No
Rough and Ready Creek	Yes	No

Angler Use

Creel surveys were conducted by the Districts for nine months in 2012 (TID/MID 2013a, W&AR-17). The highest catch rate (0.52 fish/hour) occurred in June and the lowest (0.12 fish/hour) in February. Average catch rate over all months was 0.22 fish/hour. During all months, except February and March, anglers released the majority of their catch. Black bass were the most commonly caught fish species (50.1 percent), and 78.4 percent of bass caught were released. Species composition and size statistics for fish caught by anglers interviewed during 2012 creel surveys are shown in Table 3.5-5.

CDFW regulates fishing contests in California through the issuance of permits. For example, from August 2010 through July 2011, 37 fishing contest permits were issued for Don Pedro Reservoir for black bass, and consisted of 16 annual and 21 event permits for a total of 41 contest days. For black bass contests, CDFW compiles fish catch and size information and publishes an annual *Summary Reports of Black Bass Fishing Contests held in California*. These reports summarize the annual information by California water body in terms of total contest days, total fish counted and weighed, total number of fish reported dead, total number of contest competitors, total contest hours, total fishing hours or effort, annual catch per hour (i.e., total fish counted/total fishing hours) and mean weight per fish. Many years have over 70 recorded contest days with substantial catches. Table 3.5-6 summarizes this information for Don Pedro Reservoir for the years 1985 through 2009.

Table 3.5-5. Species composition and size statistics of fish caught by anglers interviewed during creel surveys conducted on Don Pedro Reservoir between January and September 2012.

Species	Catch (released)	Catch Composition (%)	Length[1] (mm)			Weight[1] (g)		
			Min	Max	Mean	Min	Max	Mean
Black bass	338 (265)	50.1	178	559	364	385.6	3692.2	789.8
Bluegill	3 (3)	0.4	203	203	203	158.8	158.8	158.8
Catfish (spp.)	20 (15)	3.0	305	559	440	190.5	2449.4	880.0
Chinook salmon	117 (38)	17.4	324	559	398	326.6	1360.8	622.9
Kokanee	11(0)	1.6	274	373	313	226.8	567.0	381.8
Rainbow trout	177 (69)	26.3	305	559	396	340.2	907.2	550.1
Sucker (spp.)	6 (4)	0.9	356	483	415	331.1	1691.9	901.1
Total	672 (394)							

[1] Length and weight measurements were collected opportunistically and do not represent the total number of fish caught.

Table 3.5-6. Annual black bass fishing contest results for the Don Pedro Reservoir.

Year	Contest Days[1]	Total Fish Count[2]	Total Fish Weight (lb)[2]	Total Reported Dead Fish	No. Of Competitors	Total Contest Hours	Total Hours Effort	Total Catch Per Hour[2]	Mean Weight (lb) Per Fish[2]
2009	73	3,798	7,409.4	43	1,937	556.50	17,380.00	0.22	1.95
2008	82	6,006	12,180.1	35	2,447	584.50	21,571.50	0.28	2.03
2007	54	5,463	12,694.5	67	1,796	395.20	17,357.00	0.31	2.32
2006	74	6,153	14,264.0	135	2,400	543.80	21,335.00	0.29	2.32
2005	73	5,266	10,913.6	62	2,283	570.50	21,781.00	0.24	2.07
2004	77	5,676	12,016.0	90	2,482	584.50	24,007.00	0.24	2.12
2003	82	5,430	10,513.8	70	2,607	613.50	23,830.00	0.23	1.94
2002	77	5,694	10,482.8	67	2,535	582.50	24,620.00	0.22	1.91
2001	89	6,572	14,296.4	112	3,012	640.50	27,883.00	0.24	2.18
2000	70	7,312	13,674.0	121	3,112	542.50	31,080.50	0.24	1.87
1999	24	2,194	3,976.0	10	1,262	195.00	11,269.00	0.20	1.80
1998	55	5,777	10,745.0	71	2,377	432.50	22,753.00	0.25	1.86
1997	82	10,036	19,120.0	149	3,459	654.50	33,872.00	0.30	1.91
1996	63	6,461	12,582.0	86	2,260	512.00	23,299.50	0.28	1.95
1995	69	6,084	10,364.0	72	2,841	542.50	27,731.50	0.22	1.70
1994	64	5,777	10,364.0	97	1,978	479.00	17,911.50	0.32	1.79
1993	60	4,280	7,147.0	54	1,964	491.00	19,542.00	0.22	1.67
1992	76	4,996	8,096.0	105	2,460	602.00	23,354.50	0.21	1.62
1991	82	4,515	6,682.0	62	3,297	620.50	30,559.00	0.15	1.52
1990	71	5,944	9,421.0	152	3,261	569.00	28,811.00	0.21	1.58
1989	26	4,408	6,584.0	114	2,205	198.00	19,796.00	0.22	1.49
1988	28	3,614	5,230.0	78	1,993	234.00	19,452.50	0.19	1.45
1987	11	2,892	4,648.0	91	1,280	107.00	12,141.00	0.24	1.61
1986	11	1,305	1,704.0	35	1,027	105.00	11,895.00	0.11	1.31
1985	3	631	801.0	18	338	27.00	3,042.00	0.21	1.27

[1] Data represents results for permitted contests with complete contest reports only.
[2] Tournament organizers seldom distinguished between species, so the Total Fish Count, Total Fish Weight, Total Catch per Hour and Mean Weight per Fish are for largemouth, smallmouth, and spotted bass combined.
Source: CDFG Summary Reports of Black Bass Fishing Contests held in California.

Summary of Don Pedro Reservoir Fisheries

The results of the 2012 Don Pedro Reservoir fish population survey substantiate existing information that indicates current habitat conditions in the reservoir, under ongoing management programs, support quality warm-water and cold-water fisheries (TID/MID 2013a, W&AR-17). All three black bass species were prominent in the gill net and electrofishing catches and in the angler surveys. Age-scale information reveals that there are multiple age classes of black bass in the reservoir, demonstrating that successful reproduction is occurring. Bass nesting habitat was found to be of suitable quality and availability to support population recruitment, which along with the current bass stocking program, provides a popular bass fishery. The popularity of bass fishing is also evident from creel information collected in 2012, which shows that black bass were the most commonly caught fish species, and by the substantial number of black bass fishing contest days that occur on the reservoir each year.

The 2012 survey also confirmed the presence of good quality salmon and trout fisheries. Reservoir conditions in spring and fall are sufficient to provide access to potential spawning tributaries for trout and salmon, although the sustainability of cold-water fisheries in the reservoir depends on the stocking of hatchery fish (TID/MID 2013a, W&AR-17; see Potential Spawning Tributaries section above). The three special status fish species with the potential to occur in the Don Pedro Project area–hardhead, Red Hills roach, and Sacramento-San Joaquin roach–have been documented in tributaries to Don Pedro Reservoir or, in the case of hardhead, the mainstem Tuolumne River upstream and downstream of the reservoir. However, these species have not been documented within the Project Boundary.

Aquatic Invasive Species

Aquatic invasive species of concern in the Central Valley include two species of mussel, quagga mussel (*Dreissena rostriformis bugensis*) and zebra mussel (*D. polymorpha*), and the New Zealand mudsnail (*Potamopyrgus antipodarum*). To date, neither the mussel species nor the mudsnail have been documented in Don Pedro Reservoir.

Quagga and zebra mussels have been a source of significant operational problems and maintenance expenditures for water projects in the eastern United States for decades. Quagga mussels were first found in the western United States in 2007 and quickly expanded their geographic range. Quagga mussels are currently found in the following western states: California, Arizona, Nevada, Utah, Colorado, and New Mexico[27]. In California, quagga mussels have been found in the Colorado River and in reservoirs in Riverside and San Diego counties that receive Colorado River water. Zebra mussels are currently found in the following western states: California, Utah, and Colorado[2]. The zebra mussel was found in California for the first time in January 2008, at the San Justo Reservoir in San Benito County. These two species of mussel could threaten water delivery and irrigation systems by clogging intake pipes and other conveyance structures.

Quagga and zebra mussels can be introduced to water bodies from the hulls of boats and through ballast water collected in mussel-invaded waters. The larval mussel life-stage is free-floating

[27] http://nas.er.usgs.gov/taxgroup/mollusks/zebramussel/quaggamusseldistribution.aspx

and microscopic; consequently, larval mussels can enter ballast water as well as bilges, live wells, or other equipment that holds water. These mussels are prolific breeders and attach themselves to hard and soft surfaces. They can survive out of water for up to a week.

Because boating is common in both the Don Pedro and Modesto reservoirs and in Turlock Lake, these water bodies are vulnerable to the introduction of invasive quagga and zebra mussels. Based on the impacts of these mussels in other systems, and the high cost of controlling the populations once they have been introduced, an invasion of quagga or zebra mussels could be a significant water quality and operational issue.

A report, Potential Distribution of Zebra Mussels *(Dreissena polymorpha)* and Quagga Mussels *(Dreissena bugensis)* in California, prepared for CDFW, assessed the threat of these mussels to California water bodies based on the mussels' ability to tolerate a range of temperatures, calcium concentrations, pH, dissolved oxygen, and salinity (Cohen 2008). Based on its ambient conditions, Don Pedro Reservoir is not considered to be particularly vulnerable to colonization.

The New Zealand mudsnail (*Potamopyrgus antipodarum*), an invasive gastropod species, has been found in more than 20 California water bodies since 2000, including Lake Shasta in December 2007 and more recently in water bodies in Stanislaus County. This species is often introduced via anglers' waders and other equipment.

New Zealand mudsnails are able to withstand desiccation, a wide range of temperatures, and are small enough to be inadvertently transported to aquatic systems where they have not yet been introduced. The mudsnail tolerates siltation and thrives in disturbed watersheds. It occurs among macrophytes and prefers the littoral zones of lakes or slow streams but can tolerate high-flow environments. Mudsnails have been found at depths ranging from 13 to 148 ft (4 to 45 m).

Because mudsnails reproduce asexually, a single individual is capable of populating an aquatic system once introduced. The New Zealand mudsnail has no natural predators or parasites in the United States, which has contributed to its successful dispersal. Control of this species depends on vigilant cleaning of boats and other equipment to avoid its introduction into unaffected areas.

The Districts participate in the State of California's program to reduce the spread of invasive species by providing information (at boat launches and at the DPRA Visitor Center), which educates recreational users on ways to reduce the spread of invasive species. The DPRA has attended workshops to learn about methods for preventing the spread of nonnative mussel species and met with water recreation managers to discuss relevant issues. Since June 2008, MID has been monitoring for zebra and quagga mussels at its water treatment plant using submerged vertical plates, which are inspected every two weeks for mussel attachment. MID has not detected any mussels.

3.5.2.2 Fish and Aquatic Resource Effects in Don Pedro Reservoir

FERC's SD2 identifies the following fish and aquatic resources related issues associated with Don Pedro Reservoir:

- Effects of project operation and maintenance on fish populations in project reservoirs (page 35).
- Potential effects of project operations on stranding or displacement of fish (page 36).
- Potential effects of entrainment at the project dam and intake on fish populations (page 36).

The Proposed Action under review by FERC is the issuance of a new license to the Districts to authorize the continued generation of hydroelectric power at Don Pedro Dam and implementation of the Districts' proposed resource measures. As such, and as generally described in FERC's SD2 issued on July 25, 2011, any alternatives to mitigate the Project's effects ("mitigation strategies") must be reasonably related to the purpose and need for the Proposed Action, which in this case is whether, and under what terms, to authorize the continuation of hydropower generation at the Don Pedro Project.

As explained in Exhibit B of this AFLA, flow releases from Don Pedro Reservoir are made for the following purposes: (1) flood flow management, including pre-releases in advance of anticipated high flows during wet years, (2) the Districts' irrigation and M&I demands, including flows to maintain water storage in Turlock Lake and Modesto Reservoir, and (3) protection of aquatic resources in the lower Tuolumne River in accordance with the terms of the FERC license. Once the weekly and daily flow schedules are established based on these demands, outflows from the Don Pedro powerhouse are scheduled to deliver these flows. During periods of greater electric energy demand, outflows may be shaped to generate more electricity during on-peak periods and less during off-peak periods, subject to meeting the requirements of the pre-established flow schedule. In accordance with the Districts' "water-first" policy, flow releases are scheduled around the uses listed above, then delivered via the generation units up to their capacity and availability. Hydropower generation at the Don Pedro Project is a secondary consideration with respect to flow scheduling.

The following paragraphs address the issues identified by FERC in its SD2, but in the context of what can be expected to occur under an extension into the future of existing baseline conditions. As explained above, water management is driven by the primary Don Pedro Project purposes and flow-shaping for hydroelectric generation has only secondary and minor effects on conditions in the reservoir. The effect of hydropower operations on reservoir water levels would be limited to the daily shaping of flows. Using the data provided in Exhibit B (see Table 2.4-4); the greatest on-peak/off-peak change in generation was roughly 40 MW. If it is assumed that the on-peak period lasts for 16 hours during the summer, this equates to a flow of roughly 1,200 cfs more during the on-peak period than during the off-peak period. Over a 16-hour period, this amounts to a volume of 1,600 AF. At the median reservoir level of 780 ft, this represents a change in reservoir level of 0.15 ft, or 1.8 inches, occurring over a 16-hour period, compared to the off-peak flow occurring all day. This also assumes that there was zero inflow to the reservoir during the day, i.e., the change in water level would have been less than 1.8 inches. Flow-shaping for hydroelectric generation has only minor, if any, effects on conditions in the reservoir. Therefore, the Proposed Action would have no measurable effects on variation in reservoir water surface elevation, water quality, or any other environmental conditions.

As noted previously, thermal stratification in Don Pedro Reservoir allows for the existence of both a cold-water and warm-water fishery. There are two primary reservoir conditions that influence habitat and fish populations in the reservoir: cold water pool volume and sustained spawning and juvenile rearing habitats for warm-water fish species during spring.

Don Pedro Project operations affect reservoir water temperatures, which in turn have the potential to affect cold-water fish species by influencing the volume of cold, oxygenated water during times of thermal stratification. The greater the volume of cold water during the warmer months, the greater the amount of cold-water habitat available to support the stocking-dependent cold-water fisheries. The findings of the Don Pedro Reservoir Fish Population Survey Study (TID/MID 2013a, W&AR-17) are consistent with all available evidence that suggests Don Pedro Reservoir supports a quality cold-water fishery, indicating that the Don Pedro Project has no adverse effect on the persistence of cold-water fish species in the reservoir. The Districts are aware of no data or other evidence that indicate operations and maintenance associated with the primary Don Pedro Project purposes have an adverse effect on the reservoir's cold-water fishery.

FERC's SD2 identifies as an issue the potential effects of Don Pedro Project operations on stranding or displacement of fish. Changes in reservoir surface elevation that result from water uses associated with the Don Pedro Project's primary purposes have the potential to affect reservoir fish by influencing shoreline and tributary habitats. Variation in reservoir water surface elevation resulting from hydroelectric generation is insignificant and therefore has no substantial effect on shoreline habitats. Similarly, the Districts' proposed flow releases for aquatic resources in the lower Tuolumne River would not discernibly influence conditions in Don Pedro Reservoir.

As noted, warm-water fisheries are primarily dependent on sustained spawning and juvenile rearing habitats during spring. These typically littoral, shallow areas could be impacted during the spawning season if reservoir levels were to drop significantly. Decreased water surface elevations during the bass nesting season could expose nests and decrease egg survival and bass recruitment. However, the bass nest survival evaluation showed that reservoir elevation changes occurring during the period of analysis (i.e., 1984 through 2012) maintained bass nest survival at or above the acceptable level identified by CDFW (Lee 1999; TID/MID 2013a, W&AR-17). There is no evidence that existing operations related to hydroelectric power generation or the primary Don Pedro Project purposes have adverse effects on bass nesting in Don Pedro Reservoir (as explained in Section 3.5.2.1.3).

Because ordinary reservoir operations would not change with the Proposed Action, bass nesting success during the new license term would be similar to what it was during the period analyzed (i.e., 1984 through 2012) in Section 3.5.2.1.3. The proposed lowering of the minimum operating elevation from 600 to 550 feet is not expected to significantly change conditions for bass nesting relative to baseline conditions. Drawdown of the reservoir to 550 feet would occur only very rarely during successive dry years, and is not likely to occur during the main portion of the bass nesting period in Don Pedro Reservoir. For perspective, during the 1984–2012 period, Don Pedro Reservoir was never drawn down to the current minimum operating elevation of 600 feet, and was only drawn down below 700 feet once, and then only slightly.

The Don Pedro Project is operated to accommodate access to possible cold-water spawning tributaries during the spring and fall fish migration periods (TID/MID 2013a, W&AR-17). Overall, under existing operations, slopes at the locations where tributaries enter the reservoir are well below the 10 percent criterion defining a fish impediment (TID/MID 2013a, W&AR-17). Fish passage impediments were only identified in Deer Creek, which is not considered a salmonid spawning stream (TID/MID 2013a, W&AR-17). Because normal reservoir operations would not change with relicensing under the Proposed Action, tributary access during the new license term is expected to be similar to what it was during the period of analysis, i.e., 1984 – 2012 (see Section 3.5.2.1.4). The proposed lowering of the minimum operating elevation from 600 to 550 feet is not expected to significantly change tributary access relative to baseline conditions. Drawdown of the reservoir to 550 feet would occur only very rarely during successive dry years, and is unlikely to occur during the entire tributary spawning periods. For perspective, during the 1984 – 2012 period, Don Pedro Reservoir was never drawn down to the current elevation of 600 feet, and was only drawn down below 700 feet once, and then only slightly. Moreover, cold-water fisheries in Don Pedro Reservoir are primarily supported by stocking and not natural reproduction occurring in tributaries to the reservoir (TID/MID 2013a, W&AR-17).

FERC's SD2 also identifies as an issue the potential effects of entrainment at the Don Pedro Dam and intake on fish populations. The power tunnel intake at Don Pedro Reservoir is located at elevation 535 ft, or approximately 250 ft or more below the water surface throughout most years (TID/MID 2013a, W&AR-17), and as a result it is very unlikely that warm-water fish species are entrained at the Don Pedro Project. Stocked cold-water species occupy cooler, deeper water during some periods of the year. However, given the depth of the Don Pedro Project intake and the low densities of fish in deep water, entrainment of cold-water species is also likely to be infrequent. In 2012, gillnetting was conducted at maximum depths ranging from 140 to 200 ft. Only 7.2 percent of the total adult gillnet catch was collected in the deep-water net sets, at a catch rate of 0.17 fish/hour (compared to a rate of 2.91 fish/hour in shoreline adult gillnet sets). Kokanee and Sacramento sucker were the two species captured in the deep-water nets, with kokanee accounting for 92 percent of the catch. Two of the gillnet sets were located near Don Pedro Dam (see Figure 3.5-1). At these sites, nets were able to sample to a depth of 100 ft. Only three fish were captured at these sites (two kokanee and one sucker) in 18.6 hours of fishing mid-water and deep-water gillnets. Even if stocked cold-water species are entrained at low rates during some times of year, the persistence of a quality cold-water fishery in the reservoir indicates that any entrainment that occurs does so at a level that has minimal adverse effects on cold-water species, including salmonids.

The findings of the Don Pedro Reservoir Fish Population Survey Study (TID/MID 2013a, W&AR-17) are consistent with all available evidence, which demonstrates that current conditions in Don Pedro Reservoir support quality cold-water and warm-water fisheries. The Districts are aware of no evidence that indicates operations and maintenance activities related to the Don Pedro Project's primary purposes or to hydropower generation have an adverse effect on the reservoir's fish and aquatic resources. Because the Proposed Action would not significantly influence the operation or maintenance activities of the Don Pedro Project (other than rare, low-magnitude effects associated with the lowering of the minimum operating reservoir level, as explained previously), no adverse effects on fish and aquatic resources in the reservoir are anticipated over the term of the new FERC license.

Potential effects of sediment and large woody debris (LWD) retention in Don Pedro Reservoir (also identified by FERC in its SD2) would manifest themselves in the lower Tuolumne River. As a result, the potential effects of sediment and LWD retention on aquatic resources are addressed in Section 4.0, Cumulative Effects.

3.5.2.3 Proposed Environmental Measures

Because the Proposed Action would have no adverse effects on fish and aquatic resources in Don Pedro Reservoir, the Districts are proposing no fish and aquatics related environmental measures for implementation in or around the reservoir.

3.5.2.4 Unavoidable Adverse Impacts

For the reasons identified in Section 3.5.2.2, the Proposed Action would result in no unavoidable adverse impacts on fish and aquatic resources in Don Pedro Reservoir.

3.5.3 Fish Populations between Don Pedro Reservoir and La Grange Diversion Dam

3.5.3.1 Existing Environment

Fish Studies Conducted between Don Pedro Dam and La Grange Diversion Dam

In 2012, the Districts conducted a study to characterize the fish assemblage in the reach of the Tuolumne River between Don Pedro Dam and La Grange Diversion Dam (TID/MID 2013b, W&AR-13). Prior to this study, almost nothing was known about this reach, with all information based on a single sampling event that occurred in 2008 (Stillwater Sciences 2009a). No known angler harvest or stocking data exist for this reach.

The study reach between La Grange Diversion Dam (RM 52.2) and the Don Pedro powerhouse (RM 54.5), was approximately 2.3 miles long. During 2012, reconnaissance surveys were conducted to evaluate habitat in this reach, and fish sampling sites were selected to represent the availability of near-shore habitats (Figure 3.5-6). Boat electrofishing was conducted at each sampling site, with the duration of the sampling period recorded to ensure consistent sampling effort among sites.

Habitat Characteristics and Fish Species Composition, Relative Abundance, and Condition

Two types of habitat were identified in the study reach: riverine and lacustrine (TID/MID 2013b, W&AR-13). Riverine sites were characterized by observable currents, large substrate particles, and a lack of rooted aquatic macrophyte beds. Lacustrine sites were characterized by a lack of observable current, smaller substrate particles, and a greater frequency of rooted macrophyte beds. Both riverine and lacustrine habitats were characterized by a lack of habitat complexity.

The 2012 study results indicate that the reach of river between the Don Pedro Dam and La Grange Diversion Dam contains two fish species, rainbow trout and prickly sculpin (*Cottus* *asper*), and that both species are distributed across the reach (TID/MID 2013b, W&AR-13). Relative abundance, length, and weight of fish collected in 2012 are shown in Table 3.5-7.

The rainbow trout population exhibited four age classes, indicating that some reproduction occurs in the reach (as noted above, there are no records of stocking having been conducted in this reach). Rainbow trout were present in both lacustrine and riverine reaches, documenting that they use the range of available habitat (TID/MID 2013b, W&AR-13). Overall, average condition (i.e., Kn=0.99) and appearance of the rainbow trout collected in 2012 indicated that fish were healthy (TID/MID 2013b, W&AR-13).

The prickly sculpin population also exhibited multiple age classes (potentially three), and the presence of young-of-the-year fish indicates that reproduction is occurring in the reach (TID/MID 2013b, W&AR-13). Sculpin were most abundant in riverine habitats (i.e., upstream sampling sites). Overall, sculpin condition indicated that fish appeared healthy (i.e., Kn = 0.99).

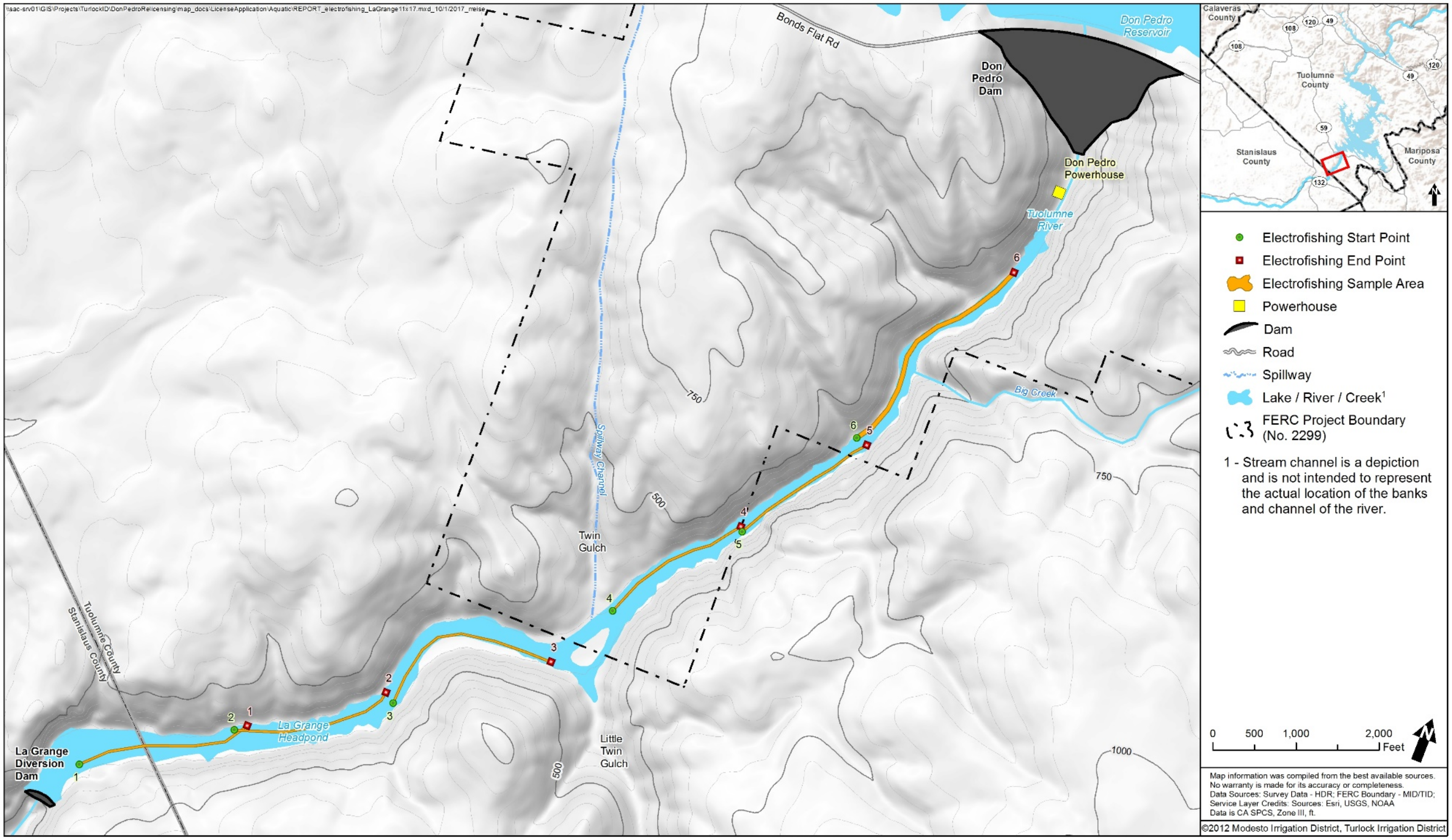

Figure 3.5-6. Study reaches and fish sampling areas in the reach between Don Pedro Dam and La Grange Diversion Dam in 2012.

Table 3.5-7. Summary of relative abundance, length, and weight of fish species collected at all sites between Don Pedro Dam and La Grange Diversion Dam in 2012.

Species	Composition		Length (mm)			Weight (g)		
	N	Percent	Min	Max	Mean	Min	Max	Mean
Rainbow Trout (*O. mykiss*)	86	64.7	85	344	153.5	5.5	469.5	67.1
Prickly sculpin (*C. asper)*	47	35.3	48	110	80.1	1.3	106.1	14.8
Total	133	100						

3.5.3.2 Fish and Aquatic Resource Effects between Don Pedro Reservoir and La Grange Diversion Dam

FERC's SD2 (page 35) identifies the following fish and aquatic resources related issue associated with the reach of the Tuolumne River between Don Pedro Reservoir and La Grange Diversion Dam:

- Effects of project operation and maintenance on fish populations in project reservoirs and the project-affected stream reach including fall Chinook salmon.

Unlike Don Pedro Reservoir and the lower Tuolumne River, where the Proposed Action would have no effect on environmental conditions (see sections 3.5.3 and 4.0, respectively), hydropower generation would have an effect on water velocities in the reach between Don Pedro Reservoir and La Grange Diversion Dam. As explained previously, outflows through the powerhouse may be shaped to generate more electricity during on-peak periods and less during off-peak periods, subject to meeting the requirements of the pre-established flow schedule. These changes in outflows affect water velocities in the reach between the two dams. In the upper part of the reach, above the island at Twin Gulch, velocities range from 5 feet per second (fps) during high outflows (about 4,000 cfs) to 3 fps during low outflows (1,000 cfs) just below the powerhouse and from 2.5 fps (high flow) to 1 fps (low flow) in the deeper pool section just above Twin Gulch. Below the island at Twin Gulch, in the lower reach affected by the backwater of La Grange Diversion Dam, velocities range from 0.8 fps during higher flows to 0.3 fps during lower flows (TID 2011). Under the Proposed Action, as under current conditions, rainbow trout would continue to be able to move through this reach to locate suitable velocities and depths. Water velocities within the range identified above are suitable for all life stages of resident rainbow trout based on the habitat suitability criteria (HSC) applicable to resident *O. mykiss* in the Tuolumne River (Stillwater 2013). The change in depth between lower flows (1,000 cfs) and higher flows (4,000 cfs) in the upstream portion of this reach is approximately 2.5 ft (from elevation 299 to 301.5 ft). In the lower portion of the reach, which is affected by La Grange Diversion Dam, the change is depth is approximately 0.2 ft (from elevation 296.4 ft to 296.6 ft) (TID 2011).

As noted above, results of the Fish Assemblage and Population between Don Pedro Dam and La Grange Diversion Dam Study conducted in 2012 (TID/MID 2013b, W&AR-13) indicate that the reach of the Tuolumne River between the dams contains two fish species, rainbow trout and prickly sculpin, and that both species are distributed across the reach.

Because both rainbow trout and sculpin exhibit multiple age classes, reproduction of these species is apparently occurring within the reach (as noted above, there are no records of stocking having been conducted in this reach). In addition, fish of both species appear to be healthy, as indicated by average condition factors near 1.0 (average Kn=0.99). Given the multi-age structure of the populations and apparent health of individual fish, velocity and stage fluctuations associated with existing operations allow for the persistence of the two fish species observed in the reach (resident *O. mykiss* and sculpin) between Don Pedro Dam and La Grange Diversion Dam. Although physical habitat conditions, structural complexity in particular, are not optimal, the Don Pedro Project does not preclude rainbow trout and sculpin from living and reproducing in the reach and, therefore, would not be expected to have an adverse effect on these species over the term of the new license. The Districts' proposed flow regime for the benefit of aquatic resources in the lower Tuolumne River would have no significant effects on resident rainbow trout and sculpin in this reach.

3.5.3.3 Proposed Environmental Measures

As noted above, the Proposed Action would have no adverse effects on fish and aquatic resources in the reach between Don Pedro Reservoir and La Grange Diversion Dam, and as a result the Districts are proposing no environmental measures for this reach.

3.5.3.4 Unavoidable Adverse Impacts

For the reasons outlined in Section 3.5.3.2, the Proposed Action would result in no unavoidable adverse impacts on fish and aquatic resources in the reach between Don Pedro Reservoir and La Grange Diversion Dam.

3.5.4 Fish and Aquatic Resources in the Lower Tuolumne River

3.5.4.1 Existing Environment

The lower Tuolumne River extends approximately 52 miles from La Grange Diversion Dam (RM 52.2) downstream to its confluence with the San Joaquin River (RM 0). The lower river can be divided into two broad geomorphic zones defined by channel slope and bed material. The upper zone (RM 24–52) is gravel-bedded with moderate slope (0.10–0.15%), whereas the lower zone (RM 0–24) is sand-bedded with a slope generally less than 0.03 percent (McBain & Trush 2000). The gravel-bedded and sand-bedded zones are subdivided into seven reaches based on present and historical land uses, valley confinement, channel substrate and slope, and salmonid use:

- Reach 1 (RM 0–10.5): Lower sand-bedded reach,
- Reach 2 (RM 10.5–19.3): Urban sand-bedded reach,
- Reach 3 (RM 19.3–24.0): Upper sand-bedded reach,
- Reach 4 (RM 24.0–34.2): In-channel gravel mining reach,
- Reach 5 (RM 34.2–40.3): Gravel mining reach,

- Reach 6 (RM 40.3–45.5): Dredger tailings reach, and
- Reach 7 (RM 45.5–52.1): Dominant salmon spawning reach.

The lower Tuolumne River contains a fish community similar to those found throughout the San Joaquin River Basin (see the fish species composition and salmonid sections below for greater detail). Currently, hatchery-origin fish represent a large proportion of the Central Valley fall-run Chinook salmon escapement (TID/MID 2013h, W&AR-05). Although precise estimates of the proportion of hatchery- and naturally-produced salmon cannot readily be discriminated in the historical record because hatchery-origin fish have not been consistently marked, straying of hatchery-origin fish has been documented in the Tuolumne River and has likely affected the numbers of salmon in annual spawning runs (TID/MID 2012b; TID/MID 2013h, W&AR-05).

Fish Studies Conducted in the Lower Tuolumne River

Fish Studies Conducted Prior to Relicensing

The Don Pedro Project and its potential environmental effects have undergone continuous study and evaluation since the initial license was issued. The Districts, in cooperation with state and federal resource agencies and environmental groups, have conducted over 200 individual resource investigations since the Don Pedro Project began commercial operation in 1971. The first 20 years of study led in 1995 to the development of a FERC-mediated settlement agreement with resource agencies and NGOs, whereby the Districts agreed to modify their operations to increase the flows released to the lower Tuolumne River for the benefit of fish, especially fall-run Chinook salmon.

Conditions in the lower Tuolumne River have also benefited from the involvement of the Tuolumne River Technical Advisory Committee (TAC), the role of which was formalized in the 1995 Settlement Agreement. Since the early 1990s to the present, the TAC has been engaged in developing, reviewing, and participating in activities to improve and protect the fisheries of the lower Tuolumne River downstream of La Grange Diversion Dam. In addition to the Districts, the TAC includes members from state and federal resource agencies, CCSF, and NGOs.

On an annual basis, the Districts file with FERC, and share with the TAC, results of ongoing monitoring downstream of the Project Boundary. The up-to-date record created by the continuous process of environmental investigation and resource monitoring has produced detailed baseline information that has been useful during the relicensing of the Don Pedro Project.

Major studies conducted by the Districts since the 1995 Settlement Agreement and independent of the current relicensing are summarized in Table 3.5-8. Studies fall into the following general categories: (1) salmon population models, (2) salmon spawning surveys, (3) seine, snorkel, and fyke net reports and various juvenile salmon studies, (4) screw trap monitoring, (5) flow fluctuation assessments, (6) smolt monitoring and survival evaluations, (7) fish community assessments (8) invertebrate reports, (9) Delta salmon salvage reports, (10) gravel, incubation, and redd distribution studies, (11) water temperature and water quality assessments (12) instream flow incremental methodology (IFIM) assessments, (13) flow and delta water export reports,

(14) restoration, monitoring, and mapping, and (15) general monitoring. Studies conducted as part of relicensing (see following section) draw on this extensive body of work as appropriate. Chinook salmon and *O. mykiss* population models developed during relicensing are the most comprehensive versions yet developed, and are based on the most current available information. As such, the findings of the newly developed models supersede those of previous models unless otherwise noted.

Table 3.5-8. Article 39 and 58 monitoring reports and other fish studies conducted in the lower Tuolumne River independent of the current relicensing.

Study No.	Study Name
Salmon Population Models	
1992 Appendix 1	Population Model Documentation
1992 Appendix 26	Export Mortality Fraction Submodel
1992 Appendix 2	Stock Recruitment Analysis of the Population Dynamics of San Joaquin River System Chinook salmon
Report 1996-5	Stock-Recruitment Analysis Report
Salmon Spawning Surveys	
1992 Appendix 3	Tuolumne River Salmon Spawning Surveys 1971-88
Report 1996-1	Spawning Survey Summary Report
Report 1996-1.1	1986 Spawning Survey Report
Report 1996-1.2	1987 Spawning Survey Report
Report 1996-1.3	1988 Spawning Survey Report
Report 1996-1.4	1989 Spawning Survey Report
Report 1996-1.5	1990 Spawning Survey Report
Report 1996-1.6	1991 Spawning Survey Report
Report 1996-1.7	1992 Spawning Survey Report
Report 1996-1.8	1993 Spawning Survey Report
Report 1996-1.9	1994 Spawning Survey Report
Report 1996-1.10	1995 Spawning Survey Report
Report 1996-1.11	1996 Spawning Survey Report
Report 1996-1.12	Population Estimation Methods
Report 1997-1	1997 Spawning Survey Report and Summary Update
Report 1998-1	Spawning Survey Summary Update
Report 1999-1	1998 Spawning Survey Report
Report 2000-1	1999 and 2000 Spawning Survey Reports
Report 2000-2	Spawning Survey Summary Update
Report 2001-1	2001 Spawning Survey Report
Report 2001-2	Spawning Survey Summary Update
Report 2002-1	2002 Spawning Survey Report
Report 2002-2	Spawning Survey Summary Update
Report 2003-1	Spawning Survey Summary Update
Report 2004-1	2003 and 2004 Spawning Survey Reports
Report 2004-2	Spawning Survey Summary Update
Report 2006-1	2005 and 2006 Spawning Survey Reports
Report 2006-2	Spawning Survey Summary Update
Report 2007-1	2007 Spawning Survey Report
Report 2007-2	Spawning Survey Summary Update
Report 2008-2	Spawning Survey Summary Update
Report 2009-1	2008 and 2009 Spawning Survey Reports
Report 2009-2	Spawning Survey Summary Update
Report 2009-8	2009 Counting Weir Report
Report 2010-1	2010 Spawning Survey Reports

Study No.	Study Name
Report 2010-2	Spawning Survey Summary Update
Report 2010-8	2010 Counting Weir Report
Report 2011-2	Spawning Survey Summary Update
Report 2011-8	2011 Tuolumne River Weir Report
Report 2012-2	Spawning Survey Summary Update
Report 2012-6	2012 Tuolumne River Weir Report
Report 2013-1	2013 Spawning Survey Reports
Report 2013-2	Spawning Survey Summary Update
Report 2013-6	2013 Tuolumne River Weir Report
Report 2014-1	2014 Spawning Survey Reports
Report 2014-2	Spawning Survey Summary Update
Report 2014-6	2014 Tuolumne River Weir Report
Report 2015-1	2015 Spawning Survey Reports
Report 2015-2	Spawning Survey Summary Update
Report 2015-6	2015 Tuolumne River Weir Report
Report 2016-1	2016 Spawning Survey Reports
Report 2016-2	Spawning Survey Summary Update
Report 2016-6	2016 Tuolumne River Weir Report
Seine, Snorkel, Fyke Reports and Various Juvenile Salmon Studies	
1992 Appendix 10	1987 Juvenile Chinook salmon Mark-Recapture Study
1992 Appendix 12	Data Reports: Seining of Juvenile Chinook salmon in the Tuolumne, San Joaquin, and Stanislaus Rivers, 1986-89
1992 Appendix 13	Report on Sampling of Chinook Salmon Fry and Smolts by Fyke Net and Seine in the Lower Tuolumne River, 1973-86
1992 Appendix 20	Juvenile Salmon Pilot Temperature Observation Experiments
Report 1996-2	Juvenile Salmon Summary Report
Report 1996-2.1	1986 Snorkel Survey Report
Report 1996-2.2	1988-89 Pulse Flow Reports
Report 1996-2.3	1990 Juvenile Salmon Report
Report 1996-2.4	1991 Juvenile Salmon Report
Report 1996-2.5	1992 Juvenile Salmon Report
Report 1996-2.6	1993 Juvenile Salmon Report
Report 1996-2.7	1994 Juvenile Salmon Report
Report 1996-2.8	1995 Juvenile Salmon Report
Report 1996-2.9	1996 Juvenile Salmon Report
Report 1996-9	Aquatic Invertebrate Report
Report 1997-2	1997 Juvenile Salmon Report and Summary Update
Report 1998-2	1998 Juvenile Salmon Report and Summary Update
Report 1999-4	1999 Juvenile Salmon Report and Summary Update
Report 2000-3	2000 Seine/Snorkel Report and Summary Update
Report 2001-3	2001 Seine/Snorkel Report and Summary Update
Report 2002-3	2002 Seine/Snorkel Report and Summary Update
Report 2003-2	2003 Seine/Snorkel Report and Summary Update
Report 2004-3	2004 Seine/Snorkel Report and Summary Update
Report 2005-3	2005 Seine/Snorkel Report and Summary Update
Report 2006-3	2006 Seine/Snorkel Report and Summary Update
Report 2007-3	2007 Seine/Snorkel Report and Summary Update
Report 2008-3	2008 Seine Report and Summary Update
Report2008-5	2008 Snorkel Report and Summary Update
Report 2009-3	2009 Seine Report and Summary Update
Report 2009-5	2009 Snorkel Report and Summary Update
Report 2010-3	2010 Seine Report and Summary Update

Study No.	Study Name
Report 2010-5	2010 Snorkel Report and Summary Update
Report 2011-3	2011 Seine Report and Summary Update
Report 2011-5	2011 Snorkel Report and Summary Update
Report 2012-3	2012 Seine Report and Summary Update
Report 2012-5	2012 Snorkel Report and Summary Update
Report 2013-3	2013 Seine Report and Summary Update
Report 2013-5	2013 Snorkel Report and Summary Update
Report 2014-3	2014 Seine Report and Summary Update
Report 2014-5	2014 Snorkel Report and Summary Update
Report 2015-3	2015 Seine Report and Summary Update
Report 2015-5	2015 Snorkel Report and Summary Update
Report 2016-3	2016 Seine Report and Summary Update
Report 2016-5	2016 Snorkel Report and Summary Update
Screw Trap Monitoring	
Report 1996-12	Screw Trap Monitoring Report: 1995-96
Report 1997-3	1997 Screw Trap and Smolt Monitoring Report
Report 1998-3	1998 Tuolumne River Outmigrant Trapping Report
Report 1999-5	1999 Tuolumne River Upper Rotary Screw Trap Report
Report 2000-4	2000 Tuolumne River Smolt Survival and Upper Screw Traps Report
Report 2000-5	1999-2000 Grayson Screw Trap Report
Report 2001-4	2001 Grayson Screw Trap Report
Report 2004-4	1998, 2002, and 2003 Grayson Screw Trap Reports
Report 2004-5	2004 Grayson Screw Trap Report
Report 2005-4	2005 Grayson Screw Trap Report
Report 2005-5	Rotary Screw Trap Summary Update
Report 2006-4	2006 Rotary Screw Trap Report
Report 2006-5	Rotary Screw Trap Summary Update
Report 2007-4	2007 Rotary Screw Trap Report
Report 2008-4	2008 Rotary Screw Trap Report
Report 2009-4	2009 Rotary Screw Trap Report
Report 2010-4	2010 Rotary Screw Trap Report
Report 2011-4	2011 Rotary Screw Trap Report
Report 2012-4	2012 Rotary Screw Trap Report
Report 2013-4	2013 Rotary Screw Trap Report
Report 2014-4	2014 Rotary Screw Trap Report
Report 2015-4	2015 Rotary Screw Trap Report
Report 2016-4	2016 Rotary Screw Trap Report
Flow Fluctuation Assessments	
1992 Appendix 14	Fluctuation Flow Study Report
1992 Appendix 15	Fluctuation Flow Study Plan: Draft
Report 2000-6	Tuolumne River Chinook Salmon Fry and Juvenile Stranding Report
2005 Ten-Year Summary Report Appendix E	Stranding Survey Data (1996-2002)
Predation Evaluations	
1992 Appendix 22	Lower Tuolumne River Predation Study Report
1992 Appendix 23	Effects of Turbidity on Bass Predation Efficiency
Report 2006-9	Lower Tuolumne River Predation Assessment Final Report
Smolt Monitoring and Survival Evaluations	
1992 Appendix 21	Possible Effects of High Water Temperature on Migrating Salmon Smolts in the San Joaquin River
Report 1996-13	Coded-wire Tag Summary Report
Report 1998-4	1998 Smolt Survival Peer Review Report

Study No.	Study Name
Report 1998-5	CWT Summary Update
Report 1999-7	Coded-wire Tag Summary Update
Report 2000-4	2000 Tuolumne River Smolt Survival and Upper Screw Traps Report
Report 2000-8	Coded-wire Tag Summary Update
Report 2001-5	Large CWT Smolt Survival Analysis
Report 2001-6	Coded-wire Tag Summary Update
Report 2002-4	Large CWT Smolt Survival Analysis
Report 2002-5	Coded-wire Tag Summary Update
Report 2003-3	Coded-wire Tag Summary Update
Report 2004-7	Large CWT Smolt Survival Analysis Update
Report 2004-8	Coded-wire Tag Summary Update
Report 2005-6	Coded-wire Tag Summary Update
Report 2006-6	Coded-wire Tag Summary Update
Report 2007-5	Coded-wire Tag Summary Update
Fish Community Assessments	
1992 Appendix 24	Effects of Introduced Species of Fish in the San Joaquin River System
1992 Appendix 27	Summer Flow Study Report 1988-90
Report 1996-3	Summer Flow Fish Study Annual Reports: 1991-94
Report 1996-3.1	1991 Report
Report 1996-3.2	1992 Report
Report 1996-3.3	1993 Report
Report 1996-3.4	1994 Report
Report 2001-8	Distribution and Abundance of Fishes Publication
Report 2002-9	Publication on the Effects of Flow on Fish Communities
Report 2007-7	2007 Rainbow Trout Data Summary Report
Report 2008-6	2008 July *Oncorhynchus mykiss* Population Estimate Report
Report 2010	Tuolumne River *Oncorhynchus mykiss* Monitoring Report (submitted January 15)
Attachment 5	March and July 2009 Population Estimates of *Oncorhynchus mykiss* Report
Report 2011	Tuolumne River *Oncorhynchus mykiss* Monitoring Summary Report (submitted January 15)
Report 2010-6	2010 *Oncorhynchus mykiss* Population Estimate Report
Report 2010-7	2010 *Oncorhynchus mykiss* Acoustic Tracking Report
Report 2011-6	2011 *Oncorhynchus mykiss* Population Estimate Report
Report 2011-7	2011 *Oncorhynchus mykiss* Acoustic Tracking Report
Invertebrate Reports	
1992 Appendix 16	Aquatic Invertebrate Studies Report
1992 Appendix 28	Summer Flow Invertebrate Study
Report 1996-4	Summer Flow Aquatic Invertebrate Annual Reports: 1989-93
Report 1996-4.1	1989 Report
Report 1996-4.2	1990 Report
Report 1996-4.3	1991 Report
Report 1996-4.4	1992 Report
Report 1996-4.5	1993 Report
Report 1996-9	Aquatic Invertebrate Report
Report 2002-8	Aquatic Invertebrate Report
Report 2004-9	Aquatic Invertebrate Monitoring Report (2003-2004)
Report 2008-7	Aquatic Invertebrate Monitoring (2005, 2007, 2008) and Summary Update
Report 2009-7	2009 Aquatic Invertebrate Monitoring and Summary Update
Delta Salmon Salvage	
Report 1999-6	1993-99 Delta Salmon Salvage Report
Gravel, Incubation, and Redd Studies	

Study No.	Study Name
1992 Appendix 6	Spawning Gravel Availability and Superimposition Report (incl. map)
1992 Appendix 7	Salmon Redd Excavation Report
1992 Appendix 8	Spawning Gravel Studies Report
1992 Appendix 9	Spawning Gravel Cleaning Methodologies
1992 Appendix 11	An Evaluation of the Effect of Gravel Ripping on Redd Distribution
Report 1996-6	Redd Superimposition Report
Report 1996-7	Redd Excavation Report
Report 1996-8	Gravel Studies Report: 1987-89
Report 1996-10	Gravel Cleaning Report: 1991-93
Report 2000-7	Tuolumne River Substrate Permeability Assessment and Monitoring Program Report
Report 2006-7	Survival to Emergence Study Report
Report 2008-9	Monitoring of Winter 2008 Runoff Impacts from Peaslee Creek
Water Temperature and Water Quality	
1992 Appendix 17	Preliminary Tuolumne River Water Temperature Report
1992 Appendix 18	Instream Temperature Model Documentation: Description and Calibration
1992 Appendix 19	Modeled Effects of La Grange Releases on Instream Temperatures in the Lower Tuolumne River
Report 1996-11	Intragravel Temperature Report: 1991
Report 1997-5	1987-97 Water Temperature Monitoring Data Report
Report 2002-7	1998-2002 Temperature and Conductivity Data Report
Report 2004-10	2004 Water Quality Report
Report 2007-6	Flow, Delta Export, Weather, and Water Quality Data Report: 2003-2007
IFIM Assessment	
1992Appendix 4	Instream Flow Data Processing, Tuolumne River
1992 Appendix 5	Analysis of 1981 Lower Tuolumne River IFIM Data
	1995 USFWS Report on the Relationship between Instream Flow and Physical Habitat Availability (submitted by Districts to FERC in May 2004)
Flow and Delta Exports	
Report 1997-4	Streamflow and Delta Water Export Data Report
Report 2002-6	1998-2002 Streamflow and Delta Water Export Data Report
Report 2003-4	Review of 2003 Summer Flow Operation
Report 2007-6	Flow, Delta Export, Weather, and Water Quality Data Report: 2003-2007
Report 2008-8	Review of 2008 Summer Flow Operation
Report 2009-6	Review of 2009 Summer Flow Operation
Restoration, Project Monitoring, and Mapping	
Report 1996-14	Tuolumne River GIS Database Report and Map
Report 1999-8	A Summary of the Habitat Restoration Plan for the Lower Tuolumne River Corridor
Report 1999-9	Habitat Restoration Plan for the Lower Tuolumne River Corridor
Report 1999-10	1998 Restoration Project Monitoring Report
Report 1999-11	1999 Restoration Project Monitoring Report
Report 2001-7	Adaptive Management Forum Report
Report 2004-12	Coarse Sediment Management Plan
Report 2004-13	Tuolumne River Floodway Restoration (Design Manual)
2005 Ten-Year Summary Report Appendix D	Salmonid Habitat Maps
2005 Ten-Year Summary Report Appendix F	GIS Mapping Products
Report 2005-7	Bobcat Flat/River Mile 43: Phase 1 Project Completion Report
Report 2006-8	Special Run Pool 9 and 7/11 Reach: Post-Project Monitoring Synthesis Report
Report 2006-10	Tuolumne River La Grange Gravel Addition, Phase II Annual Report

Study No.	Study Name
Report 2006-11	Tuolumne River La Grange Gravel Addition, Phase II Geomorphic Monitoring Report
General Monitoring Information	
Report	1992 Fisheries Studies Report
Report 2002-10	2001-2002 Annual CDFW Sportfish Restoration Report
Report	2005 Ten-Year Summary Report

Fish Studies Conducted by the Districts as Part of Relicensing

Spawning Gravel in the Lower Tuolumne River (W&AR-04)

In 2012, the Districts conducted a spawning gravel survey (TID/MID 2013j, W&AR-04) in the Tuolumne River from just downstream of La Grange Diversion Dam at RM 52.1 to RM 23, which accounts for the extent of riffle habitats documented in historical surveys (TID/MID 1992a, TID/MID 2013j, W&AR-04). The survey involved the application of a variety of analyses and modeling to: (1) estimate average annual sediment yield to Don Pedro Reservoir, (2) estimate changes in the volume of coarse bed material in the lower Tuolumne River channel from 2005 to 2012, (3) map fine bed material in the lower Tuolumne River and compare the results with previous surveys, (4) develop a reach-specific coarse sediment budget to evaluate the Don Pedro Project's contribution to cumulative effects on river sediment in the lower Tuolumne River, (5) map current riffle, spawning gravel, and suitable spawning habitat areas in the lower Tuolumne River and compare the results with previous surveys, and (6) estimate theoretical maximum Chinook spawning run sizes supported under current conditions.

Salmonid Population Information Integration and Synthesis (W&AR-05)

The Districts conducted a Salmonid Population Information Integration and Synthesis Study in 2012 (TID/MID 2013h, W&AR-05) to collect and summarize existing information to characterize Chinook salmon and *O. mykiss* populations in the Tuolumne River and develop hypotheses related to factors potentially affecting those populations. The study area included the lower Tuolumne River from La Grange Diversion Dam (RM 52.2) downstream to the confluence with the San Joaquin River (RM 0), the lower San Joaquin River from the Tuolumne River confluence (RM 84) to Vernalis (RM 69.3), the Delta[28], San Francisco Bay Estuary[29], and the Pacific Ocean. Local and regional information, as well as broader scientific literature sources, were reviewed to examine issues affecting habitat use and life history progression of Tuolumne River salmonids, including fall-run Chinook salmon and *O. mykiss*.

Chinook Salmon Population Model Study (W&AR-06)

The Districts have developed the Tuolumne River Chinook Salmon Population Model (TID/MID 2017a, W&AR-06) to investigate the relative influences of various factors on the life-stage-

[28] The Delta received its first official boundary in 1959 with the passage of the Delta Protection Act (Section 12220 of the California Water Code), with the southern boundary in the San Joaquin River located at Vernalis (RM 69.3) and the western boundary at the confluence of the Sacramento and San Joaquin Rivers (RM 0) near Chipps Island.

[29] The greater San Francisco Bay estuary extends from the Golden Gate Bridge in San Francisco Bay eastward across salt and brackish water habitats included in San Leandro, Richardson, San Rafael, and San Pablo bays, as well as the Carquinez Strait, Honker, and Suisun bays further to the east near the western edge of the Delta.

specific production of Chinook salmon in the Tuolumne River, identify critical life-stage-specific limitations that may represent a population "bottleneck," and compare relative changes in population size between potential alternative management scenarios. Drawing on information developed through interrelated studies, linked sub-models were developed using functional relationships of habitat use, growth, movement, and predation to predict changes in fry, juvenile, and smolt productivity metrics in response to changes in flow and habitat availability in particular locations along the lower Tuolumne River corridor. This model was developed with substantial involvement of interested parties in accordance with a Workshop Consultation Process used to obtain critical input at key model development stages.

Predation (W&AR-07)

In 2012, the Districts conducted a study to understand the effects of predation on rearing and outmigrating juvenile Chinook salmon in the lower river (TID/MID 2013g, W&AR-07). The study, which built upon previously conducted evaluations (TID/MID 1992a), involved estimating the relative abundance of native and non-native piscivores, updating estimates of predation rates, and evaluating habitat use by juvenile Chinook salmon and predator species at typical flows encountered during the juvenile outmigration period. The study area included the Tuolumne River from La Grange Diversion Dam (RM 52.2) to the confluence with the San Joaquin River (RM 0).

On May 21, 2013, FERC issued its Determination on Requests for Study Modifications and New Studies, which included a recommendation that the Districts conduct another year of predation studies in 2014. Following consultation with relicensing participants, and review and revision of the study plan based on agency comments, the 2014 final study plan was approved by FERC on October 18, 2013. However, as noted in the Districts' June 28, 2016 letter to the Commission, CDFW refused to issue an amended scientific collector permit to allow the Districts to conduct electrofishing of non-native predators in the lower Tuolumne River, and CDFW formally denied the Districts' request for hatchery smolts needed to perform the study. As a result, the study approved by FERC on October 28, 2013 was not performed. The best available science and data concerning predation in the lower Tuolumne River is contained in W&AR 07.

Salmonid Redd Mapping (W&AR-08)

The purpose of the Salmonid Redd Mapping study (TID/MID 2013i, W&AR-08; FISHBIO 2017) was to document the spatial distribution of fall-run Chinook salmon and *O. mykiss* redds to assist with quantifying the current spawning capacity and redd/recruit relationships of the lower Tuolumne River. The study area, which extended from La Grange Diversion Dam (RM 52) to Santa Fe Bridge (RM 22), was divided into four reaches, which correspond to reach designations used by CDFW. Bi-weekly redd mapping surveys were conducted to evaluate redd characteristics, redd status, redd superimposition, and fish presence on or near redds during the 2012-2013 and 2014-2015 spawning seasons.

Oncorhynchus mykiss *Population Study (W&AR-10)*

The Tuolumne River *O. mykiss* model (TROm) (TID/MID 2017) was developed to examine the relative influences of various factors on the production of in-river life stages of *O. mykiss*, identify life-stages that may represent a life-history "bottleneck," and compare estimated relative changes in the population among potential alternative resource management scenarios. The model was also developed to compare relative *O. mykiss* production in the Tuolumne River under different water year types, using existing literature and additional information identified in the Salmonid Population Information Integration and Synthesis Study (TID/MID 2013h, W&AR-05), including previously conducted Tuolumne River studies and interrelated relicensing studies. Independent life-stage-specific sub-models were developed to predict life-history progression from adult upstream migration through spawning, egg incubation, fry and juvenile rearing, and smolt outmigration. However, in the absence of reliable information on the numbers and timing of any anadromous *O. mykiss* spawning and the factors contributing to anadromy in the Tuolumne River, the relative changes in the production of *O. mykiss* smolts resulting from different flow and temperature conditions in the Tuolumne River should be interpreted with caution. To allow for the evaluation of *O. mykiss* production under a variety of water-year types, the calibrated TROm model was used to evaluate a Base Case simulation period (1971-2009), which provides a 37-year time series of varying hydrologic conditions. Using water temperature estimates provided by the Reservoir Temperature Model (TID/MID 2013c, W&AR-03) and Lower Tuolumne River Temperature Model (TID/MID 2017c, W&AR-16), juvenile and adult productivity were estimated at three population sizes of resident *O. mykiss*: 500, 2,000 and 10,000 fish.

Chinook Salmon Otolith Study (W&AR-11)

The objective of the Chinook Salmon Otolith Study (TID/MID 2016, W&AR-11) was to use otolith microstructural growth patterns and/or microchemistry to (1) evaluate whether adult fall-run Chinook salmon returning to the Tuolumne River originated from hatcheries or riverine environments other than the Tuolumne River and (2) estimate growth rates and sizes of "wild" fish at exit from the Tuolumne River and from the freshwater Delta.

Oncorhynchus mykiss *Habitat Survey (W&AR-12)*

The *O. mykiss* habitat survey (TID/MID 2013e, W&AR-12) conducted in 2012-2013 consisted of an inventory of instream habitat types and physical habitat characteristics and an appraisal of the distribution, abundance, and function of large woody debris (LWD). The habitat survey was conducted in the *O. mykiss* spawning and rearing reach, which extends from La Grange Diversion Dam to Roberts Ferry Bridge (approximately RM 52 to 39), and the LWD evaluation was conducted from RM 52 to RM 24.

Temperature Criteria Assessment (W&AR-14)

The Temperature Criteria Assessment (Farrell et al. 2017, W&AR-14) included the following tasks: (1) a literature review of available temperature tolerances of Chinook salmon and *O. mykiss*, (2) a desktop analysis examining the influence of temperature on the growth of Chinook salmon in the Tuolumne River, (3) a desktop analysis examining the influence of temperature on the timing of Chinook salmon spawning initiation in the Tuolumne River, (4) an empirical study of local adaptation of temperature tolerance of *O. mykiss* juveniles in the lower Tuolumne River, and (5) an analysis of existing empirical information on the spatial distribution of juvenile *O. mykiss* in response to temperature.

The results of the empirical study of local adaptation of temperature tolerance are presented in the following report: Thermal Performance of Wild Juvenile *Oncorhynchus mykiss* in the Lower Tuolumne River: a Case for Local Adjustment to High River Temperature (Farrell et al. 2017). The purpose of the this study was to investigate the thermal performance of juvenile *O*, *mykiss* from the lower Tuolumne River in response to seasonal maximum water temperatures they experience during the summer months. The study tested the hypothesis that the Tuolumne River *O. mykiss* population below La Grange Diversion Dam is locally adapted to the relatively warm thermal conditions that exist, both now and historically, in the river during summer. *O. mykiss* used in the study were locally caught and tested and then returned safely to the Tuolumne River within approximately one day of capture.

Oncorhynchus mykiss *Scale Collection and Age Determination (W&AR-20)*

In 2012, the Districts conducted the *Oncorhynchus mykiss* Scale Collection and Age Determination Study (TID/MID 2013f, W&AR-20) to use scales to estimate the age-at-length relationship of *O. mykiss* in the lower Tuolumne River. Fish were collected in the reach that extends from La Grange Diversion Dam (RM 52.2) to Turlock Lake SRA (RM 42), and a single sample was collected from the rotary screw trap survey near Waterford (RM 30).

Lower Tuolumne River Floodplain Hydraulic Assessment (W&AR-21) [30]

The July 16, 2009 FERC Order (128 FERC 61,035) required the Districts to conduct a two-dimensional (2-D) pulse flow study. The purpose of the 2-D Pulse Flow Study (Stillwater Sciences 2012a) was to assess habitat suitability for lower Tuolumne River fish species, including Chinook salmon, at conditions above bankfull discharge, and gather empirical data on the relationship between water temperature and flow during pulse flow events (i.e., >1,200 cfs). The study included the development of a 2-D hydraulic model at three study sites to assess the habitat suitability of overbank inundation areas during in-channel at flows up to 5,000 cfs.

The Lower Tuolumne River Floodplain Hydraulic Assessment (TID/MID 2017b, W&AR-21) was undertaken by the Districts to supplement the 2-D modeling described above and the USFWS (2008) assessment of floodplain inundation (i.e., Flow-Overbank Inundation Relationship for Potential Fall-Run Chinook Salmon and Steelhead/Rainbow Trout Juvenile Outmigration Habitat in the Tuolumne River).

The goal of the floodplain hydraulic assessment (TID/MID 2017b, W&AR-21) was to develop a hydraulic model to simulate the interaction between flow in the main channel and the floodplain from La Grange Diversion Dam (RM 52.2) to the confluence with the San Joaquin River to address the following objectives: (1) determine floodplain inundation extents for flows between

[30] Per FERC's May 21, 2013 study determination.

1,000 and 3,000 cfs at 250 cfs intervals and between 3,000 cfs and 9,000 cfs at 500 cfs intervals, (2) estimate the area, frequency, and duration of inundation over a range of flows for Base Case (WY 1971–2012) hydrology, and (3) apply modeled water depths and velocities to quantify the amount of suitable rearing habitat area for juvenile fall-run Chinook salmon and *O. mykiss* at the designated flow increments.

One-Dimensional (1-D) PHABSIM model (Stillwater Sciences 2013)

A number of previous instream flow studies have been conducted on the lower Tuolumne River. The most recent study was filed with FERC in April 2013. The purpose of this latest one-dimensional (1-D) physical habitat simulation (PHABSIM) model (Stillwater Sciences 2013), conducted per a July 16, 2009 FERC Order (128 FERC 61,035), was "to determine instream flows necessary to maximize fall-run Chinook salmon and *O. mykiss* production and survival throughout their various life stages." The instream flow assessment methodology (Bovee 1982) applied a mesohabitat and transect-based approach (i.e., 1-D model) for implementing the PHABSIM component of the USFWS IFIM to address flow-habitat relationships in the lower Tuolumne River from RM 51.7 to 29.0. PHABSIM study site locations in the lower Tuolumne River are shown in Figure 3.5-7. As a supplement to this PHABSIM study (Stillwater Sciences 2013), weighted usable area (WUA) versus flow analyses were conducted for Sacramento splittail and Pacific lamprey based on existing HSC.

The Districts conducted the Lower Tuolumne River Instream Flow Study–Evaluation of Effective Usable Habitat Area for Over-Summering *O. mykiss* (Stillwater Sciences 2015) to estimate the "effective" weighted usable area (eWUA) of select lower Tuolumne River habitat reaches for various life history-stages of *O. mykiss* during June–September). Unlike the traditional WUA computed for stream habitat analysis, which is based on the relationship between physical (i.e., depth, velocity, and/or substrate and cover) parameters and flow (Bovee 1982), the eWUA evaluation accounts for temperature as well. Depending on thermal conditions, the total usable habitat area in a river reach at a given flow may be less than that depicted by the standard WUA-versus-flow relationship if temperatures are unsuitable.

The Districts also conducted a Lower Tuolumne River Instream Flow Study–Non-Native Predatory Bass 1-D PHABSIM Habitat Assessment (Stillwater Sciences 2017a) in response to the Commission's April 29, 2014 determination on requests for study modifications (FERC 2014), which required an assessment of the relationship between flow and bass habitat in the lower river. The study was conducted based on existing HSC for smallmouth, largemouth, and striped bass.

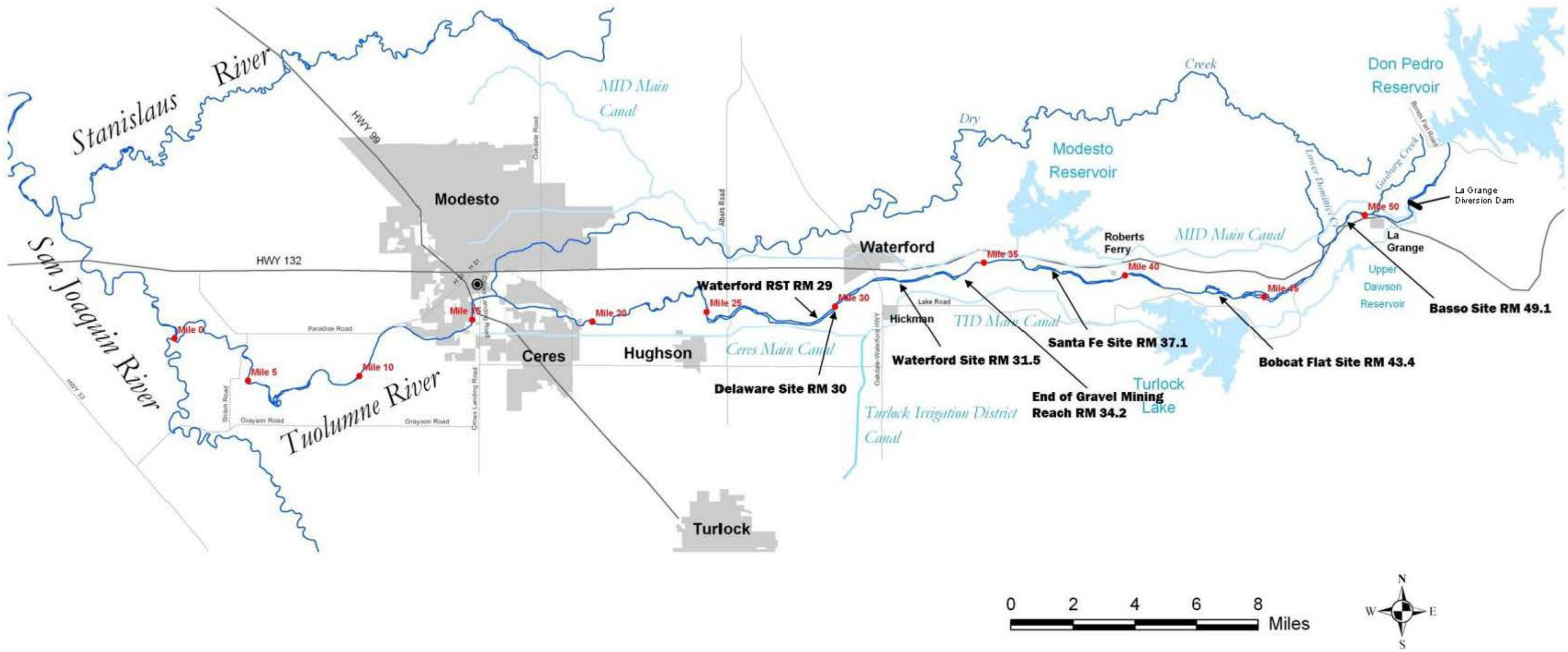

Figure 3.5-7. Vicinity map and study site locations for the Lower Tuolumne River Instream Flow Study.

Physical Habitat Conditions in the Lower Tuolumne River

Physical habitat conditions in the lower Tuolumne River, from La Grange Diversion Dam (RM 52.2) to the confluence with the San Joaquin River, have been affected by a wide range of human actions conducted over many decades. Prior to widespread European settlement, channel form in the gravel-bedded zone of the lower Tuolumne River (RM 24.0–52.1) consisted of a combination of single-thread and split channels that migrated and avulsed (McBain & Trush 2000). Anthropogenic changes that have occurred in the lower Tuolumne River corridor since the mid-1800s include gold mining, aggregate mining, grazing, agriculture, water management, and more recently, urban encroachment (greater detail regarding anthropogenic impacts on the lower Tuolumne River is provided in Section 4.0, Cumulative Effects).

Riverbed material has been excavated to depths well below the thalweg to mine gold and aggregate, eliminating active floodplains and terraces and creating large in-channel and off-channel pits. A historical timeline of mining in the San Joaquin River's tributaries includes placer mining (1848–1880), dredge mining (1880–1960s), and sand and gravel mining (1940s–present) (McBain & Trush 2000). On the Tuolumne River, dredge mining during the early 1900s resulted in the excavation of channel and floodplain sediments and left dredger tailings deposits between RM 38.0 and 50.5. Large scale, off-channel aggregate mining continues today.

Historically, sand and gravel were mined directly from the active river channel, creating large, in-channel pits now referred to as Special Run Pools (SRPs). These SRPs are as much as 400 ft wide and 35 ft deep, occupying 23 percent of the channel length in the gravel-bedded reach of the lower Tuolumne River, and are characterized by much lower water velocities and greater depths than those found in river reaches that were not mined. More recent aggregate mining operations have excavated sand and gravel from floodplains and terraces immediately adjacent to the river channel at several locations downstream of Roberts Ferry Bridge (RM 39.5) (TID/MID 2011a). Floodplain and terrace pits in this reach are typically separated from the channel by narrow berms that can breach during high flows, resulting in capture of the river channel. For example, the January 1997 flood caused extensive damage to dikes separating deep gravel mining pits from the river, breaching or overtopping nearly every dike along a 6-mile-long reach of river (TID/MID 2011a).

Agricultural and urban encroachment along the lower river, combined with a reduction in high flows and coarse sediment supply, have resulted in a relatively static channel within a floodway confined by dikes and agricultural uses. Many miles of river bank have been leveed and stabilized with riprap by agencies or landowners. Levees and bank revetment extend along portions of the river bank from near Modesto (RM 16) downstream through the lower San Joaquin River and Delta.

The relative abundance of habitat types in the lower Tuolumne River during the 2012 Spawning Gravel in the Lower Tuolumne River survey (TID/MID 2013e, W&AR-12) was as follows: 14 percent riffle, 61 percent flat water, and 25 percent pool. Sediment model simulations indicate that without gravel augmentation, the channel bed from RM 52 to 39.7 would be slowly degrading (as opposed to aggrading) and coarsening in response to a reduction in coarse sediment supply due to sediment retention in upstream reservoirs. Gravel augmentation, however, has helped to increase coarse sediment storage in this area (TID/MID 2013j, W&AR-04). Although the results of sediment modeling and topographic differencing indicate little overall change in storage from RM 52 to 45.5 during the period 2000 to 2012, high flows in water year (WY) 2006 and WY 2011 resulted in substantial pool scour, with coarse sediment re-deposited in pool tails and riffles and fine bed material mobilized to channel margins (TID/MID 2013j, W&AR-04). Most riffle mesohabitat units (i.e., 84% of total riffle habitat) mapped in 2012 from RM 52.1 to 23 contained spawning gravel (TID/MID 2013, W&AR-05).

The lower Tuolumne River has limited LWD (TID/MID 2013e, W&AR-12). There was a total of 118 LWD pieces in the 16,905 linear ft of habitat surveyed in 2012, which when extrapolated to the reach extending from RM 52 to RM 39, is an estimated 453 pieces (TID/MID 2013e, W&AR-12). The importance of LWD in habitat formation decreases with increasing channel width. The lower Tuolumne River between RM 52 and 26 has channel widths averaging 119 ft, and LWD has a limited effect on channel morphology in this reach (TID/MID 2013e, W&AR-12). Compared to smaller streams, Bilby and Bisson (1998) observed that wood has less effect on channel form in larger streams, which is consistent with the W&AR-12 surveyors' observations that LWD has a limited effect on channel morphology in the lower river.

Most LWD captured in Don Pedro Reservoir originates upstream of the reservoir, and given the size of this LWD, a majority of it would pass through the lower Tuolumne River during high flows if it were not trapped in the reservoir (TID/MID 2013e, W&AR-12). However, it is unknown to what extent smaller pieces of LWD would add to existing wood accumulations or initiate small woody debris jams in the lower river.

Although LWD provides habitat for salmonids in some systems, there are no data available for the Tuolumne River or neighboring Merced River that specifically address the role of LWD on salmonid abundance (TID/MID 2013e, W&AR-12). Of the 121 locations within the W&AR-12 study reach where LWD was recorded, about 80 percent of it was located in or adjacent to runs or pools, which are not typically the preferred habitat of juvenile or adult salmonids in the lower Tuolumne River. Because most LWD in the lower Tuolumne River is partially or wholly out of the channel, and due to its small size, it does not provide significant cover for fish, which in turn limits its value as protection from avian and aquatic predators. Due to its generally small size, location, and lack of complexity, most LWD from RM 52 to 24 provides little habitat value for salmonids.

The Districts 2012 Lower Tuolumne River Riparian Information and Synthesis Study (TID/MID 2013, W&AR-19) shows that native riparian vegetation occupies 2,691 ac along a nearly continuous but variable-width band along the lower Tuolumne River corridor. In addition, the number of locations and areal extent of lands dominated by non-native plants has decreased over the past 15 years (TID/MID 2013d, W&AR-19).

Overall, the native riparian vegetation is slowly increasing, with a 419-ac increase in the net extent of native vegetation between 1996 and 2012, brought about primarily through active restoration projects (TID/MID 2013d, W&AR-19). Areas with the greatest extent of native riparian vegetation per river mile were found along the 12 miles immediately downstream of La Grange Diversion Dam. Closer to the confluence with the San Joaquin River, several large restoration projects have also increased the extent of native riparian vegetation. However, there is limited natural replacement of mature and senescent plants with younger cohorts outside the restored areas. Areas with the least riparian vegetation and narrowest riparian corridor occur from RM 10.5 to 19.3, i.e., the section of river that runs through the urban areas of Modesto and Ceres (TID/MID 2013d, W&AR-19). The river corridor between RM 19.3 and 40.3 includes large areas that are sparsely vegetated due to historical mining and dredger tailings deposits (see Section 3.6 of this AFLA, Botanical Resources, for greater detail on riparian vegetation).

Fish Species in the Lower Tuolumne River

Fish species composition in the lower Tuolumne River is shown in Table 3.5-9 (Ford and Brown 2001; TID/MID 2010a, b, c, Reports 2009-3, 2009-4, and 2009-5), with a notation as to whether a species is native or non-native and resident or migratory. The distributions of native and non-native fishes are influenced by water temperature and velocity, which vary by location, season, and in response to flow. Most native resident fish species are riffle spawners and are generally more abundant in the gravel-bedded reach (RM 24-52). Existing data show that the Sacramento sucker is the most abundant and widespread native fish species in the lower river. Non-native fishes are present throughout the lower river but are typically most abundant in the sand-bedded reach and the lower 6-7 miles of the gravel-bedded reach, where water temperatures are warmer and SRPs provide habitat (Ford and Brown 2001). Sunfishes are the most abundant and widespread non-native fish in the lower river. The non-native predator fish community in the lower river includes largemouth, smallmouth, and striped bass (*Morone saxatilis*) (TID/MID 1992a; TID/MID 2007a).

Of the 22 non-native fish species documented in the lower Tuolumne River, 18 were introduced by state or federal agencies (CDFW, NMFS, USFWS, and the State Board of Human Health) between 1874 and 1954, and one was introduced with permission from CDFW (1967) (Dill and Cordone 1997; Moyle 2002). The remaining three were introduced by aquarists (goldfish [*Carassius auratus*] in 1862), catfish farms (red shiner [*Cyprinella lutrensis*] in 1954), or private individuals (common carp in 1877, although released in the same year by CDFW) (Dill and Cordone 1997). Sixteen of the fish species released by state or federal agencies were introduced intentionally for sport or commercial fisheries, as a prey base for sport fish, or for mosquito control; two were introduced incidentally with shipments of sport fish (Dill and Cordone 1997). The most abundant and widespread non-native fish species in the lower Tuolumne River (bluegill, redear sunfish, and green sunfish) were first released in California between 1891 and 1954. Largemouth and smallmouth bass were first released in California by CDFW between 1874 and 1891 (Dill and Cordone 1997; TID/MID 1992a).

Table 3.5-9. Fish species documented in the lower Tuolumne River.

Family/Common Name	Scientific Name	Native (N) Or Introduced (I)	Resident (R) Or Migratory (M)
Lampreys (Petromyzontidae)			
Pacific lamprey	*Entosphenus tridentatus*	N	M
Shad and Herring (Clupeidae)			
Threadfin shad	*Dorosoma petenense*	I	R
Salmon and Trout (Salmonidae)			
Chinook salmon	*Oncorhynchus tshawytscha*	N	M
Rainbow trout/steelhead	*Oncorhynchus mykiss*	N	R/M
Minnows (Cyprinidae)			
Common carp	*Cyprinus carpio*	I	R
Fathead minnow	*Pimephales promelas*	I	R
Golden shiner	*Notemigonus crysoleucas*	I	R
Goldfish	*Carassius auratus*	I	R
Hardhead	*Mylopharodon conocephalus*	N	R
Hitch	*Lavinia exilicauda*	N	R
Red shiner	*Cyprinella lutrensis*	I	R
Sacramento blackfish	*Orthodon microlepidotus*	N	R
Sacramento splittail	*Pogonichthys macrolepidotus*	N	M
Sacramento pikeminnow	*Ptychocheilus grandis*	N	R
Suckers (Catostomidae)			
Sacramento sucker	*Catostomus occidentalis*	N	R
Catfish (Ictaluridae)			
Black bullhead	*Ameiurus melas*	I	R
Brown bullhead	*Ameiurus nebulosus*	I	R
Channel catfish	*Ictalurus punctatus*	I	R
White catfish	*Ameiurus catus*	I	R
Livebearers (Poeciliidae)			
Western mosquitofish	*Gambusia affinis*	I	R
Silversides (Atherinidae)			
Inland silverside	*Menidia beryllina*	I	R
Temperate Basses (Percichthyidae)			
Striped bass	*Morone saxatilis*	I	M
Basses and Sunfish (Centrarchidae)			
Black crappie	*Pomoxis nigromaculatus*	I	R
Bluegill	*Lepomis macrochirus*	I	R
Green sunfish	*Lepomis cyanellus*	I	R
Largemouth bass	*Micropterus salmoides*	I	R
Redear sunfish	*Lepomis microlophus*	I	R
Smallmouth bass	*Micropterus dolomieu*	I	R
Warmouth	*Lepomis gulosus*	I	R
White crappie	*Pomoxis annularis*	I	R
Perch (Percidae)			
Bigscale logperch	*Percina macrolepida*	I	R
Surf Perch (Embiotocidae)			
Tule perch	*Hysterocarpus traski*	N	R
Sculpins (Cottidae)			
Prickly sculpin	*Cottus asper*	N	R
Riffle sculpin	*Cottus gulosus*	N	R

Sources: Ford and Brown 2001; TID/MID 2010a, b, c, Reports 2009-3, 2009-4, and 2009-5.

Fall-Run Chinook Salmon

Pursuant to section 305(b)(2) of the Magnuson-Stevens Act, FERC must consult with NMFS regarding any of its actions authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken that may adversely affect a species' Essential Fish Habitat (EFH). The Districts, under the direction of FERC, have prepared an Applicant-Prepared EFH Assessment to serve as the basis for consultation between FERC and NMFS. The EFH Assessment was filed concurrently with the filing of this AFLA.

Fall-Run Chinook Life History

Chinook Spawning

Chinook salmon spawning occurs primarily from October through December (with peak activity in November) in the gravel-bedded reach of the lower Tuolumne River (RM 24 to 52), where water temperatures are suitably cool and spawning riffles are present (TID/MID 2013h, W&AR-05). Egg incubation and fry emergence occur from October through January.

During the period of pre-Don Pedro Project record, maximum and minimum Chinook run sizes were 130,000 spawners in 1944 (Fry 1961, as cited in Yoshiyama et al. 1996) and 100 in 1963 (Fry and Petrovich 1970). Since the completion of Don Pedro Dam in 1971 (1971–2009), spawner estimates have ranged from 40,300 in 1985 to 77 in 1991 (TID/MID 2010d, Report 2009-2). From 1971 to 2009 the date of the peak weekly live spawner count has ranged from October 31 (1996) to November 27 (1972), with a median date of November 12 (TID/MID 2010d, Report 2009-2). Since fall 2009, escapement monitoring has been conducted at a counting weir established at RM 24.5, just below the downstream boundary of the gravel-bedded reach (TID/MID 2010e, Report 2009-8).

The availability, distribution, and quality of gravel for Chinook salmon spawning in the lower river was assessed through a series of studies conducted by the Districts from 1986 to 1992. Results showed that riffle areas extended downstream to approximately RM 23.0, although the actual area available for spawning was less extensive due to site-specific flow characteristics and gravel quality (TID/MID 1992a). Redd superimposition was estimated to occur at 44 percent of all Chinook salmon redds within the study area (RM 48.8 to 51.6), with an estimated egg loss on the order of 20 percent (TID/MID 1992a; McBain & Trush 2000). Gravel quality was poor in riffles, with an associated estimated survival-to-emergence of 16 percent (TID/MID 1992b). Gravel quality in redd locations was greater, but still considered poor, with an associated average estimated survival-to-emergence of 34 percent. Following the 1997 flood, which introduced large volumes of fine sediment to the lower Tuolumne River, an in-situ egg-survival-to-emergence study was conducted to assess the effects of various fine sediment levels within spawning gravels (TID/MID 2007b, Report 2006-7). Study results included an estimated survival-to-emergence rate ranging from near zero to approximately 40 percent, depending on fine sediment levels and intra-gravel flows. Beginning in 2001, gravel augmentation projects were undertaken to improve the quality of spawning gravel in the lower Tuolumne River (see Fish Habitat Restoration Projects, below).

In 2012, the Districts conducted biweekly redd mapping surveys between October 1 and November 2 and weekly surveys between November 5 and November 26 to evaluate peak Chinook salmon spawning (TID/MID 2013i, W&AR-08). Biweekly redd surveys were again conducted between December 10 and April 19, 2013. A total of 653 completed Chinook salmon redds were observed and cataloged between October 1, 2012 and April 19, 2013, 622 (95%) of which were observed between October 29 and November 29 (Table 3.5-10) (TID/MID 2013i, W&AR-08). An additional 233 Chinook salmon redds were classified as incomplete. Peak spawning in all survey reaches occurred during the week of November 12, when 186 new Chinook salmon redds were identified. Approximately 40 percent of Chinook salmon spawning occurred between October 1 and November 9, 2012, and more than 90 percent by November 18, 2012. Nine new Chinook redds were identified during the January to April time period. These redds were classified as Chinook redds based on either the presence of fish or a similarity in size to Chinook redds identified earlier in the spawning season. During the 2012–2013 sampling season, evidence of superimposition was noted at 15.2 percent (99 of 653) of the observed Chinook salmon redds, and most (88%) superimposition was identified during peak spawning activity between November 5 and November 21, 2012 (TID/MID 2013i, W&AR-08).

Table 3.5-10. New Chinook salmon redds identified by reach and date during the 2012–2013 survey period.

Week[1]	Survey Dates	Reach (RM) 1 (52.0–47.4)	2 (47.4–42.0)	3 (42.0–31.6)	4 (31.6–22.0)	Grand Total	Percent
1	10/1–10/4/12	7	1	1	0	9	1.4%
3	10/15–10/18/12	1	0	0	0	1	0.2%
5	10/29–11/2/12	28	13	30	5	76	11.6%
6	11/5–11/9/12	86	48	36	11	181	27.7%
7	11/12–11/15/12	87	48	37	14	186	28.5%
8	11/18–11/21/12	84	15	37	8	144	22.1%
9	11/26–11/29/12	14	9	4	8	35	5.4%
11	12/10–12/13/12	3	4	5	0	12	1.8%
14	1/2–1/5/13	0	1	2	0	3	0.5%
15	1/7–1/10/13	2	0	0	0	2	0.3%
17	1/21–1/24/13	0	0	1	0	1	0.2%
19	2/5–2/8/13	2	0	0	0	2	0.3%
21	2/18–2/21/13	0	0	0	0	0	0.0%
23	3/4–3/7/13	0	0	0	0	0	0.0%
25	3/18–3/21/13	1	0	0	0	1	0.2%
27	4/1–4/4/13	0	0	0	0	0	0.0%
29	4/17–4/19/13	0	0	0	0	0	0.0%
	Grand Total	315	139	153	46	653	100%
	Percent	48.2%	21.3%	23.4%	7.0%	100%	--

1 Week refers to the number of weeks after the week of 10/1/12.

During the 2014-2015 run year, biweekly redd mapping surveys were conducted in Reaches 1 through 3 from October 7, 2014 to April 16, 2015. Surveys in Reach 4 were conducted opportunistically between October 18 and December 30, 2014. A total of 337 completed fall-run Chinook redds were documented, of which 307 (91.1 percent) were observed between November 2 and December 30, and only 5 redds (1.5 percent) were observed prior to November 2 (Table 3.5-11). An additional 70 Chinook salmon redds were classified as incomplete. Peak spawning in all survey reaches occurred during the week of November 16, when 142 new Chinook salmon redds were identified (Table 3.5-11). Redd superimposition was identified at 9.3 percent (32 of 345 total) of Chinook salmon redds. The highest number of superimposed redds was observed in Reach 1, accounting for 59.4 percent of the superimposition events. Spawning activity at recent gravel augmentation sites accounted for 16.3 percent (55 of 337 total) of the new fall-run Chinook redds observed during 2014-2015. The majority of these redds were observed at the CDFW augmentation sites near La Grange (RM 50.6 to 51).

Table 3.5-11. New Chinook salmon redds identified by reach and date during the 2014-2015 survey period.

Survey Week[1]	Survey Dates	Reach				Grand Total	Percent
		1 (52.0-47.4)	2 (47.4-42.0)	3 (42.0-31.6)	4 (31.6-22.0)		
6	10/7	2	--	--	--	2	0.6%
8	10/22–10/23	3	0	--	--	3	0.9%
10	11/3–11/6	13	6	7	--	26	7.7%
12	11/18–11/21	57	40	43	2	142	42.1%
14	12/1–12/5	15	19	34	10	78	23.1%
16	12/15–12/18	19	6	20	7	52	15.4%
18	12/28–12/30	7	1	0	1	9	2.7%
20	1/13–1/15	2	1	6	--	9	2.7%
23	1/26–1/28	0	1	5	--	6	1.8%
24	2/9–2/11	2	0	0	--	2	0.6%
26	2/24–2/26	1	0	0	--	1	0.3%
28	3/10–3/13	2	0	0	--	2	0.6%
30	3/24–3/26	0	0	2	--	2	1.6%
33	4/14–4/16	2	0	1	--	3	0.9%
	Grand Total	125	74	118	20	337	--
	Percent	37.1%	22.0%	35.0%	5.9%	--	--

[1] Survey week refers to the number of weeks starting the first full week of September (Week of September 7, 2014).

During the 2015-2016 run year, biweekly redd mapping surveys were conducted in Reaches 1 through 3 between October 14, 2015 and April 6, 2016. A total of 106 completed fall-run Chinook redds were documented, of which 101 (95.3 percent) were observed between November 3 and December 31, and no redds were observed prior to November 2, 2015 (Table 3.5-12). An additional 23 Chinook redds were classified as incomplete. Peak spawning in all survey reaches occurred during the week of November 30, when 37 new Chinook redds were identified (Table 3.5-12). The highest abundance of observed Chinook redds (45.3 percent) occurred in Reach 3 (RM 31.6 to RM 42.0). Reach 1 (RM 47.5 to 52.0) had the second highest abundance (37.7 percent). Five additional new Chinook redds were identified in January, and no Chinook redds were marked after January 26. Chinook redds marked after December 31 were classified as Chinook redds based on either the presence of fish or because redds were similar in size to Chinook redds identified earlier in the spawning season. Redd superimposition in 2015-2016 was observed at 4.7 percent (5 of 106 total) of the fall-run Chinook redds. Although there was a low sample size, 80 percent (n=4) of the superimposed redds were observed in Reach 4. Spawning activity at recent gravel augmentation sites accounted for 12.3 percent (13 of 106 total) of the new fall-run Chinook redds observed in the Tuolumne River during 2015-2016. The majority of these redds were observed at the CDFW augmentation sites near La Grange (RM 50.6 to 51).

Table 3.5-12. New Chinook salmon redds identified by reach and date during the 2015-2016 survey period.

Survey Week[1]	Survey Dates	Reach 1 (52.0-47.4)	2 (47.5-42.0)	3 (42.0-31.6)	4[2] (31.6-21.6)	Grand Total	Percent
7	10/14	0	--	--	--	0	0.0%
9	10/27–10/28	0	0	--	--	0	0.0%
10	11/3–11/5	2	1	3	--	6	5.7%
12	11/16–11/18	14	7	7	--	28	26.4%
14	11/30–12/2	15	8	14	--	37	34.9%
16	12/14–12/16	3	0	14	--	17	16.0%
18	12/30–12/31	3	2	8	--	13	12.3%
20	1/11–1/15	1	0	2	--	3	2.8%
22	1/26–1/28	2	0	0	--	2	1.9%
24	2/8–2/9	0	0	0	--	0	0.0%
26	2/22–2/23	0	0	0	--	0	0.0%
28	3/9–3/10	0	0	0	--	0	0.0%
30	3/21–3/22	0	0	0	--	0	0.0%
32	4/5–4/6	0	0	0	--	0	0.0%
Grand Total		**40**	**18**	**48**	**0**	**106**	**--**
Redd Density		**8.7**	**3.33**	**4.6**	**--**	**--**	**--**
Percent		**37.7%**	**17.0%**	**45.3%**	**0.0%**	**--**	**--**

1 Survey week refers to the number of weeks starting the first full week of September (Week of September 6, 2015).
2 Reach 4 was not surveyed due to excessive water hyacinth growth that blocked boat passage at various locations throughout the reach.

Results from the current PHABSIM study (Stillwater Sciences 2013) corroborate results of previous studies, i.e., Chinook salmon spawning habitat (as estimated by WUA) is maximized at flows between 175 and 400 cfs (Table 3.5-13).

Table 3.5-13. Lower Tuolumne River Instream Flow Study result comparisons of maximum WUA results between 1981, 1995, and 2013.

Species/Life stage	TID/MID 2013 2013 (cfs)	TID/MID 2013 (FWS 1995 HSC)[1] (cfs)	FWS 1995[2] (cfs)	CDFG 1981[3] (cfs)
Chinook fry	≤100	≤100	<75 cfs	40–280
Chinook juvenile	50–300	50–400	75–225	80–340
Chinook spawn	200–400	200–400	175–325	180–360
O. mykiss fry	<125	--	--	--
O. mykiss juvenile	50–350	100–300	50–170	40–140
O. mykiss adult	>275	>200	50–425	140–280
O. mykiss spawn	>225	--	--	--

1 These results reflect the current PHABSIM model run with the HSC used in the FWS 1995 study.
2 The USFWS 1995 study did not include *O. mykiss* fry and spawning criteria and limited the simulations for rainbow trout to 500 cfs, primarily as a means of evaluating summer conditions (USFWS 1995). Rainbow trout results were reported separately by habitat type only (i.e., riffle, run/glide, and pool) with significant habitat indicated as being primarily associated with riffle and run/glide types.
3 The CDFG 1981 study (reported in TID/MID 1992b) simulated results to 600 cfs and did not include *O. mykiss* fry and spawning criteria. This study showed contrasting results for Chinook fry and juvenile between the two study reaches, with a 1991 reanalysis (TID/MID 1992b) documenting that the lower reach (Reach 2) results were disproportionally due to the influence of a single transect. As a consequence, only the results from Reach 1 are included above in order to maximize comparability of the data.

Barnett-Johnson et al. (2007) estimated that only 10 percent of Central Valley Chinook salmon captured in the ocean troll fishery were not raised in a hatchery setting. Assuming roughly equivalent survival of hatchery- and natural-origin fish from the fishery to the spawning grounds, up to 90 percent of annual escapement could consist of hatchery reared fish (TID/MID 2013h, W&AR-05). Stillwater Sciences (2017b) noted that a lack of genetic distinction between hatchery and naturally spawning fall-run Chinook salmon and loss of early life-history diversity due to inter-basin hatchery transfers and out-of-basin releases of hatchery-reared juveniles, are reducing the ability of fall-run Chinook to adapt to fluctuating environmental conditions, thereby contributing to a reduction in the ESU's reproductive fitness. Observations that estuary releases of late-stage smolts provide the basis for the majority of adult harvest, and hatchery escapement results in high rates of straying, indicate that hatchery practices are increasingly producing salmon that survive at relatively high rates but are decoupled from basin-specific selective pressures that influence the adaptive capacity of the species' freshwater life-stages (Stillwater Sciences 2017b).

In recent years hatchery Chinook have accounted for a large proportion of the annual escapement to the Tuolumne River. Results of the Chinook Salmon Otolith Study (TID/MID 2016) indicate that the total estimated hatchery contribution of adult fall-run Chinook salmon in the Tuolumne River during the years studied (i.e., 1998, 1999, 2000, 2003, and 2009,)[31] averaged 67 percent, and hatchery contribution generally increased in later years. Recognizing that some years in the otolith sample inventory over- or under-represent the typical age-class structure in the escapement record, the overall proportion was estimated using only three-year-old fish, which are expected to make up the bulk of the annual escapement. For three-year-old fish, hatchery contribution ranged from 36 to 90 percent, with a mean of 58 percent. Straying of hatchery Chinook can be linked to reduced fish size at return (Flagg et al. 2000) and as a result can reduce subsequent fry and smolt productivity per spawner. However, despite the high proportion of hatchery fish contributing to Chinook escapement into the Tuolumne River, Chinook size-at-return does not appear to be declining in response to hatchery introgression (TID/MID 2013h, W&AR-05).

Chinook In-River Rearing and Outmigration

Chinook salmon rearing in the Tuolumne River primarily occurs from January to May (TID/MID 2013a, W&AR-05). Low numbers of over-summering juveniles have been found downstream of the La Grange gage (RM 51.7) during routine snorkel surveys in most years (TID/MID 2013j, W&AR-04,). Based on seine and rotary screw trap monitoring, juvenile Chinook salmon outmigrate from the lower Tuolumne River into the San Joaquin River and Delta as fry (<50 mm) as early as February in years with high flows, with smolts (>70 mm) emigrating during April and May in most years (TID/MID 2013a, W&AR-05).

Results of the Tuolumne River Chinook Salmon Otolith Study (TID/MID 2016) indicate that the total number of days from formation of the otolith core to ocean entry for Tuolumne River juvenile fall-run Chinook was relatively constant at 99±20 days for each of the five outmigration

[31] The years evaluated for the Chinook Salmon Otolith Study, i.e., 1998, 1999, 2000, 2003, and 2009, were selected to represent "above normal" or "wet" and "below normal" or "dry" water-year types. These were also years during which the greatest number of otolith samples were available from the existing CDFW inventory.

years studied (1998, 1999, 2000, 2003, and 2009). During years when juvenile Chinook spent fewer days rearing in the Tuolumne River, they spent a greater number of days rearing in the Delta. The study also indicated that the vast majority of adult Chinook returning to the Tuolumne River had emigrated as parr or smolts, corroborating the notion that there is a survival advantage for fish emigrating at larger sizes.

High levels of predation-related mortality have been documented by the Districts in multi-year smolt survival studies and by comparisons of upstream and downstream smolt passage at rotary screw traps (TID/MID 2013h, W&AR-05). Predator distribution, year class success, habitat suitability, and activity all vary with differences in inter-annual runoff flows as well as seasonal variations in flow and water temperature. Historical changes in the Tuolumne River, primarily creation of in-channel mining pits, have created suitable habitat for non-native predators over a wide range of river flow.

Previous predation studies in the lower Tuolumne River identified 13 fish species[32] that potentially prey on Chinook salmon fry and juveniles, but largemouth and smallmouth bass were found to be the primary predators (TID/MID 1992a). Based on estimates of predator abundance from mark-recapture electrofishing surveys and estimated rates of consumption from gut samples, predation on juvenile salmon by largemouth bass was estimated to be approximately 8,600–14,300 individuals per day during the spring pulse flow period (300–600 cfs, USGS gage 11289650) (TID/MID 1992a).

In 2012, the potential impact of predation was assessed by estimating the abundance of target predator species between RM 5.1 (location of the Grayson rotary screw trap) and RM 30.3 (location of the Waterford rotary screw trap). Predator abundance was estimated based on shoreline lengths in this reach. The total estimate of juvenile Chinook salmon potentially consumed was estimated by multiplying the estimated number of predators, the Chinook migration period (in days), and the estimated predation rate (in number of juvenile Chinook salmon consumed per day) (TID/MID 2013g, W&AR-07).

Estimated abundance of largemouth, smallmouth, and striped bass (>150 mm FL) and associated Chinook salmon predation rate in the lower Tuolumne River (i.e., number of fall-run Chinook salmon consumed per predator) are shown in Table 3.5-14 (TID/MID 2013g, W&AR-07).

Table 3.5-14. Estimated abundance of key predators >150 mm FL and predation rate in the lower Tuolumne River (Source: TID/MID 2013g, W&AR-07).

Species	Estimated 2012 River-wide Abundance[1] (SE)	Estimated 2012 Abundance in RST Reach[2] (SE)	2012 Predation Rate (Chinook salmon/day)
Largemouth bass	4,185 (± 261)	3,013 (± 156)	0.10
Smallmouth bass	6,764 (± 260)	3,626 (± 111)	0.11
Striped bass	588 (± 57)	235 (± 21)	1.10

[1] Based on shoreline length between RM 0 and 39.4.
[2] Between Grayson (RM 5.1) and Waterford (RM 30.3) rotary screw traps.

[32] The 13 fish species[32] that potentially prey on Chinook salmon fry and juveniles in the lower Tuolumne River, as identified in TID/MID (1992a), are as follows: smallmouth bass, largemouth bass, striped bass, bluegill, redear sunfish, green sunfish, warmouth, channel catfish, white catfish, brown bullhead, Sacramento pikeminnow, riffle sculpin, and *O. mykiss*.

Largemouth bass and smallmouth bass were estimated to have consumed about 37 percent and 49 percent, respectively, of the total potential juvenile fall-run Chinook salmon consumed by the three primary non-native predator species (i.e., largemouth bass, smallmouth bass, and striped bass). Despite making up only a small fraction (< 4%) of the total of piscivore-sized fish (> 150 mm FL), striped bass were estimated to have consumed nearly 15 percent of the total potential juvenile Chinook salmon consumed by the three predator species. There was no evidence of consumption of Chinook salmon by Sacramento pikeminnow during either the 2012 study or the Districts' previous study (TID/MID 1992).

A conservative estimate of the total consumption of juvenile Chinook salmon by striped, largemouth, and smallmouth bass is about 42,000 during March 1-May 31, 2012, based on observed predation rates and estimated predator abundance. This suggests that nearly all juvenile Chinook salmon may be consumed by introduced predators between the Waterford and Grayson rotary screw traps. Only 2,268 Chinook salmon were estimated to have survived migration through the 25 miles between the screw-trapping sites (Robichaud and English 2013) during January through mid-June, making it plausible that most losses of juvenile fall-run Chinook salmon in the lower Tuolumne River between Waterford and Grayson during 2012 can be attributed to predation by non-native piscivorous fish species.

Acoustic tracking results revealed habitat overlap of juvenile Chinook and predators at three tested flows (280 cfs, 415 cfs, and 2,100 cfs) (TID/MID 2013g, W&AR-07). Striped bass had the greatest overlap (18.4–46.3%) of habitat use with Chinook salmon, followed by largemouth bass (5.8–30.5%), and smallmouth bass (0.2–38.2%).

An earlier study on the Tuolumne River (McBain & Trush and Stillwater Sciences 2006) hypothesized that at flows exceeding 2,500 cfs, higher velocities would increase Chinook salmon migration rates through SRPs, and therefore reduce predation risk. However, the results of the 2012 Predation Study (TID/MID 2013g, W&AR-07) showed that transit times across SRP 6 and SRP 10 were fastest at 280 cfs, suggesting that higher flows may decrease transit rates through SRPs due to eddy effects. Comparison of transit rates between sites showed no statistically significant difference at a given flow, suggesting that the results may apply more broadly to other SRP sites as well. Based on review of individual acoustic tracks, extended residence times were due to fish circling within the array rather than passing directly through the SRP; circling was likely caused by hydraulic conditions within the SRPs.

Results from the current PHABSIM study (Stillwater Sciences 2013) corroborate results of previous studies, indicating that WUA for Chinook fry and juveniles is maximized at lower flows, with juveniles maintaining high habitat values up to around 300 cfs (Table 3.5-13). Chinook salmon juvenile and fry WUA exhibits a similar pattern of annual fluctuation across all water year types, except for reductions in WUA that occur during high flows in wet years.

Surveys to assess the impact of flow fluctuations on salmonids in the lower Tuolumne River were conducted from 1986 to 2002. Rapid flow reductions can cause stranding and entrapment of fry and juvenile salmon on gravel bars and floodplains and in off-channel habitats that may become cut off from the main channel when flows are reduced. A comprehensive evaluation of stranding surveys was conducted on the lower Tuolumne River (TID/MID 2001, Report 2000-6) and is summarized in the 2005 Ten-Year Summary Report (TID/MID 2005). This evaluation indicated that the highest potential for stranding occurred at flows between 1,100 and 3,100 cfs, i.e., the range of flows under which the floodplain is inundated in several areas of the spawning reach. However, under current operations, the risk of salmonid stranding is considered to be low. The Districts curtailed large hydropower-related flow fluctuations in the river well before the 1995 Settlement Agreement, which established ramping rates developed to minimize the potential for stranding. As such, since 2002 there have been no requirements to monitor salmonid stranding, and all current floodplain restoration projects include design requirements for minimizing stranding potential.

Results of the Pulse Flow Study (Stillwater Sciences 2012a) indicated that flows above bankfull discharge were associated with increases in potential overbank habitat area in the lower Tuolumne River. However, results of the Lower Tuolumne River Floodplain Hydraulic Assessment (TID/MID 2017b) confirm that only a portion of the inundated floodplain area provides suitable habitat for fall-run Chinook fry and juveniles (Table 3.5-15).

Table 3.5-15. Hydraulic modeling estimates of total inundated floodplain area (ft^2) and usable floodplain habitat area (ft^2) for fall-run Chinook salmon fry and juveniles at selected flows in the lower Tuolumne River.

Modeled Flow (cfs)	1,000	2,000	3,000	5,000	7,000	9,000
RM 51.7-40						
Inundated area	2,088,000	5,633,775	9,604,125	17,265,375	23,146,875	29,926,125
Chinook fry habitat	1,222,916	3,193,092	4,756,145	6,419,680	7,108,983	7,618,930
Chinook juvenile habitat	703,341	2,961,988	5,562,806	9,963,276	12,904,300	14,726,723
RM 40-21.5						
Inundated area	1,059,525	3,055,725	5,024,700	9,061,875	12,527,100	14,743,125
Chinook fry habitat	617,099	1,609,146	2,089,023	2,789,931	2,971,408	2,392,190
Chinook juvenile habitat	355,594	1,595,783	2,846,802	4,509,524	5,631,474	5,397,445
RM 21.5-0.9						
Inundated area	724,725	2,015,550	4,044,600	9,141,300	17,406,675	37,903,950
Chinook fry habitat	438,614	1,068,951	1,993,904	3,566,876	6,423,204	14,080,302
Chinook juvenile habitat	333,783	1,082,079	2,174,819	4,469,145	7,945,966	19,178,555
River-wide (RM 51.7–0.9)						
Inundated area	3,872,250	10,705,050	18,673,425	35,468,550	53,080,650	82,573,200
Chinook fry habitat	2,278,630	5,871,189	8,839,073	12,776,487	16,503,594	24,091,422
Chinook juvenile habitat	1,392,718	5,639,850	10,584,427	18,941,945	26,481,740	39,302,723

The floodplain hydraulic assessment also shows that there is longitudinal variability in the extent of floodplain inundation at a given flow. In the reach extending from RM 51.7–40.0, the largest percent increase in inundated floodplain area occurs at low to moderate flows, although the majority of floodplain habitat in this reach is located in disturbed areas formerly overlain by dredger tailings (McBain & Trush 2000). These areas were associated with the highest frequency of stranding and entrapment of juvenile fall-run Chinook salmon in historical surveys (1990–1992, 1994–1996, 1999–2000) at flows between 1,100–3,100 cfs (TID/MID 2001). In the reach extending from RM 40.0–21.5, there are relatively low amounts of floodplain and comparatively small increases in inundated area with increasing flow. In the lowermost reach (RM 21.5–0.9), floodplain availability is relatively low at flows less than 6,000 cfs but increases greatly at flows above 7,000 cfs due to inundation of low-gradient agricultural fields near the Tuolumne River's confluence with the San Joaquin River. Floodplain inundation downstream of RM 13 also occurs as the result of backwater effects from San Joaquin River flows.

In the upper reach (RM 51.7–40), total usable habitat for Chinook fry and juvenile life stages, including both in-channel and floodplain areas, steadily increases with increasing discharge. Downstream of RM 40, total usable habitat is lower at intermediate flows (1,000–2,000 cfs) than at either low (100–500 cfs) or high (>3,000 cfs) flows, a pattern that reflects floodplain encroachment and channel incision that may limit access to overbank habitat at intermediate flows.

Studies of juvenile Chinook salmon rearing in floodplain habitats of lowland rivers in California's Central Valley (e.g., Sommer et al. 2001, 2005 [Yolo Bypass] and Jeffres et al. 2008 [Cosumnes River]) suggest that increasing the inter-annual inundation frequency of floodplain habitats may promote the production of food resources for rearing salmonids. In addition, access to floodplain habitats may reduce encounter frequencies between juvenile salmonids and predatory fish species. However, Chinook population modeling (TID/MID 2017a, W&AR-06) indicates that increased duration of floodplain access for juvenile salmonids is not closely correlated with increases in smolt productivity in the lower Tuolumne River. Also, several reaches of the lower Tuolumne River with pool habitats inhabited by predator species lack adjacent floodplain habitats (McBain & Trush 2000), so the probability of encounter between predators and juvenile salmonids remains high in these reaches regardless of flow.

Results of rotary screw trap monitoring and Delta outmigrant tracking and survival studies generally support the utility of increased spring pulse flows during April–May as a means of improving outmigrant salmonid survival from tributaries to the San Joaquin River Delta (Stillwater Sciences 2012a), if timed correctly. Based on rotary screw trap monitoring data from the Waterford (RM 29.8) and Grayson (RM 5.2) locations on the lower Tuolumne River, Robichaud and English (2013) suggested that, on average, 35 percent of Chinook smolts moved during the first day of increased flows, and 66 percent moved within the first three days. However, strontium isotope ratios ($^{87}Sr/^{86}Sr$) and otolith microstructural features analyzed as part of the Chinook Salmon Otolith Study (TID/MID 2016) suggest that average fish size at exit from the Tuolumne River was unrelated to water-year type, except for outmigration year 2000 when average fish size was significantly different ($p<0.005$) from the other four years of the study (i.e., 1998, 1999, 2000, 2003). Average fish size at freshwater exit from the Delta also exhibited no relationship with water-year type (TID/MID 2016).

Chinook Rearing and Outmigration in the Delta

Predation in the lower San Joaquin River Delta and predation related mortality within the Clifton Court forebay of the State Water Project (SWP) and Central Valley Project (CVP) water export facilities affect the number of Chinook salmon recruited to the ocean fishery (TID/MID 2013h, W&AR-05). For Chinook salmon out-migrants from the Tuolumne River, increased flows in the San Joaquin River at Vernalis have been shown to reduce predation-related mortality, but the relationship is highly dependent on the presence of the Head of Old River Barrier.[33] Salvage losses of Chinook entrained into the SWP and CVP export facilities increase with increasing export flows, and pre-screen losses of 63–99 percent have been estimated for fish entrained into the Clifton Court forebay. For juvenile Chinook salmon not entrained by the SWP and CVP export facilities, non-native fish introductions, levee construction, and changes in flow magnitudes and timing have increased predator ranges. In addition, water temperature related mortality during late spring explains much of the variation observed during past smolt survival studies in the Delta (TID/MID 2013h, W&AR-05).

Reductions in marsh and floodplain habitats in the lower San Joaquin River and South Delta, along with changes in tributary flow magnitudes and timing, have reduced access to Delta habitats historically used by rearing and emigrating Chinook salmon smolts from the Tuolumne River. Although warmer water in the Delta could increase growth rate relative to that in upstream tributary habitats, degradation of Delta habitat has reduced the primary and secondary productivity that support the food web, resulting in low growth rates of juvenile Chinook salmon.

Chinook Ocean Rearing

Environmental conditions and commercial harvest of Chinook salmon in the ocean exert a strong influence on the size and health of the Chinook salmon population in the Tuolumne River. Rates of ocean harvest of Central Valley Chinook salmon stocks have averaged more than 60 percent for many years, directly affecting the numbers of adults escaping the ocean fishery (TID/MID 2013h, W&AR-05). Harvest mortality of larger fish has reduced the age- and size-at-return, resulting in reduced fecundity of upstream migrating spawners. Multi-year El Niño Southern Oscillation (ENSO) and Pacific Decadal Oscillation (PDO) variations in ocean circulation patterns affect food web productivity, growth, and year-class strength of Chinook salmon. For example, the recent dramatic collapse of Sacramento fall-run Chinook stocks during the 2007 and 2008 spawning years was attributed to highly anomalous coastal ocean conditions during 2005 and 2006, i.e., late and weakened seasonal upwelling associated with warmer sea surface temperatures led to the deterioration of coastal food webs on which juvenile salmon depend (CalCOFI 2006, 2007; NMFS 2009). The timing of large hatchery releases in the Central Valley may result in competition between hatchery and wild fish during the first few months following ocean entry. Conditions in the ocean during the early growth period of salmonids affect year-class strength and the number of salmon escaping the ocean fishery to spawn in the lower Tuolumne River.

Chinook Upstream Migration

Adult Chinook salmon migration in the Tuolumne River extends upstream to La Grange Diversion Dam and occurs from September through December, with peak activity occurring in October and November (TID/MID 2013h, W&AR-05). Fall-run Chinook salmon spawning escapement to the Tuolumne River has varied over a wide range. During some years it was larger than the escapement to any other Central Valley river, except for the mainstem

[33] For the protection of out-migrating fall-run Chinook salmon in years when spring flow in the San Joaquin River is less than 5,000 cfs, a temporary barrier has typically been placed at the head of Old River from April 15 to May 15 in most years to prevent drawing these fish towards the pumps near Tracy (TID/MID 2013c).

Sacramento River, and was estimated at 122,000 spawners in 1940 and 130,000 spawners in 1944 (California Department of Fish and Game [CDFG] 1946; Fry 1961, as cited in Yoshiyama et al. 1996). In contrast, escapement was as low as 500, 200, and 100 returning adults in 1961, 1962, and 1963, respectively. Since the completion of Don Pedro Dam in 1971 (1971–2009), spawner estimates have ranged from 40,300 in 1985 to 77 in 1991 (TID/MID 2010). Recent escapement monitoring has been conducted at a counting weir established at RM 24.5, just below the downstream boundary of the gravel-bedded reach. Cumulative adult fall-run Chinook salmon counts at the weir from 2009–2016 are shown in Figure 3.5-8.

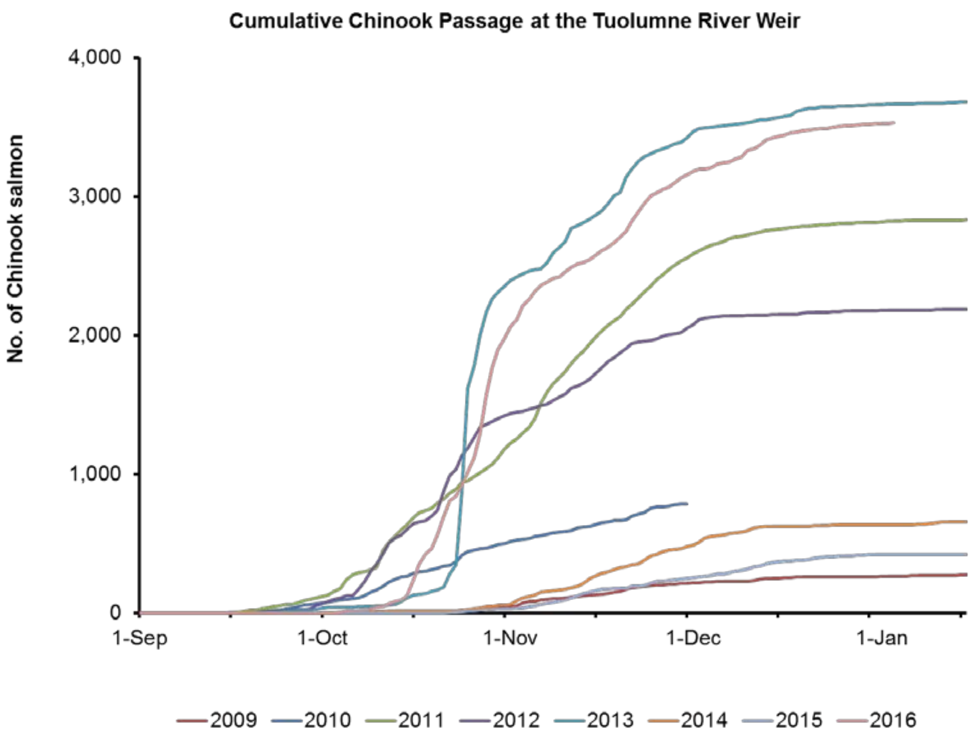

Figure 3.5-8. Cumulative adult fall-run Chinook salmon counts at the Tuolumne River weir (RM 24.5) 2009–2016.

During upstream migration, Tuolumne River flows, flows of other San Joaquin River tributaries, and flows entrained by the SWP and CVP water export facilities may affect homing of Tuolumne River origin Chinook salmon, and may also affect straying of fish from other rivers into the Tuolumne River (TID/MID 2013h, W&AR-05).

Variations in ocean productivity and commercial harvest directly affect the number of fall-run Chinook salmon escaping the ocean troll fishery to spawn in the lower Tuolumne River (TID/MID 2013h, W&AR-05). The Central Valley Harvest Rate Index (i.e., catch/[catch + escapement]) has been in excess of 70 percent in many years (TID/MID 2005), suggesting that year-to-year variations in ocean survival and harvest may affect Tuolumne River escapement and subsequent population levels (TID/MID 2013h, W&AR-05). Commercial harvest in the San Joaquin River basin is prohibited, and the Valley District[34], which includes rivers in San Joaquin,

[34] Per the 2013-2014 California Freshwater Sport Fishing Regulations (http://www.dfg.ca.gov/regulations/), the Valley District consists of all of Butte, Colusa, Glenn, Kern, Kings, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter, Yolo and

Stanislaus, and Tuolumne counties, is currently closed to the take of salmon. There are no available estimates of salmon lost to poaching in the San Joaquin and Tuolumne rivers (TID/MID 2013h, W&AR-05).

Hatchery-origin fish account for a large proportion of the Central Valley fall-run Chinook salmon ocean harvest (TID/MID 2013h, W&AR-05). Although the proportions of adipose-fin-clipped Chinook salmon identified as originating from hatcheries has been historically low in Tuolumne River spawning surveys, this proportion has increased dramatically from the 1990s to the present (TID/MID 2005; Mesick 2009; TID/MID 2012a, Report 2011-8). As noted above, results of the Chinook Salmon Otolith Study (TID/MID 2016) indicate that the total estimated hatchery contribution of adult Chinook salmon during the years studied (i.e., 1998, 1999, 2000, 2003, and 2009,) averaged 67 percent, and hatchery contribution generally increased in later years. Recognizing that some years in the otolith sample inventory over- or under-represent the typical age class structure in the escapement record, the overall proportion was estimated using only three-year old fish, which are expected to make up the bulk of the annual escapement. For three-year old fish, hatchery contribution ranged from 36 to 90 percent, with a mean of 58 percent.

In the Central Valley as a whole, it is estimated that hatchery production has provided over half of the Central Valley harvest and escapement of salmon in some years (CDFG and NMFS 2001). Barnett-Johnson et al. (2007) recently estimated that only 10 percent of Central Valley Chinook salmon captured in the ocean troll fishery were not raised in a hatchery setting. Assuming roughly equivalent survival of hatchery- and natural-origin fish from the fishery to the spawning grounds, these results imply that up to 90 percent of annual escapement could consist of hatchery reared fish (TID/MID 2013h, W&AR-05).

Straying of hatchery-origin fish has been documented in the Tuolumne River and has likely affected the numbers of salmon in annual spawning runs. Depending on prior San Joaquin River basin hatchery broodstocks and management practices, progeny of stray hatchery-origin fish spawned in the Tuolumne River may have contributed to alterations of run-timing (TID/MID 201h, W&AR-05). Lindley et al. (2007) suggest that hatchery introductions have altered the genetic structure of salmonid populations in the Central Valley.

Chinook Salmon Population Model

To integrate existing information on in-river life stages of fall-run Chinook salmon (i.e., information developed under the Tuolumne River Salmonid Information Synthesis Study [TID/MID 2013h, W&AR-05]), the Tuolumne River Chinook salmon population model (TRch) was developed. The population model (TID/MID 2017a, W&AR-06) was used to investigate the relative influences of various factors on life-stage-specific production of Chinook salmon in the Tuolumne River and identify critical life-stage-specific limitations that may represent a

Yuba counties; Tulare County west of the west boundaries of Sequoia National Forest and Sequoia National Park; Fresno County west of the west boundaries of Sierra and Sequoia National Forests (including all of Pine Flat Lake); Madera County west of the west boundary of the Sierra National Forest; Amador, Calaveras, El Dorado, Mariposa, Nevada, Placer and Tuolumne counties west of Highway 49 (including all of Don Pedro, McClure and New Melones lakes); that portion of Alameda County which is both east of Interstate 680 and north of Interstate 580; and all of Contra Costa County east of Interstate 680 and that portion of Contra Costa County which is both north of Highway 4 and east of Interstate 80; and all of Black Butte Lake.

population “bottleneck.” Model sensitivity testing suggests that Chinook salmon production under existing conditions is influenced by a number of environmental factors. The following provisional findings are based on a base-case simulation, i.e., under existing conditions (TID/MID 2017a, W&AR-06). These findings represent a simulation modeling results only, and as such do not constitute conclusions based directly on empirical population data.

Using an overall productivity metric of smolts/spawner, parameters related to the following life-stage processes were shown to exert the greatest influence on subsequent juvenile Chinook salmon production in the calibrated model:

- Upmigration and spawning**:** Sensitivity to parameters related to redd disturbance suggests that modeled smolt productivity is affected by spawning habitat availability (i.e., area of suitable gravel).
- Egg incubation and fry emergence**:** Sensitivity to parameters related to redd disturbance suggest that modeled smolt productivity is affected by spawning habitat availability. Sensitivity to parameters related to egg development rates suggest modeled smolt productivity is affected by egg survival-to-emergence, which in turn is affected by gravel quality, intra-gravel flow, etc.
- Fry rearing: Sensitivity to parameters related to fry movement suggests that modeled smolt productivity is affected by predation related mortality.
- Juvenile rearing: Sensitivity testing suggests that reductions in food availability within overbank habitats, below estimates used in the model calibration, may result in lower smolt productivity.
- Smolt emigration: Sensitivity to parameters related to smolt survival suggests that modeled smolt productivity is affected by predation related mortality and flow.

Spawning Habitat Availability

Modeling results show that reductions in smolt productivity (i.e., smolts per female spawner) with increasing escapement are consistent with redd superimposition effects suggested by sensitivity analyses and the results of Tuolumne River spawning habitat investigations summarized in the Synthesis Study (TID/MID 2013h, W&AR-05). Because estimates of weighted usable area for Chinook salmon spawning is near optimal under current FERC minimum flow requirements (Stillwater Sciences 2013), increases in spawning flows may result in only minor increases in available spawning habitat. The Spawning Gravel Study (TID/MID 2013j, W&AR-04) indicates relatively little change in available spawning area relative to historical estimates. Nevertheless, potential non-flow measures that could be evaluated with the model to increase spawning habitat include gravel augmentation at upstream locations of the lower Tuolumne River (McBain & Trush 2000, 2004) and the use of movable spawning barriers to force increased use of downstream spawning areas (TID/MID 1992b, Volume 2). In addition, gravel cleaning identified in previous studies (TID/MID 1992b, Appendix 9; McBain & Trush 2004) might improve gravel quality by reducing fine sediment intrusion, thereby increasing intra-gravel flow, egg survival-to-emergence, and subsequent smolt productivity.

Juvenile Rearing Habitat Availability

Modeling results show that rearing habitat is not limiting smolt productivity under current conditions, consistent with findings of the Synthesis Study (TID/MID 2013h, W&AR-05). Sensitivity testing shows that reductions in fry and juvenile rearing density parameters used in the model are not accompanied by reductions in subsequent smolt productivity. For the highest run sizes evaluated (10,000 female spawners), the resulting fry and juvenile production is shown to be insufficient to fully saturate available rearing habitat under current conditions. The implication of the low sensitivity to fry and juvenile rearing density is that changes in in-channel rearing habitat area through measures recommended to improve access to potential floodplain rearing areas, such as floodplain re-contouring (McBain & Trush 2000) as well as extended high flows to maintain floodplain inundation (Mesick 2009), will not result in large increases in subsequent smolt productivity on the basis of relieving any rearing habitat limitation. Although reductions in floodplain food availability below historical ration estimates used in the calibration of the model can be shown to reduce modeled smolt productivity, increases in assumed food availability at in-channel and overbank locations are not accompanied by increased smolt productivity (TID/MID 2017a, W&AR-06). This is consistent with materials reviewed as part of the Synthesis Study (TID/MID 2013h, W&AR-05), which indicate that adequate food resources exist for juvenile fall-run Chinook salmon in the main channel of the lower Tuolumne River.

Flow and Temperature Effects

Modeling results for the Base Case show that smolt productivity is consistently higher in years with increased spring discharge at La Grange Diversion Dam.[35] Flow variations affect all life stages to some degree by influencing water temperatures, habitat area and suitability, and movement related mortality due to predation on fry and juveniles. Sensitivity testing shows that smolt productivity is strongly influenced by parameters of the smolt survival versus flow relationship. This is consistent with the Synthesis Study (TID/MID 2013h, W&AR-05), which summarizes several studies examining the relationship between spring flows and subsequent adult escapement (TID/MID 1992b, Volume 2; Speed 1993; TID/MID 1997, Report 96-5; Mesick and Marston 2007; Mesick et al. 2008) and variations in annual smolt passage (Mesick et al. 2008). The historical patterns of increasing smolt productivity and subsequent adult escapement with discharge are consistent with flow effects on predation as a primary mortality source.

In addition to the direct effects of increasing discharge on smolt productivity (i.e., smolt survival with flow), model results show changes in smolt emigration timing due to water temperature effects on development rates, as found in other rivers (e.g., Rombough 1985, Roper and Scarnecchia 1999). These and other modeled effects on life history timing (e.g., spawning timing, run sizes) produce results with greater or lesser overlap with the scheduled pulse flow period (April 15 - May 15). Because of the higher smolt survival expected at higher flow rates, pulse flow timing is shown to affect smolt productivity, suggesting that variable pulse flow

[35] As noted previously, however, Sr isotope ratios ($^{87}Sr/^{86}Sr$) and otolith microstructural features analyzed as part of the Chinook Salmon Otolith Study (TID/MID 2015a) suggest that average fish size at exit from the Tuolumne River was unrelated to water-year type, except for outmigration year 2000 when average fish size was significantly different ($p<0.005$) from the other four years of the study (i.e., 1998, 1999, 2003, and 2009). Average fish size at freshwater exit from the Delta also exhibited no relationship with water-year type (TID/MID 2015a).

timing or duration by water year type or other means (e.g., real-time monitoring of fish sizes, shaped pulse flows) could be used to optimize water use and smolt productivity.

Sensitivity testing indicates that water temperature is not limiting smolt productivity under current conditions, consistent with findings of the Synthesis Study (TID/MID 2013h, W&AR-05). Because water temperatures are generally suitable for life history timing of all in-river life stages in the lower Tuolumne River under both drier and wetter years, reductions in mortality threshold parameters did not result in corresponding changes in smolt productivity. Although water temperature is an important factor controlling egg incubation rates and fry and juvenile growth rates, with the exception of issues related to the timing of smoltification and emigration discussed above, smolt productivity is unaffected by normal seasonal variations in air and water temperatures. Specifically, because the majority of spawning takes place under suitable temperatures, modeled egg mortality effects due to potentially unsuitable water temperatures for early arriving spawners during late summer or early fall do not appear to affect subsequent smolt productivity. Further, the majority of smolt emigration occurs prior to periods of potentially unsuitable water temperature in late spring.

Steelhead/Rainbow Trout (Oncorhynchus mykiss)

NMFS considers the lower Tuolumne River *O. mykiss* population to be part of the California Central Valley (CCV) steelhead Distinct Population Segment (DPS). The Endangered Species Act listing history and status of the CCV steelhead are described in the following paragraphs. However, as noted in the following section (*Steelhead/Rainbow Trout Life History*) there is no empirical evidence of a self-sustaining "run" or population of CCV steelhead currently occurring in the Tuolumne River (TID/MID 2013h, W&AR-05). In its August 18, 2017 comments on the La Grange Hydroelectric Project Draft License Application, CDFW agreed that there is no empirical evidence of a steelhead run in the lower Tuolumne River. In its final recovery plan for the CCV Steelhead DPS, NMFS (2014) notes that large resident rainbow trout populations have developed in parts of the Central Valley as a result of actions undertaken for the management of coldwater species. The low numbers of anadromous *O. mykiss* adults entering the Tuolumne River (Zimmerman et al. 2008) suggest that increased cold water releases from the Project during summer (beginning in 1996) might reduce the probability of smoltification (TID/MID 2017d, W&AR-10). In addition to the information provided in this AFLA, the Districts have developed an Applicant-Prepared draft Biological Assessment for CCV steelhead, which was filed concurrently with the filing of this AFLA.

CCV Steelhead Listing History and Status

The term "CCV steelhead" refers to all naturally spawned populations of anadromous steelhead below natural and human-made impassable barriers in the Sacramento and San Joaquin rivers and their tributaries, except for steelhead from San Francisco Bay and San Pablo Bay and their tributaries. CCV steelhead also includes anadromous fish from certain fish hatcheries, as explained below.

NMFS proposed to list CCV steelhead as endangered on August 9, 1996 (61 FR 41541). NMFS concluded that the ESU was in danger of extinction because of habitat degradation and destruction, loss of access to historical freshwater habitats, water allocation practices, genetic introgression resulting from widespread stocking of hatchery steelhead and the potential ecological interaction between introduced stocks and native stocks, and because steelhead had been extirpated from most of their historical range.

On March 19, 1998, NMFS listed the CCV steelhead as a threatened species (63 FR 13347), based on the observation that threats to steelhead had diminished since the completion of the 1996 status review and because of recently implemented California conservation efforts and federal management programs (e.g., Central Valley Project Improvement Act [CVPIA] Anadromous Fish Restoration Program [AFRP], CALFED Bay-Delta Program [CALFED]) that address key factors for the decline of the species (NMFS 2016). NMFS also found that additional actions benefiting CCV steelhead included efforts to enhance fisheries monitoring and conservation measures aimed at addressing potential adverse effects associated with artificial propagation.

On September 8, 2000, pursuant to a July 10, 2000 rule issued by NMFS under Section 4(d) of the ESA (16 USC § 1533(d)), statutory take restrictions that apply to listed species began to apply, with certain limitations, to CCV steelhead (65 FR 42422) (NMFS 2016).

On June 28, 2005, NMFS announced its final policy addressing the role of artificially propagated Pacific salmon and steelhead in listing determinations under the ESA (70 FR 37204), and on January 5, 2006, NMFS reaffirmed the threatened status of CCV steelhead and decided to apply the joint U.S. Fish and Wildlife Service-National Marine Fisheries Service DPS policy (61 FR 4722) rather than the NMFS ESU policy to populations of West Coast steelhead (NMFS 2016). This policy requires a DPS to be discrete from other con-specific populations and significant to its taxon. A group of organisms is considered to be discrete if it is ‘‘markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, and behavioral factors” (61 FR 4722).

Based on the January 5, 2006 listing determination, NMFS concluded that two of the four CCV steelhead artificial propagation programs are considered to be part of the DPS: the Coleman National Fish Hatchery and Feather River Hatchery steelhead programs. NMFS determined that these stocks are no more divergent from local natural population(s) than what would be expected between closely related natural populations within the DPS (NMFS 2016). The CCV steelhead hatchery programs at Nimbus Fish Hatchery and Mokelumne River Hatchery were not included in the DPS at that time because of the ongoing use of out-of-basin broodstock (NMFS 2016).

In 2011 NMFS completed a status review of CCV steelhead and determined that available information continued to support inclusion of the Coleman National Fish Hatchery and Feather River Hatchery steelhead stocks as part of the DPS, while continuing to exclude stocks from Nimbus Fish Hatchery and Mokelumne River Hatchery. However, according to NMFS (2016), current analyses show that steelhead from the Mokelumne River Hatchery are nearly genetically identical to those from the Feather River Hatchery (Pearse and Garza 2015), because the Mokelumne River Hatchery received all of its eggs from the Feather River Hatchery in the final years before it terminated the acquisition of eggs from out-of-basin sources. Because steelhead from the Feather River Hatchery are listed as part of the DPS, NMFS (2016) recommends that the Mokelumne River Hatchery steelhead be added to the CCV DPS.

In 2014 NMFS released its Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead. In 2016, NMFS completed its Central Valley Recovery Domain 5-Year Review: Summary and Evaluation California Central Valley Steelhead Distinct Population Segment and Viability Assessment for Pacific Salmon and Steelhead Listed under the Endangered Species Act.

CCV Steelhead Critical Habitat

NMFS proposed critical habitat for CCV steelhead on February 5, 1999 (64 FR 5740) in compliance with Section 4(a)(3)(A) of the ESA, which requires that, to the maximum extent prudent and determinable, NMFS must designate critical habitat concurrently with a determination that a species is endangered or threatened (NMFS 1999). On February 16, 2000, NMFS published a final rule (65 FR 7764) designating critical habitat for CCV steelhead. Critical habitat was designated to include all river reaches accessible to listed steelhead in the Sacramento and San Joaquin rivers and their tributaries in California. For the Tuolumne River, critical habitat extends from the confluence with the San Joaquin River upstream to La Grange Diversion Dam.

CCV Steelhead Recovery Criteria

The Final Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014) includes recovery criteria to address the five ESA listing factors: (1) current or potential destruction or modification of the species' habitat or curtailment of its range, (2) overuse for commercial, recreational, scientific, or educational purposes, (3) disease or predation, (4) inadequate regulatory mechanisms, and (5) other natural or human-induced factors affecting the species' continued existence. The purpose of these threat-based criteria is to attempt to address the factors that caused CCV steelhead to become threatened, with the ultimate aim of delisting the species.

NMFS (2016) ESU/DPS level criteria call for the establishment of two CCV steelhead populations at low risk of extinction within the Southern Sierra Diversity Group (which includes any steelhead in the Tuolumne River). The criteria specify that for a steelhead population to be at low risk of extinction it must be characterized by (1) a census population size greater than 2,500 adults or an effective population size greater than 500[36], (2) an absence of apparent productivity decline, (3) an absence of catastrophic events within the past 10 years, and (4) a low level of hatchery influence.

[36] Effective population size is the size of an idealized population considered to lose genetic heterozygosity at a rate equivalent to that of the larger, observed population. A population characterized by a high level of heterozygosity for a given genetic trait contains much genetic variability for that trait.

Steelhead/Rainbow Trout Life History

Anadromy versus Residency

Most steelhead and resident rainbow trout in the Central Valley are genetically similar (Pearse et al. 2009) and of common hatchery origin (Garza and Pearse 2008). Nielsen et al. (2005) examined the relatedness and origins of Central Valley *O. mykiss* using genetic techniques and determined that *O. mykiss* populations downstream of dams in Central Valley rivers, including the Tuolumne River, are not genetically distinct from one another. However, Nielsen et al. (2005) did find that Tuolumne River *O. mykiss* residing upstream of Don Pedro Reservoir exhibited genetic separation from those found in the lower Tuolumne River.

The causes for the expression of anadromous or resident life-histories in *O. mykiss* occupying the lower Tuolumne River is poorly understood (TID/MID 2017d, W&AR-10), and, as noted above, there is no empirical evidence of a self-sustaining "run" or population of steelhead in the lower river (TID/MID 2013h, W&AR-05). Zimmerman et al. (2008) examined the otolith chemistry of 147 *O. mykiss* from the lower Tuolumne River. Results indicated that only one of these fish was a steelhead (had displayed anadromy) and eight were spawned by a steelhead (i.e., of anadromous maternal origin). Of the eight *O. mykiss* with an anadromous parent, the range of age classes indicated that not all of them were spawned at the same time (i.e., not all of them originated from the same parent). Parental origin of these fish was unknown due to historical planting operations and straying of steelhead.

The results of recent investigations suggest that flow and temperature management of tailwater fisheries downstream of many dams in the Central Valley may be preferentially selecting for resident rainbow trout over anadromous steelhead (TID/MID 2013h, W&AR-05). In its final recovery plan for the Central Valley Steelhead DPS, NMFS (2014) notes that large resident rainbow trout populations have developed in parts of the Central Valley as a result of actions undertaken for the management of coldwater species.

The probability of *O. mykiss* smolting has been shown to vary with water temperature, with fish held in cold thermal regimes more likely to mature in freshwater than fish held in warm thermal regimes (Sloat 2013). These findings relate to both fish size (larger fish tend to survive at higher rates in the ocean than do smaller fish) as well as fat stores (fish with higher lipid content have higher energy reserves required for sexual maturation). Fish held in warm thermal regimes have higher rates of smolting because they are able to grow to larger total sizes but have lower body lipid stores than fish held in cold thermal regimes (Sloat 2013). McMillan et al. (2012) found that higher body lipid stores were significantly correlated with an increased probability of maturation in freshwater. In other words, if a juvenile *O. mykiss* has sufficient lipid reserves to allow maturation in freshwater, there is no need for it to undergo smoltification and migrate to the ocean to gain sufficient lipid stores to mature (TID/MID 2017d, W&AR-10). In some instances, decreased survival associated with downstream migration to and through the Delta and ocean rearing may not be offset by increased size (fecundity) of adult steelhead relative to resident *O. mykiss*.

It appears that increased summer flows in the lower Tuolumne River since 1996 have resulted in large increases in the abundance of resident rainbow trout, and there is no evidence that environmental conditions support a steelhead run (TID/MID 2017d, W&AR-10). The low numbers of anadromous *O. mykiss* adults entering the Tuolumne River (Zimmerman et al. 2008) suggest that increased cold water releases from the Project during summer reduce the probability of smoltification (TID/MID 2017d, W&AR-10). However, as discussed by Yoshiyama and Moyle (2012), poor migration survival along the migratory pathway (e.g., lower San Joaquin River and south Delta) of any juveniles that do smolt would result in a low probability of their returning to spawn. Narum et al. (2008) and Satterthwaite et al. (2010) suggested that reduced smolt survival through the Delta was the greatest management concern, if the goal was to preserve or enhance expression of anadromy among Central Valley *O. mykiss* populations.

Steelhead/Rainbow Trout Spawning

CCV steelhead and rainbow trout generally spawn from December through April, with peak activity occurring in February and March (TID/MID 2013h, W&AR-05). Although the tendency for anadromy or residency in sympatric populations of resident *O. mykiss* and any steelhead that may arrive in the Tuolumne River is poorly understood (TID/MID 2013h), there is no empirical evidence of a self-sustaining “run” or population of steelhead currently in the Tuolumne River (see preceding section) (TID/MID 2013h, W&AR-05).

In 2012, the Districts conducted biweekly redd mapping surveys between October 1 and November 2 and weekly surveys between November 5 and November 26 (TID/MID 2013i, W&AR-08). Biweekly redd surveys were again conducted between December 10 and April 19, 2013. Thirty-eight *O. mykiss* redds were observed during surveys conducted between October 1, 2012 and April 19, 2013 (TID/MID 2013i, W&AR-08). The first *O. mykiss* redds were observed on January 7, 2013, and peak observations occurred during the week of April 1, when 10 new redds were identified (Table 3.5-16). The majority (63 percent) of *O. mykiss* redds were observed between RM 52.0 to RM 47.4, and 97 percent were observed upstream of RM 42. *O. mykiss* were observed to be actively guarding or constructing only two of the identified redds. No *O. mykiss* redds were identified below RM 39, and there was no evidence of *O. mykiss* redd superimposition during the 2012–2013 study period (TID/MID 2013i, W&AR-08).

Table 3.5-16. New *O. mykiss* redds identified by reach and date during the 2012-2013 survey period.

Week[1]	Survey Dates	Reach				Grand Total	Percent
		1 (52.0-47.4)	2 (47.4-42.0)	3 (42.0-31.6)	4 (31.6-22.0)		
1	10/1–10/4/12	0	0	0	0	0	0.0%
3	10/15–10/18/12	0	0	0	0	0	0.0%
5	10/29–11/2/12	0	0	0	0	0	0.0%
6	11/5–11/9/12	0	0	0	0	0	0.0%
7	11/12–11/15/12	0	0	0	0	0	0.0%
8	11/18–11/21/12	0	0	0	0	0	0.0%
9	11/26–11/29/12	0	0	0	0	0	0.0%
11	12/10–12/13/12	0	0	0	0	0	0.0%
14	1/2–1/5/13	0	0	0	0	0	0.0%
15	1/7–1/10/13	5	0	0	0	5	13.2%

Week[1]	Survey Dates	Reach 1 (52.0-47.4)	Reach 2 (47.4-42.0)	Reach 3 (42.0-31.6)	Reach 4 (31.6-22.0)	Grand Total	Percent
17	1/21–1/24/13	3	2	0	0	5	13.2%
19	2/5–2/8/13	5	2	1	0	8	21.1%
21	2/18–2/21/13	0	1	0	0	1	2.6%
23	3/4–3/7/13	5	2	0	0	7	18.4%
25	3/18–3/21/13	0	2	0	0	2	5.3%
27	4/1–4/4/13	6	4	0	0	10	26.3%
29	4/17–4/19/13	0	0	0	0	0	0.0%
Grand Total		24	13	1	0	38	--
Percent		63.2%	34.2%	2.6%	0.0%	--	100%

O. mykiss redds at recent gravel augmentation sites accounted for 31.6 percent (12 of 38) of the total observed during the 2012–2013 survey period (TID/MID 2013i, W&AR-08). Eleven of these were observed at the CDFW 2011 augmentation site near La Grange (RM 51), and a single *O. mykiss* redd was identified at the Bobcat Flat augmentation site (RM 43). During the 2014-2015 surveys, 41 redds were identified (Table 3.5-17) (FishBio 2017). The first *O. mykiss* redds were observed on December 29, 2014, and peak observations occurred during the week of February 22, 2015, when 11 new redds were identified. *O. mykiss* spawning activity declined rapidly after mid-March, and the last redd was documented on March 26, 2015. The highest number of observed *O. mykiss* redds occurred in Reach 2 (RM 47.4 to RM 42.0), accounting for 56.1 percent of the *O. mykiss* redds identified (Table 3.5-17). Seventy-six percent of *O. mykiss* redds were observed above RM 42, and no *O. mykiss* redds were identified below RM 34. There was no evidence of *O. mykiss* redd superimposition during the 2014-2015 study period. *O. mykiss* spawning at recent gravel augmentation sites accounted for 19.5 percent (8 of 41 total) of the redds observed during the 2014-2015 spawning season. All of these redds were observed at the CDFW augmentation sites near La Grange (RM 50.6-51).

Table 3.5-17. New *O. mykiss* redds identified by reach and date during the 2014-2015 survey period.

Week[1]	Survey Dates	Reach 1 (52.0-47.4)	Reach 2 (47.4-42.0)	Reach 3 (42.0-31.6)	Reach 4 (31.6-22.0)	Grand Total	Percent
1	10/7	0	--	--	--	0	0.0%
3	10/22- 10/23	0	0	--	--	0	0.0%
5	11/3- 11/6	0	0	0	--	0	0.0%
7	11/18- 11/21	0	0	0	0	0	0.0%
9	12/1- 12/5	0	0	0	0	0	0.0%
11	12/15- 12/18	0	0	0	0	0	0.0%
13	12/28- 12/30	0	3	0	0	3	7.3%
15	1/13- 1/15	4	3	2	--	9	22.0%
17	1/26- 1/28	0	1	1	--	2	4.9%
19	2/9- 2/11	0	5	3	--	8	19.5%
21	2/24- 2/26	2	8	1	--	11	26.8%
23	3/10- 3/13	2	3	0	--	5	12.2%
25	3/24- 3/26	0	0	3	--	3	7.3%
28	4/14- 4/16	0	0	0	--	0	0.0%
	Grand Total	8	23	10	--	41	--
	Percent	19.5%	56.1%	24.4%	--	--	100%

[1] Week refers to the number of weeks after the week of 10/5/14.

Thirty-six *O. mykiss* redds were observed between October 14, 2015, and April 6, 2016 (Table 3.5-18) (FishBio 2017). The first *O. mykiss* redds were observed on December 30, and peak observations occurred during the week of March 9, when nine new redds were identified (Table 3.5-18). *O. mykiss* spawning activity declined after mid-March, and the last redd was documented on April 5. Spring pulse flow operations began the following week and continued through June, which prevented further redd surveys. The highest number of observed *O. mykiss* redds occurred in Reach 2 (RM 47.5 to RM 42.0), accounting for 52.8 percent of the *O. mykiss* redds identified (Table 3.5-18). Seventy-eight percent of *O. mykiss* redds were observed above RM 42, and no *O. mykiss* redds were identified below RM 34 during the 2015-2016 study period. There was no evidence of *O. mykiss* redd superimposition during the 2015-2016 study period, and no *O. mykiss* spawning activity was recorded at recent gravel augmentation sites in 2015-2016.

Table 3.5-18. New *O. mykiss* redds identified by reach and date during the 2015-2016 survey period.

Survey Week[1]	Survey Dates	Reach 1 (52.0-47.5)	Reach 2 (47.5-42.0)	Reach 3 (42.0-31.6)	Reach 4[2] (31.6-22.0)	Grand Total	Percent
7	10/14	0	--	--	--	0	0.0%
9	10/27–10/28	0	0	--	--	0	0.0%
10	11/3–11/5	0	0	0	--	0	0.0%
12	11/16–11/18	0	0	0	--	0	0.0%
14	11/30–12/2	0	0	0	--	0	0.0%
16	12/14–12/16	0	0	0	--	0	0.0%
18	12/30–12/31	0	1	0	--	1	2.8%
20	1/11–1/15	1	2	2	--	5	13.9%
22	1/26–1/28	0	0	2	--	2	5.6%
24	2/8–2/9	1	1	3	--	5	13.9%
26	2/22–2/23	1	6	1	--	8	22.2%
28	3/9–3/10	4	5	0	--	9	25.0%
30	3/21–3/22	2	2	0	--	4	11.1%
32	4/5–4/6	0	2	0	--	2	5.6%
Grand Total		**9**	**19**	**8**		**36**	
Percent		**25.0%**	**52.8%**	**22.2%**	**0.0%**	**--**	**--**

1 Survey week refers to the number of weeks starting the first full week of September (Week of September 6, 2015).
2 Reach 4 was not surveyed due to excessive water hyacinth growth that blocked boat passage.

O. mykiss often spawn in tributary habitats and smaller habitat patches, and because spawning gravels in the Tuolumne River are generally larger than those typically used by spawning *O. mykiss*. However, the *O. mykiss* population model found a lack of sensitivity to redd disturbance area and related defended area, which suggests that under current conditions, juvenile *O. mykiss* productivity is unlikely to be limited by the availability of suitable gravel (TID/MID 2013i, W&AR-08). Results from the current PHABSIM study (Stillwater Sciences 2013) show that spawning habitat is maximized at flows greater than 225 cfs (Table 3.5-13), with variation in spawning WUA results across water-year types; the WUA versus flow relationship was not appreciably altered by spawning gravel availability. Flows within the current FERC flow schedule provide 91 to 100 percent of the estimated maximum suitable habitat available for *O.*

mykiss spawning based on gravel, depth, and velocity parameters analyzed in the Spawning Gravel in the Lower Tuolumne River Study (TID/MID 2013j, W&AR-04).

Steelhead/Rainbow Trout In-River Rearing

Following emergence in winter and spring, *O. mykiss* fry occupy shallow, low-velocity areas near the stream margin and may use interstitial spaces among cobbles for resting and cover habitat (Bustard and Narver 1975). Juvenile steelhead typically rear for 1–3 years in fresh water before migrating to the ocean as smolts (McEwan 2001).

In 2010, juvenile and adult *O. mykiss* population sizes in the lower Tuolumne River were estimated to be 2,405 and 2,139, respectively (Stillwater Sciences 2012b). Population estimates of *O. mykiss* for the lower Tuolumne River from 2008 to 2011 are shown in Table 3.5-19. However, as noted above, there is little evidence of a self-reproducing anadromous run of CCV steelhead in the Tuolumne River. For any steelhead originating in the Tuolumne River, anthropogenic modifications to the flow regime and physical habitat, as well as variations in rainfall, runoff, and temperature, affect in-river rearing and successful smolt emigration (TID/MID 2013h, W&AR-05).

Table 3.5-19. Population estimates of *O. mykiss* for the lower Tuolumne River, from 2008 to 2009.

Survey Date	*O. mykiss* <150 mm				*O. mykiss* ≥150 mm			
	No. Obs.[1]	Est.	St. Dev.	95% CI[2]	No. Obs.[1]	Est.	St. Dev.	95% CI[2]
Jul 2008	128	2,472	616.9	1,263–3,681	41	643	217.7	217–1,070
Mar 2009	5	63	--	--	7	170	86.3	7–339
Jul 2009	641	3,475	1,290.5	945–6,004	105	963	254.4	464–1,461
Mar 2010	1	1	0.3	1–2	13	109	30	50–168
Aug 2010	313	2,405	908.1	625–4,185	324	2,139	720.6	727–3,552
Sep 2011	4,913	47,432	5,662.2	36,334–58,530	813	9,541	1,200.9	7,188–11,895

1 Largest numbers seen in any single dive pass for each unit, summed over units.
2 Nominal confidence intervals (CI) calculated as ± 1.96 standard deviations (SD).
Source: Adapted from Stillwater Sciences 2012b

Stillwater Sciences (2012b) reported that *O. mykiss* in the lower Tuolumne River were observed primarily in riffle and run habitats, where higher percentages of cobble were reported relative to other substrates. Adult fish habitat use was concentrated at upstream sampling units (above RM 45.0), and primarily occurred at transitional run head and pool head habitats. Juvenile fish habitat use showed a similar distribution from upstream to downstream and occurred primarily in riffle habitats, along with transitional run head and pool head habitats.

Because of its generally small size, location in the channel, and lack of complexity, most LWD in the lower Tuolumne River is unlikely to provide significant cover and habitat for *O. mykiss* (TID/MID 2013e, W&AR-12). In addition, the amount of instream shelter in the form of boulders, aquatic vegetation, small woody debris, and terrestrial vegetation is very low. During a 2012 survey, riffles, flat water, main channel pools, and scour pools had shelter ratings (on a scale of 0–300) of 10, 31, 49, and 40, respectively (TID/MID 2013e, W&AR-12). Low levels of instream cover for juvenile *O. mykiss* result in greater exposure to predation. Cover provided by overhanging terrestrial vegetation and small woody debris accumulations in the mainstem may persist to a greater extent under the current regulated flow regime than they would under more widely varying flows (TID/MID 2013e, W&AR-12).

There is apparent density-dependent exclusion of age 0+ juvenile *O. mykiss* from riffle/pool transitions by age 1+ and older fish (TID/MID 2013h, W&AR-05). The absence of other structural features (e.g., boulders, LWD) characteristic of alluvial rivers of the Central Valley is associated with reduced rearing densities for all age classes (TID/MID 2013e, W&AR-12).

Results of the current IFIM study (Stillwater Sciences 2013) show that juvenile *O. mykiss* habitat is maximized in the 50–350 cfs range, and adult WUA is maximized in the 150–400 cfs range (Table 3.5-13). Prior PHABSIM modeling combined with water temperature suitability (Stillwater Sciences 2003) suggest that flows which maximize habitat for larger fish are generally higher, and therefore flow management for adult life stages may potentially limit juvenile habitat (TID/MID 2013h, W&AR-05). Although *O. mykiss* abundance has increased since implementation of increased summer flows, stable flows and temperatures in summer, as noted above, appear to select for a resident life history. Zimmerman et al. (2008) showed that very few steelhead (only 1 of 147 fish otolith examined) occur in the Tuolumne River, and smolt-sized *O. mykiss* are rarely captured in rotary screw traps in the lower river (Ford and Kirihara 2010).

During warmer months, the downstream extent of suitable water temperatures has been thought to limit habitat availability for age 0+ *O. mykiss* in the lower Tuolumne River (TID/MID 2013h, W&AR-05). However, investigation of thermal performance (i.e., the “swim tunnel” study) (Farrell et al. 2017) showed that wild *O. mykiss* from the lower Tuolumne River can maintain 95 percent of peak aerobic capacity over a temperature range of 17.8°C to 24.6°C, and all fish tested could maintain sufficient aerobic capacity to properly digest a meal at temperatures up to 23°C. Video analysis of *O. mykiss* swimming activity in the Tuolumne River indicates that fish at ambient water temperatures have an excess aerobic capacity well beyond that needed to swim and maintain station against the river current in their usual habitat.

These thermal performance results are consistent with those derived for *O. mykiss* populations known to be high-temperature tolerant, such as the redband strain of rainbow trout (*O. mykiss gairdneri*) that occurs in the high deserts of eastern Oregon and Idaho. Whether the high thermal performance that was demonstrated for the *O. mykiss* of the Tuolumne River downstream of La Grange Diversion Dam arose through genetic selection or physiological acclimatization was beyond the scope of the thermal performance study.

Results of the study support the hypothesis that the thermal performance of wild *O. mykiss* from the Tuolumne River represents an exception to that expected based on the 18°C 7DADM temperature guidance set out by EPA (2003) for Pacific Northwest *O. mykiss* (Farrell et al. 2017). Given that lower Tuolumne River *O. mykiss* can maintain 95 percent of peak aerobic capacity at temperatures up to 24.6°C, a more reasonable upper performance limit is likely to be 22°C, rather than the suggested 18°C.

Results from a CDFW (2014a) drought stressor monitoring case study are consistent with the general findings of the thermal performance study (i.e., that *O. mykiss* in California tolerate temperatures greater than 18°C). From May through October 2014, 453 juvenile steelhead were caught in the lower American River (83 [18 percent] were of natural origin and 370 [82 percent] were of hatchery origin). A portion of these fish were PIT tagged (14 of natural origin and 59 of hatchery origin). Average monthly water temperature in the river from July through September 2014 was 20°C (68°F), and the maximum observed temperature during this period was 22.8°C (73°F). Growth rates of recaptured fish were high (1.23-1.38 mm/day), but CDFW reports that "there were no visible signs of stress in the captured fish."

Suitable water temperatures for smolt emigration are available in the San Joaquin River at Vernalis as late as mid-May in most years, and it is likely that Delta conditions are suitable for smolt emigration as late as June in some years. Unsuitable temperature conditions in excess of 25°C (77°F) are likely exceeded at Vernalis by late June in most years, limiting successful emigration or any Delta rearing opportunities during summer.

Results of the Pulse Flow Study (Stillwater Sciences 2012a) indicated that flows above bankfull discharge were associated with increases in potential overbank habitat area in the lower Tuolumne River. However, results of the Lower Tuolumne River Floodplain Hydraulic Assessment (TID/MID 2017b W&AR-21) confirm that only a portion of the inundated floodplain area provides suitable habitat for *O. mykiss* fry and juveniles (Table 3.5-20).

Table 3.5-20. Hydraulic modeling estimates of total inundated floodplain area (ft^2) and usable floodplain habitat area (ft^2) for *O. mykiss* fry and juveniles at selected flows in the lower Tuolumne River.

Modeled Flow (cfs)	1,000	2,000	3,000	5,000	7,000	9,000
RM 51.7-40						
Inundated area	2,088,000	5,633,775	9,604,125	17,265,375	23,146,875	29,926,125
O. mykiss fry habitat	1,741,791	4,318,501	6,639,330	9,167,501	10,124,053	11,863,551
O. mykiss juvenile habitat	784,686	3,155,993	5,888,722	10,533,523	13,671,567	15,922,373
RM 40-21.5						
Inundated area	1,059,525	3,055,725	5,024,700	9,061,875	12,527,100	14,743,125
O. mykiss fry	885,640	2,222,935	2,994,996	4,007,929	4,393,046	3,668,032
O. mykiss juvenile	372,266	1,693,502	3,044,601	4,906,282	6,394,684	6,497,518
RM 21.5-0.9						
Inundated area	724,725	2,015,550	4,044,600	9,141,300	17,406,675	37,903,950
O. mykiss fry	616,325	1,506,680	2,757,012	4,971,681	8,765,927	19,833,137
O. mykiss juvenile	346,295	1,074,538	2,210,151	4,828,970	8,844,476	19,448,788
River-wide (RM 51.7–0.9)						
Inundated area	3,872,250	10,705,050	18,673,425	35,468,550	53,080,650	82,573,200
O. mykiss fry	3,243,756	8,048,116	12,391,338	18,147,111	23,283,027	35,364,719
O. mykiss juvenile	1,503,247	5,924,034	11,143,474	20,268,776	28,910,727	41,868,679

The floodplain hydraulic assessment also shows that there is longitudinal variability in the extent of floodplain inundation at a given flow. In the reach extending from RM 51.7–40.0, the largest increase in inundated floodplain area occurs at low to moderate flows, although the majority of floodplain habitat in this reach is located in disturbed areas formerly overlain by dredger tailings (McBain & Trush 2000). These areas were associated with the highest frequency of stranding and entrapment of juvenile salmonids during historical surveys (1990–1992, 1994–1996, 1999–

2000) at flows between 1,100–3,100 cfs (TID/MID 2001). In the reach extending from RM 40.0–21.5, there are relatively low amounts of floodplain over the range of flows and comparatively small increases in habitat with increasing flow. In the lowermost reach (RM 21.5–0.9) floodplain availability is relatively low at flows less than 5,000-6,000 cfs but increases greatly at flows above 7,000 cfs due to inundation of low-gradient agricultural fields near the Tuolumne River's confluence with the San Joaquin River. Floodplain inundation downstream of RM 13 also occurs as the result of backwater effects from San Joaquin River flows.

In the upper reach (RM 52.2–40), total usable habitat for *O. mykiss* fry and juvenile life stages, including both in-channel and floodplain areas, steadily increases with increasing discharge. Downstream of RM 40, total usable habitat is lower at intermediate flows (1,000–2,000 cfs) than at either low (100–500 cfs) or high (>3,000 cfs) flows, a pattern that reflects floodplain encroachment and channel incision that may limit access to overbank habitat at intermediate flows.

Increasing the inter-annual inundation frequency of floodplain habitats may promote the production of food resources for rearing salmonids. In addition, access to floodplain habitats may reduce encounter frequencies between juvenile salmonids and predatory fish species. However, population modeling (TID/MID 2017d, W&AR-10) indicates that increased duration of floodplain access for juvenile *O. mykiss* is not closely correlated with increases in smolt productivity. Also, several reaches with pool habitats inhabited by predator species lack adjacent floodplain habitats (McBain & Trush 2000), so the probability of encounter between predators and juvenile salmonids remains high in these areas, regardless of flow.

Steelhead Ocean Rearing

Little is known about how CCV steelhead respond to changes in productivity patterns along the California coast (TID/MID 2013h, W&AR-05). Studies of steelhead in the North Pacific concluded that competition for food resources and inter-annual changes in sea surface temperatures are factors limiting steelhead growth, and as a result, escapement to fresh water.

Steelhead Upstream Migration

The upstream spawning migration of adult CCV steelhead generally occurs from July through March, with peak activity occurring from December through February (TID/MID 2013h, W&AR-05). However, information reviewed as part of the Salmonid Population Information Integration Study (TID/MID 2013h, W&AR-05) suggests that there are very low rates of *O. mykiss* immigration into the Tuolumne River, either as resident or anadromous life-history types. *O. mykiss* numbers recorded at the counting weir at RM 24.5 are shown in Table 3.5-21 (compare to the fall-run Chinook counts presented in Figure 3.5-8, which verify that the weir is effective). However, because counting weir operations are limited to flows below approximately 1,400 cfs, upstream migration of *O. mykiss* occurring during flood control releases, such as those that occurred during winter/spring 2011, would not be detected.

Table 3.5-21. *O. mykiss* counts at the RM 24.5 counting weir for the 2009 through 2016 run years.

Run Year	< 16 inches	> 16 inches
2009-2010	1	0
2010-2011	0	0
2011-2012	13	3
2012-2013	3	1
2013-2014	0	0
2014-2015	0	0
2015-2016	3	1
2016-2017	0	1

Source: TID/MID 2016, *unpublished data*.

Based on *O. mykiss* redd surveys conducted during 2012-2013 and again during 2014-2015 (TID/MID 2013i, W&AR-08), spawning of *O. mykiss* in the Tuolumne River occurs from late December through early April. Based on this timing, the majority of any adult upstream migrants that enter the Tuolumne River likely do so when water temperatures are relatively low. No occurrences of pre-spawn mortality due to elevated water temperatures have been identified for *O. mykiss* in the Tuolumne River.

Tuolumne River flows, flows of other San Joaquin River tributaries, and flows entrained by the SWP and CVP water export facilities would affect homing of any steelhead originating in the Tuolumne River (TID/MID 2013h, W&AR-05). Tributary flows and flow entrainment by the Delta water export facilities may also affect the number of hatchery-origin steelhead that stray into the Tuolumne River.

Annual fishing report cards (Jackson 2007) do not provide data to quantitatively assess hooking mortality or other sport fishing impacts on steelhead, and no data are available to evaluate the potential impacts of poaching.

O. mykiss Age Determination

The results of the 2012 *Oncorhynchus mykiss* Scale Collection and Age Determination Study (TID/MID 2013f, W&AR-20) were combined with those of Zimmerman et al. (2009) to develop an age-at-length relationship for the Tuolumne River that is based on a larger dataset (Table 3.5-22).

Table 3.5-22. Combined Zimmerman et al. (2009) and TID/MID 2013 (2013f, W&AR-20) age and size ranges of *O. mykiss*.

Age	No. Sampled	Fork Length Range (mm)
0	1	78
1	38	145–199
2	53	194–315
3	54	267–395
4	12*	365–450

*Includes only results from the W&AR-20 study age 4 fish.

Annual growth observed for each age group of *O. mykiss* was similar within and among years: mean annual growth ranged from 74 mm (age 2) to 78 mm (age 4) in 2011, 69 mm (age 4) to 72 mm (age 3) in 2010, and 2009 values for both the age three and age four groups were the same as 2010. The combined mean annual growth rates for all age groups ranged from 70 mm in 2010 to 76 mm in 2011.

Tuolumne River O. mykiss *Population Model*

As explained above, there is no empirical evidence of a self-sustaining run or population of steelhead currently existing in the Tuolumne River (TID/MID 2013h, W&AR-05). In its August 18, 2017 comments on the La Grange Hydroelectric Project Draft License Application, CDFW agreed that there is no empirical evidence of a steelhead run in the lower Tuolumne River. However, the Districts developed the Tuolumne River *O. mykiss* model (TID/MID 2014) to examine the relative influences of various factors on the production of in-river life stages of what appear to be resident *O. mykiss* in the Tuolumne River, and to identify critical life-stages that may represent a life-history “bottleneck” for the population. Using the calibrated *O. mykiss* population model, *O. mykiss* production was evaluated for a Base Case simulation period (1971–2009), which provides a 37-year time series of varying hydrology and meteorology to examine variations in *O. mykiss* production in the lower Tuolumne River under a variety of water year types.

Model sensitivity testing was used to identify model parameters affecting juvenile and adult *O. mykiss* population levels as well as potential smolt production from any steelhead arriving in the Tuolumne River. Using *O. mykiss* productivity metrics for juveniles (end-of-year Age 0+ fish/spawners), adults (Age 2+ and older fish/Age 2+ and older fish 1 year prior), and smolts (Age 1+ and older smolts/Age 1+ and older fish one year prior), parameters related to the following life stage processes were shown to exert the greatest influence on subsequent *O. mykiss* production.

- Upmigration and Spawning: Moderate sensitivity to parameters related to spawning timing and fecundity.
- Egg incubation and fry emergence: High sensitivity of juvenile productivity to parameters related to spawning timing as well as gravel quality parameters affecting egg survival-to-emergence; low sensitivity of juvenile productivity to other spawning related parameters.
- Fry rearing: High sensitivity of juvenile productivity to parameters related to growth and initial fish size affecting the timing of fry/parr transition. Moderate sensitivity of juvenile productivity to parameters related to fry movement and water temperature related mortality. Low sensitivity of juvenile productivity to maximum fry rearing density.
- Juvenile rearing: High sensitivity of juvenile productivity to background mortality rate parameter estimate. Moderate sensitivity of juvenile productivity to parameters related to maximum rearing density at high population sizes as well as parameters related to water temperature related mortality and movement rates.
- Resident rearing: High sensitivity of adult replacement to parameters related to water temperature related mortality in Dry water year types. Moderate sensitivity of adult replacement to spawning probability, spawning-related mortality, and background mortality rates. Low sensitivity of adult replacement to food availability and maximum adult rearing density.

- Smolt emigration: High sensitivity of smolt productivity to parameters related to the probability of smoltification based upon anadromous parentage as well as water temperatures for smoltification. Low sensitivity of smolt productivity to parameters related to adult or smolt emigration mortality.

Spawning Habitat Availability

There was a lack of model sensitivity to redd disturbance area and related defended area. This agrees with the results of the Redd Mapping Study (TID/MID 2013i, W&AR-08), which showed no evidence of *O. mykiss* redd superimposition during 2013 surveys, and with the results of the Spawning Gravel Study (TID/MID 2013j, W&AR-04), which suggest that gravel availability is not limiting juvenile productivity of *O. mykiss*. Because estimates of weighted usable area for *O. mykiss* spawning are near optimal under current FERC (1996) minimum flow requirements (Stillwater Sciences 2013), increases in spawning flows may result in only minor increases in available spawning habitat for *O. mykiss*. Because the Spawning Gravel Study (TID/MID 2013j, W&AR-04) indicates little change in available spawning area relative to historical estimates, the model results suggest that other than gravel quality improvements related to egg survival-to-emergence, potential spawning habitat enhancements such as gravel augmentation would have little effect on subsequent juvenile productivity.

Juvenile Rearing Habitat Availability

Modeling results show that in-channel juvenile habitat availability may be limiting during summer at high population sizes. Rearing density information from recent snorkel surveys summarized as part of the Synthesis Study (TID/MID 2013h, W&AR-05) suggests an apparent exclusion of juveniles from riffle/pool transitions. Modeling results suggest that the apparent density-dependence in modeled juvenile productivity for the Base Case may be linked to migration related mortality (i.e., predation) and high water temperatures at downstream rearing locations (TID/MID 2014) (although thermal performance study results indicate higher temperature tolerances for Tuolumne River fish than that associated with *O. mykiss* in cooler regions within the species' range [see below]). Information developed as part of the *Oncorhynchus mykiss* Habitat Survey Study (TID/MID 2013e, W&AR-12) suggests that the absence of structure (e.g., boulders, LWD) in the lower Tuolumne River may increase effective territory size of rearing juveniles. Nevertheless, because fry and juvenile movement rules in the model do not include avoidance of unsuitable temperatures, any fish displaced into downstream habitats may be subject to water temperature related mortality. Lastly, although increased food availability was shown to affect the timing of the fry/parr transition and increased subsequent juvenile productivity, materials reviewed as part of the Synthesis Study (TID/MID 2013h, W&AR-05) found that there are adequate food resources to support juvenile *O. mykiss* rearing in the lower Tuolumne River.

Adult Rearing Habitat Availability

Although adult replacement was shown to be sensitive to assumed background mortality rates and spawning related mortality, modeling results show that separate from temperature related issues, rearing habitat is not limiting adult *O. mykiss* under current conditions. Information developed as part of the *Oncorhynchus mykiss* Habitat Survey Study (TID/MID 2013e, W&AR-12) suggests that the absence of structure (e.g., boulders, LWD) in the lower Tuolumne River may increase effective territory size of adults. Nevertheless, model simulations show very little difference in adult replacement ratio corresponding to increases in population size for the Base Case, and sensitivity testing shows that reductions in adult rearing density parameters are not accompanied by reductions in subsequent adult replacement. This implies that even for the high population size evaluated (10,000), the number of adult *O. mykiss* is insufficient to fully saturate available rearing habitat under current conditions. Sensitivity testing also indicates that increased food availability is unlikely to be affecting adult replacement.

Modeled Flow and Water Temperature Effects

Sensitivity to parameters related to fry movement and base-case results for juvenile productivity and adult replacement suggest that *O. mykiss* production is affected by the relative influences of flow magnitude and timing on life stage progression. Modeling results for the Base Case show that juvenile productivity and adult replacement are generally higher with increased discharge at La Grange Diversion Dam; juvenile productivity and adult replacement are generally higher in "wet" years than in "dry" years. For juveniles, early fry displacement with higher flows in "wet" years reduces subsequent movement-related mortality due to exceedance of local carrying capacity. For both juveniles and adults, a greater downstream extent of cool water during summer in "wet" years corresponds to lower temperature related mortality.

Water temperature affects egg incubation rates and juvenile and adult *O. mykiss* growth rates. Water temperatures for over-summering *O. mykiss* are generally below identified mortality thresholds upstream of Roberts Ferry Bridge (RM 39.5) in "above normal" and "wet" years and corresponding estimates of juvenile productivity are relatively high in comparison to juvenile productivity evaluated in drier years. Modeling assumptions do not currently allow redistribution of fry or parr from areas approaching water temperature mortality thresholds, and low levels of juvenile mortality during summer are apparent for model fish displaced into downstream habitats. Base-case modeling results indicate that summer water temperatures may limit juvenile productivity and adult replacement in "dry" years. For adults, model implementation includes avoidance and redistribution from habitats exceeding water temperature preference limits (i.e., increased avoidance for temperatures of 20–24°C [68–75°F]). However, because adult habitat selection is made on a weekly timestep, any model fish occupying habitats exceeding assumed daily mean water temperature mortality thresholds (25°C [77°F]) at a daily time step are subject to temperature-related mortality. These results are consistent with summaries of historical monitoring data provided in the Synthesis Study (TID/MID 2013h, W&AR-05), which show reduced *O. mykiss* abundance and a reduced extent of habitat use downstream of La Grange Diversion Dam (RM 52.2) in "dry" years. For the progeny of any steelhead arriving in the lower Tuolumne River, model sensitivity to parameters related to water temperatures for smoltification suggests that the assumed smolt emigration timing may be affected by elevated water temperatures during later spring months.

Notwithstanding the implications of the Tuolumne River *O. mykiss* Population Model, the previously discussed investigation of thermal performance (see *Steelhead/Rainbow Trout In-River Rearing*) (TID/MID 2015) showed that wild *O. mykiss* from the lower Tuolumne River can maintain 95 percent of peak aerobic capacity over a temperature range of 17.8°C to 24.6°C, and all fish tested could maintain sufficient aerobic capacity to properly digest a meal at temperatures up to 23°C. These results indicate that wild *O. mykiss* from the Tuolumne River can tolerate higher temperatures than populations in the Pacific Northwest, which were used as the basis of EPA's (2003) 18°C 7DADM temperature criterion. Given that lower Tuolumne River *O. mykiss* can maintain 95 percent of peak aerobic capacity at temperatures up to 24.6°C, a more reasonable upper performance limit for the lower Tuolumne River *O. mykiss* population is likely to be 22°C, rather than the established 18°C.

Hardhead

The hardhead (*M. conocephalus*), which is included on the California Species of Special Concern watch list, occurs in the Tuolumne River both upstream and downstream of the Don Pedro Project. The life-history, habitat use, and status of this species are discussed in Section 3.5.2.1.2 of this AFLA.

Sacramento Splittail

The Sacramento Splittail (*Pogonichthys macrolepidotus*), a California Endangered Species Act threatened species, is a large cyprinid (minnow) that can grow to 30 cm or more. Unlike most minnows, it is adapted to living in estuarine habitats and alkaline lakes and sloughs as well as fresh water (Moyle 2002). Historically, splittail inhabited sloughs, lakes, and rivers of the Central Valley, with populations extending upstream to Redding in the Sacramento River, to Oroville in the Feather River, to Folsom in the American River, and to Friant in the San Joaquin River (Moyle et al. 2004).

The current distribution of splittail is limited by dams and other barriers, and the species is largely confined to the Delta, Suisun Bay, Suisun Marsh, Napa River, Petaluma River, and other parts of the Sacramento-San Joaquin estuary (Moyle 2002). Currently, the species is known to migrate up the Sacramento River to Red Bluff Diversion Dam and up the San Joaquin River to Salt Slough in wet years as well as into the lower reaches of the Feather and American rivers.

In the 1980s, successful spawning was documented in the lowest 6.8 miles of the Tuolumne River, with both adults and juveniles observed near Modesto (Moyle et al. 1995). To the extent that spawning occurs in the Tuolumne River during a given year it would take place from February through May, and juvenile rearing would take place from March through September (Stillwater Sciences 2014).

As a supplement to the Districts' PHABSIM study (Stillwater Sciences 2013), WUA versus flow analyses for Sacramento splittail, using existing HSC, were conducted in 2013-2014 (Stillwater Sciences 2014). Available HSC for Sacramento splittail, which are very limited, were developed for the Merced Hydroelectric Project relicensing based on species habitat descriptions from the literature, i.e., not from site-specific surveys. Site-specific HSC validation surveys were conducted in the lower Tuolumne River from just below La Grange Diversion Dam (RM 52) downstream to Waterford (RM 31), but no Sacramento splittail were observed during those surveys, which were conducted across a range of seasons (winter, spring, and summer) and a range of flows (100 cfs, 350 cfs, and 2,000 cfs) (Stillwater Sciences 2014).

Results for Sacramento splittail juveniles show peak WUA values at approximately 50–175 cfs, with relatively high WUA values below 300 cfs (Figures 3.5-9 and 3.5-10). Results for Sacramento splittail spawning show high WUA at about 300-400 cfs, with relatively small increases in WUA over the remaining simulation range (Figures 3.5-9 and 3.5-10). Habitat time series analyses show that under critical, dry, and below normal water year scenarios, juvenile WUA is maximized during periods of low flow and quickly drops when flow increases. In contrast, Sacramento splittail spawning WUA is minimized at lower flows and increases as flows increase above 1,000 cfs. Under above normal and wet water year scenarios, Sacramento splittail juvenile WUA is minimized when flow increases above approximately 600 cfs, and spawning WUA is maximized as flow increases up to 1,200 cfs.

The section of the Tuolumne River where splittail have been observed, i.e., in the lowest 6.8 miles of the river, is within the slow-moving, low-gradient, sand-bedded reach. Water temperatures in this reach are generally influenced by ambient air temperatures, as opposed to releases from Don Pedro Dam. The instream flow study reach (RM 29–52) is within the higher-gradient, gravel-bedded reach farther upstream and generally has lower water temperatures. The WUA results apply to the study reach only (RM 29–52), so shallow depths and low velocities preferred by juvenile splittail are maximized at lower flows in this higher gradient reach. However, the WUA results are not directly applicable to the portion of the river (RM 0.0–6.8) where the species is known to occur.

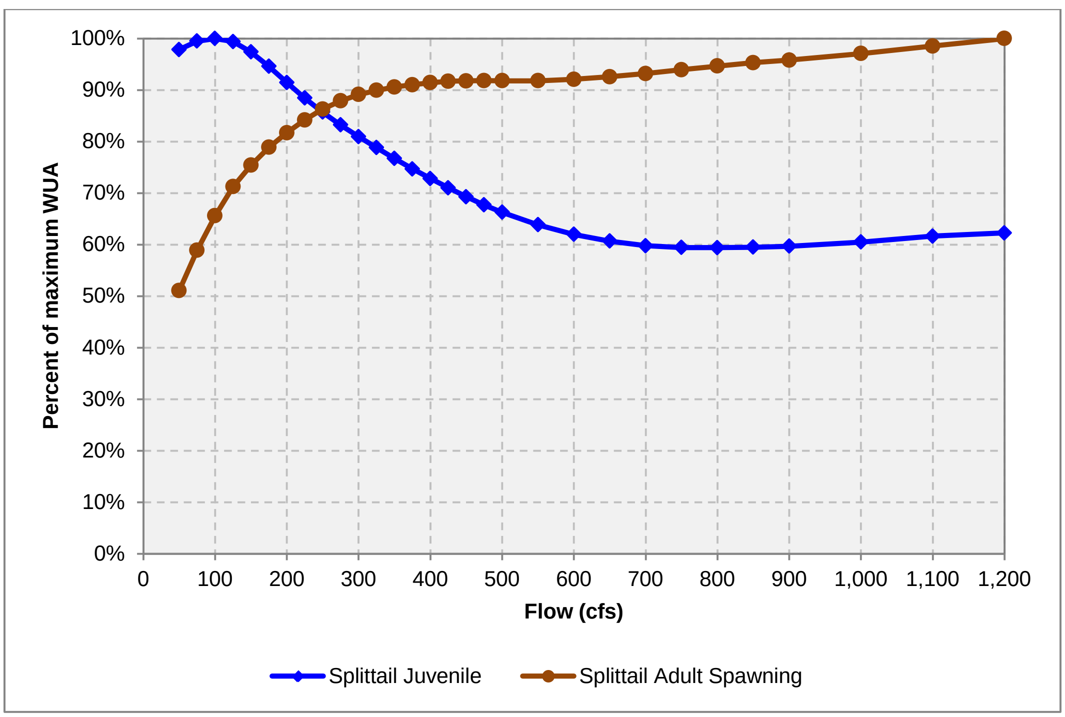

Figure 3.5-9. Sacramento splittail WUA results (percent of maximum) for the lower Tuolumne River.

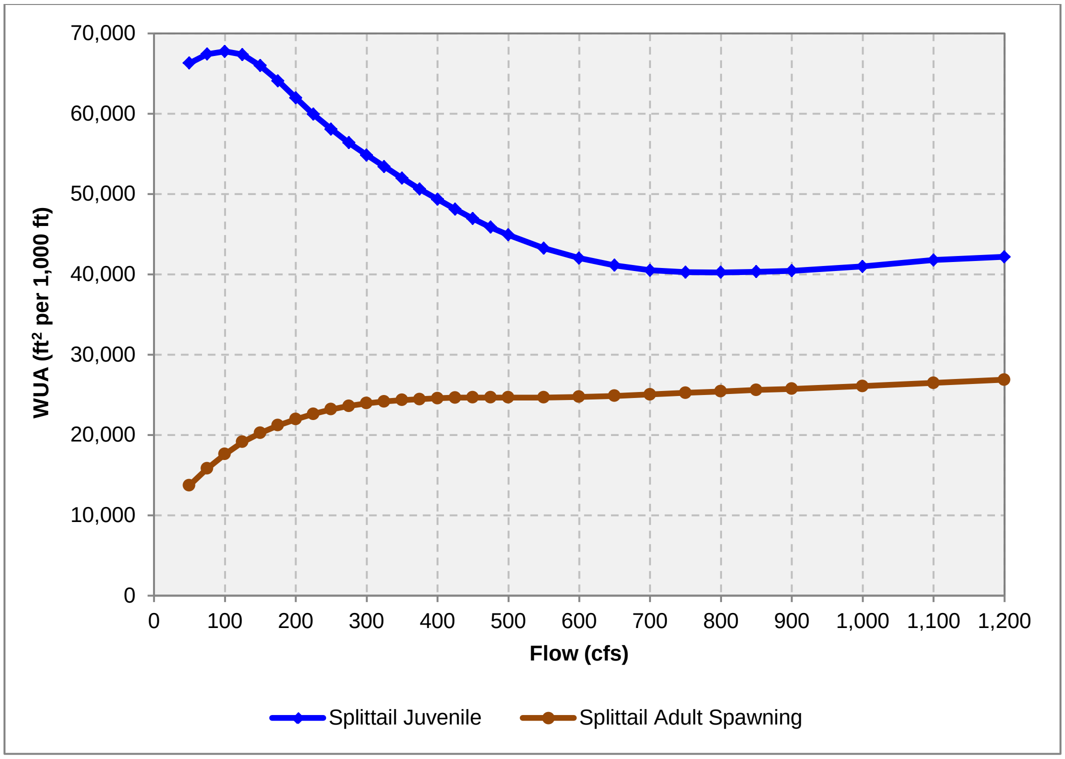

Figure 3.5-10. Sacramento splittail WUA results for the lower Tuolumne River.

Green Sturgeon

It is unknown whether green sturgeon (*Acipenser medirostris*) were present within the San Joaquin River Basin prior to large-scale human disturbance of the system, and there is no evidence that adult, larval, or juvenile green sturgeon currently occupy or historically occupied the Tuolumne River (TID/MID 2013k, W&AR-18).

Although habitat requirements for some green sturgeon life-stages may be suitable within the Tuolumne River, this does not mean that the species would be able to complete its life cycle in the river (TID/MID 2013k, W&AR-18). Based on the more extensively studied white sturgeon, it appears that very specific combinations of "suitable" habitat conditions are necessary for sturgeon to select locations for breeding and subsequent rearing, as indicated by spawning fish that do not use many sites containing apparently suitable substrate, velocity, and depth (Beamesderfer et al 2005). The presence of apparently suitable or restorable habitat elements is not an indication that those elements would actually function to support green sturgeon. Based on NMFS' determination that the river does not provide critical habitat for green sturgeon, and 36 years of fisheries monitoring without encountering any sturgeon, the species is unlikely to occur within the Tuolumne River basin.

Pacific Lamprey

As a supplement to the Districts' PHABSIM study (Stillwater Sciences 2013), WUA versus flow analyses for Pacific lamprey, using existing HSC, were conducted in 2013-2014 (Stillwater Sciences 2014). Available HSC for Pacific lamprey are very limited, i.e., developed for the

Merced Hydroelectric Project relicensing based on species habitat descriptions from literature, and not from site-specific surveys. Site-specific HSC validation surveys were conducted in the lower Tuolumne River from just below La Grange Diversion Dam (RM 52) to Waterford (RM 31), but no Pacific lamprey were observed during those surveys, which were conducted across a range of seasons (winter, spring, and summer) and flows (100 cfs, 350 cfs, and 2,000 cfs) (Stillwater Sciences 2014). However, Pacific lamprey have been observed during snorkel surveys conducted between La Grange Diversion Dam (RM 52) and Waterford (RM 31) (Stillwater Sciences 2009b, 2010).

Results for Pacific lamprey ammocoetes show that potential habitat is maximized at low flows, with peak WUA (≥ 95 percent of maximum) at flows less than about 150 cfs, followed by a slight decline, but still relatively high WUA over the remaining range of simulated flows (Figures 3.5-11 and 3.5-12) (Stillwater Sciences 2014). Results for Pacific lamprey spawning show peak WUA values at 75–150 cfs, with a steady decline in (but still relatively high) WUA values up to about 250 cfs, followed by a more gradual decline over the remaining range of simulated flows (Figures 3.5-11 and 3.5-12). Habitat time series analyses show that under critical, dry, and below normal water year scenarios, Pacific lamprey ammocoete WUA remains relatively stable, but spawning WUA fluctuates with flow until flow nears 1,200 cfs, where WUA is minimized.

Under above normal and wet water year scenarios, Pacific lamprey ammocoete WUA also remains relatively stable, whereas spawning WUA decreases with increased flow, until flow nears 1,200 cfs where WUA is minimized.

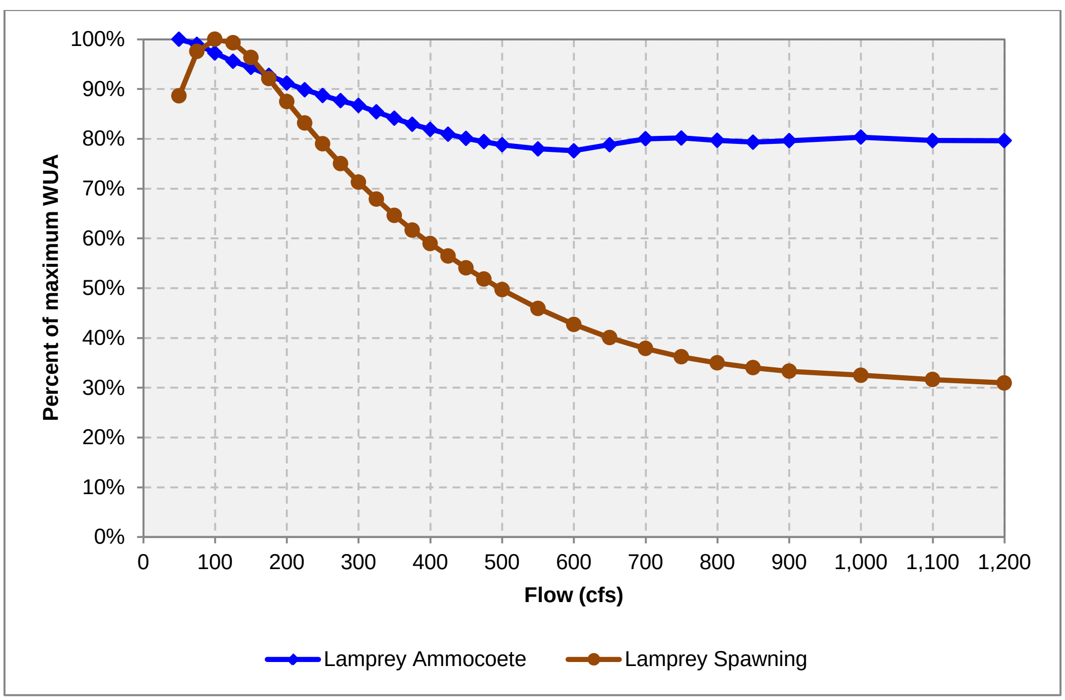

Figure 3.5-11. Pacific lamprey WUA results (percent of maximum) for the lower Tuolumne River.

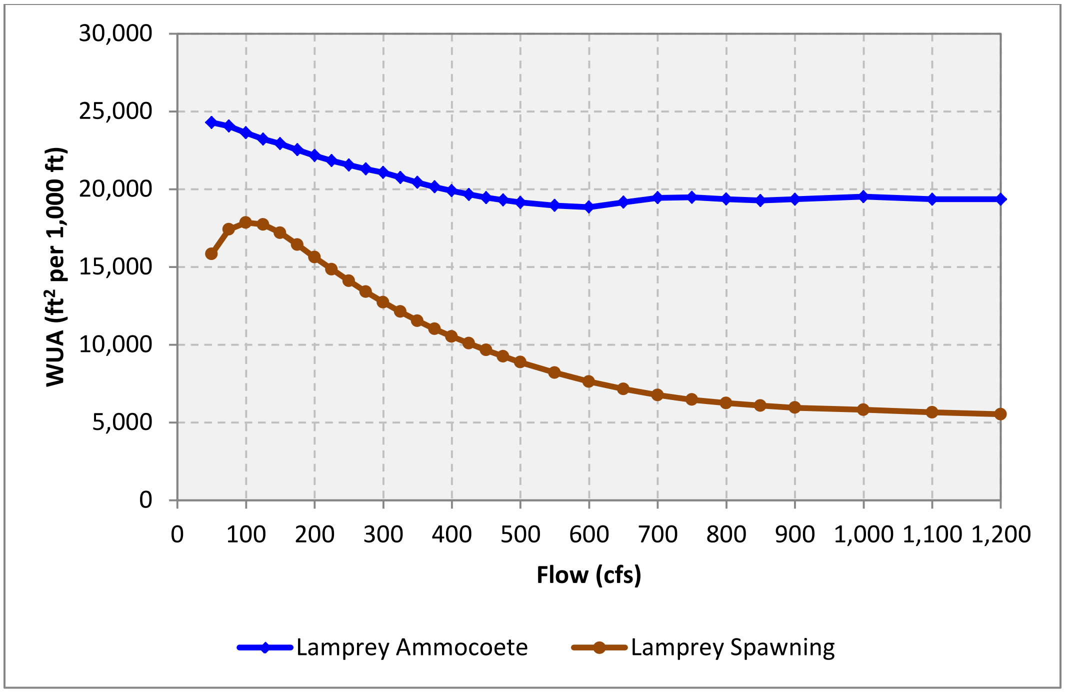

Figure 3.5-12. Pacific lamprey WUA results for the lower Tuolumne River.

Pacific lamprey occur in the study reach between La Grange Diversion Dam (RM 52) and below Waterford (RM 29) (Stillwater Sciences 2014). Ammocoetes are present year-round and typically prefer slow backwater or edge-water habitat, which is available in the study reach at all modeled flows. In contrast, lamprey spawning may be limited by higher flows in late winter and spring, as habitat availability decreases with increases in flow. As a result, lamprey spawning habitat availability declines during flood control or other high-flow releases in spring.

Black Bass

Largemouth, smallmouth, and spotted bass (collectively black bass) were all introduced into the State of California by CDFW and are now actively managed by CDFW in many locations. Largemouth and smallmouth bass were first released in California by CDFW between 1874 and 1891 (Dill and Cordone 1997; TID/MID 1992a), and spotted bass were introduced in 1976. According to CDFW (2014b), "Bass angling provides recreation and economic value to the state of California." Also according to CDFW (2014b), "…California has been the center of attention for producing trophy-sized black bass. In a list of the top 25 largest largemouth bass caught in the U.S., 21 of the bass are from California waters." Black bass can be highly piscivorous and prey heavily on salmonids and other fish species in the lower Tuolumne River. Predation by black bass on fall-run Chinook in the Tuolumne River is addressed in the "Chinook In-River Rearing and Outmigration" section of this AFLA (above).

Largemouth bass are most common in shallow, warm waters with moderate clarity and beds of aquatic macrophytes. They can be displaced from mainstem fluvial habitats by high flows, but move back into the river channel when flows recede. Largemouth bass can survive in oxygen-poor water, even to levels as low as 1 mg/L.[37] Largemouth bass become primarily piscivorous at 100-125 mm in length, although crayfish, tadpoles, and frogs are also consumed by larger individuals. Growth varies depending on genetics, food availability, temperature, and competition.

In 1990, largemouth bass abundance estimated for the lower Tuolumne River (RM 0.0 to RM 52.0) based on shoreline lengths was 11,074 individuals (TID/MID 1992c). During 2012, abundance of largemouth bass from RM 0.0 to RM 39.4 was estimated to be 3,323 based on shoreline length, and 3,891 based on habitat area (TID/MID 2013g, W&AR-07). However differences in study methods between the two sampling years preclude comparison of these estimates. For largemouth bass, site-specific density estimates ranged from 0 to 218 fish per mile (collected in 1998, 1999, and 2003) (McBain & Trush and Stillwater Sciences, 2006) and 4 to 196 per mile in 2012.

Smallmouth bass are most common in cool, clear streams with abundant cover, where they prefer complex habitat with pools, riffles, runs, rocky bottoms, and overhanging vegetation. Ideal water temperatures for adult fish range from 25°C - 27°C. Smallmouth bass can survive in areas with dissolved oxygen concentrations as low as 1-3 mg/L but require at least 6 mg/L for normal growth. As fish grow they switch from crustaceans and insects to fish and crayfish. Smallmouth bass grow from 6 - 18 cm in their first year and up to 25 - 41 cm in their fourth year. The California state record smallmouth bass is 9 pounds 13 ounces (CDFW 2014).

Smallmouth bass density estimates for the lower Tuolumne River (converted to fish per mile) from McBain & Trush and Stillwater Sciences (2006) (collected in 1998, 1999, and 2003) ranged from 2 to 97 fish per mile. In 2012, site-specific density estimates of smallmouth bass ranged from 0 to 251 fish per mile (TID/MID 2013g, W&AR-07).

Spotted bass are most common in clear, low gradient rivers, where they prefer to occupy pools. During summer they seek water temperatures ranging from 24°C to 31°C. The diet of spotted bass becomes more varied with age, with individuals relying mainly on fish and crayfish when they reach a length of about 75 mm. Growth varies with temperature and food availability, but, on average, individuals reach 65-170 mm total length (TL) in their first year and 245-435 mm TL in their fourth year. Angler catches of Alabama spotted bass over six pounds from many California waters have been verified by CDFW biologists, including one that weighed 10 pounds 4 ounces (CDFW 2014).

After monitoring largemouth and smallmouth bass in the Tuolumne River from 1996 to 2004, the Districts (TID/MID 2005) concluded that (1) populations were depleted during the 1997 floods but by 2003 had recovered to levels observed before the flood (2) largemouth bass are more abundant than smallmouth bass, and (3) velocity is the primary factor limiting bass abundance. Black bass density in the lower Tuolumne River could be reduced by re-contouring the channel to enhance riffle and run habitats, where velocities would be less suitable to black bass than in the slower-velocity habitats that are abundant under current conditions.

[37] Source: http://calfish.ucdavis.edu/species/?uid=92&ds=241

Striped Bass

Striped bass spawn from April to mid-June, beginning when water temperatures reach 16°C. Striped bass spawn in open freshwater habitats with moderate to high water velocities. Striped bass are voracious piscivores and feed opportunistically on forage fish of the appropriate size. Small striped bass feed on planktonic crustaceans, and then switch to mysid shrimp and amphipods. Large striped bass feed mainly on fish. In the marine environment, anchovies, shiner perch, and herring are important in the diet, and in the Delta and upriver areas, large striped bass feed primarily on threadfin shad, young striped bass, and other small fish.

The Delta, particularly the San Joaquin River between the Antioch Bridge and the mouth of Middle River and other channels in this area, are important spawning grounds (CDFW 2014). Another important spawning area is the Sacramento River between Sacramento and Princeton (CDFW 2014). Sublegal striped bass, under 18 inches long, are found all year in large numbers upstream of San Francisco Bay, but their migratory patterns are poorly understood. After spawning, most adult striped bass move out of the rivers and into brackish and salt water for the summer and fall. However, some adult fish remain in freshwater during summer, and many anglers have caught striped bass at unexpected times and places (CDFW 2014).

There is limited information regarding the abundance of striped bass in the Tuolumne River. However, there is anecdotal evidence of large numbers of striped bass being found in the Tuolumne River as far back as 1903 (State Board of Fish Commissioners 1904). Striped bass were captured by electrofishing in the lower Tuolumne River in 1989 (TID/MID 1992) and during predator surveys in 1998, 1999, and 2003 (McBain & Trush and Stillwater Sciences 2006). The Districts' 2012 Predation Study estimated striped bass abundance in the lower river to be in the range of 500-750 individuals during summer 2012 (TID/MID 2013g, W&AR-07).

Fish Habitat Restoration Projects in the lower Tuolumne River

As directed under the 1995 Settlement Agreement, the Tuolumne River TAC developed 10 priority habitat restoration projects aimed at improving geomorphic and biological aspects of the lower Tuolumne River corridor (listed below).

- Channel and Riparian Restoration Projects (RM 34.3 to RM 40.3):
    - Gravel Mining Reach Phase I - 7/11 Gravel Mining Reach Restoration (restored channel and floodplain along 1.5 river miles) (RM 38-39.5) (Completed in 2003),
    - Gravel Mining Reach Phase II (Not completed),[38]
    - Gravel Mining Reach Phase III (Not completed), and

[38] By the terms of the 1995 Settlement Agreement, the Districts and CCSF pledged $500,000 and an additional $500,000 in matching funds for Tuolumne River restoration projects. Also by the terms of the agreement, CDFW and USFWS were responsible for actively pursuing state and federal funding. After securing funding and constructing the initial four priority projects identified by the TAC, CDFW, while supporting additional restoration projects at the TAC, actively opposed using CALFED funding for additional projects. Consequently, approved CALFED funding of over $14.75 million for three additional TAC projects, designed to benefit fall-run Chinook and *O. mykiss*, was never able to be used and the projects were never implemented due to factors outside the control of the Districts.

- Gravel Mining Reach Phase IV (Not completed).

▪ Predator Isolation Projects (RM 25.5 to RM 25.9):

  - SRP 9 Channel and Floodplain Restoration (restored channel and floodplain along 0.2 river miles) (RM 25.7 to 25.9) (Completed in 2001), and
  - SRP 10 (RM 25.5) (Not completed).

▪ Sediment Management Projects (RM 43.0 to RM 51.8):

  - River Mile 43 Channel Restoration (restored channel and floodplain along 0.5 river miles) (Completed in 2005),
  - Gasburg Creek Fine Sediment Retention Project (RM 50) (Completed prior to 2008),
  - Gravel Augmentation (Coarse sediment) (Not completed), and
  - Riffle Cleaning (Fine sediment) (Not completed).

Other restoration efforts have been implemented in the lower Tuolumne River corridor by various groups, including Friends of the Tuolumne (FOT), Tuolumne River Trust (TRT), National Resource Conservation Service (NRCS), East Stanislaus Resource Conservation District (ESRCD), USFWS, CDFW, Stanislaus County, and the cities of Waterford, Ceres, and Modesto. Habitat restoration projects are discussed in detail in Section 5.3.2.2 of the Districts' PAD (TID/MID 2011a).

CDFW placed about 27,000 yd^3 of gravel in the river near the Town of La Grange from 1999 to 2003 to increase spawning gravel area to help offset gravel losses due to the 1997 flood. The FOT, TRT, NRCS, and ESRCD implemented several large floodplain restoration projects on the lower Tuolumne River near Modesto, including the Grayson River Ranch project, which resulted in the restoration of 140 acres of floodplain between RM 5 and RM 6. The TRT, in partnership with the NRCS, CDWR, the National Oceanic and Atmospheric Association (NOAA), and the ESRCD, acquired approximately 250 ac on both sides of the Tuolumne River from RM 5.8 to 7.4 ("Big Bend"). The Big Bend project site, which involved restoration of 240 acres of floodplain between RM 5.5 and RM 7.0, was completed from 2004 to 2006. FOT, funded by the California Bay-Delta Authority (CBDA), acquired about 250 ac of river and floodplain habitat at Bobcat Flat (RM 42.4 to 44.6). A restoration plan was developed, with the goal of enhancing natural floodplain function at the parcel. The Bancroft-Ott Floodplain and Wetland project resulted in 56 ac of restored floodplain along 0.5 river miles (at approximately RM 4).

The Adaptive Management Forum (AMF) was initiated in 2001 to review designs for restoration projects in Central Valley rivers and assist resource agencies and tributary restoration teams. The AMF panel of technical experts reviewed and made recommendations concerning tributary restoration projects and made recommendations for incorporating adaptive management into projects and maximizing restoration success.

Benthic Macroinvertebrates

Benthic macroinvertebrate (BMI) monitoring has been conducted by the Districts in the lower Tuolumne River since 1987. The sampling locations, design, methodology, and analysis metrics have varied over the years, and are described in the Districts' PAD. Study results show that the lower Tuolumne River supports a high species diversity of aquatic invertebrates and indicate that juvenile Chinook salmon preferentially prey on chironomids (midges), ephemeropterans (mayflies), and dipterans (true flies) (TID/MID 1992a).

Results of California Monitoring and Assessment Program (CMAP) metrics for the lower Tuolumne River exhibit a pattern of slightly decreasing BMI habitat quality from upstream (higher quality) to downstream (lower quality) (Table 3.5-23). Long-term comparisons of historical data collected prior to WY 2000 are confounded by differences in invertebrate emergence timing and sampling methodology. Table 3.5-24 provides a long-term comparison of Hess samples collected at riffles 4A (RM 48.4) and 23C (RM 42.3). Analysis of Hess sampling data gathered from 1988 to 2009 at Riffle 4A (RM 48.8) support the observations that increased summer flows released since the 1995 Settlement Agreement have resulted in beneficial shifts in food supply for fishes. Although overall invertebrate abundances in Riffle 4A samples declined slightly from 1996 to the present, community composition shifted away from pollution-tolerant organisms and toward those with higher food value for juvenile salmonids and other fish (TID/MID 2010f, Report 2009-7).

Table 3.5-23. Selected CMAP metrics for historical kick-net samples collected in the lower Tuolumne River, by RM (2001–2009).

Year	**2001**						**2002**						**2003**					
Riffle	**A4**	**4A**	**23C**				**A4**	**4A**	**23C**	**31**	**57**		**A4**	**4A**	**23C**	**31**	**57**	**72**
RM	**51.6**	**48.8**	**42.3**				**51.6**	**48.8**	**42.3**	**38.1**	**31.5**		**51.6**	**48.8**	**42.3**	**38.1**	**31.5**	**25.4**
Taxonomic Richness	25	21	25				20	22	20	25	23		25	33	21	21	30	22
EPT Taxa	8	6	7				5	7	5	8	5		7	8	9	7	10	7
Ephemeroptera Taxa	2	4	3				1	3	2	5	4		3	3	5	5	6	3
Plecoptera Taxa	1	0	0				1	0	0	0	0		1	0	0	0	0	0
Trichoptera Taxa	5	2	4				3	4	3	3	1		3	5	4	2	4	4
Abundance (total in sample)	1,307	835	1,642				6,680	833	310	1,642	944		3,554	7,548	1,611	943	1,110	335
Density (No./m^2)	6,873	3,655	8,634				35,953	4,482	1,668	8,634	5,079		6,231	13,234	2,825	1,654	1,946	587
Year	**2004**						**2005**						**2007**					
Riffle	**A4**	**4A**	**23C**	**31**	**57**	**72**	**A4**	**4A**	**23C**	**31**	**57**	**72**	**A4**	**4A**	**23C**	**31**	**57**	**72**
RM	**51.6**	**48.8**	**42.3**	**38.1**	**31.5**	**25.4**	**51.6**	**48.8**	**42.3**	**38.1**	**31.5**	**25.4**	**51.6**	**48.8**	**42.3**	**38.1**	**31.5**	**25.4**
Taxonomic Richness	28	23	20	25	27	26	31	33	37	23	20	16	25	28	28	17	23	22
EPT Taxa	8	9	7	10	11	8	7	10	7	5	4	5	9	8	9	6	11	8
Ephemeroptera Taxa	4	4	5	7	7	4	3	5	5	3	3	3	5	5	5	4	6	4
Plecoptera Taxa	1	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0
Trichoptera Taxa	3	5	2	3	4	4	3	4	2	1	1	2	4	3	4	2	5	4
Abundance (total in sample)	3,519	3,468	2,749	2,232	813	659	1,057	1,031	463	1,201	513	273	306	522	388	247	428	240
Density (No./m^2)	6,169	6,081	4,820	3,913	4,276	3,466	1,853	1,808	812	2,106	899	479	537	915	680	433	750	421
Year	**2008**						**2009**											
Riffle	**A4**	**4A**	**23C**	**31**	**57**	**72**	**A4**	**4A**	**23C**	**31**	**57**	**72**						
RM	**51.6**	**48.8**	**42.3**	**38.1**	**31.5**	**25.4**	**51.6**	**48.8**	**42.3**	**38.1**	**31.5**	**25.4**						
Taxonomic Richness	24	30	16	16	23	27	27	33	27	27	30	29						
EPT Taxa	7	10	9	9	7	7	5	9	9	11	10	8						
Ephemeroptera Taxa	3	6	7	6	4	2	2	5	6	6	6	4						
Plecoptera Taxa	0	1	0	0	0	0	0	1	0	0	0	0						
Trichoptera Taxa	4	3	2	3	3	5	3	3	3	5	4	4						
Abundance (total in sample)	296	360	275	185	118	345	4,720	1,507	2,146	882	428	1,189						
Density (No./m^2)	520	632	483	324	207	606	8,280	2,643	3,765	1,547	750	2,086						

Adapted from TID and MID (2010, Report 2009-7).

Table 3.5-24. BMI community metrics for long-term Hess sampling sites at riffles R4A (RM 48.8) and R23C (RM 42.3) in the lower Tuolumne River (1988–2009).

Year	San Joaquin Valley Water Year Index	Summer Flow (cfs)	30-Days Prior Flow (cfs)	Sampling Location	EPT Index (%)	EPT / Chironomid Ratio	Shannon Diversity	Percent Chironomid	Percent Insects	Percent Dominant Taxon	Density [No./m^2]
1988	1.48 (C)	16	16	R4A	9	0.52	2.28	29	53	19	33,700
1989	1.96 (C)	47	45	R4A	35	0.94	2.4	38	81	24	34,400
1990	1.51 (C)	21	26	R4A	14	0.26	2.13	53	81	33	52,658
1991	1.96 (C)	25	22	R4A	26	1.05	2.64	25	60	19	35,047
1992	1.56 (C)	20	23	R4A	14	0.28	2.13	60	76	38	23,272
1993	4.2 (W)	466	464	R4A	15	0.38	1.77	44	66	41	24,813
1994	2.05 (C)	23	23	R4A	22	1.73	2.62	17	42	22	3,897
1996	4.12 (W)	335	189	R4A	84	11.09	1.59	8	93	47	22,987
1997	4.13 (W)	283	290	R4A	28	0.45	1.31	63	94	62	20,780
2000	3.38 (AN)	459	305	R4A	52	2.57	2.13	25	79	33	28,832
2001	2.2 (D)	91	89	R4A	44	1.44	2.7	30	30	25	17,037
				R23C	48	2.17	2.43	22	75	30	15,528
2002	2.34 (D)	85	87	R4A	49	1.52	2.0	34	84	40	24,798
				R23C	11	0.38	2.26	32	59	31	11,649
2003	2.82 (BN)	241	240	R4A	41	0.85	2.32	48	90	32	23,547
				R23C	51	8.16	2.37	8	65	28	11,767
2004	2.21 (D)	113	114	R4A	68	3.18	1.92	21	90	52	28,994
				R23C	79	26.86	1.79	3	84	48	19,120
2005	4.75 (W)	1706	803	R4A	76	7.52	1.56	10	95	64	27,440
				R23C	85	15.34	1.42	3	98	66	6,710
2007	1.96 (C)	110	118	R4A	58	1.91	2.73	30	90	26	10,040
				R23C	80	15.95	1.84	5	89	59	4,143
2008	2.07 (C)	96	102	R4A	61	0.88	2.58	18	80	28	4,733
				R23C	68	23.28	2.12	3	86	48	2,762
2009	2.73 (BN)	116	110	R4A	50	1.82	2.79	28	79	19	28,516
				R23C	49	12.99	2.33	4	71	36	23,917

Source: TID and MID 2010, Report 2009-7.

Aquatic Invasive Species

Aquatic Invasive Invertebrates

As with Don Pedro Reservoir, aquatic invasive invertebrate species of concern in the lower Tuolumne River include quagga mussels, zebra mussels, and New Zealand mudsnails. Background on the life history, ecological requirements, and current ranges of these species is included in Section 3.5.2.1.7 of this AFLA.

A report, Potential Distribution of Zebra Mussels *(Dreissena polymorpha)* and Quagga Mussels *(Dreissena bugensis)* in California, prepared for CDFW, assessed the threat of these mussels to California water bodies based on the their ability to tolerate a range of temperatures, calcium concentrations, pH, dissolved oxygen, and salinity (Cohen 2008). Based on its ambient conditions, the Tuolumne River at Modesto is considered vulnerable to colonization, but was assigned a low priority designation. To date, quagga mussels, zebra mussels, and New Zealand mudsnails have not been documented in the lower Tuolumne River.

Water Hyacinth

Water hyacinth (*Eichhornia crassipes*), a plant species native to the Amazon River basin, has spread to all tropical and subtropical countries and is considered one of the world's most invasive aquatic weeds (Parsons 1992, as cited in Cal-IPC 2014). It was introduced into the United States in 1884 as an ornamental plant, spread rapidly in the warmer states, and was first documented in California in 1904 (Thomas and Anderson 1984, as cited in Cal-IPC 2014). In California, water hyacinth is usually found below about 650 ft elevation in the San Francisco Bay Area, along the South Coast, and in the Central Valley (Cal-IPC 2014), including the lower Tuolumne River.

Water hyacinth can quickly dominate an aquatic system because of its rapid proliferation. It often degrades waterfowl habitat by reducing open water areas and displaces native aquatic plants used for food or shelter by other wildlife species (Cal-IPC 2014). Water hyacinth can increase water losses from lakes and rivers because of the plant's high transpiration rate (Parsons 1992, as cited in Cal-IPC 2014) and can alter water quality beneath dense mats by reducing dissolved oxygen and affecting pH and turbidity (Penfound and Earle 1948; Center and Spencer 1981, as cited in Cal-IPC 2014). Alteration in water quality can lead to adverse effects on aquatic biota, and decaying water hyacinth beds can make water unsuitable for drinking by wildlife.

Water hyacinth can obstruct navigable waterways, impede drainage, foul hydroelectric generators and water pumps, and block irrigation channels (Cal-IPC 2014). By 1897 it had occluded many waterways in the United States and was interfering with shipping (Parsons 1992, as cited in Cal-IPC 2014). Agricultural production in California's Central Valley was at one time threatened by significant reductions in the efficiency of irrigation channels and pumping equipment caused by water hyacinth. However, control efforts have reduced the problem significantly in recent years (Parsons 1992, as cited in Cal-IPC 2014). Decaying water hyacinth beds can also make water unsuitable for drinking by humans and livestock.

During the 2012 Lower Tuolumne River Lowest Boatable Flow Study, researchers documented the existence of dense mats of water hyacinth, and in the reach between Riverdale Park (RM 12.3) and Shiloh Bridge (RM 4.0) these mats blocked the entire river in two locations, interfering with boat passage (TID/MID 2013c, RR-03). The California Division of Boating and Waterways considers water hyacinth to be too well established in the lower Tuolumne River for eradication, although herbicides are used to control its abundance when no undue risks to special-status species or subsequent human water uses are anticipated.

3.5.4.2 Fish and Aquatic Resource Effects in the Lower Tuolumne River

In the lower Tuolumne River, there would be no direct or indirect adverse effects on aquatic resources, including fall-run Chinook salmon and *O. mykiss*, as the result of continued hydroelectric power generation at the Project. For the reasons described below, continuance of existing hydropower operations at Don Pedro Dam would have no adverse effect on flows, temperature, water quality, or any other environmental conditions in the lower Tuolumne River, and as a result no effect on aquatic resources. There would, however, be direct effects on aquatic resources as the result of resource measures proposed by the Districts for implementation under the new FERC license. Descriptions of the Districts' proposed resource measures, along with an assessment of their anticipated effects on aquatic resources in the lower Tuolumne River, are discussed in Section 3.4.5.3 and referenced as appropriate in Section 4.0 (*Cumulative Effects*) of this AFLA.

Electric power is generated at the Don Pedro Hydroelectric Project using flows released for other purposes. Irrigation, municipal, and industrial water deliveries, and flood control releases are pre-scheduled based on forecasted demands and actual projected inflow and then released through the powerhouse up to its hydraulic capacity. Scheduling of these releases is adjusted, when consistent with water supply requirements, to release flows for hydroelectric energy generation with a preference for on-peak power demand rather than off-peak hours. However, any effect on flows in the reach of the Tuolumne River between Don Pedro Dam and La Grange Diversion Dam is not transferred downstream to the lower river, because flow management at and downstream of La Grange Diversion Dam reflects diversions and releases made in association with unrelated and non-interdependent actions, e.g., providing water for irrigation and M&I uses, aquatic resource protection, storage and releases for flood management, and to provide a water bank that CCSF may use to help manage the water supply from its Hetch Hetchy system while meeting the senior water rights of the Districts. The effects of the overall Don Pedro Project's primary purposes are addressed in the Cumulative Effects section (Section 4.0) of this AFLA. Hydroelectric generation at the Don Pedro Project cannot impact aquatic resources in the lower Tuolumne River, because the flows released into the lower Tuolumne River are not linked to power production and, absent power production at the Don Pedro Dam, the flow release schedule, including flows to the lower Tuolumne River, will remain the same as it is under existing conditions, i.e., driven by uses other than hydroelectric power production.

3.5.4.3 Proposed Environmental Measures

3.5.5 Improve Spawning Gravel Quantity and Quality

Augment Current Gravel Quantities through a Coarse Sediment Management Program

The results of the Spawning Gravel in the Lower Tuolumne River report (TID/MID, 2013, W&AR-04) demonstrate that the Tuolumne River downstream of the La Grange tailrace has sufficient gravel now, and for the foreseeable future, to provide sufficient habitat for fall-run Chinook and *O. mykiss* spawning. However, although availability of spawning gravel is not currently a limiting factor, Don Pedro Reservoir's capture of gravel prevents its movement downstream, which has contributed to the net loss of gravel supply to the lower Tuolumne River. Based on the results of TID/MID (2013j, W&AR-04) estimated total coarse sediment storage loss in the lower river was approximately 8,000 tons, based on differencing of 2005 and 2012 DTM data over a 13-mile study reach, which included the reach of the lower Tuolumne River where nearly all salmonid spawning occurs. Distributed over the channel within the study area, this equates to an average bed lowering of 13 mm, or less than half the average median grain size of the coarse channel bed (approximately 51 mm). The total estimated gravel volume lost from storage in the reach is comparable in magnitude to the quantity of coarse sediment added during any one of the augmentation projects that have occurred since 2002 (approximately 7,000–14,000 tons). Also, the reservoir's ongoing operations affect flow magnitude and frequency downstream, and this affects gravel mobilization, which can lead to gravel filling in with fines, which in turn impacts the suitability of gravel for salmonid spawning (TID/MID 2013j, W&AR-04).

To improve gravel conditions, the Districts propose to conduct gravel (i.e., coarse sediment) augmentation from RM 52 to RM 39 over a 10-year period following issuance of a new license. Because spawning preferences are more heavily weighted towards upstream habitats, the highest priority for the gravel augmentation is upstream of Old La Grange Bridge. Coarse sediment to be added to the river channel would range in size from 0.125 to 5.0 inches in diameter (Gravel Augmentation Plan, and Stillwater Sciences [2017b], provided in Appendix E-1). Taking biological needs, geomorphic needs, and sensitive habitat into consideration, the recommended short-term coarse sediment augmentation sites, in order of priority, would be: (1) Riffle A3/4, (2) Riffle A5/6 (3) Basso Pool, and (4) and Riffle A1/2[39] (Stillwater Sciences 2017c). Preliminary gravel augmentation designs are provided in the Gravel Plan, and estimated gravel volumes and spawning gravel areas are shown in Table 3.5-25.

[39] Riffle A1/2 is located just downstream of the confluence of the mainstem Tuolumne River and the La Grange tailrace.

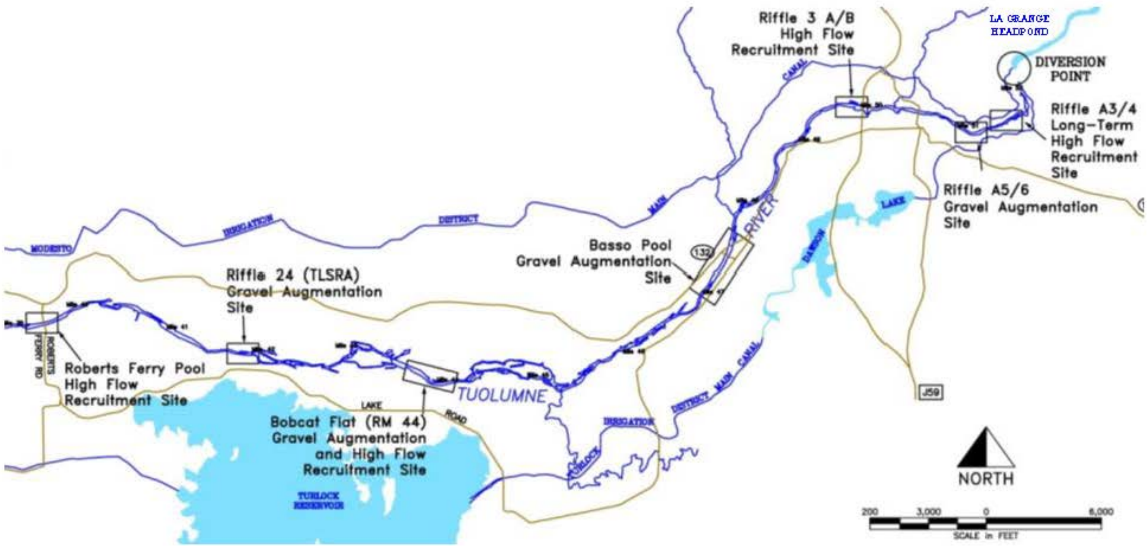

Figure 3.5-13. Map showing the proposed coarse sediment augmentation sites.

Table 3.5-25. Preliminary gravel augmentation volumes and spawning gravel areas (at 320 cfs) downstream of La Grange Diversion Dam (RM 52) in the Tuolumne River.

Riffle Location	RM	Volume (yd^3)	Tons	Wetted Area (ft^2)
A2	51.7	450	585	6,450
A3	51.5	4,300	5,590	43,640
A5	51.2	11,500	14,950	120,960
A6	51.0	18,600	24,180	100,460
Basso Upper	46.5	20,500	26,650	190,890
Basso Lower	46.2	2,300	2,990	80,269
Totals		**57,650**	**74,945**	**542,669**

Expected benefits of gravel augmentation in the future would include (1) an increase in salmonid egg-to-emergence ratio, (2) reduced superimposition of fall-run Chinook redds, (3) increased benthic macroinvertebrate production, and (4) potentially improved hyporheic flow and cold water habitat downstream of LGDD.

Monitoring activities associated with this measure would include (1) a spawning gravel evaluation in Year 12 of the augmentation program using methods comparable to those employed for the Spawning Gravel in the Lower Tuolumne River Study (TID/MID 2013j, W&AR-04) and (2) annual surveys of fall-run Chinook and *O. mykiss* spawning use of new gravel patches for five years following completion of gravel augmentation.

Gravel Mobilization Flows of 6,000 to 7,000 cfs

Flows ranging from 6,000-7,000 cfs (measured at USGS gage 11289650 below La Grange Diversion Dam) would be released to mobilize gravel and fines. These flows would be provided for at least two days at an estimated average frequency of once every three to four years, i.e., during years when sufficient spill is projected to occur (see Appendix E-1). In years when the La Grange gage spring (March through June) spill is projected to exceed 100,000 ac-ft, the Districts would plan to release a flow of 6,500 cfs for two days within the spill period, with down-ramping not to exceed 300 cfs/hr.

Potential benefits of this measure would include (1) reduced fine sediment storage in the low-flow channel and in spawning gravels, which could increase salmonid egg-to-emergence success and fry production, and benthic macroinvertebrate production, (2) increased fine sediment storage on floodplains, which could improve regeneration of native riparian plant species during wetter water years, and (3) a net increase in lateral channel migration, bar formation, and large wood introduction, which together could create new floodplains and complex hydraulic environments for improved adult salmonid holding, spawning, and juvenile rearing.

Monitoring associated with this measure would consist of conducting substrate surveys at designated test sites located upstream of RM 43 prior to a high-flow event, then examining the same test sites following the flow event to evaluate whether there are corresponding changes in channel morphology or improvements to the quality of spawning gravel, i.e., a reduction in interstitial fines. Flow magnitude and/or duration may be adjusted based on these observations.

This measure could cause localized, short-duration pulses in turbidity (see Section 3.4, *Water Resources*, of this AFLA), which depending on the timing of releases, might benefit juvenile fall-run Chinook by decreasing predator effectiveness. Benefits to spawning habitat are expected to outweigh any short-term effects associated with turbidity increases.

Gravel Cleaning

The Districts would conduct a five-year program of experimental gravel cleaning using a gravel ripper and pressure wash operated from a backhoe, or equivalent methodology. Each year of the program would consist of two to three weeks (during May) of cleaning select gravel patches. This action would involve the use of an excavator in the river channel, which would, by design, disrupt the substrate substantially for a short period. The Districts would conduct *O. mykiss* spawning and redd surveys in areas planned for gravel cleaning prior to commencing any gravel cleaning. Subject to the findings of these surveys, the gravel cleaning may coincide with May pulse flows to benefit Chinook smolt outmigration by providing increased turbidity to reduce predator sight feeding effectiveness.

Gravel cleaning has the potential to expand the availability of high quality gravel, which would improve spawning success and egg incubation for fall-run Chinook and *O. mykiss*. Gravel cleaning would coincide with the May pulse flows (see below) to aid fall-run Chinook smolt outmigration by providing increased turbidity to reduce predator sight-feeding effectiveness. Conducting gravel cleaning after April 30 would also prevent disruption of *O. mykiss* redds.

During short periods, increased turbidity might exceed state water quality standards (see Section 3.4, *Water Resources*, of this AFLA), but the benefits to spawning success and smolt survival are likely to significantly outweigh any short-term effects of increased turbidity. The Districts would coordinate with the SWRCB to secure necessary permits and conduct any required turbidity monitoring. If gravel cleaning is judged to be successful, the program would continue, adjusted as needed to comply with any water-quality related concerns of the SWRCB.

Improve Instream Habitat Complexity

Under this measure, $2 million would be provided for the collection and placement of boulder-size stone (approximately 0.7-1.5 yd^3) between RM 42 and 50. The boulder placement program would take place over four years and proceed by conducting placement in select sub-reaches each summer (after July 15). Placement locations would be selected through collaboration with parties having fisheries and recreational interests in the lower Tuolumne River. A maximum of 200 boulders would be placed. The preferred locations for materials installation would be in run/glide habitats to create velocity diversity and feeding stations. Enhancing an area downstream of a riffle would likely have the greatest benefit. Smaller boulders (12-24 inch) may be placed along stream margins in similar run/glide habitat. This would provide interstitial velocity refuges for rearing juveniles during winter and high flows that occur throughout the year. Locations between RM 48 and 50 that are run/glide habitats would be tested first. Boulders would be put into place with heavy equipment, and the size of the boulders and their positioning would provide for their stability, i.e., no permanent anchoring, including rebar or cabling, would be used. Boulders would be positioned so that they are completely overtopped during channel-forming flow events. All boulders would be transported, stored, and placed using the existing road network and staging areas along the lower Tuolumne River, i.e., no new roads or staging areas would be created. There would be no significant modifications to riparian vegetation adjacent to the placement locations. BMPs required by NMFS and other regulatory agencies would be employed to avoid effects on the river and its biota due to the use and storage of heavy equipment. Unlike placement of large wood in the channel, suitably placed boulders would represent a minimal hazard to recreational boaters using the lower river.

This measure is expected to provide favorable microhabitats for *O. mykiss* (TID/MID 2013e, W&AR-12) by increasing structural and hydraulic complexity, and improve spawning habitat for fall-run Chinook and *O. mykiss* as localized scour displaces fines from gravel beds. Unlike placement of large wood in the channel, suitably placed boulders would represent a minimal hazard to recreational boaters using the lower river.

Biological monitoring would consist of bounded *O. mykiss* count estimates in the treatment habitat units and untreated areas nearby that are hydraulically similar to the pre-treatment habitats. The Districts would collect data for at least two years prior to boulder placement and three years after placement. Annual snorkeling surveys would be conducted to assess differences in units with and without bordering boulders (see above), and evaluate changes in fish densities through time in response to boulder placement. In addition, a one-time monitoring event within five years following the completion of the boulder placement program would be conducted to examine the stability of the placed boulders and to map smaller gravel accumulations linked to the placement of the boulders.

Contribute to CDBW's Efforts to Remove Water Hyacinth

The Districts would contribute $50,000 per year to the California Division of Boating and Waterways (CDBW, the State agency responsible for implementing an Aquatic Pest Control Program to control hyacinth) to assist with the removal of water hyacinth and other non-native flora. The contribution would be made regardless of the level of water hyacinth infestation occurring in the lower Tuolumne River.

There would be no monitoring conducted by the Districts in association with this measure. CDBW employs herbicides to treat water hyacinth and other invasive aquatic plants in Central Valley rivers and the Delta. CDBW uses herbicides that are registered for aquatic use with the EPA and California Department of Pesticide Regulation. Treated areas are typically monitored weekly by CDBW to ensure that herbicide levels do not exceed allowable limits and that herbicide treatments have no adverse environmental impacts.

Because dense mats of water hyacinth can alter water quality by reducing dissolved oxygen and affecting pH and turbidity (Penfound and Earle 1948; Center and Spencer 1981, as cited in Cal-IPC 2014), removal of these introduced plants would likely benefit aquatic biota in the lower river, possibly including fall-run Chinook salmon passing through the lowermost reaches of the river where water hyacinth infestations occur. Also, CDBW applies herbicide at levels that do not exceed allowable limits so that treatments have no adverse environmental impacts.

Fall-Run Chinook Spawning Improvement Superimposition Reduction Program

Redd superimposition occurs when newly arrived female fall-run Chinook select spawning sites on top of preexisting redds, and this superimposition can displace or damage eggs in the gravel, thereby resulting in reduced fall-run Chinook productivity. To reduce this superimposition, the Districts propose to develop and install a temporary barrier to encourage spawning on less used, but still suitable, high quality riffles. The temporary barrier would be installed each year below the new La Grange Bridge (RM 49.9) after November 15 once the number of Chinook passing the proposed RM 25.5 fish counting weir (see below) exceeds 4,000 total spawners. The temporary barrier would be similar to the Alaska-type counting weir currently used on the Tuolumne River at RM 24.5 or a picket-weir type. Final design and configuration of the temporary barrier would be based on consultation with state and federal resource agencies.

Studies have shown (TID/MID 2013h, 2017a) that rates of spawning superimposition are relatively high for fall-run Chinook in the lower Tuolumne River at higher escapement levels (e.g., > 5,000 female spawners) due to a strong preference shown by fall-run Chinook to spawn upstream of RM 47. The reasons for this are uncertain, but may be correlated with the high percentage of out-of-basin hatchery strays contributing to the Tuolumne River escapement and their lack of site fidelity. Suitable spawning gravel exists in the lower Tuolumne River from RM 51.5 to approximately RM 30. Dispersing spawning activity more evenly throughout the reach containing suitable gravel is expected to improve fall-run Chinook productivity in high-escapement years.

Predator Control and Suppression Plan

The Districts' proposed predator control and suppression program would consist of two elements: (1) construction and operation of a barrier weir and (2) active predator control and suppression (see descriptions of measures below).

Studies demonstrate that predation on salmonids, fall-run Chinook smolts in particular, by non-native black bass (largemouth and smallmouth bass) and striped bass is substantial in the lower Tuolumne River (TID/MID 2013h, 2017a, 2013g; and results of rotary screw-trap monitoring). The Predator Suppression and Control Plan developed as part of the Districts' Proposed Action identifies a predator reduction of 10 percent below RM 25.5 and 20 percent above RM 25.5. Modeling confirms that reducing predator-related mortality of Chinook salmon juveniles in proportion to these predator-reduction targets would have a greater beneficial effect on smolt survival than releasing to the river 40 percent of the unimpaired flow in the February 1–June 30 period.[40] An effective predator control and suppression program would mainly improve fall-run Chinook salmon outmigration survival, but would also reduce predation risk for *O. mykiss*.

Construct a Fish Counting and Barrier Weir

The Districts are proposing to construct and operate a small barrier weir (less than 5 ft of head at normal flows) at approximately RM 25.5, about 1 mile upriver of the current counting weir. The barrier weir will be a reinforced concrete structure consisting of, from river-right to river-left (looking downstream), the components listed below. A planview of the weir is provided in Figure 3.5-13.

- A concrete abutment merging with natural grade;
- A fishway and counting structure equipped with a viewing window and fish sorting capability;
- An 8-ft long by 5-ft high bottom drop gate with a maximum hydraulic capacity of 75 cfs providing attraction flow to the fishway entrance;
- Spillway section;
- Middle abutment;
- Non-motorized craft (kayak/canoe/raft) bypass structure with flap-gate control and concrete chute; and
- Left concrete abutment merging with natural grade.

[40] Reducing predation rates by the amounts called for in the Proposed Action is projected to increase smolt production. Assuming a population of 2,000 female spawners, the Base Case smolt production estimate of 6.3 smolts per female spawner would increase to 11.4 smolts per female spawner (TID/MID 2013, W&AR-06). Increasing the February–June instream flows to 40 percent of the unimpaired flow is projected to produce 8.7 smolts per female spawner.

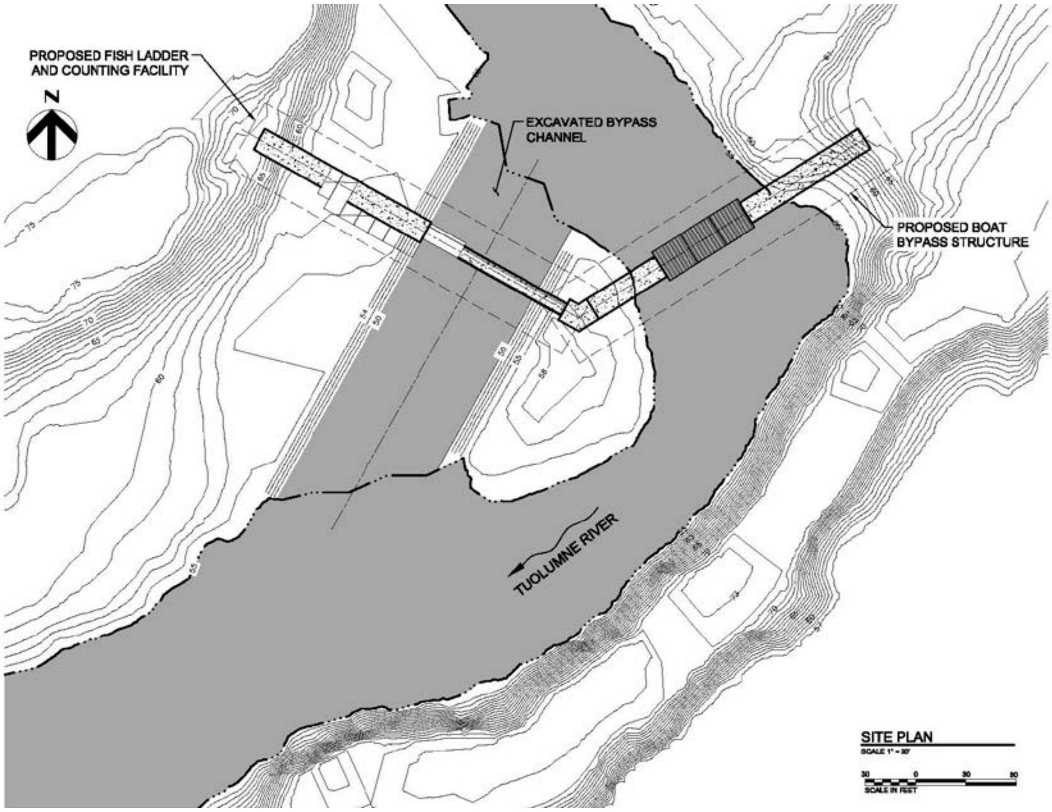

Figure 3.5-13. Planview of the fish counting and barrier weir at RM 25.5.

The fish counting and barrier weir would serve the following purposes:

- Provide a permanent upstream migrant counting weir to replace the temporary seasonally-operated Alaska-type counting weir located at RM 24.5. The seasonal weir must be removed when flows reach 1,500 cfs; the new counting weir would be capable of being operated year-round and in river flows up to at least 3,000 cfs.
- Provide a Denil-type fishway and counting window to conduct fish counts, fish species separation, and potentially public viewing. The ability to collect fish would also permit broodstock selection, if desired by fisheries agencies.
- Provide a barrier to exclude striped bass from upstream habitats used for rearing by juvenile fall-run Chinook salmon, while at the same time providing a location where striped bass are likely to congregate, which would enable their removal or isolation at key times during smolt outmigration. Striped bass are known to be voracious predators and have been observed in all seasons throughout the entire lower Tuolumne River.
- Provide for elimination of black bass movement into sections of river upstream of RM 25.5 and provide for significant long-term reductions in black bass populations above RM 25.5.

Predator Suppression and Removal

The Districts are proposing to implement a comprehensive predator suppression and control program consisting of the following components.

- Specific incentives and measures to target an annual reduction in the population of black bass and striped bass, based on levels documented in 2012, by approximately 20 percent above the proposed barrier weir (at RM 25.5) and 10 percent below the barrier weir. These measures would include, but would not be limited to, sponsoring and promoting black bass and striped bass derbies and reward-based angling in locations both above and below the barrier weir to substantially diminish the sizes of the bass populations over time.[41] Other removal and/or isolation methods would include electrofishing, seining, fyke netting, and other collection methods. Based on the 2012 population of black bass between the two Tuolumne River rotary screw-traps (RM 30 and RM 5), a 10 percent removal black bass would amount to a total of about 660 fish (roughly equal numbers of smallmouth and largemouth bass).[42] To provide context, this level of removal would take four anglers about 80 days of fishing. There are more efficient means of removal, including electrofishing, and the seasonal timing of such removal would influence its effectiveness at increasing salmonid smolt survival. To ensure compliance with this measure, the Districts propose to file an annual report on black bass and striped bass reduction efforts undertaken during the prior calendar year. The Districts propose to conduct a survey every five years to identify the number of fish to be targeted in order to reduce the bass population by 10 percent in succeeding years.
- The Districts will seek and advocate for changes to current fishing regulations for the lower Tuolumne River (e.g., length of season, bag limit, catchable size, required removal of black bass/striped bass caught, allowing a bounty program) to reduce black and striped bass numbers. In addition, the Districts propose to (1) establish a fund to carry out the activities contemplated above and to educate the public on the adverse effects of predation on O. mykiss in the Tuolumne River to encourage participation in the removal program and (2) advocate for changes to fishing regulations that facilitate such removal. Activities could include, but would not be limited to, developing educational materials about the effects of predatory fish, community outreach, or kiosks. To monitor compliance with this measure, the Districts propose to file an annual report describing the specific educational and advocacy measures undertaken during the preceding year.

Evaluating the success of predator control would be based on a set of metrics that describe predator populations before and after implementation of control measures. The following metrics could be used to assess the effectiveness of the program: (1) predator densities per unit area and unit bank length, (2) estimates of absolute predator abundance, (3) relative abundances of black and striped bass, (4) demographic statistics including age-class structure, size-at-age, and recruitment (see the Predator Control and Suppression Plan, Appendix E-1, Attachment C).

Removal of striped and black bass would lead to substantial reductions in the abundance of non-native predators in the lower river, which in turn would lead to substantial increases in the survival of outmigrating juvenile fall-run Chinook salmon. Results of the predation study

[41] Such incentives could include expansion on the Tuolumne River of the current CDFW Free Fishing Days program, which currently allows free fishing on the Labor Day and July 4 holidays, expansion of CDFW's current Fishing in the City program to promote urban youth fishing, promotion of fishing derbies and competitions similar to the Nor-Cal Guides' and Sportsmen's Association (NCGASA) pikeminnow derby on the Feather River, and/or sport-reward program for striped bass and black bass similar to pikeminnow programs currently carried out in Washington and Oregon.

[42] See Districts' Predator Control and Suppression Plan (Appendix E-1) for more details. The barrier weir will eliminate striped bass access to important Chinook rearing areas upstream of RM 25.5. Striped bass are estimated to be responsible for approximately 15-20 percent of the total predation on fall-run Chinook juveniles in the lower Tuolumne River.

(TID/MID 2013g, W&AR-07) indicated that predators that consumed juvenile Chinook were greater than 150 mm in fork length. Table 3.5-26 shows the estimated effect on fall-run Chinook predation associated with removal of black and striped bass (i.e., 10–15 percent) between the Grayson (RM 5.1) and Waterford (RM 30.3) rotary screw-traps (see the Predator Control and Suppression Plan for the Lower Tuolumne River provided as Appendix E-1).

Table 3.5-26. Estimated effect on fall-run Chinook predation rates associated with the removal of black and striped bass between the Grayson and Waterford rotary screw-traps (RM 5.1–30.3).

Species	10 Percent Removal Target	15 Percent Removal Target	Potential Reduction in Fall-Run Chinook Salmon Predation (salmon/day)
Largemouth bass	301	452	30-45
Smallmouth bass	363	544	40-60
Striped bass	24	35	26-39

Fall-Run Chinook Salmon Restoration Hatchery Program

The Districts propose to build, in cooperation with CDFW, in the general vicinity of the current location of the CDFW offices below La Grange Diversion Dam, a fall-run Chinook restoration hatchery to be operated by CDFW. The Districts would pay for hatchery construction and O&M for the first 20 years, after which the success of the hatchery would be evaluated. The hatchery is not intended to be a permanent facility. The weir described above would allow for the collection of fall-run Chinook broodstock. The proposed supplementation program, like state and federal programs, would be implemented in accordance with procedures that prevent or minimize adverse impacts on the fitness, size, abundance, run-timing, and distribution of wild fish.

The fall-run Chinook population in the lower Tuolumne River has undergone significant genetic introgression in recent years, with progeny from out-of-basin strays accounting for much of the lower river’s annual production. Recent estimates of the composition of fall-run Chinook salmon indicate that up to 50 percent of the escapement to the Tuolumne River is made up of hatchery-produced salmon from other rivers (Merced Irrigation District 2012). Barnett-Johnson et al. (2007) estimated that only 10 percent of Central Valley Chinook salmon captured in the ocean troll fishery were not raised in a hatchery setting. Assuming roughly equivalent survival of hatchery- and natural-origin fish from the fishery to the spawning grounds, up to 90 percent of annual escapement could consist of hatchery reared fish (TID/MID 2013h, W&AR-05). Results of the Chinook Salmon Otolith Study (TID/MID 2016) indicate that the total estimated hatchery contribution of adult fall-run Chinook salmon in the Tuolumne River during the years studied (i.e., 1998, 1999, 2000, 2003, and 2009,)[43] averaged 67 percent, and hatchery contribution generally increased in later years. Recognizing that some years in the otolith sample inventory over- or under-represent the typical age-class structure in the escapement record, the overall proportion was estimated using only three-year-old fish, which are expected to make up the bulk

[43] The years evaluated for the Chinook Salmon Otolith Study, i.e., 1998, 1999, 2000, 2003, and 2009, were selected to represent “above normal” or “wet” and “below normal” or “dry” water-year types. These were also years during which the greatest number of otolith samples were available from the existing CDFW inventory.

of the annual escapement. For three-year-old fish, hatchery contribution ranged from 36 to 90 percent, with a mean of 58 percent.

Stillwater Sciences (2017b) noted that a lack of genetic distinction between hatchery and naturally spawning fall-run Chinook salmon, along with loss of early life-history diversity due to inter-basin hatchery transfers and out-of-basin releases of hatchery-reared juveniles, are reducing the ability of fall-run Chinook to adapt to fluctuating environmental conditions, thereby contributing to a reduction in the Central Valley Fall, Late-Fall Run ESU's reproductive fitness. Observations that estuary releases of late-stage smolts provide the basis for the majority of adult harvest, and the fact that hatchery escapement results in high rates of straying, indicate that hatchery practices are increasingly producing salmon that survive at relatively high rates but are decoupled from basin-specific selective pressures that influence the adaptive capacity of the species' freshwater life-stages (Stillwater Sciences 2017b), presently and over the long-term.

The proposed supplementation program would be structured to attempt to counter these current adverse trends to the degree possible in the Tuolumne River through the spawning and rearing of fish selected by CDFW to best represent the wild Tuolumne River stock. The program would allow for the stocking of fish within the basin and as a result produce individuals that are adapted to the extent practicable to conditions in their natal environment. No adverse effects on *O. mykiss* are predicted as the result of implementing this supplementation program.

Infiltration Galleries 1 and 2

The Districts are proposing to complete construction of TID's infiltration gallery (IG1) (at RM 25.9) and undertake construction of a second infiltration gallery (IG2) at the same general location. IG1 has a design capacity of approximately 100 cfs, and IG2 would have a capacity of 100-125 cfs. The purpose and operation of the infiltration galleries are discussed in the next section. The locations of the proposed infiltration galleries are shown in Figure 3.5.14.

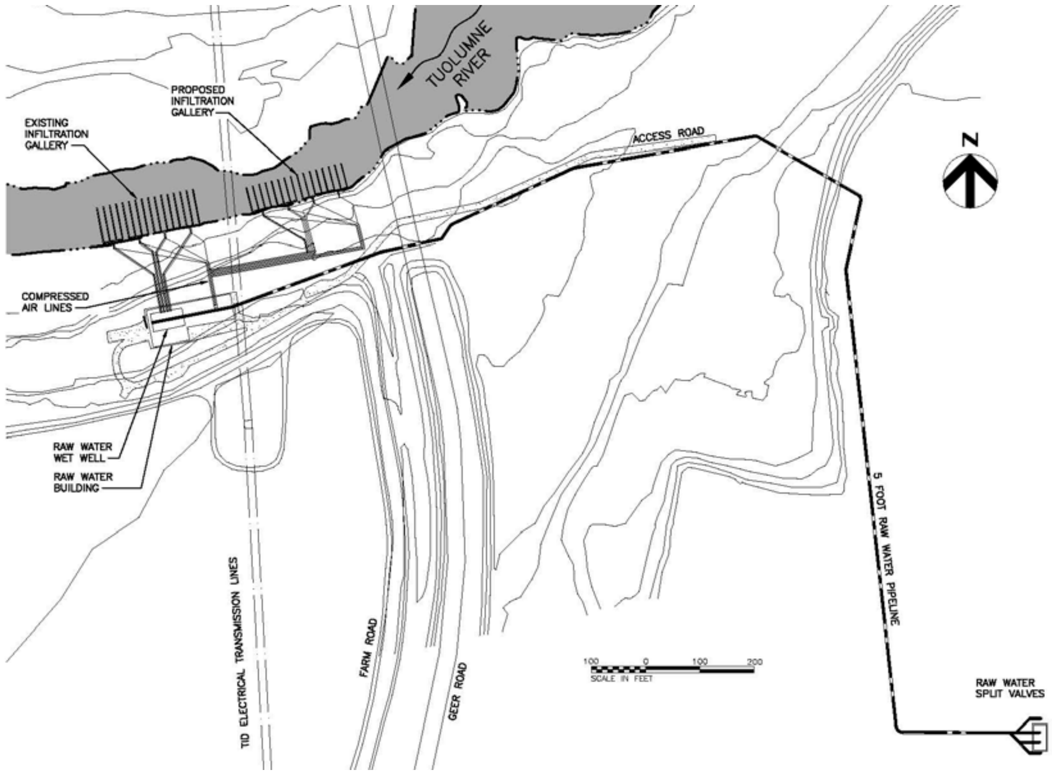

Figure 3.5-14. Site location of the infiltration galleries downstream of the Geer Road Bridge at approximately RM 25.9.

Flow-Related Measures for Fish and Aquatic Resources

The Proposed Action includes flow-related measures during all water-year types. The flow measures include a set of base flows designed for specific salmonid life stages in the Tuolumne River, and a set of pulse flows, which were designed based on 20 years of rotary screw-trapping results and other related studies specific to the Tuolumne River. An adaptive management approach to pulse-flow timing and duration is part of these measures.

For all flow-related measures, the flow schedules are based on five water-year types determined using the 60-20-20 San Joaquin River Index (SJI). The five types are wet (W), above normal (AN), below normal (BN), dry (D), and critical (C). Table 3.5-27 provides the classification of each water year for the 1971–2012 modeling period of record.

All proposed flow-related measures identified below are based on five water-year types determined using the 60-20-20 San Joaquin River Index. The current method used by TID operators to determine the water year type and the required flow release schedule would remain unchanged.[44] There would be two flow monitoring locations for compliance: (1) the existing USGS Tuolumne River at La Grange gage and (2) a new USGS gage measuring the flow in the two infiltration galleries' (see Figure 3.5-14) pipelines. The La Grange gage would be used to monitor compliance for flows between the La Grange gage and RM 25.5. Subtracting the

[44] TID operators currently determine the water-year type in early April and issue, after consultation with resource agencies, the schedule of releases for April 15 of the current year through April 14 of the next calendar year.

infiltration gallery pipelines gage from the La Grange gage would yield the instream flows to be provided downstream of RM 25.5, and this difference would constitute the second point of compliance. Compliance would be achieved if flows equaled or exceeded the amounts identified below over monthly timeframes, with no deficit of more than 10 percent below the minimum for more than 60 minutes, and no flow deficit allowed that is greater than 20 percent below the flows described below and shown in Table 3.5-28. With the two compliance points being located about 25 miles apart, during days where scheduled flow changes are to occur, time of travel would be taken into account when determining compliance. Any outage of the infiltration galleries that prevents the planned flow from being withdrawn and lasting for more than three consecutive days would result in the minimum instream flows required at the La Grange gage to be reduced by two-thirds of the amount that would have been withdrawn.

Table 3.5-27. Classification of each water year for the 1971–2012 modeling period of record.

Water Year	San Joaquin Index	Water Year	San Joaquin Index
1971	BN	1992	C
1972	D	1993	W
1973	AN	1994	C
1974	W	1995	W
1975	W	1996	W
1976	C	1997	W
1977	C	1998	W
1978	W	1999	AN
1979	AN	2000	AN
1980	W	2001	D
1981	D	2002	D
1982	W	2003	BN
1983	W	2004	D
1984	AN	2005	W
1985	D	2006	W
1986	W	2007	C
1987	C	2008	C
1988	C	2009	BN
1989	C	2010	AN
1990	C	2011	W
1991	C	2012	D

Table 3.5-27. Proposed lower Tuolumne River flows to benefit aquatic resources and accommodate recreational boating.

	Flow (cfs)	
Water Year/Time Period	**La Grange Gage**	**RM 25.5**
Wet, Above Normal, Below Normal		
June 1 – June 30	200	100[1]
July 1 – October 15[3]	350	150[2]
October 15 – December 31	275	275
January 1 – February 28/29	225	225
March 1 – April 15	250	250
April 16 – May 15[4]	275	275
May 16 – May 31[4]	300	300
Dry		
June 1 – June 30	200	75
July 1 – October 15	300	75[2]

	Flow (cfs)	
Water Year/Time Period	La Grange Gage	RM 25.5
October 15 – December 31	225	225
January 1 – February 28/29	200	200
March 1 – April 15	225	225
April 16 – May 15[4]	250	250
May 16 – May 31[4]	275	275
Critical		
June 1 – June 30	200	75
July 1 – October 15	300	75
October 15 – December 31	200	200
January 1 – February 28/29	175	175
March 1 – April 15	200	200
April 16 – May 15[4]	200	200
May 16 – May 31[4]	225	225

[1] - Cease IG withdrawal for one pre-scheduled weekend.
[2] - 200 cfs for three-day July 4 holiday, for three-day Labor Day holiday, and for two pre-scheduled additional weekends in either June, July, or August.
[3] - 1,000 cfs flushing flow (not to exceed 5,950 AF) on October 5, 6 and 7, with appropriate up and down ramps and IGs shut off.
[4] - Fall-run Chinook outmigration pulse flows: 150,000 ac-ft (Wet, Above Normal), 100,000 ac-ft (Below Normal), 75,000 ac-ft (Dry), 45,000 ac-ft (sequential Dry[s]), 35,000 ac-ft (first Critical), and 11,000 ac-ft (sequential Critical[s]).[45]

Early Summer Flows (June 1 – June 30)

Except for wet years, when high flows may extend well into June, most fall-run Chinook salmon juveniles have left the Tuolumne River by the end of May (Figure 3.5-15) (TID/MID 2013h, W&AR-05), so increased summer flows are aimed at enhancing habitat conditions for *O. mykiss*. The Districts are proposing to provide an instream flow of 200 cfs (as measured at the La Grange gage) upstream of RM 25.9 from June 1–June 30 of all water year types to benefit *O. mykiss* fry rearing. Downstream of RM 25.5 (i.e., downstream of the infiltration galleries) instream flows during this period would be 100 cfs during Wet, Above Normal, and Below Normal water years and 75 cfs in Dry and Critical years.

Based on redd surveys, *O. mykiss* in the lower Tuolumne River spawn from late December through early April (TID/MID 2013i, W&AR-08; FISHBIO 2017). Years of monitoring studies indicate that *O. mykiss* are predominantly found upstream of RM 42, with peak fry densities occurring into June. For the period of June 1 to June 30, baseflows would be provided to support *O. mykiss* fry rearing. Flow management for the benefit of *O. mykiss* fry would balance hydraulic habitat suitability and temperature suitability for fry and adult life stages. Flows higher than those proposed by the Districts in June would tend to displace weaker-swimming *O. mykiss* fry to downstream areas with lower quality physical habitat, higher water temperatures, and greater predator densities.

[45] This reduced pulse flow, while still greater than or equal to Base Case pulse flows, would also occur in a sequence of "D" and "C" years. For example, in a sequence of the years C, D, C, D, C, D, the second and third "critical" years and the second and third "dry" years would each have pulse flows of 11 TAF and 45 TAF, respectively.

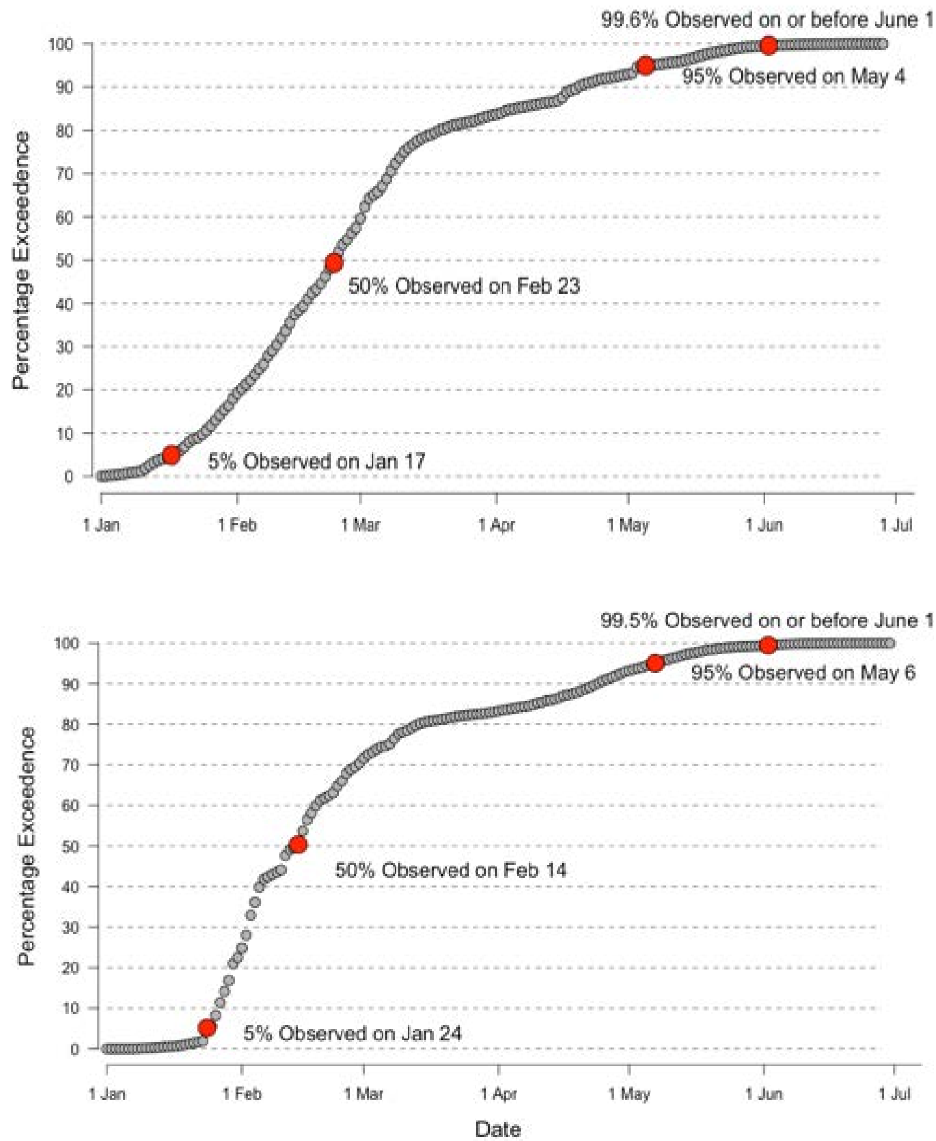

Figure 3.5-15 Long-term migration pattern of observed juvenile Chinook salmon captured at the Waterford rotary screw-trap (top; RM 30) and the Grayson rotary screw-trap (bottom; RM 5) on the Tuolumne River (2006 – 2016). Key dates of passage are indicated with red circles.

IFIM study results (Stillwater Sciences 2013) indicate that at 100 cfs, hydraulically suitable habitat for *O. mykiss* fry is 85 percent of maximum, at 150 cfs it is 78 percent of maximum, and at 200 cfs it is 71 percent of maximum (Figure 3.5-16). Water temperature modeling shows that at RM 47, a flow of 200 cfs would maintain average daily water temperatures at less than 18°C, and at RM 43, a flow of 200 cfs would maintain average daily water temperatures at less than 20°C, except when maximum daily ambient air temperatures exceed 100°F (38°C) (Figure 3.5-17), which on average occurs only 1 to 2 days in June (Figure 3.5-18). At 150 cfs, average daily water temperatures at RM 43 would be less than 20°C until maximum daily air temperature exceeds 95°F (Figure 3.5-17), which occurs on average two to three days in June (Figure 3.5-18). Adult *O. mykiss* habitat is 78 percent of maximum WUA at 200 cfs.

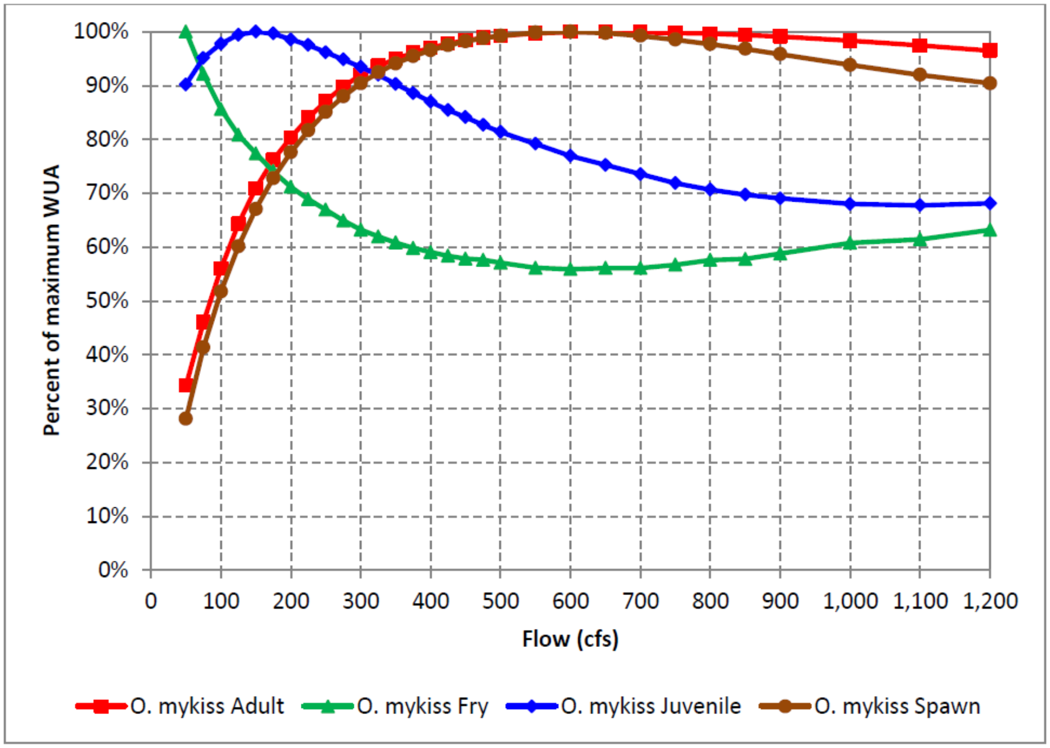

Figure 3.5-136. ***O. mykiss*** **WUA results for the lower Tuolumne River (source: Stillwater Sciences 2013).**

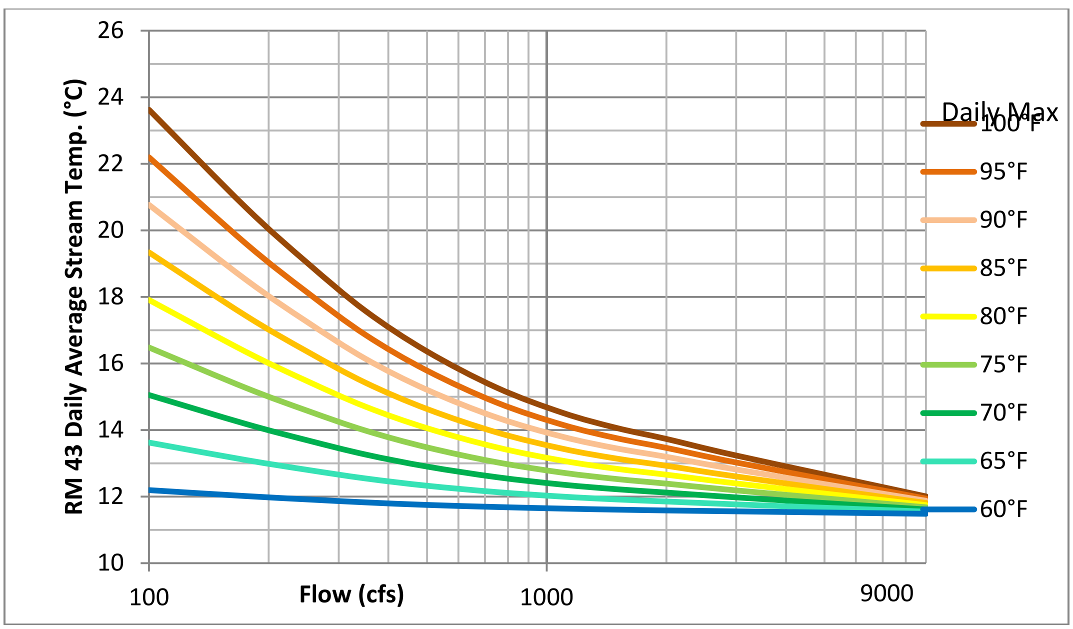

Figure 3.5-17. **RM 43 daily average water temperatures versus flow and maximum air temperatures .**

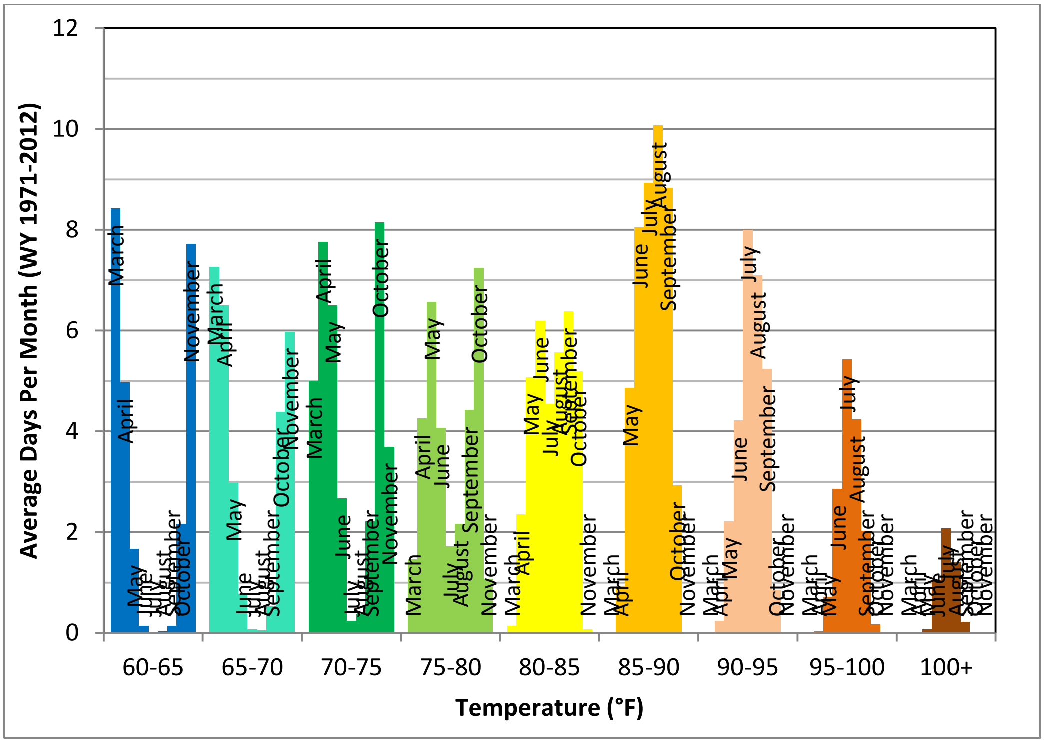

Figure 3.5-18. Frequency of occurrence of maximum daily air temperatures by month for the lower Tuolumne River (estimated for approximately RM 40).

Low numbers of over-summering juvenile Chinook are observed downstream of the La Grange gage (RM 51.7) during most years (TID/MID 2013j; W&AR-04) and would experience any flows released for the benefit of *O. mykiss*. IFIM study results (Stillwater Sciences 2013) indicate that a flow of 200 cfs provides 98 percent of the maximum WUA for juvenile Chinook in the lower Tuolumne River (Figure 3.5-19). The TRCh (TID/MID 2017a, W&AR-06) identifies an initial mortality threshold of 25°C for Chinook salmon juveniles as a daily average water temperature, which is based on information reviewed for Chinook salmon fry mortality (Brett 1952, Orsi 1971). A flow of 200 cfs upstream of RM 25.7, although selected for the benefit of *O. mykiss*, would also benefit any remaining fall-run Chinook salmon. Juvenile Chinook salmon would not over-summer downstream of RM 25.5.

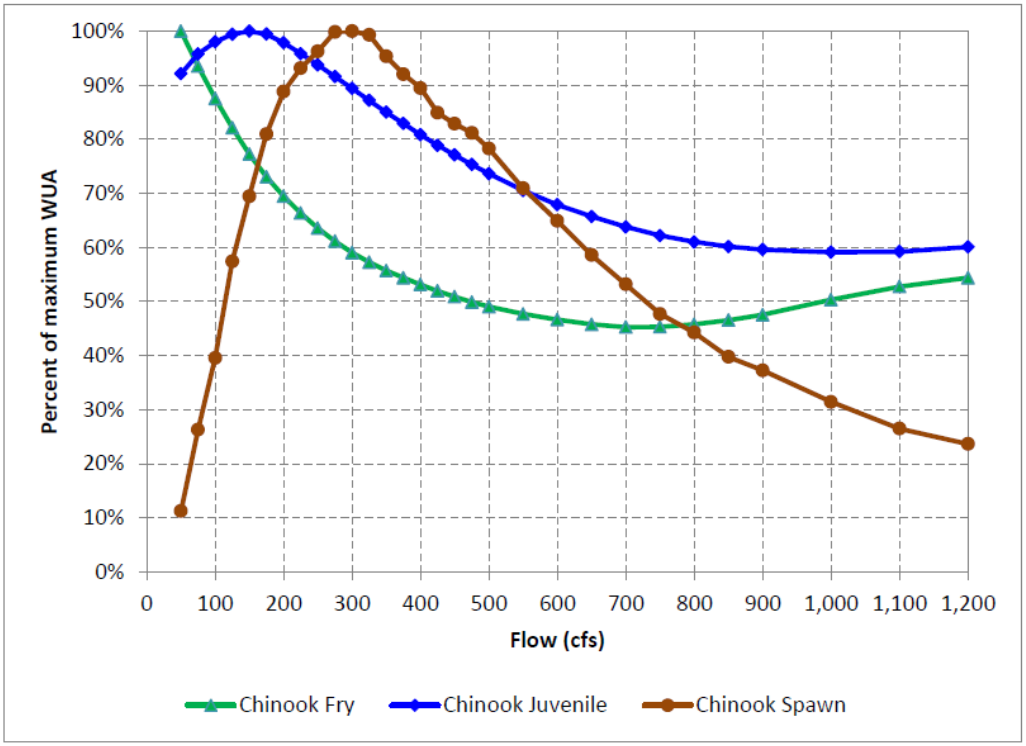

Figure 3.5-149. Chinook Salmon WUA results for the lower Tuolumne River (source: Stillwater Sciences 2013).

Late Summer Flows (July 1 – October 15)

The Districts are proposing to provide an instream flow of 350 cfs (as measured at the La Grange gage) upstream of RM 25.7 from July 1–October 15 of Wet, Above Normal, and Below Normal water year types to benefit *O. mykiss* juvenile rearing. During Dry and Critical water years, flow at the La Grange gage would be reduced to 300 cfs. Downstream of RM 25.5 (i.e., downstream of the infiltration galleries) instream flows during this period would be 150 cfs during Wet, Above Normal, and Below Normal water years and 75 cfs in Dry and Critical years.

During this period, the Districts would provide a flushing flow to clean gravels of accumulated algae and fines prior to the onset of substantial spawning. The Districts would provide an instream flow of 1,000 cfs (not to exceed 5,950 AF) on October 5, 6 and 7, with appropriate up and down ramps and IGs shut off. These flows would be provided in Wet, Above Normal, and Below Normal water years only. In Dry and Critical years, the flows at La Grange would continue to be 300 cfs, with withdrawals of 225 cfs at the IGs leaving 75 cfs in the river below RM 25.5.

By July, *O. mykiss* in the lower Tuolumne River consist predominantly of juvenile and adult life-stages. Juveniles are stronger swimmers than fry and can maintain position at higher flows. The primary habitat concern during this period is the maintenance of adequate water temperatures from just downstream of the La Grange Project to approximately RM 42. Wild *O. mykiss* juveniles tested as described in TID/MID (2016) had an optimum metabolic capacity between 21 and 22°C, and maintained 95 percent of peak aerobic capacity over a temperature range of 17.8°C to 24.6°C.

At a flow of 350 cfs, adult hydraulic habitat for *O. mykiss* in the lower Tuolumne River is 95 of maximum and juvenile hydraulic habitat is 90 percent of maximum (Figure 3.5-16). A flow of 350 cfs would maintain average daily water temperatures below 18°C at RM 43 until daily maximum air temperatures exceed 105°F (40.6°C) (Figure 3.5-17). During Dry and Critical years, flow at the La Grange gage would be reduced to 300 cfs, at which both juvenile and adult habitat is about 91 percent of maximum. Under these flows, average dailywater temperatures would be maintained below 19°C at RM 43 until daily maximum air temperatures exceed 100°F (38°C) (Figure 3.5-17).

Any over-summering juvenile fall-run Chinook would also benefit from these flows. IFIM study results (Stillwater Sciences, 2013) indicate that flows between 300 cfs and 350 cfs provide between 85 and 90 percent of the maximum WUA for juvenile Chinook in the lower Tuolumne River (Figure 3.5-19), and water temperatures would be well below mortality thresholds (see previous section). The TRCh (TID/MID 2017a, W&AR-06) identifies an initial mortality threshold of 25°C (77°F) for Chinook salmon juveniles as a daily average water temperature, which is based on information reviewed for Chinook salmon fry mortality (Brett 1952, Orsi 1971). A flow of 200 cfs upstream of RM 25.7, although selected for the benefit of *O. mykiss*, would also benefit fall-run Chinook salmon. Juvenile Chinook salmon are not expected to over-summer downstream of RM 25.5.

Fall-Run Chinook Spawning Flows (October 16 – December 31)

In early fall, Chinook salmon usually begin to enter the Tuolumne River. The Districts have maintained an adult counting weir at RM 24.5, near the downstream end of the gravel-bedded reach, since 2009. As indicated by Figure 3.5-8, the majority of adult fall-run Chinook enter the spawning reach above the counting weir after mid-October.

To provide habitat for fall-run Chinook spawning, the Districts propose to provide the following minimum instream flows for the October 16 – December 31 spawning period: 275 cfs (BN, AN, and W water years), 225 cfs (D water years), and 200 cfs (C water years). Most fall-run Chinook spawning in the lower Tuolumne River occurs from mid-October through mid-December (TID/MID 2013i, W&AR-08; FISHBIO 2017).

IFIM study results (Stillwater Sciences 2013) indicate that flows of 275 cfs, 225 cfs, and 200 cfs provide 100, 93, and 89 percent, respectively, of the maximum WUA for Chinook spawning in the lower Tuolumne River (Figure 3.5-19). Although studies of spawning habitat indicate sufficient spawning gravels to accommodate between about 50,000 and 60,000 fall-run Chinook between RM 52 and RM 23 (TID/MID 2013j, W&AR-04), improvements provided by gravel mobilizing flows (6,000-7,000 cfs) and the non-flow measures described previously would increase the quality and abundance of spawning gravels in the primary spawning reach located upstream of RM 45, thereby further reducing the rate of superimposition of Chinook redds.

At a flow of 275 cfs, adult *O. mykiss* habitat is 90 percent of maximum, and juvenile habitat is 95 percent of maximum (Figure 3.5-16). At a flow of 225 cfs, adult *O. mykiss* habitat is 84 percent of maximum, and juvenile habitat is 98 percent of maximum (Figure 3.5-16). At a flow of 200 cfs, adult *O. mykiss* habitat is 80 percent of maximum, and juvenile habitat is 99 percent of maximum (Figure 3.5-16).

At 275 cfs, average daily water temperatures at RM 43 would be less than 14.5°C until daily maximum air temperatures exceed 75°F, which is estimated to occur about one day in November on average (see Figures 3.5-17 and 3.5-18). Average daily water temperatures would generally remain below 14°C in December throughout the entire gravel-bedded reach of the lower Tuolumne River.

Fall-Run Chinook Fry Rearing (January 1 – February 28/29)

To provide habitat for fall-run Chinook fry rearing, the Districts propose to provide the following minimum instream flows for the period of January 1–February 28/29: (1) 225 cfs (BN, AN, and W water years), (2) 200 cfs (D water years), and 175 cfs (C water years).

Many Chinook salmon leave the upper reaches of the lower Tuolumne River as fry (TID/MID 2013h, W&AR-05), and fry that migrate out of the Tuolumne River basin account for only a small percentage (< 5 percent) of the adult Chinook escapement (TID/MID 2016, W&AR-11). IFIM study results (Stillwater Sciences 2013) indicate that maximum fry WUA occurs at 50 cfs (Figure 3.5-19). At 100 cfs, Chinook salmon fry WUA is 88 percent of maximum, at 150 cfs it is 76 percent of maximum, and at 225 cfs it is about 67 percent of maximum. Also, higher flows during early fry rearing (i.e., January–February) tend to promote downstream movement of fry, potentially into areas with higher densities of predatory fish species (TID/MID 2013h, 2017a).

Although the proposed flows would not maximize fry-rearing WUA, fry-rearing habitat is not limiting the Chinook population in the lower Tuolumne River. As shown in Figure 3.5-20, in-channel fry rearing capacity exceeds 13 million fry at lower river flows less than 200 cfs. Also, higher flows during early fry rearing (i.e., January–February) tend to promote downstream movement of fry, potentially into areas with higher densities of predatory fish species (TID/MID 2013h, 2017a), and fry that migrate out of the Tuolumne River basin account for only a small percentage (< 5 percent) of the adult Chinook escapement (TID/MID 2016, W&AR-11). Moreover, there appears to be little benefit in attempting to provide floodplain habitat for Chinook fry rearing in the Tuolumne River. Based on the results of the Floodplain Hydraulic Analysis study (TID/MID 2017b, W&AR-21), river flows exceeding 4,000 cfs would be required to provide the same level of in-channel plus floodplain juvenile rearing habitat as that provided by in-channel habitat alone at flows of 100 to 200 cfs (Figure 3.5-20).

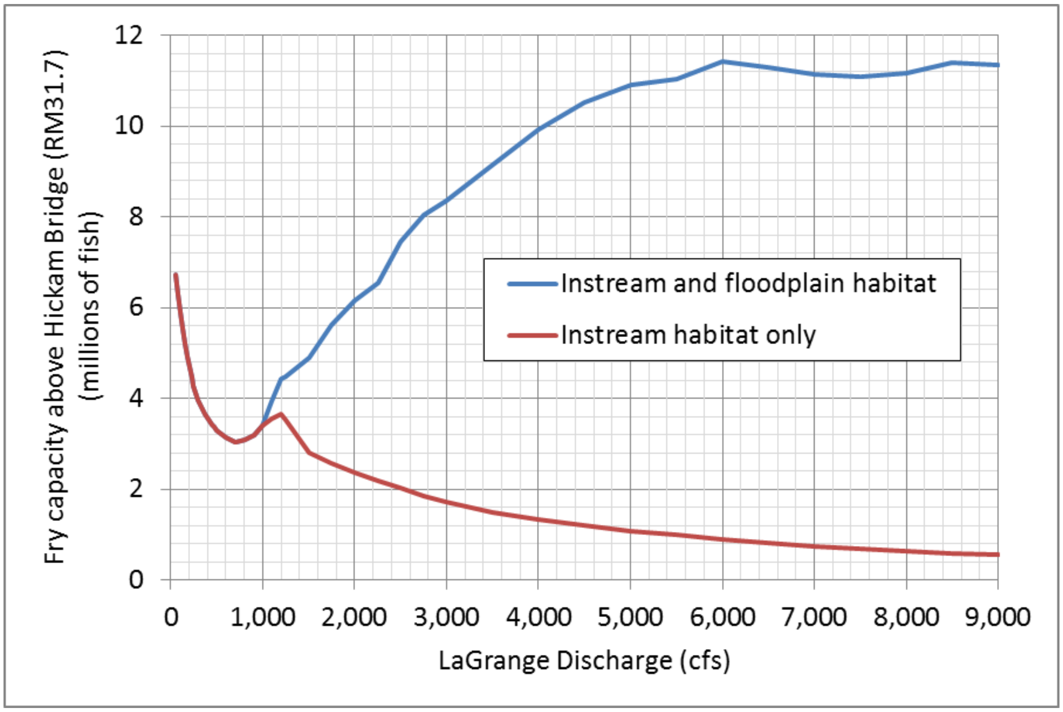

Figure 3.5-20. Chinook fry capacity (millions of fish) in the lower Tuolumne River for both in-channel and floodplain rearing above RM 31.7.

It is also important that flows do not decline substantially following the spawning period (see previous section), which would result in the dewatering of established Chinook redds. The flows identified here represent a balance between protecting Chinook redds while still providing substantial Chinook fry rearing habitat. The mean pot depth of Chinook redds during the 2012 redd survey was 1.8 feet, and the minimum observed depth to date is 0.9 feet (TID/MID 2013i, W&AR-08) (Figure 3.5-21). Based on the rating curve for the USGS gage at La Grange, the change in flow from 275 cfs (i.e., spawning flow in BN, AN, and W water years) to 225 cfs (i.e., fry rearing flow in BN, AN, and W water years) would result in a 0.4-ft stage change, and from 225 cfs (spawning in D water years) to 200 cfs (rearing in D water years) a 0.2 ft stage change (Figure 3.5-22).

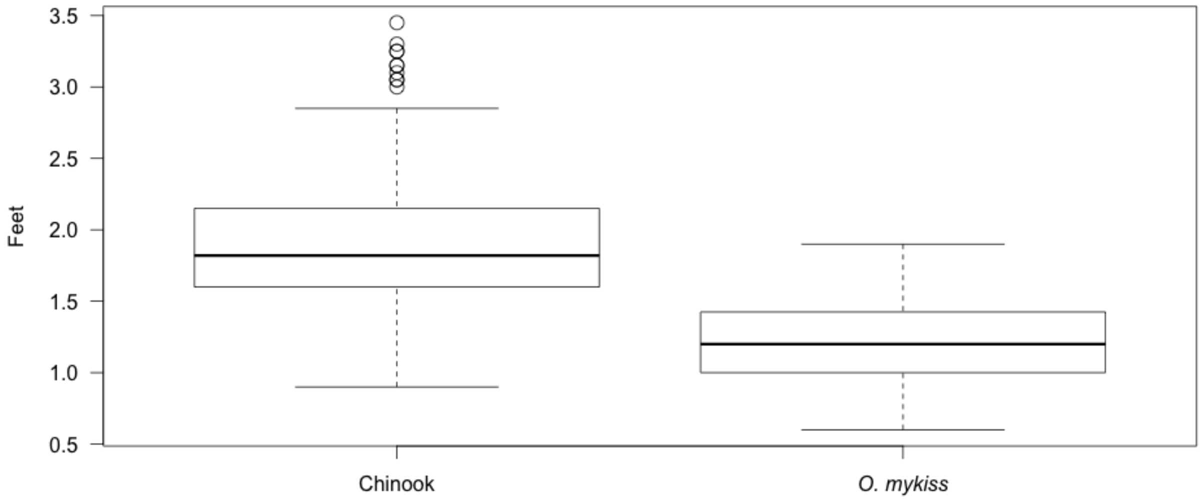

Figure 3.5-21. Boxplots of pot depths measured in Chinook salmon and *O. mykiss* redds surveyed on the lower Tuolumne River during 2012/2013 (source: TID/MID 2013i, W&AR-08).

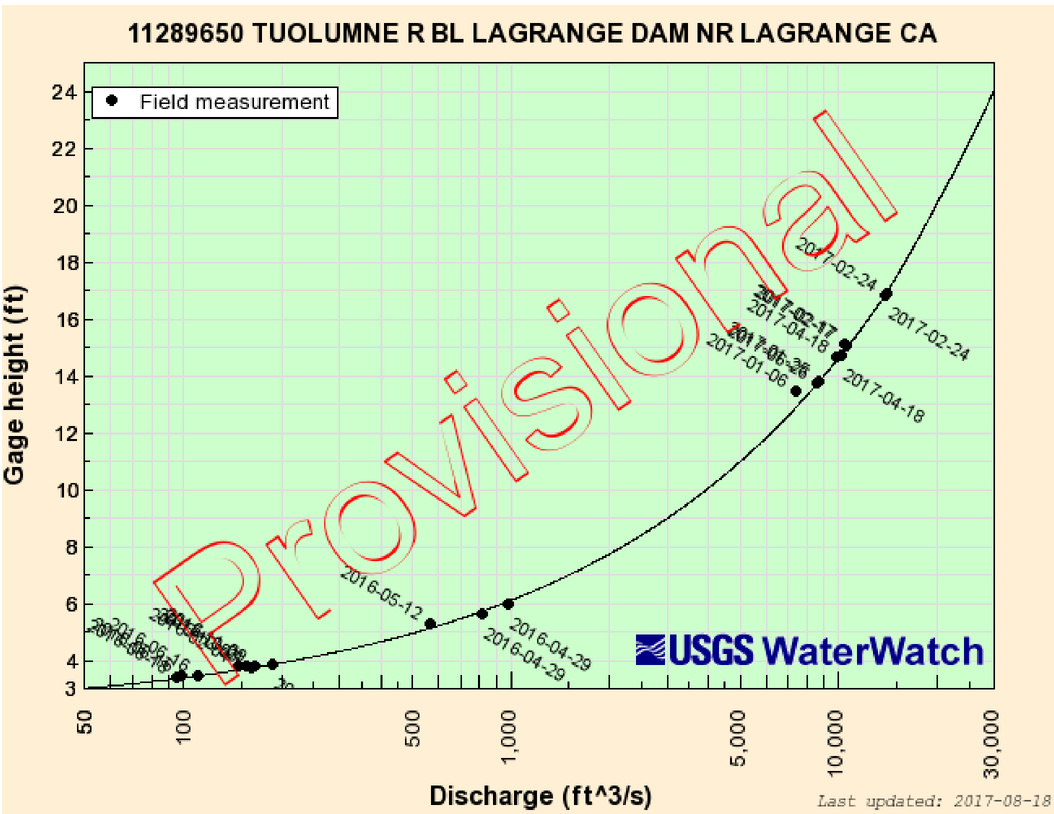

Figure 3.5-22. Stage-discharge rating curve of the USGS Tuolumne River at La Grange gage.[46]

[46] High flows occurring in 2017 may require adjustment to the rating curve. The control section at the gage has remained stable over previous high-flow periods. Minor adjustments to the rating curve have occurred from time to time.

At a flow of 225 cfs, *O. mykiss* spawning habitat is 82 percent of maximum, adult *O. mykiss* habitat is 84 of maximum, and juvenile habitat is 98 percent of maximum (Figure 3.5-16). At a flow of 200 cfs, *O. mykiss* spawning habitat is 78 percent of maximum, adult *O. mykiss* habitat is 80 of maximum, and juvenile habitat is 99 percent of maximum (Figure 3.5-16). At a flow of 175 cfs, *O. mykiss* spawning habitat is 73 percent of maximum, adult *O. mykiss* habitat is 77 of maximum, and juvenile habitat is 100 percent of maximum (Figure 3.5-16).

Fall-run Chinook Juvenile Rearing (March 1 – April 15)

In the lower Tuolumne River, juveniles constitute the predominant Chinook life-stage from March through mid-April, with many fish reaching parr-size (50-64 mm) by mid-March (FISHBIO 2015a, 2015b, 2016). To provide habitat for Chinook juvenile rearing, the Districts propose to provide the following minimum instream flows for the period of March 1–April 15: (1) 250 cfs (BN, AN, and W water years), (2) 225 cfs (D water years), and 200 cfs (C water years).

IFIM study results (Stillwater Sciences 2013) indicate that WUA for fall-run Chinook juvenile rearing is maximized at 150 cfs and exceeds 97 percent of maximum at flows from 100 to 200 cfs (Figure 3.5-19). At 300 cfs, WUA declines to 90 percent of maximum (Figure 3.5-19). The flows proposed by the Districts would provide 90 and 97 percent of the maximum available WUA, which would have a beneficial effect on rearing juvenile fall-run Chinook in the lower river. As shown in Figure 3.5-23, in-channel juvenile rearing habitat is not a limiting factor for fall-run Chinook salmon in the Tuolumne River. At a flow of 250 cfs, in-channel rearing habitat supports 3 million juvenile fall-run Chinook salmon. When considering floodplain rearing habitat, a flow of 2,300 cfs is required to produce the same level of rearing habitat. Using a minimum time period of floodplain inundation of 14 days to be considered effective rearing habitat (Matella and Merenlender 2015), a flow of 7,000 ac-ft produces the same rearing habitat as a flow of 64,000 ac-ft.[47] Nevertheless, in W and AN water years, which in the 1971 to 2012 period occurred about 50 percent of the time, flows at the La Grange gage would frequently exceed minimum flows, and provide floodplain access for juvenile fall-run Chinook. Under the Proposed Action, flows of at least 3,000 cfs for 14 consecutive days in the February through June period would occur in 17 of the 42-year 1971-2012 period.

At 250 cfs, average daily water temperatures would remain below 18°C at RM 39.5 until maximum daily air temperatures exceed about 80°F (Figure 3.5-24), which occurs on average between three and four days in April (Figure 3.5-18), and would remain below 20°C at RM 39.5 until maximum daily air temperature exceeds 85°F (Figure 3.5-24), which occurs about one day in April on average (Figure 3.5-18).

[47] That is, 250 cfs for 14 days = 7,000 ac-ft and 2,300 cfs for 14 days = 64,000 ac-ft.

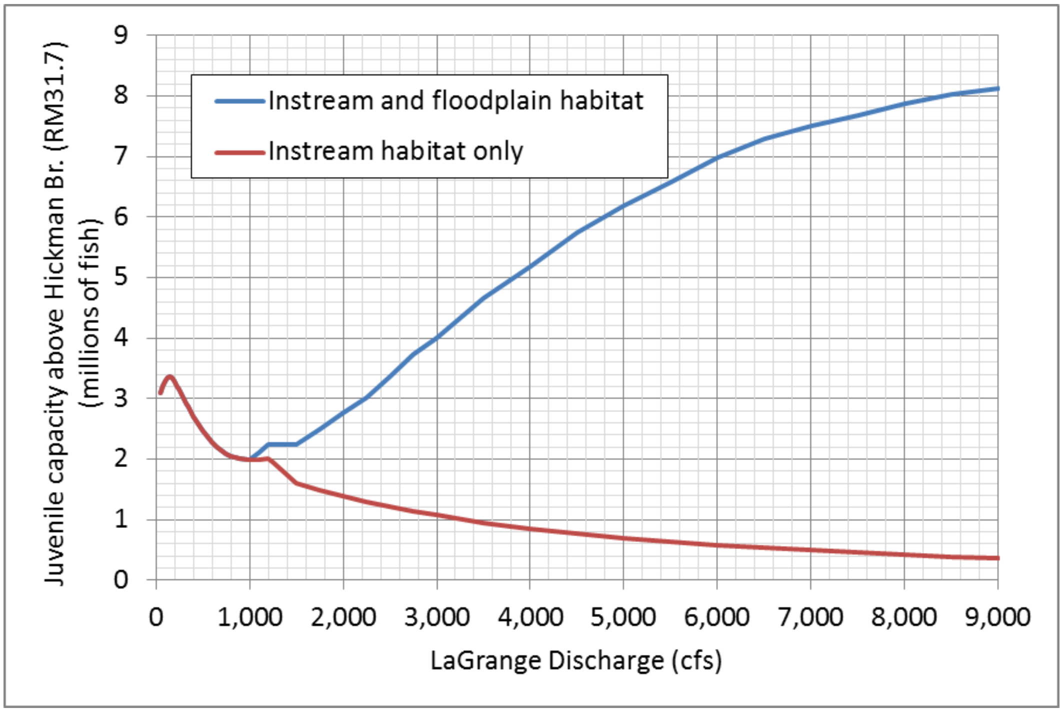

Figure 3.5-23. Juvenile Chinook capacity (millions of fish) in the lower Tuolumne River for both in-channel and floodplain rearing, above RM 31.7.

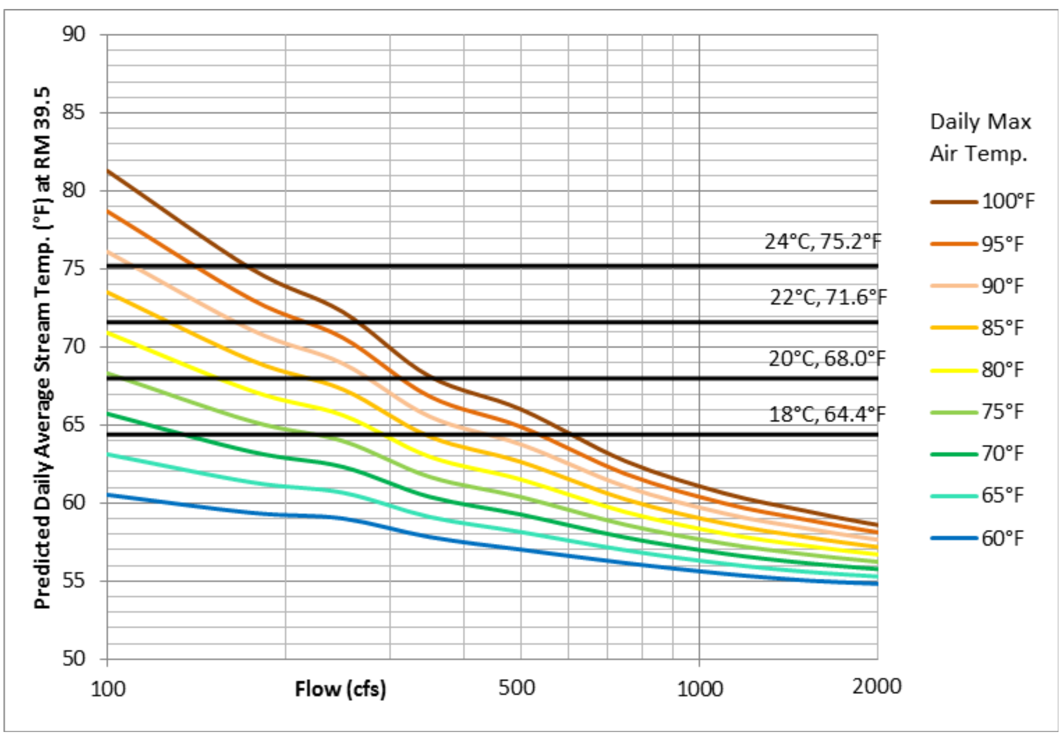

Figure 3.5-24. RM 39.5 daily average water temperatures versus flow and maximum air temperatures.

At a flow of 250 cfs, *O. mykiss* spawning habitat is 85 percent of maximum, adult *O. mykiss* habitat is 88 of maximum, juvenile habitat is 97 percent of maximum, and fry habitat is 67 percent of maximum (Figure 3.5-16). At a flow of 225 cfs, *O. mykiss* spawning habitat is 82 percent of maximum, adult *O. mykiss* habitat is 84 of maximum, juvenile habitat is 98 percent of maximum, and fry habitat is 69 percent of maximum (Figure 3.5-16). At a flow of 200 cfs, *O. mykiss* spawning habitat is 78 percent of maximum, adult *O. mykiss* habitat is 80 of maximum, juvenile habitat is 99 percent of maximum, and fry habitat is 70 percent of maximum (Figure 3.5-16).

Outmigration Base Flows (April 16 – May 15)

The Districts propose to provide the following outmigration baseflows for the period of April 16–May 15: (1) 275 cfs (BN, AN, and W water years), (2) 250 cfs (D water years), and 200 cfs (C water years). These baseflows could be augmented by outmigration pulse flows, depending on the timing of pulse flows, as explained below.

Fall-run Chinook salmon leaving the Tuolumne River as large parr or smolts display a much greater adult return rate (nearly a 20:1 ratio based on outmigration years 1998-2000, 2003, 2009; TID/MID 2016, W&AR-11) than those leaving as fry (TID/MID 2016, W&AR-11), so providing favorable growth conditions through smoltification is beneficial. Increasing base flows above those in the March 1–April 15 period would maintain favorable water temperatures during the mid-April through mid-May period, which is expected to benefit smolts. Water temperature modeling shows that at RM 43, a flow of 275 cfs would maintain average daily water temperatures at less than 20°C, even at maximum daily ambient air temperatures that exceed 100°F (38°C) (Figure 3.5-17). At RM 43, a flow of 275 cfs would maintain average daily water temperatures below 15°C until maximum daily air temperatures exceed 80°F (Figure 3.5-17), which, on average, occurs about three to four days in April and 15 in May (Figure 3.5-18). At RM 39.5, a flow of 275 cfs would maintain average daily water temperatures below 21°C until maximum daily air temperatures exceed 95°F (35°C) (Figure 3.5-24), which occurs on average about two days in May (Figure 3.5-18). At RM 39.5, a flow of 225 cfs would maintain average daily water temperatures below 21°C until maximum air temperatures exceed 95°F (32°C) (Figure 3.5-24), which occurs on average about two days in May (Figure 3.5-18). As explained below, these base flows could be augmented by outmigration pulse flows, depending on the timing of pulse flows, which would further reduce water temperatures at a given location and extend the plume of colder water farther downstream.

These flows represent a balance between facilitating fall-run Chinook outmigration and maintaining adult and juvenile *O. mykiss* habitat at substantial levels and fry habitat at moderate levels. At a flow of 275 cfs, adult *O. mykiss* habitat is 90 percent of maximum, juvenile habitat is 95 percent of maximum, and fry habitat is 65 percent of maximum (Figure 3.5-16). At a flow of 250 cfs, adult *O. mykiss* habitat is 88 of maximum, juvenile habitat is 97 percent of maximum, and fry habitat is 68 percent of maximum (Figure 3.5-16). At a flow of 200 cfs, adult *O. mykiss* habitat is 80 of maximum, juvenile habitat is 99 percent of maximum, and fry habitat is 70 percent of maximum (Figure 3.5-16).

Outmigration Base Flows (May 16 – May 31)

Although during most years juvenile fall-run Chinook salmon have left the Tuolumne River by mid-May (Figure 3.5-15), in some years there are still parr and smolts in the river beyond May 15. To maintain lower water temperatures during this period, the Districts are proposing the following base-flow releases: (1) 300 cfs (BN, AN, and W water years), (2) 275 cfs (D water years), and 225 cfs (C water years). These base flows could be augmented by outmigration pulse flows, as explained below.

Outmigration Pulse Flows (April 16 – May 31)

Data collected since 2008 from the Districts' rotary screw traps suggest that fish identified as fall-run Chinook smolts are generally above 65 mm in size (Robichaud and English 2013 and 2017; Sonke 2017). To encourage smolt outmigration and increase survival, pulse flows would be provided to coincide with periods when large numbers of parr- or smolt-size fish are occurring in the river. Active monitoring of spawn timing and river temperatures, supplemented by data from snorkel surveys or seining, will be used to track juvenile size and identify the best timing for spring pulse flow releases. The available pulse flow volumes will be substantially increased over baseline levels, except in the second (and subsequent to the second) Dry and Critical water year. The Districts are proposing to allocate the following volumes of water for pulse flow releases: 150,000 ac-ft (AN and W water years), 100,000 ac-ft (BN water years), 75,000 ac-ft (D water years), 45,000 ac-ft (sequential D water years), 35,000 ac-ft (initial C water year), and 11,000 ac-ft (sequential C water years).[48]

The pulse flow volume would continue to be determined as it is under the current license; but using five water year types instead of 10 to reduce the frequency of the need for "interpolation water." Since 1997, there has been "interpolation water" available in 11 of 18 years[49]. Under the pulse flow schedule identified above, "interpolation water" would have been needed in only five of the 18 years (1997-2015) according to the Districts' Operations Model. Reducing the number of years in which "interpolation water" would occur increases the amount of water dedicated to spring outmigration pulse flows.

Rotary screw-trap data would continue to be used to estimate smolt survival in response to pulse flows. Timing pulse flows to coincide with periods when large numbers of juvenile Chinook are ready to outmigrate, combined with spawning gravel improvements, habitat improvements, and predator control measures, is expected to significantly improve Tuolumne River outmigration rates (see Appendix E-1).

[48] This reduced pulse flow, while still greater than or equal to Base Case pulse flows, would also occur in a sequence of "D" and "C" years. For example, in a sequence of the years C, D, C, D, C, D, the second and third "critical" years and the second and third "dry" years would each have pulse flows of 11 TAF and 45 TAF, respectively.

[49] Article 37 of the existing Project license (FERC 2006) requires that between a Median Critical Water Year and an Intermediate Below Normal-Above Normal Water Year, the precise volume of flow to be released each fish flow year is to be determined using accepted methods of interpolation between index values.

Flow Hydrograph Shaping

In spill years, the Districts would make reasonable efforts to shape the descending limb of the snowmelt runoff hydrograph to mimic natural conditions. Floodplain inundation along the lower Tuolumne River is initiated at a flow of approximately 1,100 cfs. Based on flows in the 1971–2012 period, the Proposed Action would result in flows at the La Grange gage greater than 1,500 cfs from February through July in 28 years (or more than 60 percent of the years). Flows exceeding 2,500 cfs would occur in 45 percent of the years in that period.

If spill conditions allow, streamflow recession rates would be managed during the cottonwood seed dispersal period to provide soil moisture conditions that allow seeds to take up water, germinate, and form roots. All flows released to promote seed dispersal and germination would also be based on the need to minimize water supply impacts. Riparian recruitment streamflows timed to coincide with cottonwood seed dispersal would also benefit tree willows. Increasing natural recruitment of snowmelt-dependent hardwoods would increase stands of trees that could contribute large wood to the channel over the long-term and provide cover and shade for aquatic species.

Flows to Enhance Recreational Boating

The Districts would release the flows described below to enhance conditions for canoeing and kayaking on the lower Tuolumne River. The flow releases are based on the assumption that the lower river boating season extends from April 1 to October 31. The results of Districts' Lowest Boatable Flow Study (TID/MID/2013, RR-03) show that flows above 175 cfs on the lower Tuolumne River are considered boatable by non-motorized craft.

From April 1–May 31 of all water years, a flow of 200 cfs or greater would be provided at the LaGrange gauge. During this time, the infiltration galleries would be either be shut off, or additional flows to be withdrawn for water supply purposes would be released to the La Grange gage. Provision of these flows would be a byproduct of the flows provided for the benefit of aquatic resources, so no incremental effects would occur beyond those described in the preceding sections.

From June 1–June 30, a flow of 200 cfs would be provided in all water years at the La Grange gage. Provision of this flow would be a byproduct of that provided for the benefit of aquatic resources, so no incremental effects would occur beyond those described above in the preceding sections. In Wet, Above Normal, and Below Normal water years, withdrawal of water at the infiltration galleries (described above) would cease for one pre-scheduled weekend in June to provide an additional 100 cfs (for a total of 200 cfs) downstream of RM 25.5. This short-duration incremental flow in the sand-bedded reach of the lower river would have no significant effects on fall-run Chinook or *O. mykiss*. No juvenile (see Figure 3.5-15) or adult Chinook would be expected to occur downstream of RM 25.5 during the June 1–June 30 timeframe.

From July 1–October 15, a flow of 350 cfs in Wet, Above Normal, and Below Normal water years and 300 cfs in Dry and Critical water years would be provided at the La Grange gage. Provision of these flows would be a byproduct of those provided for the benefit of aquatic resources, so no incremental effects would occur beyond those described above in the preceding sections. In all but Critical water years, the Districts would provide a flow of 200 cfs below RM 25.5 for the three-day July 4 holiday, the three-day Labor Day holiday, and for two pre-scheduled additional weekends in either July or August. In Wet, Above Normal, and Below Normal water years this would represent an incremental increase of 50 cfs downstream of RM 25.5 (over the background of 150 cfs), and in Dry water years this would represent an incremental increase of 125 cfs (over the background of 75 cfs). In both cases, these short-duration incremental flows in the sand-bedded reach of the lower river would have no significant effects on fall-run Chinook or *O. mykiss*. No juvenile fall-run Chinook would be expected to occur downstream of RM 25.5 during the July 1–October 15 timeframe (see Figure 3.5-15). Fall-run Chinook adults migrate upstream from late August through December, with peak migration in November, so individuals would be present in the Tuolumne River downstream of RM 25.5 during July 1–October 15. However, these adult fish can negotiate a wide range of hydraulic conditions and would not be adversely affected by small shifts in flow brought about by occasionally providing recreational boating flows downstream of RM 25.5 during July 1–October 15. Flow increases associated with shutting off the infiltration galleries would effectively constitute a low-magnitude pulsed flow (i.e., an enhancement measure often recommended by fisheries agencies).

3.5.5.1 Unavoidable Adverse Impacts

There are no unavoidable adverse impacts associated with the Proposed Action, i.e., the continuation of hydroelectric power generation and the implementation of the measures described above, on fish and aquatic resources in the lower Tuolumne River.

3.6 Botanical Resources

California supports a variety of botanical resources, including vegetation communities and individual species that provide regional biodiversity, wildlife habitats, and other services. The Don Pedro Project is located in the central Sierra Nevada Foothills geographic subregion of California (Jepson Flora Project 2013) and the Central Valley and South Sierra CalVeg vegetation mapping zones (USFS 2009). The local climate is characterized by hot, dry summers, and limited annual rainfall (under 20 inches of precipitation annually [Western Regional Climate Center 2013]).

The current Project Boundary encompasses over 5,538 ac of terrestrial habitats, dominated by blue oak woodlands and open annual grass-forb vegetation, and substantial components of shrub-dominated chaparral. Wetland and riparian habitats are uncommon; the bulk of Don Pedro Reservoir shoreline is steep-sided, with upland plant communities adjacent to the reservoir margin. Areas below the normal maximum surface elevation that are periodically exposed are sparsely vegetated or bare. The majority of terrestrial habitats within the Project Boundary are unmanaged and geographically removed from any Project activity. Routine maintenance activities, including vegetation management and noxious weed control efforts, are restricted to facilities and the Districts' three recreation areas.

The PAD compiled and presented existing information regarding botanical resources in the Don Pedro Project vicinity. Additionally, the Districts' consultation with stakeholders resulted in the development and implementation of a suite of botanical resource studies that address each of the botanical resource issues identified during consultation and in FERC's SD2. Existing information and the results of the botanical resource studies are presented below, including descriptions of the existing environment, including: (1) vegetation types within the Project Boundary; (2) special-status plants; (3) wetland and littoral habitats; and (4) noxious weeds.

3.6.1 Existing Environment

3.6.1.1 Vegetation Type Distribution and Abundance

In 2011, vegetation within the Project Boundary was characterized using existing vegetation mapping and classifications from the USFS' CalVeg mapping and data system (USFS 2009). Vegetation types (CalVeg "alliances") within the Project Boundary were mapped and quantified using GIS software. The Don Pedro Project falls within two CalVeg mapping zones, Central Valley and South Sierra. Within these, the Project Boundary is dominated by three vegetation alliances: Blue Oak, Chamise, and Annual Grasses and Forbs. There are also large areas of Gray Pine, and smaller inclusions of Lower Montane Mixed Chaparral and Interior Live Oak (Table 3.6-1).

Table 3.6-1. CalVeg vegetation alliances, zones and acres mapped within the Project Boundary.

CalVeg Zone	CalVeg Alliances	Total Acres in Project Boundary
South Sierra	Canyon Live Oak	0.2
	Interior Live Oak	10.8
	Annual Grasses and Forbs	3.8
Central Valley	Douglas Fir- Pine	5.2
	Gray Pine	447.5
	Riparian Mixed Hardwood	0.6
	Blue Oak	3,326.9
	Interior Live Oak	166.9
	Chamise	542.2
	Lower Montane Mixed Chaparral	277.0
	Annual Grasses and Forbs	2,276.7
	Barren/Rock	549.7

The majority of the Project Boundary is dominated by the Blue Oak and Annual Grasses and Forbs alliances (i.e., open habitats dominated by non-native grasses). However, lands near Willow Creek Arm, Hatch Creek Arm, and Don Pedro Bar support dense stands of the Chamise alliance, a chaparral shrub alliance dominated by a single species. The Tuolumne Arm and Wood's Creek Arm support a mixture of alliances, including Lower Montane Mixed Chaparral, Chamise, Interior Live Oak, Gray Pine, Annual Grasses and Forbs and a few small areas of Riparian Mixed Hardwoods.

Vegetation alliance descriptions from the CalVeg mapping system (USFS 2009) are presented below.

Canyon Live Oak Alliance - Canyon live oak (*Quercus chrysolepis*) as a dominant species has been frequently mapped in scattered stands in the foothills at elevations below about 6,400 feet. Its main conifer associates include Douglas fir (*Pseudotsuga menziesii*), ponderosa pine (*Pinus ponderosa*) and gray pine (*Pinus sabiniana*). Interior live oak (*Quercus wislizeni*), wedgeleaf ceanothus (*Ceanothus cuneatus*) and annual grasses are also likely to be found within and adjacent to these stands.

Interior Live Oak Alliance - The Interior Live Oak alliance occurs throughout the Central Valley on recent alluvial terraces, older terraces and rolling hills. It is in semi- open or closed stands and may associate with the Canyon Live Oak alliance at the higher elevations of this alliance's range. Gray pine and blue oak (*Quercus douglasii*) are associated species. This alliance is generally found below about 4,400 feet and is often located at higher elevations than the Blue Oak alliance (range up to about 3,900 feet).

Annual Grasses and Forbs Alliance - Annual grasslands are the most commonly encountered plant community of the Central Valley Ecological Province, generally occurring between urban/agricultural developments and the foothill woodlands. Dominant species in this alliance include ripgut brome (*Bromus diandrus*), Italian ryegrass (*Lolium multiflorum*), soft chess (*Bromus hordeaceus*), wild oats (*Avena barbata*), and silver hairgrass (*Aira carophyllea*). The invasive Bermudagrass (*Cynodon dactylon*) is common in this alliance. Vernal pools (small depressions often containing hardpan soil layers and ephemeral ponding) occur throughout the Annual Grasses and Forbs alliance. Species common to vernal pools include downingia (*Downingia* spp.), meadowfoam (*Limnanthes douglasii*), goldfields (*Lasthenia chrysostoma*), water atarwart (*Callitriche marginata*), popcorn flower (*Plagiobothrys* spp.), Johnny-tuck (*Orthocarpus erianthus*), bur medic (*Medicago hispida*), and linanthus (*Linanthus* spp.).

Douglas Fir-Pine Alliance - This alliance is a mixture of Douglas fir and ponderosa pine that usually occur on moderately steep slopes below an elevation of about 5,200 feet. Canyon live oak, interior live oak, and blue oak are common hardwood associates. Shrubs in low to mid montane environments are also likely to be associated with these stands, such as whiteleaf manzanita (*Arctostaphylos viscida*).

Gray Pine Alliance - Gray pine forms prominent open or sparse stands throughout the lower elevations of the foothills east and west of the Sacramento Valley (Central Valley Ecological Province). In the Project Boundary, these diverse stands occur mainly with blue oak and interior live oak. Shrubs associated with this alliance include chamise (*Adenostoma fasciculatum*), wedgeleaf ceanothus, whiteleaf manzanita, and birchleaf mountain mahogany (*Cercocarpos betuloides*). In the southern Sierra foothills, mixed stands of gray pine and canyon live oak in this alliance have been mapped in the elevation range of about 4,200 to 4,600 feet, but the pine has been mapped as low as 100 feet.

Interior Mixed Hardwood Alliance - No single species is dominant in the Interior Mixed Hardwood alliance. It has been identified in scattered pockets in the valley and more abundantly in the foothills. The density of blue oak and interior live oak usually exceeds that of black oak in this mixture. Minor amounts of California buckeye (*Aesculus californica*), California bay (*Umbellularia californica*), and coast live oak (*Quercus agrifolia*) may also be part of this alliance. Because this alliance has been mapped mainly at elevations below about 5,000 feet, it is likely to have inclusions of low-elevation chaparral species such as wedgeleaf ceanothus, scrub oaks (*Quercus* spp.), and chamise.

Blue Oak Alliance - This alliance is dominated by blue oak, which naturally occurs in an oak-grass association on well drained, gentle slopes. Blue oak and gray pine are the major trees in this hillside alliance. Blue oak may be the only hardwood species, although interior live oak, valley oak (*Quercus lobata*) and/or California buckeye may also be present. Shrubs such as wedgeleaf ceanothus, manzanitas (*Arctostaphylos* spp.), coffeeberry (*Rhamnus* spp.), birchleaf mountain mahogany and poison oak (*Toxicodendron diversilobum*) are also part of this alliance. The understory of the Blue Oak alliance is dominated by annual grasses such as wild oats and cheatgrass (*Bromus* spp.). This alliance generally occurs below about 3,900 feet.

Chamise Alliance - Relatively pure stands of chamise occupy xeric sites at elevations up to about 4,000 feet and often occupy upper ridge slope positions. Other chaparral shrub species such as wedgeleaf ceanothus, whiteleaf manzanita and birchleaf mountain mahogany are often occur in this alliance. Scattered gray pine and interior live oak are found in this alliance.

Lower Montane Mixed Chaparral Alliance - This alliance is a mixture of low- elevation chaparral species such as whiteleaf manzanita, wedgeleaf ceanothus, chamise, birchleaf mountain mahogany and other shrub species. No single species is dominant in the mixture. In general, this alliance is mapped between elevations of about 1,300 to 5,200 feet.

3.6.1.2 Special-Status Plants

In 2012, botanical surveys were conducted targeting special-status plants within the Project Boundary. Prior to the surveys, the California Native Plant Society (CNPS) database (CNPS 2012) was reviewed for special-status plant species occurring within the nine USGS quadrangle maps on which the Project Boundary is located. Additionally, a query of CDFW's California Natural Diversity Database (CNDDB) Rarefind 4 (CDFG 2012) identified 31 plant species that are considered special-status and have a reasonable potential to occur in the Project Boundary. For the purposes of the study, species that were considered special-status were those meeting one or more of the following criteria:

- Found on public land administered by the BLM and formally listed by the BLM-S.
- Listed under the ESA as Proposed or a Candidate for listing as endangered or threatened or proposed for delisting.
- Listed under the State of CESA as proposed for listing.
- Found on the CDFG list of California Rare (SR) species listed under the Native Species Plant Protection Act of 1977.
- Found on the CNPS Inventory of Rare Plants and formally listed as a CNPS 1, 2, or 3 plants (CNPS 1, CNPS 2, CNPS 3).

Plants listed under the federal ESA or the CESA – even if they are also considered BLM-S, CNPS 1, CNPS 2 or CNPS 3 – are considered separately, in Section 3.8 – Threatened and Endangered Species.

Survey protocols were developed in consultation with relicensing participants and were consistent with the botanical survey protocol section of CDFW's *Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Natural Communities* (CDFG 2009). Prior to field work, nearby reference occurrences of special-status plants were visited, and herbarium records from the Consortium of California Herbaria were used to help determine blooming periods. Field surveys were floristic in nature (i.e., all vascular plant species were identified). A random meander technique was employed, with additional focus in high quality habitat or other areas with a higher probability of supporting special-status plants.

Field studies were performed in portions of the Project Boundary where there was potential for effects, including all Don Pedro Project facilities, recreation areas, and high-use dispersed recreation areas as identified during study plan consultation. The study area extended outside of the Project Boundary as needed to survey the full extent of plant occurrences, up to 300 ft outside the Project Boundary within high-use recreation areas or the BLM's Red Hills ACEC, and, where necessary to document the full extent of each special-status plant occurrence, up to 0.25 mi outside the Project Boundary. The study area included in surveys consisted of approximately 3,870 ac.

Surveys located a total of 86 occurrences (either a single plant or a distinct geographic collection of plants) of eight different special-status plants, all listed as BLM-S (BLM 2012): 58 occurrences were on public land administered by the BLM and 28 occurrences were on private land owned by the Districts. Table 3.6-2 summarizes the 85 special-status plant occurrences by land ownership.

The most abundant special-status plants were Mariposa clarkia (*Clarkia biloba* ssp. *australis*) (25 occurrences), Red Hills soaproot (*Chlorogalum grandiflorum*) (20 occurrences), and Mariposa cryptantha (*Cryptantha mariposae*) (10 occurrences). In addition, a number of serpentine-adapted species were found in the Red Hills ACEC, including Red Hills onion (*Allium tuolumnense*) (10 occurrences), Congdon's lomatium (*Lomatium congdonii*) (seven occurrences), shaggy-haired lupine (*Lupinus spectabilis*) (seven occurrences), tripod buckwheat (*Eriogonum tripodum*) (four occurrences), and Red Hills ragwort (*Packaera clevelandii*) (two occurrences).

Table 3.6-2. Special-status plant species found in the study area, with status and land ownership.

Common Name/Scientific Name	Status[1]	No. of Occurrences by Land Owner	
		Public (BLM)	TID/MID
Red Hills onion *Allium tuolumnense*	BLM-S, CNPS 1B	10	--
Red Hills soaproot *Chlorogalum grandiflorum*	BLM-S, CNPS 1B	20	--
Mariposa clarkia *Clarkia biloba* ssp. *australis*	BLM-S, CNPS 1B	2	23
Mariposa cryptantha *Cryptantha mariposae*	BLM-S, CNPS 1B	10	1[2]
Tripod buckwheat *Eriogonum tripodum*	BLM-S	4	--
Congdon's lomatium *Lomatium congdonii*	BLM-S, CNPS 1B	7	--
Shaggyhair lupine *Lupinus spectabilis*	BLM-S, CNPS 1B	4	3
Red Hills ragwort *Packera clevelandii*	BLM-S, CNPS 1B	1	1
	Total Occurrences	**58**	**28**

[1] Special-status:
BLM-S = Bureau of Land Management Sensitive Plant Species.
CNPS 1B = California Native Plant Society list endangered in California and elsewhere.
[2] Occurrence is primarily on public lands but crosses into TID/MID lands.

Red Hills Onion

Ten occurrences of Red Hills onion were documented within the study area, all on public land administered by the BLM. Six occurrences were at Sixbit Gulch, two at Kanaka Point, one near Moccasin Point Recreation Area and one at Poor Man's Gulch for a total of over 700 individuals over a combined area of approximately 0.3 ac. Two potential disturbances were associated with Red Hills onion: noxious weeds and grazing. In addition, small parts of two occurrences extended below the reservoir normal maximum surface elevation, one was found in proximity to a county-maintained road, and two were within developed or dispersed recreation areas. Other special-status plants growing in association with Red Hills onion included Layne's ragwort (*Packera layneae*),[50] Congdon's lomatium, Red Hills soaproot, tripod buckwheat, shaggy-haired lupine, and Mariposa cryptantha.

Red Hills Soaproot

Twenty occurrences of Red Hills soaproot were documented within the study area, all on public land administered by the BLM; 12 were at Sixbit Gulch and eight at Poor Man's Gulch for a total of over 1,600 individuals combined over 0.4 ac. At the time of survey, approximately 80 percent of plants were in vegetative form and approximately 20 percent were in bloom (i.e., reproductive form). Two potential disturbances, noxious weeds and grazing, were associated with Red Hills soaproot. No disturbances associated with O&M were observed. Other special-status plants

[50] Layne's ragwort is an ESA-listed species. Plants listed under the federal ESA or the CESA, even if they are also considered special-status, are considered separately, in Section 3.8.

growing in association with Red Hills soaproot included Layne's ragwort, Red Hills onion, Congdon's lomatium, tripod buckwheat, shaggy-haired lupine, and Mariposa cryptantha.

Mariposa Clarkia

Twenty-five occurrences of Mariposa clarkia were documented within the study area, of which two were documented on public land administered by the BLM. Occurrences were found at the Moccasin Point Recreation Area, at Rogers Creek Arm, near the Moccasin transmission line, and along Shawmut Road for a total of over 35,000 individuals. Additionally, one occurrence was in an area associated with a burn pile from debris removal activities, and parts of some occurrences extended below the reservoir normal maximum surface elevation. At the time of survey, the majority of plants were in bloom. Five potential disturbances were associated with Mariposa clarkia: recreation, noxious weeds, grazing, use of a burn pile, and road and transmission line maintenance. No disturbances associated with O&M were observed in these areas. Other special-status plants were located with Mariposa clarkia occurrences, including Red Hills onion.

Mariposa Cryptantha

Ten occurrences of Mariposa cryptantha were documented within the study area at Kanaka Point, all on public lands administered by the BLM (one crossed the ownership boundary onto TID/MID land). Occurrences were found at Moccasin Point Recreation Area, Railroad Canyon, and Sixbit Gulch for a total of about 2,300 individuals over a combined area of approximately 1.24 ac. At the time of survey, the majority of the plants were either in flower or fruit, with a small percentage still vegetative. Potential disturbances associated with these occurrences included noxious weeds and dispersed recreation. Additionally, Mariposa cryptantha at Moccasin Point Recreation Area was observed in the middle of an equipment and vehicle storage yard, sometimes growing around equipment. The Mariposa cryptantha occurrences were primarily scattered on rocky, serpentine slopes amidst grassy openings of toyon (*Heteromeles arbutifolia*), chamise and gray pine.

Tripod Buckwheat

Four occurrences of tripod buckwheat were documented within the study area, of which all were on public land administered by the BLM at Sixbit Gulch. A total of approximately 277 individuals, over a combined area of approximately 0.07 ac, were observed, nearly all in bloom. A review of existing information indicated that the species had not previously been documented within one mile of the Project Boundary. Noxious weeds were the only potential disturbance associated with tripod buckwheat; however, part of one occurrence grew below the reservoir normal maximum surface elevation. Special-status plants growing in association with tripod buckwheat included Layne's ragwort, Red Hills onion, Congdon's lomatium, shaggy-haired lupine and Red Hills soaproot.

Congdon's Lomatium

Seven occurrences of Congdon's lomatium were documented within the study area, all of which were documented on public land administered by the BLM; five occurrences were documented at Sixbit Gulch and two at Poor Man's Gulch. At the time of survey, an estimated 80 percent of the plants were in fruit and 20 percent were in flower. Two potential disturbances associated with Congdon's lomatium, recreational use and noxious weeds, were observed. In addition, part of one occurrence extended below the reservoir normal maximum surface elevation. Special-status plants were frequently growing in association with Congdon's lomatium, including Layne's ragwort, Red Hills onion, Red Hills soaproot, tripod buckwheat, shaggy-haired lupine and Mariposa cryptantha.

Shaggy-haired Lupine

Seven occurrences of shaggy-haired lupine were documented within the study area, four of which were observed on public land administered by the BLM. Two were documented at Poor Man's Gulch and five were documented at Railroad Canyon. Individual occurrences ranged from one to 2,000 plants, totaling a combined area of approximately 0.25 ac. At the time of survey, over 90 percent of the individuals were in fruit and the rest were in flower. All but one occurrence was at the margin (just above or partially below) the reservoir normal maximum surface elevation. Special-status plants growing in association with shaggy-haired lupine include Layne's ragwort, Red Hills onion, Red Hills soaproot, tripod buckwheat, and Congdon's lomatium.

Red Hills Ragwort

Two occurrences of Red Hills ragwort were documented within the study area, one of which was documented on public land administered by the BLM. Red Hills ragwort was also found at Recreation Bay and Sixbit Gulch. A total number of 268 individuals were observed over a combined area of approximately 0.02 ac. At the time of survey, an estimated 65 percent were in flower and 35 percent were vegetative. Three potential disturbances, recreation, weeds, and grazing, were associated with Red Hills ragwort. In addition, part of one occurrence extended below the reservoir normal maximum surface elevation. Special-status plants found growing in association with Red Hills ragwort included Red Hills soaproot and shaggy-haired lupine.

3.6.1.3 Wetland and Riparian Habitats

Wetland and riparian habitats are uncommon within the Project Boundary. Most of Don Pedro Reservoir is steep-sided, with upland plant communities directly adjacent to the reservoir margin. Areas below the normal maximum surface elevation that are periodically exposed are sparsely vegetated or bare. National Wetland Inventory mapping identifies a total of 82.4 ac of wetland and riparian habitats within the Project Boundary (Table 3.6-3) (USFWS 1987). In general, these areas are present as narrow margins to steep ephemeral streams which drain to Don Pedro Reservoir.

Table 3.6-3. Wetland and riparian habitats within the Project Boundary as mapped by the National Wetland Inventory (USFWS 1987).

Type	NWI Code	Acres in Project Boundary
Palustrine Emergent	PEM	22.4
Palustrine Scrub-Shrub	PSS	1.2
Palustrine Unconsolidated Bottom	PUB	10.5
Palustrine Unconsolidated Shore	PUS	0.4
Riverine Unconsolidated Bottom	RUB	30.9
Riverine Unconsolidated Shore	RUS	1.7
Riverine Streambed	RSB	15.3
	Total	**82.4**

In 2012, these National Wetland Inventory mapping data were supplemented with a field study of wetland habitats associated with Don Pedro Reservoir. A total of 10 drainages were examined for the presence of wetlands. The condition of each wetland was assessed using the California Rapid Assessment Methodology (CRAM) (CWMW 2012). The drainages were selected in cooperation with relicensing participants during the study plan development process. CRAM evaluates each wetland for a series of attributes: (1) Topographic Complexity, (2) Hydrology, (3) Physical Structure, and (4) Biotic Structure. CRAM then provides a measurement of wetland services, such as water storage, retention of particles, dissipation of energy (e.g., energy associated with high flow events), cycling of nutrients, and the maintenance of plant and animal communities. The maximum CRAM score possible is 100; a score of 100 indicates that every wetland service is provided by the wetland. Scores identify how many services are observed. The accompanying narrative description provides details on the functional qualities and any limiting factors present (i.e., limitations of plant establishment due to bedrock substrates, or anthropogenic stressors).

Of the ten drainages examined, nine supported wetlands. The CRAM scores for these wetlands ranged from 59 to 97. At eight of these wetlands, the majority of the wetland habitat was observed outside the Project Boundary and consisted primarily of patches of riparian vegetation along intermittent or ephemeral drainages to Don Pedro Reservoir. In each of these drainages, wetland conditions began at or above the reservoir normal maximum surface elevation and continued upstream (often beyond the Project Boundary) where conditions allowed. Wetland habitat below reservoir normal maximum surface elevation was not observed except for open water represented by Don Pedro Reservoir itself. In general, most wetlands were dominated by bedrock or cobble and boulder substrates, which do not support hydric soils, but do allow the development of hydrophytic vegetation. In addition, other indicators of ground saturation during some part of the growing season, such as watermarks, were often evident.

The ninth wetland, Big Creek, is not hydrologically associated with Don Pedro Reservoir; instead, it appears to be supported by subsurface drainage from the swimming lagoon at Fleming Meadows Recreation Area located upslope. Big Creek has no defined channel but supports hydrophytic vegetation and hydric soils throughout. The tenth area specified for study, Three Springs Gulch, did not support wetlands.

No facilities, access roads, recreational use, or O&M activities occur in any of the studied wetlands. Additionally, noxious weeds were infrequent within the wetland habitats examined. Those that were present were generally upland species at the wetland margin. The most prevalent invasive species observed were Himalayan blackberry (*Rubus armeniacus*) and wooly mullein (*Verbascum thapsus*); neither of these species is listed as a noxious weed (California Department of Food and Agriculture (CDFA) 2010).

Each documented wetland is described below.

Sixbit Gulch

Sixbit Gulch is small drainage located within the Red Hills ACEC that supports two wetland types: riverine intermittent streambed, seasonally flooded (R4SBC) and palustrine scrub-shrub, temporarily flooded (PSSA) (USFWS 1987). It is moderately confined by slopes of annual grasslands interspersed with buck brush (*Ceanothus cuneatus*) and gray pine (*Pinus sabiniana*). Large bedrock and boulder outcrops occur along the perimeter of the wetland.

Vegetation communities alternate between hummocks of naked sedge (*Carex nudata*) interspersed with herbs, and dense patches of red willow (*Salix laevigata*) and spicebush (*Calycanthus occidentalis*) surrounding pools. The wetland area alternates between dense cover and open bedrock, with medium vertical and horizontal vegetation complexity. Although three vertical layers are present within the wetland vegetation, most areas support no more than two vertical overlapping layers (e.g., willow mid-story over sedge ground-cover) and have horizontally alternating, rather than mixed patches, of vegetation types.

An old road crosses the channel near the midpoint of the wetland. The road is paved where it crosses the channel and is graded dirt on either side. The Districts do not use this road; the BLM closed the road to vehicle traffic and brush has overgrown the route both in and out of the channel. The road provides an opening in the dense riparian shrubs for sedge, springseep monkeyflower (*Mimulus guttatus*), and Sonoma hedgenettle (*Stachys stricta*) to flourish.

Sixbit Gulch received a CRAM Overall Attribute Score of 83. The score indicates that the wetland is meeting its potential, experiences few stressors from upland or hydrologic sources, and provides a multitude of wetland services.

Poor Man's Gulch

Poor Man's Gulch is a small drainage located within the Red Hills ACEC. It supports one wetland type, riverine intermittent streambed, seasonally flooded (R4SBC) (USFWS 1987). The drainage is unconfined within a narrow valley of non-native annual grasslands dotted with gray pines, buckbrush, and occasional hollyleaf redberry (*Rhamnus ilicifolia*). Shallow soils overlie bedrock. Hummocks of naked sedge and mixed herbs alternate with exposed bedrock with tufts of perennial ryegrass (*Lolium perenne*) and rabbitfoot grass (*Polypogon monspeliensis*) occur at the perimeter. Alternating with these areas are patches of red willow and spicebush, which occur with more frequency near the upstream end assessment area. The vertical and horizontal complexity is limited in this system, with few overlapping vertical layers, and alternating, rather than mixed, vegetation patches. The micro-topography is somewhat complex, while the macro-topography is simple, with the channel at the center of the gently sloping valley floor.

Poor Man's Gulch received a CRAM Overall Attribute Score of 83. The score indicates that the wetland is meeting its potential, experiences few stressors from upland or hydrologic sources, and provides a multitude of wetland services.

Moccasin Creek

Moccasin Creek supports one type of NWI-classified wetland, riverine intermittent streambed, seasonally flooded, excavated (R4SBCx) (USFWS 1987). Moccasin Creek is moderately confined within a valley; its floodplain becomes narrower and steeper as the creek winds upstream from the reservoir. Upslope vegetation is comprised of non-native annual grassland and oak woodlands. The channel is low gradient, with well-sorted bed material dominated by cobbles, with some boulders and finer sediments. The banks tend to be soil, stabilized by mature alder (*Alnus incana*) and red willow trees and shrubs, with occasional California sycamore (*Platanus racemosa*) and narrowleaf willow (*Salix exigua*). The canopy is well developed, providing shade throughout the creek. Herbaceous vegetation is rich, but not overly abundant, with many species occurring in small patches around tree roots. The creek supports complex vertical and horizontal stratification, with multiple layers of vegetation present throughout.

The creek is accessed frequently by fishermen, with trails weaving through upslope Himalayan blackberries, black mustard (*Brassica nigra*), and other weedy species. The river left bank just upstream of the Hatchery discharge has a short eroded area, where the dirt bank has collapsed. Established root systems on either side will prevent extension of the bank failure. The Highway 120 Bridge crosses over the creek near the upstream end of the assessment area, but does not create a break in riparian vegetation connectivity.

Two CRAM assessments were performed at Moccasin Creek to capture differences in channel width and discharge. Both received the same CRAM Overall Attribute Score of 97, indicating that the wetlands in Moccasin Creek experience few stressors from upland or hydrologic sources and provides a multitude of wetland services.

Hatch Creek

Hatch Creek supports one NWI-mapped wetland type, riverine intermittent streambed, temporarily flooded (R4SBA) (USFWS 1987). It is moderately unconfined with some incision in areas with soil terraces. Although access to the area is limited due to a lack of landowner permission, study of the area was possible to a limited extent by looking upstream or downslope from two public roads, respectively: Sunset Oaks Lane Bridge, which crosses Hatch Creek at the Project Boundary, and Marshes Flat Road, which roughly parallels Hatch Creek for a short distance.

The Hatch Creek channel bed alternates between bedrock and cobble dominated areas, with pooling in many of the bedrock areas. Non-native annual grasses meet the bankfull edge and continue upslope, dotted with canyon live oak (*Quercus chrysolepis*) and gray pines. Patches of riparian plants are present just downstream of the Project Boundary, but are discontinuous through the length of the assessment area. Cattle were present during the time of the survey and all herbaceous plants occurring within the bankfull area were grazed. Red willow, mule fat

(*Baccharis salicifolia*), and spicebush are present between stretches of open, rocky banks and pools. Himalayan blackberry is present on many of the banks under a canopy of red willow or upland canyon live oaks. There is little vertical overlap and limited horizontal interspersion, with vegetation occurring in isolated patches.

The Sunset Oaks Bridge crosses Hatch Creek in an area with limited vegetation that appears to be typical for the system. No adverse effects from the bridge are apparent. Bank failure, possibly caused by the compounded effects of grazing and debris jam in the channel, is present at a short stretch of dirt terrace on the north bank.

Hatch Creek supports a limited riparian system, and received a CRAM Overall Attribute Score of 68. The score indicates that the wetland experiences limited stressors from upland or hydrologic sources and provides some wetland services. Channel and vegetation complexity are limited by the bedrock substrate and possibly by cattle grazing.

Big Creek

The emergent wetland system at Big Creek is contained within the Project Boundary and is located roughly east of Don Pedro Dam and south of the Reservoir. (All other assessed wetlands began within the Project Boundary, but continued upstream, with most wetland habitat occurring outside the Project Boundary.) Big Creek is identified on USGS topographic maps as "intermittent" and is not identified on NWI maps as supporting any wetland types (USFWS 1987). It drains runoff from surrounding slopes and does not have a surface hydrologic connection with the Reservoir.

The Big Creek wetland is a swale formed by the meeting of adjacent hillslopes, with no distinct bed or banks. The surrounding landscape consists of non-native annual grasslands and blue oak (*Quercus douglasii*) woodland. The wetland is characterized by a change from upland grasses to more hydrophytic plants where it appears to be saturated to inundated for most of the year, with some intermittent ponding. The creek supports primarily herbaceous species, such as broad-leaved cattail (*Typha latifolia*), tall flatsedge (*Cyperus eragrostis*), rabbitfoot grass, dallisgrass (*Paspalum dilatatum*), spike rush (*Eleocharis ovata*), and lady's thumb (*Persicaria maculosa*). A few red willow shrubs and trees occur near saturated areas. Two small ponds in the channel support aquatic plants, including floating primrose (*Ludwigia peploides*) and duckweed (*Lemna minor*), the presence of which indicates that surface water is present during the majority of the year. The channel has very little vertical or horizontal complexity, consisting predominantly of the same herbaceous dominants throughout. Micro- and macro-topography are also simple, with very few patch types.

Big Creek is bisected by Bonds Flat Road, a public two lane road with a culvert connecting the upper and lower portions of the creek. A fenced area in the lower portion of the creek is highly grazed, with most of the wetland vegetation grazed to a nub. Recent cattle activity is evident. In this same area, a vehicle crossing is present joining a dirt road on either side. The road is not currently used by the Districts, but was originally created to support transmission lines and other infrastructure in the area.

Big Creek received a CRAM Overall Attribute Score of 71, which indicates that the wetland experiences limited stressors from upland and hydrologic sources, and provides some wetland services. However, the system is not structurally complex, and has limited vegetative richness.

Kanaka Creek

Kanaka Creek supports one NWI-mapped wetland, a riverine intermittent streambed, seasonally flooded (R4SBC) (USFWS 1987). It is unconfined and supports riparian vegetation on narrow floodplains flanking both sides of the channel. Surrounding upslope areas support non-native annual grasslands and mixed oak woodlands.

Vegetation occurs throughout all vertical layers, and is horizontally complex with well-stratified vegetation communities throughout the channel, wetted edge, and floodplain. Watercress (*Rorippa nasturtium-aquaticum* [*Nasturtium officinale*]) is present in the channel where the canopy is more open, and herbaceous vegetation such as seepspring monkeyflower and sneezeweed (*Helenium puberulum*) dots the banks. The shrub layer alternates between spicebush and red willow, with patches of Himalayan blackberry and fig (*Ficus carica*). An overstory of red willows and canyon live oak provides structure for climbing vines of California wild grape (*Vitis californica*), which traverses all layers of the vegetation.

The channel bed is steep bedrock and boulder controlled falls with deep pools alternating with low gradient cobble riffles. The macro- and micro-topography of the channel and floodplain are complex, with high connectivity between the channel and floodplain. Some signs of human access were observed in the lower areas of the reach, where litter was present and a mining shack appeared to be in active use. A public two-lane highway, Jacksonville Drive, crosses the wetland over a culvert, with pools formed on either side. The slopes of the highway support abundant yellow star thistle (*Centaurea solstitialis*), with a few individual plants occurring in the creek downstream.

Kanaka Creek received a CRAM Overall Attribute Score of 87, indicating that the wetland experiences few stressors from upland or hydrologic sources and provides most wetland services. Two non-native plant species, fig and Himalayan blackberry, are common throughout.

Deer Creek

Deer Creek supports one type of NWI-mapped wetland, a R4SBC (USFWS 1987). The channel is highly confined in a steep bedrock-dominated canyon, with non-native annual grasses, weedy forbs, poison oak (*Toxicodendron diversilobum*), and interior live oak scrub occurring upslope. Ward's Ferry Road roughly parallels Deer Creek for a short distance upslope on the north side.

The bed and banks of Deer Creek are dominated by bedrock and boulder substrates, with limited vegetation present below bankfull elevation. The channel is mostly bare, with small patches of herbaceous vegetation, alternating with lower gradient areas supporting red willow, spicebush, and button willow (*Cephalanthus occidentalis*). Bedrock pools are common in the streambed. The vegetation community is horizontally and vertically simple, with patchy vegetation and few areas with overlapping layers. The micro- and macro-topography is somewhat complex, but limited by the bedrock substrates.

A limited amount of debris is present in Deer Creek, with car parts and other trash likely originating from individuals using Ward's Ferry Road. Non-native herbaceous species dot the northern slope of the Deer Creek canyon wall, with denser populations near the top of the slope near the roadway. These species include Klamath weed, wooly mullein, and Italian thistle; while occasionally present within the riparian area, they are mostly limited to upslope habitats.

Deer Creek received a CRAM Overall Attribute Score of 71. The score indicates the wetland experiences few stressors from upland or hydrologic sources and provides some wetland services, although the bedrock bed and banks limit the vegetative capacity of the wetland.

Drainage #7

Drainage #7 is located within the Red Hills ACEC and supports one type of NWI-mapped wetland, R4SBC (USFWS 1987). Wetland habitats within Drainage #7 do not occur within the Project Boundary; no riparian or wetland vegetation is present until approximately 100 m upstream of the Project Boundary. The inclusion of this drainage as a wetland is based primarily on the NWI classification (USFWS 1987), as the plant species investigation indicated that the majority of plants present are not hydrophytic, indicating that the area likely does not meet formal wetland criteria.

The areas surrounding Drainage #7 consist of steep slopes supporting non-native annual grasslands with buck brush intermittently interspersed throughout. The grasslands end abruptly at the edge of the drainage, which has almost vertical bedrock walls and bedrock floors. California buckeye (*Aesculus californica*), red willow, and spicebush grow from within the drainage, with the canopy just overtopping the lip of the drainage. Some herbaceous vegetation grows along the bed and walls, such as seepspring monkeyflower, naked sedge, and canyon liveforever (*Dudleya cymosa*).

Drainage #7 received a CRAM Overall Attribute Score of 59. The score indicates that the wetland does not experience stressors from upland or hydrologic sources and provides some wetland benefits, but has little vegetation because of the bedrock substrates dominating the drainage.

Drainage #8

Drainage #8 is located within the Red Hills ACEC and supports one type of NWI-mapped wetland, R4SBC (USFWS 1987). The lower portion of Drainage #8, just upstream of Gardner Falls, is composed of bedrock and boulder bed, with banks of either bedrock or shallow soils overlying bedrock.

Areas dominated by bedrock and boulders have limited vegetation, with red willows and small patches of naked sedge or stream orchid (*Epipactis gigantea*) occurring in crevices between boulders. Alternating areas with soils support lush herbaceous vegetation with narrow-leaf milkweed (*Asclepias fasicularis*), Deptford pink (*Dianthus armeria*), stream orchid, and naked sedge. Spicebush and red willow occur with the forbs, becoming dense near the wetted edge. The alternating pattern of substrates and patchiness within each type of substrate provide complex horizontal stratification, although the vertical stratification is typically limited to two overlapping layers of herbs and shrubs. One ESA-listed plant, California vervain, was identified within this wetland.

Drainage #8 exhibits three distinct habitats, defined by gradient and substrates that determine the potential of each area. The upper portion of Drainage #8 has a steep gradient composed exclusively of bedrock and boulders. A series of falls, plunge-pools, chutes, and sheets form the channel, with intermittent red willows, spicebush, and California buckeyes occurring at the channel edge and in areas where sediment is present. Drainage #8 opens to Don Pedro Reservoir at Gardner Falls, a waterfall over a bedrock cliff. The lower portion of drainage #8 is low gradient, and supports multiple vertical layers of vegetation, including sediment retaining herbs and graminoids, mid-layers of spicebush and red willows, and a taller layer of California buckeye. The waterfall area supports little vegetation, although California buckeye and California wild grape were both observed.

Two CRAM assessments were performed at Drainage #8 to reflect the differences in the geomorphic and vegetative characteristics of the channel. The lower portion, just upstream of Gardner Falls, received a CRAM Overall Attribute Score of 91. The score indicates that the wetland does not experience stressors from upland or hydrologic sources and provides a multitude of wetland benefits.

The upstream portion of Drainage #8 is steeper and is almost exclusively composed of bedrock or boulder substrate; it received a CRAM Overall Attribute Score of 73. The score indicates the wetland experiences few stressors from upland or hydrologic sources and provides some wetland services, although the bedrock bed and steep gradient banks limit the vegetative capacity of the wetland.

3.6.1.4 Noxious Weeds

In 2012, a noxious weed survey was conducted addressing those lands potentially affected by O&M and recreational use, and adjacent lands as specified in the Noxious Weed Study Plan. The study area covered approximately 3,870 ac. For the purpose of the study, noxious weeds were defined as those species meeting one or more of the following criteria:

- listed as “noxious” under the Federal Plant Protection Act (FPPA);
- listed as “noxious” and with a pest rating of A, B or C by the CDFA; or
- listed as a Target Species in the Districts’ Noxious Weed Survey study plan.

This effort identified twelve noxious weed species in the study area (Table 3.6-4). These species were distributed in 623 geographically distinct occurrences; however, one species (Italian thistle [*Carduus pychnocephalus*]) was considered ubiquitous such that individual occurrences were not mapped. Each of the species located is listed by the CDFA: eight are C-listed species considered widespread and generally not warranting management, and four are CDFA B-listed, indicating management efforts may be warranted in some instances. Table 3.6-4 summarizes noxious weed occurrences by land ownership.

Table 3.6-4. Noxious weeds/invasive plant occurrences identified in the study area.

Common Name / Scientific Name	2013 CDFA[1] Rating	No. of Occurrences by Land Ownership	
		Districts/Private Lands	Public (BLM)
Barbed goatgrass / *Aegilops triuncialis*	B	1	4
Tree-of-heaven / *Ailanthus altissima*	C	4	3
Giant reed / *Arundo donax*	B	--	1
Italian thistle / *Carduus pychnocephalus*	C	n/a	n/a
Smooth distaff thistle / *Carthamus creticus*	B	9	6
Yellow starthistle / *Centaurea solstitialis*	C	21	17
Bermudagrass / *Cynodon dactylon*	C	57	19
Medusahead grass / *Elymus caput-medusae*	C	293	24
Klamathweed / *Hypericum perforatum*	C	147	11
Russian thistle / *Salsola tragus*	C	2	--
Tamarisk / *Tamarix* sp.	B	1	--
Puncturevine / *Tribulus terrestris*	C	3	--
	Total	**538**	**85**

[1] California Department of Food and Agriculture (CDFA) Rating:
A = Eradication, containment, rejection, or other holding action at the state-county level. Quarantine interceptions to be rejected or treated at any point in the state.
B = Eradication, containment, control, or other holding action at the discretion of the commissioner. State endorsed holding action and eradication only when found in a nursery.
C = Action to retard spread outside of nurseries at the discretion of the commissioner; reject only when found in a crop seed for planting or at the discretion of the commissioner (CDFA 2010).

Noxious weeds are common throughout the study area and Project Boundary, occurring in most habitat types. The most widespread and common weed was Italian thistle, which occurred in all habitat types (including the gabbro soils of the Red Hills ACEC). Bermudagrass was also common, occurring in a discontinuous band around Don Pedro Reservoir just below the normal maximum surface elevation, as well as at an additional 76 occurrences within the study area. Other frequently located weeds included medusahead grass (*Elymus caput-medusae*), with 317 occurrences, and Klamathweed (*Hypericum perforatum*), with 158 occurrences. Yellow starthistle (*Centaurea solstitialis*) was the fifth most common weed located in the study area, with 38 occurrences. Among all the noxious weed occurrences, eight species were observed in 85 occurrences on public land administered by the BLM.

Barbed Goatgrass

Five occurrences of barbed goatgrass (*Aegilops triuncialis*) were surveyed at three locations: four occurrences on public land administered by the BLM (two at Sixbit Gulch and two at Poor Man’s Gulch) directly adjacent to Red Hills ACEC, and one occurrence on Districts’ land above Recreation Bay. Over 10,000 stems were estimated in these occurrences, primarily in Sixbit and Poor Man’s gulches. The estimated area of the combined occurrences is approximately 21.6 ac.

Tree-of-heaven

Tree-of-heaven (*Ailanthus altissima*) were found at three locations: one occurrence on Districts' land at Fleming Meadows Point, three on TID/MID and private land at Shawmut Road and three on public land administered by the BLM below Don Pedro Dam and the powerhouse. Nearly 150 trees were counted at these occurrences. The estimated area of the combined occurrences was less than an acre.

Giant Reed

Giant reed (*Arundo donax*) was found at one location within the study area, on public land administered by the BLM at a turn along the Don Pedro powerhouse access road. There were over 500 plants growing in an area of approximately 0.1 ac.

Italian Thistle

Italian thistle is prevalent throughout the Project Boundary, particularly in the annual grasslands and blue oak woodlands of Don Pedro Reservoir. Italian thistle was found in denser patches in shady areas and wet drainages, but also grew in more diffuse occurrences in sunny grasslands and on exposed slopes. The only areas where Italian thistle was less common were the Red Hills ACEC and dense areas of chamise. There were hundreds of thousands of plants covering many acres through the study area.

Smooth Distaff Thistle

Smooth distaff (*Carthamus creticus*) thistle was found at 15 locations: six occurrences on public land administered by the BLM and nine occurrences on Districts' lands. Of these occurrences, five were on Kanaka Point (BLM), one was on Jacksonville Road, one was on Harney Road, seven were in Moccasin Point Recreation Area, and one was on Woods Creek Arm below the normal maximum surface elevation. Approximately 1,600 plants were counted over a combined area of nearly 2 ac.

Yellow Starthistle

Yellow starthistle was found at a total of 38 locations; there were four occurrences near the Grizzly Road area, two at the Highway 49 bridge, five occurrences at multiple locations along Jacksonville Road, four within or near Kanaka Point, 19 within or near Moccasin Point Recreation Area and single occurrences at Poor Man's Creek, Shawmut Road, Wood's Creek Arm, and within the Moccasin Transmission Line area. Seventeen of these occurrences were located on public land administered by BLM (nine in the Moccasin Point Recreation Area, one at Kanaka Point, two in the Grizzly Road area, two in the area of Jacksonville Road, one in the Moccasin transmission line area, and one each at Poor Man's Creek and the Kanaka Creek area), while the rest (21) were located on Districts' or private lands. Tens of thousands of individual plants were observed in these occurrences, which were estimated to cover over 20 ac.

Bermudagrass

Bermudagrass was found growing in a thin, discontinuous band below the normal maximum water surface elevation mark of Don Pedro Reservoir. An additional 76 occurrences at other locations were documented within the study area. The majority of these additional occurrences were in disturbed areas within recreation sites and along roadways. Nineteen of these occurrences were located on public land administered by the BLM (one at the Grizzly Road area, five near Don Pedro powerhouse access road, two at Kanaka Point, three in the area of Jacksonville Road, one at Moccasin Point Recreation area, four in the Moccasin Transmission Line area, and one each at Poor Man's Creek, Sixbit Gulch and Don Pedro Bar), while the rest (58) were located on Districts' or private lands. The 76 occurrences not growing below the reservoir normal maximum surface elevation were estimated to contain over 50,000 stems on around 20 ac.

Medusahead Grass

Medusahead grass was found at 19 locations with a total of 317 occurrences; this plant was found mostly in large, diffuse patches within annual grasslands. Twenty-four of the occurrences were located on public land administered by the BLM (two in the Moccasin Recreation Area, 17 near Don Pedro powerhouse access road area, one at Don Pedro Bar, and five in the Blue Oaks Recreation Area), and the majority (293) were on TID/MID and private lands. Hundreds of thousands of plants were observed.

Klamathweed

Klamathweed was found at 13 locations with a total of 158 occurrences. Eleven of the occurrences were located on public land administered by the BLM (two at Moccasin Point Recreation Area, two in the Grizzly Road area, one at Jacksonville Road, one at Ward's Ferry Bridge, two in the Ramos Creek area, two at Don Pedro Bar, and one near the Don Pedro powerhouse access road), while the rest (147) occupied TID/MID or private lands. Over 100,000 plants were observed.

Russian Thistle

Russian thistle (*Salsola tragus*) was found at two locations: one occurrence on Districts' land in the DPRA staff housing area and one occurrence on TID/MID land within the Blue Oaks Campground. The occurrences covered less than 0.1 ac and contained about 35 plants.

Tamarisk

Tamarisk (*Tamarix* sp.) was found at one location. Ten plants were located on TID/MID land adjacent to a restroom facility within the Moccasin Point Recreation Area. The occurrence was approximately 0.1 ac in size.

Puncturevine

Three occurrences of puncturevine (*Tribulus terrestris*) were found on TID/MID lands within Fleming Meadows Recreation Area. All occurrences were found along the paved road to the marina and contained around 50 plants. The estimated area of the combined occurrences was approximately 0.02 ac.

3.6.2 Resource Effects

Page 36 of FERC's SD2 specifically identifies the following potential issues associated with botanical resources:

- Potential effects of project operation, including water level fluctuations, ground-disturbing activities, and maintenance on special-status plant species and botanical resources.
- Potential effects of project operation, including recreation, water level fluctuations, ground-disturbing activities, and maintenance on the presence and spread of noxious weeds, including yellow starthistle.
- Effects of project operation, including water level fluctuations, ground-disturbing activities, and maintenance activities on wetland, riparian, cottonwood and willow, and littoral vegetation communities.
- Effects of maintenance and use of project recreation facilities by recreationists on special-status plant species and botanical resources, and shoreline vegetation.
- Effects of vegetation clearing for project maintenance on botanical resources, and the presence and spread of noxious weeds.

Each of these potential effects of the Don Pedro Project[51] is analyzed below.

3.6.2.1 Special-Status Plants

Of more than 700 plant species identified during botanical surveys, a total of 58 occurrences of eight special-status plant species were located within the Project Boundary. Each is listed by the BLM as Sensitive. For the majority of these occurrences, noxious weeds and private grazing activities were the only stressors identified. Over half of the occurrences of special-status plants were located with noxious weed occurrences, many in areas geographically removed from any O&M activity where evidence of private grazing was observed. In general, lands with evidence of substantial grazing were observed to have some of the highest concentrations of noxious weed occurrences. Both grazing and noxious weed occurrence may affect the health, distribution, or

[51] The Proposed Action covered in this application is the Districts' proposal to continue hydroelectric generation at the Don Pedro Project. While reservoir water level fluctuations have the potential to affect botanical resources, the water level fluctuations of the Don Pedro Reservoir are due to operations for the purposes of water supply and flood control. Hydroelectric project operations are dependent upon water released for these purposes; therefore, reservoir water level fluctuations are not the result of hydroelectric operations. The effect of the Proposed Action has no measurable impact on reservoir water level fluctuations. During relicensing of the Don Pedro Hydroelectric Project, the Districts undertook comprehensive investigations of the botanical resources associated with the Don Pedro Project within the study area identified in the study plan. The Districts intend to address effects to botanical resources of Don Pedro Project operations within the Draft Vegetation Management Plan.

abundance of special-status plants, and may have compounded impacts where they occur in tandem.

Three instances of routine maintenance activities were observed with the potential to affect special-status plants, based on their proximity to the occurrences: (1) road maintenance (one occurrence of Red Hills onion and six occurrences of Mariposa clarkia); (2) a storage area, where a special-status plant occurrence is growing among stored equipment (one occurrence of Mariposa cryptantha); and (3) a burn pile associated with woody debris removal and disposal (one occurrence of Mariposa clarkia). Although these special-status plant occurrences are not currently affected by these maintenance activities, future activities associated with maintenance or use of these areas could stress or physically cause damage to (e.g., trampling) individual special-status plants or the entire occurrence.

Six occurrences of special-status plants were located in areas where they could be affected by recreation near developed recreation areas (two Red Hills onion, two Mariposa clarkia, and two Mariposa cryptantha). Potential threats presented by recreation activities include trampling or soil disturbance, and the associated spread of noxious weeds. Additionally, portions of seven special-status plant occurrences of five species are located near or below normal maximum water surface elevation; for each, this represented the outside boundary of the occurrence. These plants are not adversely affected by current operations

3.6.2.2 Wetland and Riparian Habitats

Wetland and riparian habitats are uncommon within the Project Boundary. The bulk of Don Pedro Reservoir is steep-sided, with upland grass or shrub habitats directly adjacent to the reservoir margin. Periodically exposed areas below the normal maximum surface elevation are sparsely vegetated or bare. Wetlands that do occur are generally in valleys that drain into Don Pedro Reservoir from surrounding hillslopes. These wetlands each sustain hydrophytic vegetation that is influenced primarily by the channel gradient, substrate, and flow duration, rather than operations. Wetland conditions in these drainages begin at above the normal maximum surface elevation of Don Pedro Reservoir, and continue upstream (often well beyond the Project Boundary) where conditions allow. No wetland conditions below the Reservoir normal maximum surface elevation were observed during study efforts, and no water backs up into wetlands as a result of operations. As a result, operations and Don Pedro Reservoir fluctuations do not affect wetland systems, each of which was documented by CRAM assessments as providing wetland services at or near its overall potential, with few upstream or downstream stressors.

One wetland, at Big Creek, occurs in a swale downslope of Fleming Meadows Recreation Area, and appears created by drainage from a settling pond and a swimming lagoon. The wetland is not hydrologically associated with Don Pedro Reservoir. It has no defined channel but supports hydrophytic vegetation and hydric soils throughout; wetland services provided by the Big Creek wetland are limited but present. The area shows signs of substantial anthropogenic disturbance, including grazing and vehicle use. While the Big Creek wetland appears to be created by Don Pedro facilities and contained within the Project Boundary, these anthropogenic uses appear to be the primary drivers of habitat quality.

No facilities, access roads, recreational use, or O&M activities occur in any of the other wetlands examined. Additionally, the wetlands support few noxious weed occurrences, these generally represented by upland species at the wetland margin. The most prevalent non-native plants observed in wetlands were Himalayan blackberry and wooly mullein, neither of which is listed as a noxious weed. Study efforts identified cattle grazing, noxious weeds, and human use as the primary potential causes for stress on wetland habitats associated with Don Pedro Reservoir. These disturbances are not associated with the Don Pedro Project.

3.6.2.3 Noxious Weeds

Botanical surveys documented twelve noxious weed species in 636 occurrences (one species, Italian thistle, was not mapped into individual occurrences due to its ubiquitous distribution). Of the 12 species, four are CDFA B-listed: barbed goatgrass, giant reed, smooth distaff thistle and tamarisk. CDFA B-listed weeds are usually subject to eradication on BLM lands and can be subject to eradication on all lands (CDFA 2010). Of the 22 occurrences of CDFA B-listed weeds, 11 of them occurred on BLM lands. This included four occurrences of barbed goatgrass in and two occurrences of distaff thistle directly adjacent to the Red Hills ACEC.

Nearly 100 occurrences of noxious weeds along or in roads within the study area were documented. Distaff thistle (CDFA B-listed) was observed at one location on Jacksonville Road and one location on Harney Road. The most common weeds associated with roads were Bermudagrass, medusahead grass, and Klamathweed. Roads within the Project Boundary are generally managed by Tuolumne County. However, roads in and along the Fleming Meadows, Blue Oaks, and Moccasin Point Recreation Areas, which are managed by the Districts, also supported substantial numbers of noxious weeds. These roads, and all lands associated with developed recreation facilities within the Project Boundary, are subject to periodic noxious weed management efforts using herbicides or mechanical methods.

Nearly 150 occurrences of noxious weeds were mapped within developed recreation areas. Recreationists frequently cause disturbances to vegetation and soils through normal use of an area which can facilitate noxious weed colonization. Additionally, recreationists carry seeds and plant parts on their clothing, vehicles, and other equipment, potentially facilitating noxious weed dispersal (CDFA 2012). Seven of the 15 occurrences of distaff thistle (CDFA B-listed) were located in areas of high recreation use, such as Moccasin Point Recreation Area and Kanaka Point. Additionally, the one occurrence of tamarisk (CDFA B-listed) was found in the Moccasin Point Recreation Area and appeared to have been planted adjacent to a restroom facility. The majority of yellow starthistle (CDFA C-listed) occurrences were also located in developed recreation areas.

Numerous occurrences of noxious weeds in areas subject to cattle grazing were identified, though most occurrences were found on lands not associated with the four existing TID/MID grazing permits. Cattle can spread noxious weeds via transport on their hooves, hair or skin, and in their digestive tracts, and ground disturbance and overgrazing caused by cattle can also open areas to invasion by noxious weeds (CDFA 2012). The most common noxious weeds found in grazed areas were medusahead grass, Bermudagrass and Klamathweed (all CDFA C-listed).

Additionally, one occurrence of barbed goatgrass (CDFA-B listed) was found on Recreation Bay in a grazed area not associated with the Districts' four grazing permits.

Nineteen occurrences of noxious weeds were observed below the normal maximum water surface elevation of Don Pedro Reservoir, including four occurrences of distaff thistle. Operations restrict the development of most vegetation below the Reservoir normal maximum surface elevation, potentially providing a favorable environment for these species. Additionally, because distaff thistle and other noxious weed seeds may be dispersed by water, these occurrences may disperse to adjacent or downstream areas. Propagules of barbed goatgrass, tree-of-heaven, giant reed, smooth distaff thistle, Bermudagrass, medusahead grass, Klamathweed, and tamarisk can similarly be transported by water (CDFA 2012).

A variety of other routine maintenance activities (e.g., grading, mowing, and vegetation management) were also found to occur within or near noxious weed occurrences. Ten occurrences of noxious weeds were located in areas of grading, five were found in waste or storage areas, and 19 were located in areas that were mowed. Although the genesis of these occurrences is undetermined, the overlap of O&M and existing weeds may facilitate the potential for weed dispersal or establishment.

Each of the noxious weeds located is common throughout the Central Valley and California as a whole, and their distributions are generally reflective of region-scale biotic invasions combined with local land use patterns. Study efforts documented multiple contributing factors related to the distribution and abundance of noxious weeds within the Project Boundary.

3.6.3 Proposed Resource Measures

The Districts propose to develop and implement a Terrestrial Resources Management Plan to guide noxious weed and other vegetation management activities within the Project Boundary during the term of a new license (Appendix E-1). Components of the plan include best management practices to limit the spread of existing noxious weed occurrences or the establishment of new occurrences, special-status plant monitoring, employee training, and agency consultation. The implementation of the Terrestrial Resources Management Plan is expected to protect and enhance botanical resources within the Project Boundary.

3.6.4 Unavoidable Adverse Impacts

There are no unavoidable adverse impacts affecting botanical resources associated with the Don Pedro Project.

3.7 Wildlife Resources

This discussion of wildlife resources is divided into three subsections: (1) general information and context for wildlife resources in the Don Pedro Project vicinity; (2) a description of available information on individual wildlife species, including special-status species that potentially occur in the Project Boundary or were the subject of study efforts; and (3) analysis of Don Pedro

Project effects on wildlife resources. Information on species listed under the ESA and CESA is presented separately, in Section 3.8 of this Exhibit E.

The PAD provided existing information on wildlife resources, including special-status species that are known to occur or have the potential to occur in the Don Pedro Project vicinity (TID/MID 2011). Additionally, the Districts' consultation with stakeholders resulted in the development and implementation of three studies covering 14 special-status wildlife species in order to address wildlife resource issues identified during consultation and in FERC's SD2.

Existing information and the results of 2012 wildlife resource studies are presented below, including results from the following relicensing studies:

- Special-Status Amphibians and Aquatic Reptiles Study (TR-06),
- Bald Eagle Study (TR-10), and
- Special-Status Wildlife – Bats Study (TR-09).

3.7.1 Existing Environment

3.7.1.1 Wildlife Habitats and Setting

The Don Pedro Project is situated in the foothills of the west slope of California's Sierra Nevada. The Project Boundary encompasses over 5,538 acres of terrestrial wildlife habitats, dominated by blue oak (*Quercus douglasii*) woodlands and open annual grass-forb vegetation, and substantial components of shrub-dominated chaparral. Wetland and riparian habitats are uncommon; the bulk of Don Pedro Reservoir shoreline is steep-sided, with upland plant communities adjacent to the reservoir margin. Areas below the normal maximum surface elevation that are periodically exposed are sparsely vegetated or bare. The majority of terrestrial habitats within the Project Boundary are unmanaged and geographically removed from any Don Pedro Project activity. O&M activities, including local vegetation management efforts, are restricted to facilities and the Districts' three recreation areas.

Don Pedro Reservoir consists of two distinct morphological sections. The narrow, upstream portion of the reservoir occupies the steep-sided, rocky and winding Tuolumne River canyon. The downstream portion of the reservoir fills the gentler-sloped canyon where the Tuolumne River emerges into the low Sierra foothills and then into the wider Tuolumne River valley. The foothills area in this portion of the watershed is dominated by gently rolling grasslands and agricultural areas.

Don Pedro Reservoir itself is characterized by perennial, deep, slow-moving, open water and steep poorly vegetated banks. Wetland and riparian habitats are uncommon; shallow areas and areas of emergent vegetation are primarily associated with tributary mouths. Fishing is a common recreation activity; CDFW manages the Don Pedro Reservoir fishery as a put-and-grow resource with substantial stocking.

In 2011, wildlife habitats within the Project Boundary were classified using CDFW's California Wildlife Habitat Relationship (CWHR) system (deBecker and Sweet 2005; CDFG 2008). The dominant CWHR habitat type within the Project Boundary is Lacustrine, representing Don Pedro Reservoir, while the dominant terrestrial CWHR habitat types are Blue Oak Woodland and Annual Grasslands (Table 3.7-1) (TID/MID 2011).

Table 3.7-1. CWHR wildlife habitat types within the Project Boundary and their equivalent CalVeg community types.

California WHR[1]	CalVeg Community Types[2]	Acres	%
Annual Grasslands (AGS)	Annual Grasses and Forbs	2,280.5	12.4
Barren (BAR)	Barren	549.7	3.0
Blue Oak Woodland (BOW)	Blue Oak, Interior Live Oak	3,504.6	19.1
Montane Hardwood (MHW)	Canyon Live Oak	0.2	0.0
Chamise-Redshank Chaparral (CRC)	Chamise	542.2	3.0
Douglas-Fir (DFR)	Douglas-Fir-Ponderosa Pine	5.2	0.0
Blue Oak-Foothill Pine	Gray Pine	447.5	2.4
Montane Hardwood (MHW)	Interior Mixed Hardwood	0.6	0.0
Mixed Chaparral (MCH)	Lower Montane Mixed Chaparral	277	1.5
Lacustrine (LAC)	Water (General)	10,762.6	58.6
	Total	**18,370.1**	**100**

1 Source: deBecker and Sweet 2005; CDFG 2008.
2 Source: USFS 2009. See Section 3.6 for CalVeg community type descriptions

In addition to classifying wildlife habitat, the CWHR model predicts wildlife presence and use based on habitat type, age class, size class, canopy closure or cover, and occurrence of specific habitat elements (e.g., natural or manmade features such as cliffs, springs, or transmission lines). For the habitat types and elements identified within the Project Boundary, a total of 339 terrestrial vertebrate wildlife species are predicted to have the potential to occur. Of these species, CDFW's CNDDB includes records for a total of five special-status vertebrates[52] from within quadrangles occupied by the Project Boundary (CDFW 2013a):

- Western pond turtle (WPT) (*Actinemys* [*Emys*] [formerly *Clemmys*] *marmorata*),
- Foothill yellow-legged frog (FYLF) (*Rana boylii*),
- Bald eagle (*Haliaeetus leucocephalus*),
- Sierra Nevada yellow-legged frog (*Rana sierrae*), and
- Coast horned lizard (*Phrynosoma blainvillii*).

Sierra Nevada yellow-legged frog is not considered further here, as it is restricted to elevations generally above 6000 ft mean sea level (msl), well above those present in the Project Boundary (International Union for the Conservation of Nature [IUCN] 2013).

Additionally, the coast horned lizard is not known to occur in the Project Boundary; only one record exists in the vicinity, and it is more than four miles from the Project Boundary. Because there is limited potential for the O&M to affect this species, coast horned lizard is not considered further here.

52 A special-status wildlife species is a species that has a reasonable possibility of occurring in the Project vicinity on lands managed by the BLM and listed on the *California - BLM Animal Sensitive Species List, Updated September 2006* (BLM 2006). With the exception of Bald Eagle, addressed herein, species listed by CDFW under the CESA or as Fully Protected are addressed in Section 3.8.

In its SD2, FERC indicated its environmental review will evaluate the effects of the Don Pedro Project on special-status wildlife, including the following species:

- WPT (Actinemys [Emys] [formerly Clemmys] marmorata),
- FYLF (Rana boylii),
- Swainson's hawk (Buteo swainsoni),
- Bald eagle (Haliaeetus leucocephalus),
- Osprey (Pandion haliaetus), and
- Special-status bats.

Each of these species is addressed below. Additionally, discussion is included of one species not included in CNDDB records, Golden eagle (*Aquila chrysaetos canadensis*), but that has been observed in the vicinity.

3.7.1.2 Western Pond Turtle

Western pond turtle (WPT) surveys and evaluations were conducted in 2012 in an area consisting of: (1) suitable aquatic habitats within the Project Boundary within 0.5 miles from the normal maximum water surface elevation of Don Pedro Reservoir, including accessible sections of the Tuolumne River up to RM 79, and (2) tributaries up to 1.0 mi upstream of the reservoir (TID/MID 2013a).

WPT is listed as a Sensitive species by the BLM. There are two known records of WPT within the study area (Cranston 2012), with additional records just outside the FERC-approved study area. Additional WPT occurrences further outside the study area (e.g., reservoirs in Mariposa County) are also known (CDFW 2012).

WPT is a habitat generalist occurring in a wide variety of aquatic habitats up to about 6,000 ft elevation, particularly permanent ponds, lakes, side channels, backwaters, and pools of streams. WPT is uncommon in high-gradient streams (Jennings and Hayes 1994). To attain suitable body temperature ("thermoregulate"), individuals engage in basking behavior. Basking sites are an important habitat element (Jennings and Hayes 1994) and substrates include emergent and/or floating LWD, overhanging vegetation, rock outcrops, mats of submergent vegetation, mud banks, rocks, logs, and root wads on banks (Ashton et al. 1997).

As part of the 2012 study, an initial desktop assessment of WPT habitat was performed within the study area. Field habitat assessment locations and basking survey site locations were determined based on this assessment and property access. A total of 15 non-reservoir and 29 reservoir sites were assessed for essential WPT habitat characteristics such as basking substrate, depth, hydrology, bank habitat, vegetation, and exposure. Basking surveys were conducted at both reservoir and non-reservoir locations. Basking surveys sites on the reservoir were chosen based on the presence of suitable basking habitat and were diversified to represent each geographic area of the reservoir. Non-reservoir basking survey sites were selected based on the presence of suitable WPT habitat, including open water over one meter deep and suitable aquatic and terrestrial refugia. Potential WPT nesting habitat within 100 m of the reservoir and other water bodies associated with the Don Pedro Project was mapped in GIS according to available data on nesting habitat suitability criteria (slope of two to 15 degrees and southeast, south, or southwest aspect).

WPT basking surveys were conducted at five non-reservoir sites and eight reservoir sites. Six WPT were observed during basking surveys; one WPT was observed at a non-reservoir site and five WPT were observed at four reservoir sites. Within the reservoir, WPT were only observed at sites that were located in narrower coves.

An additional 10 WPT (eight live and two dead) were observed incidentally during the performance of the relicensing studies. Of the 10 locations where WPT were incidentally observed, six were within Don Pedro Reservoir or on the shoreline, one was noted in a pool in the Don Pedro spillway channel, and three were noted in a tributary to Don Pedro Reservoir.

Reviews of aerial imagery and field reconnaissance indicate potential suitable habitats for WPT are largely concentrated in backwater inlets, typically associated with seasonal or perennial tributary streams where shallower water occurs. In many areas, the only potential basking substrate was along steep banks. Partially submerged woody debris and cut stumps were rarely observed on aerial imagery but were observed in some locations during field reconnaissance. Boulders and bedrock outcrops were also identified as potential basking sites and were most numerous when the water surface elevation of Don Pedro Reservoir was low. At high water, partly submerged shoreline vegetation may provide basking habitat.

The Project Boundary has a limited availability of terrestrial areas suitable for WPT oviposition, aquatic habitats suitable for hatchlings (i.e., warm, shallow water with ample hiding cover in the form of dense submergent or short emergent vegetation), and basking sites for juveniles and adults. Don Pedro Reservoir is a large, deep reservoir, with mostly steep slopes and open expanses of water that rarely support WPT. Site assessments documented sparse to abundant amounts of emergent vegetation in areas associated with tributary mouths; however, most of the shoreline of Don Pedro Reservoir consists of steep poorly vegetated banks. In areas upstream of the reservoir, surveyors observed few areas of submerged or emergent vegetation. Some tributaries with low to moderate slope gradients and suitable water depths have the potential to support WPT, including West Fork Big Creek, Big Creek, Six-Bit Gulch, Poor Man’s Gulch, Woods Creek, Sullivan Creek, Blue Gulch, Smarts Gulch, and Rough and Ready Creek.

Potential WPT nesting habitat is common within the study area based on aspect, slope, and distance-to-water criteria. No WPT nests were observed.

3.7.1.3 Foothill Yellow-Legged Frog

Foothill yellow-legged frog (FYLF) surveys and evaluations were conducted in 2012 in an area consisting of: (1) suitable aquatic habitats within the Project Boundary within 0.5 mi from the normal maximum water surface elevation of Don Pedro Reservoir, including accessible sections of the Tuolumne River up to RM 79, and (2) tributaries up to 1.0 mi upstream of the reservoir (TID/MID 2013a).

FYLF is a stream-adapted species usually found in streams with backwater habitats and coarse substrates (Seltenrich and Pool 2002) that occur between approximately 600 to 5,000 ft in elevation (Moyle 1973; Seltenrich and Pool 2002; ECORP Consulting, Inc. 2005). Populations of FYLF persist on at least some portions of most drainages with known historical occurrences (NatureServe 2009). FYLF populations may require both mainstem and tributary habitats for long-term persistence. Streams too small to provide breeding habitat for this species may be critical as seasonal habitats, such as in winter and during the hottest part of the summer (VanWagner 1996). There is also evidence that habitat use by young-of-the-year, sub-adult, and adult frogs differs by age-class and can change seasonally (Randall 1997). Breeding tends to occur in spring or early summer. Eggs are laid in areas of shallow, slow moving waters near the shore. FYLF are less abundant in habitats where introduced fish and bullfrogs are present (Jennings and Hayes 1994).

FYLF is listed as Sensitive by the BLM. Two historic occurrences of FYLF are known from the study area (Cranston 2012). FYLF are known to occur more than three miles upstream of the Project Boundary in Moccasin Creek and Mountain Pass Creek. Additionally, FYLF were observed in Hatch Creek, upstream of the Project Boundary, in 1970 (TID/MID 2011).

As part of 2012 studies, desktop FYLF habitat assessments were conducted at twenty locations along perennial streams within in the study area. Based on potential habitat identified during desktop assessments and property access, 17 of those locations were assessed for FYLF habitat in the field. FYLF visual encounter surveys (VES) were performed at five tributary sites: Six-Bit Gulch, Poor Man's Gulch, Woods Creek, Moccasin Creek, and Drainage #8 (an unnamed tributary of Don Pedro Reservoir at Gardiner Falls). No FYLF were observed at any VES sites during surveys. No FYLF were incidentally observed during the course of other relicensing studies. Suitable FYLF breeding habitat was scarce. Additionally, bullfrogs were observed throughout the Don Pedro Project vicinity, including at three FYLF VES sites (Six-Bit Gulch, Poor Man's Gulch, and Woods Creek). Crayfish were also found throughout the vicinity. Predatory fish species have been documented in each of the tributaries surveyed for FYLF (BLM 1980).

Don Pedro Reservoir is characterized by perennial, deep, slow-moving water and steep, poorly vegetated banks. Tributaries to the reservoir have limited aquatic habitat suitable for oviposition and larval development (i.e., shallow, flowing water with at least some cobble-sized substrate). American bullfrog and a variety of introduced predatory fish are present, limiting the suitability of the habitat for FYLF. No surveyed tributaries to Don Pedro Reservoir were found to support FYLF or suitable habitat for FYLF. Therefore, Don Pedro Reservoir does not provide potential habitat for FYLF.

3.7.1.4 Bald Eagle

Bald eagle surveys were conducted in 2012 and 2013 on a study area consisting of a 1,000 ft area around the entirety of Don Pedro Reservoir and facilities, including those accessible portions of the Tuolumne River that are within the Project Boundary (TID/MID 2013b).

Bald eagle was listed by the USFWS as an endangered species in 1978, primarily due to population declines related to habitat loss and contamination of prey species by past use of organochlorine pesticides, such as dichlorodiphenyltrichloroethane (DDT) and dieldrin (USFWS 2007). On August 11, 1995, the bald eagle's federal status was changed to "threatened" in all lower 48 states. The USFWS delisted the bald eagle on August 9, 2007 (72 FR 37346). Although delisted with the USFWS, the bald eagle was listed by CDFG as a California endangered species on June 27, 1971, and is fully protected in wintering and nesting habitat. Additionally, the bald eagle is protected by the federal Bald and Golden Eagle Protection Act, enforced by the USFWS.

Bald eagle breeds and winters throughout most of California, except for desert areas (CDFG 2000). Most breeding in the state occurs in the northern Sierra Nevada, Cascades, and North Coast Ranges, and is expanding into the central and southern Sierra Nevada and Sierra Nevada foothills. California's bald eagle breeding population is resident year-round in most areas where the climate is relatively mild (Jurek 1988). Between mid-October and December, migratory birds from areas north and northeast of California arrive in the state. Wintering populations remain through March or early April.

In general, bald eagle foraging habitat consists of large bodies of water or free-flowing rivers with abundant fish and adjacent snags and other perches (USFWS 2007). Breeding bald eagles are typically found in reservoirs in the northern Sierra Nevada, Cascades, and north Coast Ranges. While Don Pedro Reservoir is located in the central Sierra Nevada foothills, outside of what is thought to be the historic breeding range for bald eagles in California (i.e., northern Sierra Nevada, Cascades and north Coast Ranges), occupied nests are a strong indicator that the reservoir possess suitable nesting sites. Bald eagles typically nest in large trees with open branching, and within two mi of a lake, reservoir, or river inhabited by fish. Most nesting territories in California are located in elevations ranging from 1,000 to 6,000 ft; however, nesting can occur from near sea level to over 7,000 ft (Jurek 1988). Nest trees typically provide an unobstructed view of the associated water body and are often prominently located on the topography. Bald eagles often construct up to five nests within a territory and alternate among them from year to year.

Nine bald eagle nests were located during surveys of the Don Pedro Project in 2012, three of which were occupied by nesting bald eagle pairs. Three nests were found in Woods Creek Arm, and one nest was found at each of the following locations: Upper Bay, Big Creek Arm, Mine Island, Jenkins Hill, South Bay, and Tuolumne River Arm. Of these, two nests (one at Mine Island and one at Woods Creek Arm) successfully produced bald eagle nestlings that were observed during the second 2012 survey. Because these nestlings were not observed through fledging, both of these nests were categorized as Occupied, Success Unknown. A third nest (at South Bay) was occupied by a bald eagle pair during the first survey, but no adult bald eagles or nestlings were located during the second survey. This nest was categorized as Occupied, Not Successful. The remaining six nests were categorized as Not Occupied; these nests likely serve as alternate nests to the three occupied nests located in 2012.

Ten bald eagle nests were found during surveys in 2013. Two of these nests, Mine Island nest and Woods Creek Arm No. 1, were occupied in 2013. Both of these nests were also occupied in 2012. Nestlings were present at both of these nests. The single nestling at the Woods Creek Arm nest likely fledged prior to the second survey visit. The two nestlings at the Mine Island nest had also fledged. Both nests were categorized as Occupied, Successful.

Incidental sightings of bald eagles were also recorded as part of other 2012 and 2013 relicensing studies. Twenty-one incidental sightings of bald eagles were recorded during relicensing studies in 2012. Eight incidental observations of nine bald eagles were made in the study area during the two survey visits in 2013. Sightings included both adult and juvenile bald eagles either perched, feeding near the reservoir bank, or in flight. Incidental sightings of bald eagles from 2012 are shown in Table 3.7-2, and incidental sightings of eagles from 2013 are shown in Table 3.7-3. Additionally, the BLM reported an incidental observation from June 12, 2013 of a juvenile bald eagle perched in a tree with a nest, and a second bald eagle in flight near the nest (Cranston 2013). The observation was upstream of the Ward's Ferry Bridge on the Tuolumne River.

Table 3.7-2. Results of incidental bald eagle sightings on Don Pedro Reservoir in 2012.

Date	No. of Bald Eagles	Location	UTM-N	UTM-E	Activity/Observation[1]	Perch Type
1/26/2012	1	Blue Oaks Recreation Area	--	--	perched	--
2/10/2012	2	Woods Creek Arm	4195114	727510	adults – nesting	--
2/10/2012	1	Hatch Creek Arm	4180762	732779	juvenile – perched	--
3/7/2012	1	Blue Oaks Boat Launch	--	--	perched	--
3/7/2012	1	Mine Island	4178397	729669	adult – perched	--
3/19/2012	2	Don Pedro Recreation Agency Headquarters	4175411	727029	flying	--
3/20/2012	1	North end of Mine Island	4179762	728485	flying in area near nest, on nest	gray pine (*Pinus sabiniana*)
4/3/2012	1	West Bay of Don Pedro Reservoir	4176529	726937	perched on boulder near waters edge	boulder
4/3/2012	1	Blue Oaks Boat Launch Fish Cleaning Station	4176010	726313	flying around fish cleaning station	--
4/17/2012	2	Big Creek upstream of Don Pedro Reservoir	4183779	727495	1 adult feeding, juvenile and adult seen flying together shortly after initial observation	creek bank
4/18/2012	1	49er Bay	4181134	729015	juvenile – perched	ground
4/19/2012	1	Rogers Creek	4173124	734437	adult – soaring	--
5/9/2012	1	Near siphon	--	--	feeding	on land at water's edge
5/9/2012	1	Middle Bay	4182123	731523	flying	--

Date	No. of Bald Eagles	Location	UTM-N	UTM-E	Activity/Observation[1]	Perch Type
5/9/2012	1	Upper Bay	4186873	728035	perched	on land at water's edge
5/22/2012	1	Six Bit Gulch near outlet	4188644	727592	juvenile – soaring, perched	pine
6/25/2012	1	Rogers Creek Arm	4173712	733736	juvenile, perched	snag
6/27/2012	2	End of Woods Creek Arm	4195370	727690	adult – soaring, w/prey; perched	--
--	1	South Bay	4176928	733342	juvenile – 1 year old	--
--	1	Middle Bay	4182123	731523	juvenile – 1 year old flying	--
--	1	Upper Bay	4186497	727999	juvenile	on land at water's edge

[1] Activity/Observation = the observation made of the individual(s) or nest during helicopter surveys.
Perched – the individual was found perched on an object; on nest – indicates the individual was found on a nest.
Feeding – individual was observed in the act of feeding.
Flying – individual was observed in flight.
Nest – indicates the presence of a nest.
Perch Type = Type of structure or tree used as a perch or in which nest was built.
-- indicates information was not included in the incidental observation report.

Table 3.7-3. Results of incidental bald eagle sightings on Don Pedro Reservoir in 2013.

Species	No.	Age[1]	UTM-N	UTM-E	Observation Notes
Bald Eagle (*Haliaeetus leucocephalus*)	1	Adult	4194720	733577	In flight along northeast rim of Tuolumne River Arm canyon, direction of flight was up-canyon towards Ward's Ferry Bridge.
Bald Eagle	1	Adult	4193764	733774	In flight along northeast rim of Tuolumne River Arm canyon, direction of flight was up-canyon towards Ward's Ferry Bridge.
Bald Eagle	1	2 yr. old	4187184	728949	Perched on north shore of the west end of Upper Bay.
Bald Eagle	1	3 yr. old	4187331	727346	Perched on south shore of west end of Upper Bay.
Bald Eagle	1	2 yr. old	4187346	728277	In flight, entering Railroad Canyon from Upper Bay.
Bald Eagle	2	Adult	4184374	731273	Two adults perched together. Both flew due west after 20 minutes of observation.
Bald Eagle	1	2 yr. old	4182252	729593	In flight between 49er Bay and Upper Bay, individual pursued by male from Mine Island Nest.
Bald Eagle	1	2 yr. old	4176348	727228	Perched on island adjacent to Don Pedro Dam.

[1] The age of bald eagles is based on plumage phase as described by Jackman and Jenkins (2004).

3.7.1.5 Golden Eagle

Golden eagle is listed by CDFW as a Fully Protected Species, and is found throughout California, generally as year-round residents. Golden eagles use a range of terrestrial habitats, including forests, chapparal, grasslands, and oak woodlands, feeding on mammals, birds, and terrestrial reptiles, including as carrion. Open water is not considered foraging habitat for the species (CDFW 2013b). Nesting is generally in high cliffs, artificial structures, and large trees (Pagel et al. 2010). No golden eagle nests are known to occur in the Project Boundary or in the vicinity, but one golden eagle was incidentally observed on and above a high ridgetop near the Project Boundary in 2012, and suitable habitat is present within the Project Boundary.

3.7.1.6 Swainson's Hawk

Swainson's hawks are a highly mobile species with wide ranges that inhabit open grasslands with scattered trees, riparian areas, juniper-sage flats, savannahs, and agricultural lands, particularly alfalfa fields; hawks tend to avoid mountainous areas and steep canyons, particularly during the nesting season (CDFW 2013c; Woodbridge 1998). Swainson's hawks migrate to the Central Valley of California in late February and early March for the nesting season, departing in early September (Woodbridge 1998). Hawks feed mainly on insects, except during nesting periods, where the diet includes voles, other small mammals and birds (CDFW 2013c; Woodbridge 1998). Hawks will often nest in lone trees close to foraging habitat, typically in large trees associated with riparian forest. Adults usually have only one brood per year of one to four eggs. Hatchlings take about four to six weeks to fledge, and then remain dependent upon adults for food for an additional two to four weeks (Woodbridge 1998).

Swainson's hawk is listed as California Threatened Species under the CESA (ST) by CDFW and Sensitive by the BLM. Swainson's hawk has declined due to loss of nesting and foraging habitat to residential development and riparian habitat removal (Woodbridge 1998). Additionally, pesticide use on the hawk's migration routes and wintering areas have caused an increase in mortality (Woodbridge 1998).

Nests are not uncommon near roads and active agricultural lands, suggesting that nesting Swainson's hawks are not heavily impacted by regular and consistent human activity (Woodbridge 1998). However, hawks can be sensitive to new activity in areas that were previously inactive and nest abandonment may occur (Woodbridge 1998).

Suitable habitat for Swainson's hawk within the current Project Boundary includes approximately 2,300 acres of annual grasslands, as well as adjacent habitats. No Swainson's hawk were observed during relicensing studies, and there have been no reported occurrences of Swainson's hawk nests within the Project Boundary. The closest reported occurrence of a Swainson's hawk nest to the Project Boundary was in 2001 and was over four miles south of the Project Boundary (CDFW 2013a).

3.7.1.7 Osprey

Osprey range throughout North, Central, and South America. In California, breeding primarily occurs in northern parts of the state. The osprey's diet primarily consists of fish in most open-water habitats along the coast and freshwater lakes and rivers. Osprey feed by flying over water and diving feet-first to grasp fish with their talons. Osprey are not listed as a special-status species by the BLM or other agencies.

Osprey winter in South and Central America, as well as parts of southern California and Arizona. Nesting usually begins in December and lasts until February. Nests are found at the top of large snags, utility poles, channel markers, and in urbanized areas where ospreys readily utilize man-made nesting platforms. Like other raptors, ospreys will reuse their nests for many years. Females lay two to four yellowish eggs that are incubated for approximately 32 days. Both adults tend to the eggs and nestlings, though the female typically provides the majority of care to nestlings, while the male brings food to the nest for the female and young. Adult osprey provide food for young for about 3 months. Young begin to fly at around 55 days after hatching.

Osprey were frequently observed on Don Pedro Reservoir during relicensing studies, either in flight, or perched on or near nests (TID/MID 2013b). Osprey foraging behavior was observed on multiple occasions, although a predator-prey interaction was not directly observed. Surveyors observed eight osprey nests on Don Pedro Reservoir, with concentrations in the areas of the Upper and Middle Bays (three nests and two nests, respectively). Additionally, one nest was recorded in the vicinity of the Highway 49 Bridge, one nest in the West Bay area, and one adjacent to Jacksonville Road close to Jacksonville Road Bridge. Table 3.7-4 summarizes observations of osprey and osprey nests documented during bald eagle surveys, as well as incidental observations reported during other relicensing studies.

Table 3.7-4. Incidental osprey observed on Don Pedro Reservoir.

Date	No.	Location	UTM-N	UTM-E	Activity/Observation[1]	Perch Type
3/7/2012	1	West Bay	4177624	728581	adult – nesting	--
3/20/2012	1	Mine Island	4179763	728490	adult – nesting	--
3/20/2012	2	Below Don Pedro Dam	4174987	726816	soaring	--
3/26/2012	2	Riley Ridge/Big Creek	4175092	727993	soaring	--
4/9/2012	1	Middle Bay	4179061	731281	adult – soaring	--
4/9/2012	1	Rogers Creek	4173368	733675	adult – soaring	--
4/9/2012	1	Rogers Creek	4173237	733975	adult – foraging	--
4/17/2012	2	Middle Bay	4182896	731263	adult – soaring/perched	--
4/17/2012	2	Middle Bay	4179000	732207	adult – soaring/perched	--
4/18/2012	2	Jacksonville Rd/Kanaka Point	4191537	733124	nest – occupied	Power pole
4/18/2012	1	49er Bay	4181492	728977	adult – foraging	--
5/8/2012	--	Riley Ridge/Big Creek	4175290	727876	nest – occupancy unknown	--
5/9/2012	--	Highway 49 bridge area	4190906	730818	nest – occupied	--
5/9/2012	--	Upper Bay	4186601	728220	nest – occupied	--
5/9/2012	--	Upper Bay	4186748	729201	nest – occupied	--
5/9/2012	--	Upper Bay	4186546	730333	nest – occupied	--
5/9/2012	--	Middle Bay	4181418	730771	nest – occupied	--
5/9/2012	--	Mine Island	4179797	728452	nest – occupied	--
5/9/2012	--	West Bay	4178038	728199	nest – occupied	--
2013	--	Woods Creek Arm	4193446	729257	nest – occupied	--

[1] Activity/Observation = the observation made of the individual(s) or nest during helicopter surveys.
Perched – the individual was found perched on an object; on nest – indicates the individual was found on a nest.
Flying – individual was observed in flight.
Nest – indicates the presence of a nest.
Perch Type = Type of structure or tree used as a perch or in which nest was built.
-- indicates information was not included in the incidental observation report.

3.7.1.8 Special-status Bats

Nine special-status bats are known to occur or have the potential to occur in the vicinity of the Don Pedro Project. These nine species are pallid bat (*Antrozous pallidus*), Townsend's big-eared bat (*Corynorhinus townsendii*), spotted bat (*Euderma maculatum*), western mastiff bat (*Eumops perotis*), western red bat (*Lasiurus blossevillii*), western small-footed myotis (*Myotis ciliolabrum*), long-eared myotis (*Myotis evotis*), fringed myotis (*Myotis thysanodes*), and Yuma myotis (*Myotis yumanensis*). The long-eared myotis and Yuma myotis are designated as sensitive species by the BLM; the Western red bat is designated as a Species of Special Concern by the CDFW; the pallid bat, Townsend's big-eared bat, spotted bat and Western mastiff bat are designated as both Species of Special Concern by the CDFW and Sensitive by the BLM.

Pallid Bat

Pallid bats are most abundant in low elevation xeric ecosystems, including rocky arid deserts and canyon lands, shrub-steppe grasslands, karst formations and higher elevation coniferous forests (0–7,000 ft elevation). Pallid bats roost alone, or in small groups of two to 20 individuals, or in larger groups of more than 100. Common roosts include caves, rocky outcrops, crevices, and manmade structures such as buildings and bridges. Pallid bats are primarily gleaning bats that take prey from surfaces; preferred forage consists of insects, including beetles and grasshoppers (Western Bat Working Group (WBWG) 2005a).

Townsend's Big-Eared Bat

Townsend's big-eared bats occupy a wide variety of habitats from sea level to over 10,000 ft in elevation. They can be found in coniferous forests, mixed mesophytic forests, deserts, native prairies, riparian communities, active agricultural areas, and coastal habitat types. Distribution is strongly correlated with the availability of caves and cave-like roosting habitat, including abandoned mines. Townsend's big-eared bats are communal roosters, with maternity colonies ranging in size from a few individuals to several hundred. Foraging occurs on the wing, with over 90 percent of its diet composed of moths (WBWG 2005b).

Spotted Bat

Spotted bats occur throughout the western United States, and have been found from below sea level up to 8,800 ft. They inhabit a wide range of ecosystems including arid deserts, grasslands, and mixed conifer forests. Spotted bats roost singularly, but occasionally can be found in small groups. Prominent rock features appear to be necessary for roosting, and include cracks, crevices, and caves, usually high in fractured rock cliffs. Spotted bats forage on the wing; their primary prey species are moths (WBWG 2005c).

Western Mastiff Bat

Western mastiff bats are primarily a cliff-dwelling species found in a variety of habitats, including desert scrub, chaparral, oak woodland and ponderosa pine, and high elevation meadows. Recent surveys documented western mastiff bats roosting as high as 4,500 ft in

California. Maternity colonies range from 30 to several hundred individuals. Roosts are often high above the ground, and can be found under exfoliating rock slabs. They forage on the wing at heights of 100 to 200 ft. Their common prey items are moths (WBWG 2005d).

Western Red Bat

Western red bats are widely distributed throughout the western United States and are associated with intact riparian habitats. They roost singularly in tree foliage. Western red bats forage on the wing and have been reported to eat insects, beetles, wasps, flies, and moths (WBWG 2005e).

Long-Eared Myotis

Long-eared myotis range across the western United States, occurring in semiarid shrublands, sage, chaparral, and agricultural areas, but are usually associated with coniferous forests. Roost sites include under exfoliating tree bark, in hollow trees, caves, mines, cliff crevices, sinkholes, and rocky outcrops on the ground. They may also be found roosting in buildings and under bridges. Long-eared myotis females form small maternity colonies. Long-eared myotis is a gleaning bat, taking prey off foliage, tree trunks, rocks, and from the ground. Prey items include moths, small beetles, flies, lacewings, wasps, and true bugs (WBWG 2005f).

Yuma Myotis

Yuma myotis are known to use variety of habitats including riparian, arid scrublands, deserts and forests. They are usually associated with permanent water sources. Yuma myotis are roost generalists and can be found in buildings, bridges, cliff crevices, caves, mines and trees. Maternity colonies may have several thousand individuals. They feed on the wing, primarily on aquatic emergent insects (WBWG 2005g).

Reconnaissance surveys, focused surveys, and long-term acoustic monitoring efforts for special-status bats were conducted within the Project Boundary during 2012 (TID/MID 2013c). The reconnaissance survey took into consideration habitat suitability, accessibility, and sampled a broad range of habitat types and localities within the Project Boundary. During the initial reconnaissance for focused survey and Long Term Acoustic Monitoring sites, facilities and recreation sites throughout the study area were evaluated for evidence of bat use. The Districts do not operate or maintain bridges, overpasses, or related structures; as a result, these structures were not considered during study efforts. At each site evaluated, possible bat foraging opportunities and flight corridors were noted, and a visual inspection of structures was performed. The information collected during the initial reconnaissance was used to prioritize locations for focused bat surveys.

During the 2012 relicensing study, seven special-status bat species were documented:

- Pallid bat was documented at four of five survey locations selected for this study: Fleming Meadows Recreation Area swimming lagoon, Don Pedro Dam spillway, Blue Oaks Recreation Area, and Don Pedro powerhouse.

- Western red bat was documented at three sites: Fleming Meadows Recreation Area swimming lagoon, Don Pedro Dam spillway, and Don Pedro powerhouse.
- Long-eared myotis was documented at three sites: Don Pedro Dam spillway, Moccasin Recreation Area, and Don Pedro powerhouse.
- Both Townsend's big-eared bat and Western mastiff bat were documented at two sites: Don Pedro Dam spillway and Don Pedro powerhouse.
- Spotted bat was documented at Don Pedro powerhouse.
- Yuma myotis was documented at Don Pedro Dam spillway.

No maternity roosts or winter hibernacula were identified at facilities or recreation sites. Based on observed use patterns, maternity roosts and winter hibernacula are likely within the study area or vicinity, but none occur at facilities or areas affected by O&M. Two facilities are likely used as day roosts: the Fixed Wheel Gate building and the tunnel adjacent to Don Pedro powerhouse.

A total of 32 night roots were identified, many adjacent to DPRA campgrounds and likely subject to indirect disturbance related to recreational use. Evidence of roosting at campground facilities identified during the 2012 bat study suggests that in general, disturbance to night roosts is limited and is unlikely to result in abandonment by bats. However, the small cinderblock structure near the A2 restroom in the Blue Oaks campground, used by pallid bats as a night roost, showed evidence of human activity (burn marks on the interior walls of the structure, broken glass on the floor).

3.7.2 Resource Effects

Page 36 of FERC's SD2 identifies the following special-status wildlife related issues:

- Effects of project operation, including water level fluctuations, ground-disturbing activities, and maintenance on special-status wildlife species and habitat.[53] […]
- Effects of maintenance and use of project recreation facilities by recreationists on special-status wildlife species, **special-status plant species and botanical resources**, and shoreline vegetation.
- Effects of vegetation clearing for project maintenance on wildlife and botanical resources, **and the presence and spread of noxious weeds**.

Each of these potential effects[54] is analyzed below.

[53] Special-status wildlife species cited during scoping include the western pond turtle, foothill yellow-legged frog, swainson's hawk, bald eagle, osprey, and the California roach or Red Hill roach.

[54] The Proposed Action covered in this application is the Districts' proposal to continue hydroelectric generation at the Don Pedro Project. While Don Pedro Project activities and/or water level fluctuations may have the potential to effect wildlife resources, these operations and routine maintenance activities are for the purposes of water supply and flood control. Hydroelectric project operations are dependent upon water released for these purposes; therefore, reservoir water level fluctuations are not the result of hydroelectric operations. The effect of the Proposed Action has no measurable impact on reservoir water level fluctuations. During relicensing of the Don Pedro Hydroelectric Project, the Districts undertook comprehensive investigations of the wildlife resources associated with the Don Pedro Project within the study area identified in the study plan.

3.7.2.1 Terrestrial Wildlife Habitats

Over 90 percent of the Project Boundary is undeveloped land that is well-removed from any O&M activity and unaffected by the Don Pedro Project. Near facilities and developed recreation areas, O&M includes basic maintenance, including vegetation management, minor ground disturbance, use of county roads within the Project Boundary, and related efforts. In general, these efforts maintain currently developed lands in a developed state, as required for daily operations and recreation uses. This work has the potential to affect wildlife using these habitats, as noise, movement, and disturbance may disrupt wildlife and animals may be flushed or displaced. However, these efforts are infrequent, concentrated in already-disturbed areas, and are limited in scope and duration. As a result, the effects of O&M on wildlife habitats are minor.

As part of the Proposed Action the Districts would extend the existing rip rap protection on the upstream face of Don Pedro Dam from the current elevation of 585 ft to elevation 535 ft. Areas potentially affected by riprap, including staging areas, would receive complete resource survey efforts prior to any ground-disturbing activity and sensitive resources located during such surveys would be avoided or protected; as a result, no adverse resource effects are expected. No other habitat or wildlife species would be affected by periodic use of storage between 600 ft and 550 ft., because the occurrence would be temporary and infrequent, and the areas are typically submerged and not providing terrestrial habitat.

3.7.2.2 Western Pond Turtle and Foothill Yellow-Legged Frog

A total of 14 live WPT were reported in the course of various relicensing studies. Six WPT were detected at five basking survey sites and 10 WPT (eight live, two dead) were observed incidentally at 10 locations. Although Don Pedro Reservoir is used by WPT, the majority of the reservoir does not represent favorable habitat for WPT. Don Pedro Reservoir is characterized by deep, open water and steep banks, a scarcity of basking areas except for backwater areas associated with major tributaries, abundant introduced predatory fish, and occurrences of American bullfrog. These conditions are considered suitable for adult and sub-adult WPT; however, they are less suited for hatchling WPT (approximately 2.5 cm in length) and growing juveniles until they attain size and shell hardness sufficient to escape predation (Ashton et al. 1997). Suitable habitats for juvenile WPT consist of vegetated shallow water which is limited in extent at Don Pedro Reservoir and primarily associated with the mouths of tributaries. Because of vulnerability to predation by introduced predatory fish and bullfrogs, WPT population recruitment at Don Pedro Reservoir appears low.

Don Pedro Reservoir is primarily operated as a storage reservoir; following peak storage the water level is gradually drawn down until its lowest elevation is reached in midwinter. As a result, for those few WPT that do occur, water level changes resulting from reservoir fluctuations could affect potential WPT nesting habitat below the normal maximum water surface elevation in Don Pedro Reservoir. Young WPT in nests (eggs are laid in summer and hatchling turtles remain in the nest for approximately one year) within the fluctuation zone have the potential to be flooded out and/or drowned. The average increase in water surface elevation from May 1 through July 31 during the period of record is 16.9 ft; this suggests there is potential for nests below the normal maximum water surface elevation to be flooded if eggs are laid prior to the peak water surface elevation. However, because WPT typically select sites with at least some vegetation (low grasses and forbs), these sites are likely not impacted by frequent inundation (Holt 1988). While individual nests in the fluctuation zone have the potential to be impacted, a population effect from those impacts (i.e., population decline) is unlikely.

Interactions between recreationists and WPT are likely. Much of the area from Railroad Canyon south is open to shoreline camping, and boating occurs across all of Don Pedro Reservoir. WPT are relatively sensitive to disturbance, and loud or invasive activities may affect the frequency and duration of basking or foraging behavior. Interruptions in basking may lead to a delay in the maturation and deposition of eggs, decreasing hatching success or overwinter behavior (Holland 1991). However, no direct impacts from recreational activities were observed during surveys, and overall use of the Reservoir by WPT, including in recreational areas, is low.

No FYLF were detected during study efforts, and FYLF are not reported to occur within the Project Boundary. Don Pedro Reservoir is characterized by perennial, deep, slow-moving water and steep, poorly vegetated banks. A variety of introduced predatory fish are present, and American bullfrog tadpoles larval and post-metamorphic life stages were observed at many locations within the study area. Although BLM records document two historical FYLF records within the study area upstream of Don Pedro Reservoir, the reservoir itself does not represent potential habitat for FYLF. Tributaries to the reservoir have limited availability of aquatic habitat suitable for oviposition and larval development (i.e., shallow, flowing water with at least some cobble-sized substrate). Additionally, the presence of introduced aquatic predators such as fish and bullfrogs limits the suitability of the habitat for FYLF. Because FYLF are not present in Don Pedro Reservoir and habitat suitability is poor within the study area as a whole, O&M activities are unlikely to affect FYLF populations.

3.7.2.3 Bald Eagle, Osprey, Swainson's Hawk, and Golden Eagle

The results of the 2012 and 2013 bald eagle surveys on Don Pedro Reservoir suggest that the Don Pedro Project is compatible with successful bald eagle foraging and nesting. The majority of Don Pedro Reservoir is subject to recreational uses, such as camping, hiking, motorized and non-motorized boating, and off highway vehicle use, providing the potential for disturbance to bald eagles. However, USFWS guidelines note that bald eagles are "unlikely to be disturbed by routine use of roads, homes, and other facilities where such use pre-dates the eagles' successful nesting activity…[I]n most cases, ongoing existing uses may proceed…with little risk of disturbing bald eagles."[55] Recreational use of Don Pedro Reservoir has been ongoing since Don Pedro Project construction, and two of the three occupied bald eagle nests observed were located in areas of high recreational use. In particular, the Mine Island nest is located in an area that experiences frequent and heavy recreational boat traffic during the spring and summer seasons. Similarly, the nest in the Woods Creek Arm is located in an area that not only receives regular use by boaters, but was constructed in a narrow portion of the canyon that exposes the nest to all passing boats. Disturbances to nesting birds as a result of the O&M does not occur, since no facilities or maintenance activities are located within 1.5 mi of a bald eagle nest.

[55] USFWS 2007

O&M also includes periodic gopher and ground squirrel management in developed recreation areas. The Districts use a GopherX carbon monoxide system that presents no risk to other wildlife and leaves burrows intact following treatment.

Don Pedro Reservoir provides abundant foraging and nesting habitat for osprey, which are frequently observed in the Project Boundary. Osprey are known to have a high tolerance level for human activity in the vicinity of their nests relative to most other raptors, and often select nest sites in close proximity to high levels of human activity. As a result, the Don Pedro Project is not likely to have a substantial impact on osprey.

O&M activities are unlikely to affect Swainson's hawk populations because there are no known Swainson's hawks or hawk nests in the vicinity of the Don Pedro Project. Similarly, while one golden eagle was observed on ridgetops in the vicinity, no nests are known or reported to occur, and the species does not forage on Don Pedro Reservoir. Although both species likely use lands within the Project Boundary, any coincidence of such use and O&M is likely to be limited in frequency and scope.

3.7.2.4 Special-status Bats

A total of seven species of special-status bats were documented in the Project Boundary. Because use of Don Pedro Project facilities and developed recreation areas by special-status bats is common, the use of facilities and disturbance associated with recreation has the potential to affect special-status bats. Bats are sensitive to various disturbances and can be affected by human activities, including the presence of humans at roost sites, or disturbance to roosting and foraging habitat.

No maternity roosts or winter hibernacula were located in areas potentially affected by O&M (bat use patterns suggest they are present in the larger vicinity). Thirty-two night roosts were identified, many within or adjacent to Don Pedro Project campgrounds. However, roosting at campground facilities persisted throughout the 2012 bat study, suggesting that in general, disturbance to night roosts is limited or absent, and is unlikely to result in abandonment by bats.

One night roost was observed to have evidence of human activity: a small cinderblock structure near the A2 restroom in the Blue Oaks campground. This structure is used by pallid bats as a night roost, and was found to have burn marks on the interior walls of the structure and broken glass on the floor. Although this structure was used as a pallid bat night roost for the study duration, the direct nature of the disturbance to this structure suggests that continued or future disturbances occurring at night could lead to a reduction of use by bats or abandonment.

3.7.3 Proposed Resource Measures

3.7.3.1 Terrestrial and Recreation Resource Management Plans

The Districts propose to implement a Terrestrial Resources Management Plan including detailed protection measures for bald eagles and bats in addition to vegetation and noxious weed management efforts and protection for special-status plants. Components of the Terrestrial Resource Management Plan related to wildlife resources include the following:

- bald eagle surveys,
- protection of existing nests and access restrictions to prevent disturbance during bald eagle mating and rearing,
- bat protection guidelines,
- monitoring and recording of incidental observations of Western Pond Turtle, and
- awareness training for employees regarding terrestrial resources.

Additionally, the Districts propose implement a Recreation Resource Management Plan, including management of public access to and use of the cinderblock structure near the A2 restroom in the Blue Oaks campground in order to protect what was documented as a night roost for pallid bats. The implementation of the Terrestrial Resources Management Plan is expected to protect and enhance wildlife resources within the Project Boundary.

3.7.4 Unavoidable Adverse Impacts

The Don Pedro Project has no known unavoidable adverse effects on wildlife species.

3.8 Threatened and Endangered Species

This section addresses Threatened or Endangered species with the potential to occur in the Don Pedro Project vicinity. Species evaluated are listed under the federal ESA, the California Endangered Species Act (CESA), or both. Designated and proposed critical habitat for these species is also addressed. This section references certain species listed as Rare or Fully Protected under California law. Species not listed under the ESA or CESA, but afforded other special designations (e.g., by a federal or state agency), are referred to as “special-status species” and are addressed in sections 3.5, 3.6, and 3.7 of this Exhibit E.

Threatened and Endangered species investigations began by identifying the species with the potential to occur in the Don Pedro Project vicinity. A list of ESA-listed species for the 7.5-minute USGS topographic quadrangles (Chinese Camp, La Grange, Moccasin, Penon Blanco Peak, Sonora, and Standard), which include the area within the Don Pedro Project Boundary, was generated via the on-line request service available at the USFWS’s website (USFWS 2013). Following removal of species that do not occur in the vicinity (based on elevation or habitat requirements), 15 species remained, four listed as Endangered and 11 as Threatened:

- ESA Endangered:
  - Hartweg’s golden sunburst (*Pseudobahia bahiifolia*),
  - Hairy Orcutt grass (*Orcuttia pilosa*),
  - Greene’s tuctoria (*Tuctoria greenei*), and
  - San Joaquin kit fox (*Vulpes macrotis mutica*).

- ESA Threatened:
  - Succulent owl's-clover (*Castilleja campestris ssp. succulenta*),
  - Hoover's spurge (*Chamaesyce hooveri*),
  - Colusa grass (*Neostapfia colusana*),
  - Chinese Camp brodiaea (*Brodiaea pallida*),
  - Layne's ragwort (*Packera layneae*),
  - California vervain (*Verbena californica*),
  - Valley elderberry longhorn beetle (VELB) (*Desmocerus californicus dimorphus*),
  - Vernal pool fairy shrimp (*Branchinecta lynchi*),
  - California tiger salamander (CTS), Central Valley Distinct Population Segment (DPS) (*Ambystoma californiense*),
  - California red-legged frog (CRLF) (*Rana draytonii*), and
  - Steelhead, California Central Valley DPS (*Oncorhynchus mykiss irideus*)[56].

The CDFW list of State and Federally Listed Endangered and Threatened Animals of California was reviewed to identify CESA-listed animals potentially occurring in the Don Pedro Project vicinity. The list includes 157 fish and wildlife species, of which 55 are listed under both the ESA and CESA, 71 are listed only under the ESA, and 31 are listed only under the CESA. The Districts also reviewed the State of California, CDFW List of State Fully Protected Animals. The list includes 37 fish and wildlife species. The California Natural Diversity Database (CNDDB) was reviewed for ESA and CESA plant species occurrences (TID/MID 2013a).

Based on review of habitat requirements and known distributions, 12 species (nine plants, two birds, and one amphibian) were identified that could occur in the vicinity of the Don Pedro Project and are protected under the CESA or listed as rare or fully protected under California law:

- CESA Endangered:
  - Succulent owl's-clover,
  - Hartweg's golden sunburst,
  - Colusa grass,
  - Hairy orcutt grass,
  - Chinese Camp brodiaea,
  - Delta button-celery (*Eryngium recemosum*), and
  - Bald eagle (*Haliaeetus leucocephalus*)[57].

[56] Central Valley steelhead are addressed in sections 3.5 and 4.0 of this Exhibit E.
[57] Bald eagle and golden eagle are addressed in Section 3.7 of this Exhibit E.

- CESA Threatened:
  - California vervain, and
  - California tiger salamander (CTS), Central Valley DPS.
- State Rare:
  - Layne's ragwort, and
  - Greene's tuctoria,
- State Fully Protected:
  - Golden eagle (*Aguila chrysaetos*)[28].

3.8.1 Species Removed from Consideration

In addition to the ESA-listed species initially considered by the Districts (see previous section), FERC's SD2 identified the following ESA-listed wildlife species to be addressed in FERC's environmental analysis for the Project:

- Riparian brush rabbit (*Sylvilagus bachmani riparius*),
- Riparian wood rat (*Neotoma fuscipes riparia*),
- Least Bell's vireo (*Vireo bellii pusillus*), and
- Conservancy fairy shrimp (*Branchinecta conservatio*).

In addition to being ESA-listed, the riparian brush rabbit is also listed as Endangered under the CESA. These four species and their critical habitats (when designated) have not been reported to occur within 5 miles of the Don Pedro Project Boundary, nor within Tuolumne County (CDFW 2013). As a result, these species were removed from further consideration. Habitat within the Don Pedro Project Boundary does not appear to be suitable for any of these species. The closest designated critical habitat for Conservancy fairy shrimp is over 10 miles from the Don Pedro Project Boundary, and no vernal pool habitats, which are required by Conservancy fairy shrimp, were found during extensive field studies conducted within the Don Pedro Project Boundary (Eng et. al 1990). Riparian brush rabbit, riparian wood rat, and least Bell's vireo each require riparian shrub habitats. Field studies conducted by the Districts documented that these habitats are uncommon within the Don Pedro Project Boundary.

3.8.2 ESA- and CESA-listed Plants

Of the 10 ESA- or CESA-listed plants identified above, only two species, Layne's ragwort and California vervain, have been documented to occur within the Don Pedro Project vicinity. CDFW (2013) reported occurrences of these species within 1 mile of the Don Pedro Project Boundary.

The potential for the other eight ESA- or CESA-listed plant species to occur in the Don Pedro Project vicinity is low. Based on life history information gathered through the literature search and on-the-ground observations made during floristic surveys, seven of the 10 species require conditions that are not present in the study area, including:

- Vernal pools, the habitat of Hoover's spurge, succulent owl's clover, Colusa grass, Greene's tuctoria, and hairy Orcutt grass.
- Mima mounds, on which Hartweg's golden sunburst has been found to grow almost exclusively.
- Clay or silty soils in seasonally flooded plains and swales, which are the habitats of Delta button-celery.
- Vernal swales, the habitat of Chinese Camp brodiaea.

Because these plant species are not present in the Don Pedro Project vicinity, they are not addressed in this AFLA.

In 2012, botanical surveys for ESA- and CESA-listed plants were conducted within and adjacent to the Project Boundary, following survey protocols developed in consultation with relicensing participants (TID/MID 2013a). Field studies were conducted in locations within the Don Pedro Project Boundary where there was the potential for resource effects, i.e., all Don Pedro Project facilities, recreation areas, and high-use dispersed recreation areas as identified during study plan consultation. The study area extended outside of the Don Pedro Project Boundary as needed to survey the full extent of plant occurrences, up to 300 ft outside the boundary within high-use recreation areas or the BLM's Red Hills Area of Critical Environmental Concern (ACEC), and where necessary to document the full extent of each ESA- or CESA-listed plant occurrence, up to 0.25 miles outside the Don Pedro Project Boundary. The study area assessed during surveys was approximately 3,870 ac.

Surveys were floristic in nature and followed the botanical survey protocol section of CDFW's *Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Natural Communities* (CDFG 2009). As detailed in the FERC-approved study plan, surveys were conducted using a random meander technique, with additional focus in high quality habitat or other areas with a higher probability of supporting ESA- or CESA-listed plants. Additional detail on survey methodology is provided in Section 3.6 of this Exhibit E.

During these surveys, 25 occurrences of Layne's ragwort and two occurrences of California vervain were documented, all of which were found on federal lands administered by the BLM within the Red Hills ACEC. No other ESA- or CESA-listed plants were found on lands potentially affected by operation and maintenance (O&M) or recreational use.

3.8.2.1 Layne's Ragwort

Regulatory Status

On October 18, 1996, the USFWS listed Layne's ragwort as threatened under the federal ESA (61 FR 54346). No critical habitat has been designated for this species. A 5-year review was initiated by the USFWS for this species in March 2009 (USFWS 2012a). The USFWS issued a

Recovery Plan for Gabbro Soil Plants of the Central Sierra Nevada, which included Layne's ragwort, among other species (USFWS 2002a). Layne's ragwort is not listed under CESA or listed as a sensitive species by the BLM, but is on the CDFW list of state rare species, under the Native Species Plant Protection Act of 1977 (USFWS 2012a).

Habitat Requirements

Layne's ragwort is a perennial herb that grows within dry pine or oak woodlands (USFWS 2012c) in open, disturbed rocky areas on gabbro and serpentine soils between 660 ft and 3,280 ft elevation (Baldwin 2012, CNPS 2012). The species is also occasionally found along streams. CNPS reports rapid urbanization as the primary threat to Layne's ragwort, along with clearing, grazing, road construction, and fire suppression (CNPS 2012).

Occurrence and Habitat within the Don Pedro Project Boundary

During botanical surveys, 25 occurrences of Layne's ragwort were recorded within or adjacent to the Don Pedro Project Boundary. Occurrences ranged from five to 250 plants, with a total estimated area of 2.9 ac. The majority of Layne's ragwort was located in gray pine (*Pinus sabiniana*) woodlands, with wedgeleaf ceanothus (*Ceanothus cuneatus*), toyon (*Heteromeles arbutifolia*), chamise (*Adenostoma fasciculatum*), and common manzanita (*Arctostaphylos manzanita*) as common subdominants. Four of the occurrences were found in chaparral, dominated by wedgeleaf ceanothus, hollyleaf redberry (*Rhamnus ilicifolia*), and toyon. Special-status plants commonly co-occurred with Layne's ragwort, including Red Hills onion (*Allium tuolumnense*), Red Hills soaproot (*Chlorogalum grandiflorum*), tripod buckwheat (*Eriogonum tripodum*), Congdon's lomatium (*Lomatium congdonii*), and shaggy-haired lupine (*Lupinus spectabilis*). Three Layne's ragwort occurrences were recorded at Kanaka Point, near a day-use area off Jacksonville Road. There are multiple footpaths throughout the area, including one that runs within a few feet of two occurrences.

3.8.2.2 California Vervain

Regulatory Status

On September 14, 1998, the USFWS listed California vervain as threatened under the ESA (Federal Register 63:49002). No critical habitat has been designated for this species. The USFWS is currently developing a Recovery Plan for California vervain. In December 2007, a 5-year review of the species by the USFWS recommended no change in designation. California vervain is also listed as threatened under CESA, but is not listed as a sensitive species by the BLM (USFWS 2012a).

Habitat Requirements

California vervain is a perennial herb that is found along small intermittent or perennial streams (CDFG 2005), usually within serpentinite, cismontane woodlands in valley and foothill grasslands between 853 ft and 1,312 ft elevation. It is occasionally found in non-wetland areas (Calflora 2012). This species is only known to grow in the Red Hills of California (CNPS 2012).

The USFWS identifies recreational activities such as gold mining, mountain biking, and hiking as threats to California vervain. In addition, hydrological fluctuations also affect the species (USFWS 2012c).

Occurrence and Habitat within the Don Pedro Project Boundary

Two occurrences of California vervain were recorded within the study area during botanical surveys: one in Poor Man's Gulch and one in Six Bit Gulch. Both occur on public lands administered by the BLM within the Red Hills ACEC. During the surveys, the occurrence in Poor Man's Gulch consisted of over 200 individuals occupying approximately 0.2 ac. The occurrence in Six Bit Gulch consisted of two individuals occupying approximately 4 ft^2. Both were located within riparian zones dominated by arroyo willow (*Salix lasiolepis*), sedges (*Carex sp.*), white broadiaea (*Triteleia hycinthina*), and baltic rush (*Juncus balticus*).

3.8.3 ESA and CESA-listed Invertebrates

3.8.3.1 Valley Elderberry Longhorn Beetle

Regulatory Status

On August 8, 1980, the USFWS listed VELB as threatened under the ESA (Federal Register 45:52803). VELB is not listed as threatened or endangered under CESA, nor formally listed as a sensitive species by BLM, nor considered a Species of Special Concern by the CDFW. Critical habitat has been designated for the species, including the American River Parkway and Sacramento Zones (USFWS 1980). The Don Pedro Project is outside of the critical habitat zones, but falls within the potential range of the beetle.

The USFWS issued a VELB Recovery Plan on August 28, 1984. On February 14, 2007, the USFWS completed a 5-year review, which resulted in the recommendation that VELB be de-listed (USFWS 2012b). In October 2012, the USFWS began the process of reviewing the delisting proposal (USFWS 2012c).

Delisting is being assessed because of evidence that VELB may be widespread and less threatened than it was when initially listed. There are currently over 200 recorded occurrences of VELB, where there had been only 10 at the time of listing. Also, the destruction of riparian areas has slowed, and recovery efforts have led to the restoration and replanting of riparian areas, including plantings of elderberry (USFWS 2012c).

Life History and Habitat Requirements

The VELB is dependent on its host plant, elderberry (*Sambucus* spp.), which is a common component of riparian corridors and adjacent upland areas in the Central Valley, for all of its life stages (i.e., egg, larva, and adult). VELB primarily occurs within the riparian corridor but can occur infrequently in non-riparian scrub habitats adjacent to the corridor, and less commonly in annual grasslands and live oak woodlands. VELB appear to be capable of limited dispersal and prefer to remain within contiguous patches of high quality riparian habitat.

The VELB life cycle takes one or two years to complete. Eggs are laid on elderberry leaves or bark and hatch within two days. The larvae live within the stems of the plants feeding on the pith for one to two years. Adults emerge from the stems through holes made by larvae prior to pupation. Adults generally emerge from late March through June and are short-lived (USFWS 2009). The exit holes created by larvae prior to pupation are often the only evidence of VELB presence.

Occurrence and Habitat Within the Don Pedro Project Boundary

In 2012, the Districts conducted a data review for known occurrences of VELB, botanical surveys for elderberry plants, and stem inspections for beetle exit holes on elderberry plants within the Don Pedro Project Boundary (TID/MID 2013b). Surveys for elderberry plants followed CDFW's *Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Natural Communities* (CDFG 2009). The study included all areas potentially subject to O&M activities, including all facilities and recreation sites, dispersed recreation areas on Don Pedro Reservoir, and 10 drainages within the Don Pedro Project Boundary that were also designated for wetland studies.

During surveys, 73 elderberry plant occurrences were recorded. VELB boreholes were observed at 14 of the elderberry occurrences, ranging from two to 43 exit holes (Table 3.8-1). Of the 14 elderberry plants with exit holes, only two were found in riparian areas; the majority were in partially disturbed habitat near roads or developed recreation areas.

Table 3.8-1. Elderberry plants with observed VELB exit holes.

Site Location	Riparian Yes|No	Stem Count[1]	Number of Exit Holes	Recent Yes|No	Land Ownership
Moccasin Point Recreation Area	No	15	15	No	MID/TID
Moccasin Point Recreation Area	No	13	7	No	MID/TID
Moccasin Point Recreation Area	Yes	10	43	Yes	MID/TID
Moccasin Point Recreation Area	Yes	1	2	No	Public - BLM
Below dam	No	1	8	No	MID/TID
Sewage pond across from Blue Oaks Recreation Area	No	1	5	No	MID/TID
Hatch Creek	No	1	10	No	MID/TID
Jacksonville Road	No	1	6	No	Public – BLM
Jacksonville Road	No	1	3	No	Public - BLM
Jacksonville Road	No	1	2	No	MID/TID
Jacksonville-Harney Road	No	1	2	No	Public - BLM
Moccasin transmission line	No	n/a	19	No	MID/TID
Rogers Creek Arm	No	18	8	No	MID/TID
Rogers Creek Arm	No	7	9	No	MID/TID

[1] Stems one inch or greater at the base.

3.8.3.2 Vernal Pool Fairy Shrimp

Regulatory Status

On September 19, 1994, vernal pool fairy shrimp were listed as Threatened under the ESA (59 FR 48136-48153). Critical habitat for vernal pool fairy shrimp, along with other vernal pool species, was originally designated in a final rule on August 6, 2003. A revised final rule for critical habitat, with unit designations by species, was published on February 10, 2006, with 35 critical habitat units for vernal pool fairy shrimp totaling 597,821 ac (USFWS 2006a). Of these, critical habitat unit VERFS21B is the closest to the Don Pedro Project, at approximately 2.6 miles from the edge of the Don Pedro Project Boundary.

The USFWS issued a draft Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon in October 2004; the recovery plan was finalized on December 15, 2005 (USFWS 2005a). A five-year status review for vernal pool fairy shrimp and other species was initiated on May 25, 2011 (USFWS 2011).

Life History and Habitat Requirements

Vernal pool fairy shrimp occur mostly in vernal pools, but may also occur in natural and artificial seasonal wetland habitats, such as alkali pools, ephemeral drainages, stock ponds, roadside ditches, vernal swales, and rock outcrop pools (NatureServe 2009). Vernal pool fairy shrimp occupy a variety of different vernal pool habitats, from small, clear, sandstone rock pools to large, turbid, alkaline, grassland valley floor pools (Eng et al. 1990, Helm 1998). Although vernal pool fairy shrimp have been collected from large vernal pools, including one exceeding 25 ac in area (Eriksen and Belk 1999), the species tends to occur primarily in smaller pools (Platenkamp 1998), and it is most frequently found in pools measuring less than 0.05 ac (Gallagher 1996, Helm 1998). The vernal pool fairy shrimp typically occurs at elevations from 30 to 4,000 ft (Eng et al. 1990), although the species has been found at two sites in the Los Padres National Forest at an elevation of 5,600 ft. The vernal pool fairy shrimp has been collected at water temperatures as low as 4.5°C (Eriksen and Belk 1999) and has not been found in water with temperatures above about 23°C (Helm 1998, Eriksen and Belk 1999). The species is typically found in pools with low to moderate amounts of salinity or total dissolved solids (Collie and Lathrop 1976, Keeley 1984, Syrdahl 1993). Because vernal pools are mostly rain-fed, they usually have low nutrient levels and often have dramatic daily fluctuations in pH, dissolved oxygen, and carbon dioxide (Keeley and Zedler 1998).

Occurrence and Habitat Within the Don Pedro Project Boundary

Most of the known occurrences of vernal pool fairy shrimp are in the Central Valley and Coast Ranges of California, with disjunct populations in San Luis Obispo County, Santa Barbara County, and Riverside County (Eng et al. 1990, Erickson and Belk 1999). The CNDDB includes a record of one occurrence within the Sonora quad, which is adjacent to the Don Pedro Project quads (CDFW 2013). The Districts engaged in detailed terrestrial resource studies in 2012, during which no vernal pools, or vernal pool plants that might indicate their presence, were located.

3.8.4 ESA and CESA-listed Vertebrates

3.8.4.1 California Tiger Salamander

Regulatory Status

On August 4, 2004, the Central California DPS of CTS was listed as Threatened under the ESA (69 FR 47212). Critical habitat was designated for the Central California Population DPS on August 23, 2005, (70 FR 79380), including an area approximately 1 mile southwest of the Don Pedro Project Boundary in Stanislaus County.

Life History and Habitat Requirements

CTS breeding habitat is generally associated with shallow, seasonal (i.e., continuously flooded for a minimum of 10-12 consecutive weeks), or semi-permanent pools and ponds that fill during heavy winter rains, or in permanent ponds (Alvarez 2004b). Adult CTS spend little time at breeding sites before returning to upland habitats. CTS populations generally do not persist where fish, American bullfrog, or predacious insects are well established. Breeding occurs mainly from December through February after rains fill pools and ponds. Eggs are laid singly or in small clusters, often attached to submerged stems and leaves, and hatch in two to four weeks. Larvae transform in about four months (Behler and King 1979) as water recedes in late spring or summer, but larvae may overwinter in permanent ponds (Alvarez 2004a). CTS may not breed at all in drought years when ponds fail to fill. CTS live in vacant or mammal-occupied burrows (e.g., California ground squirrel, *Otospermophilus beecheyi*, and valley pocket gopher, *Thomomys bottae*) (Trenham 2001), or occasionally other underground retreats, throughout most of the year in grassland, savannah, or open woodland habitats.

According to the Interim Guidance on Site Assessment and Field Surveys for Determining Presence or a Negative Finding of the CTS (USFWS 2003), the criteria for CTS breeding habitat include the presence of standing water for a period sufficient for larvae to achieve metamorphosis. Breeding generally occurs between December and February. Larvae may metamorphose in as little as 10-12 weeks, although typically not until May to July (Laabs et al. 2001). Natural vernal pools, stock ponds, drainage ditches, and pools in low-gradient streams are potential habitats. Permanent ponds may be suitable, but not if predatory fish are established. The presence of American bullfrog (*Lithobates* [*Rana*] *catesbeianus*), introduced crayfish, and predacious insects may also decrease site suitability. Suitable upland habitats are equally important to the occurrence of CTS.

Occurrence and Habitat within the Don Pedro Project Boundary

There are five known historical CTS occurrences within 5 miles of the Don Pedro Project Boundary. The most recent of these was documented in 2007, approximately 0.4 miles from Don Pedro Reservoir (CDFW 2013). No CTS were observed during site assessments performed as part of 2012 surveys, nor were there any incidental sightings of CTS during other relicensing studies.

Site assessments and habitat characterizations were performed for CTS in the Don Pedro Project vicinity, which consisted of a review of historical data, identification of potential habitats using aerial photography and National Wetlands Inventory digital maps (USFWS 1987), and site evaluations (TID/MID 2013c). As specified in the FERC-approved study plan, the study area consisted of all suitable aquatic habitats within the Don Pedro Project Boundary and lands within 1.24 miles of the boundary, consistent with USFWS requirements. The study locations varied from large streams with substantial overhanging vegetation to manmade agricultural or water treatment ponds with no cover and limited vegetation. Ponds and streams within the Don Pedro Project vicinity are located in a mix of oak pastureland and pine savannah with shrubs, grasses, and forbs adjacent to the aquatic habitat. The diversity of study locations was representative of the Don Pedro Project Area as a whole. Small burrows were present at many sites.

Potential CTS breeding habitat (standing water for at least 10 weeks during the breeding season) was documented at or near 247 habitat sites within the study area. Many of the aerially assessed sites that held water for at least 10 weeks appeared to have suitable upland dispersal habitat nearby. Following aerial assessment, field surveys were conducted to verify habitat conditions and collect additional information at potential breeding sites within the Don Pedro Project Boundary and representative breeding locations on publicly accessible lands within 1.24 miles of the boundary. Field surveys revealed that the majority of these sites were perennial streams that were unsuitable because of high gradient or a lack of upland habitat suitable for dispersal. Within the Don Pedro Project Boundary, 38 field-assessed sites were characterized as potentially suitable for CTS breeding, 29 of which were considered more favorable to CTS breeding due to the presence of small burrows and upland habitat suitable for dispersal.

Based on their proximity to Don Pedro Project facilities or Don Pedro Reservoir, 20 sites were identified as having the potential to be affected by O&M activities. Of these 20 sites, two sites did not meet the 10-week criterion. Lack of emergent or overhanging vegetation or the presence of aquatic predators diminishes the potential suitability of most of the sites. Several pools in the spillway channel could not be accessed in the field due to safety concerns, making it impossible to determine whether CTS predators, such as fish and American bullfrog, were present. Table 3.8-2 summarizes the sites that are potentially affected by O&M activities, and describes elements important to CTS breeding habitat.

Table 3.8-2. Summary of CTS breeding sites potentially affected by O&M (TID/MID 2013c).

Site Number	Habitat Description	Area (acres)	Ownership	Meets 10-Week Criterion	Fish Known to Occur at Don Pedro Project Site
F31	Stream in Moccasin Point Recreation Area	0.39	MID/TID	N	None
F45	Sewage Treatment Pond near Fleming Meadows Recreation Area	1.51	MID/TID	Y	None
F46	Sewage Treatment Pond near Blue Oaks Recreation Area	1.53	MID/TID	Y	None
F47	Swimming lagoon at Fleming Meadows Recreation Area	2.16	MID/TID	Y	None

Site Number	Habitat Description	Area (acres)	Ownership	Meets 10-Week Criterion	Fish Known to Occur at Don Pedro Project Site
F49	Sewage Treatment Pond near Fleming Meadows Recreation Area	0.12	MID/TID	Y	None
F50	Sewage Treatment Pond near Blue Oaks Recreation Area	0.71	MID/TID	Y	None
F51	Sewage Treatment Pond near Moccasin Point Recreation Area	0.68	BLM	Y	None
F52	Sewage Treatment Pond near Moccasin Point Recreation Area	0.02	BLM	Y	None
F73	Stream in Moccasin Point Recreation Area	0.22	MID/TID	N	None
F77	Pool in spillway channel	0.14	MID/TID	Y	Not likely
F78	Pool in spillway channel	0.06	MID/TID	Y	Not likely
F80	Pool in spillway channel	1.61	MID/TID	Y	Not likely
F81	Pond at base of Gasburg Creek Dike, adjacent spillway channel.	0.88	MID/TID	Y	None
F82	Pool in spillway channel	0.33	MID/TID	Y	Not likely
F83	Pool in spillway channel	0.45	MID/TID	Y	Not likely
F85	Pool in spillway channel	0.33	MID/TID	Y	Not likely
F86	Pool in spillway channel	0.80	MID/TID	Y	Not likely
F87	Pool in spillway channel	0.32	MID/TID	Y	Not likely
F88	Pool in spillway channel	0.33	MID/TID	Unknown	Not likely
F89	Pool in spillway channel	0.06	BLM	Y	Not likely

3.8.4.2 California Red-Legged Frog

Regulatory Status

On May 23, 1996, the USFWS listed CRLF as threatened throughout its range (61 FR 25813 25833). The Final Recovery Plan for CRLF was issued on September 12, 2002 (67 FR 57830), and critical habitat was designated on March 13, 2001 (66 FR 14626), with additional critical habitat designated on April 13, 2006 (71 FR 19244), and revised on March 17, 2010 (75 FR 12816). No USFWS-designated Critical Habitat Units occur within 29 miles of the Don Pedro Project Boundary.

Life History and Habitat Requirements

CRLF is primarily associated with perennial ponds or pools and perennial or seasonal streams, where water remains for a minimum of 20 weeks beginning in the spring (i.e., sufficiently long for breeding to occur and larvae to complete development) (Jennings and Hayes 1994, USFWS 2006b). CRLF is also typically associated with low-gradient streams (Hayes and Jennings 1988), backwaters, and lentic habitat with emergent vegetation, although habitats lacking vegetation are sometimes used. Suitable CRLF breeding habitat is defined as:

> *Low-gradient fresh water bodies, including natural and manmade (e.g., stock) ponds, backwaters within streams and creeks, marshes, lagoons, and dune ponds….To be considered essential breeding habitat, the aquatic feature must*

> *have the capability to hold water for a minimum of 20 weeks in all but the driest of years* (USFWS 2010).

Locations with the highest densities of CRLF exhibit dense emergent or shoreline riparian vegetation closely associated with moderately deep (greater than 2.3 ft), still, or slow moving water. Plants that provide the most suitable structure are willows, cattails, and bulrushes at or close to the water level, which shade a substantial area of the water (Hayes and Jennings 1988). Another factor correlated with CRLF occurrence is the absence or near-absence of introduced predators such as American bullfrog and predatory fish, particularly mosquitofish and freshwater sunfishes, the latter of which feed on CRLF larvae at higher rates than do native predatory fish species (Hayes and Jennings 1988). The presence of non-native fish favors survival of bullfrogs over CRLF in streams (Hayes and Jennings 1988, Kruse and Francis 1977, Werner and McPeek 1994, Adams et al. 2003, Gilliland 2010). Hiding cover used to avoid predators may consist of emergent vegetation, undercut banks, and semi-submerged root wads (USFWS 2005b). Some habitats that are not suitable for breeding (e.g., shallow or short-seasonal wetlands, pools in intermittent streams, seeps, and springs) may constitute habitats for aestivation, shelter, foraging, predator avoidance, and juvenile dispersal.

Depending on elevation and climate, CRLF may breed from late November to late April. Egg masses are attached to emergent vegetation such as cattails or bulrush in natural ponds, stock ponds, marshes, or in deep pools and stream backwaters. Larvae typically metamorphose between July and September (Jennings and Hayes 1994).

Adult dispersal outside the breeding season may be directed upstream, downstream, or upslope of breeding habitat, and may be associated with foraging and pursuit of hiding cover or aestivation habitat. Telemetry and other detection methods indicate that CRLF use small mammal burrows, leaf litter, and other moist sites as much as 200 ft from riparian areas (Jennings and Hayes 1994, USFWS 2006b). Long-distance dispersal has been documented at distances of up to 1 mile but probably occurs only during wet periods (USFWS 2006b).

Occurrence and Habitat within the Don Pedro Project Boundary

No occurrences of CRLF have been recorded within 5 miles of the Don Pedro Project Boundary since 1984, and the USFWS's recovery plan for the species lists CRLF as extirpated from the Tuolumne River watershed (USFWS 2002b).

Site assessments and habitat characterizations were performed for CRLF in the Don Pedro Project vicinity, including a review of historical data, identification of potential habitats using aerial photography and National Wetlands Inventory digital maps (USFWS 1987), and site evaluations (TID/MID 2013d). As specified in the FERC-approved CRLF study plan, the study area for this effort consisted of all suitable aquatic habitats within the Don Pedro Project Boundary and lands within 1 mile of the boundary, consistent with USFWS requirements. Ponds and streams within the study area are located in a mix of oak pastureland and pine savannah with shrubs, grasses, and forbs adjacent to the aquatic habitat. The study locations varied from large streams with substantial overhanging vegetation to agricultural or water treatment ponds with no cover and limited vegetation. The diversity of study locations was representative of the Don Pedro Project area as a whole.

Initial assessment using aerial photography and National Wetlands Inventory digital maps determined that a total of 211 locations within the study area met the minimum criterion of 20 weeks of standing or slow-moving water during the CRLF breeding season. Many of the aerially assessed sites that met the 20-week criterion had some emergent and overhanging vegetation, but while these sites were located within the study area, they were not located within the Don Pedro Project Boundary, and were classified as marginal due to habitat type (e.g., human-made agricultural ponds) and the presence of bullfrogs.

Following aerial assessment, field surveys to verify habitat characterizations and collect additional information were performed at potential breeding sites within the Don Pedro Project Boundary, and representative breeding locations on publicly accessible lands within one mile of the boundary. Field surveys revealed that the majority of these sites provide marginal habitat due to a lack of emergent or overhanging vegetation or because of the presence of predators such as fish and bullfrogs. Of the field-assessed sites, 52 were characterized as potentially suitable CRLF breeding sites based on the minimum criterion, 10 of which were considered more favorable for CRLF breeding due to the presence of suitable vegetation and lack of predators. No CRLF were observed during this or other studies. Table 3.8-3 summarizes sites that are potentially affected by O&M activities, and describes elements important to CRLF breeding habitat.

Table 3.8-3. Summary of CRLF breeding sites potentially affected by O&M activities (TID/MID 2013d).

Site Number	Habitat Description	Area (acres)	Meets 20-Week Criterion	Notes
F31	Stream in Moccasin Point Recreation Area	0.39	N	No emergent vegetation present Blackberry overhanging.
F45	Sewage Treatment Pond near Fleming Meadows Recreation Area	1.51	Y	No emergent or overhanging vegetation present.
F46	Sewage Treatment Pond near Blue Oaks Recreation Area	1.53	Y	No emergent of overhanging vegetation present.
F47	Swimming lagoon at Fleming Meadows Recreation Area	2.16	Y	Pool lined with concrete. No vegetation present.
F49	Sewage Treatment Pond near Fleming Meadows Recreation Area	0.12	Y	Pond lined with concrete. No vegetation present.
F50	Sewage Treatment Pond near Blue Oaks Recreation Area	0.71	Y	Pond lined with concrete. No vegetation present.
F51	Sewage Treatment Pond near Moccasin Point Recreation Area	0.68	Y	Emergent vegetation limited. No overhanging vegetation.
F52	Sewage Treatment Pond near Moccasin Point Recreation Area	0.02	Y	Pond lined with concrete. Vegetation consisted of sparse forbs.
F73	Stream in Moccasin Point Recreation Area	0.22	N	Emergent vegetation: curled dock, cleavers, aster, grasses, and submerged rushes. Oak and toyon overhanging.

Site Number	Habitat Description	Area (acres)	Meets 20-Week Criterion	Notes
F77	Pool in spillway channel	0.14	Y	Emergent vegetation: cattail, monkey flower, bulrush, and primrose. No overhanging vegetation present.
F78	Pool in spillway channel	0.06	Y	Emergent vegetation: cattail, bulrush, primrose, and fern. No overhanging vegetation.
F80	Pool in spillway channel	1.61	Y	Emergent vegetation: cattail and some sedges. Sparse buckeye overhanging.
F81*	Pond at base of Gasburg Creek Dike, adjacent spillway channel.	0.88	Unknown	Emergent vegetation: primrose and bulrush. Blue oak overhanging.
F82	Pool in spillway channel	0.33	Y	Emergent vegetation present. Willows overhanging.
F83	Pool in spillway channel	0.45	Y	Emergent vegetation present. Willows overhanging.
F85	Pool in spillway channel	0.33	Y	Emergent vegetation present. Willows and shrubs overhanging.
F86	Pool in spillway channel	0.80	Y	Emergent vegetation present. Willows overhanging.
F87	Pool in spillway channel	0.32	Y	Emergent vegetation present. Oaks and willows overhanging.
F88	Pool in spillway channel	0.33	Unknown	Emergent and aquatic vegetation present. Shrubs overhanging.
F89	Pool in spillway channel	0.06	Y	No emergent or overhanging vegetation present.

* Sites considered more favorable for CRLF breeding due to the presence of suitable vegetation and lack of predators.

3.8.4.3 San Joaquin Kit Fox

Regulatory Status

The San Joaquin kit fox was originally listed as endangered in 1967 under the Endangered Species Preservation Act (32 FR 4001). It is currently ESA-listed as an endangered species. The Final Recovery Plan for Upland Species of the San Joaquin Valley, including San Joaquin kit fox, was issued on September 30, 1998 (Williams et. al. 1998). A five-year review was completed for the species in February 2010, and no change to listing status was recommended.

Life History and Habitat Requirements

San Joaquin kit foxes mate in winter and have between four and seven young in February or March. They use multiple underground dens throughout the year, sometimes using pipes or culverts as den sites in addition to burrows. Their primary prey is usually the most abundant nocturnal rodent or lagomorph in their area. They also feed opportunistically on carrion, birds, reptiles, insects, and fruits (NatureServe 2009).

San Joaquin kit foxes are reported to use a wide range of habitats, including alkali sink, valley grassland, and foothill woodlands (NatureServe 2009), at times in proximity to agriculture and grazing lands (Bell 1994). Kit foxes prefer loose-textured soils (Grinnell et al. 1937, Hall 1946, Egoscue 1962, Morrell 1972) but are found on virtually every soil type. Dens appear to be scarce in areas with shallow soils (OFarrell and Gilbertson 1979, OFarrell et al. 1980), high water tables (McCue et al. 1981), or impenetrable hardpan layers (Morrell 1972). However, kit foxes will occupy soils with high clay content, such as those in the Altamont Pass area in Alameda County, where they modify burrows excavated by other animals (Orloff et al. 1986).

Occurrence and Habitat within the Don Pedro Project Boundary

The CNDDB includes a single record of a San Joaquin kit fox within the general vicinity of the Don Pedro Project Boundary, approximately 2.1 mi southwest of the boundary. The record is from 1972-1973, in an area that is currently an Off-Highway Vehicle recreation development (CDFW 2013). No occurrences of San Joaquin kit fox have been recorded within 5 miles of the Don Pedro Project Boundary since 1973 (CDFW 2013). No kit fox sightings or large burrows were documented during the Districts' extensive terrestrial surveys conducted during 2012, but apparently suitable habitat for the species is common. As a result, the presence of kit foxes cannot be ruled out.

3.8.5 Resource Effects

Page 37 of FERC's SD2 identifies the following issues related to Threatened and Endangered species:

- Effects of project operation, including water level fluctuations, ground-disturbing activities, and maintenance on plants and wildlife species listed as threatened or endangered under the Endangered Species Act (ESA).[58]
- Effects of maintenance and use of project recreation facilities by recreationists on species listed as threatened or endangered under the ESA.
- Effects of project operation and maintenance on designated critical habitat under the ESA.[59]
- Effects of vegetation clearing for project maintenance on species listed as threatened or endangered under the ESA.

[58] (Footnote from FERC's SD2) Species cited by Districts as Threatened or Endangered under the ESA occurring in the Don Pedro Project area and surrounding lands include the Hartweg's golden sunburst, Hairy Orcutt grass, Greene's tuctoria, San Joaquin kit fox, succulent owl's-clover, Hoover's spurge, Colusa grass, Chinese Camp brodiaea, Layne's ragwort, Red Hills vervain, Valley elderberry longhorn beetle, vernal pool fairy shrimp, California tiger salamander (Central Valley DPS), California red-legged frog, and the steelhead (California Central Valley DPS)). Additional species cited during scoping as Threatened or Endangered under the ESA occurring in the Don Pedro Project Area or surrounding lands include the riparian brush rabbit, the riparian wood rat, the Least Bell's vireo, and conservancy fairy shrimp.

[59] (Footnote from FERC's SD2) Species cited by Districts with designated critical habitat occurring in the project area and surrounding lands include the Hairy Orcutt grass, Greene's tuctoria, Succulent owl's-clover, Hoover's spurge, Colusa grass, vernal pool fairy shrimp, California tiger salamander (Central Valley DPS), and steelhead (California Valley DPS).

3.8.5.1 Effects of the Proposed Action

The Proposed Action would have no direct or indirect adverse effects on the ESA-and CESA-listed species addressed in this AFLA. The Districts' Preferred Plan would have no effect on reservoir water surface elevations, recreational use, or maintenance activities, and as a result have no adverse effect on listed species or their potential habitats.

The Districts have proposed to lower the minimum operating pool from the current elevation of 600 ft. to 550 ft. The Districts would extend the existing riprap protection on the upstream face of Don Pedro Dam from the current elevation of 585 ft to elevation 535 ft. Areas potentially affected by riprap, including staging areas, would receive complete resource survey efforts prior to any ground-disturbing activity and sensitive resources located during such surveys would be avoided or protected; as a result, no adverse resource effects are expected. No other lands or terrestrial species would be affected by periodic use of storage between 600 ft and 550 ft. because the areas potentially affected are typically submerged.

Electric power is generated at the Don Pedro Hydroelectric Project using flows released for other purposes. Irrigation, municipal, and industrial water deliveries are pre-scheduled based on forecasted demands and actual projected inflow and then released through the powerhouse up to its hydraulic capacity. These releases are shaped during periods of peak electrical demand, when consistent with water supply requirements and subject to irrigation infrastructure constraints, to release more flow during on-peak rather than off-peak hours. However, such minor variability in flow releases immediately downstream of Don Pedro Dam as the result of hydroelectric operations has no significant influence on water surface elevation or other conditions in Don Pedro Reservoir. Reservoir levels reflect operations related to diversions and releases made in association with unrelated and non-interdependent actions, e.g., providing water for irrigation and municipal and industrial uses, as well as flood management in accordance with ACOE guidelines. Hydroelectric generation at the Don Pedro Hydroelectric Project cannot adversely impact ESA-listed species, because environmental variability in the reservoir is not linked to power production and, absent power production at the Don Pedro Project, the operations, including recreation, would remain as they are under existing conditions, i.e., driven by uses other than hydropower production.

3.8.5.2 Resource Effects of Don Pedro Project O&M Actions

Description of O&M Actions

All actions described and evaluated below are related to the Don Pedro Project's primary purposes (water supply for irrigation and M&I uses and water management for flood control). These actions are unrelated to the Proposed Action, which would not contribute to adverse effects on ESA-listed species.

Facilities and Road Maintenance

As part of operating the Don Pedro Project to achieve its primary purposes, the Districts maintain developed facilities and roads using a combination of mechanical mowing and periodic use of pre-emergent herbicides to manage vegetation. Areas maintained by the Districts are typically managed in proportion to their use. Developed facilities and associated roads are managed with pre-emergent herbicides annually after the first fall rain, usually in November. Similarly, the perimeters of wastewater treatment facilities are sprayed annually, using herbicides labeled for aquatic use when appropriate, to manage vegetation or aquatic weeds and algae. Mechanical removal of aquatic weeds is also conducted when growth is excessive. Main access road shoulders are mechanically mowed or treated with herbicides. In contrast, unpaved roads leading to Don Pedro Dam from the main road are rarely used, and no formal management is conducted. All herbicide use is conducted by licensed applicators in accordance with label requirements.

Recreation Area Maintenance

The Districts' three developed recreation areas are managed to control vegetation and the associated risk of fire. High-use sections of each recreation area are subject to mechanical mowing and trimming on a frequent basis, and pads, road edges, firebreaks, and the immediate areas around restrooms and DPRA facilities are sprayed with pre-emergent and/or post-emergent herbicides annually after the first rains. All herbicide use is conducted by licensed applicators in accordance with label requirements. O&M also includes periodic gopher and ground squirrel management in developed recreation areas. The Districts use a GopherX carbon monoxide system that presents no risk to other wildlife and leaves burrows intact following treatment.

The Districts have a Prescribed Burn Program that allows the use of prescribed burns for vegetation management. The Prescribed Burn Program includes limitations on the timing and frequency of burns, depending on weather conditions, to minimize fire risk and the potential for damage to adjacent habitats. The Districts use prescribed burning on a limited basis as a management tool. The last burn conducted under the program occurred in 2009, but the Districts will continue to use prescribed burns as conditions permit.

Woody Debris Management

Article 52 of the existing FERC license requires the implementation of the Districts' Log and Debris Removal Plan. Under the Plan, the Districts collect and remove woody debris at Don Pedro Dam and from other areas in the reservoir as needed so it does not impede rafting and other recreational uses. Debris is collected in boom rafts, piled in un-vegetated areas below the high-water mark along the reservoir's edge, and burned during fall and winter. The Districts have proposed continuing this support for recreational uses of Don Pedro Reservoir through the implementation of a Woody Debris Management Plan.

Effects Analysis for O&M Actions

The following sections provide an assessment of the potential effects of O&M activities conducted to support the Don Pedro Project's primary purposes (water supply and flood control) on each ESA-/CESA-listed species addressed in this AFLA. Effects discussed in the following sections are unrelated to the Proposed Action for the reasons described above.

Layne's Ragwort and California Vervain

Potential stressors and disturbances to Layne's ragwort and California vervain include terrestrial recreation, cattle grazing, noxious weeds, vegetation management, and road maintenance. Small portions of several Layne's ragwort occurrences are located below the normal maximum water surface elevation of the reservoir. These plants are not currently adversely affected by variation in water surface elevation related to the Don Pedro Project's primary purposes of water supply and flood control.

Three occurrences of Layne's ragwort and one occurrence of California vervain were found near recreation sites, but no occurrences were found adjacent to roads or other facilities. Recreation activities, particularly equestrian trail riding, take place in the vicinity of several occurrences of Layne's ragwort and California vervain in Poor Man's Gulch. A cleared trail runs close by Layne's ragwort occurrence 631. Equestrians ride into the area from upstream of the Don Pedro Project. Very few recreationists appear to access the gulches from the reservoir shoreline. On Kanaka Point, recreationists access the area via a free day-use parking lot, and there is evidence of a walking trail in the vicinity of all Layne's ragwort surveyed in the area. In addition, distaff thistle (*Carthamus creticus*) was observed within 250 ft of a Layne's ragwort occurrence. Distaff thistle is a noxious weed that spreads quickly and can form dense stands, which can displace native plants (DiTomaso and Healy 2007). Because no occurrences of Layne's ragwort or California vervain are located near roads or other facilities, O&M activities are unlikely to affect these two plant species.

California Red-Legged Frog and California Tiger Salamander

CRLF are not known to occur within the Don Pedro Project boundary. No occurrences have been documented within a 5-mile radius of the Don Pedro Project, and the species is reported to be extirpated from the Tuolumne River watershed. Because the species is not believed to occur within the boundary, there is little to no potential for facilities and road maintenance, recreation, recreation area maintenance, and woody debris management to have an adverse effect on CRLF.

CTS are not known to occur within the Don Pedro Project Boundary, but are reported to occur in the Don Pedro Project vicinity. CTS breeding habitat is present within the Don Pedro Project boundary, but it is considered to be of marginal quality. As a result, adverse effects on CTS resulting from facilities and road maintenance, recreation, or recreation area maintenance are unlikely.

CRLF and CTS breeding habitat was documented at seven sites located at recreational facilities, i.e., one constructed swimming lagoon and six sewage treatment ponds. Each of these sites is lined with either concrete or gravel and has little or no surrounding upland vegetation. Although these sites all hold water for at least 10 weeks during the CTS breeding season and 20 weeks during the CRLF breeding season, they are considered to be marginal habitat due to their lack of overhanging and emergent vegetation and lack of suitable adjacent upland habitat. Therefore, they are unlikely to support CRLF or CTS. No potential CRLF or CTS breeding habitat was documented adjacent to roads or other facilities.

Ten of the sites that met the minimum criteria for both CTS and CRLF breeding habitats are located within or adjacent to the Don Pedro Dam spillway channel. However, flow has only been passed through the spillway twice since Project construction (i.e., during the 1997 and 2017 flood). The rare use of the spillway makes potential adverse effects on any CTS or CRLF, if they were present, highly unlikely.

Valley Elderberry Longhorn Beetle

VELB host plants (i.e., elderberry) and evidence of VELB were documented within the Don Pedro Project Boundary. Most elderberry shrubs are located on shorelines or hillsides that are not affected by the Don Pedro Project. The elderberry plants located in developed recreation areas and adjacent to facilities were vigorous at the time of the 2012 surveys, showing no signs of stress.

Elderberry occurrences 47 and 307 are located near the normal maximum water surface elevation of Don Pedro Reservoir. Under existing conditions, these plants are not adversely affected by variation in water surface elevation related to the Don Pedro Project's primary purposes of water supply and flood control.

Two elderberry occurrences are located near a sewage pond, where vegetation management activities are conducted. Six occurrences at Moccasin Point and one occurrence at Blue Oaks Recreation Area are located near roads and campsites, and nine occurrences at Kanaka Point, Harney Road, Hatch Creek, Shawmut Road, and Rogers Creek Arm are potentially subject to trampling caused by day-use recreation, particularly during summer months.

Under existing conditions, elderberry found near roads and recreation areas showed no signs of stress from human disturbance. Therefore, under existing conditions, road maintenance, recreation facilities maintenance, and woody debris management are expected to have no significant adverse effects on elderberry, and as a result should have no effects on VELB. Disturbance by recreational users is possible, as stated above, but because elderberry found near roads and recreation areas showed no signs of stress from human disturbance under existing conditions, it is reasonable to assume that disturbance is likely to be limited in the future.

San Joaquin Kit Fox

San Joaquin kit fox are not reported to occur within the Don Pedro Project Boundary, and during extensive terrestrial field surveys conducted in 2012 no kit foxes were sited and no large burrows were documented. The Districts do not engage in predator control that could affect San Joaquin kit fox, and no habitat conversions are proposed that would alter potential San Joaquin kit fox habitat within the Action Area. As a result, adverse effects on any kit foxes that might at times occupy potentially suitable habitat in the Project Boundary are unlikely.

Vernal Pool Fairy Shrimp

Vernal pool fairy shrimp are not reported to occur within the Don Pedro Project Boundary, and no vernal pools or plant species indicating the presence of vernal pools were documented during the Districts' extensive terrestrial resources field surveys conducted in 2012. Given the absence of the vernal pool fairy shrimp and its habitat, there will be no adverse effects on the species associated with any O&M or recreation activities.

3.8.6 Proposed Resource Measures

The Districts propose to develop and implement a Terrestrial Resources Management Plan to guide noxious weed and other vegetation management activities within the Project Boundary during the term of a new license. Components of the plan include best management practices to limit the spread of existing noxious weed occurrences or the establishment of new occurrences, special-status plant monitoring, employee training, and agency consultation. The Plan also requires the Districts to follow USFWS Conservation Guidelines pertaining to the VELB for the management of elderberry within the Don Pedro Project Boundary (USFWS 1999). These enhancement measures are expected to benefit ESA- and CESA-listed plant species by limiting noxious weed distributions and providing protection of VELB habitat.

3.8.7 Unavoidable Adverse Impacts

The Don Pedro Project has no unavoidable adverse effects on ESA- and CESA-listed species.

3.9 Recreation, Land Use, and Shoreline Management

3.9.1 Existing Environment

3.9.1.1 Recreation in the Don Pedro Project Vicinity

The Don Pedro Project, located on the Tuolumne River in Tuolumne County, California, provides diverse and substantial recreation opportunities, including house boating, pleasure boating, fishing, swimming, water skiing, picnicking, hiking, and camping at either developed or remote sites. Numerous recreational opportunities are also available in the area surrounding the Don Pedro Project as well. Federally managed lands along the Tuolumne River along and above the Don Pedro Reservoir, including the BLM's Area of Critical Environmental Concern (ACEC), the Stanislaus National Forest, and Yosemite National Park, provide extensive opportunities for many popular recreational activities, including hiking, camping, fishing, and high-gradient whitewater boating in an undisturbed natural setting. Downstream of La Grange Diversion Dam, owned by the Districts and located about two miles below Don Pedro Dam, the lower Tuolumne River provides opportunities for fishing, swimming, and low gradient or flat-water boating in a rural/urban setting with agriculture and gravel mining along much of the river corridor.

Overview of Regional Recreation Demand

The California State Parks (2008) California Outdoor Recreation Planning Program (CORP) identifies trends and challenges in providing recreation opportunities to Californians. Trends identified by the 2008 CORP include:

- increasing population densities in urbanized areas,
- demographic shifts in California such as:
  - increased ethnic and cultural diversity,
  - estimated doubling of Californians aged 55 to 75 by the year 2030, and
  - increasing income inequality.
- increasing rates of obesity combined with a decrease in children actively recreating outdoors,
- increased high-tech-related recreation, such as geocaching,
- decline in participation of some traditional outdoor activities such as hunting and fishing,
- increasing use by Californians of their state's local park and recreation areas due to a combination of the economic downturn, the rise in home foreclosures, and fluctuating gasoline prices, and
- continued interest in the pursuit of adventure activities (e.g., mountain biking, scuba diving, kite surfing, and wilderness backpacking) and high-risk activities (e.g., rock climbing, bungee jumping, and hang gliding).

A critical component of the 2008 CORP is to determine the current attitudes, opinions, and beliefs of Californians regarding their experiences using outdoor recreation areas, facilities, and programs. This is achieved through the administration of the Public Opinions and Attitudes in Outdoor Recreational (POAOR) Survey (California State Parks 2009). The survey was conducted in 2007 and differed from previous surveys by including surveys for both adult and youth populations. Similar to previous CORP reports, responses from Hispanic and non-Hispanic adult residents were compared in order to identify any differences in recreation uses and needs between these two groups.

To understand latent demand, Californians were asked to identify which activities they would like to participate in more often. A list of the activities with the highest latent demand for each of these subgroups is found in Tables 3.9-1 through 3.9-3.

Table 3.9-1. Activities with highest latent demand – adult survey.

Ranking	Activity	Ranking	Activity
1	Walking for fitness or pleasure	9	Attending outdoor cultural events
2	Camping in developed sites	10	Off-highway vehicle use
3	Bicycling on paved surfaces	11	Driving for pleasure, sightseeing
4	Day hiking on trails	12	Swimming in a pool
5	Picnicking in picnic areas	13	Wildlife viewing
6	Beach activities	14	Outdoor photography
7	Visiting outdoor nature museums	15	Swimming in freshwater lakes, rivers
8	Visiting historic or cultural sites	--	--

Source: California State Parks, Public Opinions and Attitudes on Outdoor Recreation in California, 2009, p. 38

Table 3.9-2. Activities with highest latent demand – youth survey.

Ranking	Activity	Ranking	Activity
1	Horseback riding	9	Surfing, boogie boarding
2	Sledding, ice and snow play	10	Waterskiing or wakeboarding
3	Snowboarding	11	Swimming in oceans, lakes, rivers and streams
4	Swimming in a pool	12	Archery
5	Jet skis or wave runners	13	Camping
6	Rock climbing	14	Attending outdoor events
7	Beach activities	15	Paddle sports
8	Off-road vehicle use	--	--

Source: California State Parks, Public Opinions and Attitudes on Outdoor Recreation in California, 2009, pp.112-114

Table 3.9-3. Activities with highest latent demand – Hispanic adults.

Ranking	Activity	Ranking	Activity
1	Bicycling on paved surfaces	9	Attending outdoor cultural events
2	Walking for fitness or pleasure	10	Off-highway vehicle use
3	Day hiking on trails	11	Driving for pleasure, sightseeing
4	Picnicking in picnic areas	12	Swimming in a pool
5	Visiting outdoor nature museums	13	Wildlife viewing
6	Camping in developed sites	14	Outdoor photography
7	Beach activities	15	Swimming in freshwater lakes, rivers
8	Visiting historical or cultural sites	--	--

Source: California State Parks, Public Opinions and Attitudes on Outdoor Recreation in California, 2009, pp.86-87

There are four primary categories of outdoor recreation areas in the 2008 CORP. These are (1) highly developed park and recreation areas, (2) developed nature-oriented park and recreation areas, (3) historical or cultural buildings, sites and areas, and (4) natural or undeveloped areas. Californians visit all four types of outdoor recreation areas, with the most popular being highly developed parks and recreation areas.

The broader geographic area beyond the Project vicinity currently provides opportunities for visitors to participate in many of the outdoor activities that have high latent demand. These opportunities include:

- camping in developed sites,
- day hiking on established trails,
- picnicking in picnic areas,
- beach activities,
- wildlife viewing,
- outdoor photography,
- swimming in freshwater lakes, rivers,
- jet skiing or wave runner use,
- waterskiing or wakeboarding, and
- paddle sports (canoeing, kayaking, row boating).

Upper Tuolumne River Recreation Opportunities

Yosemite National Park and Stanislaus National Forest are prominent features of the watershed above the Don Pedro Project. The Tuolumne Meadows area within Yosemite National Park provides easily accessible recreational opportunities for people of all ages and abilities, and many individuals, families, and groups establish traditional ties with the area. The National Park Service (NPS) and other organizations promote the river and adjacent meadows as a focus of nature interpretation and education in the Sierra Nevada. The Pacific Crest Trail, one of eight National Scenic Trails, generally follows the river corridor in this segment of the trail.

In 1984, Congress designated portions of the upper Tuolumne River as Wild and Scenic. A total of 54 miles of the Tuolumne River within Yosemite National Park have been designated as Wild and Scenic. These sections include the Dana Fork and Lyell Fork at the headwaters of the river; a scenic segment through Tuolumne Meadows; a wild segment from the Grand Canyon of the Tuolumne River to the inlet of Hetch Hetchy Reservoir; a scenic segment from one mile west of O'Shaughnessy Dam; and the remaining five mile wild segment through Poopenaut Valley to the park boundary. Approximately 13 river miles of the Hetch Hetchy Reservoir were not included in the 1984 Wild and Scenic River designation and thus are not included within the Tuolumne Wild and Scenic River corridor.

The remaining segments of the Wild and Scenic Tuolumne River are under the administration of the USFS and the BLM. Approximately six miles below the O'Shaughnessy Dam, the Tuolumne River leaves Yosemite National Park and enters the Stanislaus National Forest. The Stanislaus National Forest encompasses 898,099 ac on the western slope of the Sierra Nevada between Lake Tahoe and Yosemite National Park. There are three wilderness areas within the Stanislaus National Forest: Carson-Iceberg, Emigrant, and Mokelumne. The forest offers a full range of year-round recreation opportunities including wildlife viewing, hiking, fishing, camping, picnicking, and off-road vehicle use (USDA undated).

There are a variety of developed and undeveloped camping areas along the upper Tuolumne River upstream of the Project Boundary. Campsites are utilized by hikers, whitewater boaters, anglers, and other recreational users. The most commonly used camping areas along the upper Tuolumne are the Tuolumne Meadows located within Yosemite National Park and Hetch Hetchy Reservoir. Camping at Hetch Hetchy is undeveloped camping, and a wilderness permit is required (NPS 2010).

In all, portions of the Tuolumne River designated as Wild & Scenic include stretches of the river extending 83 miles upstream of the Don Pedro Project Boundary. No specific reaches of the Tuolumne River within the FERC Project Boundary were designated by Congress as Wild or Scenic. However, when establishing an approximate location for the wild and/or scenic reaches, the USFS' description of the wild and scenic corridor overlapped with the 1966 authorized FERC Project Boundary for a distance of about one mile. This USFS description is contrary to the 1984 designating act which states "[n]othing in this section is intended or shall be construed to affect any rights, obligations, privileges, or benefits granted under any prior authority of law including chapter 4 of the Act of December 19, 1913, commonly referred to as the Raker Act (38

Stat. 242) *and including any agreement or administrative ruling entered into or made effective before the enactment of this paragraph."* [emphasis added]. (Public Law 98-425).

Camping

Within the Stanislaus National Forest, there are 12 riverside campsites and three USFS campgrounds. Motorhomes and vehicles with trailers are not recommended in many of the campgrounds along the upper Tuolumne River, as the access roads can be steep and rutted and electric and sewer hookups are not available in many of the dispersed camping areas (2009 Great Outdoor Recreation Pages [GORP] - Tuolumne River). A summary of the camping areas and amenities is provided in Table 3.9-4.

Table 3.9-4. Upper Tuolumne Campgrounds.

Developed Campgrounds
Tuolumne Meadows Campground (Yosemite National Park) - located on the Tioga Road, northeast of Yosemite Valley at an elevation of 8,600 ft. Open July through late September, offering 304 tent campsites, seven group campsites, and four horse campsites. Fees for campgrounds are: $20/night for each campsite (maximum six people per site); $40/night for the group campsite (13 to 30 people per site); and $25/night for the horse sites (maximum six horses and six people per site). Additional amenities include a dump station and general store.
Glen Aulin Campground (Yosemite National Park) - located along the Tuolumne River approximately one mile upriver from the Grand Canyon of the Tuolumne at an elevation of approximately 7,800 ft. Open July through September (snowmelt permitting); reservations and NPS wilderness permits required; tent cabins and traditional tent campsites available by lottery through High Sierra Camps.
Hetch Hetchy Campground (Yosemite National Park) - located along the Tuolumne River immediately downriver from the Hetch Hetchy Reservoir. Open year round (snowmelt permitting); reservations and NPS wilderness permits required; trailers, vehicles over 25 ft long, and RVs and other vehicles over eight ft wide are not allowed on Hetch Hetchy Road. No boating or swimming permitted at Hetch Hetchy Reservoir.
South Fork Campground (Stanislaus National Forest) - located near the confluence of the South and Main Forks of the Tuolumne River at an elevation of 1,500 ft. Approximately one mile upstream from the Lumsden Campground. The facility offers eight campsites with two vault toilets, stoves, and tables. Most sites are on the river or have river access. There is no running water, no use fee, and is not recommended for trailers / RV campers.
Lumsden Campground (Stanislaus National Forest) - located on the Tuolumne River one mile from South Fork Campground, within the Tuolumne-Lumsden Recreation Area off of Lumsden Road and Highway 120 at an elevation of 1,500 ft. The facility offers eleven campsites along the river with four vault toilets, stoves, and tables. There is no running water, no use fee, and is not recommended for trailers / RV campers.
Lumsden Bridge Campground (Stanislaus National Forest) - located on the Tuolumne River next to Lumsden Campground, within the Tuolumne-Lumsden Recreation Area off of Lumsden Road and Highway 120 at an elevation of 1,500 ft. The facility offers nine campsites along the river with two vault toilets, stoves, and tables. There is no running water, no use fee, and is not recommended for trailers / RV campers.
Undeveloped Camping[1]
Tin Can Cabin - located 3.5 miles downriver from Lumsden Campground on the Tuolumne River.
Clavey - located 5.5 miles downriver from Lumsden Campground on the Tuolumne River.
Powerhouse - located 7.6 miles downriver from Lumsden Campground on the Tuolumne River.
Grapevine - located 8.0 miles downriver from Lumsden Campground on the Tuolumne River.
Indian Creek - located 8.3 miles downriver from Lumsden Campground on the Tuolumne River.
Wheelbarrow - located 8.8 miles downriver from Lumsden Campground on the Tuolumne River.
Baseline - located 8.9 miles downriver from Lumsden Campground on the Tuolumne River.
Driftwood Paradise - located 11.4 downriver from Lumsden Campground on the Tuolumne River.
Cabin - located 12.8 miles downriver from Lumsden Campground on the Tuolumne River.
Big Creek - located 13.0 miles downriver from Lumsden Campground on the Tuolumne River.

Developed Campgrounds
Mohican - located 14.1 miles downriver from Lumsden Campground on the Tuolumne River.
North Fork - located 15.0 miles downriver from Lumsden Campground on the Tuolumne River.

[1] All undeveloped camping managed by Stanislaus National Forest.
Source: GORP 2009 - Tuolumne River, NPS 2010

Whitewater Boating/Rafting

In addition to camping along the Tuolumne, whitewater boating/rafting occurs upstream of the Project Boundary. All of the whitewater boating reaches identified in Table 3.9-5 provide opportunities for both kayaks and rafts. The upper Tuolumne River whitewater rafting season generally runs from April through August. The area along the upper Tuolumne from Cherry Creek to Don Pedro Project Boundary is commonly referred to as the Main Tuolumne. Most of the 27 mile Main Tuolumne River reach is an advanced Class IV-V river, and many portions require USDA Forest Service permits (California Whitewater 2010). There are four commercial white water companies that operate regularly on the Main Tuolumne (All-Outdoors California Whitewater Rafting, ARTA River Trips, O.A.R.S. California Whitewater Rafting, and Sierra Mac River Rafting Trips).

Table 3.9-5. Known whitewater boating runs on the Tuolumne River upstream of the Project area.

Whitewater Run	Length (miles)	Gradient (feet per mile)	Flow Range (cfs)	Optimum Flow Range (cfs)	Whitewater Classification
Upper Tuolumne (Meral's Pool to Ward's Ferry)	18.0	40	600-10,000	3,000	IV-V (600-4000) IV+ (4000-8000) V-V+ (8000+)
Cherry Creek (Cherry Creek just below bridge to Meral's Pool)	9.0	110	600-2,000	1,500	V (600-1500) V+ (1500-2000)
Clavey River (Upper Bridge to Lower Bridge)	8.5	n/a	n/a	n/a	V+
South Fork of Tuolumne (Highway 120 to Rainbow Pool Picnic Area)	7.0	n/a	n/a	n/a	IV-V

Source: California Whitewater 2010

Fishing

Fishing is also a popular recreational activity along the upper Tuolumne River. There are a variety of access points along this reach. The sections listed below outline some of the main fishing areas along the upper Tuolumne, as well as the season, bag limit, and special regulations pursuant to the CDFW (CDFG 2010a).

- Lyell Fork of the Tuolumne in Yosemite National Park:
  - Season: Last Saturday in April through November 15,
  - Bag limit: five, and
  - Special regulations: Brook trout minimum 10 inches. No fishing from piers or bridges. Use of live bait prohibited.

- Dana Fork of the Tuolumne in Yosemite National Park:
  - Season: Last Saturday in April through November 15,
  - Bag limit: five, and
  - Special regulations: Brook trout minimum 10 inches. No fishing from piers or bridges. Use of live bait prohibited.
- Grand Canyon of the Tuolumne in Yosemite National Park:
  - Meadows or from Hetch Hetchy Campgrounds,
  - Season: Last Saturday in April through November 15,
  - Bag limit: five, and
  - Special regulations: Brook trout minimum 10 inches. Use of live bait prohibited.
- Hetch Hetchy Reservoir:
  - Season: Year round,
  - Bag limit: five, and
  - Special regulations: Use of live bait prohibited. No boating or swimming permitted.
- O'Shaughnessy Dam to Early Intake Diversion Dam (Cherry Creek Confluence) in Yosemite National Park and Stanislaus National Forest:
  - Season: Last Saturday in April through November 15,
  - Bag limit: two, and
  - Special regulations: Minimum length 12 inches. Only artificial lures with barbless hooks may be used.
- Early Intake Diversion Dam (Cherry Creek Confluence) to South Fork Tuolumne confluence in Stanislaus National Forest:
  - Season: Last Saturday in April through November 15,
  - Bag limit: five, and
  - Special regulations: Minimum length 12 inches. Only artificial lures with barbless hooks may be used.
- South Fork Tuolumne confluence to Clavey River confluence in Stanislaus National Forest:
- Season: Last Saturday in April through November 15,
- Bag limit: two, and
- Special regulations: Minimum length 12 inches. Only artificial lures with barbless hooks may be used.
- Clavey River confluence to North Fork Tuolumne confluence in Stanislaus National Forest:
  - Season: Last Saturday in April through November 15,
  - Bag limit: five, and

  - Special regulations: Minimum length 10 inches. Only artificial lures with barbless hooks may be used.
- North Fork Tuolumne confluence to Don Pedro Reservoir:
  - Season: Last Saturday in April through November 15,
  - Bag limit: five, and
  - Special regulations: Minimum length 10 inches. Only artificial lures with barbless hooks may be used.

Recreation Opportunities Downstream of the Don Pedro Project

Downstream of the Don Pedro Project, the Tuolumne River continues through rural farmland, gravel mining areas, and urban landscapes before joining with the San Joaquin River. The main focus of recreational activity downstream of the Don Pedro Project area takes place at Turlock Lake and Modesto Reservoir, followed by fishing and boating on the lower Tuolumne River.

There are eight publicly available means of access to the lower Tuolumne River from Old La Grange Bridge at RM 50.5 to Shiloh Bridge at RM 3:

- Old La Grange Bridge (RM 50.5),
- Basso Bridge (RM 47.5),
- Turlock Lake SRA (RM 42),
- Riverwalk Park in Waterford (RM 31),
- Fox Grove (RM 26.1),
- Legion Park (RM 17.6),
- Riverdale Park in West Modesto (12.3), and
- Shiloh Bridge Fishing Access Site (RM 3).

Camping

Turlock Lake SRA is located in eastern Stanislaus County, approximately seven miles from Don Pedro Reservoir and provides the only developed camping facilities along the lower Tuolumne River corridor. The Turlock Lake SRA is open year-round and provides for water-oriented outdoor activities. The recreation area features the lake with its 26 miles of shoreline and access to the Tuolumne River. Picnicking, day-use, and boat launch ramps are offered at the lake. A campground and boat launch are located on the Tuolumne River within the SRA. Views of the surrounding savannas and some of the cattle ranches and orchards nearby are available at several lookout points. From Lake Road, which separates the campground from the day use area, the river and sloughs, and miles of dredger tailing piles, the by-product of a half century of mining, can be viewed (California State Parks 2013).

Each of the 66 campsites at the campground has a stove, table and food locker; piped drinking water is also available within one hundred feet of each campsite. Hot showers and restrooms with flush toilets are available within the campsite area. Although no trailer hookups are available, trailers up to 27 ft can be accommodated in the campsites.

Modesto Reservoir Regional Park is located a few miles east of the town of Waterford off California State Highway 132. This regional park offers 3,240 ac of land and 2,800 ac of reservoir for recreation and camping. Facilities include approximately 150 full hook-up campsites, undeveloped camping areas, marina, concessions, restrooms, picnic shelter, barbeques, picnic tables, archery range, and radio-control glider airplane field.

Campsites at the Modesto Reservoir Regional Park are available on a "first-come, first-served basis." Recreation opportunities include swimming, fishing, boating, water/jet skiing, bird watching, waterfowl hunting (with permit during specific times of year), archery, and radio-control airplane flying.

Boating

The Tuolumne River from La Grange Diversion Dam to the San Joaquin River, a 50-mile river reach, has a mild to low gradient, resulting in flat and swift water boating opportunities for floating in kayaks, rafts, and inner tubes. The steeper gradients (approximately five-six feet per mile) are in the upstream portion from Old La Grange Bridge (RM 50.5) to Turlock Lake SRA (RM 42). Downstream of RM 32, gradients are less than two feet per mile.

Fishing

The lower Tuolumne River provides fishing opportunities, with special regulations for trout and salmon fishing. From La Grange Diversion Dam to the mouth of the San Joaquin River, no trout or salmon may be taken from the Tuolumne. Turlock Lake is stocked with trout, black bass, crappie, bluegill and catfish. Modesto Reservoir also offers fishing opportunities. Anglers fish from boats on these reservoirs or from the shoreline, as well as along the lower Tuolumne River. Table 3.9-6 summarizes the fishing regulations on the lower Tuolumne River from La Grange Diversion Dam to the mouth of the San Joaquin River. Fishing access is restricted from October 16 through December 31 due to the salmon run (Stanislaus County 2010).

Table 3.9-6. Summary of fishing regulations for Tuolumne River downstream of Don Pedro Project area.

Fish Type	Open Season	Bag Limit	Special Regulations
Tuolumne River			
Trout	1/1 - 10/31	0	Only artificial lures with barbless hooks may be used.
Black Bass	1/1 - 10/31	5	N/A
Striped Bass	1/1 - 10/31	2	Minimum length 18 in.
Salmon	1/1 -- 10/31	0	Only artificial lures with barbless hooks may be used.
Turlock Lake			
Trout	All year	5	N/A
Black Bass	All year	5	Minimum length 12 in.
Striped Bass	All year	2	Minimum length 18 in.

Fish Type	Open Season	Bag Limit	Special Regulations
Crappie	All year	25	N/A
Bluegill	All year	25	N/A
Catfish	All year	No limit	N/A

Source: CDFG 2010a.

3.9.1.2 Recreation within the Project Boundary

Primary access to the Don Pedro Reservoir is by California State Highways 120 and 49 and Jacksonville Road from the north; Kelly-Grade, Marshes Flat Road, and Blanchard Road from the east; California State Highway 132 from the southeast; Bonds Flat Road from the south; and County Road J-59 from the southwest. The public has access from the three developed recreation areas described above and a number of minor roads outside the main recreation areas.

The Don Pedro Reservoir has a normal maximum surface area of slightly less than 13,000 ac at a reservoir elevation of 830 ft, and the Project Boundary encompasses a total of approximately 18,370 ac. The Project Boundary extends from below the Don Pedro Dam at RM 53.8 to RM 80.8. The total shoreline length is approximately 160 miles, including islands.

Primary recreation activities at Don Pedro Reservoir include fishing; boating and other water based activities; hiking, biking, and general trail use; picnicking; camping; and activities at dispersed recreation areas. Developed recreation areas account for under 10 percent of the reservoir shoreline leaving over 90 percent of the Don Pedro shoreline undeveloped and in its natural state. This undeveloped shoreline allows for dispersed boat-in camping along the majority of the reservoir, as well as fishing, boating, and other day use opportunities discussed in more detail below.

Don Pedro Project Recreation Facilities

There are three developed recreation facilities on Don Pedro Reservoir: Moccasin Point Recreation Area, Blue Oaks Recreation Area, and Fleming Meadows Recreation Area (Figure 3.9-1).

Developed recreation facilities are maintained and operated by the DPRA with oversight by the Don Pedro Board of Control. Together, the three developed recreation areas include 559 campsites of various types, three boat launch facilities with a total of 14 launch lanes, three designated picnic areas with a total of 43 picnic sites, two full-service marinas, a houseboat dock and repair yard, five fish cleaning stations, and one swimming lagoon (TID/MID 2013a). In addition, there are 749 single vehicle parking spaces, 566 vehicle and trailer parking spaces, and 56 boat trailer-only parking spaces.

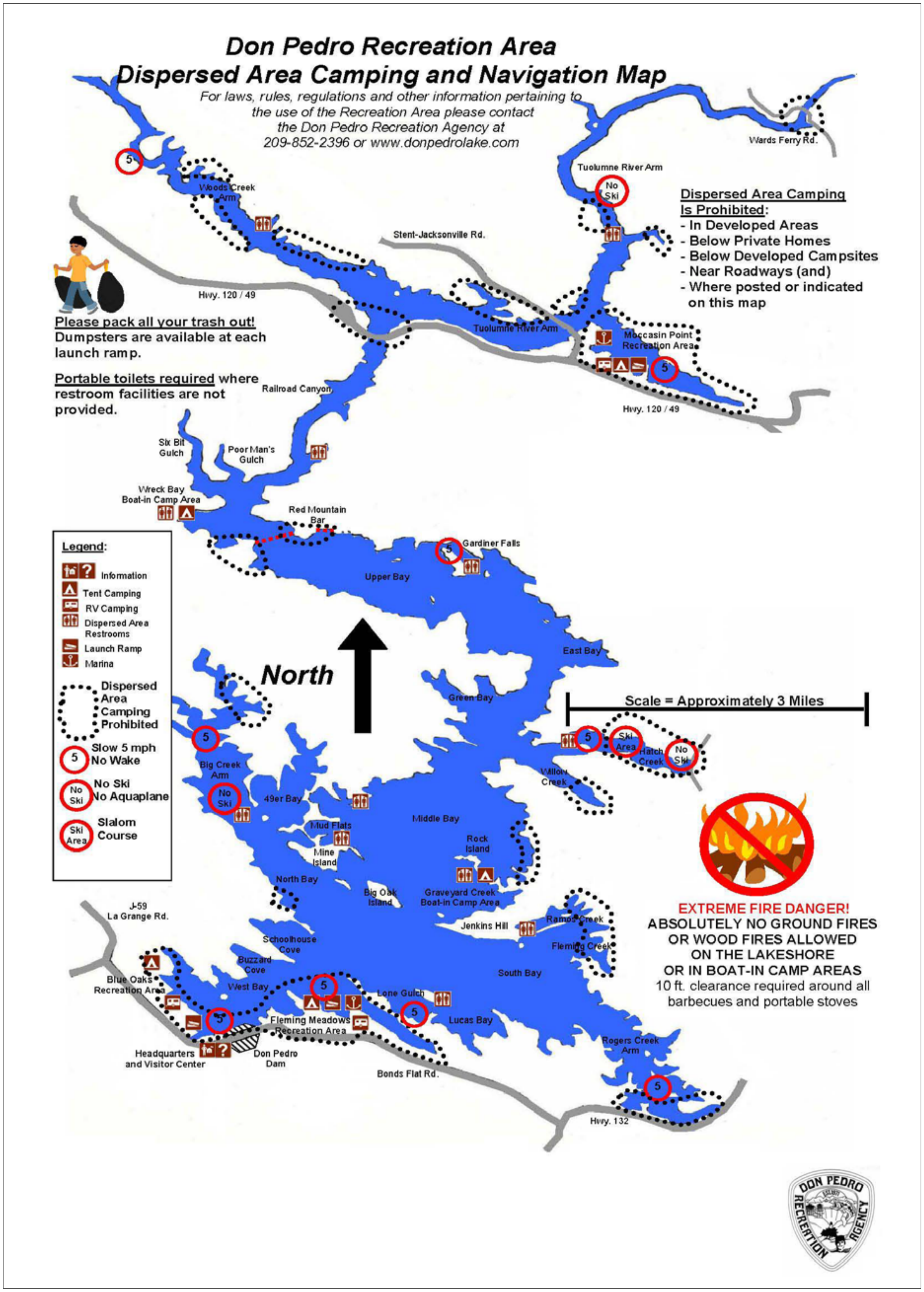

Figure 3.9-1. Existing recreation facilities on Don Pedro Reservoir.

Table 3.9-7 summarizes the amenities offered at the three developed recreation facilities. The three facilities are discussed in detail below.

Table 3.9-7. Summary of recreation facilities and other on-site amenities at developed recreation areas on Don Pedro Reservoir.

Amenities	Moccasin Point RA	Blue Oaks RA	Fleming Meadows RA
Don Pedro Project Recreation Facilities			
Camping Units - Total	96	195	267
With water and electric hookups	18	34	90
Picnic Areas –Total	2	1	2
Group Picnic Sites	1	1	1
Boat Launch Ramp	1	1	1
Fish Cleaning Stations	1	1	1
Comfort Stations - Total	8	11	14
With hot showers	3	5	5
Additional On-Site Recreation Amenities			
Concession Store	Yes	No	Yes
Swimming Lagoon	No	No	Yes
Volleyball / Softball Area	No	No	Yes
Marina	Yes	No	Yes
Amphitheatre	No	No	Yes
Houseboat Mooring	Yes	No	Yes
Boat Rentals	Yes	No	Yes
Houseboat Rentals	Yes	No	Yes
Boat Repair Yard	No	Yes	No
Gas and Oil	Yes	No	Yes
Sewage Dump Station	Yes	Yes	Yes

Source: TID/MID 2013a.

Fleming Meadows Recreation Area

The Fleming Meadows Recreation Area, located just east of the Don Pedro Dam, is comprised of 267 campsites, one boat launching facility, a sewage station, trading post, swimming lagoon, picnic area, amphitheater, softball and volleyball area, and two marinas—one with a full range of services, and one specifically for mooring private houseboats. There are also five designated parking lots located throughout the recreation area as well as a parking lot specific to the marina. Fleming Meadows has the highest use of the three recreation areas at the Don Pedro Project (TID/MID 2013a).

The Fleming Meadows Recreation Area has Americans with Disabilities Act (ADA)-accessible restrooms which include enlarged, ADA-accessible stalls. At least one sink in each restroom is height adjusted for ADA-accessible use. The urinals at the Fleming Meadows Launch Ramp and swimming lagoon are adapted to individual use urinals. The ramp access to ADA-accessible restrooms is designed for ADA-accessibility and meets grade and surface guidelines. ADA-accessible parking spaces have been designated at the boat launch ramp, main parking lot, and at all ADA-accessible restroom facilities (TID/MID 2013a). Amenities at Fleming Meadows Recreation Area are depicted in Figure 3.9-2.

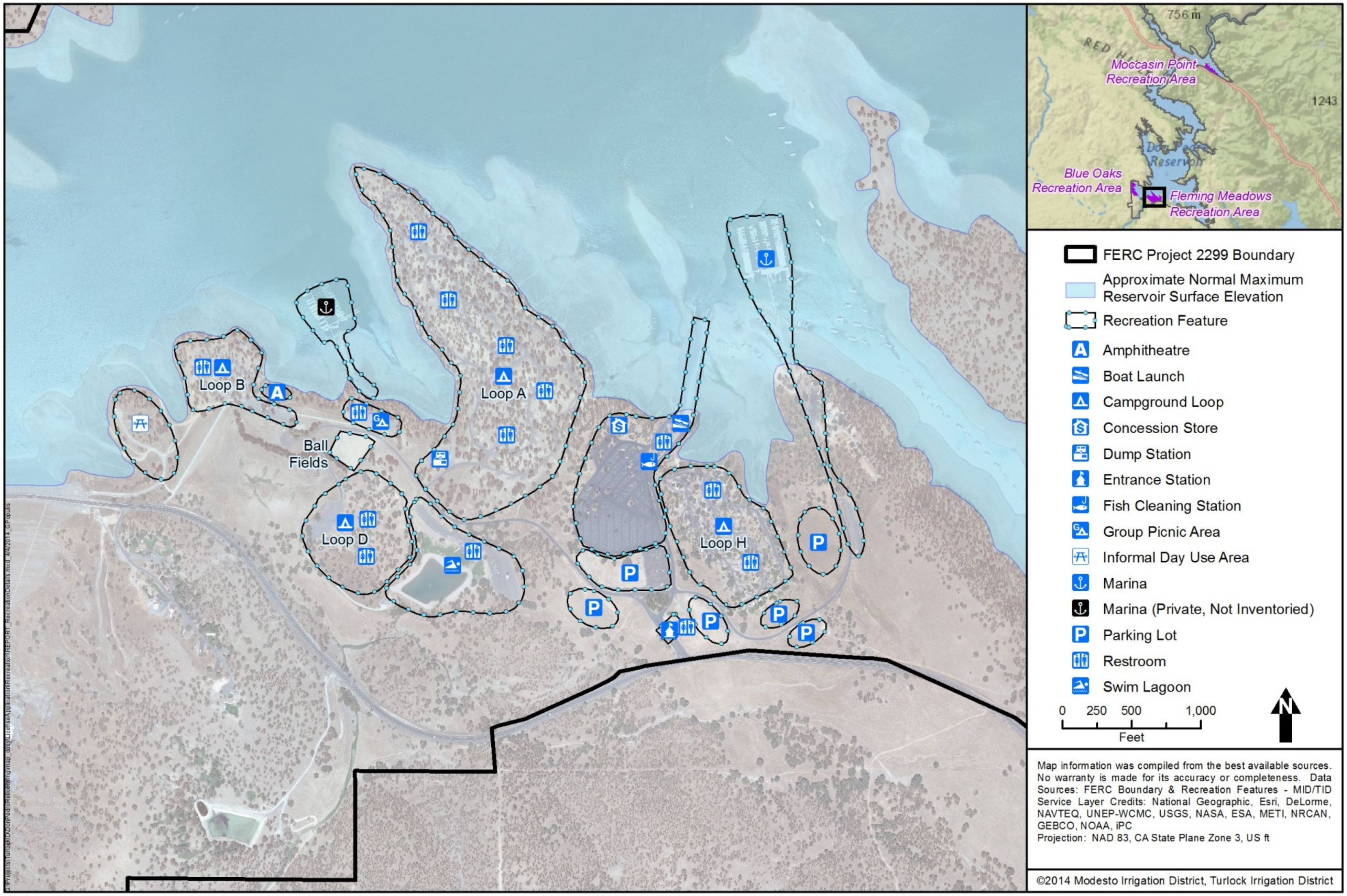

Figure 3.9-2. Fleming Meadows Recreation Area amenities.

Blue Oaks Recreation Area

The Blue Oaks Recreation Area, located just north of the emergency spillway section of the dam, includes 195 campsites, two RV full hookup sites, 34 RV partial hookup sites (four of which are ADA-accessible), and one boat launching facility. Additional amenities include a sewage dump station, a waste water treatment facility, boat repair yard, and a group picnic area. There are also three designated parking lots located throughout the recreation area, as well as a parking lot specific to the group picnic shelter (TID/MID 2013a).

The Blue Oaks Recreation Area also contains the Shoreline Trail hiking route, which is comprised of 3.5 miles of scenic hiking and mountain biking trails. The trail route starts at the Blue Oaks Group Area vista point and follows the shoreline of the Don Pedro Reservoir to Buzzard Point. The trail traverses wildflower displays in the spring, passes large quartz outcroppings, and offers unique vistas of Don Pedro Reservoir and the Sierra Nevada range. The trail is popular for viewing wildlife and birds such as bald eagles, ospreys, red-tailed hawks, and great blue herons (National Geographic Society 2009).

Restrooms contain ADA-accessible stalls, and a sink in each restroom is height-adjusted for ADA-accessible use. In addition, the shower restrooms at the Blue Oaks Recreation Area campground has one ADA-accessible shower station in each facility, and ADA-accessible parking spaces at all restroom facilities (TID/MID 2013a). Amenities at Blue Oaks Recreation Area are depicted in Figure 3.9-3.

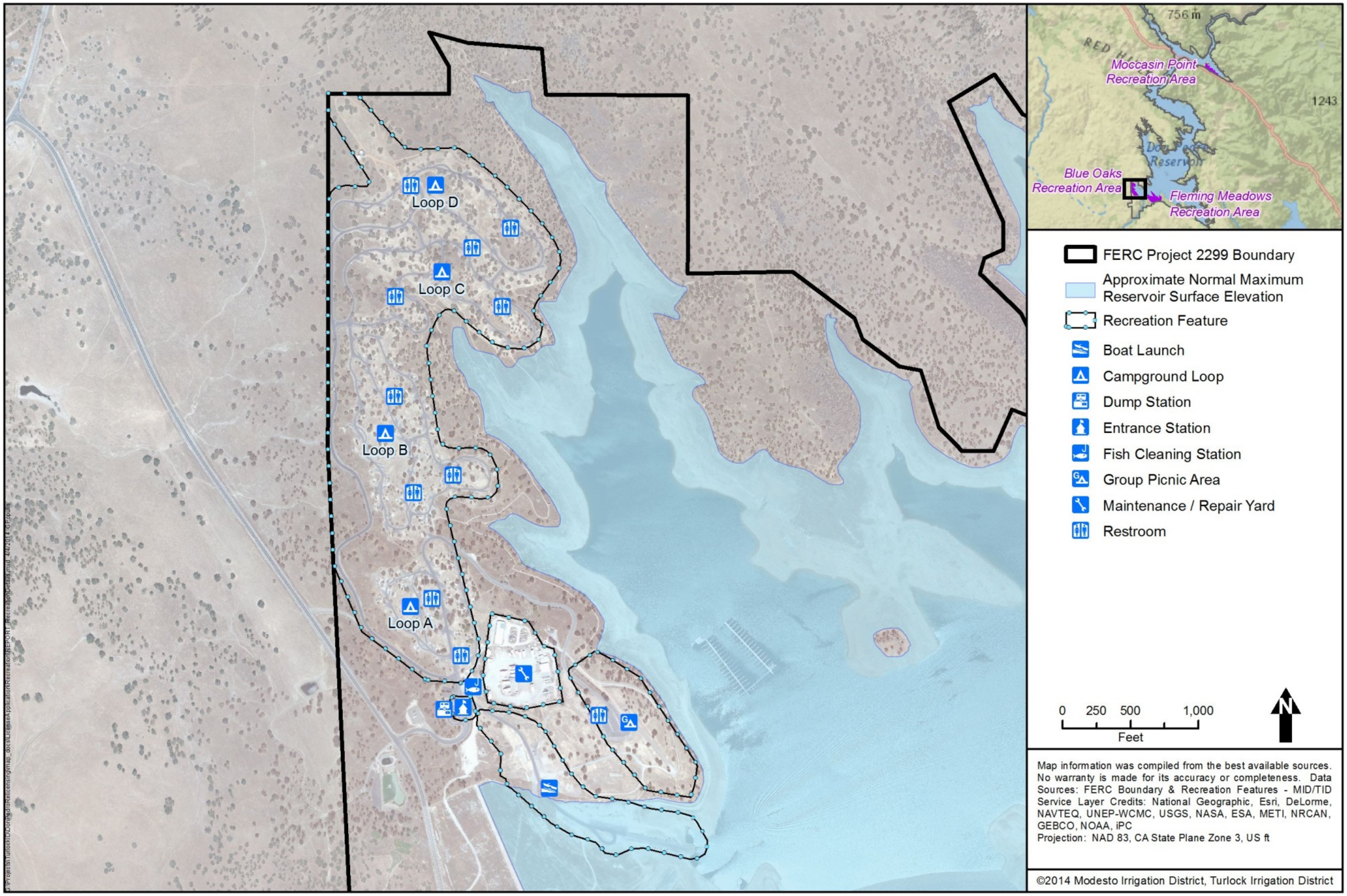

Figure 3.9-3. Blue Oaks Recreation Area amenities.

Moccasin Point Recreation Area

The Moccasin Point Recreation Area, located near the upper end of the Don Pedro Reservoir, is comprised of 96 campsites, 18 RV hookup sites, and one boat launching facility. Additional amenities include a marina, a sewage dump station, a waste water treatment facility, and two picnic areas. There are also five designated parking lots located within the recreation area (TID/MID 2013a).

ADA-compliant restrooms are installed at Moccasin Point Launch Ramp. One sink in each restroom is height-adjusted for ADA-accessible use. In addition, ADA-accessible parking spaces have been designated at these restrooms as well as at the launch ramp area (TID/MID 2013a). Amenities at Moccasin Point Recreation Area are depicted in Figure 3.9-4.

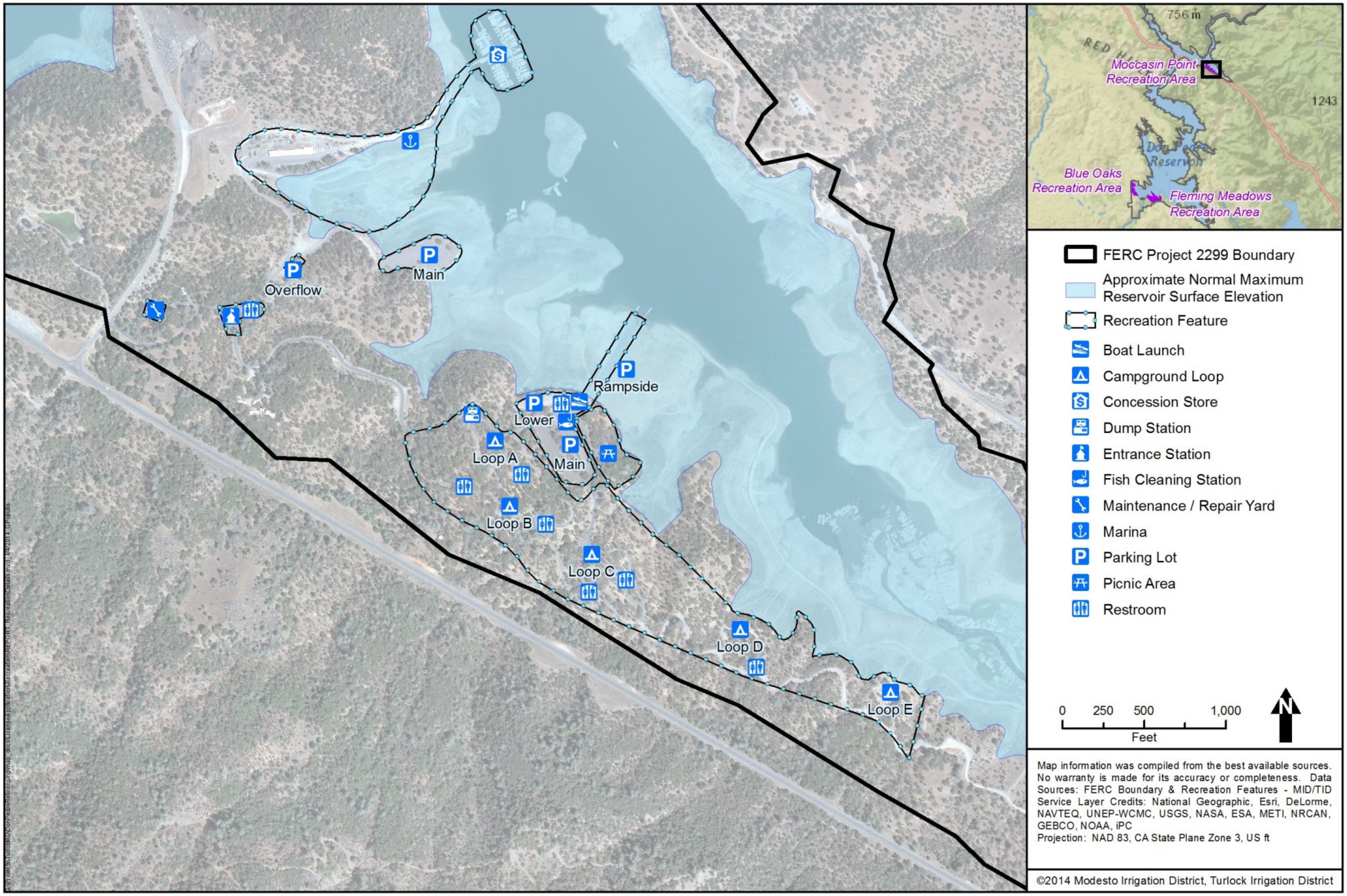

Figure 3.9-4. Moccasin Point Recreation Area amenities.

Recreational Use at the Don Pedro Project

The most popular recreational activities at the Don Pedro Project include fishing, boating, and camping. Other activities include water based activities; hiking, biking, and general trail use; picnicking; and activities at dispersed recreation areas. These activities are discussed below.

Fishing

Don Pedro Reservoir supports year-round fishing for cold and warm water species. Day use visitors have access to fishing opportunities both along the shoreline and via boating access. The many forks of the reservoir also afford the opportunity for isolated and quiet settings for fishing. DPRA, in conjunction with the Tuolumne County Sheriff's Office, enforces five mph no-wake boating and/or no-ski zones in the upper reaches of many of these forks to provide conditions suitable for fishing.

CDFW stocks trout and the DPRA stocks Florida-strain largemouth bass in the reservoir annually (DPRA 2010). The CDFW's Moccasin Creek Fish Hatchery typically stocks the reservoir with a variety of trout species every two to four weeks during the fall and winter months (CDFG 2010b).

Don Pedro Reservoir requires that all individuals fishing on the lake follow all regulations as set forth by the CDFW and all anglers must have a current California fishing license. The CDFW has a special silver (Coho) salmon regulation in California. The regulation prohibits keeping any silver salmon; any silver salmon hooked must be released back into the waters in which it was caught.

Don Pedro Reservoir is also a site for frequent bass fishing tournaments. For example, in 2010, 30 different organizations held 45 fishing tournaments at Don Pedro Reservoir. Table 3.9-8 summarizes the 2010 fishing tournament schedule.

Table 3.9-8. 2010 fishing tournament schedule for Don Pedro Lake.

Date	Day of Week	Organization	Launch Location
1/2/10	Saturday	Won Bass	Fleming Meadows
1/30/10	Saturday	LB Bass Club	Blue Oaks
2/6/10	Saturday	Won Bass	Fleming Meadows
2/12/10	Friday	California Bass Champs	Fleming Meadows
3/6/10	Saturday	Sonora Bass Anglers	N/A
3/6/10	Saturday	Diablo Valley Hawg Hunters	N/A
3/6/10	Saturday	American Bass	Fleming Meadows
3/6/10 3/7/10	Saturday Sunday	CA Landscape Contractors Trout Tournament	N/A
3/13/10	Saturday	Future Pro Tour	Fleming Meadows
3/13/10	Saturday	Tri Valley Bassmasters	N/A
3/14/10	Sunday	Fresno Bass	Fleming Meadows
3/20/10	Saturday	Won Bass	Fleming Meadows
3/20/10 3/21/10	Saturday Sunday	Kerman Bass Club	Fleming Meadows
3/21/10	Sunday	CA Bass Federation	Fleming Meadows
3/27/10 3/28/10	Saturday Sunday	Sierra Bass Club	Blue Oaks

Date	Day of Week	Organization	Launch Location
3/28/10	Sunday	Kings River Bass Club	Blue Oaks
3/28/10	Sunday	Fresno Bass	Fleming Meadows
4/10/10	Saturday	Angler's Choice	Fleming Meadows
4/10/10	Saturday	Modesto Elk's Lodge #1282	Fleming Meadows
4/10/10	Saturday	Manteca Bassin Cuddies	N/A
4/17/10	Saturday	100% Bass	Fleming Meadows
4/17/10 4/18/10	Saturday Sunday	Wasco Bass Club	Fleming Meadows
4/24/10	Saturday	King Salmon Derby	Blue Oaks
4/24/10	Saturday	Northern California Bass Federation	Fleming Meadows
4/25/10	Sunday	100% Bass	Fleming Meadows
5/1/10	Saturday	American Bass	Fleming Meadows
5/8/10	Saturday	Angler's Choice	Fleming Meadows
5/8/10 5/9/10	Saturday Sunday	Taft Bass	Fleming Meadows
5/15/10	Saturday	Bethel Assembly of God	Fleming Meadows
5/22/10	Saturday	Won Bass	Fleming Meadows
5/22/10	Saturday	Kerman Bass Club	Fleming Meadows
6/6/10	Sunday	Angler's Choice	Fleming Meadows
6/12/10	Saturday	Sacramento Bass Trackers	N/A
6/12/10 6/13/10	Saturday Sunday	Modesto Ambassadors Night Classic	Fleming Meadows
6/26/10 6/27/10	Saturday Sunday	U.S. Angler's Choice Night Tournament	Fleming Meadows
7/17/10	Saturday	Christian Bass League	N/A
7/17/10	Saturday	Riverbank Bass Anglers	N/A
8/7/10	Saturday	Point Seekers Bass Club	N/A
9/11/10	Saturday	Mid Valley Bass Club	N/A
10/9/10	Saturday	Jigs Bait and Tackle	Fleming Meadows
10/9/10	Saturday	Contra Costa Bass Club	N/A
10/16/10	Saturday	Christian Bass League	N/A
11/13/10	Saturday	US Angler's Choice	Fleming Meadows
12/5/10	Sunday	Riverbank Bass Anglers	N/A
12/11/10	Saturday	Won Bass	Fleming Meadows

Source: DPRA 2010.

Boating and Water Based Activities

The Don Pedro Reservoir covers 12,960 ac at normal maximum water surface elevation, and offers extensive open water for motor boating. There are also enough coves and sheltered areas to enjoy boat-tow activities. The Don Pedro Reservoir also provides a ski slalom course in the Hatch Creek Arm. Water based activities on the reservoir include water skiing and wake boarding, boat fishing, jet skiing, canoeing, flat water kayaking, windsurfing, sailing, and whitewater rafting and kayaking take-out areas. In 2007, 24 percent of the total gate receipts from recreation facilities were a result of boating use, and approximately 3,500 rafting take-outs occurred at the Reservoir (DPRA 2008). Licensed concessionaires provide 80 small vessel boat rentals and 378 small vessel moorings for reservoir visitors.

Whitewater rafting and kayaking are popular on the Wild and Scenic Tuolumne River above the Don Pedro Project Boundary. Boater put-in occurs primarily at Meral's Pool (RM 96) and recreational boating use is managed by the USFS. The Ward's Ferry Bridge, located near RM

78.5 towards the upstream end of the Don Pedro Reservoir, is used as a take-out location by whitewater boaters who run the whitewater reach. Most use occurs from April through August. While use levels are highly dependent on flow, an estimated 4,225 boaters used the Ward's Ferry Bridge as a site of river egress annually for the period 2003-2012 (USDA 2013). USFS estimates that two-thirds of these boaters were customers of commercial rafting companies and one-third were private boaters (USDA 2013). A whitewater boating take-out improvement feasibility study was conducted in 2012 by the Districts. The study is discussed further below.

Houseboating is also a popular activity at the Don Pedro Reservoir, and many boats anchor in the coves and arms of the lake for overnight camping or day use / swimming activities. Between the two marinas, there are 40 houseboats available for rent from the authorized concessionaires, and there exists 257 total moorings available for privately owned houseboats.

Camping

Moccasin Point Recreation Area, Blue Oaks Recreation Area, and Fleming Meadows Recreation Area offer a combined total of 558 camping units for recreational use with 142 offering water and electric hookups. Additionally, dispersed camping is allowed on most of the remaining lands, subject to the DPRA's published Rules and Regulations. None of the dispersed shoreline areas have developed camping spaces, and overnight camping is prohibited in some of these shoreline areas. Figure 3.9-5 shows locations where dispersed recreation most frequently occurs along the Don Pedro Reservoir.

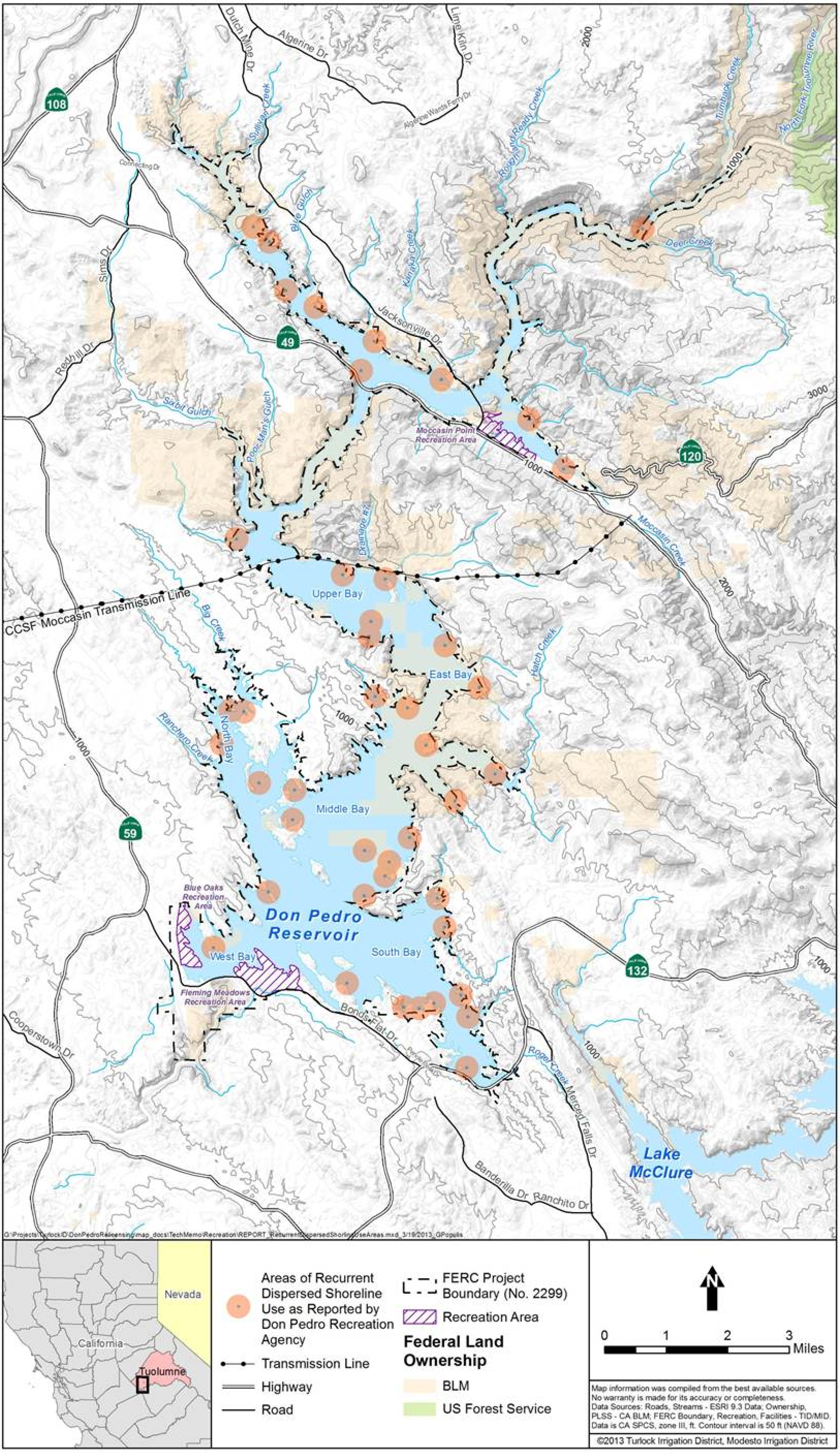

Figure 3.9-5. Dispersed recreation areas at the Don Pedro Project.

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Hiking, Biking, and General Trail Use

There are several hiking and biking trails that are within or partially within the Project Boundary. Red Hills is a region of 7,100 ac of public land located just south of the historic town of Chinese Camp and immediately east, west, and northwest of the Railroad Canyon and Woods Creek Arm of Don Pedro Reservoir. Common visitor activities include hiking, horseback riding, wildflower viewing, birding, mountain biking, and some limited hunting (BLM 2009). The trail system in Red Hills totals approximately 17.3 miles. Scenic biking and hiking is available on the Shoreline Trail hiking route at Blue Oaks Recreation Area.

Picnicking

Picnicking is a popular activity within the Project Boundary. Picnic areas and group picnic sites are present at Moccasin Point Recreation Area, Blue Oaks Recreation Area, and Fleming Meadows Recreation Area.

Dispersed Recreation Opportunities

Dispersed recreation is allowed on most of the Don Pedro Project lands except within developed areas, below private homes, below developed campsites, near roadways, and where posted. None of the dispersed shoreline areas have developed camping spaces, and overnight camping is prohibited in some of these shoreline areas. These areas are subject to the DPRA's published Rules and Regulations (provided as Appendix H-4 of Exhibit H). DPRA routinely patrols and maintains these shoreline areas. An inventory and evaluation of potential use impacts to recurrent dispersed recreation locations was conducted in 2012 as part of Recreation Facility Condition and Public Accessibility Assessment, and Recreation Use Assessment. The study is discussed further below.

Boating, fishing, camping and wildlife viewing are popular for those who boat into these dispersed areas.

3.9.1.3 Recreation Studies Conducted as Part of Relicensing

The Districts conducted three recreational studies in 2012 and 2013 in support of relicensing: the Recreation Facility Condition and Public Accessibility Assessment, and Recreation Use Assessment (RR-01), Whitewater Boating Take-Out Improvement Feasibility Study (RR-02), and Lower Tuolumne River Lowest Boatable Flow Study (RR-03). These studies are discussed in further detail below.

Recreation Facility Condition and Public Accessibility Assessment, and Recreation Use Assessment

The Districts conducted the Recreation Facility Condition and Public Accessibility Assessment, and Recreation Use Assessment (RR-01) in 2012 (TID/MID 2013a). The goal of the study was to provide information about the need for maintenance or enhancement of existing recreation facilities to support current and future demand for public recreation at the Don Pedro Project. The objectives of the study were to:

- assess the condition of existing developed recreation facilities, including dispersed use areas,
- estimate present capacity of recreation facilities to support present and future demand for public recreation (i.e., facility carrying capacity),
- describe the preferences, attitudes, and characteristics of the recreation users,
- collect information about current recreation activities and future demand for activities, and
- undertake a creel survey in coordination with Study Plan W&AR-17, Reservoir Fish Population Study.

The study methods consisted of five steps: (1) conduct an inventory and evaluation of the recreation facilities for condition, ADA-compliance, and use impacts; (2) identify recreation uses and visitor attitudes, beliefs, and preferences at recreation resource areas; (3) estimate the current recreation use at recreation resource areas; (4) identify future use and demand opportunities; and (5) analyze the data collected and prepare a report.

Based on study results, existing facilities meet current recreation demand and are generally in good condition (TID/MID 2013a). Use levels projected through 2050 at each of the three recreational areas are not expected to exceed the capacity of the campgrounds, picnic areas, or parking areas, except for the Fleming Meadows houseboat marina parking facility and the Moccasin Point marina parking facilities and group picnic parking facilities. The congestion anticipated at these three parking facilities is expected to be mitigated by the use of overflow parking. Most survey respondents reported that facilities were acceptable or they did not have an opinion (TID/MID 2013a). Similarly, most respondents had no clear desire for specific improvements to recreation facilities.

Survey results indicated the most frequently identified activities of day-use respondents surveyed at Fleming Meadows, Blue Oaks, and Moccasin Point recreational areas are recreational activities common to the area and to the Central Valley Region. The primary recreational activities varied between day-use respondents and overnight respondents (Table 3.9-9).

Table 3.9-9. Primary day-use and overnight-use recreation activities at Fleming Meadows, Blue Oaks, and Moccasin Point.

Recreation Area	Day-Use	Overnight Use
Fleming Meadows	Fishing (44.9%) Boating (14.1%) Swimming (10.3%)	Camping (36.4%) Houseboating (20.2%) Fishing, boating, and relaxing (7%)
Blue Oaks	Fishing (75.8%) Watersports (7.6%) Boating (6.1%)	Camping (38.4%) Boating (11%) Houseboating (8.2%) Fishing (6.8%) Relaxing (5.5%)
Moccasin Point	Fishing (39.5%) Boating (18.6%) Picnicking and Relaxing (9.3%)	Camping (39%) Fishing (18.6%) Houseboating (11.9%)

Recreation users generally view Fleming Meadows, Blue Oaks, and Moccasin Point Recreation Areas as relatively unique recreation experiences offering easy access, natural conditions, great staff and facilities, good fishing, and less congestion than comparable recreation facilities in central California. Users also did not perceive any adverse effects on recreation experiences as a result of reservoir water levels. Overall, demand is being met for a wide range of outdoor recreation activities typical of reservoirs in central California.

As a component of the Recreation Facility Condition and Public Accessibility Assessment, and Recreation Use Assessment, recurrent dispersed recreation use locations along the Don Pedro Reservoir shoreline outside of the developed recreation facilities and within the Project Boundary were documented in 2012. A total of 23 discrete locations showing signs of recurrent dispersed shoreline recreation use were documented within the Project Boundary. Of the 23 recurrent dispersed recreation sites, the majority of the sites (70 percent or 16 sites) showed "low" impact; five sites (22 percent) showed "moderate" impact; and two sites showed "high" impact. The "low" impact sites either showed no signs of use impact or only a few signs with minimal scope. At the "moderate" impact sites, one to three signs of impact were typically observed with at least a few signs of litter and toilet paper, but also some unauthorized tree cutting, large areas of bare/compacted ground and/or user-created trails. At the "high" impact sites, four signs of use impact were observed, but most were significant or widespread impacts such as toilet paper (more than 5 occurrences); large areas of bare/compacted ground with trampled vegetation; user-created trails to satellite areas; and/or a fire ring without adequate clearances.

Whitewater Boating Take-Out Improvement Feasibility Study

The Districts conducted the Whitewater Boating Take-Out Improvement Feasibility Study (RR-02) in 2012 and 2013. A study report was filed with FERC on January 17, 2013 as an attachment to the Initial Study Report (ISR) in the ILP relicensing process. In response to relicensing participant requests for additional take-out site analyses and recommendations in FERC's May 21, 2013 *Determination on Requests for Study Modifications and New Studies for the Don Pedro Hydroelectric Project*, the Districts amended the study report to include more details on the benefits and constraints associated with the Ward's Ferry Bridge take-out site and alternative river egress sites at Deer Creek and Deer Flats (Figure 3.9-6). A revised study report was filed on January 6, 2014.

The Ward's Ferry Bridge spans the Tuolumne River at RM 78.5 and is the downstream terminus of whitewater boating on the Tuolumne River. The Ward's Ferry Bridge is not a recreation destination in and of itself; it is the location where whitewater boaters and boats exit the river at the end of their excursion. Commercial outfitters currently extract their equipment and numerous boats from the river, after boaters disembark, from a vantage point atop the bridge by using truck cranes that locate on the bridge roadway. As many as three truck cranes are on the roadway at the same time, disrupting traffic, posing potentially hazardous driving conditions, and in violation of county ordinances. The congestion is a result of the fact that river flows suitable for whitewater boating are provided by the hydropower operations of CCSF's Holm powerhouse located near the mouth of Cherry Creek at RM 103.6 of the Tuolumne River. The powerhouse is a peaking hydro plant and in the summer months generally provides peaking flows from about 7 am to noon. Whitewater boaters must capture these flows, so river entry at Lumsden Campground, and therefore, river exit at Ward's Ferry, occur over relatively short intervals, resulting in congestion at Ward's Ferry.

The primary goal of the Districts' study was to assess if, from an engineering feasibility perspective, functional options exist to make improvements to the existing take-out at the Ward's Ferry Bridge site. The feasibility of alternative sites for providing boat take-out was also evaluated.

This study elicited knowledge on the use of the existing site, potential improvements, and alternative sites from a focus group meeting with guides and boaters familiar with the Tuolumne River and the existing take-out methods at the Ward's Ferry Bridge. Information from the site assessments and focus group meeting in April 2012, August 2013, and September 2013 was used to examine proposed alternative take-out locations and assess the technical feasibility of potential improvements. Characteristics of the existing take-out and alternative locations were assessed including proximity to the terminus of the whitewater run, proximity to improved roads, site topography and bank slope, and presence of sensitive resources. The operational goal of the whitewater boating take-out study at the Ward's Ferry location was to examine whether reasonable engineering options exist to improve the efficiency and safety of removing boats and boaters from the river at the end of the whitewater trip at this location.

After the Recreation Facility Condition and Public Accessibility Assessment, and Recreation Use Assessment was filed January 6, 2014, the Districts continued planning and discussion with relicensing participants on a variety of issues. Relicensing participants provided additional information to the Districts on the use patterns at the Ward's Ferry Bridge take-out site. In 2016, the Districts observed use patterns and behaviors at the site to better understand use patterns and opportunities for site improvement. Commercial outfitters make up the large majority of users of the site, with private whitewater boaters, general recreationists arriving by road, and motorboaters from lower on the reservoir making up a small minority. Commercial rafting groups arrive in a concentrated, coordinated fashion in a timeframe of two hours or less each afternoon.

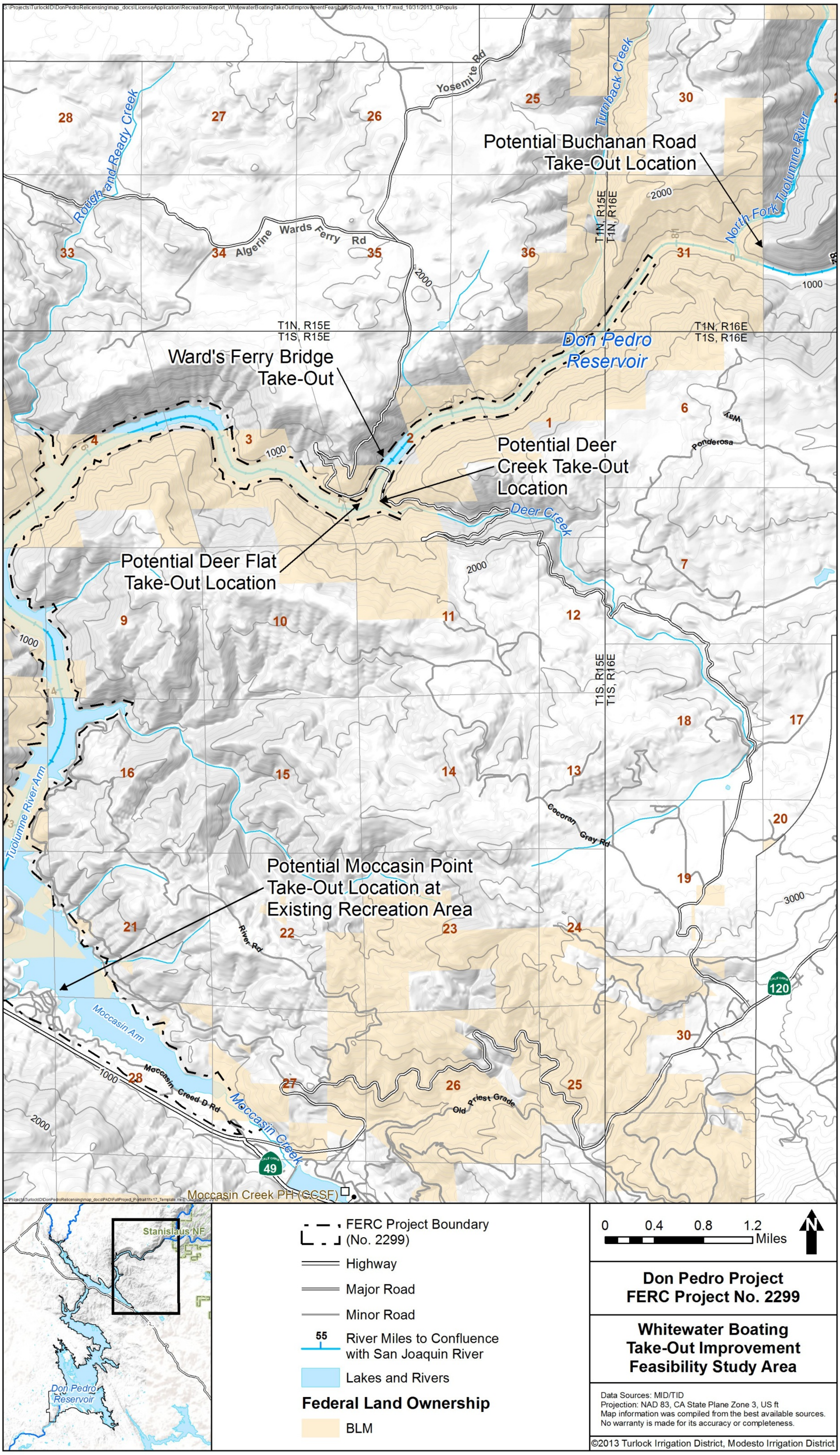

Figure 3.9-6. Potential upper Tuolumne River whitewater boating take-out locations.

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Lower Tuolumne River Lowest Boatable Flow Study

The Districts conducted the Lower Tuolumne River Lowest Boatable Flow Study (RR-03) in 2012 and 2013 (TID/MID 2013c). The primary goal of the study was to determine if the minimum flows required under the current license provide boatable flows for non-motorized, recreational river boating in portions of the lower Tuolumne River where put-ins and take-outs are available. The study was designed to achieve the following objectives:

- determine whether the minimum flows provide for river boating in portions of the lower Tuolumne River,
- use existing recreation information, where possible, to assess river boating including gradient of river segments,
- determine the number of flow days by month at or above the minimum boatable flow for river boating opportunities under current operations,
- determine operational constraints, if any, of providing minimum flows for the river boating opportunities,
- identify and describe put-in and take-out locations for river boating between La Grange Diversion Dam and the confluence with the San Joaquin River,
- identify and describe the locations on the river where boaters encounter features of special interest, challenges, hazards, or difficulties, and
- evaluate the adequacy of flow information available to the public.

The 2012 river boating study effort was conducted in canoes, hard shell kayaks, inflatable kayaks, and a drift raft from May 30 to June 2, 2012, with flows ranging from 171 cfs to 256 cfs as recorded at the USGS Gage 11289650 Tuolumne River near La Grange, California. The study team also assessed flow opportunistically throughout the study period by boating at flows ranging from 98 cfs to 132 cfs. One last event was boated September 29, 2012 at a flow of 101 cfs to 109 cfs. Flows recorded at the USGS' gage at Modesto at RM 16 were consistently greater than those at the La Grange gage, consistent with other findings that the Tuolumne River is generally considered a "gaining" stream. Average daily accretions in the Lower Tuolumne range from 40 cfs to 200 cfs, with an annual average accretion of 218 cfs from water year 1970-1987 and 103 cfs from water year 1988-2010, resulting in a water year 1970-2010 average of 152 cfs (TID/MID 2017).

In its May 21, 2013 Determination on Requests for Study Modifications and New Studies for the Don Pedro Hydroelectric Project, FERC staff recommended that the Lower Tuolumne River Lowest Boatable Flow study be modified to include a determination of the lowest boatable flow for: (1) hardshell kayaks, inflatable kayaks, and canoes and; (2) drift boat/rafts on each section of the lower Tuolumne River between Old La Grange Bridge (RM 51) and Riverdale Park (RM 12). FERC staff stated that the study should achieve the required five to eight boaters (with no financial connection to the Districts) for both groups of watercraft types for each section of the river, and participants should be notified at least six weeks in advance of conducting the study, with reminders at least three weeks and one week prior to the study. Prior volunteer participant data (not including the Districts' consultants) should be included as part of the data for the approved study.

The Districts conducted the FERC recommended second year study in 2013. Relicensing participants assisted in identifying segments of the river to be paddled and revisions to the survey instrument. The 2013 field studies were conducted August 17, August 24, September 7, and September 14, with flows ranging from approximately 125 cfs to 200 cfs as recorded at the USGS Gage 11289650 (La Grange gage). Participants used hardshell kayaks, inflatable kayaks, canoes, and drift boats/rafts. A revised study report was filed on January 6, 2014 with the USR.

Flows as low as 100 cfs as recorded at the USGS La Grange gage were determined to be boatable in the reach between Old La Grange Bridge and Turlock SRA in 2012. This segment has the highest gradient of the entire lower Tuolumne and provides the most interesting paddling. At flows in the 100 cfs range, one experienced boater in a kayak found the Old La Grange Bridge to Turlock SRA segment to be boatable, but also noted no attributes to entice toward boating at lower flows. Based on this very limited input (one boater) it would seem that 100 cfs is boatable and lower flows would not provide enjoyable boating in kayaks, or any other craft.

In 2013, a greater number of volunteers participated in the study, and results indicate 200 cfs and 175 cfs were equally judged boatable by an overwhelming majority of participants. More than half of the boaters who participated in the study reported that 150 cfs was boatable on the study reaches – Old La Grange Bridge to Riverwalk Park in Waterford and Riverdale Park to Shiloh Bridge.

Study results and the level of volunteer participation in both 2012 and 2013 indicate that shallow draft canoes and kayaks are ideally suited for the boating opportunities on the lower Tuolumne. Very few drift boaters/rafters participated in the study, and of those who did participate, the majority reported the river unboatable at study flows of 175 cfs and lower.

La Grange gage data for the calendar years 1997[91] through 2012 reported flows were greater than or equal to 150 cfs 84 percent of the time. For the more popular boating season, flow was at or above 150 cfs 98% of the time in May, 60% of the time in June, 56% of the time in July, August, and September, and 94% if the time in October. Flows were at or above 175 cfs 76 percent of the time for the period 1997-2012. During the months of the typical boating season of May through October, flows were at or above 175 cfs 97 percent of the time in May and 56 percent of the time in July, August, and September. For the same period, the flow of 200 cfs is exceeded 88% of the time in April, 95% of the time in May, 56% of the time in June, July, August and September, 74% of the time in October, and 70% of the time in November. Only in dry years is a flow of 200 cfs rare, and this is at a time when all resource uses, including developmental uses, are being significantly affected. (TID/MID 2013c).

[91] The year 1997 was the first full calendar year following the implementation of the 1996 FERC order adopting new, higher minimum flows for the Don Pedro Project.

3.9.1.4 Land Use

The current Don Pedro Project Boundary encompasses approximately 18,370 acres. The Districts own in fee title approximately 78 percent of the land within the Project Boundary, and the remaining 26 percent are federal lands. These lands are subject to the Districts' land use policies (see Appendix H-4 of Exhibit H), which strictly limit the use of lands outside the developed recreation areas. The Districts' land use policy is implemented through the DPRA and prohibits shoreline disturbances such as dredging, docks, moorings, piers, or developed improvement of any kind. DPRA rules prohibit all off-road vehicle use on lands, as well as motorized boat access over lands expect at designated boat launches. These rules and regulations are designed to protect and preserve the natural character and integrity of the Don Pedro Project area. Outside the Project Boundary, lands are a mix of lands administered by the BLM and private lands.

Upstream of the Project Boundary, the Tuolumne River is designated as a National Wild and Scenic River. Lands in this portion of the watershed are primarily publicly owned and managed, including Yosemite National Park, managed by the NPS, and Stanislaus National Forest, managed by the USFS. Immediately upstream of the Don Pedro Project, much of the land is managed by the BLM. Downstream of the Don Pedro Project, in the lower valley area of the Tuolumne River watershed, land is primarily privately owned and used for agriculture, grazing and rural residential purposes, or for denser residential, M&I purposes (Stanislaus County 2006).

3.9.1.5 Shoreline Management

The Don Pedro Reservoir has approximately 160 miles of shoreline including the numerous small islands within the lake. The Districts own approximately 122 miles of the shoreline while BLM administers the remaining 38 miles. Within the Project Boundary, the Districts and the BLM do not permit any commercial or residential shoreline development except at Moccasin Point, Blue Oaks, and Fleming Meadows Recreation Areas. In particular, the Districts' land use policy prohibits shoreline disturbances such as dredging, docks, moorings, piers, or developed improvement of any kind. Boat launching is only permitted at the designated launch ramps found in each of the three developed recreation areas.

Dispersed use (both day and overnight) of the majority of the undeveloped Don Pedro Reservoir shoreline is permitted. Use of some shoreline areas is restricted due to conditions such as on-shore hazards or the potential for nuisance activity to affect adjacent property owners.

3.9.2 Resource Effects

Based on study results, existing facilities appear to meet current recreation demand and are generally in good condition. Use levels projected through 2050 at each of the three recreation areas are not expected to exceed the capacity of the campgrounds, picnic areas, or parking areas, with a few exceptions as described previously in this section of Exhibit E.

Pages 37 and 38 of FERC's SD2 identified the following recreation and land-use related issues:

- Effects of water levels in Project reservoirs on recreation.
- Effects of Project operations on public access to Project waters, existing recreational opportunities, and future recreational opportunities within the Project Boundary.
- Effects of Project operations on quality and availability of flow-dependent recreation opportunities, including whitewater boating, angling, and wading.
- Adequacy of existing recreation facilities (including accessible facilities) to meet current and future recreation demand.
- Effects of the Project operations and maintenance on the condition and use of roads within the Project area.
- Adequacy of existing Ward's Ferry Bridge whitewater boating takeout and restroom facility to meet current and future recreational demand.

3.9.2.1 Effects of Water Levels in the Don Pedro Reservoir on Recreation

The Recreation Facility Condition and Public Accessibility Assessment, and Recreation Use Assessment conducted by the Districts in 2012 specifically addressed visitor preferences and expectations related to reservoir water level. Visitors were asked to indicate whether the level of the reservoir was a problem for a variety of different recreational activities. For both overnight and day-use visitors, the level of the reservoir was not perceived as a problem for different types of activities. The vast majority of visitors reported the reservoir level was either "not a problem" or selected "no opinion/not applicable" (TID/MID 2013a). The continuation of the current water level fluctuations under current water supply operations does not have an adverse effect on recreation at the Don Pedro Project.

As part of the Proposed Action the Districts are proposing to lower the minimum pool from the current elevation of 600 ft. to 550 ft. The lowering of the reservoir level from the current elevation of 600 ft to elevation 550 ft would occur very infrequently. If the reservoir level is lowered below the current 600 ft, access to existing boat ramps will be limited, and a temporay boat ramp location will need to be identified upstream of the old Don Pedro dam location. Operations protocols to address minimum pool levels on recreation access and facilities are in place and will continue to be initiated as needed during the term of the new license.

3.9.2.2 Effects of Don Pedro Project Operations on Public Access to Waters, Existing Recreational Opportunities, and Future Recreational Opportunities within the Project Boundary.

Overall, demand is being met for a wide range of outdoor recreation activities typical of reservoirs in central California. The Recreation Facility Condition and Public Accessibility Assessment, and Recreation Use Assessment found that survey respondents rated the three developed Recreation Areas - Fleming Meadows, Blue Oaks, and Moccasin Point - as a unique recreational experience. Reasons contributing to the uniqueness were identified as easy access, natural conditions, great staff and facilities, good fishing, and less congestion than comparable recreation facilities in Central California. Access to existing recreational facilities was rated by survey respondents as in the acceptable range overall (TID/MID 2013a).

Survey respondents were also asked whether the existing facilities were acceptable, most respondents felt that facilities were acceptable or did not have an opinion (TID/MID 2013a). Similarly, most respondents had no clear desire for specific improvements to recreation facilities indicating that the existing Recreation Areas are providing opportunities for recreation activities identified in the California Outdoor Recreation Plan.

The public currently has access to the entire shoreline from the high-water line down and has vehicle access through a number of rural and unimproved roads outside the Recreation Areas. Access is currently viewed as acceptable by survey respondents. Access to Don Pedro Project waters and recreational opportunities is expected to remain the same. The proposal to lower the operating elevation from 600 ft. to 550 ft. does not require a change in operations protocols that are in place to ensure safe, reasonable access to the reservoir during low pool conditions.

3.9.2.3 Effects of Don Pedro Project Operations on Quality and Availability of Flow-dependent Recreation Opportunities, including Whitewater Boating, Angling, and Wading

Operations do not affect the flows available for whitewater boating, angling or wading in the reaches designated as Wild and Scenic upstream of the Don Pedro Project. Water level fluctuations of the reservoir, by definition, do not affect the Wild and Scenic reaches. The only use of the Don Pedro Project by whitewater boaters is as a location where boaters choose to exit the Tuolumne River, this being at the Ward's Ferry Bridge, a non-Don Pedro Project facility. The current river exit procedures are adequate to support the current level of whitewater use. Commercial and private boaters believe that improved take-out facilities at Ward's Ferry are warranted to efficiently get recreationists off the river and improve public safety on the bridge. The Districts' engineering study demonstrated that options exist to accommodate more efficient and safer exit. Angling in the upper reaches of the reservoir is dependent on water levels. Higher water levels allow motorboat traffic access to and above Ward's Ferry Bridge; however, this creates conflict with whitewater excursionists.

Regarding water-dependent recreation in the lower Tuolumne River, boating, angling and wading occur from the La Grange powerhouse tailrace to the confluence with the San Joaquin River. All current minimum flows are supportive of angling, wading, and swimming. The results of the Lower Tuolumne River Lowest Boatable Flow Study Report indicate that 200 cfs and 175 cfs were equally judged boatable by an overwhelming majority of participants, and that more than half of the boaters who participated in the study reported that 150 cfs was boatable. La Grange gage data for the calendar years 1997 through 2012 reported flows were greater than or equal to 150 cfs 84 percent of the time. For the more popular boating season, flow was at or above 150 cfs 98 percent of the time in May, 60 percent of the time in June, 56 percent of the time in July, August, and September, and 94 percent if the time in October. Flows were at or above 175 cfs 76 percent of the time for the period 1997-2012. During the months of the typical boating season of May through October, flows were at or above 175 cfs 97 percent of the time in May and 56 percent of the time in July, August, and September. For the same period, the flow of 200 cfs is exceeded 88 percent of the time in April, 95 percent of the time in May, 56 percent of the time in June, July, August and September, 74% of the time in October, and 70% of the time in November. Only in dry years is a flow of 200 cfs rare, and this is at a time when all resource uses, including developmental uses, are being significantly affected. (TID/MID 2013c).

The Districts are proposing fish habitat enhancements that include improvements to recreational boating opportunity for non-motorized canoeing and kayaking on the lower Tuolumne River.

- Construct a new take out-put in facility at RM 25.7, where the fish counting and barrier weir are to be located. Concept plans for these facilities are presented in the proposed Recreation Resource Management Plan (RRMP).
- <u>April 1 to May 31</u>
    - Boatable flow of 200 cfs or greater provided in all water years for the entire lower Tuolumne River from RM 52 to RM 0.
- June 1 to June 30
    - Boatable flow of 200 cfs provided in all water years from RM 52 to RM 25.7.
    - In Wet, Above Normal, and Below Normal water years, cease Infiltration Gallery withdrawal for one pre-scheduled weekend in June to provide boating opportunity from RM 25.5 to RM 0.
- July 1 to October 15
    - Boatable flow of at least 325 cfs provided in all water years from RM 52 to RM 25.7.
    - In all but Critical water years, provide a boatable flow of 200 cfs from RM 25.7 to RM 0 for 3-day July 4^{th} holiday, for three day Labor Day holiday, and for two-pre-scheduled additional weekends in either July or August.

3.9.2.4 Adequacy of Existing Recreation Facilities (including accessible facilities) to Meet Current and Future Recreational Demand

The Districts conducted a Recreation Facility Condition and Public Accessibility Assessment, and Recreation Use Assessment (RR-01) in 2012. Study components included:

(1) Inventorying and evaluating the developed recreation facilities for condition, ADA compliance, and use impacts;

(2) Estimating current recreation use; and

(3) Identifying future use and demand opportunities.

Inventory and evaluation of developed recreation facilities (Fleming Meadows, Blue Oaks, and Moccasin Point recreation areas as well as 12 remote facilities where toilets are maintained) included four subtasks:

(1) A complete inventory of developed recreation facilities associated with the Don Pedro Project including campgrounds, boat launches, marinas, the swimming lagoon, picnic areas, signs, and interpretive displays;

(2) An assessment of the condition of each component (tables, fire rings, restrooms, walkways, parking areas, roads, etc.) of the developed recreation facilities;

(3) An assessment of whether each component complies with current ADA accessibility guidelines; and

(4) An assessment of the use impacts at each recreation facility.

The study team assessed the developed recreation facilities based on established criteria. Overall, existing facilities appeared to be in generally good condition with partial accessibility for persons with disabilities. Impact of recreation use varied by site between "low" and "high" impacts. Table 3.9-10 presents a summary of the inventory and evaluation of recreation facilities.

Table 3.9-10. Summary of inventory and evaluation of developed Don Pedro Project recreation facilities.

Facility	Facility Site Evaluation	Accessibility Assessment	Assessment of Recreation Use Impacts
Fleming Meadows	Excellent condition	Partially accessible[2]	Low[3]
Blue Oaks	Excellent condition	Partially accessible	High[4]
Moccasin Point	Good condition[1]	Partially accessible	High
Dispersed Developed Toilet Facilities	Good Condition	Not designed to be accessible	N/A

[1] "Good Condition" defined as requiring routine care/maintenance
[2] "Partially accessible" defined as some handicap facilities, but in disrepair or not up to current ADA/ABAAG standards (e.g., slopes too steep, docks inaccessible, etc.)
[3] "Low" defined as few, if any signs of use impact are observed at each site
[4] "High" Defined as extensive signs of use impact; widespread use with many impacts evident
Source: TID/MID 2013a

Additional details regarding the inventory and evaluation of developed recreation sites can be found in the RR-01 study report.

The study also estimated current recreation use and identified future use and demand opportunities. Data routinely collected by DPRA formed the basis of an estimate for the number of Visitor Days to the Don Pedro Project. Results of the observation and visitor survey were used to characterize participation in various activities. These surveys were conducted January 2012 through December 2012 at Fleming Meadows, Blue Oaks, and Moccasin Point. Additionally the study identified future use and demand opportunities (next 30 to 50 years) by assessing existing unmet demand, future recreation demand, and the regional uniqueness or significance of the Don Pedro Project for recreation. Overall, the results indicated that current demand is being met for a wide range of outdoor recreation activities typical of reservoirs in central California (TID/MID 2013a).

The study also characterized the capacity for future use through 2050 at the developed recreation sites. Use levels through 2050 at Fleming Meadows Recreation Area are not projected to exceed the capacity of the campgrounds, picnic areas, and parking areas (including boat launch, marina, and overflow lots), except for the houseboat marina parking facility experienced over 80 percent occupancy on the weekends in 2012. Weekend use of the marina parking facility is projected to exceed capacity by 2020 and overall use is projected to exceed capacity by 2040 as marina users seek to park as close to the marina as possible. Use of the Overflow Parking Lot is projected to remain below capacity through 2050 (TID/MID 2013a).

Similarly, use levels projected through 2050 at Moccasin Point Recreation Area are not projected to exceed the capacity of the campgrounds, picnic areas (including boat launch, marina, and overflow lots), except for the marina and group picnic parking facilities. Total parking use is projected to remain below capacity through 2050 (TID/MID 2013a).

Use levels through 2050 at Blue Oaks Recreation Area are not projected to exceed capacity of the campgrounds, picnic area, and parking areas (including boat launch and group picnic area parking).

Overall existing facilities appeared to be in generally good condition with partial accessibility for persons with disabilities. Current demand is being met for a wide range of outdoor recreation activities with the existing facilities and is consistent with recreation demands identified in the 2008 CORP (CORP 2008). Use levels through 2050 at the Don Pedro Project facilities are not expected to exceed the designed carrying capacity with the exception of the houseboat marina parking facility at Fleming Meadows and the marina parking facility at Moccasin Point Recreation Area. Both of these facilities have overflow parking lots that are expected to remain below capacity through 2050 (TID/MID 2013a).

Effective operation and maintenance (O&M) of existing and future recreation facilities are key elements of effective recreation resource management. The proposed RRMP describes the Districts' and DPRA's commitment to maintain a five-year budget plan that is updated annually which includes ongoing O&M commitments.

3.9.2.5 Effects of Don Pedro Project Operations and Maintenance on the Condition and Use of Roads within the Don Pedro Project Area

The Districts conducted an inventory and evaluation of roads at the existing recreational facilities under the Recreation Facility Condition and Public Accessibility Assessment, and Recreation Use Assessment (RR-01). Road conditions at the recreation areas ranged from fair to excellent with asphalt roads dominating road type. Table 3.9-11 summarizes evaluation of the road inventory at Fleming Meadows Recreation Area, Blue Oaks Recreation Area, and Moccasin Point Recreation Area.

Table 3.9-11. Summary of road evaluation at existing recreational facilities.

Site	Surface Material	Road Width (ft)	Circulation Type	Condition
Fleming Meadows Recreation Area				
Campground A	asphalt	12	1-way loop	Excellent[1]
Campground B	asphalt	12	1-way loop	Good[2]
Campground D	asphalt	20	2-way	Excellent
Campground H	asphalt	12	1-way loop	Good
Boat Launch	asphalt	20	2-way	Excellent
Swim Lagoon	asphalt	20	2-way	Excellent
Group Picnic Area	asphalt	20	2-way	Excellent
Marina	asphalt	20	2-way	Fair[3]
Informal Day Use	gravel	20	2-way in/out	Good

Site	Surface Material	Road Width (ft)	Circulation Type	Condition
Area				
Blue Oaks Recreation Area				
Campground A	asphalt	12 / 20	1-way loop / 2-way	Excellent
Campground B	asphalt	12	1-way loop	Excellent
Campground C	asphalt	12	1-way loop	Excellent
Campground D	asphalt	12	1-way loop	Good
Campground B, C and D Access Road	asphalt	20	2-way	Excellent
Group Picnic Area	asphalt	22	2-way	Good
Moccasin Point Recreation Area				
Campground A	asphalt	12	1-way loop	Fair
Campground B	asphalt	12	1-way loop	Fair
Campground C	asphalt	12	1-way loop	Fair
Campground C Access Road	asphalt	24	2-way	Good
Campground D	gravel	12	1-way loop	Fair
Campground D Access Road	gravel	20	2-way	Good
Campground E	gravel	10	1-way loop	Fair
Boat Launch/Group Picnic Area	asphalt	20	2-way	Good
Boat Launch Overflow Parking Lot	asphalt	24	2-way	Good
Marina	asphalt	20	2-way	Good

[1] "Excellent" defined as rehabilitation required beyond 10 years
[2] "Good" defined as no rehabilitation required within the next 5-10 years
[3] "Fair" defined as rehabilitation required within 5 years
Source: TID/MID 2013a

Continued operations are not likely to negatively impact the condition of the roads aside from normal wear and tear. The majority of roads accessed by the public for recreational purposes are deemed to be in excellent condition and thus likely not require rehabilitation for at least 10 years (TID/MID 2013a). As stated above, the proposed RRMP describes the five-year budget plan that includes ongoing O&M commitments for roads and other facilities.

3.9.2.6 Adequacy of Existing Ward's Ferry Bridge Whitewater Boating Takeout and Restroom Facility to Meet Current and Future Recreational Demand

Current and future demand for whitewater boating takeout and appurtenant visitor facilities such as restrooms at Ward's Ferry Bridge and its vicinity is driven mostly by available flow, which varies from year to year and are unrelated to and unaffected by Project operations. The timing and amount of flows during the whitewater boating season (April – August) are established each spring by CCSF. The maximum number of whitewater boaters allowed on the river at any one time and during any one year is managed by the USFS via a private and commercial permitting system. Use data from the period 2003 to 2012 indicates that an annual average of 4,225 people annually used the take-out at Ward's Ferry Bridge during this period (USDA 2013).

The existing whitewater boating take-out is located just upstream of the Ward's Ferry Bridge at approximately RM 78.5. Remnant abutments from an old bridge are located at this site and the area was used as a laydown and construction access site during construction of the existing bridge in the early 1970s (Bechtel 1970). Under the terms of the current license, DPRA maintains a restroom on the shoulder of Ward's Ferry Road near the south end of the existing bridge, on river left. The 2012 Recreation Facility Condition and Public Accessibility Assessment, and Recreation Use Assessment study found the vault toilet to be in good condition and the parking areas along the road were found to be in fair condition. Commercial and private whitewater boaters use this site as a take-out at the end of trips on the Upper Tuolumne River. Its location is favorable due in part to proximity to the terminus of the whitewater run, downstream of all rapids and upstream of significant slackwater at most water levels (TID/MID 2013b).

During the relicensing process, relicensing participants expressed that the Ward's Ferry Bridge take-out location presents challenges to safe and efficient take-out due to topography, condition of the access trails, and the frequency of vandalism at the site. BLM, NPS, and other relicensing participants requested that the Districts research and identify potential improvements to whitewater boating take-out opportunities. In response to these requests, the Districts conducted a Whitewater Boating Take-Out Improvement Feasibility Study. The primary goal of the study was to assess the engineering feasibility of improving the existing take-out location at the Ward's Ferry Bridge (TID/MID 2013b).

The recreation-related concerns at Ward's Ferry Bridge are not related to the operations of the Don Pedro Project. However, the Districts are proposing to enhance river recreation and help ameliorate bridge and road safety concerns, by improving the boat take-out. The whitewater boating take-out study and further assessment concluded that based on site assessment and preliminary engineering, whitewater take-out improvements at Ward's Ferry Bridge appear to be technically feasible at river right option and river left options. The Moccasin Point Recreation Area take-out was also identified as a viable option. Deer Creek and Deer Flats were not feasible due to topography and potential environmental impacts. The Ward's Ferry river left platform option was somewhat superior because it best relieves the congestion problems that result from rafters arriving at Ward's Ferry bridge over a short period of time due to the need to take advantage of CCSF's Holm powerhouse peaking operations.

3.9.3 Proposed Resource Measures

The Districts propose to develop and implement a Recreation Resource Management Plan (RRMP) to include the following components:

- The Recreation Facility Development Program is intended to help address existing and future recreation facility needs identified by upgrading existing facilities and constructing new facilities, where appropriate, based on regular monitoring of recreation use and trends. The program also defines the current capital construction-related plans of the Districts, identifies proposed recreation development projects and their estimated costs, and provides conceptual diagrams of the locations of anticipated improvements. The Recreation Facility Development Program addresses needs identified by relicensing recreation studies, including the current desire for improved river-egress for whitewater boaters at the Ward's Ferry Bridge location.

- The RRMP presents functional design drawings and cost estimate to build a platform on river left just upstream of the bridge sized and suitable to support up to two to three truck cranes and associated vehicles, allowing equipment and boat extraction to occur without blocking the Ward's Ferry Bridge roadway. Vehicle access to the platform would be via the County Road near the left side bridge abutment. The existing restroom facility would be relocated to river right.
- The RRMP presents concept plans for a new take out-put in facility at RM 25.7, where the fish counting and barrier weir are to be located.
- The operation and maintenance (O&M) program describes of O&M of existing and future developed multi-purpose recreation areas, recreation areas with limited-facility infrastructure, and dispersed areas with no facility infrastructure. The Districts will continue to provide O&M as described in the RRMP, Section 4. The Districts and DPRA maintain a five-year budget plan that is updated annually.
- The Recreation Monitoring Program component of the RRMP is designed to measure recreation use levels, recreation use impacts, visitor tolerances for impacts (crowding, conflict, use impacts, facility conditions, etc.) and management actions that may be used to address identified "impact problems." This program defines the Districts' role in collecting and analyzing recreation data, and proposes how the data might be used to guide planning related to recreation management and capital facility improvements over the term of the new license. As described in the RRMP Section 5, the Districts will collect recreation use data every year beginning in the year following FERC approval of the RRMP.
- Over the term of the new license, additional consultation may occur as necessary to ensure that the goal and objectives of the RRMP are being met and the proposed measures are implemented. Consultation activities conducted during the new license terms will include periodic reporting of recreation use and facility condition as described in the RRMP Section 6.

3.9.4 Unavoidable Adverse Impacts

There are no unavoidable adverse impacts on recreation resources.

3.10 Aesthetic Resources

3.10.1 Existing Environment

The Don Pedro Project is located in western Tuolumne County on the Tuolumne River, about 40 miles east of the City of Modesto and 26 miles northeast of the City of Turlock, both in Stanislaus County. The Don Pedro Project is located in the Sierra foothills region, an area characterized by rolling hills, rural landscapes, native grasslands, and blue oak woodland.

The Don Pedro Project consists of Don Pedro Reservoir, Don Pedro Dam and spillway, Don Pedro powerhouse, and a number of other, primarily recreation-related, facilities. Don Pedro Reservoir has a normal maximum water surface elevation of 830 ft msl and extends about 24 miles upstream from the dam. At maximum water surface elevation, the reservoir has a surface area of 12,960 ac and 160 miles of shoreline, including islands. Don Pedro Dam is an earth-and-rockfill structure with a reinforced-concrete upstream face approximately 580 ft high, with a top elevation of 855 ft. The Don Pedro powerhouse, located at the base of Don Pedro Dam, is a semi-outdoor, above-ground concrete powerhouse.

Views of the Don Pedro Project Boundary are scenic due to the natural beauty of the Tuolumne River and Sierra foothills. Because residential and commercial development are not allowed within the Project Boundary, vegetation along the reservoir is generally well established and lands within the Project Boundary blend into the surrounding landscape. Figure 3.10-1 shows a typical spring reservoir view. However, Don Pedro Project facilities are structural elements that visually contrast with the surrounding rural or natural landscape, as described below.

Figure 3.10-1. View across Don Pedro Reservoir from the intersection of Grizzly Road and New Priest Grade Road (March 2012).

All facilities and lands within the current Project Boundary are owned by TID and MID, with the exception of 4,802 ac of federal lands administered by the BLM. These federal lands are part of a larger land unit managed by the BLM in accordance with the Sierra Resource Management Plan (SRMP). The BLM has identified the lands within the Project Boundary as Visual Resource Management (VRM) areas in the SRMP. In the SRMP, the BLM described the following goals for these lands:

- protect and enhance the scenic and visual integrity of the characteristic landscape, and
- maintain the existing visual quality of the Lake Don Pedro/Highway 49 viewshed and the Red Hills ACEC.

In 2012, the Districts conducted a Visual Quality Study (TID/MID 2013a) to document current visual conditions of the Don Pedro Project as viewed from BLM lands during various times of the year and identify any adverse visual resource effects due to continued operation. The objectives of the study were to identify, map, and describe BLM inventories associated with Don Pedro Project facilities and features on land administered by BLM and document the Existing Visual Condition (EVC) of all facilities and features from associated viewsheds on land administered by BLM.

The study area included Don Pedro Reservoir and the Tuolumne River upstream to Ward's Ferry Bridge (Figure 3.10-2). The features and facilities listed below were assessed for visual quality. Greater detail regarding the delineation of the study area, basis of study site selection, and assessment methods used is included in the Visual Quality Study Report and associated appendices (TID/MID 2013a).

- Ward's Ferry Bridge,
- State Highway 49/120 Vista Point,
- Moccasin Point Recreation Area,
- State Highway 132,
- BLM dispersed use areas,
- Don Pedro Reservoir and Tuolumne River,
- Fleming Meadows Recreation Area,
- Don Pedro Dam and Powerhouse,
- DPRA Headquarters and Visitor's Center,[92]
- Don Pedro Spillway, and
- Blue Oaks Recreation Area.

Current operating protocols permit reservoir drawdown to elevation 600 ft. Since construction of the new Don Pedro Dam, the Don Pedro Reservoir has operated between elevations 690 ft and 830 ft msl, depending on hydrologic, precipitation, and water management factors. A zone of exposed soil with sparse and/or low growing vegetation is evident in the drawdown zone. As reservoir surface elevation declines and the drawdown zone expands, the visual effect is often one of strong visual contrast (TID/MID 2013a). Where the slopes are steeper, sandy brown soils are exposed; and where slopes are gentler, grasses and low vegetation become established. In some locations the reservoir drawdown exposes large rocky areas that tend to match rocky areas above the high water mark and therefore present little visual contrast.

[92] The DPRA headquarters building overlooking Don Pedro Dam burned to the ground in 2016. The Districts are developing plans and designs for a building located closer to the Fleming Meadows Recreation Area.

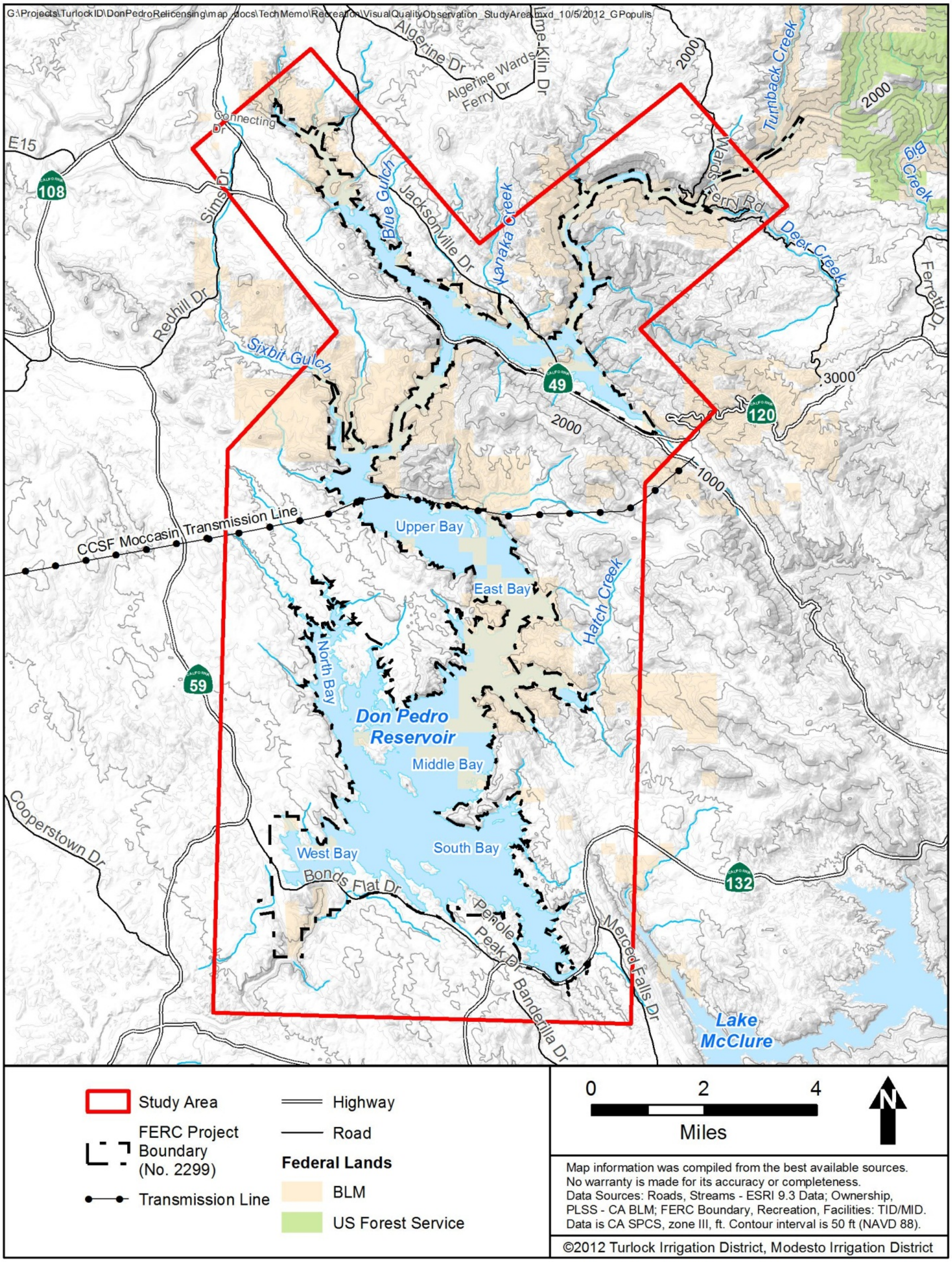

Figure 3.10-2. Visual Quality Study area.

3.10.1.1 Ward's Ferry Bridge

Ward's Ferry Bridge is located in a steep canyon in the upstream portion of the study area (Figure 3.10-3). A whitewater boating take-out, which is used primarily from April through September, is located just upstream of the bridge. Looking up- and down-river from Ward's Ferry Bridge, the effects of drawdown are evident on the steep slopes adjacent to the reservoir and present a strong visual contrast to the landscape outside the drawdown zone (TID/MID 2013a).

Figure 3.10-3. View from Ward's Ferry Bridge looking upriver (July 2012).

3.10.1.2 Moccasin Point Recreation Area

Moccasin Point Recreation Area is located south of the Jacksonville Road Bridge. No Key Observation Points (KOPs) were established in the campground because there are limited views of the reservoir and it is not located on BLM land (TID/MID 2013a). However, KOPs were selected in four locations associated with dispersed recreation areas located on BLM land where either the reservoir or Moccasin Point Recreation Area can be seen from BLM administered lands (Figure 3.10-4). Views of the reservoir from these locations are considered favorable.

Figure 3.10-4. View from the end of Grizzly Road of houseboats and Moccasin Point Recreation Area boat ramp (March 2012).

3.10.1.3 Highway 49/120 and Vista Point

Views from Highway 49/120 include Don Pedro Reservoir and BLM, District, and private lands were recorded; Figure 3.10-5 depicts a sample view. The foreground is dominated by the reservoir, shoreline lands constitute the middle ground, and the background consists of steep foothill slopes. Hetch Hetchy pipeline can be seen to the east. This view of the reservoir is the one most often seen by people, i.e., typically those traveling to Yosemite National Park.

A few residences can be seen when looking across the reservoir. The colors and shapes of these present weak visual contrasts to the surrounding terrain (TID/MID 2013a). The Jacksonville Road Bridge can be seen to the south, which presents a moderate to strong contrast, depending on lighting.

During high water there is little to no visual contrast of the reservoir shoreline with the surrounding area. However, as reservoir water level decreases, the drawdown zone contrasts with the surrounding vegetation. This contrast, as seen from the Vista Point, was considered to be moderate when viewed in March and July 2012 (TID/MID 2013a).

Figure 3.10-5. View of Don Pedro Reservoir from Highway 49/120 Vista Point (July 2012).

3.10.1.4 State Highway 132

State Highway 132 runs east-west along the southern portion of the Don Pedro Project area, immediately adjacent to the Rogers Creek Arm of Don Pedro Reservoir. Although the reservoir can be seen along a short section (several hundred feet) of road, there are no views of facilities or recreation areas (TID/MID 2013a).

3.10.1.5 Fleming Meadows Recreation Area

The Fleming Meadows Recreation Area is located on a peninsula, with views of Don Pedro Reservoir, the dam and spillway, a marina, and three houseboat mooring areas. The strong visual contrast of the houseboat mooring areas and marina are typical of recreation management areas on reservoirs (Figure 3.10-6). The long-range views of the dam and spillway result in a weak visual contrast (TID/MID 2013a). When the reservoir is below full pool, the drawdown zone can be seen, resulting in a moderate visual contrast (TID/MID 2013a).

Figure 3.10-6. View from campsite A19 at Fleming Meadows Recreation Area looking east at Don Pedro Reservoir and houseboat marina (March 2012).

3.10.1.6 Don Pedro Dam

Don Pedro Dam can be viewed directly in the foreground from former location of DPRA Headquarters and Visitor's Center (Figure 3.10-7). The dam can also be viewed from the Blue Oaks Recreation Area. At both locations, the dam presents a strong visual contrast to the surrounding natural landscape (TID/MID 2013a). Because the BLM's Visual Resource Objective (VRO) maps were developed with the Don Pedro Dam present, the continued presence of the dam is consistent with BLM's objective of retaining the existing character of the landscape (TID/MID 2013a).

Figure 3.10-7. View east towards the Don Pedro Dam from DPRA Headquarters and Visitor's Center (March 2012).

3.10.1.7 Don Pedro Powerhouse

The Don Pedro powerhouse can be seen briefly when traveling east along Bonds Flat Road (Figure 3.10-8). Although the powerhouse presents a strong visual contrast to the surrounding landscape, it is located at the bottom of a valley, which makes it difficult to see from a moving vehicle. The powerhouse cannot be seen from the site of the DPRA headquarters or elsewhere along the reservoir (TID/MID 2013a). As with the dam, BLM's VRO maps were developed with the Don Pedro Powerhouse in place, and as a result the presence of the powerhouse is consistent with BLM's objective of retaining the existing character of the landscape (TID/MID 2013a).

Figure 3.10-8. View south of powerhouse from Bonds Flat Road. Picture is taken from the passenger window at the center of the dam road. The powerhouse is located at the bottom of the canyon and is in the middle ground (July 2012).

3.10.1.8 Don Pedro Spillway

The Don Pedro Spillway can be seen briefly by those traveling along Bonds Flat Road and from the Blue Oaks Recreation Area group picnic site (Figure 3.10-9). The spillway strongly contrasts with the surrounding landscape (TID/MID 2013a), but like the other facilities discussed above, its presence is consistent with BLM's objective of retaining the existing character of the landscape.

Figure 3.10-9. View east of Don Pedro Spillway from Bond Flats Road (March 2012).

3.10.1.9 Blue Oaks Recreation Area

The Blue Oaks Recreation Area is located partially on BLM land. Views from the area include the reservoir and campground in the foreground; the dam, a houseboat mooring area, undeveloped landscape, and rolling hills in the middle ground; and the foothills in the background. Figure 3.10-10 includes a sample view. When recreation sites are occupied, their visual contrast with the surrounding landscape is strong (TID/MID 2013a). The dam and houseboat area likewise present a strong visual contrast with the surrounding area (TID/MID 2013a). Again, because the BLM's VRO maps were developed with the Blue Oaks Recreation Area in place, the area's presence is consistent with BLM's objective of retaining the existing character of the landscape (TID/MID 2013a).

Figure 3.10-10. View from campsite D-19 at Blue Oaks Recreation Area looking east at Don Pedro Reservoir and Don Pedro Dam (July 2012).

3.10.1.10 Don Pedro Reservoir

Don Pedro Reservoir is a major visual asset to the landscape, as evidenced by development of residential property with views of the reservoir (TID/MID 2013a). The reservoir, with its complex shoreline and many bays and arms, looks like a natural lake when at full pool (TID/MID 2013a). Although at lower water surface elevations the drawdown zone presents a strong contrast to the surrounding landscape, public attitudes toward the drawdown zone are not necessarily negative (TID/MID 2013a); a sample low reservoir view is shown in Figure 3.10-11. Particularly during low water years, recreationists know the reservoir will be drawn down and understand the various demands for the water stored in the reservoir. This is supported by the results of the recreation use assessment, which show that over 70 percent of respondents surveyed did not view variation in reservoir water level as an impairment of the scenic quality of the area (TID/MID 2013b).

Figure 3.10-11. View depicting low reservoir elevation condition taken from the Blue Oaks Recreation Area looking east towards Don Pedro Reservoir (Photograph provided by DPRA).

3.10.2 Resource Effects

Page 38 of FERC's SD2 identifies the following potential Don Pedro Project effects:

- Effects of Project operations, maintenance activities, and project recreation use on aesthetic resources, including the reservoirs and downstream reach, within the Project area.

Views of the Don Pedro Project Boundary are scenic due to the natural beauty of the Tuolumne River and Sierra foothills. Because residential and commercial development are not allowed within the Project Boundary, vegetation along the reservoir is generally well established and lands within the Project Boundary provide scenic landscape vistas. The Proposed Action does not include changes in the current footprint of the existing powerhouse and switchyard or other facilities. Effects on aesthetic resources during the term of the new FERC license will be the same as those described above for existing conditions.

The Districts have proposed to lower the minimum operating pool from the current elevation of 600 ft. to 550 ft. Under current and historic operations, the reservoir fluctuates across a broad band to which people who view reservoir have grown accustomed. Fluctuations and reservoir levels proposed for the new license and their effects on BLM aesthetic resources will be substantially similar to current operations.

3.10.3 Proposed Resource Measures

The Districts are proposing two construction projects in the Preferred Plan that have the potential to affect BLM aesthetic resources:

- Extend the existing riprap protection on the upstream face of Don Pedro Dam from the current elevation of 585 ft. to elevation 535 ft.
- Construction of a platform on river left immediately upstream of the Ward's Ferry Bridge.

The Districts will adhere to best management practices and consult with BLM during the planning and construction phases of these projects to minimize impacts to BLM aesthetic resources and ensure conformance with BLM aesthetic resource goals.

3.10.4 Unavoidable Adverse Impacts

There will continue to be visual contrasts associated with the Don Pedro Project, as described in the previous sections. These are an unavoidable consequence associated with a water storage project and its related facilities, including those developed for recreation. However, because BLM's VRO maps were developed with the Don Pedro Project facilities in place, the continued presence of these facilities, though at times presenting a visual contrast with surrounding natural areas, is consistent with the BLM's objective of retaining the existing character of the landscape (TID/MID 2013a).

3.10.3 Proposed Resource Measures

There are no proposed measures related to aesthetic resources.

3.10.4 Unavoidable Adverse Impacts

There will continue to be visual contrasts associated with the Don Pedro Project, as described in the previous sections. These are an unavoidable consequence associated with a water storage project and its related facilities, including those developed for recreation. However, because BLM's VRO maps were developed with the Don Pedro Project facilities in place, the continued presence of these facilities, though at times presenting a visual contrast with surrounding natural areas, is consistent with the BLM's objective of retaining the existing character of the landscape (TID/MID 2013a).

3.11 Cultural Resources

The Districts have undertaken an extensive investigation of the cultural resources at the Don Pedro Project, including efforts to identify those cultural resources that may be affected by ongoing O&M activities. The studies undertaken to investigate cultural resources include the Historic Properties Study (CR-01), which focused on archaeological and built environment resources, and the Native American Traditional Cultural Properties Study (CR-02), which focused on TCPs. These investigations substantially added to the existing information provided in the Districts' PAD. Draft study reports have been distributed to the Cultural Resources

Workgroup in order to inform consultation with state and federal agencies and the potentially affected Tribes regarding the results of these studies. These studies have supported the development of a draft Historic Properties Management Plan (HPMP) [93], which is included as Appendix E-4 to this Exhibit E.

3.11.1 Existing Environment

This section describes existing cultural resources associated with the Don Pedro Project. It is presented by the following six areas: (1) regulatory context, including Section 106 consultation; (2) APEs; (3) cultural history overview; (4) existing information; (5) results of the Historic Properties Study; and (6) results of the Native American TCP Study.

3.11.1.1 Regulatory Context

Section 106 of the National Historic Preservation Act (NHPA), requires FERC to take into account the effects of licensing on properties listed or eligible for listing in the National Register of Historic Places (NRHP) prior to issuance of a new license. Pursuant to the applicable regulations found at 36 CFR 800.16, an undertaking is defined as a project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a federal agency, including those requiring a Federal permit, license or approval. In this case, the undertaking is FERC's consideration of issuing a new license for the Don Pedro Project. Potential effects that may be associated with this undertaking include any Don Pedro Project-related effects associated with day-to-day operations and maintenance and any new construction activity proposed under the new license.

Historic properties are cultural resources listed or eligible for listing in the NRHP. Historic properties represent objects, structures, districts, traditional places, or archeological sites that can be either Native American or Euro-American in origin. In most cases, cultural resources less than 50 years old are not considered eligible for the NRHP. Cultural resources also must retain integrity (i.e., the ability to convey their significance) to qualify for listing in the NRHP. For example, dilapidated structures or heavily disturbed archeological sites may not retain enough integrity to relay information relative to the context in which the resource is considered to be important and, therefore, are not eligible for listing on the NRHP.

Section 106 also requires that FERC consult with the SHPO on any determinations of NRHP eligibility and findings of effect to historic properties, and allow the Advisory Council on Historic Preservation (ACHP) an opportunity to comment on any finding of adverse effects. If Native American properties have been identified, Section 106 also requires that FERC consult with interested Native American Tribes that might attach religious or cultural significance to such properties (i.e., TCPs).

On April 8, 2011, FERC designated the Districts as its non-federal representatives for purposes of consultation under Section 106 of the NHPA. As FERC's non-federal representatives, the Districts have consulted throughout the relicensing effort with BLM, potentially affected Tribes,

[93] The draft HPMP contains sensitive information and is therefore being filed with FERC as a PRIVILEGED, non-public document.

and SHPO, including obtaining SHPO's concurrence on the Area of Potential Effects (APE). By letter dated January 9, 2012, SHPO concurred with the Districts proposed APE. Consultation efforts further included six meetings between the Districts, interested Tribes, BLM, and SHPO that focused on the collaborative development of study plans and preliminary study results. Representatives from five Tribes, BLM, NPS, SHPO and FERC participated in these meetings, although not all parties attended each meeting.

3.11.1.2 Area of Potential Effects

The study area investigated for the Historic Properties Study and the Native American TCP Study is the APE. As defined in the applicable regulations found at 36 CFR 800.16(d), the APE is "...the geographic area or areas within which an undertaking may directly or indirectly cause changes in the character or use of historical properties, if any such properties exist." The APE for the Don Pedro Project relicensing study effort is defined as all lands within the FERC boundary that are (1) within 100 ft beyond the normal maximum water surface elevation (830 ft), (2) within designated Don Pedro Project facilities and formal recreation use areas, (3) within informal recreation use areas identified by the DPRA[94], (4) within the Red Hills ACEC, and (5) along the reservoir edges, including reservoir reaches that contain intermittent and perennial streams.

3.11.1.3 Cultural History Overview

The Don Pedro Project area has a varied and rich history related to cultural resources. This discussion is presented in two parts: prehistory and post-European settlement, and is based on research conducted during the relicensing studies.

Prehistory and Archaeology

The broad outline of prehistoric California cultural chronology and culture history has been established primarily by observation of basic changes through time in artifact assemblages in areas in the vicinity of the Don Pedro Project. These include overviews of the central Sierra Nevada (cf., Arnold et al. 2004:41-43; Chartkoff and Chartkoff 1984:121-124, 162-165 [Table 4.9], 176-178; Hull 2007:184, Figure 12.4; Jackson et al. 1994; Moratto 1984: Chapters 5 and 7; 1999:Table 4.9; Rosenthal et al. 2007). A number of other culture-historical schemes have also been applied to various western-slope drainages over the last several decades (e.g., Bennyhoff 1956; Elston et al. 1977; Moratto 1972; Wirth Environmental Associates 1985). Many of these schemes link back to temporal divisions originally outlined in the traditional western Great Basin projectile point chronology (e.g., Baumhoff and Byrne 1959; Bettinger and Taylor 1974; Clewlow 1967; Heizer and Baumhoff 1961; Heizer and Hester 1978; Thomas 1970, 1981), and to a lesser extent the original Central Valley chronology (Bennyhoff and Heizer 1958; Bennyhoff and Hughes 1987; Heizer 1951; Ragir 1972).

[94] The FERC approved Historic Properties Study Plan specified that if informal recreation areas were found to extend beyond the Don Pedro Project APE during the study, these areas would be surveyed at that time and the APE expanded to incorporate the informal recreation areas up to the FERC Project Boundary. No such areas have been identified to date.

Cultural chronologies/culture histories of particular relevance to the current APE include that developed for the new Don Pedro Project by Michael Moratto who conducted a study of the reservoir locality in 1970-1971 using students from San Francisco State College (Moratto 1984:311-312; papers in Moratto 1971). In addition to the Don Pedro Reservoir area, project localities in the north-central Sierras of particular interest include the New Melones Reservoir (Moratto 2002; Moratto et al. 1988), and the Sonora Locality (papers in Rosenthal ed. 2011). These are summarized below.

Don Pedro Reservoir Cultural Chronology/Culture History

During 1970 and 1971, M. Moratto and others conducted an archaeological survey and limited excavations at the site of the new Don Pedro Reservoir, recording 28 historic-era resources and 41 prehistoric sites or features (Moratto 1984:311-312; papers in Moratto 1971). The latter were mostly small middens, bedrock milling stations, a few cupule petroglyphs, and a single rock shelter. Moratto noted that many of the sites or features had been damaged or nearly destroyed by previous earth-moving operations, including dredging, tunneling, hydraulic mining, road construction, agricultural activities, and inundation by the La Grange headpond and the original Don Pedro reservoir in the 1890s and 1923, respectively.

Test excavations at seven of the prehistoric sites located by Moratto suggested that they dated to the last 1,500 years, and at least four of them to the last 500 years. Despite the lack of identified older components, Moratto surmised that there were probably older settlements along the inundated reaches of the Tuolumne River. The lithic materials at the seven Don Pedro sites were dominated by local cryptocrystalline silicate (CCS) toolstone, with smaller amounts of obsidian. Some of the later sites also yielded steatite disc beads, ornaments, and vessels; small (presumably arrow) points; small obsidian flake tools; and the remains of circular, semi-subterranean houses. Moratto reported that numerous flake and core tools “occur throughout the sequence without noticeable temporal clustering” (1971:144). One site, CA-TUO-300, produced “heavy” projectile points, a “boatstone,” and disc beads made of abalone shell. Two of the sites contained a total of at least 16 burials.

Moratto (1984:311-312) recognized two well-documented cultural phases at the Don Pedro locality. One dated to c. 500-300 years before present (B.P.)[95] and was considered an expression of the Mariposa Phase, representing Miwok prehistory. The other, dated at c. 1700-500 B.P., was correlated with the Crane Flat Phase, generally associated with the Yosemite area of the Sierra Nevada and often affiliated with Yokuts prehistory. Evidence for earlier occupation of the area suggested that humans were present from c. 5,000 B.P. on. These studies documented a long and intensive history of use of the Don Pedro Reservoir area by native people.

Jackson (1971) sourced 112 obsidian artifacts from five Don Pedro locality sites, representing one of the first attempts to systematically source prehistoric obsidian artifacts from the central Sierra. Bodie Hills was the primary source, followed by Casa Diablo, and Mount Hicks. One artifact was made from Mono Glass Mountain obsidian and one from Konocti glass.

[95] Years before present (B.P.) is a time scale used in archaeology, geology, and other scientific disciplines to specify when events in the past occurred. Because the "present" time changes, standard practice is to use the year 1950 as the arbitrary origin of the age scale (i.e., the present).

New Melones Reservoir Cultural Chronology/Culture History

Over a period of 30 years, numerous survey efforts documented over 700 archaeological sites in a cultural resource study that has become known as the New Melones Archaeological Project[96]. These archaeological investigations were initiated for the construction of the New Melones Dam and Reservoir in the 1960s/1970s. The New Melones facilities are located less than 6 miles northwest of the Don Pedro Project area on the Stanislaus River. Testing and/or data recovery, conducted by several entities for the New Melones work, occurred at 34 historic and 68 prehistoric sites. A ten-volume final report was prepared covering the investigations, and a synthesis and summary of findings has also been prepared (Moratto et al. 1988).

Moratto (2002) has summarized the prehistoric chronology/culture history of the New Melones locality in a series of temporal and formal units (Moratto 2002:36, Figure 7; see also pp. 31-35, Figures 2-6 for locations of archaeological sites associated with each major time period). Peak and Crew (1990) defined the earliest signs of human occupancy at New Melones.

Between c. 9450 and 5450 B.P., stemmed series projectile points occur, joined after c. 5950 B.P. by Pinto and Humboldt Series points. The Clarks Flat Phase occurred from c. 9450 B.P. to c. 6950/6450 B.P., followed by the Stanislaus Phase (c. 6950/5950 B.P. to 6200 B.P.), and a terminal period of undesignated components (c. 6200-5450 B.P.). During Early Clarks Flat Subphase times (c. 9450-7950 B.P.), bipointed, foliate, and stemmed points occurred, along with scrapers, notched tools, and beaked gravers. Great Basin transverse points (i.e., "crescents") may be associated with this or possibly an earlier, undesignated phase. Several sites appear to have functioned as hunting camps. Low assemblage diversity and artifact densities suggest limited, temporary use of sites during this time period.

During the subsequent Late Clarks Flat Subphase, c. 7950-6950/6450 B.P., Early Clarks Flat flaked stone tool types continue with the addition of milling slabs, handstones, a variety of scrapers, and Western Stemmed Series points. The "Stanislaus Phase" is characterized by continuance of Late Clarks Flat artifact types, with the addition of Stanislaus Broad-Stemmed points, and abundant milling tools. Pinto and Humboldt Series points begin to appear after c. 5950 B.P. Increasing artifact densities and assemblage diversity occurs during the Late Clarks Flat through Stanislaus Phase sequence. This is thought to reflect diversification of economic pursuits, especially those resulting from expanding use of plant resources, and occupational intensification. Some New Melones sites contain poorly documented assemblages with Pinto and Humboldt Series points which appear unrelated to the Clarks Flat-Stanislaus continuum.

The period c. 5450-4750 B.P. witnessed the Texas Charley Phase, typified by the presence of Pinto and Humboldt points, large lanceolate bifaces, and distinctive scrapers. A hiatus in the New Melones archaeological records appears to have occurred after the Texas Charley Phase until c. 4450 B.P. when the Calaveras Phase commenced, marked by the presence of Pinto and Humboldt Series points and milling stones. For a period after the Calaveras Phase ended, c. 3950 B.P., the New Melones archaeological record is poorly known, with traces of minimal site occupancy noted.

[96] See Moratto 2002 for a summary of Don Pedro Project history, and a bibliography of relevant resultant literature.

Between c. 2950 B.P. and 1450 B.P., the Sierra Phase took place. Typical artifacts include Elko Series, Sierra Concave Base, and Sierra Side-Notched projectile points, bowl mortars, cylindrical pestles, and Olivella F and G Series beads (the Olivella bead types are based on Bennyhoff and Hughes 1987). This phase is marked by economic diversity, acorn use, large populations, intensive occupation, middens and structural remains, cemeteries, use of mortuary caves, abundant funerary artifacts, and signs of extensive material conveyance.

From c. 1450-950 B.P., the Redbud Phase occurred. Typical artifacts are Rosegate Series projectile points, and Olivella D, K, and M Series beads. After c. 950 B.P., other as yet undefined phases may have occurred until c. 650 B.P. Throughout this time, ephemeral site use by small populations engaged in minimal material conveyance seems to have occurred in the New Melones region. During the later part of this time, this may reflect unfavorable climatic conditions resulting from the Medieval Climatic Anomaly.

The Horseshoe Bend Phase, c. 600 B.P. to Anno Domini (A.D.) 1848 – the beginning of the gold rush – was marked by Stockton Serrated, Cottonwood Triangular, Desert Side-Notched, and Gunther Barbed projectile points, and Olivella E, K, and M Series beads. At this time, the New Melones region was occupied by large numbers of people, who intensively occupied the area. These were ancestral Sierra Miwok speakers who practiced an intensified acorn-based economy, and lived in year-round settlements.

Between A.D. 1848 and 1910, the Peoria Basin Phase is associated with historic Sierra Miwok village communities. Associated artifacts include glass trade beads and Desert Side-Notched and Cottonwood Triangular points. During this period, the Sierra Miwok experienced severe depopulation from a variety of causes along with the effects of acculturation with introduced elements of Euro-American culture.

The Sonora Region Cultural Chronology/Culture History

The original cultural chronology/cultural history for the Sonora area, located roughly eight miles from the Don Pedro Reservoir, was developed during the New Melones Reservoir project (Moratto et al. 1988; Moratto 2002). The New Melones chronology, which was the first systematic attempt to organize the local archaeological record, distinguishes six major time periods. As described above, from youngest to oldest they include: Peoria Basin, Horseshoe Bend, Redbud, Sierra, Calaveras/Texas Charley, Stanislaus, and Clarks Flat, with temporal divisions between them occurring at 650 B.P., 1450 B.P., 2950 B.P., 5450 B.P., and 7950 B.P. Each of these breaks was thought to represent a significant transition in the archaeological record, distinguishable through changes in technology and land use.

Subsequent recent and ongoing research in the Sonora region of Tuolumne County by Far Western and Sonoma State University, directed by archaeologists Jeffrey Rosenthal and Jack Meyer (e.g., Meyer 2008, 2011; Meyer and Dalldorf 2004; Meyer et al. 2005; Rosenthal 2008; Rosenthal ed. 2011; Rosenthal et al. 2008; Whitaker and Rosenthal 2009) has resulted in development of a more inclusive regional cultural/chronology/culture history. This scheme was developed for the Sonora region based on a synthesis of chronological information from more than 100 excavated sites in the watersheds of the Mokelumne, Calaveras, Stanislaus, and Tuolumne rivers, including those excavated as part of the New Melones project (cf., papers in Rosenthal ed. 2011). Based on spatial and stratigraphic analyses of more than 200 radiocarbon dates, more than 4,000 source-specific obsidian hydration readings, slightly more than 875 projectile points, and close to 600 shell beads, five major time periods were defined, including the Early Archaic, Middle Archaic, Late Archaic, Recent Prehistoric I, and Recent Prehistoric II (Table 3.11-1).

Also identified were dominant projectile point styles and obsidian hydration brackets associated with each time period, facilitating interpretation of calendric ages of Bodie Hills hydration readings below 4,000 ft (1,219 meters) in elevation (Rosenthal 2011b:48, Table 16). This new chronology revises the one developed for New Melones, and provides a framework for timing of major prehistoric technological, subsistence, and land-use changes occurring in the central Sierra Nevada (cf., papers in Rosenthal ed. 2011).

Table 3.11-1. Archaeological chronology of the West-Central Sierra Nevada developed for the Sonora Region.

Period	Age Range (cal B.P.)[1]	Hydration Range (microns)[2]
Recent Prehistoric II	610-100	2.4-0.9
Recent Prehistoric I	1100-610	3.1-2.5
Late Archaic	3000-1100	4.7-3.2
Middle Archaic	7000-3000	6.8-4.8
Early Archaic	11,500-7000	8.6-6.9

[1] "cal" refers to calibrated. Uncorrected, or 'conventional' radiocarbon ages are calculated using an assumption that the concentration of naturally occurring radiocarbon in the atmosphere is constant. Calibration of these conventional ages to calendar years corrects for known minor variations over time in the concentration of atmospheric radiocarbon. This calibration also corrects for an error in the estimate of 'half-life,' or the rate at which radiocarbon decays. While the half-life of radiocarbon is now known to be slightly longer than was estimated when the technique was invented, laboratories continue to report radiocarbon dates using the older, less accurate value, hence the term 'conventional.' Because of this, uncalibrated dates earlier than about 2000 years B.P. tend to be substantially 'younger' than calibrated dates.

[2] Bodie Hills Obsidian; applicable only below 4,000 ft (below snow line). From Rosenthal (2008), based on Rosenthal and Meyer (2004).

General Prehistoric Chronological Sequence

The general chronological sequences described in this section reflect the new regional chronology for the Sonora region that is based on the research conducted by Jeffrey Rosenthal and Jack Meyer (e.g., Meyer 2008, 2011; Meyer and Dalldorf 2004; Meyer et al. 2005; Rosenthal 2008; Rosenthal ed. 2011; Rosenthal et al. 2008; Whitaker and Rosenthal 2009), as described above.

Early Archaic (11,500-7000 cal B.P.)

Like most places in California, well-dated deposits from the Early Archaic are quite rare in the Sierra Nevada foothills. To date, they have been identified at Skyrocket (CA-CAL-629/630) in Salt Springs Valley and at Clark's Flat (CA-CAL-342), located upstream from New Melones Reservoir along the Stanislaus River. Both sites were observed in buried stratigraphic contexts. Artifacts included large numbers of Wide-stem and Large-stemmed dart points, as well as very small numbers of other notched and stemmed projectile points.

The Early Archaic stratum at the Skyrocket site contained hundreds of handstones and milling slabs, and a variety of cobble-core tools, large percussion-flaked "greenstone" bifaces, and comparatively high frequencies of obsidian from the Bodie Hills and Casa Diablo sources located east of the Sierra crest (La Jeunesse and Pryor 1996). Milling equipment was substantially less abundant at the Clark's Flat site. Plant macrofossil assemblages recovered from Skyrocket are dominated by gray pine and acorn nutshell, but include few if any small seeds or other spring- and summer-ripening plant foods (e.g., manzanita). This suggests that the site was primarily used during the fall and early winter when nuts were available. Plant remains were not sampled at Clarks Flat.

The large accumulation of ground stone in the early stratum at CA-CAL-629/630 probably represents sustained residential use or the residue of repeated seasonal occupations occurring over many millennia. This pattern of repeated or extended occupation suggests that Early Archaic land use in the western central Sierra was seasonally structured, and was not the wide-ranging, highly mobile lifestyle often believed to characterize the Early Archaic throughout the mountain west. This conclusion is further supported by the almost exclusive use of local toolstone for the manufacture of bifaces and projectile points at both Skyrocket and Clark's Flat.

Other sites with evidence of Early Archaic occupation include Taylor's Bar (CA-CAL-1180) on the Calaveras River. There, large stemmed points and an early Holocene radiocarbon date are reported from buried soil. This material was mixed with a substantial Late Holocene deposit (Milliken et al. 1997). In addition, the Poppy Hills site (CA-TUO-2797/H), located downslope from Sonora near Jamestown, produced Early Holocene radiocarbon dates and obsidian hydration readings from a buried soil mixed with Middle Archaic material (Whitaker and Rosenthal 2010).

Middle Archaic (7000-3000 cal B.P.)

The Middle Archaic has traditionally been the most misunderstood portion of the central Sierra Nevada archaeological record, with sites from this time period once thought to be quite rare in many foothill areas (e.g., Moratto et al. 1988). However, the apparent absence of this record can be attributed primarily to long-standing confusion over the timing of corner-notched dart points on the western slope. The common assumption has been that they date to only the last 3,000 years, and that either broad-stem points (e.g., Stanislaus Broad Stem), or Pinto and Humboldt Concave points, are diagnostic of this period (cf., Moratto 2002; Moratto et al. 1988; Peak and Crew 1990). However, recent excavations of several well-dated and stratified Middle Archaic sites clearly indicate that Corner-notched dart points were the predominant projectile point form used on the western slope of the north-central Sierra Nevada from about 7,000 to 1,100 years ago (Rosenthal 2011a; Rosenthal and McGuire 2004). Other stemmed and notched dart points also were used during the Middle Archaic, but in significantly lower numbers.

Like the Early Archaic, most known Middle Archaic deposits from the western Sierran slope have been identified in buried stratigraphic contexts. These often include large numbers of handstones and milling slabs, a variety of cobble-based pounding, chopping, and milling tools; and an occasional mortar and pestle (found only at the most intensively occupied sites). The earliest house structures identified so far on the western slope were present in a Middle Archaic stratum at the Edgemont Knoll site (CA-TUO-4559) at Sonora, associated with large subterranean storage pits (Meyer 2008).

A diverse assemblage of flaked, ground, and battered stone tools, along with comparatively high densities of dietary debris (i.e., plant remains and animal bone) suggests that the Edgemont site served as a primary residential encampment. Archaeobotanical remains, dominated by gray pine and acorn nutshell, reveal that the site was used primarily in the fall and winter, when large quantities of nuts were stored in underground granaries. The overwhelming abundance of nut crops at other Middle Archaic sites in the foothill woodlands suggests a similar season of occupation. In contrast, summer-ripening berries and other fruits are dominant in higher elevation sites located in the Lower Montane Forest.

These differences indicate a pattern of seasonal transhumance, with fall and winter villages placed below the snow line in the Blue Oak-Gray Pine Woodland, and summer camps situated in the conifer forest zone where annual roots, bulbs, seeds, and fruits were common during warmer months. Faunal assemblages from Middle Archaic sites are dominated by large mammal remains (e.g., deer), a pattern that continued throughout the remainder of the prehistoric sequence. The presence of atlatl weights and spurs in these deposits confirms that the dart and atlatl were the primary hunting implements. Soapstone “frying pans” and other vessels first appear in the local record during the Middle Archaic, along with various types of stone pendants, incised slate, and stone beads.

Late Archaic (3000-1100 cal B.P.)

Late Archaic sites are among the most common on the western slope, with many of these also occurring in buried stratigraphic contexts (Meyer 2011). Late Archaic lifeways, technologies, and subsistence patterns were quite similar to that of the previous Middle Archaic period, the primary difference being an increase in the use of obsidian. Handstones and milling slabs made up the vast majority of ground stone implements, and Corner-notched dart points were the most common projectile.

Various expedient, cobble-core tools, battered cobbles, and heavily used flake-based implements are common in Late Archaic foothill deposits. These heavy-duty tools were probably associated with the processing of pine nuts, the primary plant-food refuse present in Late Archaic foothill sites. Fall-ripening acorn nutshell also occurs regularly. Summer grass seeds and fruit and berry pits continue to be rare in foothill deposits, and common in higher elevation sites, indicating that seasonal mobility remained the primary strategy for overcoming spatial and seasonal differences in the availability of important plant foods.

This pattern of seasonal movements between the foothills and conifer forest is further supported by the distribution of different toolstones. Chert, only available in the western Sierra foothills below about 3,000 ft, is common at Archaic sites in the Lower Montane Forest up to about 6,000 ft. Above that elevation, flaked stone assemblages on the western slope are composed almost entirely of obsidian (>80%). This suggests groups using the upper elevations of the western Sierra traveled from the east side, where obsidian was the primary toolstone.

Recent Prehistoric I and II (1100-100 cal B.P.)

Moratto (2002; Moratto et al. 1978, 1988) pointed out that sites dating to the Recent Prehistoric I Period are under-represented in the foothills of the western Sierra Nevada, a pattern that continues to be apparent in subsequent studies (e.g., Rosenthal 2008). He suggested that pervasive drought in the Sierra Nevada may be responsible for wide-spread settlement disruption (Moratto 1984:338; 2002; Moratto et al. 1988). Subsequent research has shown that this period coincides with a region-wide interval of reduced precipitation and higher temperatures, the Medieval Climatic Anomaly.

During this period, among the most important changes in the archaeological record of the western slope is the introduction of the bow and arrow at about 1100 calibrated (cal) B.P., an innovation apparently borrowed from neighboring groups to the north or east. This shift in technology is clearly reflected by the dominance of Small-stemmed and Corner-notched arrow points in the earlier Recent Prehistoric I sites. It remains unclear whether bedrock mortars were first widely used during this period. Their common occurrence at Recent Prehistoric II sites in the Sonora vicinity suggests that they had become an important milling technology by 610 cal B.P. Unlike the earliest arrow points, bedrock mortar technology appears to have developed west of the Sierra Nevada, the center of distribution for these milling features.

Unfortunately, too few single-component Recent Prehistoric I assemblages exist to adequately describe the basic lifeways and subsistence patterns characterizing this period. For the Recent Prehistoric II Period, however, numerous well-dated sites and components provide abundant evidence for changes in the nature of local subsistence economies. The dominance of acorn nutshell in these sites is among the most compelling evidence for acorn intensification in central California. Bedrock milling fixtures are established across the landscape, near well-developed residential middens, and as isolated features both above and below the oak zone. Subsistence remains in foothill sites include many more spring and summer grass seeds, and fruits and berry pits than were present in Archaic deposits. This indicates that occupation occurred for a longer part of the year, or that sites below the snow line were more regularly used to store warm-season resources for winter use.

There also appears to have been greater settlement differentiation during the Recent Prehistoric II Period. Residential sites often include house-depressions and other structural remains. Special-use localities consisting simply of bedrock milling features also occur. Summer use of higher elevations is also apparent. Many sites from this time period are found in the Lower Montane Forest, often containing high proportions of summer-ripening plant foods.

Like the Archaic, large mammal remains continue to make up a substantial portion of faunal assemblages from both high- and low-elevation sites. Similarly, the distribution of different east- and west-side toolstones indicates that regions above 6,000 ft remained primarily within the seasonal round of east-side people, probably targeting sheep and deer which congregate at high elevations during the summer. Many more specialized technologies are associated with the Recent Prehistoric II Period than were evident during the Archaic, including stone drills and bone awls.

The Desert Side-notched arrow point was first introduced on the western slope at about 610 cal B.P., clearly borrowed from Great Basin peoples to the east. Circular, perforated stone shaft-straighteners are also common in these sites, consistent with use of the bow and arrow. Imported shell beads from coastal California first appear in appreciable amounts in Recent Prehistoric II village sites, as do other rare items such as shell ornaments and bone whistles.

Ethnohistory

Ethnographically, the Don Pedro Project area lies within Central Sierra Miwok territory, located in the Sierra Nevada foothills and mountains spanning the upper drainages of the Stanislaus and Tuolumne Rivers. The Central Sierra Miwok group is considered a member of the Eastern Miwok, one of the two major divisions of the Miwokan subgroup of the Utian language family (Levy 1978). The Eastern Miwok peoples belonged to five separate linguistic and cultural groups each of which had distinct language and cultural characteristics (Levy 1978). Anthropologists have categorized the Eastern Miwok into language areas according to geographical location, which consist of (1) the Bay Miwok that occupied the eastern area of the Contra Costa County extending from Walnut Creek eastward to the Sacramento-San Joaquin delta; (2) the Plains Miwok, which inhabited the lower reaches of the Mokelumne and Calaveras river drainages; (3) the Northern Sierra Miwok that occupied foothills and mountains of the Mokelumne and Calaveras river drainages; (4) the Southern Sierra Miwok, which inhabited the foothill and mountain portions of the Merced and Chowchilla drainages; and (5) the Central Sierra Miwok mentioned above (Levy 1978).

These five groups were further designated as three distinct groups based on their phonological history and structural and lexical similarity (Levy 1978). Plains and Bay Miwok are both members of a distinct group, while the other three groups comprise a Sierra Miwok language group (Levy 1978). It has been suggested that Plains Miwok separated from the Sierra Miwok languages around 2,000 years ago (Levy 1978). Lexicostatistical chronology and language classification suggests that ancestral Miwok occupation of the Sierra Nevada and its foothills is probably a much more recent event compared to the central California delta region, since Sierra Miwok internal time depth is estimated at around 800 years (Levy 1978).

The main political unit of the Miwok was the tribelet, which was an independent and sovereign nation that had a defined and bounded territory designating its zone of control over natural resources. Among the Sierra Miwok, tribelets included political lineage localities that made up the permanent settlements with an average population estimate of around 25 persons, as well as several semi-permanent settlements and numerous seasonally occupied campsites that were used at various times throughout the seasonal round of gathering, hunting, and fishing activities (Levy 1978). Ethnographic literature points to the presence of a chief or an assembly house in the community at the capital or principal settlement (Levy 1978). The dominant form of house was a conical structure of bark slabs, supported by posts or frameworks.

The main foci of subsistence were the gathering of wild plant foods, especially acorn, and the hunting of mammals. The Sierra Miwok traveled to higher or lower elevation levels during various seasons of the year to obtain subsistence resources unavailable in the vicinity of their permanent settlements. The inhabitants occupying the Transition Zone forest moved to higher elevations during the summer months in pursuit of deer. Those in the foothill areas would occasionally visit the plains of the central valley to hunt antelope and tule elk, which are unavailable in the mountains. Gathering of plant foods varied seasonally, as greens were gathered in the spring and were used to supplement the diet of acorns stored since the previous fall. Seeds were gathered from May to August. Pine nuts were collected after August, when the land was burned. In the late fall and early winter, acorns were gathered (Levy 1978). Meat consumption was its greatest in the winter months when plant resources were limited to stored foods (Levy 1978).

Technological skills included basket making and production of ground stone items, such as mortars and pestles used in acorn processing. Lithic technology consisted of projectile points, knives, scrapers, and expedient tools like hammer stones and choppers made from various materials, such as chert and obsidian (Levy 1978).

The Eastern Miwok in the Sacramento-San Joaquin Valley were first contacted by Spanish explorers in the second part of the eighteenth century (Levy 1978). Since then, dramatic cultural changes developed, including the transformation of previously independent tribelets into unified militias resisting forced labor, forced missionization, and displacement that was intensified by epidemics and targeted violence against the Miwok by the Spanish, which killed many thousands of Miwok persons in the first half of the nineteenth century (Levy 1978).

During the 1840s, fur trappers, gold miners, and settlers arrived in large numbers and often hostile relations arose between these newcomers and Sierra Miwok. For a brief time, Southern Sierra Miwok supplied labor for J.D. Savage's gold mining operations in the Big Oak Flat district, but as the number of non-indigenous miners increased in the region, large mining operations were shut down, and Miwok participation decreased (Levy 1978). Records indicate that at least 200 Miwok were killed by the miners during the years 1847 to 1860 (Levy 1978).

A period of confiscation of Indian lands began with the annexation of California by the U.S. (Levy 1978). Although treaties were signed by several members of the tribelets, they were never ratified by the U.S. Senate (Levy 1978). A few groups of Sierra Miwok were removed to the Fresno area but most of the Sierra Miwok population remained in rancherias scattered throughout the Sierra Nevada foothills (Levy 1978). Reliance on wage labor steadily increased and dependence on gathering and hunting diminished throughout the end of the nineteenth century and early twentieth century. Federally recognized Sierra Miwok Tribes in the vicinity of the Don Pedro Project area include the Chicken Ranch Rancheria of Jamestown, California and the Tuolumne Band of Me-Wuk Indians of Tuolumne, California.

General Historical Themes

Regional Mining History

Like every other county along California's Mother Lode, reaching from Mariposa in the south to Auburn in the north (Clark 1970:15), intensive non-Native settlement in Tuolumne County began with gold mining operations.

County folklore credits the initial discovery of gold in Tuolumne County to James Savage and Benjamin Wood and company in July of 1848, on what is now Woods Creek near its crossing with the Stockton Road (State Route 108). Although it is not known who first mined for gold in the region, evidence points to people of Hispanic origin. The diaries of Americans who arrived in the area in 1848 provide accounts of Mexicans from Sonora, Mexico, working the flats and streams for gold. Extensive placer mining was carried out during the early years of the Gold Rush in nearly all of the ravines and gulches in present-day Tuolumne County, to be followed by hydraulic and hard-rock or quartz mining. The results of these activities can still be seen in the drainages and on the hillsides in and around the Don Pedro Project vicinity.

Placer Mining

The richest deposits of retrievable gold in California were found in the Sierra Nevada foothill region. How the gold came to the foothills is an involved story of geological processes. Basically, granitic rock, quartz lodes, and the contact zones were washed and eroded, and naturally milled by flowing water which concentrated the native gold in former and present streams and gravel beds. It was this “free” or placer gold which attracted the Gold Rush miners. Placer mining was the initial extraction method used in Tuolumne County, already familiar to miners from Mexico, Central America, and South America, where placer mining began in the 1500s.

Placer mining was the most common technique used in the APE and vicinity along the Tuolumne River and its drainages, from the earliest years of the Gold Rush through the Depression era. Most of the successful placer mines are now located beneath the waters of Don Pedro Reservoir, although some activity was carried on in the Jacksonville area until the New Don Pedro Dam was built in the late 1960s. Although placer mining was carried on all along the river, the most successful mines were located near Jacksonville and on the river bars along its length. Major placer mining activities on Moccasin Creek, Woods Creek, Sullivan Creek, and Kanaka Creek were identified above the present water line and were recorded during the Historic Properties Study (CR-01), while smaller operations were noted on Mine Island and on many drainages and gulches in the area.

Hydraulic Mining

After placer mining declined in the 1860s, hydraulic and quartz lode mining gave the region a more permanently based mining economy, one which continued—with cycles of expansion and contraction—through the 1930s and in some areas until the 1950s. Invented in California, hydraulic mining began in the 1850s when Anthony Chabot attached a wooden nozzle to a canvas hose and washed ancient river gravels. Over the next 20 years, miners improved upon Chabot’s design, developing “the Little Giant,” used for more than 100 years thereafter. The Little Giant, or monitor, required vast amounts of gravity-fed water at high head to spray on the Tertiary river gravels. Torrents of water would melt away boulders, trees, gravel, and dirt, all mixed with gold.

Although a simple and economic way of recovering rich nuggets deep in the gravels, hydraulic mining had numerous adverse effects downstream, where thousands of cubic yards of dirt and rocks were sent into the Central Valley. The tons of waste that entered the valley rivers caused the water level to rise, resulting in floods that destroyed crops, agricultural fields, and buildings. Hydraulic mining effectively ended in 1884, when Judge Sawyer of the United States Circuit Court granted an injunction making it illegal to discharge mining residue into rivers and streams. The 1893 Caminetti Act permitted hydraulic mining if debris-impounding dams were constructed, but the construction and maintenance of such dams was generally too expensive and not very successful and so the method was not widely used in Tuolumne County; it was successfully employed for many years, however, in nearby La Grange in Stanislaus County.

Hydraulic mining, with its dramatic landscapes and large open pits, never took hold in the Southern Mines[97], including those in Tuolumne County, to the degree it did in the Northern Mines of Placer, Nevada, Amador, and El Dorado counties. A small hydraulic pit has been identified near Moccasin and hydraulic mining was conducted at Hawkins Bar.

Hard-Rock Mining

Hard-rock (or quartz) mining began in Tuolumne County in the 1850s. Some of the earlier quartz mines continued to operate for many years: Carlin, Cherokee, Buchanan, Confidence, App, Soulsby, Dutch, and the Trio/Whiskey Hill mines. Hard-rock mining is a method of exploration that is largely subsurface but that leaves many remains on the landscape, including shafts, adits, haul roads, waste rock, prospects, surface vein workings, and tunnels.

The advent of the hard-rock mining boom of the late 1880s, which continued until most of the mills were shut down for World War I, was induced by a combination of advanced mining and milling technologies, primarily the invention of dynamite and the development of square-set timbering in the Comstock lode, the chlorination and cyanide ore refining processes, water or steam power drills, and water pumps and air power. Along with investment of foreign capital, these technologies provided for the resurgence of the mining industry in Tuolumne County and the foothills.

With the advent of hard-rock mining, mines that had closed throughout Tuolumne County were reopened during the late 1880s, often with new names and under new ownership. The larger mines were owned by corporations with abundant capital to invest in the construction of modern and larger stamp mills and recovery systems. The Eagle-Shawmut near Jacksonville (now beneath the waters of Don Pedro Reservoir) and the Harvard Mine near Jamestown were the largest of these, although hundreds of small and medium-sized mines were developed at Confidence, Soulsbyville, Jamestown, Stent, Quartz, Carters, Big Oak Flat, Groveland, Tuttletown, Sonora, and other locations. This boom continued for two decades, and by 1915, mining was still the major industry in the county (Hamilton 1915:136-166). Physical remains from that era include shafts and adits, stamp mills, haul roads, abandoned equipment, leach fields, powder magazines, mill tailings, ponds, waste rock dumps, workers' and superintendents' housing, and company offices.

[97] The term "Southern Mines" is commonly used in Gold Rush related literature and refers to those mining areas at the southern end of the Mother Lode gold belt. Conversely, the term "Northern Mines" is commonly used in Gold Rush related literature and refers to those mining areas at the northern end of the Mother Lode gold belt.

The Eagle-Shawmut Mine, the Orcutt, Harriman, Mammoth, Republican, Tarantula, Wheeler, and other mines on the Mother Lode vein near Jacksonville were inundated by the new Don Pedro Reservoir in the late 1960s. Other hard-rock mining activities in the area included surface vein workings, prospecting, coyoting, and small adits and "gyppo" (independent operator) mines, some of which are above the present water line of the reservoir and were recorded during the relicensing studies (49 Mine, McCormick/Tuolumne River Mine, coyoting on Kanaka Creek, the surface vein workings on the Penrose property near Jacksonville, and others).

Gold Dredging

Bucket-line and dragline dredges, which are based on the large-scale processing of low-grade placer-bearing gravel, became important producers of placer gold in the early 20th century. . Although introduced into California in 1897, dredging did not become a viable method of mining in Tuolumne County until the 1930s, when dredges worked on and in the Stanislaus and the Tuolumne rivers, Moccasin Creek, and at Montezuma. "Doodlebug" dredges were used on the hillsides below Jamestown during the 1940s. Both forms of dredging have left characteristic scars on the landscape, although many dredger gravel bars are now under reservoirs, including Don Pedro. Dredge tailings on the Ferretti/Sandner Ranch near Moccasin on Moccasin Creek are the most visible remnants of this activity in the APE. Tailings from the extensive dredge mining near La Grange were used in the construction of the new Don Pedro Dam.

Tuolumne County Agricultural Development

While gold mining drove the study area's economy, agriculture was a necessary industry to supply the miners with food. Close behind the prospectors and miners came the agriculturalists, families from the eastern states and Europe who saw opportunities for stock-raising and truck-garden operations on the open grasslands. Following the decline of placer deposits in the Mother Lode after c. 1860, ranching and farming became more important to the foothill economy. Settlers established farms in the area where they grew hay, alfalfa, and wheat, and planted orchards. Most families practiced a mixed agricultural economy, raising cattle, sheep, hogs, and poultry and maintained vegetable gardens and orchards. As the mining economy declined, farming gained importance as a family enterprise which helped to establish more permanence and stability in the local society.

In Tuolumne County, agricultural pursuits were always critical as a supporting service and at times were the most important source of income; even so, agricultural development was not as great as conditions warranted, since the interest in the county was so heavily centered on mining. In the early years when animals provided much of the labor, massive production of hay and grasses was necessary to feed the cattle, oxen, and horses. In 1909 about 18,000 ac were devoted to "hay" (wheat, barley, and oats), since these could be grown without water or much attention. County grasslands were used for stock grazing. Hogs were among the first animals to be raised in the county. Though few ranchers developed hog operations, other animals, such as goats, llamas, sheep, dairy cows, chickens, and other poultry were raised on county ranches and farms.

Livestock grazing was the primary agricultural industry in the vicinity of the APE, and in Tuolumne County as a whole. In 1909 more than half of the cattle ranches in the county were located in or near the Don Pedro area (*Union Democrat* 1909:63). When the first Don Pedro dam was constructed in the 1920s, lands that were to be inundated were purchased from ranchers, including Rosasco, Rushing Land & Cattle Company, Rydberg, Randall, Fleming, Hammond, Donahue, Hughes, Bartlett, Kassabaum, and others (Meikle 1927). As noted by Bill Welch, who was born and raised in the area: "When the dams were built the water backed up over many of the old ranches and the settlers moved out. There were big families here and I often wondered how they all made a living—they had nice homes and big barns and buildings" (Beard 1988:87). Additional lands were purchased in the 1960s when the new Don Pedro Dam was constructed. By that time, many of the ranchers no longer lived on their grazing lands full time, but resided in La Grange, Merced Falls, Empire, Jamestown, Chinese Camp, and other nearby communities.

Transportation Development

Most of the major highways and corridors in California follow the routes of Indian trails (Davis 1961). Such routes in Tuolumne County include State Route 49 and likely include portions of State Route 120. Within Tuolumne County, the pattern of roads generally led to river fords, which later became ferries crossings, and then successive bridge crossings, many of which persist to this day. Stevens Bar was bridged in 1859 and Ward's Ferry in 1879. Other crossings were made at Central Ferry (replaced by Central Bridge in the late 1850s), Jacksonville Ferry, McLeans Ferry, and more. Most physical remains are no longer extant or are underwater in reservoirs, but the names of those crossings survive today as road names: Parrotts Ferry, O'Byrnes Ferry, Reynolds Ferry, Ward's Ferry, and Don Pedro Bar. Numerous avenues between towns, camps, wood mills, mines, ranches, and all the other human additions to the landscape were developed, especially during the period 1849-1900. With the advent of the automobile and other gasoline-powered vehicles, there grew a state-wide interest in transportation development.

Early Wagon Roads

Several early roads and routes traversed the APE and are depicted on historical maps, including the late 19th century General Land Office (GLO) plat maps and historic USGS topographic maps. These include Coulterville Road, Merced and Coulterville Road, Sonora to Jacksonville Road, Sonora to Big Oak Flat Road, Don Pedro Road, Marsh Flat Road, Chinese Camp and Jacksonville Road, Moccasin Road, Ward's Ferry Road, Moffitts Road, Knights Ferry and Don Pedro Bar Road, Road to Crawford's Ranch, Salumbo and French Bar Road, Crimea House Road, Chinese Camp to Stevens Bar Road, Morgans Bar Road, Indian Bar Road, Hatch Creek Road, and other smaller routes between ranches and settlements. Most of them were established in the 1850s, first as public roads, then as county roads, and some later as state highways. The Sonora to Big Oak Flat Road was accepted into the state highway system and later named State Route 120, while the Sonora to Coulterville Road became part of State Route 49.

With the construction of the old and new Don Pedro dams and reservoirs, several roads were inundated and their names and destinations altered. Old Don Pedro Road became Don Pedro Bar Road, the Chinese Camp to Jacksonville Road (c. 1900) was changed to Shawmut Road, Jacksonville Road was moved to the east and Jacksonville-Stent Road was abandoned, the road from Priest Grade along the northeast side of Moccasin Creek was named Grizzly Road and on the south side was named Moccasin Road; and the old Coulterville Road from La Grange was rerouted to cross the New Don Pedro Dam and renamed Bonds Flat Road. Several early roads were truncated and new turnarounds constructed, as on Kanaka Creek Road, old Highway 49 near Moccasin, Grizzly Road, and others. The old road along the northwest side of the river above Stevens Bar was inundated and a new River Road constructed to serve the mines along its route (Rose c. 1970; TID 1975).

Railroads

Although the first common-carrier railroad in California was in place by 1852, and the transcontinental rails of the Central and Union Pacific were laid by 1869, it was not until the end of the 19th century that Tuolumne County began to consider building a railroad. The first one in the county, the Sierra Railway, was incorporated in 1897 as a standard gauge railroad between the cities of Oakdale (on the Southern Pacific line) and Angels Camp in Calaveras County (Coleman 1952:165). The railway was completed to Jamestown that year, financed by Thomas S. Bullock, W. H. Crocker, and Prince Andre Poniatowski. When the railroad to Tuolumne was completed in 1901 to serve the financiers' mill there, it penetrated farther into the Sierra Nevada than any other railroad in California except the Central Pacific (Deane 1960:318). Six branches and secondary railroads were built that linked directly with the Sierra Railway in subsequent years, including the Atlas Branch, the Don Pedro Branch (or spur), the Hetch Hetchy Railroad, the Melones Branch, the Yosemite Short Line Railroad, and the Angels Camp Branch (Tuolumne County Historical Society 2013). Of these, the Don Pedro Branch, the Hetch Hetchy Railroad and the Yosemite Short Line Railroad ran through the APE. Though the railway was built to service the lumber industries and gold fields in the Sierras, the Sierra Railway was instrumental in the construction of several dams, for which most of the spurs and secondary railroads were built. The railroad was used during the 1920s construction of the Don Pedro Dam, the Melones Dam, and the O'Shaughnessy Dam. It also supported the construction of the Tri-Dam Project. During the Great Depression the railway went into receivership and emerged in 1937 as the Sierra Railroad. The last passenger train ran in 1955, after which the train hauled freight exclusively. The train complex in Jamestown was sold in 1982 to the State of California Parks and Recreation Department and became Railtown 1897 State Historic Park. Today the train still runs and offers passenger excursion rides along a portion of the old route.

Water and Power Development[98]

The earliest efforts to control water in Tuolumne County (and elsewhere in the Mother Lode region) were the ditches and flumes constructed originally to provide water for the miners working the rich gold-bearing gravels in the gold diggings. By 1853, within five years of the initial gold discovery, most easily retrievable gold had been recovered. Decreasing quantities of placer gold and the need for vast quantities of water to mine in new ways and areas spurred the development of large-scale water storage and conveyance systems.

[98] Much of the Tuolumne County Water Company history and La Grange Hydraulic Mining Company history is provided from Marvin and Francis 2012.

Tuolumne County Water Company

From its organization in 1851 to its purchase by Pacific Gas and Electric (PG&E) in 1927, the Tuolumne County Water Company (TCWC) constructed dams, reservoirs, ditches, flumes, and watercourses, purchasing virtually every other ditch and flume company within its sphere of operations. Starting with small ditches built only to serve Columbia, TCWC's system expanded to provide water to the entire area between the Tuolumne and Stanislaus rivers. Over the ensuing years, the use of water controlled by the company shifted from placer mining to hard-rock mining, then to agriculture, and finally to domestic use, reflecting the changing economic pattern of Tuolumne County and the entire foothill region. One important early ditch of the TCWC, the Algerine Ditch, ran close to the APE, near Sullivan and Curtis Creeks. An extension of the ditch appears to have extended into the APE.

La Grange Hydraulic Mining Company

The town of La Grange, also known as French Bar, was one of the important mining camps on the Tuolumne River, established by a group of Frenchmen in the early 1850s. The wealth of the area was based upon the rich gravel bars along the river and associated terraces. A townsite was laid out in 1852 and by 1856 mining had proved so successful that La Grange (French for "the farm") became the Stanislaus County seat. It held that honor until 1862, when the county seat was moved to Knights Ferry. After the county seat was moved and the mining excitement had subsided, the town lost its former prestige and began to show signs of decline (Branch 1881:114, 116).

To help counter this decline, the La Grange Ditch was constructed from 1871 to 1872 for the La Grange Hydraulic Mining Company, headed by San Francisco attorney Edmund Green. The ditch was built to bring water from the Tuolumne River to the company's hydraulic mining operations north of La Grange, where gold was found in the rich auriferous gravels in surface diggings and in an old river channel. By the late 1880s the ditch system had fallen into poor condition (JRP and Caltrans 2000:40, 41, 45, 46, and 50). In the early 20th century the ditch was used for dredging operations and later the water rights were used to supply water for the town of La Grange. However, by the 1920s, following the construction of the old Don Pedro Dam, the La Grange Ditch, portions of which were inundated by the newly formed Don Pedro Reservoir, was abandoned for good (TID vs. Allen Zanker et al. 2006).

Turlock Irrigation District

The first irrigation system to be completed under the Wright Act was by TID, which was also the first public irrigation district to be established in California and one of only four in California today to deliver retail electric power (TID 2013). Its history has been written at length elsewhere (Annear et al. 1950; Elias 1924; Hohenthal et al. 1972; Paterson 1989; Tinkham 1921) and is only briefly summarized here. Although impetus for the development of irrigation systems within Stanislaus County began in the early 1870s, only one canal, the San Joaquin and King's River Canal on the west side of the county, was constructed during that decade (Elias 1924:203–204). The following decade saw the submission of the first irrigation bills in the California legislature, but no action was taken until the late 1880s.

In 1886, Turlock and Ceres farmers began proposing the formation of irrigation districts for the farmers of their regions, stating that “a new water code for equal distribution of water and water rights, under strict regulations, with no chance of monopoly, should be drawn up” (Hohenthal et al. 1972:61). The answer to their demands was provided by a young Modesto attorney, C. C. Wright, who had recently been elected to the State Assembly and chosen “for the express purpose of advocating some measure providing for the municipal control of water for irrigation” (Paterson 1989:53). In the spring of 1887 Wright drafted the Irrigation Districts Act, based largely on the draft of a law prepared the previous year by William Hammond Hall, State Engineer of California.

The Wright Act, approved in March 1887, provided “for the organization and government of irrigation districts and…for the acquisition of water and other property and for the distribution of water thereby for irrigation purposes.” The act was designed to give “highest legal sanction to the permanent union of land and water, but at the same time to recognize every other existing right and equity.” Patterned on the government of California counties, the district was to have an elected board and powers to assess and collect funds, with all district lands to be taxed (Hohenthal et al. 1972:62).

Within three months of passage of the Wright Act, on June 6, 1887, TID was formed, boundaries were fixed and officers elected. Initially, 176,210 ac (over 275 mi^2) were included in the district, which was all the irrigable land between the Tuolumne and Merced Rivers, from the foothills on the east to the San Joaquin River on the west. The first members of the board, W. L. Fulkerth, E. V. Cogswell, R. M. Williams, J. T. Dunn, and E. B. Clark, met in June of 1887. The TID offices were established in Turlock.

The Board soon located a water right for 225,000 inches near Wheaton’s Dam on the Tuolumne River close to La Grange. George Manuel of Fresno, who was hired as district engineer, surveyed the dam site and canal routes and estimated costs for the system at $467,544.62. The Board called for an election to authorize issuance of $600,000 in bonds. The election was held in October of 1887 and only 12 of 188 votes cast opposed the sale. The first sale occurred in November, when Robert McHenry purchased $50,000 in bonds. The first contracts for construction were let in 1890.

Concerned with the prospect of lawsuits against the Wright Act, the TID Board commenced a writ of mandate before the State Supreme Court to compel the secretary of TID to sign certain bonds, which the secretary had refused to sign on the grounds that the Wright Act was unconstitutional and void. The decision, handed down on May 31, 1888, upheld the Wright Act in all respects and ordered the secretary to sign the bonds. TID then set about construction of the La Grange Diversion Dam, located about one-and-one-half miles above La Grange, near the site of the 1870s Wheaton Dam. Built as a joint undertaking by MID and TID, under an agreement made in August of 1890, the water rights were divided in proportion to the number of acres in the respective districts, giving TID 68.46 percent of the total and MID 31.54 percent of the total. The dam was completed by the Pacific Bridge Company in 1893 at a cost of $543,164. At the time of its completion, La Grange Diversion Dam was the highest overflow dam in the country and one of the largest in the world. Most of the design was done by Luther Wagoner, Engineer for MID. E. H. Barton, TID Engineer, supervised the construction.

The years following construction of the La Grange Diversion Dam were characterized by lawsuits, difficulties in selling bonds and making payroll, and deterioration of the canal system during delays. Finally, by 1902 all of the main canals west and some east of the main line of the Southern Pacific Railroad, a total length of 10 miles, were completed. With the La Grange Diversion Dam and the system on line, TID began to look for storage reservoirs. In 1910, bonds were passed for the construction of reservoirs downstream from the La Grange Diversion Dam in order to store more water from the Tuolumne River for irrigation.

That same year, TID formally began to consider producing electric power, with the intention of building hydroelectric plants at La Grange Diversion Dam and the Hickman Drop. By 1913, 17 dams and one levee were nearly completed, including the Owens (Turlock) Reservoir on the bluff south of the Tuolumne River on the old Morley Ranch (Paterson 1989:158-159). In 1915, TID and MID agreed to build a water-storage dam at the Don Pedro site. The following year, TID Chief Engineer Roy V. Meikle revived a proposal to build a power plant at Hickman Drop, though this plan was later abandoned.

By 1923, the old Don Pedro Dam and Reservoir had been completed and more than 55 miles of main and lateral canals had been lined with concrete to reduce seepage and avoid washouts. A decade later, another 50 miles of concreting had been completed, contributing to a 30 percent increase in canal capacity and reducing the average interval between irrigations from 30 or 35 days to 10 or 15 days (Paterson 1989:258-259). Additional canal improvements and lining were accomplished during the mid-1930s when TID received funding from the Public Works Administration (PWA) (Paterson 1989:271). Over the ensuing years the canals have been periodically upgraded to modern construction standards. In the late 1960s the new Don Pedro Dam was built by TID and MID downstream of the old Don Pedro Dam. Following completion of the new Don Pedro Dam the old dam quickly became inundated by the new Don Pedro Reservoir, which at full capacity holds over 2,000,000 AF of water.

Modesto Irrigation District

Much of MID's history has been closely entwined with that of TID since 1890, when they reached an agreement to construct the La Grange Diversion Dam. MID's history has been written about at length elsewhere (Annear et al. 1950; Barnes 1987; Elias 1924; Hohenthal 1972; Tinkham 1921) and is summarized briefly herein.

Almost immediately after the signing of the Wright Act in March 1887, the organizers of MID circulated a petition calling for formation of the District, presenting it to the Board of Supervisors on April 25. However, the plan was petitioned against. Numerous challenges and court cases led by farmer Christopher Columbus Baker and harness-maker William Tregea delayed the formation of the District for several years. In November of 1889, however, Justice Minor ruled in favor of the District's organization. The decision was immediately appealed by Tregea but was upheld by the California Supreme Court in March of 1891 (Barnes 1987:31).

By early 1894, following completion of the La Grange Diversion Dam, MID had a means of diverting water from the Tuolumne River but no canals to carry it. In April 1890, work began on a gravity-flow main canal running 25 miles through the foothills to the district. The canal was damaged in the floods of 1892 but quickly repaired, and the rest of the main canal contracts were awarded that year. By 1893 all the main canals were finished, but headworks and gates at the dam and lateral canals were not yet complete. A portion of the canal below the dam was declared unsafe and had to be rebuilt. Almost nothing happened in the district from 1896 through 1900, except for the natural deterioration of the canals.

On February 2, 1901, control of MID's Board of Directors was wrested from the anti-irrigationists in an election made contentious by the Board's refusal to act. A bond election held in January of 1902 was overwhelmingly approved by the voters and, with the refinancing bonds approved, the Board set about to raise its $71,000 share of the construction money. The bonds, approved in 1895, were purchased by rancher and president of the First National Bank of Modesto, Oramil McHenry, and work commenced under the direction of Engineer R. H. Goodwin.

Water first flowed through the main canal from the La Grange Diversion Dam to the district boundary and into Dry Creek at 7 a.m. on April 3, 1903. Irrigation formally began in 1904 when Oramil McHenry, George Covell, and T. H. Kewin received the first "official" water.

Irrigation forever altered the early dry-land wheat farming and cattle grazing within the district, as the large grain farms were broken up into smaller parcels and alfalfa became the dominant crop. Dairying also became a major factor in the region's agricultural economy, with grapevines and orchards close behind. Canning and packing plants were established, and in 1907 and 1908 special rail coaches traveled throughout the nation displaying the fruits grown in the MID and TID areas and carrying real estate agents promoting small farm and residential developments. By 1913 more than half of the tillable land in the district was under irrigation, and the amount of land provided with water had increased by 160 percent. Stanislaus County had become the 27^{th} largest producer of crops and livestock in the nation and was second only to Los Angeles County in the pace of agricultural growth. By the beginning of the 1920s, alfalfa had given way to fruit, nut, and vine crops.

As the demand for water storage grew, MID decided to provide its own storage along its main canal below La Grange Diversion Dam. MID enlarged the Dallas and Warner lakes near Waterford, to cover 2,800 ac with a capacity of 27,700 AF. Now known as Modesto Reservoir, the original Dallas-Warner Reservoir was completed in 1912.

Within a decade the wooden flumes and trestles of the irrigation canals began to deteriorate and were replaced with concrete. In March 1914, the voters approved, by a seven-to-one vote, two bond issues totaling $610,000 as part of a policy to expand the irrigating facilities and supersede the temporary early construction with concrete. New headgates, weirs, and diversion points were constructed, and existing canal facilities were replaced and improved (Barnes 1987:55–56).

Evaporation and seepage along MID's canals and ditches accounted for a loss of 30 percent of the water, while weeds and tules clogged the canals and ground squirrels dug holes in the structures and caused additional integrity problems. Accordingly, MID's most important long-range water management program after completion of the La Grange Diversion Dam was the concerted effort to line with concrete or divert into underground pipelines all of its main canal, laterals, and ditches. By 1921, only one mile of the main canal had been lined, and by 1933, less than 25 miles of canals had been piped or concreted. The Work Progress Administration (WPA) improved additional sections of the canal during the Great Depression (mid-1930s to early 1940s). After World War II, however, MID began a 20-year program to line or pipe all of its main canal and laterals. By 1955, 93.7 miles of the total network had been improved. By 1960, 81 percent of the work had been completed. The Don Pedro Project was finished in the mid-1960s. Today, all 288 miles of the main canal, laterals, and drains are piped or lined with concrete (Barnes 1987:118).

In addition to these important long-range management measures to improve the infrastructure of the canal system, MID's largest projects include construction of the original Don Pedro Dam and Reservoir in 1923 and the new Don Pedro Dam and Reservoir in the late 1960s. Including the new Don Pedro Dam and Reservoir, numerous new facilities and improvements were completed in the latter half of the twentieth century. Following the merger with the Waterford Irrigation District in 1978, MID completed the New Hogan hydroelectric plant and the Coldwater Creek geothermal plant (in 1986) and the Modesto Regional Water Treatment Plant (in 1994). In 1997 MID expanded electric service to Oakdale, Ripon, and Escalon.

The New Don Pedro Project

The 1940s through the 1960s proved to be a critical period for TID and MID, as the Districts often had to defend their Tuolumne River water rights. To ensure that water requirements for TID and MID would be met "for all time," the Districts began planning for the new Don Pedro Dam and Reservoir, which would require a Federal Power Commission (FPC) license (Barnes 1987:124).

The first official report of plans to construct a new dam and reservoir dates to 1931, when the California Department of Water Resources (CDWR) discussed the feasibility of such a development. By that time, farmers and officials of the Districts were aware of the need for additional storage, especially as there had been only one year of "normal" rainfall since completion of the first Don Pedro Dam. In addition, about a decade later the ACOE looked to the Tuolumne for additional flood control, and the City of San Francisco began pressing to develop resources based upon the Raker Act. An agreement to proceed with the new dam and reservoir was reached by the three local agencies in November of 1943, and three months later the COE recommended the construction to Congress. Congress concurred with the recommendation in December 1944, and the next year the California Legislature authorized construction of a 1,200,000 AF reservoir (increased to 2,030,000 AF after aerial mapping). The CDWR issued rights in 1953, and by 1955 five potential dam sites had been identified by geologist Roger Rhoades. Two years later, after additional mapping and boring studies, the present location was selected.

The construction site was located in a V-shaped gorge, where terrain was rugged, access was difficult, and the river was violent. Access to much of the river was achieved by filling the old

La Grange Ditch (1871), perched on the side of the hill. Later, John Goodier, vice-president and chief engineer of the Atkinson Company, the company contracted to build the dam, noted that it had been an interesting job for a contractor, with two diversion tunnels, a shaft, a powerhouse, a switchyard, a dam, and a spillway—all in one job.

Atkinson established its construction camp at what is now the Blue Oaks Campground, managed by the DPRA. Irrigation engineer, Charles Crawford, a 39-year employee of MID, was named as coordinator. The first order of work was to build a diversion tunnel and clear the dam site. The tunnel was completed and the river diverted on September 7, 1967; nine days later the first loads of dredge tailings were delivered. Following the dam completion, the diversion tunnel became part of the outlet works, draining the downstream portal located south of the powerhouse. On February 27, 1969, the first of the dam's clay core (of silty sand mixed with clay found near La Grange) was placed. For the next 15 months the dam rose 18 inches a day, raised with tailings dumped by earth movers nicknamed "belly dumps." The rigs operated around the clock from 8 a.m. Mondays to 8 p.m. Saturdays, stopping only for a half-hour lunch period on each shift. Two years after construction began, 500 men were working on construction and the development was 53 percent complete.

The last load of material was delivered May 28, 1970, with TID Chief Engineer Roy Meikle riding in the passenger seat (Barnes 1987:140–143). The new dam began storing water in November 1970 (Barnes 1987:146). Formal dedication ceremonies were held May 22, 1971, where San Francisco mayor Joseph Alioto addressed an audience of 3,000. The total cost of the development was $115,697,000 (Barnes 1987:148–150).

Tourism/Recreation

Provisioned by the local agricultural and livestock industries, inns, boarding house, hostelries, and restaurants were established in virtually every community, at crossroads, and at stopping places along the major roads in Tuolumne County. Although tourism was an early activity in the county (Bower Cave, Hetch Hetchy, and Table Mountain all drew visitors), the railroad from Stockton to Milton, completed in May 1871 (originally part of the Stockton & Copperopolis Railroad), greatly increased tourism. After the completion of the Sierra Railway, many locations in the county became destinations for vacationers who came to admire its natural wonders and cooler temperatures.

During the Don Pedro Project FPC hearings in 1962, Tuolumne County lobbied the Districts to incorporate boating and camping facilities into the new Don Pedro Project. The county felt it would benefit financially from the recreation tourism at the reservoir. The Districts maintained they did not have to provide public recreation services and did not want to add this aspect to their management operations. The FPC disagreed and included a recreation requirement in the Don Pedro Project license (Paterson 1989:344). This resulted in the creation of the Don Pedro Recreation Area in 1970, which incorporated all lands and water available for recreation use within the federally licensed Don Pedro Project (FERC Project Number 2299). Subsequently, three formal recreation areas were built around the reservoir in the early 1970s. These areas, Fleming Meadows Recreation Area, Blue Oaks Recreation Area, and Moccasin Point Recreation Area, continue to be operated and maintained today much as they were in the 1970s.

Settlement

The vicinity of the APE includes the locations of several historic-era towns and mining camps, often located on bars of the Tuolumne River or along its larger tributaries. Fire and weather destroyed many of the earliest settlements, and others were later razed before reservoir inundation[99] or abandoned (such as Poverty Hill #1, Curtisville, and Blanket Creek). The following sections provide details of the communities located within the APE. Most of these communities initially sprang up as a result of the Gold Rush, and represented either mining camps or supply centers that supported the surrounding mining communities.

Jacksonville and Shawmut

Jacksonville, located on the Tuolumne River near its confluence with Woods Creek, was named for Colonel Aldan Apollo Moore Jackson, for whom the town of Jackson in Amador County is also named. Jackson is believed to have discovered gold here in 1849 and opened a trading post. Later that year it was reported that there were about 40 people engaged in mining and storekeeping. By April of 1851 the community boasted 252 inhabitants, with a post office established that October. According to Heckendorn and Wilson, in 1855 the river was being successfully worked in the months of August through November, at its lowest stage (Heckendorn and Wilson 1856:85). The rich placer deposits in the district reportedly produced $9 million in gold, while hard-rock mining (beginning in the late 1850s) produced more than $7.5 million (Clark 1970:77).

Jacksonville's population waned with the depletion of the easy gold, and it slumbered until reawakened by the hard-rock mining boom of the late 1880s. In 1909, with its location on the Mother Lode Vein and with quartz and gravel mining continuing on an extensive scale, the town was still providing goods and services to the surrounding mines and farms, with a couple of stores, a hotel, and some small farms (*The Union Democrat* 1909:84). Jacksonville was registered as State Historic Landmark No. 419, but all buildings were removed and the townsite was inundated by the waters of Don Pedro Reservoir when the new dam was built in the late 1960s (Gudde 1975:174).

Shawmut, named for the Shawmut Mine on Woods Creek, was located about two miles northwest of Jacksonville. The mine was the most important reason for the town's existence. The first hard-rock mine in the area was the Eagle on Blue Gulch, which started in the 1860s with a 10-stamp mill. After changing hands several times, in the 1890s it was consolidated with the Shawmut claim as the Eagle-Shawmut Mine, the most important in the Jacksonville Mining District and the largest in Tuolumne County in the early 1900s. After being closed for a short time, the mine was reopened in 1897 with a 40-stamp mill (increased to 100 stamps in 1901), with a power plant driven by water purchased from the Sierra and San Francisco Power Company (Hamilton 1915:146). Numerous extensive improvements were made over the ensuing years to the mine and mill, surrounded by Shawmut, a company town with boarding houses and

[99] Including dozens of camps such as Melones or Pine Log Crossing on the Stanislaus River, every major mining center on the Tuolumne River from Brazoria Bar to Jacksonville to Don Pedro's Bar to Rodgers Bar, and Junction Camp and Dutch Bar on Woods Creek.

cottages for workers and their families (Wagner 1980:56). The mine continued to operate successfully until shut down by World War II in 1942, by which time it was noted as one of the major mines along the Mother Lode, having many miles of workings (3,550 ft below bedrock), and the producer of huge tonnages of low-grade ore. Most of the extensive workings had been driven after the turn of the 19th century, resulting in a production of approximately $7.5 million in gold (Jenkins 1948:48). For over 50 years the Eagle-Shawmut had been the lifeblood of the district, which never recovered after the mine closure at the start of World War II. Today, what remains of the mine and mill site are under the waters of the Woods Creek Arm of Don Pedro Reservoir, and surface only during times of extreme low water (personal communication with Dave Jigour of DPRA).

Tuolumne River Bars

Many other settlements, in addition to the larger, more permanent communities of Jacksonville and Shawmut, sprang up along the river bars. Heckendorn and Wilson (1856:89) provided this description of the smaller bars and settlements along the Tuolumne River in the mid-1850s:

> *Stevens', Red Mountain, Hawkins', Indian, Texas, Morgan's, Don Pedro's, Rodgers' and many other Bars on the Tuolumne river, are all in Tuolumne County, and are places of considerable note. In 1850 they were the largest camps in the county—thousands of miners were engaged in attempting to turn the river, the bed of which they imagined contained millions in treasure; but few companies succeeded in diverting the channel from its course, and what few did were disappointed in its supposed richness. Some few companies [have] done well, but as a general thing the river turning that year was a failure—since then the mode of operating has been very different, and the bed of the stream in a number of places has paid well for the expense of fluming, which is the only mode by which it can be successfully worked. The River will furnish profitable employment for many years to come.*

In 1850, the river camps along the Tuolumne were among the largest in the county; few, however, enjoyed any great prosperity and all of them had disappeared by the beginning of the 20th century. Only Don Pedro Bar, Indian Bar, and Red Mountain Bar continued to exist, and those only until the construction of the first Don Pedro Dam in the early 1920s. Not even the bars themselves remain, for the river has changed its course several times since the 1850s and the bars are now located beneath the waters of the reservoir (Hoover et al. 1990:519).

Demographic History of the APE and Vicinity

The cultural resources which remain today in Tuolumne County gain much of their importance from the people who lived and worked there, and from those who designed or built or used the resources. Tuolumne County's structures, sites, objects, and buildings often bear more meaning or significance because of their association with a particular ethnic, religious, or social group that constructed it, lived in it, or was otherwise associated with it. This section provides a brief demographic history of the APE and vicinity, focusing primarily on the ethnic background of the Tuolumne County population.

Although there were other ethnic groups present in California prior to the Gold Rush, particularly Hispanic and Russian peoples, very few made it into what is now Tuolumne County. In the middle of the 19th century, the area was inhabited by several different Indian groups, *Californios*, a handful of Americans, and others. The *Californios* (one of the names for the people of Iberian descent who lived in California before the Gold Rush) were born in California, usually of Spanish, Mexican, and/or Indian parents. Another early group was composed of the 500 men from the eastern United States who came to California in 1846 with Colonel Jonathan D. Stevenson to become the first American regiment in the state. The Mexican-American War had begun and Stevenson's regiment, fought in Baja California but otherwise saw no action in the war, spending its latter part on the Stanislaus River. By 1849 their military tasks were finished and many stayed to become craftsmen, miners, and merchants, and were among the first Americans to settle and mine for gold in California.

Many different groups have lived in Tuolumne County, some of which are still reflected in local place-names like Chinese Camp, Chili Camp, and Kanaka Creek. The Anglos, or people of British extraction, composed an early majority of inhabitants, including the Cornish, with their important hard-rock mining skills, as well as the English, Irish, Welsh, and Scots. Other Europeans were also important to the early development of the county, and many of them stayed when the placer gold was depleted.

The Chinese were a particularly important ethnic group in the history of the Gold Rush as they offered a large labor force. The Chinese Exclusion Act of 1882 essentially ended Chinese immigration and forced many to return to their native land.

3.11.1.4 Existing Information and Need for Additional Information

To gather existing, relevant, and reasonably available information regarding cultural resources in the Don Pedro Project APE and vicinity, the Districts performed a records search in July 2010 at the Central California Information Center (CCIC) of the California Historical Resources Information System at California State University (CSU), Stanislaus in Turlock. In addition to identifying cultural resources, this research also served to obtain background information pertinent to understanding the archaeology, history, and ethnohistory of the Don Pedro Project vicinity and APE. The data gathering area included the FERC Project Boundary, which is much larger than the APE, plus an additional 0.25-mile buffer beyond, to identify previously recorded cultural resources and previous cultural studies that may require consideration.

The records search included reviews of cultural resources records and site location maps, historic GLO plats, NRHP, California Register of Historic Resources, Office of Historic Preservation Historic Property Directory, *California State Historic Landmarks* (CDPR 1996), *California Inventory of Historic Resources* (CDPR 1976), historic topographic maps, and the Caltrans Bridge Inventory.

The records search indicates that the Project Boundary contains numerous prehistoric- and historic-era properties and that some areas have been subject to previous cultural surveys (see Section 5.8 in the PAD). However, the research also revealed that many areas within the APE have not yet been surveyed for cultural resources and a portion of previously surveyed areas should be reexamined to meet current professional standards for identifying historic properties. A comprehensive field survey of the APE was conducted to accomplish this.

Summary of Record Search

Previous Cultural Studies

The above-described records search identified 62 previous cultural resource investigations within 0.25 miles of the APE, of which 32 fall within the APE, and were conducted prior to a variety of different undertakings, to include proposed water control/treatment facilities, utilities, housing developments, mining activities, road/highway construction, recreation facilities, and grazing leases. Two of the previous investigations are comprised of articles from The Quarterly of the Tuolumne Historical Society, and one is comprised of documentation of monuments and plaques of the E Clampus Vitus organization.

The previous investigations covered roughly 20 percent of the APE, though many of these studies were not completed to current (2010) professional standards. One of the largest studies in the APE (Moratto 1971) did not include a map of the area surveyed, thus it is unclear exactly what locations within the APE were included in this study.

Previously Recorded Archaeological Sites

The records searches identified 160 known archaeological sites previously documented within 0.25 miles of the Don Pedro Project APE, of which 104 fall within the APE. Of the 160 sites within 0.25 miles of the APE, one is protohistoric, one includes both prehistoric and protohistoric components, 12 have both prehistoric and historic-era cultural remains, three did not have any information on file and therefore are unknown as to their age, 65 are prehistoric in age, and 78 contain historic-era resources. The prehistoric components typically include flaked stone with and without bedrock milling stations, with both short term and long term occupation sites represented. The historic components are predominantly represented by refuse scatters and/or remains of habitation structures/buildings, and also include a number of mining relates sites. According to the Office of Historic Preservation’s Archaeological Determinations of Eligibility list and the Directory of Properties in the Historic Property Data File on file at the CCIC, of the 160 sites recorded in the vicinity of the Don Pedro Project APE, nine have been evaluated as eligible for inclusion on the NRHP. The remaining 151 resources remain unevaluated for the NRHP.

Potential Historic-Period Cultural Resources

Historic period USGS topographic quadrangles and GLO plats were reviewed during the records search to identify locations of potential historic-era sites and features within the APE and within 0.25 miles of the APE. This resulted in the identification of well over 50 locations where unrecorded historic period sites or features may be present within the APE. These sites and features include potential roads and trails, the town site of Jacksonville, buildings, mines, ditches, the Hetch Hetchy Railroad/Yosemite Short Line Railroad, the Hetch Hetchy Aqueduct, and other features.

Historic period maps often provide a general idea of where sites may be located but are not necessarily accurate. Today's maps and mapping standards are not always translatable to the past and plots cannot be taken as exact. Because of the disparity between historic-period maps and modern maps, it is not known if physical attributes associated with the potential sites and features are accessible, or if the remains are actually within the APE. As well, the presence of cultural features on an historic map does not confirm that the features still exist. Many historic features, such as town sites, mines, roads, etc., often have continued use into present times that may obliterate any historic remains. As well, historic features can also disappear over time through natural erosion or other weathering processes. Based on the inventory of previously recorded cultural resources in the APE and the 0.25 mile study area, it appears that many of the historic features identified on the historic maps of the Don Pedro Project area have not been formally recorded as archaeological sites.

3.11.1.5 Results of Relicensing Studies

To assist FERC in identifying historic properties that may be affected by continued operation and maintenance of the Don Pedro Project under the new FERC license, the Districts conducted two cultural resources studies: the Historic Properties Study (TID/MID 2014a) and the Native American Traditional Cultural Properties (TCP) Study (TID/MID 2014b). The results of each of these studies are provided in the following sections and summarized in the table below (Table 3.11-2).

Table 3.11-2. Summary of results for the cultural resources relicensing studies.

Resource Type	NRHP Evaluation			Totals
	Ineligible	Unevaluated	Eligible	
Historic Properties Study				
Isolated Find	127	0	0	**127**
Archaeological Site[1]	130	75	29	**234**
Built Environment Resource[2]	33	3	1	**37**
Native American TCP Study				
TCP[3]	0	0	1	**1**
Totals	**290**	**78**	**31**	**399**

[1] This count includes two historic districts and one prehistoric district, the primary components of which are archaeological. All three districts have been evaluated as eligible for the NRHP.

[2] This count includes two historic districts comprised of built environment resources. Both districts are currently ineligible for the NRHP.

[3] The TCP identified is represented by a district.

Historic Properties Study

The Historic Properties Study focused on identifying archaeological and built environment resources within the APE. It included conducting a comprehensive and intensive field survey of the APE, which was completed between January 2012 and September 2012 in accordance with the Secretary of Interior's Standards and Guidelines for Identification (NPS 1983) and the BLM's Class III/intensive standards, per the BLM's 8100 manual series. Tribal monitors from the Tuolumne Band of Me-Wuk Indians and the Southern Sierra Miwuk Nation accompanied the field crew during the field survey.

Archaeological Resources

A total of 361 archaeological resources were identified as a result of the Historic Properties Study, including 127 isolated finds and 234 archaeological sites. Each of these resource groups are described below, including their NRHP evaluations.

Isolated Finds

A total of 127 isolated finds were located and documented within the APE as a result of the Historic Properties Study (see Attachment A for an isolate location map). Of the 127 isolated finds, 85 are prehistoric in affiliation and 42 are historic-era isolates. The prehistoric isolated finds are predominantly comprised of isolated flakes and groundstone tools, but also include flaked stone tools, cores, core tools, possible charm stones or atlatl weights, a bowl mortar fragment, and one milling station that is no longer in situ. The historic isolated finds include isolated occurrences of mining activity and isolated cairns/cadastrals, concrete features, rock alignments, earthen dams (likely modern), glass fragments, ceramic fragments, an earthen structure pad, a brick feature, and a tire.

As is usual for isolated finds, all 127 of these resources were evaluated as ineligible for inclusion on the NRHP.

Archaeological Sites

A total of 234 archaeological sites were identified within the APE as a result of the Historic Properties Study, of which at least 22 were previously documented during prior investigations and 212 were newly identified (see Attachment B for an archaeological site location map). As summarized in Section 2.2.2, there are a total of 97 previously recorded cultural resources within the APE, of which 19 archaeological sites were revisited and updated during the present field investigation[100]. Of the remaining 78 previously recorded resources, one is a built environment resource that is discussed in the following section (P-55-3913, the Red Mountain Bar Siphon) and 77 were not located in the field as they were likely either miss-mapped and are actually outside the APE or were inundated by the reservoir. Many of the historical features identified on historic maps of the APE were also located in the field and documented as archaeological sites; conversely, many were also not relocated due to inundation and because they have either eroded away over time or have been removed/covered by modern development.

Of the 234 archaeological sites identified, 129 contain historic-era deposits and features (two of these represent the Woods Creek Mining Landscape and the Kanaka Creek Mining Landscape), 76 represent prehistoric or Native American use (one of these represents the Tuolumne River Prehistoric Archaeological District) and 29 represent both prehistoric and historic-era occupations. The types of prehistoric sites represented in the APE include occupation sites, lithic quarry sites, small temporary task locations (lithic retooling, lithic reduction, subsistence

[100]Two of these previously recorded archaeological sites (P-55-1920 and P-55-1921) were merged to create one site during the present survey. As well, four of the other sites updated during the present survey (P-55-110, P-55-3876, P-55-5231, and P-55-7353) are comprised of linear sites, of which the segments previously recorded were located outside of the APE. Accordingly, these four sites were not counted as part of the 97 previously recorded cultural resources within the APE.

procurement and processing, and hunting-related locals), districts/landscapes, and possibly other types of prehistoric or ethnographic occupation that could not be distinguished. Based on the artifact assemblages recorded during the study, the prehistoric or Native American occupation of the area appears to be focused on the Middle to Late Archaic periods through to the ethnographic or contact period (from roughly 7000 to 100 cal B.P., as provided above in Section 3.11.1.3.2). The historic sites observed represent the remains of a variety of historic-era land uses, primarily consisting of extensive mining, including two historic mining landscapes, utilities, homesteads, ranching/farming, transportation (roads, railroads), water control and conveyance features, and other unassociated historical remains. The historic occupation dates to as early as the late 1840s and as late as the 1960s.

As summarized in Table 3.11-3 below, 159 of the 234 archaeological sites identified within the APE were evaluated for the NRHP during the Historic Properties Study; 130 have been evaluated ineligible for inclusion in the NRHP and 29 have been evaluated as eligible for inclusion in the NRHP. The remaining 75 sites are unevaluated for the NRHP pending further work.

The remainder of this section provides more details of the archaeological sites. It is organized by site age – prehistoric, historic, and multi-component.

Table 3.11-3. Summary of NRHP evaluations for archaeological sites identified within the APE.

Age	Ineligible	Unevaluated	Eligible	Totals
Historic	98	23	8	**129**
Prehistoric	27	37	12	**76**
Multi-component	5	15	9	**29**
Totals	**130**	**75**	**29**	**234**

Prehistoric Resources

Of the 76 prehistoric sites identified within the APE, 12 are evaluated as eligible for inclusion on the NRHP, while 27 are evaluated as ineligible and 37 remain unevaluated pending further investigations (Table 3.11-4). The prehistoric sites have been grouped according to the following types:

(1) Lithic Scatter (26)

(2) Short-Term Habitation (14)

(3) Quarry (13)

(4) Long-Term Habitation (12)

(5) Milling Feature (6)

(6) Rock Shelter (2)

(7) Other (2)

(8) District (1)

Those sites included under the lithic scatter type include flaked stone debitage and/or flaked stone tools and contain no groundstone, milling features, or habitation features that might suggest more long term activity or a multi-task site. The lithic scatter sites may represent secondary lithic reduction and/or retooling locations and also locations related to hunting activities. Those sites grouped under the short-term habitation type include flaked and groundstone tools and debris and may include non-extensive bedrock milling stations (<10 mortar cups). It is assumed that these sites represent small temporary campsites that are occupied longer than the lithic scatters and thus are more complex and may represent multiple kinds of tasks being undertaken at them. Long-term habitation sites include those sites with prominent midden deposits and/or housepits or extensive (>10 mortar cups) milling features. These sites represent village sites that were occupied for much longer time periods than the short-term habitation sites, and generally represent an even greater variety of tasks and activities, with greater complexity of features and artifact types. The quarry type represents those sites with small to extensive quarries, where the primary activity appears to be focused on tool stone acquisition and usually includes moderate to heavy primary lithic reduction debris. The milling feature type includes those sites with an isolated milling feature or containing a non-extensive (<10 mortar cups) milling feature(s) with minimal associated debris. The rock shelter type represents those sites that contain a prominent rock shelter. As rock shelters are important sites that usually offer a great deal of information potential, it was important to identify these sites separately from the other site types, even when they contained other prominent features. The other type includes two sites that do not conform to the other categories. One is a possible tool cache and/or procurement location and one is a possible hunting blind. Finally, the district type represents one archaeological district, the Tuolumne River Prehistoric Archaeological District.

Historic Resources

Of the 129 historic sites identified within the APE, eight have been evaluated as eligible for inclusion on the NRHP, while 98 have been evaluated as ineligible and 23 remain unevaluated pending further investigations (Table 3.11-5). The historic sites have been grouped according to the following types:

(1) Transportation (51)

(2) Mining (40)

(3) Water Control/Hydroelectric (WCH) (20)

(4) Other (8)

(5) Utilities (5)

(6) Habitation (3)

(7) Trash Scatter (2)

The sites that fall within the transportation type include roads and railroads. Those within the mining type include placer mining and lode mining complexes and sites comprised of prospect pits, tailings, waste rock, shafts/adits, or other mining-related features. Additionally, two of the resources included under the mining type are historic landscapes that incorporate several sites as elements of the landscapes: Kanaka Creek Mining Landscape and Woods Creek Mining

Landscape. Sites included under the water control/hydroelectric type are ditches, dams, reservoirs, and other features directly associated with water control and hydroelectric-related facilities. The other type covers those sites that do not conform to any of the other types, or whose type is unknown. The utilities type covers sites related to power transmission/distribution and/or communication facilities (telephone/telegraph lines and one radio tower) and includes sites comprised of utility poles and transmission line or radio tower footings. Sites that fall under the habitation type include those sites that represent primary residential locations. Finally, sites that are within the trash scatter type include those sites that are refuse scatters and represent primary or secondary discard, but are not associated with a primary residential location and have no features that represent an activity that would suggest association with one of the other types.

It is important to note that even though all of the sites have been assigned to one type, several of them may contain features or components that represent another type. For example, a mining complex under the mining type may also incorporate a habitation feature, transportation feature, and/or a water control feature. These sites are assigned to a particular type based on the primary activity/focus of the site, as determined by the number and type of components contained within the site.

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Table 3.11-4. Summary of prehistoric sites.

Count	Temporary Site No.	Primary No./ Trinomial	Age	Type	Description	Land Owner	NRHP Eligibility[1]	
							Individual Eligibility	NRHP Eligibility as a Contributing or Non-Contributing Element to the Tuolumne River Prehistoric Archaeological District
1	FW-DP-003	--	Prehistoric	Lithic Scatter	Lithic Scatter. Age unknown.	TID/MID/ BLM	U	U
2	FW-DP-004	--	Prehistoric	Lithic Scatter	Lithic Scatter; three artifacts and ~20 flakes. Age unknown.	TID/MID/ BLM	U	U
3	FW-DP-005	--	Prehistoric	Lithic Scatter	Lithic Scatter: Small, moderately dense (up to three flakes per square meter) greenstone flake and artifact scatter of 23 items. Age unknown.	TID/MID/ BLM	U	U
4	FW-DP-006	--	Prehistoric	Lithic Scatter	Lithic Scatter small, sparse, greenstone flake scatter (eight flakes on the surface), shovel probe test uncovered four additional flakes. Age unknown.	TID/MID/ BLM	U	U
5	FW-DP-043	--	Prehistoric	Settlement	Habitation site; 40 cultural items were recorded and mapped. These consist of ten core tools, 14 handstones, two bifaces, one pestle, one perforator, two milling slabs, one cobble tool, one flake tool, two cores, and six flakes. Dates to Middle Archaic.	TID/MID	E	C
6	FW-DP-068	--	Prehistoric	Subsistence	BRM with one cup. Age unknown.	TID/MID/ BLM	I	NC
7	FW-DP-072	--	Prehistoric	Subsistence	Two BRMs ~50m apart. Age unknown.	TID/MID	I	NC
8	FW-DP-081	--	Prehistoric	Settlement	Occupation site with BRMs across from marina; eight bedrock milling features, a possible rockshelter, midden deposit, ground stone artifacts, and at least one flake. Age unknown.	TID/MID/ Private	E	C
9	FW-DP-086	--	Prehistoric	Short-term Habitation	Lithic scatter with three bifacial tools, two battered cobbles, one core, two handstones, one millingstone fragment, and one cobble tool. Age unknown.	TID/MID/ BLM	U	U
10	HDR-DP-001	--	Prehistoric	Milling Feature	A single milling station. Age unknown.	TID/MID	I	NC
11	HDR-DP-013	--	Prehistoric	Short-term Habitation	One milling station; lithic scatter (50+ flakes). Age unknown.	TID/MID	I	NC
12	HDR-DP-014	--	Prehistoric	Quarry	Lithic scatter (40+ flakes, one handstone, one biface); one quarry feature. Age unknown.	TID/MID	I	NC
13	HDR-DP-015	--	Prehistoric	Quarry	Quarry/assay location with lithic scatter (100+ flakes). Age unknown.	TID/MID	I	NC
14	HDR-DP-018	--	Prehistoric	Quarry	Quarry; lithic scatter (500+ flakes, one battered cobble, one scraper, and one milling slab); one milling station. Age unknown.	TID/MID	U	C
15	HDR-DP-021	--	Prehistoric	Quarry	Quarry/assay location; Lithic scatter (200+ flakes, 20+ assayed cobbles, one spokeshave). Age unknown.	TID/MID	I	NC
16	HDR-DP-024	--	Prehistoric	Long-term Habitation	Lithic scatter (65+ flakes, one core, one handstone, one abrader, one scraper, one chopper); three milling features with possible rock art; Looter's pile. Age unknown.	TID/MID	E	C
17	HDR-DP-026	--	Prehistoric	Long-term Habitation	Two loci: lithic scatter and tools (450+ flakes, 20+ FCR, five hanstones, three choppers, two Elko series projectile points, one modified flake, one scraper, one biface). Dates to Middle Archaic.	TID/MID	E	C
18	HDR-DP-027	--	Prehistoric	Other	Three features: two possible hunting blinds; one rock scatter. Age unknown.	TID/MID	U	U
19	HDR-DP-028	--	Prehistoric	Short-term Habitation	Three milling stations; lithic scatter (25+ flakes). Age unknown.	TID/MID	U	U
20	HDR-DP-032	--	Prehistoric	Short-term Habitation	Lithic scatter (300+ flakes, two handstones, one milling slab). Age unknown.	TID/MID	I	C
21	HDR-DP-033	--	Prehistoric	Lithic Scatter	Lithic scatter (10 flakes). Age unknown.	TID/MID	U	U
22	HDR-DP-034	--	Prehistoric	Short-term Habitation	Lithic scatter (30+ flakes and 1 handstone). Age unknown.	TID/MID	I	NC
23	HDR-DP-041	--	Prehistoric	Quarry	Quarry/assay location; Lithic scatter (100+ flakes, one core). Age unknown.	TID/MID	U	U
24	HDR-DP-043	--	Prehistoric	Lithic Scatter	Lithic scatter (12 flakes - two are utilized, one scraper, one core, one possible spokeshave). Age unknown.	TID/MID	U	U
25	HDR-DP-046	--	Prehistoric	Milling Feature	One milling station feature (four cups); lithic scatter (three flakes). Age unknown.	TID/MID	U	U
26	HDR-DP-047	--	Prehistoric	Milling Feature	One milling station feature (three cups); lithic scatter (two flakes). Age unknown.	TID/MID	U	U
27	HDR-DP-049	--	Prehistoric	Lithic Scatter	Lithic scatter (eight flakes, one core). Age unknown.	TID/MID	U	U
28	HDR-DP-050	--	Prehistoric	Quarry	One quarry feature; lithic scatter (500+ flakes). Age unknown.	TID/MID	I	NC

Count	Temporary Site No.	Primary No./ Trinomial	Age	Type	Description	Land Owner	NRHP Eligibility[1] Individual Eligibility	NRHP Eligibility as a Contributing or Non-Contributing Element to the Tuolumne River Prehistoric Archaeological District
29	HDR-DP-054	--	Prehistoric	Quarry	One quarry feature; lithic scatter (27 flakes). Age unknown.	TID/MID	I	NC
30	HDR-DP-055	--	Prehistoric	Lithic Scatter	Lithic scatter (six flakes). Age unknown.	TID/MID	I	NC
31	HDR-DP-056	--	Prehistoric	Lithic Scatter	Lithic scatter (15 flakes). Age unknown.	TID/MID	I	NC
32	HDR-DP-057	--	Prehistoric	Quarry	One quarry feature; Lithic scatter (215+ flakes, one core). Age unknown.	TID/MID	I	NC
33	HDR-DP-058	--	Prehistoric	Lithic Scatter	Lithic scatter (50+ flakes). Age unknown.	TID/MID	U	U
34	HDR-DP-060	--	Prehistoric	Lithic Scatter	Lithic scatter (six flakes). Age unknown.	TID/MID	U	U
35	HDR-DP-061	--	Prehistoric	Long-term Habitation	Lithic scatter (two loci, 60+ flakes, one retouched flake, one scraper); midden; possible housepit. Age unknown.	TID/MID	U	U
36	HDR-DP-062	--	Prehistoric	Lithic Scatter	Lithic scatter (four flakes - one is a possible scrapper, one broken CCS cobble). Age unknown.	TID/MID	I	NC
37	HDR-DP-063	--	Prehistoric	Quarry	One milling station feature (three cups); quarried outcrop; lithic scatter (12 pieces of debitage). Age unknown.	TID/MID	U	U
38	HDR-DP-064	--	Prehistoric	Lithic Scatter	Lithic scatter (nine flakes). Age unknown.	TID/MID	I	NC
39	HDR-DP-065	--	Prehistoric	Lithic Scatter	Lithic scatter (100 flakes, one digging tool); a quarried CCS cobble with flake scars. Age unknown.	TID/MID	U	U
40	HDR-DP-066	--	Prehistoric	Short-term Habitation	Lithic scatter (25 flakes, two utilized flakes, two cores, one chopper, one scraper, two milling slabs, and two projectile points shown to the crew by local residents who collected them from the site the year before; Rosegate Series and Elko Series). Dates to Middle Archaic to Late Archaic.	TID/MID	U	C
41	HDR-DP-067	--	Prehistoric	Lithic Scatter	Lithic scatter (one flake, two assayed cobbles). Age unknown.	TID/MID	I	NC
42	HDR-DP-068	--	Prehistoric	Short-term Habitation	Lithic scatter (one portable mortar, three pieces of debitage). Age unknown.	TID/MID	I	NC
43	HDR-DP-069	--	Prehistoric	Quarry	Lithic scatter/assay location (four pieces of debitage). Age unknown.	TID/MID	I	NC
44	HDR-DP-071	--	Prehistoric	Lithic Scatter	Lithic scatter (one modified flake, one chopper, and two flakes). Age unknown.	TID/MID	I	NC
45	HDR-DP-073	--	Prehistoric	Lithic Scatter	Lithic scatter (one Elko Series projectile point, four cores, and seven flakes). Dates to Middle Archaic.	TID/MID	U	C
46	HDR-DP-074	--	Prehistoric	Long-term Habitation	Four bedrock milling station features; midden; lithic scatter (100+ flakes, three cores, three handstones, one milling slab, and one bifacially modified amethyst bottle glass fragment). Dates to Protohistoric age.	TID/MID	E	C
47	HDR-DP-075	--	Prehistoric	Lithic Scatter	Lithic scatter (two cores, one modified flake, and one biface). Age unknown.	TID/MID	I	NC
48	HDR-DP-076	--	Prehistoric	Quarry	Lithic scatter (100+ flakes, 50+ tools including choppers, hammerstones, edge modified cores, edge modified flakes, and cores); quarry (cobbles and outcrops across site). Age unknown.	TID/MID	E	C
49	HDR-DP-077	--	Prehistoric	Quarry	Lithic scatter (500+ flakes, 100+ tools, a sample was recorded including 25 edge modified flakes, nine bifaces, eight cores, five edge modified cores, four unifaces, three utilized flakes, four handstones, one scraper, one blade, one flake blank, and one chopper); quarry. Age unknown.	TID/MID	E	C
50	HDR-DP-095	--	Prehistoric	Long-term Habitation	One milling feature (12 cups); One handstone. Age unknown.	TID/MID	U	U
51	HDR-DP-106	--	Prehistoric	Long-term Habitation	Eight housepit features; nine milling station features; a possible water retention basin feature; a rock feature; a lithic scatter with four artifact scatters (100+ flakes, two edge modified flakes, one biface, one uniface, one cached pestle, several cores). Age unknown.	TID/MID	E	C
52	HDR-DP-107	--	Prehistoric	Lithic Scatter	Lithic scatter (150+, one biface). Age unknown.	TID/MID	I	NC
53	HDR-DP-109	--	Prehistoric	Short-term Habitation	Two milling station features (three cups total); lithic scatter (100+ flakes, one biface). Age unknown.	TID/MID	U	U
54	HDR-DP-110	--	Prehistoric	Lithic Scatter	Lithic scatter (14 flakes, one core/scraper). Age unknown.	TID/MID	I	NC
55	HDR-DP-112	--	Prehistoric	Lithic Scatter	Lithic scatter (two flakes, two modified flakes, one biface, one uniface). Age unknown..	TID/MID	I	NC
56	HDR-DP-113	--	Prehistoric	Long-term Habitation	Nine housepits with possible midden deposits; five milling stations; lithic scatter (50+ flakes, one uniface, one scraper, 100+ FCR, one bowl mortar fragment). Age unknown.	TID/MID	E	C
57	HDR-DP-115	--	Prehistoric	Quarry	Quarry feature; lithic scatter (200+ flakes, 30-60 cores). Age unknown.	TID/MID	I	C
58	HDR-DP-116	--	Prehistoric	Long-term Habitation	Five milling station features; lithic scatter (10+ flakes, one scraper). Age unknown.	TID/MID	U	U
59	HDR-DP-118	--	Prehistoric	Short-term Habitation	One milling station feature; lithic scatter (two loci, 190+ flakes, one biface). Age unknown.	TID/MID	U	U

Count	Temporary Site No.	Primary No./ Trinomial	Age	Type	Description	Land Owner	NRHP Eligibility[1] Individual Eligibility	NRHP Eligibility as a Contributing or Non-Contributing Element to the Tuolumne River Prehistoric Archaeological District
60	HDR-DP-127	--	Prehistoric	Long-term Habitation	Lithic scatter with possible midden deposits (215+ flakes, two loci, one artifact concentration, six bifaces, four edge modified flakes, two unifaces, one handstone, one hammerstone, one core, and one flake blade. Age unknown.	TID/MID	U	C
61	HDR-DP-128	--	Prehistoric	Short-term Habitation	Two bedrock milling station features (nine cups total); lithic scatter (two flakes, one handstone). Age unknown.	TID/MID	U	U
62	HDR-DP-131	--	Prehistoric	Other	Ten+ possible atlatl weights, some are cached. Age unknown.	TID/MID	E	C
63	HDR-DP-135	--	Prehistoric	Short-term Habitation	Lithic scatter (two concentrations, eight flakes, one Elko Corner-notched projectile point, one bowl mortar fragment). Dates to Middle to Late Archaic age.	TID/MID	U	C
64	HDR-DP-137	--	Prehistoric	Lithic Scatter	Lithic scatter (5 flakes). Age unknown.	TID/MID	I	NC
65	HDR-DP-140	P-55-1331/ CA-TUO-306	Prehistoric	Long-term Habitation	Eight bedrock milling stations. Age unknown.	TID/MID	U	C
66	HDR-DP-141	--	Prehistoric	Lithic Scatter	Lithic scatter (eight flakes). Age unknown.	TID/MID	U	U
67	HDR-DP-145	--	Prehistoric	Lithic Scatter	Lithic scatter (70+ flakes, two bifaces, one flake tool, and one Elko Corner-notched point). Dates to Middle Archaic age.	TID/MID	U	C
68	HDR-DP-147	--	Prehistoric	Lithic Scatter	Lithic scatter (four flakes). Age unknown.	TID/MID	U	U
69	HDR-DP-151	--	Prehistoric	Long-term Habitation	Three milling station features; lithic scatter (100+ flakes, two handstones, one biface, two cores, two cached pestles, two cobble tools, one flake tool). Age unknown.	TID/MID	U	C
70	HDR-DP-155	--	Prehistoric	Short-term Habitation	Lithic scatter (four flakes, four handstones). Age unknown.	TID/MID	U	U
71	HDR-DP-158	--	Prehistoric	Short-term Habitation	Three groundstone artifacts and one flake tool. Age unknown.	TID/MID	I	NC
72	HDR-DP-164	P-55-1925/ CA-TUO-915	Prehistoric	Lithic Scatter	Lithic scatter (two flakes, one core). Previously identified milling station with 14+ mortar cups was not observed and likely inundated during current recordation. Age unknown.	TID/MID	U	U
73	HDR-DP-186	--	Prehistoric	Short-term Habitation	Lithic scatter (three handstones, two pestles, one millings slab, one flake). Age unknown.	TID/MID	U	U
74	HDR-DP-192	P-55-1363/ CA-TUO-340	Prehistoric	Rock Shelter	One rock shelter, midden, two bedrock milling stations; Lithic scatter (30+ flakes, 60+ cobble tools, 40+ groundstone tools). Age unknown.	TID/MID	E	C
75	HDR-DP-195	--	Prehistoric	Milling Feature	One milling station feature (one mortar cup) and one handstone. Age unknown.	TID/MID	U	U
76	HDR-DP-196	--	Prehistoric	District	Tuolumne River Prehistoric Archaeological District. Elements of the district are comprised of all prehistoric archaeological site components documented in the APE. Dates from 11,500 cal B.P. to the mid-19th Century.	TID/MID/ BLM	E	N/A

[1] NRHP Eligibility Evaluations: E = Eligible; I = Ineligible; U = Unevaluated; C = Contributing Element; NC = Non-Contributing Element; N/A = Not Applicable (this resource is the Tuolumne River Prehistoric Archaeological District and is not an element of the district).

Table 3.11-5. Summary of historic sites.

Count	Temporary Site No.	Primary No./ Trinomial	Age	Type[1]	Description	Land Owner	NRHP Eligibility[2]: Individual Eligibility	NRHP Eligibility[2]: NRHP Eligibility as a Contributing or Non-Contributing Element to the Kanaka Creek Mining Landscape	NRHP Eligibility[2]: NRHP Eligibility as a Contributing or Non-Contributing Element to the Woods Creek Mining Landscape
1	FW-DP-002/25/79	--	Historic	Utilities	Remnants of a former above-ground utility line. Dates to late 19th/early 20th century.	TID/MID/BLM	I	N/A	N/A
2	FW-DP-010	--	Historic	WCH	Ditch near Taco House site, two segments. Dates to c. 1850s-1950s.	TID/MID/BLM	I	N/A	N/A
3	FW-DP-011/012	--	Historic	WCH	Two parallel square-shaped ditches on Raggio parcel. Dates to c. 1930s.	TID/MID/BLM	I	N/A	N/A
4	FW-DP-013	--	Historic	Transportation	Road to Ferretti property near Moccasin Creek. Dates to late 19th/early 20th century.	TID/MID/BLM	I	N/A	N/A
5	FW-DP-016	--	Historic	Transportation	Old Sonora to Big Oak Flat Road; 690 feet road segment. Dates to c. 1850s-1970s.	TID/MID/BLM	I	N/A	N/A
6	FW-DP-020	--	Historic	WCH	Placer mining ditch with stacked rock support along Moccasin Creek. Dates to c. 1850s to early 20th century.	TID/MID/BLM	I	N/A	N/A
7	FW-DP-021	--	Historic	Mining	Temporary camp with three features: square rock alignment, fire ring, prospect pit. Historic age unknown.	TID/MID/BLM	U	N/A	N/A
8	FW-DP-022	--	Historic	Mining	Mining - Dredge Area with several tailings piles. Dates to c. 1935-1942.	TID/MID/BLM	I	N/A	N/A
9	FW-DP-024	--	Historic	Transportation	Jacksonville to Big Oak Flat Road. Dates to c. 1850s-1930s.	TID/MID/BLM	I	N/A	N/A
10	FW-DP-026	--	Historic	WCH	Ditch West of Steven's Bar, approximately 150 in length. Dates to c. 1850s-early 20th century.	TID/MID	I	N/A	N/A
11	FW-DP-030/031	--	Historic	Mining	Hard rock mining complex, two loci with four collapsed adits each, four features. Dates to c. 1850s-early 20th century.	TID/MID/BLM	U	N/A	N/A
12	FW-DP-032	--	Historic	Other	Bulldozed structure and leveled area (possible structure location), no artifacts/features. Dates to c. 1960s-1970s or later.	TID/MID/BLM	I	N/A	N/A
13	FW-DP-033	--	Historic	WCH	Ditch, ~470 feet long, near Jacksonville. Dates to c. 1850s-early 20th century.	TID/MID/BLM	I	N/A	N/A
14	FW-DP-034/035/036/063	--	Historic	Transportation	Jacksonville area roads: three road segments, one trail; one rock wall. Dates to c. late-19th /early-20th century.	TID/MID/BLM	I	N/A	N/A
15	FW-DP-037/038	--	Historic	Transportation	Don Pedro and Indian Bar Road. Dates to c. 1850s-1970.	TID/MID/BLM	I	N/A	N/A
16	FW-DP-039	--	Historic	Transportation	Road, 290 feet long. Unknown Historic age (pre-1971).	TID/MID	I	N/A	N/A
17	FW-DP-040	--	Historic	Transportation	Road, 360 feet long. Unknown historic age (pre-1971).	TID/MID/BLM	I	N/A	N/A
18	FW-DP-041	--	Historic	Transportation	Road; two segments, 210 and 2,495 feet long. Unknown historic age (pre-1971).	TID/MID/BLM	I	N/A	N/A
19	FW-DP-042	--	Historic	WCH	Ditch (Brown Adit area). Dates to c. 1850s-early 20th century.	TID/MID/BLM	I	N/A	N/A
20	FW-DP-046	P-55-3227/ CA-TUO-2253H	Historic	WCH	Brown Adit site, originally recorded in 1989 by Napton and Greathouse, four new features (adit, shop building foundations, concrete platform, waste rock pile). Dates to c. 1920s-1945.	TID/MID/BLM	E	N/A	N/A
21	FW-DP-047/048/051/052	--	Historic	Transportation	Road (Railroad Canyon); four segments. Dates to c. 1850s-early 20th century.	TID/MID/BLM	I	N/A	N/A
22	FW-DP-050	--	Historic	Mining	Clio Mine; 14 features. Dates to c. 1870s-c. 1942.	TID/MID/BLM/Private	E	N/A	N/A
23	FW-DP-053	--	Historic	Mining	Kanaka Creek mining landscape (District); several features including roads, ditches, coyote holes (adits), numerous randomly stacked tailings piles, pits, and channels in Kanaka Creek. There are sixe elements (FW-DP-54, FW-DP-57, FW-DP-58, FW-DP-59, FW-DP-80, FW-DP-99); Dates to c. 1850s- c. 1930s. A prehistoric component within the District is not considered an element of the District as it is not affiliated with the time period or theme of the District.	TID/MID/BLM/Private	E	N/A	N/A
24	FW-DP-054	--	Historic	WCH	Ditch above Kanaka Creek Cabin, 195 feet long. Dates to c. 1850s-c. 1930s.	TID/MID/Private	I	NC	N/A
25	FW-DP-055	--	Historic	Mining	Hard Rock mining site; four features (one pit, three linear prospects). Dates to c. 1880-post 1945.	TID/MID/BLM	I	N/A	N/A

Count	Temporary Site No.	Primary No./ Trinomial	Age	Type[1]	Description	Land Owner	NRHP Eligibility[2]		
							Individual Eligibility	NRHP Eligibility as a Contributing or Non-Contributing Element to the Kanaka Creek Mining Landscape	NRHP Eligibility as a Contributing or Non-Contributing Element to the Woods Creek Mining Landscape
26	FW-DP-056	--	Historic	WCH	Ditch (west of Stevens Bar) ~60 feet long, four features. Dates to c. 1850s-early 20th century.	TID/MID/BLM	I	N/A	N/A
27	FW-DP-058	--	Historic	WCH	Two ditches with reservoir in Kanaka Creek Landscape; five features - ditch segment, earthen berm, ditch, dam breach, linear rock pile. Dates to c. 1850s to c. 1930s.	TID/MID/BLM	I	C	N/A
28	FW-DP-059	--	Historic	Transportation	470 foot earthen road (along Kanaka Creek). Dates to c. 1850s to c. 1930s.	TID/MID/BLM	I	NC	N/A
29	FW-DP-061	--	Historic	WCH	Two Ditch segments, 90 feet and 106 feet. Dates to c. 1850s to c. 1880s.	TID/MID/BLM	I	N/A	N/A
30	FW-DP-064	--	Historic	WCH	Ditch 1,366 feet long. Dates to c. 1869.	TID/MID/BLM	I	N/A	N/A
31	FW-DP-065	--	Historic	Mining	Woods Creek placering mining complex with habitation area; seven features: hand stacked rock wall, linear stacked rock wall, tailings piles, placer mining gulch, tailings piles, hand-stacked waste rock, tailing piles. Dates to c. 1850s-1880s.	TID/MID/BLM	U	N/A	C
32	FW-DP-066	--	Historic	WCH	One Ditch (above FW-DP-65) 970-feet, six features incl. stacked rock feature. Dates to c. 1850-1880s.	TID/MID/BLM	I	N/A	C
33	FW-DP-069	--	Historic	Mining	Placering area at mouth of Sullivan Creek; six features (channel, pit, tailings, mining cuts with associated tailings, channel, and fire ring). Dates to c. 1848-1880s.	TID/MID/BLM	U	N/A	N/A
34	FW-DP-070/071	--	Historic	Mining	Woods Creek Mining Landscape (includes FW-DP-65; FW-DP-66; FW-DP-87; FW-DP-88; FW-DP-89; FW-DP-91; FW-DP-94; FW-DP-95; FW-DP-96; FW-DP-97; FW-DP-98; ISO-FW-DP-09; ISO-FW-DP-13; ISO-FW-DP-33). Dates to c. 1850-1880s.	TID/MID/BLM/Private	E	N/A	N/A
35	FW-DP-073	P-55-3877/ CA-TUO-2893H	Historic	Transportation	Ward's Ferry Road; two segments and three new features (stacked rock retaining wall, two board-formed reinforced concrete abutments) recorded as part of this update. The stone bridge abutments of old Ward's Ferry Bridge were recorded as a separate site. Dates to c. 1875-1930s.	TID/MID/BLM	U	N/A	N/A
36	FW-DP-074	--	Historic	Transportation	Ward's Ferry Bridge Abutments (two stone abutments on either side of the Tuolumne River). Dates to c. 1875.	TID/MID	I	N/A	N/A
37	FW-DP-075	--	Historic	Transportation	Old River Road, 1,935 feet long, one stacked rock feature. Dates to c. 1914.	TID/MID/BLM	I	N/A	N/A
38	FW-DP-076	--	Historic	Mining	McCormick River Mine; five features: stacked rock walls, collapsed adit, drainage pipe, gate post, wooden lean-to (possibly modern). Dates to post 1914 to c. 1930s.	TID/MID/BLM/Private	U	N/A	N/A
39	FW-DP-077	--	Historic	Transportation	Road, inaccessible by foot; 0.5 miles long. Age unknown.	TID/MID/Private	I	N/A	N/A
40	FW-DP-080	--	Historic	Transportation	Road adjacent to Cabin near Kanaka Creek (FW-DP-57); 150 foot segment in the APE. Dates to late-19th to early-20th century.	TID/MID/Private	I	NC	N/A
41	FW-DP-082	--	Historic	Transportation	Earthen road on Mine Island; approximately 150 feet in length. Dates to late 19th/early 20th century.	TID/MID/BLM	I	N/A	N/A
42	FW-DP-083	--	Historic	WCH	Earthen bermed ditch on Mine Island. Dates to late 19th/early 20th century.	TID/MID/BLM	I	N/A	N/A
43	FW-DP-084	--	Historic	Transportation	Earthen road on Mine Island, approximately 1,882 feet in length. Unknown Historic age.	TID/MID/BLM	I	N/A	N/A
44	FW-DP-087	--	Historic	WCH	Ditch with rock-work along Woods Creek, two linear segments. Dates to c. 1850s to 1880s.	TID/MID	I	N/A	C
45	FW-DP-088	--	Historic	WCH	Earthen bermed ditch along Woods Creek. Dates to c. 1850s to 1880s.	TID/MID	I	N/A	C
46	FW-DP-089	--	Historic	Transportation	Road above Woods and Slate creeks. Dates to c. 1850s-early 20th century.	TID/MID/Private	I	N/A	C
47	FW-DP-091	--	Historic	WCH	Ditch along Woods Creek; two discontinuous segments (A and B), segment A contains a stacked-rock retaining wall (Feature 1). Dates to c. 1850s-1880s.	TID/MID	I	N/A	C
48	FW-DP-092	--	Historic	Habitation	Raggio Parcel across from Taco House; rectangular rock foundation, concrete structure pads, a cased well, and two ditches (FW-DP-11/12). Dates to c. late 19th-century to c. 1930s.	TID/MID/BLM	U	N/A	N/A
49	FW-DP-093	--	Historic	Transportation	Earlier alignment of Grizzly Road/Highway 120; paved and measures approximately 25 feet wide and 1,710 feet long. Dates between c. 1934 and c. late 1960s/early 1970s.	TID/MID/Private	I	N/A	N/A

Count	Temporary Site No.	Primary No./ Trinomial	Age	Type[1]	Description	Land Owner	NRHP Eligibility[2] Individual Eligibility	NRHP Eligibility as a Contributing or Non-Contributing Element to the Kanaka Creek Mining Landscape	NRHP Eligibility as a Contributing or Non-Contributing Element to the Woods Creek Mining Landscape
50	FW-DP-094	--	Historic	Mining	Woods Creek placer mining complex; three distinct areas of mining resources (loci H, I, and J) that include placer tailings piles, mining cuts, and a mining claim. Dates to c. 1850s-1880s.	TID/MID/BLM/Private	U	N/A	C
51	FW-DP-095	--	Historic	Mining	Woods Creek placer mining complex with habitation areas, three loci (F, G, and K), 13 features recorded (more located). Dates to c. 1850s-1880s.	TID/MID/Private	E	N/A	C
52	FW-DP-096	--	Historic	Mining	Woods Creek placer mining complex, remnants of placer mining activities along a terrace above Woods Creek; three loci (C, D, and E) and three hand-stacked waste rock features (feature 1a, 1b and 2); single "black" glass bottle base fragment Dates to c. 1850s-1880s.	TID/MID/Private	U	N/A	C
53	FW-DP-097	--	Historic	Mining	Woods Creek placer mining complex including hand-stacked rock walls and placering piles; three loci (L, M, and N), three features (dry-stacked rock wall dam, hand-stacked waste rock feature, prospect pit), no artifacts. Dates to c. 1850s-1880s.	TID/MID/BLM	U	N/A	C
54	FW-DP-098	--	Historic	Mining	Woods Creek placer mining complex with possible structure flat/tent pad (feature 1). Dates to c. 1850s-1880s.	TID/MID/BLM	U	N/A	C
55	FW-DP-100	--	Historic	Transportation	Road segment along Willow Creek. Dates to c. pre-1944.	TID/MID/BLM	U	N/A	N/A
56	FW-DP-109	P-55-3876/ CA-TUO-2892H	Historic	Transportation	Pedestrian/animal trail with rock retaining walls. Dates to 1851.	BLM	U	N/A	N/A
57	HDR-DP-002	--	Historic	Transportation	A historic road segment. Dates between the late 19th century and the 1960s.	TID/MID	I	N/A	N/A
58	HDR-DP-004	--	Historic	Transportation	Four historic dirt road segments. Dates to pre-1944.	TID/MID	I	N/A	N/A
59	HDR-DP-005	--	Historic	Mining	Two tailings piles; A pile of waste rock; Two features comprised of multiple placer scrapes; Artifact Concentration of historic metal. Dates to after the turn of the century.	TID/MID	I	N/A	N/A
60	HDR-DP-007	--	Historic	Other	Two features: a concrete pad; wooden beam; debris scatter. Dates to the early modern period (c. late 1960s or later).	TID/MID	I	N/A	N/A
61	HDR-DP-012	--	Historic	Transportation	Two historic road segments; two metal items; two quartz crystals (natural). Dates to c. 1890s.	TID/MID	I	N/A	N/A
62	HDR-DP-016	--	Historic	Mining	Nine mining features: four back dirt/tailings piles; three placer scar features; two ditches. Dates to post 1930.	TID/MID	I	N/A	N/A
63	HDR-DP-017	--	Historic	Mining	Two features: Three-four bulldozer scrapes, and backdirt pile. Age unknown.	TID/MID	I	N/A	N/A
64	HDR-DP-020	--	Historic	Mining	One feature comprised of about four tailings piles. Age unknown.	TID/MID	I	N/A	N/A
65	HDR-DP-022	--	Historic	Other	Two concrete foundations. Dates to c. late 1960s.	TID/MID	I	N/A	N/A
66	HDR-DP-023	--	Historic	Other	Nine features: one feature of concrete footings, three bulldozer scrapers, two rock cairns, two prospect pits, a benchmark. Dates to c. late 1960s.	TID/MID	I	N/A	N/A
67	HDR-DP-025	--	Historic	Transportation	A historic road segment. Dates to c. 1940 - 1960s	TID/MID	I	N/A	N/A
68	HDR-DP-030	--	Historic	Transportation	Old Highway 132. Two segments of a historic road; four features: a borrow scrape, two culvert, and earthen dam. Dates between the 1870s and early 1970s.	TID/MID	I	N/A	N/A
69	HDR-DP-035	--	Historic	Habitation	Historic homestead site of the Haskell family: two pits (possible cellar features), a rock alignment, and sparse trash scatter. Dates between 1880s and 1910s.	TID/MID	U	N/A	N/A
70	HDR-DP-051	--	Historic	Other	Windmill remains. Dates to c. 1960.	TID/MID	I	N/A	N/A
71	HDR-DP-052	--	Historic	Other	Windmill/well remains. Dates to c. 1960.	TID/MID	I	N/A	N/A
72	HDR-DP-072	--	Historic	Transportation	Road segment. Dates to c. 1960.	TID/MID	I	N/A	N/A
73	HDR-DP-079	--	Historic	Utilities	A segment of a utility pole line, with 17 pole remnants. Age unknown.	TID/MID	I	N/A	N/A
74	HDR-DP-081	--	Historic	Mining	Three features: a road/ditch, a placer scrape, an earthen dam. Age unknown.	TID/MID	I	N/A	N/A
75	HDR-DP-083	--	Historic	Transportation	Ten segments of an old alignment of Highway 49; five features: three flattened terraces, a debris pile, a stacked rock wall; one glass fragment and a few ceramic fragments. Dates between the 1850s and 1970s.	TID/MID/ BLM	I	N/A	N/A

Count	Temporary Site No.	Primary No./ Trinomial	Age	Type[1]	Description	Land Owner	NRHP Eligibility[2] Individual Eligibility	NRHP Eligibility as a Contributing or Non-Contributing Element to the Kanaka Creek Mining Landscape	NRHP Eligibility as a Contributing or Non-Contributing Element to the Woods Creek Mining Landscape
76	HDR-DP-084	--	Historic	Mining	Five waste rock/tailings piles. Age unknown.	TID/MID	I	N/A	N/A
77	HDR-DP-085	--	Historic	Mining	Mining complex with eight features (rock piles, a large pit with a rock alignment, placer scars), a metal pipe and tin can fragment. Age unknown.	TID/MID	I	N/A	N/A
78	HDR-DP-086	--	Historic	Mining	20 features: nine scrapes (possible tent platforms), three ditch segments, three pits, two features comprised of pipes sticking out of the ground, one road segment, one excavated area, and one rock pile; waste rock/placer tailings; limited associated debris. Dates between the late 19th Century and 1940.	TID/MID	E	N/A	N/A
79	HDR-DP-087	P-55-1913/ CA-TUO-903H	Historic	Habitation	Ten features: a dug-out house structure, a modern landmark shrine, one rock wall, one rock alignment, a structural foundation, remnants of a corral, an improved spring, a structural depression, a spring box, and a ditch segment; moderate trash scatter. Dates from 1870s to 1930s-1940s.	TID/MID	E	N/A	N/A
80	HDR-DP-090	--	Historic	Other	Two metal pipes. Dates to the late 1960s.	TID/MID	I	N/A	N/A
81	HDR-DP-094	--	Historic	Transportation	Don Pedro Road with two culverts, rock retaining wall; concrete pad; post; bulldozer scrape. Dates to early 1900s.	TID/MID	I	N/A	N/A
82	HDR-DP-096	--	Historic	Utilities	One feature: radio tower foundation. Dates to c. 1960.	TID/MID	I	N/A	N/A
83	HDR-DP-100	--	Historic	Mining	Six tailings/waste rock piles and a rock cairn. Dates to c. 1880s - 1890s	TID/MID	I	N/A	N/A
84	HDR-DP-101	P-55-1346/ CA-TUO-321H	Historic	Mining	Mining complex with waste rock/tailings, two level areas, a trench, a depression, a road trace, a standing stone structure, and three pieces of metal. Dates between the 1880s and 1890s.	TID/MID	U	N/A	N/A
85	HDR-DP-102	--	Historic	Mining	Four waste rock/tailings concentrations; one metal artifact; two historic fence posts. Dates between 1880s and 1940s.	TID/MID	I	N/A	N/A
86	HDR-DP-103	P-55-110/ CA-TUO-2007H	Historic	Transportation	Four segments of the Hetch Hetchy Railroad; three features (two culverts, one road), two railroad ties. Dates between 1916/1917 and 1949.	TID/MID	I	N/A	N/A
87	HDR-DP-104	--	Historic	Mining	Six distinct concentrations of waste rock, a cut utility pole and two beer cans. Dates to c. 1900.	TID/MID	I	N/A	N/A
88	HDR-DP-108	--	Historic	Mining	Four features: one hearth, one cairn, two waste rock/tailings concentrations. Age unknown.	TID/MID	I	N/A	N/A
89	HDR-DP-111	--	Historic	Transportation	One historic road segment. Dates to c. 1940 - 1960s	TID/MID	I	N/A	N/A
90	HDR-DP-114	P-55-7353/ CA-TUO-4795H	Historic	Transportation	Segment of the Don Pedro Spur of the Sierra Railway (one railroad spike, no features or other artifacts). Dates to c. 1921-1923.	TID/MID	I	N/A	N/A
91	HDR-DP-117	P-55-5231	Historic	Transportation	One historic road segment. Dates from the mid-1800s.	TID/MID/BLM	I	N/A	N/A
92	HDR-DP-120	--	Historic	Transportation	Three historic road segments. Dates from the mid-1800s.	TID/MID	I	N/A	N/A
93	HDR-DP-122	--	Historic	Mining	Four features: one earthen dam with rock retaining wall, one prospect pit, one rock alignment, two prospect trenches; trash scatter. Dates from the mid-1800s to the early 1900s.	TID/MID	U	N/A	N/A
94	HDR-DP-124	--	Historic	Mining	Six prospect pits; one water control feature; waste rock. Age unknown.	TID/MID	I	N/A	N/A
95	HDR-DP-125	--	Historic	Transportation	One historic road segment, "road to coulterville". Dates to pre-1875 through late 1870s.	TID/MID	I	N/A	N/A
96	HDR-DP-126	--	Historic	Mining	Three prospect trench features, one prospect pit; waste rock. Age unknown.	TID/MID	U	N/A	N/A
97	HDR-DP-129	--	Historic	Transportation	Two segments of Morgan's Bar Road. Dates to mid to late 1800s.	TID/MID	I	N/A	N/A
98	HDR-DP-133	--	Historic	Mining	Nine tailings piles. Age unknown.	TID/MID	U	N/A	N/A
99	HDR-DP-136	--	Historic	Transportation	One historic road segment with bulldozer scrapes/push piles. Age unknown.	TID/MID	I	N/A	N/A
100	HDR-DP-138	--	Historic	Transportation	Two historic road segments. Age unknown.	TID/MID	I	N/A	N/A
101	HDR-DP-143	--	Historic	Transportation	One historic road segment. Dates from the mid to late 1800s.	TID/MID	I	N/A	N/A

Count	Temporary Site No.	Primary No./ Trinomial	Age	Type[1]	Description	Land Owner	NRHP Eligibility[2]		
							Individual Eligibility	NRHP Eligibility as a Contributing or Non-Contributing Element to the Kanaka Creek Mining Landscape	NRHP Eligibility as a Contributing or Non-Contributing Element to the Woods Creek Mining Landscape
102	HDR-DP-144	P-55-3175/ CA-TUO-2201H	Historic	WCH	A historic pipeline with 13 access point features. Dates between the 1870s to the present.	TID/MID	I	N/A	N/A
103	HDR-DP-146	--	Historic	Transportation	One road segment. Dates to late 1960s/early 1970s.	TID/MID	I	N/A	N/A
104	HDR-DP-148	--	Historic	Trash Scatter	Three can dumps (over 1,500 tin cans and other refuse) associated with the construction of the Hetch Hetchy Project. Dates between the late 1920s and early 1930s.	TID/MID	U	N/A	N/A
105	HDR-DP-149	P-55-1887/ CA-TUO-877H	Historic	Mining	Three mine shafts, one pit, and one linear cut. Age unknown.	TID/MID	I	N/A	N/A
106	HDR-DP-150	--	Historic	Transportation	Two segments of a historic road. Dates to c. 1850 - 1920s	TID/MID	I	N/A	N/A
107	HDR-DP-152	--	Historic	Utilities	Seven cut utility poles. Dates from 1923-early 1960s.	TID/MID/BLM	I	N/A	N/A
108	HDR-DP-153	--	Historic	Transportation	One historic road segment; three railroad ties and a metal can. Dates to the mid-1920s to the 1930s.	TID/MID	I	N/A	N/A
109	HDR-DP-154	--	Historic	Transportation	Two segments of a historic road; likely remnants of the Brown Adit Tramway. May date to mid 1870s, certainly 1920s-1960s.	TID/MID/BLM	I	N/A	N/A
110	HDR-DP-156	--	Historic	Transportation	One historic road segment. May be associated with HDR-DP-154 and date to c. 1920s.	TID/MID	I	N/A	N/A
111	HDR-DP-157	--	Historic	Trash Scatter	Possible remnants of a tramway associated with the construction of the Red Mountain Bar Siphon. One feature: an iron wheel encased in concrete; metal debris. Dates between the late 1920s and early 1930s.	TID/MID	I	N/A	N/A
112	HDR-DP-160	--	Historic	Transportation	One historic road alignment. Age unknown.	TID/MID	I	N/A	N/A
113	HDR-DP-161	--	Historic	Transportation	Seven segments of an historic road. Dates to c. 1890s	TID/MID	I	N/A	N/A
114	HDR-DP-165	--	Historic	Transportation	One historic road segment. Dates to c. 1905	TID/MID	I	N/A	N/A
115	HDR-DP-170	--	Historic	Other	One historic rock wall. Age unknown.	TID/MID	U	N/A	N/A
116	HDR-DP-171	--	Historic	Mining	A collapsed mine entrance; an adit; two concrete structures; trash scatter. Dates to the 1880s through the mid 1940s.	TID/MID	U	N/A	N/A
117	HDR-DP-173	--	Historic	Mining	Two features: one prospect pit, one prospect trench. Age unknown.	TID/MID	I	N/A	N/A
118	HDR-DP-174	--	Historic	WCH	One segment of a historic ditch. Age unknown.	TID/MID	I	N/A	N/A
119	HDR-DP-175	--	Historic	Transportation	One historic road segment, a metal pipe and a railroad spike. Dates to c. 1900 - c. 1942.	TID/MID	I	N/A	N/A
120	HDR-DP-178	--	Historic	Utilities	Four utility pole posts. Age unknown.	TID/MID	I	N/A	N/A
121	HDR-DP-179	--	Historic	Mining	One concrete foundation; one quartz tailing pile, one road segment, one adit. Dates from the 1880s to 1947.	TID/MID	U	N/A	N/A
122	HDR-DP-180	--	Historic	Mining	One historic road segment; three prospect trenches, three mine shafts/adits. Age unknown.	TID/MID	I	N/A	N/A
123	HDR-DP-181	--	Historic	Transportation	Two segments of a historic road, two rock features, and a railroad tie timber. Dates to c. 1895 - 1905.	TID/MID	I	N/A	N/A
124	HDR-DP-182	--	Historic	Transportation	Three historic road segments; dumped car. Dates to c. 1905 and c. 1970.	TID/MID	I	N/A	N/A
125	HDR-DP-183	--	Historic	Mining	13 mining-related features. Age unknown.	TID/MID	I	N/A	N/A
126	HDR-DP-187	--	Historic	Mining	One mining trench; one tailings pile. Age unknown.	TID/MID	I	N/A	N/A
127	HDR-DP-188	--	Historic	Mining	Two features: one trench, one tailings pile. Age unknown.	TID/MID	I	N/A	N/A
128	HDR-DP-193	--	Historic	WCH	Pedro Adit - portal for the Foothill Tunnel of the Hetch Hetchy Project. Remains include concrete foundations, waste rock pile, adit entrance, two road segments, utility pole stub, possible tent platform, trench, possible powder house, and limited debris. Dates between the 1920s and 1930s.	TID/MID	E	N/A	N/A

Count	Temporary Site No.	Primary No./ Trinomial	Age	Type[1]	Description	Land Owner	NRHP Eligibility[2]		
							Individual Eligibility	NRHP Eligibility as a Contributing or Non-Contributing Element to the Kanaka Creek Mining Landscape	NRHP Eligibility as a Contributing or Non-Contributing Element to the Woods Creek Mining Landscape
129	HDR-DP-197	--	Historic	Transportation	Gravel access road that was used during the construction of the Foothill Tunnel of the Hetch Hetchy Project. The road is now used as access for maintenance and inspections of the Foothill Tunnel, Pedro Adit, the Red Mountain Bar Syphon, and a transmission line. Dates from the 1920s to the 1930s.	TID/MID	U	N/A	N/A

[1] Types: WCH = Water Control / Hydroelectric.
[2] NRHP Eligibility Evaluations: E = Eligible; I = Ineligible; U = Unevaluated; C = Contributing Element; NC = Non-Contributing Element; N/A = Not Applicable (i.e., not an element of the landscape).
[3] In addition to those resources identified herein as elements to this landscape, the following resources are also elements of this landscape: FW-DP-57, a standing cabin (recorded as a built environment resource), FW-DP-99, a multi-component site addressed below, and ISO-FW-DP-9, ISO-FW-DP-13, and ISO-FW-DP-33 (recorded as isolated finds).

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Multi-Component Resources

Of the 29 multi-component sites identified within the APE, nine have been evaluated as eligible for inclusion on the NRHP, while five have been evaluated as ineligible and 15 remain unevaluated pending further investigations (Table 3.11-6). The 29 prehistoric and historic components represented by the multi-component sites fall within the following historic and prehistoric types, which are the same as those described in the above sections, with the exception of the farming/ranching type that represents those historic components associated with farming/ranch activities:

Historic Types:

(1) Transportation (2)

(2) Mining (9)

(3) WCH (1)

(4) Utilities (3)

(5) Other (3)

(6) Habitation (8)

(7) Trash Scatter (1)

(8) Farming/Ranching (2)

Prehistoric Types:

(1) Lithic Scatter (4)

(2) Short-Term Habitation (9)

(3) Long-Term Habitation (10)

(4) Quarry (1)

(5) Milling Feature (3)

(6) Other (2)

Built Environment Resources

A total of 37 built environment resources were identified and recorded within the APE as a result of the Historic Properties Study (Table 3.11-7). These resources have been grouped into eight categories[101]:

(1) Don Pedro Project Dam System Resources (15)

(2) TID and MID Transmission Lines (2)

(3) Don Pedro Project Dam Construction-Related Resources (1)

(4) Don Pedro Project Operations Support Resources (8)

(5) Don Pedro Project Recreation-Related Resources (4)

(6) Don Pedro Project Historic District (1)

(7) Don Pedro Recreation Agency Historic District (1)

(8) Other Non-Don Pedro Project resources (5)

[101] The resources within the following categories are Don Pedro Project-related facilities, the operations and maintenance of which is licensed by FERC: Don Pedro Project Dam System Resources, Don Pedro Project Dam Construction-Related Resources, Don Pedro Project Operations Support Resources, Don Pedro Project Recreation-Related Resources, Don Pedro Project Historic District, and Don Pedro Recreation Agency Historic District. The resources in the other built environment categories are non-Don Pedro Project related resources, thus the operation and maintenance of these facilities does not fall under the Don Pedro Project FERC license.

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Table 3.11-6. Summary of multi-component sites.

Count	Temporary Site No.	Primary No./ Trinomial	Age	Type[1]	Description	Land Owner	NRHP Eligibility[2]	
							Individual Eligibility	NRHP Eligibility as a Contributing or Non-Contributing Element to the Tuolumne River Prehistoric Archaeological District
1	FW-DP-017	P-55-6021	Multi-component	P: Long-term Habitation H: Habitation	Habitation site - Taco House Site with Human remains; eight features: two possible house pit features associated with the prehistoric/protohistoric component, and six features associated with the historic-era component. Historic dates to c. 1930s. Age unknown. However, glass beads indicate a protohistoric component.	TID/MID/BLM	E	C
2	FW-DP-018	--	Multi-component	P: Long-term Habitation H: Mining	Habitation site with human remains and a historic artifact scatter; two loci, two features, ~three BRMs, 22 artifacts; previously recorded but no trinomial. Age unknown. Historic dates to late 19th to mid-20th century.	TID/MID/BLM	E	C
3	FW-DP-078	P-55-1351/ CA-TUO-326	Multi-component	P: Long-term Habitation H: Habitation	Habitation site excavated by Moratto; Feature 1 is a quartz bedrock outcrop with three cupules, 12 artifacts. Dates to Protohistoric. Historic age dates to c. 1848 to c. 1914.	TID/MID/BLM	E	C
4	FW-DP-085	--	Multi-component	P: Short-term Habitation H: Mining	Multi-component site on Mine Island; Historic: (nine features) collection of mining-related archaeological resources: tailings piles, prospecting pits, surface vein workings, an adit, and a stock dam; Prehistoric: scatter of flaked and ground stone artifacts and debitage. Historic age dates to late 19th-early 20th century. Age unknown.	TID/MID/BLM	U	U
5	FW-DP-099	--	Multi-component	P: Milling Station H: Mining	Kanaka Creek placer and hard rock mining complex; BRMs with groundstone; two loci - A:linear tailings piles, sluicing channels, drainage trenches, pits, and randomly stacked tailings piles; B:two mortar cups; additional features 1-4; (three adits, one cut); no historic artifacts; three prehistoric artifacts (pestle, handstone end frag, pestle). Age unknown. Historic age dates to c. 1880s-1930s.	TID/MID/BLM	U	N/A
6	HDR-DP-006	P-55-1902/ CA-TUO-892	Multi-component	P: Quarry H: Habitation	Historic habitation location with two structural remnants (structure pads) and associated refuse (glass, ceramics, metal, one cut animal bone); a placer mining complex (two prospect pits, one area of placer scrapes, one ditch, and one excavated area) with limited debris (two pieces of metal and one piece of animal bone); an extensive lithic scatter with two quarry features (1,500+ flakes, one concentration, four scrapers, two bifaces, two cores, one quartz crystal, one milling slab, one utilized flake). Age unknown. Historic age dates between 1850 and 1960 and may represent either multiple periods of occupation of consistent occupation.	TID/MID	U	C
7	HDR-DP-009	--	Multi-component	P: Other H: Other	Two historic rock features; single prehistoric lithic flake. Prehistoric age unknown. Historic c. late 19th/early 20th century	TID/MID	I	NC
8	HDR-DP-019	--	Multi-component	P: Short-term Habitation H: Mining	Historic: 11 mining features and two metal artifacts. Prehistoric: milling station; lithic scatter (270+ flakes, one pestle, one core, one handstone). Prehistoric age unknown. Historic component dates to c. late 19th/early 20th Century.	TID/MID	U	U
9	HDR-DP-029	P-55-1920, P-55-1921, CA-TUO-910/H, CA-TUO-911/H	Multi-component	P: Long-term Habitation H: Habitation	Two loci; two features: a historic rock alignment and prehistoric milling station, seven depressions that are previous archaeological excavation units, historic refuse scatter including residential discard and structural debris (two historic artifact concentrations), lithic scatter (700+ flakes, 40+ lithic tools, 50-100 fire cracked rock). Prehistoric component dates to Late Archaic period based on previously identified point types (Desert Side-notched and Rosegate Series) and historic age dates to c. 1870 to c. 1900s.	TID/MID	E	C
10	HDR-DP-031	P-55-1923/ CA-TUO-913	Multi-component	P: Short-term Habitation H: Other	Five features: three modern depressions with backdirt piles, two historic bulldozer scrapes; lithic scatter (300+ flakes, two handstones). Prehistoric age is between 550 A.D. (1400 BP) and 1450 A.D. (500 BP) and historic age dates to between the 1930s and 1950s.	TID/MID	I	NC
11	HDR-DP-039	--	Multi-component	P: Short-term Habitation H: Habitation	Prehistoric lithic scatter (two flakes, one scraper) and milling station and four historic features (rock foundations for a residential structure and three rock alignments) and historic refuse. Age unknown. Historic component dates to late 19th Century/early 20th Century.	TID/MID	U	U
12	HDR-DP-042	--	Multi-component	P: Lithic Scatter H: Habitation	Five historic features: three pits and two rock foundations, limited historic trash scatter, lithic scatter (<ten flakes, four cores, one spokeshave, one gouge, two possible digging tools, one hammerstone). Unknown Prehistoric age and historic age c. 1890s to c. 1900s.	TID/MID	U	U
13	HDR-DP-045	--	Multi-component	P: Lithic ScatterH: Utilities	Lithic scatter (250+ flakes, two choppers, one modified flake, one utilized flake); transmission line tower foundations. Unknown Prehistoric age and historic age 1921-1923.	TID/MID	U	U

Count	Temporary Site No.	Primary No./ Trinomial	Age	Type[1]	Description	Land Owner	NRHP Eligibility[2]	
							Individual Eligibility	NRHP Eligibility as a Contributing or Non-Contributing Element to the Tuolumne River Prehistoric Archaeological District
14	HDR-DP-053	--	Multi-component	P: Short-term Habitation H: Utilities	Transmission tower foundation; Lithic scatter (one pestle, one retouched flake, and three flakes). Unknown Prehistoric age and historic age 1921-1923.	TID/MID	U	U
15	HDR-DP-070	--	Multi-component	P: Short-term Habitation H: Mining	Historic component: three bulldozer scars, one bulldozer mound, one rock pile. Prehistoric component: lithic scatter (two flakes, two chunks of CCS with flake scars, one milling slab). Unknown Prehistoric and Historic age.	TID/MID	I	NC
16	HDR-DP-078	--	Multi-component	P: Lithic Scatter H: Transportation	Historic road segment; Lithic scatter (10+ flakes, one modified flake). Age unknown. Historic age between 1944 and 1962.	TID/MID	I	NC
17	HDR-DP-092	--	Multi-component	P: Long-term Habitation H: Utilities	15 prehistoric housepits; eight milling stations; three possible midden areas; lithic scatter (one artifact concentration, 350+ flakes, four bifaces, three modified flakes, one handstone, one uniface); one historic transmission line tower; limited historic trash scatter. Unknown Prehistoric age and historic age 1921-1923.	TID/MID	E	C
18	HDR-DP-093	--	Multi-component	P: Other H: Other	One feature with prehistoric and historic petroglyphs (three panels). Age unknown. Historic component dates to 1887.	TID/MID	I	NC
19	HDR-DP-098	--	Multi-component	P: Long-term Habitation H: Transportation	One segment of a historic road and four metal pipe fragments; one milling station (12 cups and two possible cups), two flakes, one possible handstone. Age unknown. Historic component dates between the 1920s and 1950s.	TID/MID	U	U
20	HDR-DP-099	--	Multi-component	P: Long-term Habitation H: Ranching / Farming	Two historic features: a concrete trough, one historic road segment, two prehistoric milling station features; three historic metal artifacts; lithic scatter (16 flakes, one core, one uniface). Unknown Prehistoric age and historic age possibly as early as the 1890s with continued use through the present.	TID/MID	U	U
21	HDR-DP-119	P-55-1360/ CA-TUO-336/H	Multi-component	P: Long-term Habitation H: Habitation	Prehistoric component: thousands of flakes, thousands of fire cracked rocks (FCR), several milling stations, midden deposits, numerous lithic tools, possible hearth features, possible remnant housepits, a cluster of quartz boulders that may represent a grave marker, and human remains. Historic component: sparsely scattered refuse (ceramics, metal, and glass), two rock alignments that appear to be property boundaries, and a depression of unknown function. Prehistoric component dates from the Middle to Late Archaic and ethnographic periods. Historic component dates to late 19th Century/early 20th Century.	TID/MID/ BLM	E	C
22	HDR-DP-130	--	Multi-component	P: Long-term Habitation H: Mining	One bedrock milling station feature; three prospect trenches; sparse trash scatter (glass, metal, ceramics); lithic scatter (six flakes, one handstone); one historic road segment. Age unknown. Historic component dates to the 1890s.	TID/MID	U	U
23	HDR-DP-134	--	Multi-component	P: Short-term Habitation H: Mining	One earthen dam feature; one dug-out feature; one ditch; one rock wall; one ditch/trail; three placer mining areas; lithic scatter (50+ flakes, one core, one flake tool, one handstone, one concentration). Unknown Prehistoric and Historic ages.	TID/MID	U	U
24	HDR-DP-139	--	Multi-component	P: Lithic Scatter H: Trash Scatter	Lithic scatter (10+ flakes, one core, one biface, one handstone); historic trash scatter (bottle glass, ceramics, and a nail). Age unknown.. Historic component dates to late 19th Century/early 20th Century.	TID/MID	U	U
25	HDR-DP-142	P-55-1384/ CA-TUO-361	Multi-component	P: Milling Feature H: Ranching / Farming	One historic fence segment; two milling stations (five cups) and three pestles. Unknown Prehistoric and Historic ages.	TID/MID	U	U
26	HDR-DP-162	P-55-1927/ CA-TUO-917	Multi-component	P: Short-term Habitation H: WCH	Two milling station features; two concrete footings; lithic scatter (25+ flakes, two cobble tools, one Elko Corner-notched point; historic trash scatter (bottle glass, a ceramic, and a square metal nut). Prehistoric component dates to Middle Archaic in age. Historic component dates to 1860s-1950s.	TID/MID	U	C
27	HDR-DP-189	--	Multi-component	P: Long-term Habitation H: Mining	Seven bedrock milling stations; Lithic scatter (two concentrations, 150+ groundstone tools - mostly fragmented, one battered cobble, and one core); Historic adit and two rock piles. Prehistoric age unknown. Historic age 1902.	TID/MID	E	C

Count	Temporary Site No.	Primary No./ Trinomial	Age	Type[1]	Description	Land Owner	NRHP Eligibility[2]	
							Individual Eligibility	NRHP Eligibility as a Contributing or Non-Contributing Element to the Tuolumne River Prehistoric Archaeological District
28	HDR-DP-198	P-55-1928/ CA-TUO-918/H	Multi-component	P: Short-term Habitation H: Habitation	Only part of the historic component was observed and recorded during the present survey. This part included a fenceline, one piece of glass, a modern water system, an orchard area, and a few other fruit/nut trees. Previous recordation noted the following: A prehistoric lithic scatter with six+ flakes and one handstone; a historic ranching complex with 12 standing structures, two wells and associated water systems, a former structure location, a recent trash pit, many exotic fruit, nut, and other trees and vegetation, roads, fences, ranching machinery, and other associated remains. Prehistoric age unknown. Historic component dates from the 1860s to the present.	TID/MID	E	U
29	HDR-DP-250	--	Multi-component	P: Millling Feature H: Mining	Extensive placer mining area with 17 historic features (four trenches or sluicing channels, two structural depressions, one stone foundation, one stone oven, one road trace, one culvert, one rock pile/cairn, one rock alignment, a waste rock pile, a collapsed adit, one stacked rock pile, a reservoir, and one feature comprised of rock dams) and limited associated trash (one automobile and automobile parts date to a later period than the rest of the historic component). The prehistoric component is an isolated milling station (three mortar cups). Historic component dates to two periods: 1848 to 1850s and 1950s to 1960s. Prehistoric age is unknown.	TID/MID/ BLM	E	NC

1 Types: P = Prehistoric; H = Historic; WCH = Water Control / Hydroelectric.
2 NRHP Eligibility Evaluations: E = Eligible; I = Ineligible; U = Unevaluated; Only the prehistoric components of these multi-component sites are considered district elements.

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Of the 37 built environment resources documented within the APE, all but four are less than 50 years of age. Of these four resources that are older than 50, one has been evaluated as eligible for inclusion on the NRHP and three remain unevaluated regarding their eligibility for inclusion on the NRHP pending further work (one of these is also an element to a NRHP eligible historic landscape that is discussed with the archaeological resources above). Of the remaining 33 built environment resources, all were constructed less than 50 years ago, e.g., 1968–1972. None of these 33 resources are considered to be exceptionally significant (NRHP Criterion Consideration G), as would be required of resources less than 50 years of age to be considered eligible for inclusion on the NRHP. Subsequently, these 33 resources are evaluated as not eligible for listing on the NRHP. However, when these resources do become 50 years of age, reassessment of their eligibility for inclusion on the NRHP will likely find several of these resources eligible for inclusion on the NRHP (Table 3.11-8), assuming their current level of integrity remains intact. Table 3.11-8 provides a summary of all 37 built environment resources, their NRHP eligibility evaluations, and potential future NRHP eligibility evaluations, if applicable. As two of the resources not yet 50 years of age are historic districts that incorporate several of the other resources as elements, the table below also identifies which elements of the two districts will potentially be evaluated in the future as contributing and non-contributing elements to the districts once the districts reach 50 years of age.

Table 3.11-7. Summary of built environment resources identified within the APE.

Building/Structure (Field Designation)	Date	Engineering Style/Type	Designer
Don Pedro Project Dam System Resources			
Don Pedro Dam (FR-1)	1970	Earth and Rock Fill	Bechtel
Gated Dam Spillway (HDR-1a)	1969	None	Bechtel
Un-gated Dam Spillway (HDR-1b)	1969	None	Bechtel
Dike A (HDR-2a)	1969-1970	Earth and cobble fill	Bechtel
Dike B (HDR-2b)	1969-1970	Earth and cobble fill	Bechtel
Dike C (HDR-2c)	1969-1970	Earth and cobble fill	Bechtel
Gasburg Creek Dike (HDR-2d)	1970	Earth and cobble fill	Bechtel
Powerhouse (FR-2)	1968-1970	Industrial	Bechtel
Switchyard (FR-3a)	1971	Industrial	Bechtel
Power Intake and Tunnel (FR-4)	1968-1970	None	Bechtel
Outlet Works/Diversion Tunnel (FR-5)	1968	None	Bechtel
Unit 1 Substation (HDR-3)	1970	None	Bechtel
Unit 2 Substation (HDR-4)	Circa 1972	None	Bechtel
Cable Hoist Building/Inclined Gate Track (HDR-5)	1969-1971	Utilitarian	Bechtel
Reservoir (FR-6)	1970	None	Bechtel
TID and MID Transmission Lines			
TID (east) Transmission Line (FR-3b)	1970 to 1971	Steel lattice towers	Bechtel
MID (west) Transmission Line (FR-3c)	1970 to 1971	Steel lattice towers	Bechtel
Don Pedro Project Dam Construction-Related Resources			
Guy F. Atkinson Company construction camp powder house (HDR-6)	1967-1968	Utilitarian	Bechtel
Don Pedro Project Operations Support Resources			
Dam Storage Yard Warehouse (HDR-8)	1971	Butler style building	Bechtel
Riley Ridge Microwave Building and Tower (1 building and attached tower), and second tower built in 1986 (HDR-9)	1970–1971; 1986	Contemporary	Unknown; Possibly James W.B. Shade-Turlock
Riley Ridge Employee Housing House 1 (HDR-10a)	1970–1971	Contemporary	James W.B. Shade-Turlock
Riley Ridge Employee Housing House 2 (HDR-10b)	1970–1971	Contemporary	James W.B. Shade-Turlock
Riley Ridge Employee Housing House 3 (HDR-10c)	1970–1971	Contemporary	James W.B. Shade-Turlock
Riley Ridge Employee Housing House 4 (HDR-10d)	1972	Contemporary	James W.B. Shade-Turlock
Riley Ridge Employee Housing House 5 (HDR-10e)	1972	Contemporary	James W.B. Shade-Turlock
Riley Ridge Water Tank (HDR-11)	1971	Utilitarian	National Tank Manufacturing Company of Los Angeles

Building/Structure (Field Designation)	Date	Engineering Style/Type	Designer
Don Pedro Project Recreation-Related Resources			
Headquarters and Visitor Center (HDR-12)	1972	Pole	Caywood, Nopp, Takata, Hansen, and Ward of Sacramento
Moccasin Point Recreation Area (HDR 13)	1971-1972	Designed Landscape	Clair A. Hill & Associates/Caywood, Nopp, Takata, Hansen, and Ward of Sacramento
Blue Oaks Recreation Area (HDR-14)	1971-1972	Designed Landscape	Clair A. Hill & Associates/Caywood, Nopp, Takata, Hansen, and Ward of Sacramento
Fleming Meadows Recreation Area (HDR 15)	1971-1972	Designed Landscape	Clair A. Hill & Associates/Caywood, Nopp, Takata, Hansen, and Ward of Sacramento
Don Pedro Project Historic District			
Don Pedro Project Historic District	1968-1972	Industrial/Utilitarian/ Contemporary	Bechtel, James W.B. Shade, and National Tank Manufacturing Company
Don Pedro Recreation Agency Historic District			
Don Pedro Recreation Agency Historic District	1971-1972	Pole/Designed Landscape	Clair A. Hill & Associates/Caywood, Nopp, Takata, Hansen, and Ward of Sacramento
Other Non-Don Pedro Project resources			
Kanaka Creek cabin (FW-DP-57)	1930s-1950s	Vernacular	Unknown
La Grange Ditch (FW-DP-08)	1872	Vernacular water conveyance structure	Augustus Bowie
Red Mountain Bar Siphon (P-55-3913/CA-TUO-2928H)	1923	Engineered water conveyance structure	Marsden Manson and Michael Maurice O'Shaughnessy
Moccasin Creek stone building (HDR-DP-101/P-55-1346/CA-TUO-321H)	1890s	Vernacular rubble construction	Unknown
Hetch Hetchy Moccasin-Newark Transmission Line (HDR-16)	1969	Steel lattice towers	Unknown

Table 3.11-8. Summary of NRHP evaluations for built environment resources identified within the APE. [1]

Building/Structure (Field Designation)	NRHP Eligibility	Potential Future NRHP Eligibility of Resources Not Yet 50 Years of Age	Potential Future NRHP Eligibility as a Contributing or Non-Contributing Element of the Don Pedro Project Historic District	Potential Future NRHP Eligibility as a Contributing or Non-Contributing Element of the Don Pedro Recreation Agency Historic District
Don Pedro Project Dam System Resources				
Don Pedro Dam (FR-1)	Ineligible	Eligible	Contributing Element	N/A
Gated Dam Spillway (HDR-1a)	Ineligible	Eligible	Contributing Element	N/A
Un-gated Dam Spillway (HDR-1b)	Ineligible	Eligible	Contributing Element	N/A
Dike A (HDR-2a)	Ineligible	Ineligible	Contributing Element	N/A
Dike B (HDR-2b)	Ineligible	Ineligible	Contributing Element	N/A
Dike C (HDR-2c)	Ineligible	Ineligible	Contributing Element	N/A
Gasburg Creek Dike (HDR-2d)	Ineligible	Ineligible	Contributing Element	N/A
Powerhouse (FR-2)	Ineligible	Eligible	Contributing Element	N/A
Switchyard (FR-3a)	Ineligible	Ineligible	Contributing Element	N/A
Power Tunnel (FR-4)	Ineligible	Eligible	Contributing Element	N/A
Outlet Works/Diversion Tunnel (FR-5)	Ineligible	Eligible	Contributing Element	N/A
Unit 1 Substation (HDR-3)	Ineligible	Ineligible	Non-Contributing Element	N/A
Unit 2 Substation (HDR-4)	Ineligible	Ineligible	Non-Contributing Element	N/A
Cable Hoist/Incline Track (HDR-5)	Ineligible	Eligible	Contributing Element	N/A
Don Pedro Reservoir (FR-6)	Ineligible	Ineligible	Contributing Element	N/A
TID and MID Transmission Lines				
TID (east) Transmission Line (FR-3b)	Ineligible	Ineligible	N/A	N/A
MID (west) Transmission Line (FR-3c)	Ineligible	Ineligible	N/A	N/A
Don Pedro Dam Construction-Related Resources				
Guy F. Atkinson Company construction camp powder house (Blue Oaks Campground) (HDR-6)	Ineligible	Ineligible	N/A	N/A
Don Pedro Project Operations Support Resources				
Dam Storage Yard Warehouse (HDR-8)	Ineligible	Ineligible	Non-Contributing Element	N/A
Riley Ridge Microwave Building and two towers (HDR-9)	Ineligible	Ineligible	Non-Contributing Element	N/A
Riley Ridge Employee Housing House 1 (HDR-10a)	Ineligible	Ineligible	Non-Contributing Element	N/A
Riley Ridge Employee Housing House 2 (HDR-10b)	Ineligible	Ineligible	Non-Contributing Element	N/A
Riley Ridge Employee Housing House 3 (HDR-10c)	Ineligible	Ineligible	Non-Contributing Element	N/A

Building/Structure (Field Designation)	NRHP Eligibility	Potential Future NRHP Eligibility of Resources Not Yet 50 Years of Age	Potential Future NRHP Eligibility as a Contributing or Non-Contributing Element of the Don Pedro Project Historic District	Potential Future NRHP Eligibility as a Contributing or Non-Contributing Element of the Don Pedro Recreation Agency Historic District
Riley Ridge Employee Housing House 4 (HDR-10d)	Ineligible	Ineligible	Non-Contributing Element	N/A
Riley Ridge Employee Housing House 5 (HDR-10e)	Ineligible	Ineligible	Non-Contributing Element	N/A
Riley Ridge Water Tank (HDR-11)	Ineligible	Ineligible	Non-Contributing Element	N/A
Don Pedro Project Recreation-Related Resources				
Headquarters and Visitor Center (HDR-12)	Ineligible	Eligible	N/A	Contributing Element
Moccasin Point Recreation Area (HDR 13)	Ineligible	Eligible	N/A	Contributing Element
Blue Oaks Recreation Area (HDR-14)	Ineligible	Eligible	N/A	Contributing Element
Fleming Meadows Recreation Area (HDR 15)	Ineligible	Eligible	N/A	Contributing Element
Historic Districts				
Don Pedro Project Historic District	Ineligible	Eligible	N/A	N/A
Don Pedro Recreation Agency Historic District	Ineligible	Eligible	N/A	N/A
Other Non-Don Pedro Project Resources				
Red Mountain Bar Siphon (P-55-3913/CA-TUO-2928H)	Unevaluated	N/A	N/A	N/A
La Grange Ditch (FW-DP-08)	Eligible	N/A	N/A	N/A
Kanaka Creek Cabin (FW-DP-57)[2]	Unevaluated	N/A	N/A	N/A
Hetch Hetchy Moccasin-Newark Transmission Line (HDR-16)	Ineligible	Ineligible	N/A	N/A
Moccasin Creek Stone Building (HDR-DP-101/P-55-1346/CA-TUO-321H)[3]	Unevaluated	N/A	N/A	N/A
Totals	**Ineligible = 33 Eligible = 1 Unevaluated = 3 Total = 37**	**Eligible = 13 Ineligible = 20 N/A = 4 Total = 37**	**Contributing = 13 Non-Contributing = 10 Total Elements = 23 N/A = 14**	**Contributing = 4 Non-Contributing = 0 Total Elements = 4 N/A = 33**

[1] N/A = Not Applicable.
[2] The Kanaka Creek Cabin (FW-DP-57) is also a contributing element to the Kanaka Creek Mining Landscape (FW-DP-53), which is discussed in the archaeological discussion above and has been evaluated as eligible for inclusion on the NRHP.
[3] The Moccasin Creek Stone Building (HDR-DP-101) is a feature of an archaeological site (site HDR-DP-101) also addressed in the archaeological discussion above. The entire site remains unevaluated regarding its eligibility for inclusion on the NRHP.

Native American Traditional Cultural Properties Study

The primary goal of this study was to assist FERC in meeting its compliance requirements under Section 106 of the NHPA, as amended, by determining if licensing of the Don Pedro Project would have an adverse effect on eligible TCPs. The objective of this particular study was to identify TCPs that may potentially be affected by O&M, evaluate their eligibility to the NRHP, and identify Don Pedro Project-related activities that may affect eligible TCPs, and/or locations of ethnographic use.

To be considered a historic property, a TCP must have integrity and meet at least one of the NRHP criteria. When a place of traditional practices is evaluated as eligible for listing on the NRHP, it is termed a TCP. A TCP is defined as any property that is "…eligible for inclusion in the National Register because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community" [NR Bulletin 38 (Parker and King 1998:1)].

TCPs are further defined in National Register Bulletin 38 (Parker and King 1998:1) as:

(1) Locations associated with the traditional beliefs of a Native American group about its origins, its cultural history, or the nature of the world.

(2) A rural community, whose organization, buildings and structures, or patterns of land use reflect the cultural traditions valued by its long-term residents.

(3) An urban neighborhood that is the traditional home of a particular cultural group, and that reflects its beliefs and practices.

(4) Locations where Native American religious practitioners have historically gone and are known or thought to go to today, to perform ceremonial cultural rules of practice.

The Districts contracted Dr. Michael Moratto in early 2012 to complete the Native American TCP Study. Dr. Moratto is a Senior Cultural Resources Specialist with Applied EarthWorks, Inc. and has over 40 years of experience in cultural studies throughout California.

The study included completing archival research focusing on locations used by or important to local Native Americans. The study also included outreach to both recognized and non-recognized Tribes and tribal members that may have interests in the Don Pedro Project location and may be able to offer intellectual knowledge of places important to local Native American groups. As part of this effort, Dr. Moratto conducted close to 20 face-to-face and telephone interviews with Tribal representatives (both individually and in groups) from three groups (the Tuolumne Band of Me-wuk Indians, the Southern Sierra Miwuk Nation, and the Chicken Ranch Rancheria) and one unaffiliated Yokuts/Miwuk individual that lives in Chinese Camp, California near the Don Pedro Project. Two field visits with Tribal representatives and Tribal elders to archaeological sites and other locations of importance to Tribal participants were also conducted. These investigations showed that certain traditional cultural activities—harvesting plants for use as foods, medicines, and basketry materials, the redistribution of harvested plants, fishing, and panning for gold—are still practiced today by residents of foothill Me-wuk communities.

As a result of the Native American TCP Study, eight cultural properties were identified as possible TCPs:

(1) the lower Kanaka Creek native plant gathering area;

(2) lower Moccasin Creek cultural area, encompassing a native plant harvesting area and archaeological sites 4-Tuo-307, 4-Tuo-313, 4-Tuo-314, 4-Tuo-318, FW-DP-81, and HDR-DP-192;

(3) auriferous streams;

(4) archaeological site HDR-DP-92;

(5) archaeological site HDR-DP-106;

(6) archaeological site HDR-DP-113;

(7) archaeological site HDR-DP-119; and

(8) a spring with associated native plants in the Blue Oaks Recreation Area.

Each of these properties was evaluated in terms of the significance and integrity criteria for the NRHP (36 CFR 60.4) as well as the additional qualifications for TCP status (Parker and King 1998). As a result of this evaluation process, one property—the Lower Kanaka Creek Traditional Native Plant Gathering District—was evaluated as NRHP-eligible under NRHP Criterion A (i.e., 36 CFR 60.4(a)) as a TCP and thus is a historic property that must be managed in accordance with Section 106 of the NHPA and its implementing regulations, 36 CFR 800 (see Attachment D for location map of the TCP). The archaeological resources investigated as potential TCPs were also assessed for the NRHP separately during the Historic Properties Study, for their archaeological attributes, the results of which are summarized in Section 3.11.2.1.1, above.

The diverse natural vegetation along lower Kanaka Creek has been viewed by generations of Indians as a source of traditional foods, medicines, and materials for making baskets and ceremonial regalia. Plants are still harvested in this locality today, and their availability contributes importantly to the maintenance of the foothill Me-wuk community's cultural traditions and identity. The plant-gathering area along lower Kanaka Creek is deemed to be a NRHP-eligible district significant under Criterion A because of its association with a "pattern of events or a historic trend that made a significant contribution to the development of a community, a State, or the nation" (NPS 1995:12), and specifically because of its association with cultural practices of a living community.

3.11.2 Resource Effects

Continued operation and maintenance of the Don Pedro Project may affect cultural resources that are listed on or eligible for listing on the NRHP (i.e., historic properties). The effect may be direct (e.g., result of ground disturbing activities), indirect (e.g., public access to recreation areas), or cumulative (e.g., caused by a Don Pedro Project activity in combination with other non-Don Pedro Project activities). Certain O&M activities may affect historic properties within the Project Boundary or outside the Project Boundary.

Adverse effects are activities that may alter those characteristics of an historic property that contribute to its NRHP eligibility in a manner diminishing the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Examples of adverse effects would include road maintenance that affects a previously undisturbed archaeological deposit, or a facilities upgrade that removes the windows or doors of an historic powerhouse and does not replace them in kind, with new windows and doors of a similar style and material. There are a number of such activities that could potentially affect historic properties within the APE, including use and maintenance of Don Pedro Project facilities and roads, maintenance to historic buildings or other structures, vegetation management activities, recreational site use, issuance of grazing leases, emergency actions, looting/vandalism, and erosion caused by wave action and fluctuating water levels of the reservoir. In addition, certain kinds of Don Pedro Project-related activities may not have a direct impact on historic properties, but may create the conditions by which damage occurs. For example, a Don Pedro Project road may not directly impact historic properties, but may enable public access to areas that do contain historic properties.

By contrast, there are Don Pedro Project O&M activities that may not have an adverse effect on historic properties and there may also be historic properties within the APE that are not subject to O&M activities. For example, the continued use of a paved access road that is closed to the public and travels through an historic property that is an archaeological site, will likely not be considered an adverse effect. As well, a historic property comprised of a recreation facility will likely not be adversely affected by continued use and maintenance of the facility, if the facility is used as it has been in the past and any maintenance activities maintain the existing integrity of the facility. Furthermore, there may be historic properties located within the APE that are substantially above the high waterline of the Don Pedro Reservoir and nowhere near any other Don Pedro Project facility or within the vicinity of O&M activities. Subsequently, O&M activities may not adversely affect these historic properties.

3.11.2.1 Types and Causes of Effects

The following sections describe in more detail some of the activities in the APE that may affect historic properties. Section 3.11.2.2, which follows, provides an assessment of Don Pedro Project-related effects on historic properties and resources not yet evaluated for the NRHP, as identified during relicensing studies within the APE.

Routine Operation and Maintenance of Buildings and Structures

The Don Pedro Project's hydroelectric operating system includes dams, powerhouses, penstocks, and associated features. As well, a few additional buildings, associated with other historic activities not directly related to the hydroelectric system, were also identified within the APE. As these facilities age, they may require maintenance to maintain operational efficiency or usefulness as a storage or residential facility. Maintenance can affect the character-defining features of a building or structure that contribute to its significance. Future activities might include structural, mechanical or electrical upgrades of these facilities, maintenance or repair of buildings and other structures, replacement of windows, doors, roofing, or other building components; expansion or improvement of parking and storage area; and similar activities. Moreover, above ground resources (i.e. buildings and structures) often require consideration of the integrity of their viewscape as an important factor. Viewscapes can contribute to a resource's significance and eligibility to the NRHP, and to the integrity of setting, association, and feeling of a resource. Planned and unplanned O&M tasks associated with structures and buildings, including repairs, upgrades, or viewscape changes, could result in negative or adverse effects on those built or engineered resources that are considered eligible for listing on the NRHP and must be considered.

Reservoir Inundation and Fluctuation[102]

Historic properties within a reservoir basin may be consistently inundated by water or subject to wet and dry cycles and wave action associated with annual fluctuations in reservoir water level. Research indicates that the effects of these actions may include erosion, deflation, hydrologic sorting or displacement of artifacts, and are primarily dependent on where within the reservoir basin a site is located (Lenihan et al. 1981). Inundated sites are subject to less impact than sites within the annual fluctuation zone.

Several studies have been conducted on the effects of reservoir inundation to archaeological sites in California and elsewhere (Foster et al. 1977; Foster and Bingham 1978; Henn and Sundahl 1986; Lenihan et al. 1981; Stoddard and Fredrickson 1978; Ware 1989). These studies show that the nature and extent of the effects are dependent on several factors, most notably the location of a cultural resource within the reservoir basin. Sites within the zone of seasonal fluctuation or drawdown suffer the greatest impacts, primarily in the form of erosion/scouring, deflation, hydrologic sorting, and artifact displacement caused by waves and currents. Sites located lower in the reservoir are more likely to be covered with silt, sometimes forming a protective cap, but burrowing clams and crayfish have been known to rework these sediments too. Finally, it should be emphasized that resources lying deep within the reservoir pool are also subject to erosion when major drawdown and refilling events occur (e.g., during major droughts or periodic maintenance activities).

Vegetation Management

In addition, DPRA complies with the CPRC section 4291 that requires maintenance of vegetation within 30 to 100 feet of a structure (defensible space). Additionally, DPRA maintains vegetation around developed campsites and other DPRA improvements to protect life and property from fire and other injury that could be caused by low hanging branches. The vegetation maintenance includes removal of all grassy vegetation in a 30 foot perimeter around structures and campsite furnishings, along road edges, and then the mowing of grassy vegetation for an additional 70 feet beyond the 30 foot cleared areas. Pruning of trees and shrubs is done

[102] The Proposed Action covered in the application for a new FERC license is the Districts' proposal to continue hydroelectric generation at the Don Pedro Project. While reservoir fluctuations have the potential to affect historic properties, the fluctuations of the Don Pedro Reservoir are due to operations for the purposes of water supply and flood control. Hydroelectric project operations are dependent upon water released for these purposes; therefore, reservoir fluctuations are not the result of hydroelectric operations. The effect of the Proposed Action has no measureable impact on reservoir fluctuations. During relicensing of the hydroelectric project, the Districts undertook comprehensive investigations of the cultural resources associated with the Don Pedro Project within the APE identified in the study plan. These cultural resource investigations considered the effects of all Don Pedro Project operations. The Districts intend to address the effects of all Don Pedro Project operations within the Historic Properties Management Plan.

around structures and furnishings to remove ladder fuels that are subject to spreading fire up into the trees and into structures, and to eliminate low branches that could injure passing humans.

Grazing Leases

Issuing grazing leases for lands within the Project Boundary may result in moderate to heavy cattle grazing/trampling which can cause both direct and indirect effects to historic properties. Direct effects result from cattle trampling which can impact the surface of an historic property. Indirect effects can result from both grazing and trampling. Grazing reduces vegetation coverage and can increase erosion. Cattle trampling around historic resources can also increase erosion, which can affect the integrity of historic resources. However, no grazing leases will be issued during the term of the new license.

Road Maintenance, Construction and Use

Numerous road maintenance and construction activities have the potential to affect historic properties. Dirt access roads within the Project Boundary are maintained by grading, which can affect historic properties that may lie buried beneath them. In addition, ditches excavated for roadway drainage may cause further impacts to archaeological sites. Vehicular traffic on dirt roadways can also damage historic properties by traveling through or over, depending on the condition of the road, the season of use, and the types of vehicles that travel the roads. Roads also make historic properties more accessible to the public, in some cases increasing their vulnerability to looting and vandalism.

Recreation

Common recreational activities include boating, fishing, hiking, picnicking, and camping. These activities can expose historic properties to public use and can lead to disturbance of intact cultural deposits, increased erosion or deterioration of sites, unauthorized artifact collection, or more severe vandalism and looting. Ongoing maintenance at recreational facilities, formal and informal improvements, and infrastructure development can also affect significant cultural values. The more accessible historic properties are to public traffic, the more likely they are to be affected by recreational activities.

Emergency Repairs

Emergency repairs to facilities, including dams, penstocks, powerhouses, etc., may be necessary in response to serious threats life, property, or the safe operation of Licensee's hydroelectric facilities. Such actions, however, have the potential to affect historic properties. For example, an historic dam may require repair not in keeping with its original materials, or the creation of a fire break could affect a lithic scatter.

Artifact Collection/Vandalism

Vandalism and looting pose potential threats to historic properties within the APE. Looting includes the casual collection of surface artifacts as well as deliberate unauthorized digging and theft of cultural resources. Vandalism is the destruction or defacement of cultural resources. Looting is one form of vandalism, as it contributes to the destruction of a cultural resource, but vandalism can also include acts that don't necessarily result in the removal of materials, but certainly contribute to the defacement or physical destruction of a resource. A prehistoric rock art site can be vandalized by modern graffiti added to rock art panels or the removal of a panel. An historic structure can be vandalized by shooting holes through the windows or walls.

The more accessible historic properties are to public traffic, such as resources in close proximity to public roads and recreation areas, the more likely they are to be affected by vandalism. As well, reservoir drawdowns can expose artifacts and sites within the fluctuation zone to looting. Additionally, archaeological sites that have been impacted by looting in the past are prone to additional looting.

3.11.2.2 Assessment of Ongoing Don Pedro Project-Related Effects

This section presents an assessment of ongoing Don Pedro Project-related effects on historic properties and resources not yet evaluated for the NRHP, as identified during relicensing studies within the APE. The Districts have identified a total of 234 archaeological sites, 127 isolated finds, 37 built resources, and one TCP within the APE. Of the 234 archaeological sites identified within the APE, 130 have been evaluated as ineligible for the NRHP, 75 are unevaluated with regards to their eligibility for inclusion in the NRHP, and 29 have been evaluated as eligible for the NRHP. All 127 of the isolated finds are ineligible for listing on the NRHP. Of the 37 built resources, 33 have been evaluated as ineligible, three are unevaluated, and one is eligible for listing on the NRHP. The TCP identified within the APE has been evaluated as eligible for the NRHP.

The resources that have been evaluated as ineligible for the NRHP are not historic properties and are therefore not further assessed with regards to ongoing Don Pedro Project-related effects. The unevaluated and eligible resources are addressed below.

Ongoing Don Pedro Project-Related Effects on Archaeological Sites[103]

Of the 234 archaeological sites identified within the APE, 130 have been evaluated as ineligible for the NRHP, 75 are unevaluated with regards to their eligibility for inclusion in the NRHP, and 29 have been evaluated as eligible for the NRHP. Of the 29 eligible resources, 8 are historic, 12 are prehistoric, and 9 are of multi-component affiliation. Of the 75 unevaluated resources, 23 are historic, 37 are prehistoric, and 15 are of multi-component affiliation. As summarized in Table 3.11-9, below, there are a total of 26 eligible archaeological sites and 64 unevaluated archaeological sites experiencing ongoing Don Pedro Project-related effects.

[103] Note that archaeological isolated finds are not addressed as all of these finds have been determined to be ineligible for inclusion on the NRHP and, therefore, are not historic properties that require an assessment of Don Pedro Project-related effects.

Table 3.11-9. Summary of ongoing Don Pedro Project-related effects assessments for eligible and unevaluated archaeological sites.

Experiencing Ongoing Don Pedro Project-Related Effects	Age			
	Historic	Prehistoric	Multi-Component	Total
Eligible Archaeological Sites				
Yes	7	12	7	**26**
No	1	0	2	**3**
Total	**8**	**12**	**9**	**29**
Unevaluated Archaeological Sites				
Yes	17	34	13	**64**
No	6	3	2	**11**
Total	**23**	**37**	**15**	**75**

Of the 90 eligible and unevaluated archaeological sites experiencing ongoing Don Pedro Project-related effects, eight are experiencing effects from cattle grazing only; 47 are experiencing effects from fluctuating water levels only; 24 are experiencing effects from fluctuating water levels and recreation; one site is affected by fluctuating water levels and cattle grazing; one site is affected by fluctuating water levels, cattle grazing, and looting; one site is affected by fluctuating water levels, cattle grazing, looting, and recreation; one site is affected by fluctuating water levels, cattle grazing, and recreation; two sites are being affected by fluctuating water levels and looting; two sites are being affected by fluctuating water levels, looting, and recreation; and three sites are affected by recreation only. Table 3.11-10, below, lists all 104 unevaluated and eligible archaeological sites identified within the APE, and identifies which have been determined to be impacted by ongoing Don Pedro Project-related effects and which have not.

Table 3.11-10. Ongoing Don Pedro Project-related effects assessment for eligible and unevaluated archaeological sites.

Temp Number	Primary/ Trinomial/Other	Age	Type[1]	Individual Eligibility[2]	Land Ownership	Ongoing Don Pedro Project-Related Effects	Type of Ongoing Don Pedro Project Effects
FW-DP-003	--	Prehistoric	Lithic Scatter	U	TID/MID/ BLM	Yes	Fluctuating water levels, recreation
FW-DP-004	--	Prehistoric	Lithic Scatter	U	TID/MID/ BLM	Yes	Fluctuating water levels, recreation
FW-DP-005	--	Prehistoric	Lithic Scatter	U	TID/MID/ BLM	Yes	Fluctuating water levels, recreation
FW-DP-006	--	Prehistoric	Lithic Scatter	U	TID/MID/ BLM	Yes	Fluctuating water levels, recreation
FW-DP-017	P-55-6021	Multi-component	P: Long-term Habitation H: Habitation	E	TID/MID/ BLM	No	N/A
FW-DP-018	--	Multi-component	P: Long-term Habitation H: Mining	E	TID/MID/ BLM	Yes	Fluctuating water levels, recreation
FW-DP-021	--	Historic	Mining	U	TID/MID/ BLM	No	N/A
FW-DP-030/031	--	Historic	Mining	U	TID/MID/ BLM	No	N/A
FW-DP-043	--	Prehistoric	Long-term Habitation	E	TID/MID	Yes	Fluctuating water levels
FW-DP-046	P-55-3227 CA-TUO-2253H	Historic	WCH	E	TID/MID/ BLM	Yes	Fluctuating water levels
FW-DP-050	--	Historic	Mining	E	TID/MID/ BLM/Private	Yes	Fluctuating water levels
FW-DP-053	--	Historic	Mining	E	TID/MID/ BLM/Private	Yes	Fluctuating water levels
FW-DP-065	--	Historic	Mining	U	TID/MID/ BLM	Yes	Fluctuating water levels
FW-DP-069	--	Historic	Mining	U	TID/MID/ BLM	Yes	Fluctuating water levels
FW-DP-070/071	--	Historic	Mining	E	TID/MID/ BLM/Private	Yes	Fluctuating water levels, recreation
FW-DP-073	P-55-3877 CA-TUO-2893H	Historic	Transportation	U	TID/MID/ BLM	Yes	Fluctuating water levels, recreation

Temp Number	Primary/ Trinomial/Other	Age	Type[1]	Individual Eligibility[2]	Land Ownership	Ongoing Don Pedro Project-Related Effects	Type of Ongoing Don Pedro Project Effects
FW-DP-076	--	Historic	Mining	U	TID/MID/ BLM/Private	Yes	Recreation
FW-DP-078	P-55-1351 CA-TUO-326	Multi-component	P: Long-term Habitation H: Habitation	E	TID/MID/ BLM	Yes	Fluctuating water levels
FW-DP-081	--	Prehistoric	Rock Shelter	E	TID/MID/ Private	Yes	Fluctuating water levels, recreation
FW-DP-085	--	Multi-component	P: Short-term Habitation H: Mining	U	TID/MID/ BLM	Yes	Fluctuating water levels, recreation
FW-DP-086	--	Prehistoric	Short-term Habitation	U	TID/MID/ BLM	Yes	Fluctuating water levels, recreation
FW-DP-092	--	Historic	Habitation	U	TID/MID/ BLM	No	N/A
FW-DP-094	--	Historic	Mining	U	TID/MID/ BLM/Private	Yes	Fluctuating water levels, recreation
FW-DP-095	--	Historic	Mining	E	TID/MID/ Private	Yes	Fluctuating water levels, recreation
FW-DP-096	--	Historic	Mining	U	TID/MID/ Private	Yes	Fluctuating water levels, recreation
FW-DP-097	--	Historic	Mining	U	TID/MID/ BLM	Yes	Fluctuating water levels, recreation
FW-DP-098	--	Historic	Mining	U	TID/MID/ BLM	Yes	Fluctuating water levels, recreation
FW-DP-099	--	Multi-component	P: Milling Station H: Mining	U	TID/MID/ BLM	Yes	Fluctuating water levels
FW-DP-100	--	Historic	Transportation	U	TID/MID/ BLM	Yes	Fluctuating water levels
FW-DP-109	P-55-3876 CA-TUO-2892H	Historic	Transportation	U	BLM	Yes	Fluctuating water levels
HDR-DP-006	P-55-1902 CA-TUO-892	Multi-component	P: Quarry H: Habitation	U	TID/MID	Yes	Fluctuating water levels; Cattle grazing; Looting; Recreation
HDR-DP-018	--	Prehistoric	Quarry	U	TID/MID	Yes	Fluctuating water levels; Cattle grazing; Looting

Temp Number	Primary/ Trinomial/Other	Age	Type[1]	Individual Eligibility[2]	Land Ownership	Ongoing Don Pedro Project-Related Effects	Type of Ongoing Don Pedro Project Effects
HDR-DP-019	--	Multi-component	P: Short-term Habitation H: Mining	U	TID/MID	Yes	Fluctuating water levels; Cattle grazing
HDR-DP-024	--	Prehistoric	Long-term Habitation	E	TID/MID	Yes	Fluctuating water levels; Cattle grazing; Recreation
HDR-DP-026	--	Prehistoric	Long-term Habitation	E	TID/MID	Yes	Fluctuating water levels; Recreation
HDR-DP-027	--	Prehistoric	Other	U	TID/MID	No	N/A
HDR-DP-028	--	Prehistoric	Short-term Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-029	P-55-1920, P-55-1921, CA-TUO-910/H, CA-TUO-911/H	Multi-component	P: Long-term Habitation H: Habitation	E	TID/MID	Yes	Fluctuating water levels; Recreation
HDR-DP-033	--	Prehistoric	Lithic Scatter	U	TID/MID	Yes	Fluctuating water levels; Recreation
HDR-DP-035	--	Historic	Habitation	U	TID/MID	No	N/A
HDR-DP-039	--	Multi-component	P: Short-term Habitation H: Habitation	U	TID/MID	No	N/A
HDR-DP-041	--	Prehistoric	Quarry	U	TID/MID	Yes	Cattle grazing
HDR-DP-042	--	Multi-component	P: Lithic Scatter H: Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-043	--	Prehistoric	Lithic Scatter	U	TID/MID	Yes	Cattle grazing
HDR-DP-045	--	Multi-component	P: Lithic Scatter H: Utilities	U	TID/MID	Yes	Cattle grazing
HDR-DP-046	--	Prehistoric	Milling Feature	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-047	--	Prehistoric	Milling Feature	U	TID/MID	Yes	Cattle grazing
HDR-DP-049	--	Prehistoric	Lithic Scatter	U	TID/MID	No	N/A
HDR-DP-053	--	Multi-component	P: Short-term Habitation H: Utilities	U	TID/MID	Yes	Recreation
HDR-DP-058	--	Prehistoric	Lithic Scatter	U	TID/MID	Yes	Recreation
HDR-DP-060	--	Prehistoric	Lithic Scatter	U	TID/MID	Yes	Cattle grazing

Temp Number	Primary/ Trinomial/Other	Age	Type[1]	Individual Eligibility [2]	Land Ownership	Ongoing Don Pedro Project-Related Effects	Type of Ongoing Don Pedro Project Effects
HDR-DP-061	--	Prehistoric	Long-term Habitation	U	TID/MID	Yes	Cattle grazing
HDR-DP-063	--	Prehistoric	Quarry	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-065	--	Prehistoric	Lithic Scatter	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-066	--	Prehistoric	Short-term Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-073	--	Prehistoric	Lithic Scatter	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-074	--	Prehistoric	Long-term Habitation	E	TID/MID	Yes	Fluctuating water levels
HDR-DP-076	--	Prehistoric	Quarry	E	TID/MID	Yes	Fluctuating water levels
HDR-DP-077	--	Prehistoric	Quarry	E	TID/MID	Yes	Fluctuating water levels
HDR-DP-086	--	Historic	Mining	E	TID/MID	Yes	Fluctuating water levels; Recreation; Looting;
HDR-DP-087	P-55-1913, CA-TUO-903H	Historic	Habitation	E	TID/MID	Yes	Fluctuating water levels; Looting
HDR-DP-092	--	Multi-component	P: Long-term Habitation H: Utilities	E	TID/MID	Yes	Cattle grazing
HDR-DP-095	--	Prehistoric	Long-term Habitation	U	TID/MID	Yes	Cattle grazing
HDR-DP-098	--	Multi-component	P: Long-term Habitation H: Transportation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-099	--	Multi-component	P: Long-term Habitation H: Ranching / Farming	U	TID/MID	Yes	Fluctuating water levels; Recreation
HDR-DP-101	--	Historic	Mining	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-106	--	Prehistoric	Long-term Habitation	E	TID/MID	Yes	Fluctuating water levels
HDR-DP-109	--	Prehistoric	Short-term Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-113	--	Prehistoric	Long-term Habitation	E	TID/MID	Yes	Fluctuating water levels

Temp Number	Primary/ Trinomial/Other	Age	Type[1]	Individual Eligibility [2]	Land Ownership	Ongoing Don Pedro Project-Related Effects	Type of Ongoing Don Pedro Project Effects
HDR-DP-116	--	Prehistoric	Long-term Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-118	--	Prehistoric	Short-term Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-119	P-55-1360 CA-TUO-336/H	Multi-component	P: Long-term Habitation H: Habitation	E	TID/MID/ BLM	Yes	Fluctuating water levels; Recreation
HDR-DP-122	--	Historic	Mining	U	TID/MID	Yes	Fluctuating water levels; Recreation
HDR-DP-126	--	Historic	Mining	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-127	--	Prehistoric	Long-term Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-128	--	Prehistoric	Short-term Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-130	--	Multi-component	P: Long-term Habitation H: Mining	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-131	--	Prehistoric	Other	E	TID/MID	Yes	Fluctuating water levels
HDR-DP-133	--	Historic	Mining	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-134	--	Multi-component	P: Short-term Habitation H: Mining	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-135	--	Prehistoric	Short-term Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-139	--	Multi-component	P: Lithic Scatter H: Trash Scatter	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-140	P-55-1331 CA-TUO-306	Prehistoric	Long-term Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-141	--	Prehistoric	Lithic Scatter	U	TID/MID	No	N/A
HDR-DP-142	P-55-1384 CA-TUO-361	Multi-component	P: Milling Feature H: Ranching / Farming	U	TID/MID	No	N/A
HDR-DP-145	--	Prehistoric	Lithic Scatter	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-147	--	Prehistoric	Lithic Scatter	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-148	--	Historic	Trash Scatter	U	TID/MID	No	N/A

Temp Number	Primary/ Trinomial/Other	Age	Type[1]	Individual Eligibility [2]	Land Ownership	Ongoing Don Pedro Project-Related Effects	Type of Ongoing Don Pedro Project Effects
HDR-DP-151	--	Prehistoric	Long-term Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-155	--	Prehistoric	Short-term Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-162	P-55-1927 CA-TUO-917	Multi-component	P: Short-term Habitation H: WCH	U	TID/MID	Yes	Fluctuating water levels; Recreation
HDR-DP-164	P-55-1925 CA-TUO-915	Prehistoric	Lithic Scatter	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-170	--	Historic	Other	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-171	--	Historic	Mining	U	TID/MID	Yes	Fluctuating water levels; Recreation
HDR-DP-179	--	Historic	Mining	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-186	--	Prehistoric	Short-term Habitation	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-189	--	Multi-component	P: Long-term Habitation H: Mining	E	TID/MID	Yes	Fluctuating water levels
HDR-DP-192	P-55-1363 CA-TUO-340	Prehistoric	Rock Shelter	E	TID/MID	Yes	Fluctuating water levels; Looting
HDR-DP-193	--	Historic	WCH	E	TID/MID	No	N/A
HDR-DP-195	--	Prehistoric	Milling Feature	U	TID/MID	Yes	Fluctuating water levels
HDR-DP-196	--	Prehistoric	District	E	TID/MID/ BLM	Yes	Fluctuating water levels; Recreation
HDR-DP-197	--	Historic	Transportation	U	TID/MID	No	N/A
HDR-DP-198	P-55-1928 CA-TUO-918/H	Multi-component	P: Short-term Habitation H: Habitation	E	TID/MID	No	N/A
HDR-DP-250	--	Multi-component	P: Millling Feature H: Mining	E	TID/MID/ BLM	Yes	Fluctuating water levels; Recreation; Looting

[1] H: Historic; P: Prehistoric.
[2] E: Eligible; U: Unevaluated.

Ongoing Don Pedro Project-Related Effects on Built Environment Resources

There are 37 built environment resources identified within the APE. Of these, 33 have been determined ineligible, three are unevaluated, and one is eligible for inclusion in the NRHP. The three unevaluated resources are Red Mountain Bar Siphon (P-55-3913/CA-TUO-2928), Kanaka Creek Cabin (FW-DP-57), and Moccasin Creek Stone Building (HDR-DP-101). The Red Mountain Bar Siphon is an inverted siphon constructed by the City and County of San Francisco in 1923 to carry the Hetch Hetchy Aqueduct under the Tuolumne River (later Don Pedro Reservoir). Though running under water, beneath the reservoir, the siphon is functioning as intended and is not being impacted by O&M. The Kanaka Creek Cabin (FW-DP-57) is also a contributing element to the Kanaka Creek Mining Landscape (FW-DP-53), which is documented with the archaeological resources above. The Moccasin Creek Stone Building (HDR-DP-101) is within a larger archaeological site and thus is also part of an archaeological site (site HDR-DP-101) discussed above. Both the cabin and stone building are in rather secluded areas and are above the high waterline of the reservoir and are not being impacted by any identified Don Pedro Project-related activity. The La Grange Ditch (FW-DP-08) is the NRHP eligible built environment resource. It is located on a steep canyon wall and is also not impacted by Don Pedro Project-related effects.

Ongoing Don Pedro Project-Related Effects on TCPs

Only one TCP was identified in the APE: Lower Kanaka Creek Native Plant Gathering Area. This is an area along lower Kanaka Creek, extending 100 meters (330 feet) on both sides of the stream and one kilometer (0.6 mile) upstream from the edge of Don Pedro Reservoir. It has been viewed by generations of Native Americans as a source of traditional foods, medicines, and materials for making baskets and ceremonial regalia. Plants are still harvested in this locality today, and their availability contributes importantly to the maintenance of the Tuolumne Me-wuk community's cultural traditions and identity (see Chapters 6 and 8 of the TCP Study Report, Moratto et al. 2014). This TCP is located predominately above the high waterline of the reservoir and is accessible by Tribal members from Jacksonville Road. While the Don Pedro Reservoir appears to inundate a small portion of the TCP, this does not appear to be adversely affecting the resource. No other potential Don Pedro Project-related effects to this resource were identified and it has been determined that there are no ongoing adverse effects to the TCP (TID/MID 2014b).

3.11.3 Proposed Resource Measures

The Districts have developed a draft HPMP to manage potential effects on historic properties throughout the term of any new license. The draft HPMP is appended to this Exhibit E (being filed as PRIVILEGED) and has been provided to the Tribes, BLM, and SHPO for review and comment. FERC typically completes Section 106 by entering into a Programmatic Agreement (PA) or Memorandum of Agreement (MOA) with the licensee, the ACHP, if they choose to participate, and the SHPO that requires the licensee to develop and implement an HPMP. Additionally, FERC requires the licensee to consult with various federal, state, tribal, and non-government parties in the development of any HPMP.

The purpose of an HPMP is to outline actions and processes to manage historic properties within the APE under the new license. It is intended to serve as a guide for the licensee's operating personnel when performing necessary O&M activities and identify resource treatments designed to address potential ongoing and future effects to historic properties. An HPMP should also describe a process of consultation with appropriate state and federal agencies, as well as with Native Americans who may have interests in historic properties within the APE. Following the *Guidelines for the Development of Historic Properties Management Plans for FERC Hydroelectric Projects* issued by FERC and ACHP in 2002 (FERC and ACHP 2002), an HPMP should include: management measures; training for all O&M staff; mechanisms for providing the public interpretive information on cultural resources; and periodic review and revision of the HPMP.

3.11.4 Unavoidable Adverse Impacts

Adverse impacts to historic properties are discussed above in Section 3.11.2. The draft HPMP describes those adverse impacts that cannot be avoided. The HPMP also provides a schedule and plan for managing adverse effects to historic properties caused by Don Pedro Project O&M. The draft HPMP is included herein as an appendix of this Exhibit E and is being filed with FERC as PRIVILEGED.

The purpose of an HPMP is to outline actions and processes to manage historic properties within the APE under the new license. It is intended to serve as a guide for the licensee's operating personnel when performing necessary O&M activities and identify resource treatments designed to address potential ongoing and future effects to historic properties. An HPMP should also describe a process of consultation with appropriate state and federal agencies, as well as with Native Americans who may have interests in historic properties within the APE. Following the Guidelines for the Development of Historic Properties Management Plans for FERC Hydroelectric Projects issued by FERC and ACHP in 2002 (FERC and ACHP 2002), an HPMP should include: management measures; training for all O&M staff; mechanisms for providing the public interpretive information on cultural resources; and periodic review and revision of the HPMP.

3.12 Socioeconomic Resources

The Don Pedro Project is essential to the economic welfare of the central San Joaquin Valley. The Don Pedro Project provides irrigation water to more than 200,000 ac of highly productive farmland, drinking water to residential and business customers, flood flow management, hydropower generation, recreation, and flows for the protection of aquatic resources. The Don Pedro Project also provides important benefits to the Bay Area by virtue of the 570,000 acre-foot "water bank" CCSF acquired by its financial contribution to the construction of the Don Pedro Project. As a part of the relicensing process, the Districts conducted a thorough analysis of the socioeconomic effects of the Don Pedro Project (TID/MID 2014). The primary goals of the Socioeconomics Study were to quantify the baseline economic values and socioeconomic effects of current Don Pedro Project operations. Because the primary purpose of Don Pedro Project is to supply water for regional agriculture, municipal, and industrial water users, any changes in operations may have broad socioeconomic effects well beyond changes to hydropower generation. Information from this analysis is summarized below, and more detailed information is available in the Socioeconomic Study Report (TID/MID 2014).

3.12.1 Existing Environment

The Don Pedro Project has many positive direct and indirect economic effects on the entire regional economy within Stanislaus, Merced, and Tuolumne counties. By providing reliable irrigation water supplies, it directly supports the vibrant agricultural sector which has evolved in the Districts' service areas. And by extension, it indirectly supports the large agribusiness complex that has developed around crop and dairy farm production, including input suppliers, dairy plants, food processing businesses, and many others. The Don Pedro Project also provides reliable M&I water supplies that are essential to meet population and business growth in the area.

The Districts' study of socioeconomics demonstrates the economic strength of the area, including the many people and industries which are directly and indirectly affected by the Don Pedro Project. The Don Pedro Project is shown to be a major economic factor in the region by supporting agriculture and many other industries which provide thousands of jobs and millions of dollars of output and income in the central San Joaquin Valley.

Table 3.12-1 presents a summary of the regional economic effects of the Don Pedro Project. Accounting for both directly supported activities and other forward-linked sectors, it is estimated that the Don Pedro Project supports approximately 18,900 total jobs and $734.8 million in total annual labor income.

Table 3.12-1. Regional economic benefits – summary ($millions per year).[1,2]

Activity	Output ($millions)		Labor Income ($millions)		Employment (Full and Part-Time Jobs)	
	Direct	Total	Direct	Total	Direct	Total
Directly-Supported Activities						
Crop Production	$527.9	$854.2	$171.7	$278.1	4,340	7,270
Recreation Spending	$6.2	$9.7	$1.9	$2.9	80	100
Hydropower	$24.7	$31.2	$7.5	$9.5	30	90
Directly-Supported Sub-total	*$558.9*	*$859.1*	*$181.1*	*$290.5*	*4,400*	*7,500*
Forward Linkages						
Crop Processing	$569.1	$854.9	$87.0	$165.8	1,050	3,020
Crop Processing Subtotal[3]	*$512.6*	*$854.9*	*$87.0*	*$173.4*	*1,050*	*2,870*
Dairy Production	$537.4	$816.7	$23.6	75	2,270	3,630
Dairy Processing	$787.6	$1,143.1	$71.8	156	1,060	3,040
Dairy Subtotal[3]	*$922.1*	*$1,959.8*	*$95.4*	*$231.6*	*3,330*	*6,670*
Cattle Production	$128.1	$233.0	$7.2	23	620	1,220
Cattle Processing	$119.8	$166.0	$11.8	24	270	630
Cattle Subtotal[3]	*$172.9*	*$399.0*	*$19.0*	*$46.9*	*890*	*1,850*
Forward-Linkage Sub-Total	*$1,607.6*	*$3,213.7*	*$201.4*	*$444.3*	*5,300*	*11,400*

Activity	Output ($millions)		Labor Income ($millions)		Employment (Full and Part-Time Jobs)	
	Direct	Total	Direct	Total	Direct	Total
Total Economic Benefits						
Total	**$2,166.4**	**$4,108.8**	**$382.5**	**$734.8**	**9,700**	**18,900**

Source: Cardno ENTRIX (based on IMPLAN modeling)
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI)
[2] Results represent annual effects in three-county study area (Stanislaus, Merced, and Tuolumne counties)
[3] Forward linkage direct output values are adjusted to avoid double counting of crop, dairy, and cattle output that become inputs into a processing sectors (where their value is included in the processing sector output value). For example, $56.5 million of crop output is estimated to be processed in the food and beverage processing sectors, and is included in the $569.1 direct processing output value. The direct additional output due to crop processing is thus $512.6 million ($569.1 million less the $56.5.0 million of crop input.)

3.12.1.1 Agriculture

Agriculture has been, and remains, a very important industry, particularly in Merced and Stanislaus counties. Agriculture has been a foundation industry of the San Joaquin Valley for more than 150 years. Development of surface water supplies encouraged additional land cultivation and helped offset the groundwater overdraft problems that resulted from widespread pumping in many parts of the Valley.

Water supply reliability has been a critical issue for agriculture in the San Joaquin Valley. In this respect, the Don Pedro Project has been crucial to the development, directly, of crop and dairy production in the MID and TID service areas. Water supply reliability has been one of the most important factors supporting the large investments made by farmers in such permanent crops as almonds, peaches, and grapes; and in the dairies which rely on the associated production of corn silage, alfalfa, and other forage crops used in those operations.

Today, crop and livestock operations in the Districts' service areas represent a cornerstone in the regional economy of Stanislaus and Merced counties. In revenue alone, farmers in the Districts' service areas contribute an estimated $1.2 billion annually directly into the local economy, including $527.9 million from crop production and $665.5 million from livestock operation. In addition to supporting about 7,230 on-farm (direct) full and part-time jobs generating an estimated $202.5 million in labor income.

The estimated $1.2 billion in annual gross agricultural production (e.g. crops, dairy and cattle) supported by crops grown with Don Pedro Project water supports an additional $2.9 billion in annual output, taking into account both the industries which support and which are supported by production agriculture. These industries create another 11,670 jobs generating $532.3 million in labor income. Among major employers in Stanislaus and Merced counties, half are directly related to agriculture.

Neither Stanislaus County nor Merced County would have the agricultural strength they have absent the reliable irrigation water supply provided by the Don Pedro Project. Neither county is capable of being served by the SWP or CVP, and groundwater availability and quality are not sufficient to independently support the large, highly productive agricultural land base in the area. Thus, Tuolumne River water provided by the Don Pedro Project has been critical to the success of agriculture.

In 2011, Merced and Stanislaus counties were the fifth and sixth largest counties in California as measured by gross value of agricultural production (Table 3.12-2).[73] Together, they contributed $6.5 billion in gross value, 12.3 percent of total gross value for the state, with a significant portion of this production coming from land irrigated with water supplies provided by MID and TID.

The Districts have key roles in the agricultural economies of Stanislaus and Merced counties and the entire San Joaquin Valley. Through the Don Pedro Project, the Districts have provided highly reliable water supplies to their customers. With these reliable supplies, growers and producers have invested heavily in high-value perennial crops, such as almonds and peaches, as well as dairy production. The consistent, high value of agricultural output has, in turn, resulted in a large complex of agricultural support industries being developed in the area. With those supplies, the two counties are regularly among the top 10 most productive agricultural counties in California.

3.12.1.2 Municipal and Industrial Use

In addition to agriculture, the Don Pedro Project supplies water to M&I users in both Districts. M&I water demands trace directly to the economic development and job creation characterizing the area. In addition to those presently served, several municipalities within Stanislaus County are seeking Don Pedro Project water as a substitute for groundwater supplies. In addition, the CCSF, through its water bank credits in the Don Pedro Reservoir, is able to reliably deliver Hetch Hetchy water supplies to 26 water agencies in the Bay Area, serving 2.6 million people.

The value of M&I water supplies is less easily estimated than that for agriculture. Farm profit is the difference between gross production value and costs, aggregated over all crops. The value of M&I supplies is not directly measurable and such measurement instead requires estimates of the costs of alternative supplies. Those alternatives may include groundwater, desalination, recycling, or transfers from other areas. Based on those alternatives, Don Pedro M&I water values range from $143 per AF (for groundwater pumping[74]) to $700 per AF, reflecting the estimated willingness to pay by the SFPUC for municipal water supplies.

3.12.1.3 Recreation

In addition to consumptive agricultural and M&I water uses, the Don Pedro Reservoir provides unique recreational opportunities in designated recreation areas managed by DPRA. Annual visitation to the reservoir is in the hundreds of thousands, whose expenditures benefit the entire regional economy. At current estimates of 378,000 visitor days per year, the economic value of recreation to participants is between $19.8 million and $25.4 million per year. Table 3.12-2 lists visitor use of the Don Pedro Reservoir for 2010–2012.

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[73] Gross value represents the product of price and quantity for farm products as they leave the farms where they are produced. It does not represent net income, which incorporates farm expenses.

[74] Includes both fixed (capital) and variable (operating) costs associated with groundwater pumping.

Table 3.12-2 presents the regional economic benefits generated by recreation spending by visitors to Don Pedro Reservoir. The approximate $10 million in recreation spending is estimated to generate about $6.2 million in direct output at local businesses and $9.7 million in total output across all industries on an annual basis. In addition, total labor income and jobs supported by recreation spending totals about $2.9 million per year and 100 total full and part-time jobs.

Table 3.12-2. Regional economic benefits – recreation visitation at DPRA ($millions).[1,2]

Metric	Direct	Indirect	Induced	Total
Output ($millions)	$6.2	$1.8	$1.7	$9.7
Labor Income ($millions)	$1.9	$0.5	$0.5	$2.9
Employment (full and part-time jobs)	80	10	10	100

[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
[2] Results represent regional effects in three-county study area (Stanislaus, Merced, and Tuolumne counties).
Source: TID/MID 2014 (based on IMPLAN modeling).

3.12.1.4 Hydropower Generation

Another of the important benefits which the Don Pedro Project provides is hydroelectric generation. Since 1997, the facility has provided an average of 550,000 MWh of clean, low cost energy per year (1997-2016). It is used by MID and TID to serve 21 communities in their combined service areas. About 80 percent of the electrical accounts are residential or commercial and industrial, with agriculture, municipal, and street lighting, and other types making up the remainder.

MID provides electrical service to seven communities in Stanislaus and San Joaquin counties, comprising about 114,000 accounts in a service territory of 560 mi^2. The composition of those accounts is shown in Table 3.12-3.

Table 3.12-3. MID customer accounts, by type of account.

Type of Account	No. of Accounts	Percent of Accounts
Residential	94,119	82.6%
Commercial	12,265	10.8%
Industrial	157	0.1%
Agricultural	1,819	1.6%
Other	5,571	4.9%
Total	113,931	100.0%

Source: MID 2013.

TID serves 100,345 accounts across 14 communities in a service area of 662 mi^2 in Stanislaus, Merced, Tuolumne, and Mariposa counties. The communities served include Ballico, Ceres, Crows Landing, Delhi, Denair, Diablo Grande, Hickman, Hilmar, Hughson, Keyes, La Grange, Patterson, South Modesto, and Turlock. The composition of those accounts is shown in Table 3.12-4.

Table 3.12-4. TID customer accounts, by type of account.

Type of Account	No. of Accounts	Percent of Accounts
Residential	72,033	72%
Municipal/street lighting	16,367	16%
Commercial	6,983	7%
Agricultural	2,508	2%
Other	1,656	2%
Industrial	798	1%
Total	**100,345**	**100%**

Source: TID 2013.

The output and price data used to estimate hydropower output values are shown in Table 3.12-5. As shown, output varied considerably over the five years from 2008 to 2012, with peak production in 2012 at more than 1.0 billion kilowatt-hour (kWh); and the minimum in 2009, at about 340 million kWh. Over the same period, electricity prices varied from a peak of $0.085 per kWh in 2008 to a minimum of $0.032 per kWh in 2012, with an average price of $0.047 per kWh (in 2012 dollars). As shown, the five-year average value of hydropower generation supported by the Don Pedro Project is approximately $26.9 million annually.

Table 3.12-5. Value of hydropower generation, Don Pedro Hydroelectric Plant, 2008–2012.[1]

Year	Output (kWh)	Price/Value ($/kWh)[2]	Total Value
2008	399,858,940	$0.085	$33,947,361
2009	339,501,259	$0.042	$14,174,961
2010	364,964,701	$0.042	$15,352,087
2011	715,749,872	$0.037	$26,220,584
2012	1,013,360,425	$0.032	$32,447,801
Average (5 Year)	**556,687,039**	**$0.047**	**$26,902,782**

[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
[2] Prices are annual average day ahead on-peak prices.
Sources: TID/MID 2017, FERC 2013.

3.12.1.5 Land Values

Land values, particularly agricultural land values, are affected by the availability and reliability of affordable water and electricity from the Don Pedro Project. Irrigators who have access to reliable water supplies, other factors equal, will be more profitable than those who do not have such access. The availability of reliable water supplies at reasonable cost is capitalized into land values because those values frequently reflect the stream of net income available from the land; and because net income is higher, other factors being equal, with lower water prices.

Land values in the Districts' service areas have been relatively stable despite the economic recession, the effects of which have been offset by high crop prices, low interest rates, and available water supplies. Currently, cropland in the Districts' service areas is valued from 30 to 50 percent higher than similar cropland in other districts served by both surface water and groundwater. The land valuation is important in supporting the decisions by irrigators to invest in permanent and other high value crops that account for such a large part of overall agricultural value in the area.

Overall, there appears to be a clear premium on land values in the Districts' service areas compared to other nearby regions with access to surface or groundwater supplies. The land value differential is more dramatic when compared to rangeland without water supplies. Irrigated land values in the Districts' service areas are five to 15 times greater than rangeland values, demonstrating the value added by reliable water supplies for agricultural production. However, there are likely a number of factors other than water supplies that also drive land values in the region, such as soil quality and proximity to urban centers and infrastructure. Therefore, it is not reasonable to attribute the land value premium solely to water supplies. However, it is clear that high quality, reliable surface water supplies provided by the Don Pedro Project have a positive influence on land values. Table 3.12-6 shows regional land values from 2007 to 2011.

Table 3.12-6. Regional land values, 2007–2011.[1]

Region/Land Use	Land Value ($/acre)		
	Low	**High**	**Average**
Merced County			
Cropland: TID	**$15,870**	**$22,410**	**$19,140**
Cropland: Well Water (ENID & CWD)	$5,290	$10,580	$7,930
Cropland: Merced ID	$10,170	$19,290	$14,730
Cropland: Westside, Exchange Contractors	$5,700	$10,300	$8,000
Cropland: Westside, Federal and Other	$3,700	$5,820	$4,760
Permanent Cropland: Almonds	$12,690	$22,430	$17,560
Permanent Cropland: Walnuts	$12,450	$21,320	$16,880
Rangeland: West County	$530	$1,270	$900
Rangeland: East County and Mariposa County	$740	$1,670	$1,210
Stanislaus County			
Cropland: MID and TID	**$16,500**	**$26,040**	**$21,270**
Cropland: Non-Federal Water (Westside, incl. Gustine)	$10,000	$15,000	$12,500
Cropland: Well Water and Federal (Westside)	$8,170	$12,910	$10,540
Cropland: Well and OID (Eastside)	$10,370	$17,350	$13,860
Permanent Cropland: Almonds (MID and TID)	**$17,760**	**$28,160**	**$22,960**
Permanent Cropland: Almonds (Minor Irrigation Districts and Wells)	$15,020	$20,500	$17,760
Permanent Cropland: Walnuts	$14,560	$24,530	$19,540
Permanent Cropland: Cling Peaches	$15,230	$23,080	$19,160
Permanent Cropland: Wine Grapes (District 12)	$13,990	$20,980	$17,480
Rangeland: Westside	$1,060	$1,900	$1,480
Rangeland: Eastside and Tuolumne County	$1,940	$4,570	$3,250

[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
ENID = El Nido Irrigation District
CWD = Chowchilla Water District
OID = Oakdale Irrigation District
Source: California Chapter of the American Society of Farm Managers and Rural Appraisers, 2012.

3.12.2 Resource Effects

Page 38 of FERC's SD2 identifies the following issues associated with socioeconomic resources:

- The socioeconomic effects of any proposed measures to change Don Pedro Project operations on affected governments, residents, agriculture, businesses, and other related interests.

- Water supply effects on San Francisco Public Utility Commission retail and wholesale customers that would result if the CCSF were required to provide additional water to the Districts to support a change in operation for environmental mitigation.

Section 5.0 of this Exhibit E includes analysis of the Preferred Plan as well as alternatives proposed by others as does the report Regional Economic Impact Caused by a Reduction in Irrigation Water Supplied to Turlock Irrigation District and Modesto Irrigation District included in Attachment C to this AFLA. The socioeconomic resources of the Bay Area are not analyzed in detail as a part of this Exhibit.[75]

3.12.3 Proposed Resource Measures

No measures that specifically address socioeconomic resources are proposed.

3.12.4 Unavoidable Adverse Impacts

The Don Pedro Project has no known unavoidable adverse effects on socioeconomic resources.

[75] CCSF prepared an independent study on the potential socioeconomic effects of potential changes in Don Pedro Project operations entitled *Socioeconomic Impacts of Water Shortages within the Hetch Hetchy Regional Water System Service Area.*

4.0 CUMULATIVE EFFECTS OF THE PROPOSED ACTION

According to the Council on Environmental Quality's regulations for implementing the National Environmental Policy Act (NEPA) (50 CFR §1508.7), cumulative effects on a resource are the result of the combined influence of past, present, and reasonably foreseeable future actions within a specified geographical range (FERC 2008), regardless of what agency (federal or non-federal) or person undertakes such actions. Cumulative effects may be beneficial or adverse.

Resources of the Tuolumne River may be cumulatively affected by individually minor but collectively significant actions taking place over a period of time. Activities contributing to cumulative effects on resources in the Tuolumne and San Joaquin rivers include hydropower operations, water storage and diversions for irrigation and M&I water supply, historical and ongoing gravel and gold mining, dredging operations, riparian diversions, urbanization, other land and water development activities, the introduction of non-native species to the watershed, channel modification by levees and for shipping, recreation, flood control operations, wastewater treatment plant discharges, climate change, and a host of other potential activities.

Based on scoping meetings, comments FERC received during scoping, and information in the PAD, FERC identified the resources having the potential to be cumulatively affected by the Proposed Action: (1) geomorphology, (2) water resources, (3) aquatic resources including anadromous fish and habitat, and (4) socioeconomic resources. For water resources, aquatic resources, anadromous fish and their essential habitat, and socioeconomics, FERC defined the geographic scope as extending from Hetch Hetchy Reservoir to San Francisco Bay. For geomorphology, the geographic scope extends only to the confluence of the Tuolumne and San Joaquin rivers. The temporal scope includes past and present actions and reasonably foreseeable actions that could occur over the next 30 to 50 years. Actions potentially contributing to cumulative effects to the identified resources are described in Section 4.1, and the cumulative effects of these actions are addressed, by resource, in sections 4.2 through 4.5.

The Don Pedro Project provides water storage for irrigation and municipal and industrial (M&I) use, flood control, hydroelectric generation, recreation, and natural resource protection (hereinafter, the "Don Pedro Project"). The environmental analysis contained in this Exhibit E considers all the components, facilities, operations, and maintenance that make up the Don Pedro Project. The Don Pedro Project was constructed for the following primary purposes: (1) to provide water supply the Districts, for irrigation of over 200,000 ac of Central Valley farmland and for M&I use, (2) to provide flood control benefits along the Tuolumne and San Joaquin rivers, and (3) to provide a water banking arrangement for the benefit of the CCSF and the 2.6 million people CCSF supplies in the Bay Area.[76] The original Project license was issued in 1966. In 1995, the Districts entered into an agreement with a number of parties which resulted in the release of greater flows to the lower Tuolumne River for the protection of aquatic resources.

[76] The Project contributes substantially to the water supplies of the City of Modesto (population: 210,000) and 2.6 million people in the San Francisco Bay Area. The CCSF contributed financially to the construction of the Don Pedro Project in exchange for water banking privileges that benefit CCSF's Bay Area water customers. Protecting the primary purpose of the Don Pedro Project--providing reliable water supplies, especially during drought periods--is essential not only to the welfare and economies of the Districts' service territory, but to the Central Valley region and the Bay Area.

Hydroelectric generation is a secondary purpose of the Don Pedro Project. Hereinafter, the hydroelectric generation facilities and operations will be referred to as the "Don Pedro Hydroelectric Project", or the "Project." With this license application to FERC, the Districts are seeking a new license to continue generating hydroelectric power. Based on the information contained in this application, and other sources of information on the record, FERC will consider whether, and under what conditions, to issue a new license for the continued generation of hydropower at the Districts' Don Pedro Hydroelectric Project. The Districts are providing a complete description of the facilities and operation of the Don Pedro Project so the effects of the operation and maintenance of the Don Pedro hydroelectric facilities can be distinguished from the effects of the operation and maintenance activities of the overall Don Pedro Project's flood control and water supply/consumptive use purposes.

Being able to differentiate the effects of hydropower operations from the effects of the flood control and consumptive use purposes and needs of the Don Pedro Project allowed the Districts to identify reasonable and prudent resource measures for the lower Tuolumne River, as described in Section 2.2 and discussed in sections 3, 4, 5, and 6 of this Exhibit E. As FERC states in SD2 in a discussion related to alternative project operation scenarios: "…alternatives that address the consumptive use of water in the Tuolumne River through construction of new structures or methods designed to alter or reduce consumptive use of water are…alternative mitigation strategies that could not replace the Don Pedro *hydroelectric* [emphasis added] project. As such, these recommended alternatives do not satisfy the NEPA purpose and need for the Proposed Action and are not reasonable alternatives for the NEPA analysis."

4.1 Actions In and Outside of the Tuolumne River Basin

4.1.1 Summary of the Chronology of In-Basin and Out-of-Basin Actions

In accordance with the requirements of cumulative effects assessments provided under NEPA, the initial step of performing the analysis is to identify significant past, present, and foreseeable future actions that potentially contribute to cumulative effects to the target resources. The Tuolumne and San Joaquin river basins have been affected by substantial resource management and land and water use activities over the past 150 years. Table 4.1-1 summarizes a chronology of the in-basin and out-of-basin actions that are likely to contribute to cumulative effects to the four resource areas identified in FERC's SD2. The information available to describe and address each of these actions varies greatly, ranging from very little (e.g., commercial and sport salmonid harvest in the early to mid 1900s) to volumes of studies (e.g., recent studies of salmonid juvenile and smolt survival studies in the Delta). A map of the San Joaquin River basin and Delta is provided in Figure 4.1-1.

Table 4.1-1. Chronology of actions in the San Joaquin River Basin and Delta contributing to cumulative effects.

Action	Date
Dams, Diversions, Flow Regulation	
Tuolumne River Basin	
Wheaton Dam	1871
La Grange Mining Ditch (Indian Bar Diversion)	1871
Phoenix Dam	1880

Action	Date
La Grange Diversion Dam	1893
Modesto Reservoir	1911
Turlock Lake	1914
Eleanor Dam	1918
Old Don Pedro Dam	1923
O'Shaughnessy Dam (Hetch Hetchy)	1923
Priest Dam	1923
Early Intake	1924
Dennett Dam	1933
Hetch Hetchy Aqueduct completed; exports to San Francisco begin	1934
O'Shaughnessy Dam raised	1938
Cherry Lake	1956
Pine Mountain Dam	1969
New Don Pedro Dam	1971
Riparian water diversions along the Lower Tuolumne River	1870s – present
San Joaquin River Basin and Delta (excluding Tuolumne River)	
Central Valley Project	
Friant Dam	1942
Madera Canal	1945
Friant-Kern Canal	1951
Jones Pumping Plant	1951
Delta-Mendota Canal	1951
Delta Cross-Channel	1951
Hidden and Buchanan Projects	1962
San Felipe Division	1964 – 1987
Los Banos Detention Dam	1965
Little Panoche Detention Dam	1966
B.F. Sisk Dam	1967
O'Neill Pumping Plant	1967
William R. Gianelli Pumping-Generating Plant	1967
State Water Project	
Harvey O. Banks Pumping Plant	1968
Edmonston Pumping Plant	1971
Pyramid Dam	1973
Castaic Dam	1973
San Luis Drain	Halted in 1975
Warne Powerplant	1982
New Melones Dam	1983
Alamo Powerplant	1986
Coastal Branch Aqueduct	1997
Upper San Joaquin River	
Mendota Dam	1871
Sack Dam	Seasonal 1870s – 1946
Merced River Basin	
Robla Canal Company begin diverting Merced River	1870
Merced Canal and Irrigation Company forms	1883
Merced Falls Diversion Dam	1901
Crocker-Huffman Dam	1910
Exchequer Dam	1926
New Exchequer Dam	1967
Stanislaus River Basin	
Big Dam	1856

Action	Date
Herring Creek, Upper Strawberry, and Lower Strawberry reservoirs	1856
Lyons Reservoir	1898
Sand Bar Diversion Dam	1908
OID/SJID purchase Tulloch water rights/distribution system	1910
Relief Dam	1910
Goodwin Dam	1913
Philadelphia Diversion Dam	1916
Lower Strawberry Reservoir	1917
Old Melones Dam	1926
Spicer Meadow Dam	1929
Lyons Reservoir enlarged	1930
Tri-Dam Project (Donnells, Beardsley, and Tulloch dams)	1958
New Melones Dam (also in CVP section)	1983
New Spicer Dam	1989
In-Channel and Floodplain Mining	
Tuolumne River Basin	
Placer mining	1848 – 1890
Hydraulic mining (La Grange)	1871 - c.1900
Dredge mining of the Lower Tuolumne River (gold)	1908-1942, 1945-1951
Gravel and aggregate mining of the Lower Tuolumne River	1940s to present
San Joaquin River Basin and Delta (excluding Tuolumne River)	
Sand and gravel mining from Bay floor shoals begins	1915
Channel Alteration	
Begin large-scale construction of levees in San Joaquin River basin and Delta	1850s
Stockton Deep Water Ship Channel	1930s
San Joaquin River and Tributaries Project (> 100 miles of levees and bypasses)	1950s - 1960s
Non-Native Fish Species	
18 fish species introduced in Tuolumne River basin by state/federal agencies	1874 – 1954
4 additional fish species introduced in Tuolumne River basin	After 1954
Hatchery Practices	
CDFW begins stocking fish in the inland waters of California	Late 1800s
CDFW begins large-scale supplementation of anadromous fish stocks	1945
California's hatcheries at times use out-of-basin broodstocks/move fry to other basins	Before 1980s
Salmon from Central Valley hatcheries released in San Francisco Bay	Ongoing
Commercial and Sport Harvest	
Commercial salmon fishing begins in California	Early 1850s
Gill net salmon fisheries well established in lower San Joaquin River	1860
Well-developed canning industry (20 canneries)	1880
12 million pounds of salmon landed and processed	1882
Ocean troll fishery dominates harvest	1917
Last inland cannery shutdown due to decline of inland fishery	1919
Last commercial river salmon fishery closed in Sacramento-San Joaquin basin	1957
Agriculture, Livestock, and Timber Harvest	
Timber operations begin in upper watersheds	Mid 1800s to present
Large-scale agriculture and livestock grazing begins in region	Mid 1800s to present
Urban Development	
Within Tuolumne River watershed and downstream	Mid 1800s to present
San Francisco Bay Area (Hetch Hetchy diversions)	1934 to present
MID M&I deliveries	1995 to present
Climate Change	
Changes in global climate and weather patterns	Ongoing

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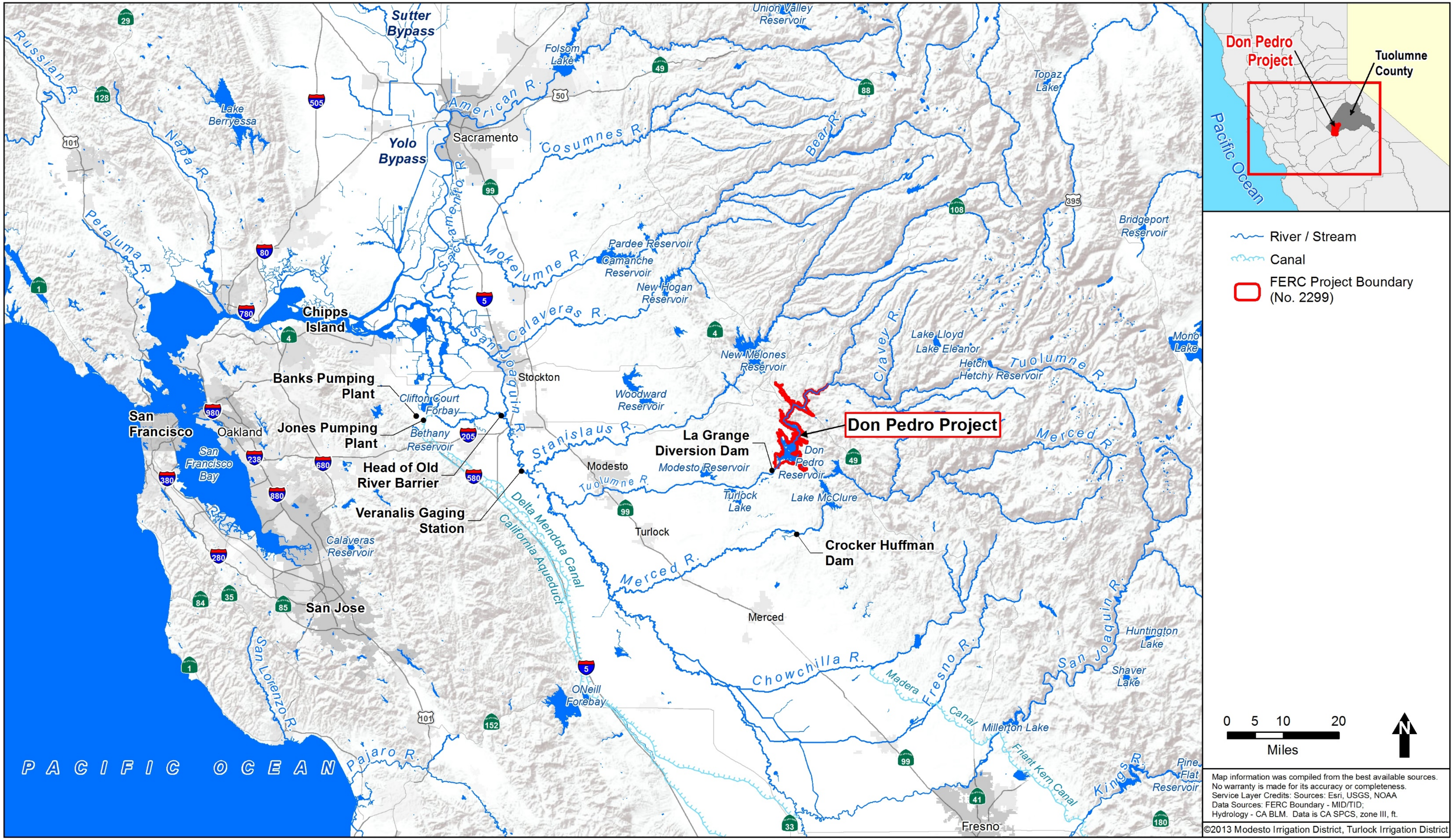

Figure 4.1-1. Map of the San Joaquin River basin and Delta.

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Don Pedro Hydroelectric Project

4.1.1.1 Proposed Action

The Proposed Action under review by FERC is the issuance of a new license to the Districts to authorize the continued generation of hydroelectric power at Don Pedro Dam and implementation of the measures proposed by the Districts to enhance resource values in and downstream of the Project area. As such, and as described in FERC's SD2 issued on July 25, 2011, any measures proposed to mitigate the Project's effects must be reasonably related to the purpose and need for the Proposed Action, which in this case is whether, and under what terms, to authorize the continuation of hydroelectric power generation at the Don Pedro Hydroelectric Project. As described in Section 2.2 and discussed in sections 3–6 of this Exhibit E, the Districts are proposing a suite of resource measures, which includes modifications to the existing lower Tuolumne River flow schedule for the enhancement of fish and aquatic resources and provide opportunities for recreational boating.

Under the current license, flow releases through the powerhouse from Don Pedro Reservoir are scheduled based on requirements for (1) flood flow management, including pre-releases in advance of anticipated high flows during wet years, (2) the Districts' irrigation and M&I demands, including flows to maintain water storage in Turlock Lake and Modesto Reservoir, and (3) protection of aquatic resources in the lower Tuolumne River in accordance with the terms of the FERC license. Once the weekly and daily flow schedules are established based on these demands, outflows from the Don Pedro powerhouse are scheduled to deliver these flows. During periods of on-peak electrical demand, daily outflows may be shaped to generate more electricity during on-peak periods and less during off-peak periods, subject to meeting the requirements of the pre-established flow schedule and the physical constraints of the Districts' irrigation systems. In accordance with the Districts' "water-first" policy, flow releases are scheduled around the three requirements listed above, then delivered via the generation units up to their capacity and availability. Hydroelectric generation at the Don Pedro Project is a secondary consideration with respect to flow scheduling. Under the new Project license, flow scheduling would continue to be conducted as it is under the existing license, except for proposed modifications aimed at the enhancement of fish and aquatic resources and enabling recreational boating in the lower Tuolumne River.

Issuance of a new FERC license will allow the Districts to continue generating electricity at the Project for the term of the new license, producing low-cost electric power from a non-polluting, renewable resource. Clean, renewable hydropower generation is a valuable benefit of the Project. The average annual generation from the Project from 1997 to 2012 was 622 million kilowatt hours (kWh) of electricity. The current maximum hydraulic capacity of the four turbines is approximately 5,500 cfs, and the current FERC-authorized capacity is 168 MW.

The electricity generated at the Project is important to the State of California. The California Energy Commission (CEC) issued an Updated California Energy Demand Forecast 2011–2022 in May 2011. The report presented an update to the 2009 California Energy Demand electricity forecast adopted for the 2009 Integrated Energy Policy Report in December 2009. The updated forecast was meant to provide the CEC's best estimate of the effect of economic conditions on energy demand since the 2009 forecast was published. The updated forecast presents low, mid, and high forecasts for the state; average annual growth rates for consumption for 2010–2022 are 1.13 percent, 1.28 percent, and 1.53 percent, respectively (CEC 2011).

4.1.1.2 Independent Primary Purposes of the Don Pedro Project

Water storage and releases for the Don Pedro Project's primary purposes, i.e., irrigation, M&I uses, the CCSF's water bank, and flood control in cooperation with the ACOE, are not dependent on the issuance of a FERC license for the Project, and will occur with or without the licensing of the hydroelectric project. As such, these uses are not interrelated or interdependent with the issuance of a FERC license for hydroelectric power generation. Because the Districts are seeking a license to permit the Proposed Action, and power would be generated as it has been historically (i.e., the Proposed Action would be equivalent to the environmental baseline as defined by FERC, and there would be no effects on the lower Tuolumne River, as explained below), the non-hydropower water uses are independent actions. These independent actions contribute to cumulative effects in the Tuolumne and San Joaquin river basins but do not constitute direct or indirect effects associated with the Proposed Action.

4.1.1.3 Don Pedro Dam and Reservoir

Don Pedro Dam is a 1,900-ft-long and 580-ft-high, zoned earth and rockfill structure. The top of the dam is at 855 ft (NGVD 29). Don Pedro Reservoir extends upstream for approximately 24 miles at its normal maximum water surface elevation of 830 ft. The tailwater elevation at the outlet works tunnel is approximately 300 ft. Under normal operations of the hydroelectric units, the powerhouse tailwater elevation varies from about 300 ft to about 305 ft. Water levels in Don Pedro Reservoir have exceeded the normal maximum water level of 830 ft only once since Don Pedro Project construction, i.e., in early January 1997.

4.1.1.4 Timing and Magnitude of Flow Releases

As noted above, water is generally provided from Don Pedro Reservoir for only three reasons: (1) to provide water needed to meet the Districts' irrigation and M&I demands, (2) for flood management purposes, and (3) to provide flows required by the Project license for the benefit of aquatic resources in the lower Tuolumne River. In general, reservoir operations follow a relatively consistent annual cycle of water management for flood control, capturing runoff from snowmelt and seasonal rainfall, and delivery of water to serve the purposes identified above. Don Pedro Project operations must consider potential water availability over the course of multiple years, so that even in drier years the reservoir can retain a water supply that is sufficient to provide for consumptive use and resource protection.

Flows released at Don Pedro Dam to meet the Districts' irrigation and M&I water demands are all diverted from the Tuolumne River at La Grange Diversion Dam to the TID and MID canal systems. The Districts possess senior water rights in the Tuolumne River. Diversions for irrigation purposes can occur year-round, but generally occur from late February to early November. From 1971 to 2012, the average annual water diversion at La Grange Diversion Dam to the Districts' canals was approximately 900,000 AF for irrigation and M&I purposes.

ACOE guidelines call for making 340,000 AF of storage available in Don Pedro Reservoir for management of high-flow conditions. The ACOE contributed financially to the construction of Don Pedro Dam to acquire this flood reservation. Flows released at Don Pedro Dam to comply with the ACOE flood management guidelines consist of both pre-releases in anticipation of high runoff and releases during periods of high runoff. Both of these release scenarios occur to balance reservoir levels, forecasted runoff, and downstream flows. "High" river flows can be defined as any flows released that are greater than those needed for irrigation and M&I purposes and protection of aquatic resources. Flow releases for high-flow management may occur from November to July, and from February to July these releases must also consider water supply needs for consumptive use purposes. High flows in the Tuolumne River upstream of the Don Pedro Project are affected by operation of CCSF's Hetch Hetchy system.

The resulting water elevations and water velocities in the lower Tuolumne River during high-flow releases are affected by past and present in-channel and floodplain mining, levee construction and maintenance, agricultural development on the floodplain, and urban development and encroachment, particularly in the Modesto area.

In addition to flood storage reservation within the reservoir, downstream flow restrictions also affect Don Pedro Project operations from a flood management perspective. The primary downstream flow guideline cited in the 1972 ACOE Flood Control Manual is that flow in the Tuolumne River at Modesto (as measured at the 9th Street Bridge) should generally not exceed 9,000 cfs. Flows in excess of 9,000 cfs have the potential to cause significant damage to property in this reach of the Tuolumne River, while also potentially contributing to flood flows in the San Joaquin River. If a large volume of water that could result in releases higher than 9,000 cfs is forecasted, pre-flood releases may be made at Don Pedro Dam to reduce the risk of having to release greater flows at a later time.

Between La Grange Diversion Dam and 9th Street in Modesto, the single largest contributor of local flow to the Tuolumne River is Dry Creek. The Dry Creek watershed has its headwaters in the foothills just northwest of the Don Pedro Project. It is a flashy watershed, and once its soil is saturated rainfall events can result in rapid runoff. High flows, about 6,000 cfs or higher, can occur when significant rainfall occurs between Modesto and the upper end of the Dry Creek watershed. Because Dry Creek flows enter the Tuolumne River upstream of the USGS's 9th Street gage, they must be taken into account when making releases from Don Pedro Reservoir to the lower river to avoid exceeding the 9,000 cfs limit.

CCSF also contributed financially to the construction of the current Don Pedro Dam. In return for this financial participation, CCSF obtained up to 570,000 AF of water banking privileges in Don Pedro Reservoir, which has allowed CCSF to improve water supply management for its Bay Area water users. CCSF pre-releases water from its upstream facilities into the water bank in Don Pedro Reservoir so at other times it can hold back an equivalent amount of water that would otherwise have to be released to satisfy the Districts' senior water rights. Once the water enters Don Pedro Reservoir, it belongs to the Districts, which then have unrestricted entitlement to its use.

The FPC's 1964 decision set normal-year flow releases of 123,210 AF from the Don Pedro Project for fish protection during the first 20 years of the Don Pedro Project's existence. The decision also required the Districts to conduct studies that could be used to develop future fisheries requirements. FERC's 1996 order (FERC 1996) amending the Don Pedro Project license required the incorporation of the lower Tuolumne River minimum flow provisions contained in the 1995 Settlement Agreement between the Districts, CCSF, resource agencies, and environmental groups. The revised minimum flows in the lower Tuolumne River vary from 50 to 300 cfs depending on water year hydrology and time of year. The water year classifications are re-calculated each year to maintain approximately the same frequency distribution of water year types.

Under the existing FERC license, certain pulse flows are required for the benefit of upstream migrating adult salmon and downstream migrating juvenile salmon, the volume of which varies with water year type. The downstream flow schedule provided for by the settlement agreement and subsequent FERC order is shown in Table 4.1.-2. Under certain circumstances, the Districts and CCSF share responsibility for meeting FERC license requirements in the lower Tuolumne River downstream of the Don Pedro Project.

As described in Section 2.2 and discussed in sections 3-6 of this Exhibit E, the Districts are proposing a suite of resource measures, including a new lower river flow schedule, for implementation over the term of the new FERC license. The proposed flow regime includes modifications of the existing pulse flow protocol, as described in sections 2.2, 3.4, 3.5, and 4 of this Exhibit E.

4.1.1.5 Hydroelectric Power Production

As noted in Section 4.1.2.1, electric power is generated at the Don Pedro Project using flows released to satisfy the Don Pedro Project's independent, primary purposes (i.e., irrigation and M&I releases and flood management) and to provide flows to the lower Tuolumne River for the benefit of aquatic resources. Water deliveries and high-flow releases are pre-scheduled based on forecasted demands and actual projected inflows and then released through the powerhouse up to its hydraulic capacity. Scheduling of these releases is shaped, consistent with water supply requirements and physical constraints of the Districts' irrigations systems, to release flows with a preference for on-peak rather than off-peak hours during periods of high electrical demand.

4.1.1.6 Other Don Pedro Project-Related Actions

Recreation and Shoreline Protection at Don Pedro Reservoir

Don Pedro Reservoir is a popular recreation location providing about 400,000 user-days of recreation each year to mostly local and regional users. Recreation at the Don Pedro Project is well-managed and limited to the reservoir proper. The Districts' land use policy, implemented through the DPRA, prohibits shoreline disturbances such as dredging, docks, moorings, piers, or developed improvements of any kind. DPRA rules prohibit all off-road vehicle use on Don Pedro Project lands and restrict motorized boat access to designated boat launches. These and other rules ensure that over 90 percent of the reservoir shoreline remains in its natural condition.

Recreational activities and facilities associated with the Don Pedro Project are independent of the Proposed Action, i.e., they will occur even in the absence of hydroelectric generation.

Herbicide and Pesticide Applications near Don Pedro Reservoir

The DPRA applies herbicides to certain areas in the Don Pedro Project area. Pre- and post-emergent herbicides are used to treat invasive plants at campsite pads and road edges. Other areas treated with herbicides include locations surrounding wastewater treatment facilities, wastewater ponds, shoreline trails and firebreaks, immediate areas around DPRA structures, immediate areas around shoreline restrooms, and semi-developed dispersed camping pads. Although rarely used, DPRA sometimes applies a rodenticide in early spring or late fall to control ground squirrels around developed recreation facilities. Application of these herbicides and rodenticide is independent of the Proposed Action, i.e., it will occur even in the absence of hydroelectric generation.

Table 4.1-2. Schedule of flow releases from the Don Pedro Project to the lower Tuolumne River by water year type contained in FERC's 1996 order.

Schedule	Units	# of Days	Critical and Below	Median Critical[1]	Interm. CD	Median Dry	Interm. D-BN	Median Below Normal	Interm. BN-AN[1]	Median Above Normal	Interm. AN-W	Median Wet/Max
Occurrence	%		6.4%	8.0%	6.1%	10.8%	9.1%	10.3%	15.5%	5.1%	15.4%	13.3%
October 1-15	cfs	15	100	100	150	150	180	200	300	300	300	300
	AF		2,975	2,975	4,463	4,463	5,355	5,950	8,926	8,926	8,926	8,926
Attraction Pulse	AF		none	none	None	none	1,676	1,736	5,950	5,950	5,950	5,950
October 16-May 31	cfs	228	150	150	150	150	180	175	300	300	300	300
	AF		67,835	67,835	67,835	67,835	81,402	79,140	135,669	135,669	135,669	135,669
Outmigration Pulse Flow	AF		11,091	20,091	32,619	37,060	35,920	60,027	89,882	89,882	89,882	898
June 1-Sept 30	cfs	122	50	50	50	75	75	75	250	250	250	250
	AF		12,099	12,099	12,099	18,149	18,149	18,149	60,496	60,496	60,496	60,496
Volume (total)	AF	365	94,000	103,000	117,016	127,507	142,502	165,003	300,923	300,923	300,923	300,923

[1] Between a Median Critical Water Year and an Intermediate Below Normal-Above Normal Water Year, the precise volume of flow to be released by the Districts each fish flow year is to be determined using accepted methods of interpolation between index values.

Source: FERC 1996.

4.1.2 Non-Don Pedro Project In-Basin Actions

The first dam built on the Tuolumne River, Wheaton Dam, was constructed in 1871 near the current location of La Grange Diversion Dam at approximately RM 52.2. There are currently a number of dams in the mainstem Tuolumne River and its tributaries, some of which are used for storage and others that are primarily diversion dams. Table 4.1-3 lists the owners of the dams in the Tuolumne River basin and the capacities of their associated impoundments, if known. Table 4.1-4 provides information on known hydropower facilities in the Tuolumne River basin, including both small and conventional hydroelectric generation facilities. Completion dates for select impoundments are also provided in Table 4.1-3.

Table 4.1-3. Owners and capacities of dams or diversion facilities and their associated reservoirs in the Tuolumne River basin.

Owner	FERC Project No.	Stream	Dam or Diversion Dam	Reservoir or Impoundment Name (date completed)	Capacity (AF)
CCSF	None	Tuolumne River	O'Shaughnessy Dam / diversion to Mountain Tunnel	Hetch Hetchy Reservoir (1923)	360,360 (USGS 1999)
CCSF	None	Eleanor Creek	Eleanor Dam	Lake Eleanor (1918)	26,146 (USGS 1999)
CCSF	None	Cherry Creek	Cherry Dam	Cherry Lake (1956)	274,2520 (USGS 1999)
CCSF	None	Tuolumne River	Early Intake (facility only used by CCSF for infrequent diversion from Cherry watershed)	n/a (1924)	<100
CCSF	None	Off-stream	Priest Dam	Priest Forebay (1923)	1,500
CCSF	None	Off-stream (Moccasin Creek and all local runoff diverted under or around impoundment)	Moccasin Dam	Moccasin Afterbay	Approx. 500
Private	None	Big Creek	Pine Mountain Dam	Pine Mountain Lake (1969)	7,700 (USGS 1999)
Private	None	Sullivan Creek (receives diversion from SF Stanislaus River)	Phoenix Dam	Phoenix Lake (1880)	612 (USGS 1999)
TID MID	2299	Tuolumne River	Don Pedro Dam	Don Pedro Reservoir	2,030,000
TID MID	None	Tuolumne River	La Grange Diversion Dam	La Grange headpond	100
MID	None	Off-stream	Modesto Reservoir Dam	Modesto Reservoir (1911)	28,000
TID	None	Off-stream	Turlock Lake Dam	Turlock Lake (1914)	48,000
TID	None	Off-stream	Dawson Dam	Dawson Lake	< 100

Source: USGS 1999; CCSF 2006.

Table 4.1-4. Hydropower generation facilities in the Tuolumne River watershed.

Owner	FERC Project No.	Powerhouse	Location / Description
CCSF	None	Robert C. Kirkwood Powerplant	124 MW; Completed 1967; water diverted from Hetch Hetchy Reservoir to powerhouse via Canyon Tunnel (CCSF 2006)
CCSF	None	Dion R. Holm Powerplant	169 MW; Completed 1960; water diverted from Lake Lloyd via Cherry Power Tunnel (CCSF 2006)
CCSF	None	Moccasin Powerhouse (off-stream)	110 MW; water diverted to powerhouse via CCSF Mountain Tunnel by way of Priest Forebay (CCSF 2006)
MID TID	2299	Don Pedro Powerhouse	Immediately downstream of Don Pedro Dam; 4 units, authorized capacity 168 MW.
TID	None	La Grange Powerhouse	4.5 MW Powerhouse; water source is TID Upper Main Canal.
TID	4450	Dawson Power Plant (off-stream)	5.5 MW; Small hydro located on TID Upper Main Canal between La Grange Diversion Dam and Turlock Lake
TID	3261	Turlock Lake (off-stream)	3.3 MW; Small hydro located at the outflow of TID's Turlock Lake
MID	290	Stone Drop (off stream)	230 kW; small hydro located on the MID main canal just below Modesto Reservoir
TID	1000	Hickman (off stream)	1,100 kW, first built 1979 on the TID Main Canal

4.1.2.1 Dam and Reservoir Operations Upstream of the Don Pedro Project

CCSF's Hetch Hetchy Water and Power Division maintains and operates several reservoirs in the middle-elevation band of the Tuolumne River watershed upstream of the Don Pedro Project, including CCSF's Cherry Lake (elevation 4,700 ft), Lake Eleanor (elevation 4,660 ft), and Hetch Hetchy Reservoir (elevation 3,800 ft) (CCSF 2006). These projects provide storage for water supply and also generate hydroelectric energy. CCSF stores and diverts water from the upper Tuolumne River for use outside the Tuolumne River basin. The Project also contributes substantially to the water supplies of the City of Modesto (population: 210,000) and 2.6 million people in the San Francisco Bay Area. The CCSF contributed financially to the construction of the Don Pedro Project in exchange for water banking privileges that benefit CCSF's Bay Area water customers.[77] The Hetch Hetchy system includes the San Joaquin Pipeline, which transports about 85 percent of CCSF's total water supply. The Hetch Hetchy system is an indispensable component of the welfare and economy of the Bay Area. The Hetch Hetchy system also produces about 1,700,000 MWh of renewable hydroelectric energy in an average year. The maximum rate of diversion from the upper Tuolumne River to the San Francisco Bay Area is about 465 cfs. The historical average annual diversion is about 250,000 AF, or about 13 percent of the average annual runoff.[78]

Another user of water in the upper Tuolumne River is CDFW, which operates the Moccasin Fish Hatchery below CCSF's Moccasin Reservoir, a 505-AF water supply reservoir. Flow to the hatchery is estimated to be about 15 million gallons per day (23 cfs) or about 11,000 AF per

[77] CCSF provides the potable water supply for 2.6 million people in the Bay Area. The Hetch Hetchy System provides 85% of the supply to San Francisco's Regional Water System. The Regional Water System meets 98% of CCSF's needs (800,000 people) and about 65% of CCSF's wholesale customers' needs (population: 1.8 million).

[78] For the period 1987 - 2012.

year. Water from the hatchery is discharged into Moccasin Creek, which flows into Don Pedro Reservoir. Water from Moccasin Reservoir also feeds CCSF's Foothill Tunnel, which delivers water to the San Joaquin Pipelines.

4.1.2.2 Dam and Reservoir Operations Downstream of the Don Pedro Project

Water released through the Don Pedro powerhouse or outlet works discharges into the Tuolumne River and about 1 mile downstream enters the La Grange headpond. At La Grange Diversion Dam, an irrigation diversion dam owned by the Districts, water is diverted into MID's canal system on the north side of the Tuolumne River and into TID's canal system on the south side of the river. Flows greater than the Districts' irrigation and M&I needs continue on to the lower Tuolumne River by passing over the dam's spillway, through TID's La Grange powerhouse located off the TID main canal, or through sluice gates associated with the La Grange facilities.

La Grange Diversion Dam is located near the border of Stanislaus and Tuolumne counties at RM 52.2. Originally constructed by TID and MID between 1891 and 1893, the primary purpose of the dam is to raise the level of the Tuolumne River to permit diversion of water, by means of gravity, into the Districts' canal systems. La Grange Diversion Dam, which replaced Wheaton Dam (built by other parties in the early 1870s), was constructed at the downstream end of a narrow, steep-sided canyon. Operation of La Grange Diversion Dam results in very little fluctuation of water surface elevation in the La Grange headpond. When not in spill mode (i.e., above elevation 296.5 ft, which occurs about 30 percent of the time), the headpond operates between elevation 296 ft and 294 ft about 90 percent of the time. The volume of storage in this 2-ft operating band is less than 100 AF. La Grange Diversion Dam is the most downstream dam on the Tuolumne River. Flows in the lower Tuolumne River are recorded at the USGS' La Grange gage located about 0.3 miles below La Grange Diversion Dam.

4.1.2.3 Diversions Downstream of Don Pedro Project

There are 26 points of pumping diversions along the lower Tuolumne River between La Grange Diversion Dam and the San Joaquin River (with an estimated total combined withdrawal capacity of 76.6 cfs [CDWR 2013]), and four diversions along Dry Creek (Figure 4.1-2). There are numerous diversions and water exports along the San Joaquin River and in the Delta. The diversions along the lower Tuolumne River typically occur during irrigation season.

4.1.2.4 Accretion Flows

Runoff from Dry Creek, agricultural return flows, groundwater seepage, and operational spills from irrigation canals all enter the lower portion of the Tuolumne River. Average monthly accretion flows in the lower Tuolumne River range from 40 cfs to 200 cfs, with an estimated annual average accretion from water year 1970-2010 of 152 cfs (TID/MID 2017c, Attachment A).

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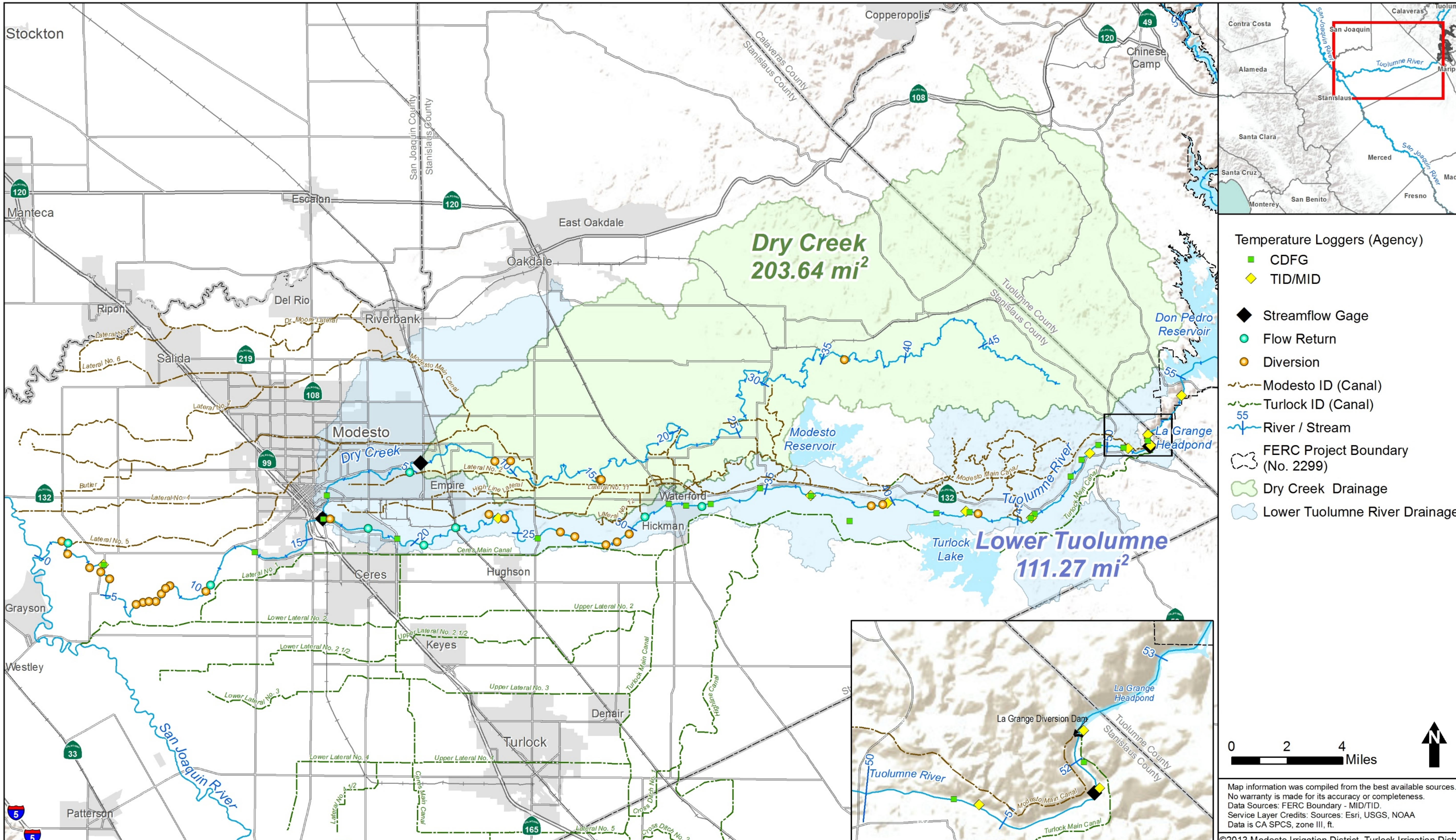

Figure 4.1-2. Locations of diversions along the lower Tuolumne River and Dry Creek.

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4.1.2.5 Resource Extraction, Land Development, and Land Use Practices along the Tuolumne River

In-Channel and Floodplain Mining

Mining-related impacts in and along the mainstem Tuolumne River began with the California Gold Rush in 1848. The major mining camps of Sonora, Columbia, and Jacksonville were founded in 1848 and 1849. A historical timeline of mining activities in the San Joaquin River's tributaries, including the Tuolumne River, includes placer mining (1848–1880), hydraulic mining in the La Grange vicinity (1871 to about 1900), dredge mining (1908-1942, 1945-1951), and gravel and aggregate mining (1940s to present) (McBain & Trush 2000). Decades of dredge mining in the main channel of the Tuolumne River resulted in the excavation of channel and floodplain sediments, which has left a legacy of significant Tuolumne River channel modifications and dredger tailing deposits between RM 50.5 and 38.0. Gravel and aggregate mining, with their attendant floodplain modifications, continue to be conducted alongside the river corridor.

The chief mining commodities in the vicinity of the Don Pedro Project are gold and gravel. The Columbia and Springfield placer mining operations northwest of the Don Pedro Project produced approximately $55 million in gold prior to 1899 (TID/MID 2011). The pocket mines of Sonora and Bald Mountain, as well as others in their vicinity, have been highly productive and long-lived. Marble and limestone products have been second in value to gold. The Columbia marble beds northwest of the Don Pedro Project had a long history of production prior to 1941, and two plants are currently processing stone from these deposits (TID/MID 2011). From the 1860s to the 1940s, roughly 10,000 tons of chromite ore and several hundred tons of crude magnesite ore were mined in the Don Pedro Project vicinity (TID/MID 2011). Most of the chromite came from the McCormick Mine, located northwest of the Project Boundary. All magnesite production in Tuolumne County occurred in the 1920s and came from two sites in the northern portion of the Red Hills located northwest of the Don Pedro Project (TID/MID 2011).

Gold mined in Stanislaus County has come predominantly from placers. Quaternary gravels of the Tertiary lower Tuolumne River channel near Waterford were among the most productive (TID/MID 2011). In the early 1900s, large-scale dredging of Quaternary gravels began along the Tuolumne River between La Grange and Waterford, and most of the gold produced in Stanislaus County from 1932 through 1959 came from this area. In the late 1940s, gold mining declined sharply (Koschmann and Bergendahl 1968).

On the other hand, California leads the United States in aggregate production, and virtually all aggregate is removed from alluvial deposits (Kondolf 1995). As of 1994, sand and gravel mining exceeded the economic importance of gold mining in the state. Large-scale, in-channel aggregate mining began in the Tuolumne River corridor in the 1940s, when aggregate mines extracted sand and gravel directly from large pits excavated in the active river channel. Off-channel and floodplain aggregate mining along the Tuolumne River has also been extensive. Aggregate in Stanislaus County is currently classified as Aggregate Resources (potentially useable aggregate that may be mined in the future but for which no mining permit has been granted) and Aggregate Reserves (aggregate resources for which mining and processing permits have been granted) (Higgins and Dupras 1993).

An estimated 540 million tons (338 million yd^3) of aggregate resources are located in six different geographic areas of Stanislaus County (Higgins and Dupras 1993). The lower Tuolumne River corridor is the largest of the six areas and contains an estimated 217 million tons (135 million yd^3) in its channel and terraces (Higgins and Dupras 1993). The Gravel Mining Reach of the lower Tuolumne (RM 34.2 to 40.3) is currently the focus of development by commercial aggregate producers.

Much of the residual dredger tailings upstream of RM 45 were removed from the floodplain downstream of La Grange Diversion Dam as part of the construction of the new Don Pedro Dam in the 1960s. Reaches of the Tuolumne River between RM 47 and 50 that had been affected by gold dredger mining in the early 1900s were reconfigured following removal of the dredger tailings.

Agriculture, Livestock Grazing, and Timber Harvest

After the Gold Rush there was a substantial increase in crop production and ranching in the Central Valley (TID/MID 2013a). During this period, woody vegetation along the Tuolumne River was cleared to allow for crop production in the rich alluvial soils of the bottomlands. Levees were constructed to protect the new farmlands from flooding in spring, and irrigation canals were constructed to provide water during the growing season (Thompson 1961, Katibah 1984). Of the estimated 4 million acres of wetland that occurred historically in the Central Valley, only about 300,000 acres remained in 1990. The conversion of wetlands to agricultural uses accounts for much of this reduction in wetland area.

Land in the lower Tuolumne River watershed is primarily privately owned, including that used for agriculture and livestock grazing (Stanislaus County 2006). Primary agricultural land uses along the gravel-bedded reach include orchards, row crops (RM 24.0 - 40), and livestock grazing (RM 40 - 51) (McBain & Trush 2000).

Timber operations existed throughout the Sierra Nevada since the mid-1800s. However, the subsequent Gold Rush of 1849 fueled a human migration into California that resulted in dramatic increases in the demand for timber. The indirect effects of gold mining included steamship transportation along the major rivers of the Central Valley, which was fueled by cordwood harvested from adjacent lands, which likely resulted in the first wave of riparian forest clearing in some areas of the Tuolumne River basin (Rose 2000, as cited in McBain & Trush 2002).

In recent times, timber harvest in the Tuolumne River watershed has typically been limited to lands in the upper basin. The Yosemite Stanislaus Solutions (YSS) collaborative group was formed in December 2010 to assist the Stanislaus National Forest in developing restoration plans across the landscape regardless of ownership patterns, in the southern part of the Forest (USFS 2013). One critical area within the YSS collaborative is Hetch Hetchy Reservoir. Approximately one third of the land within the YSS boundary burned in 1987 and succeeding years. After 1987, the majority of this land was successfully reforested. The 2013 Rim Fire (which burned from August 17, 2013 through September 20, 2013) burned a total of 253,360 acres (USFS 2013); much of the burn occurred in the Tuolumne River watershed.

Industrial, Urban and Residential Development

Privately owned land in the lower Tuolumne River watershed is also used for rural residential purposes or for denser residential, municipal, and industrial purposes in communities such as Waterford and Modesto (Stanislaus County 2006). Many miles of river bank have been leveed and stabilized with riprap by agencies or landowners. Levees and bank revetment extend along portions of the river bank from near Modesto (RM 16) downstream to the San Joaquin River. Following the 1997 flood, some subdivisions that had been inundated in the Modesto area were found to have been constructed within the Federal Emergency Management Agency floodplain area designated prior to 1997 (TID/MID 2013a).

Four wastewater treatment plants (WWTPs), i.e., Tuolumne County Water District #1, Jamestown, Sonora, and Tuolumne contribute a little over 19 percent of the total phosphorus to the Don Pedro Reservoir. Urban runoff to the lower Tuolumne River from the Modesto area has been shown to contain pesticides (Dubrovsky et al. 1998). Fifteen pesticides were detected, and chlorpyrifos, diazinon, DCPA, metolachlor, and simazine were detected in almost every sample (Dubrovsky et al. 1998).

The CVRWQCB has issued various Cleanup and Abatement Orders for the Tuolumne River and its tributaries (TID/MID 2011). For example, in 2004, the CVRWQCB issued Order No. R5-2004-0718 for a discharger within the City of Hickman because a water retention pond at a nursery failed and caused 2,000 cubic yards of sediment and rock to enter the Tuolumne River. In 2008, the CVRWQCB issued Order No. R5-2008-0701 because two dischargers graded over 1,000 acres of land and caused significant discharges (11,200 NTU) of sediment into Peaslee Creek and the Tuolumne River. In 2009, the CVRWQCB issued Order No. R5-2009-0707 because a discharger graded over 76 acres of land and caused significant discharges of sediment into Peaslee Creek and one of its unnamed tributaries.

4.1.2.6 Fish Hatchery Practices

The following paragraphs relate to fish hatchery practices as they pertain specifically to the Tuolumne River and Don Pedro Reservoir. Out-of-basin hatchery practices are discussed in Section 4.1.4.8, *Hatchery Practices*, of this Exhibit E.

The Moccasin Creek Hatchery, which was completed in 1954, receives its water from the afterbay of the Moccasin Creek Powerhouse, which is a part of the Hetch Hetchy water supply system (CDFW 2016a). Annual average hatchery production from 2004 through 2008 included approximately 41,000 brook trout (mostly fingerlings), about 88,000 brown trout (fingerlings and sub-catchable), 21,000 Lahontan cutthroat throat (mostly fingerlings), 124,000 Eagle Lake trout (mostly yearlings), and 807,000 rainbow trout (primarily yearlings and fingerlings) (CDFG and USFWS 2010). In the past, the hatchery was also used to rear non-salmonid species.

CDFW manages the Don Pedro Reservoir salmonid fishery as a put-and-grow resource with substantial stocking and associated fishing regulations. Don Pedro Reservoir is also managed by CDFW as a year-round fishery for black bass. CDFW and DPRA have been releasing hatchery fish into Don Pedro Reservoir since 1953, when more than 10,000 kokanee salmon were planted. From 1954-1956 between 49,000 and 57,000 kokanee were planted annually. In 1959, about 222,000 brook trout were planted, and in 1964, about 389,000 rainbow trout were planted. From 1972 onward, stocking of various fish species in Don Pedro Reservoir became more frequent and consistent (Table 4.1-5). Moccasin Creek, a tributary to Don Pedro Reservoir, is stocked with rainbow trout (CDFG 2006).

Chinook salmon planted in Don Pedro Reservoir in the 1980s and 1990s came from the Feather River Hatchery, and Chinook salmon were sourced from the Nimbus and Iron Gate hatcheries on the Klamath River (Perales et al. 2015). Starting in 2014, triploid (sterile) Chinook salmon from the Iron Gate Hatchery/Silverado Fisheries Base have been stocked in Don Pedro Reservoir (Perales et al. 2015). Kokanee planted in Don Pedro Reservoir come from the San Joaquin Hatchery, and all stocked trout have come from the Moccasin Creek Hatchery (CDFW, unpublished data).

No known fish stocking has occurred in the reach of the Tuolumne River between Don Pedro Dam and La Grange Diversion Dam (TID/MID 2013c).

Large numbers of trout have been stocked in the Tuolumne River basin upstream of Don Pedro Reservoir. The reaches of the mainstem Tuolumne River below Yosemite National Park are stocked by CDFW with triploid (sterile) rainbow trout and triploid brown trout raised at the Moccasin Creek Hatchery. CDFW stocks rainbow trout and Eagle Lake trout in the North Fork, Middle, and South Fork Tuolumne River (CDFW 2016b). Eleanor Creek, a tributary to Cherry Creek, is not currently stocked, but a hatchery was operated on one of its tributaries (Frog Creek) until the 1950s. The hatchery raised rainbow trout sourced from Lake Eleanor. Brook trout were historically stocked in the headwaters of Clavey Creek, a tributary to the Clavey River (Carion et al. 2010), and during 1975-1976, more than 100,000 brown trout fingerlings were stocked by CDFW into the Clavey River, although these brown trout did not establish a self-sustaining population (Carion et al. 2010).

Table 4.1-5. Fish Stocked in Don Pedro Reservoir (1970-2012).

Year	Kokanee Salmon[1]	Chinook Salmon	Brook Trout	Brown Trout	Rainbow Trout	Eagle Lake Trout	Largemouth Bass	Coho Salmon
1972	0	0	0	0	813,012	0	0	27,584
1973	0	0	0	0	0	0	0	72,800
1974	0	0	0	0	52,500	0	0	111,241
1975	0	0	0	0	40,150	0	0	36,480
1976	0	0	0	0	660,810	10,320	0	102,295
1977	17,184	0	0	0	16,036	15,660	0	111,600
1978	0	0	135,500	0	18,080	0	0	100,208
1979	0	0	228	200	64,800	22,000	0	0
1980	0	0	0	0	25,530	18,150	0	100,000
1981	6,000	0	0	600	36,160	31,260	0	0
1982	25,155	131,510	0	0	1,200	3,600	7,500	0
1983	0	66,920	7,600	0	1,900	20,010	0	0

Year	Kokanee Salmon[1]	Chinook Salmon	Brook Trout	Brown Trout	Rainbow Trout	Eagle Lake Trout	Largemouth Bass	Coho Salmon
1984	0	0	0	0	50,500	10,000	0	0
1985	0	61,130	0	0	5,780	10,075	0	0
1986	0	0	0	0	5,029	10,105	0	0
1987	0	0	0	0	62,485	0	0	0
1988	0	54,800	0	0	70,150	0	0	0
1989	0	0	0	0	77,705	0	0	0
1990	0	0	0	0	164,635	0	0	0
1991	0	30,600	0	0	228,905	0	0	0
1992	0	25,500	0	0	112,760	0	0	0
1993	0	0	0	0	170,340	0	15,000	0
1994	0	0	0	0	77,920	0	2,222	0
1995	0	0	190,405	20,124	0	0	2,711	0
1996	0	0	22,450	40,912	0	0	2,222	0
1997	0	0	0	20,400	36,980	0	2,222	0
1998	0	0	0	20,000	101,736	0	2,222	0
1999	0	40,000	35,341	22,925	13,055	0	1,682	0
2000	45,982	0	2,000	20,070	59,100	0	1,980	0
2001	50,103	0	3,520	19,800	65,600	0	2,758	0
2002	10,080	0	0	14,600	52,450	0	1,719	0
2003	10,043	0	0	0	71,675	0	1,825	0
2004	9,984	0	0	26,400	179,263	0	3,621	0
2005	10,143	100,440	118,400	73,687	262,585	3,600	2,000	0
2006	4,061	70,015	0	22,100	388,720	405	1,062	0
2007	6,517	91,000	0	15,860	41,720	72,680	1,667	0
2008	10,080	93,885	18,222	10,050	37,617	31,600	1,680	0
2009	10,050	100,006	5,610	31,320	329,495	93,790	1,367	0
2010	10,032	100,000	0	0	4,800	52,300	1,755	0
2011	10,260	129,980	0	16,000	44,300	55,300	0 [2]	0
2012	10,000	99,997	0	15,400	52,300	37,900	2,000	0

[1] Stocked kokanee are primarily reared at San Joaquin Hatchery
[2] No bass planted due to mortalities at hatchery

4.1.2.7 Freshwater Salmonid Harvest

CDFW implemented sport catch limits on salmon in the early 2000s within a portion of the Tuolumne River. Salmon fishing is currently banned in the lower Tuolumne River and San Joaquin River upstream of the Delta. No estimate of salmon lost to poaching is available (TID/MID 2013b). However, poaching of Chinook salmon, to the extent that it occurs, would likely only take place during the adult upstream migration period. No data are available that address the extent of *O. mykiss* poaching.

4.1.2.8 Non-Native Fish Species

Of the 23 non-native fish species documented in the lower Tuolumne River, 19 were introduced by state or federal agencies (CDFW, NMFS, USFWS, and the State Board of Human Health) between 1874 and 1954, and one was introduced with permission from CDFW in 1967 (Dill and Cordone 1997; Moyle 2002). The remaining three species were introduced by aquarists, catfish farms, or private individuals (Dill and Cordone 1997). Sixteen of the fish species released by state or federal agencies were introduced intentionally for sport or commercial fisheries, as a prey base for sport fish, or for mosquito control; two were introduced incidentally with shipments of sport fish (Dill and Cordone 1997). The most abundant and widespread non-native fish species in the lower Tuolumne River–bluegill, redear sunfish, and green sunfish–were first released in California between 1891 and 1954. Other introduced fish species in the lower Tuolumne River include threadfin shad, black and brown bullhead, white and channel catfish, common carp, fathead minnow, red shiner, golden shiner, goldfish, striped bass, largemouth bass, smallmouth bass, spotted bass, black and white crappie, warmouth, bigscale logperch, western mosquitofish, and inland silversides.

Black Bass and Striped Bass

Largemouth, smallmouth, and spotted bass (collectively black bass) were all introduced into California waters by CDFW and are now actively managed by CDFW in many locations. Largemouth and smallmouth bass were first released in California by CDFW between 1874 and 1891 (Dill and Cordone 1997; TID/MID 1992, and spotted bass were introduced in 1976. According to CDFW (2014), "Bass angling provides recreation and economic value to the state of California." Also according to CDFW (2014), "…California has been the center of attention for producing trophy-sized black bass. In a list of the top 25 largest largemouth bass caught in the U.S., 21 of the bass are from California waters." The California state record smallmouth bass is 9 pounds 13 ounces (CDFW 2014). Angler catches of Alabama spotted bass over six pounds have been verified by CDFW biologists for many California water bodies, including one spotted bass that weighed 10 pounds 4 ounces (CDFW 2014). All three species of black bass can be highly piscivorous and prey heavily on salmonids and other fish species (see below).

In 1990, largemouth bass abundance estimated for the lower Tuolumne River (RM 0.0 to RM 52.0) based on shoreline lengths was 11,074 individuals (TID/MID 1992). During 2012, the abundance of largemouth bass from RM 0.0 to RM 39.4 was estimated to be 3,323 based on shoreline length, and 3,891 based on habitat area (TID/MID 2013e). However differences in study methods between the 1990 and 2012 sampling years preclude comparison of these estimates. For largemouth bass, site-specific density estimates ranged from 0 to 218 fish per mile (collected in 1998, 1999, and 2003) (McBain & Trush and Stillwater Sciences 2006) and 4 to 196 per mile in 2012.

Smallmouth bass density estimates for the lower Tuolumne River (converted to fish per mile) from McBain & Trush and Stillwater Sciences (2006) (collected in 1998, 1999, and 2003) ranged from 2 to 97 fish per mile. In 2012, site-specific density estimates of smallmouth bass ranged from 0 to 251 fish per mile (TID/MID 2013e).

The Districts' 2012 Predation Study represented the first year that abundance estimates were produced by the Districts for smallmouth bass, largemouth bass, and striped bass, because only the abundance of largemouth bass was estimated during the 1990 study. Additional years of study are likely necessary to understand the population dynamics of these species in relation to river conditions.

There is limited information regarding the abundance of striped bass in the Tuolumne River. However, there is anecdotal evidence of large numbers of striped bass being found in the

Tuolumne River as far back as 1903 (State Board of Fish Commissioners 1904). Striped bass were captured by electrofishing in the lower Tuolumne River in 1989 (TID/MID 1992) and during predator surveys in 1998, 1999, and 2003 (McBain & Trush and Stillwater Sciences 2006). The Districts' 2012 Predation Study estimated striped bass abundance in the lower river to be in the range of 500-750 individuals during summer 2012.

Average consumption rates of juvenile Chinook salmon (i.e., number of Chinook salmon per predator) by largemouth and smallmouth bass in the lower Tuolumne River (not scaled by gastric evacuation rates) ranged from 0–0.20 during the 2012 predation study (TID/MID 2013e) and from 0–1.7 in an earlier study conducted by the Districts (TID/MID 1992). In 2012, predation rates averaged for all habitat types and sampling events were 0.07 Chinook salmon per largemouth bass per day and 0.09 per smallmouth bass per day. Striped bass predation rates in the lower river were generally higher than those of smallmouth bass and largemouth bass (TID/MID 2013e). In 2012, predation rate averaged for all habitat types and sampling events was 0.68 Chinook salmon per striped bass per day.

Largemouth bass and smallmouth bass were estimated to have consumed about 37 percent and 49 percent, respectively, of the total potential juvenile Chinook salmon consumed by the three primary non-native predator species (i.e., largemouth bass, smallmouth bass, and striped bass). Despite making up only a small fraction (< 4%) of the total of piscivore-sized fish (> 150 mm FL), striped bass were estimated to have consumed nearly 15 percent of the total potential juvenile Chinook salmon consumed by the three predator species. There was no evidence of consumption of Chinook salmon by Sacramento pikeminnow during either the 2012 study or the Districts' previous study (TID/MID 1992).

A conservative estimate of the total consumption of juvenile Chinook salmon by striped, largemouth, and smallmouth bass is about 42,000 during March 1-May 31, 2012 based on observed predation rates and estimated predator abundance. This suggests that nearly all juvenile Chinook salmon may be consumed by introduced predators between the Waterford and Grayson rotary screw traps. Only 2,268 Chinook salmon were estimated to have survived migration through the 25 miles between the screw-trapping sites (Robichaud and English 2013) during January through mid-June, making it plausible that most losses of juvenile Chinook salmon in the lower Tuolumne River between Waterford and Grayson during 2012 can be attributed to predation by non-native piscivorous fish species.

4.1.2.9 Tuolumne River Fisheries Management and Recovery Activities

Native Salmonid Management and Recovery Programs

The Ecosystem Restoration Program[79] is designed to improve the ecological health of the Bay-Delta watershed through restoring and protecting habitats, ecosystem functions, and native species. The Watershed Program Element specifically works in tandem with the Ecosystem Restoration Program Element to ensure that the ecological health of the Delta is restored and that water management is improved by working with communities at the watershed level.

[79] (http://www.dfg.ca.gov/ERP)

The draft Central Valley Salmon and Steelhead Recovery Plan (NMFS 2009) addresses the Sacramento River winter-run Chinook salmon Evolutionarily Significant Unit (ESU), the Central Valley spring-run Chinook salmon ESU, and the Distinct Population Segment (DPS) of Central Valley steelhead. The draft plan describes recovery strategies, lists recovery goals, objectives, and criteria, and proposes recovery scenarios and numerous recovery actions throughout the Central Valley (see Section 4.1.4.11 of Exhibit E for greater detail regarding the plan).

The California Advisory Committee on Salmon and Steelhead Trout was established by California legislation in 1983 to develop a strategy for the conservation and restoration of salmon and steelhead in California. The committee's recommendations were advanced and discussed in the related publications described in the following four paragraphs.

The Central Valley Salmon and Steelhead Restoration and Enhancement Plan (CDFG 1990) was intended to outline CDFW's restoration and enhancement goals for salmon and steelhead resources of the Sacramento River and San Joaquin River systems and to provide direction for various CDFW programs and activities.

The Restoring Central Valley Streams (CDFG 1993) plan identifies the following goals to benefit anadromous fish: restore and protect California's aquatic ecosystems that support fish and wildlife, protect threatened and endangered species, and incorporate the state legislature's mandate and policy to double the size of populations of anadromous fish in California. The plan encompasses only Central Valley waters accessible to anadromous fish, excluding the Sacramento-San Joaquin Delta.

The Steelhead Restoration and Management Plan for California (CDFG 1996) focuses on restoration of native and naturally produced (wild) fish stocks because they have the greatest value for maintaining genetic and biological diversity. Goals for steelhead restoration and management are: (1) increase natural production, as mandated by The Salmon, Steelhead Trout, and Anadromous Fisheries Program Act of 1988, so that steelhead populations are self-sustaining and maintained in good condition and (2) enhance angling opportunities and non-consumptive uses.

The Final Restoration Plan for Anadromous Fish Restoration Program (USFWS 2001) identifies restoration actions that may increase natural production of anadromous fish in the Central Valley of California. This plan is divided to address different watersheds within the Central Valley, and restoration actions are identified for each watershed. It also includes the involved parties, tools, priority rating, and evaluation of each restoration action. The plan addresses only Central Valley waters accessible to anadromous fish.

Habitat Protection, Restoration, and Enhancement Projects

The USFS Tuolumne Wild and Scenic River Management Plan was approved in 1986 and revised in 1988 (NPS 2006). The purpose of the plan is to provide "direction for managing the federal lands within the boundaries of the designated corridor." The plan addresses portions of the Tuolumne Wild and Scenic River (29 miles) outside of Yosemite National Park.

As directed under the 1995 Settlement Agreement, the TRTAC developed the following 10 top priority habitat restoration projects aimed at improving geomorphic and biological elements of the lower Tuolumne River corridor (completion status in parentheses):

- Channel and Riparian Restoration Projects (RM 34.3–RM 40.3):
  - Gravel Mining Reach Phase I - 7/11 Gravel Mining Reach Restoration (restored channel and floodplain along 1.5 river miles) (RM 38-39.5) (Completed in 2003),
  - Gravel Mining Reach Phase II (Not completed),[80]
  - Gravel Mining Reach Phase III (Not completed), and
  - Gravel Mining Reach Phase IV (Not completed).
- Predator Isolation Projects (RM 25.5 to RM 25.9):
  - Special Run-Pool (SRP) 9 Channel and Floodplain Restoration (restored channel and floodplain along 0.2 river miles) (RM 25.7–25.9) (Completed in 2001), and
  - Special Run-Pool (SRP) 10 (RM 25.5) (Not completed).
- Sediment Management Projects (RM 47.5–RM 51.8):
  - River Mile 43 Channel Restoration (restored channel and floodplain along 0.5 river miles) (Completed in 2005),
  - Gasburg Creek Fine Sediment Retention Project (RM 50) (Completed prior to 2008),
  - Gravel Augmentation (Coarse sediment) (Not completed), and
  - Riffle Cleaning (Fine sediment) (Not completed).

Other restoration efforts have been implemented in the lower Tuolumne River corridor by various groups, including FOT, TRT, NRCS, ESRCD, USFWS, CDFW, Stanislaus County, and the cities of Waterford, Ceres, and Modesto. Habitat restoration projects are discussed in detail in Section 5.3.2.2 of the Districts' PAD (TID/MID 2011).

To improve salmonid spawning and rearing conditions in the lower Tuolumne River, several coarse sediment augmentation and habitat restoration projects have been completed (TID/MID 2005, from TID/MID 2013b). CDFW placed approximately 27,000 cubic yards of gravel in the river near Old La Grange Bridge (RM 50.5) from 1999 to 2003 (TID/MID 2007, Report 2006-10). Riffle and floodplain reconstruction projects have also been completed at Bobcat Flat (RM 43.5), near the site of 7/11 Materials (RM 40.3–37.7), and at Special Run Pools (SRPs) 9 and 10 (≈ RM 25.7), with designs and preliminary permitting completed for additional gravel augmentation projects at upstream locations (TID/MID 2007, Report 2006-8).

[80] By the terms of the 1995 Settlement Agreement, the Districts and CCSF pledged $500,000 and an additional $500,000 in matching funds for Tuolumne River restoration projects. Also by the terms of the agreement, CDFW and USFWS were responsible for actively pursuing state and federal funding. After securing funding and constructing the initial four priority projects identified by the TAC, CDFW, while supporting additional restoration projects at the TAC, actively opposed using CALFED funding for additional projects. Consequently, approved CALFED funding of over $14.75 million for three additional TAC projects, designed to benefit fall-run Chinook and *O. mykiss*, was never able to be used and the projects were never implemented due to factors outside the control of the Districts.

Riparian restoration projects along the Tuolumne River include Grayson River Ranch, Big Bend, SRP 9, 7/11 Mining Reach Segment #1, and River Mile 43 at Bobcat Flat. Floodplain restoration was conducted at Grayson River Ranch (located approximately 4 miles upstream of the San Joaquin River confluence) by The Friends of the Tuolumne in 2000. Anecdotal evidence indicates some recovery of riparian vegetation has occurred on the floodplain and along newly constructed sloughs. The Tuolumne River Trust and other partners acquired approximately 250 acres on both sides of the Tuolumne River at Big Bend (RM 5.8 to 7.4). Restoration was completed in 2005, and monitoring results suggest that planting to reestablish native, woody riparian species was effective. In 2001, restoration of river and floodplain habitat was completed at SRP 9 (RM 25.7 to 25.9). A brief survey conducted in 2002 indicated that tree survival typically exceeded 60 percent for most species one year after planting. In 2003, restoration of river and floodplain habitat was completed at the 7/11 site (RM 40.3 to 34.4). Post-project monitoring has been limited to quantifying survival of planted vegetation and replacing plants as stipulated in the construction contract. The Bobcat Flat restoration site includes 303 acres of riparian and instream habitat owned by Friends of the Tuolumne. Restoration was conducted in 2005–2006, and anecdotal evidence, including some site photos, indicates some success in restoration of riparian vegetation at the site.

The AMF was initiated in 2001 to review designs for restoration projects in Central Valley rivers and assist resource agencies and tributary restoration teams. The AMF panel of technical experts reviewed and made recommendations on tributary restoration projects, incorporating adaptive management into projects, and maximizing restoration success (Adaptive Management Forum Scientific and Technical Panel and Information Center for the Environment 2004).

As noted above, The Ecosystem Restoration Program[81] is designed to improve the ecological health of the Bay-Delta watershed through restoring and protecting habitats and ecosystem functions.

4.1.3 Non-Don Pedro Project Out-of-Basin Actions

The San Joaquin River originates in the high Sierra Nevada range, flows northward, and enters the legally-defined Delta near the USGS Vernalis gaging station (RM 73) (see Figure 4.1-1). The drainage area of the San Joaquin River above the Vernalis gage is 13,539 mi^2. The average annual flow at Vernalis was 3.26 million AF from WY 1924 through WY 2012 (3.19 million AF for WY 1971–WY 2012). The three main tributaries to the San Joaquin River above Vernalis are the Merced (drainage area 1,726 mi^2), Tuolumne (drainage area 1,960 mi^2), and Stanislaus (drainage area 1,075 mi^2) rivers.

The Sacramento and San Joaquin rivers meet at the western boundary of the Sacramento-San Joaquin Delta. Freshwater from the rivers mingles with saltwater from the Pacific Ocean, creating the West Coast's largest estuary. Under historical conditions, the south Delta and lower San Joaquin River were composed of tidal wetlands merging southward into floodplain wetlands interspersed with complex side-channel habitats, lakes, and ponds, with seasonal wetlands bordering upland habitats (Whipple et al. 2012). As summarized by Lund et al. (2007), the

[81] (http://www.dfg.ca.gov/ERP)

present day Delta encompasses about 60,000 acres of open water (exclusive of Suisun Bay), 520,000 acres of agricultural lands, 64,000 acres of towns and cities, and 75,000 acres of undeveloped areas.

For the purposes of documenting out-of-basin actions within the FERC-defined geographical scope for cumulative effects assessment, the following sections focus on water management and other past, present, and reasonably foreseeable actions in the lower San Joaquin River basin, including the mainstem San Joaquin River below Friant Dam, two of the three major San Joaquin River tributaries, i.e., the Merced and Stanislaus rivers (actions on the Tuolumne River have been discussed previously in sections 4.1.2 and 4.1.3), and the Delta.

4.1.3.1 CCSF Regional Water System

The CCSF, through the SFPUC, owns and operates a regional water system that extends from the Sierra Nevada to San Francisco and serves retail and wholesale customers in San Francisco, San Mateo, Santa Clara, Alameda, and Tuolumne Counties. The regional water system consists of water conveyance, treatment, and distribution facilities. The regional system includes over 280 miles of pipelines, over 60 miles of tunnels, 11 reservoirs, five pump stations, and two water treatment plants. The source of the water supply is a combination of local supplies from streamflow and runoff in the Alameda Creek watershed and in the San Mateo Creek and Pilarcitos Creek watersheds (referred to together as the Peninsula watersheds), along with imported supplies from the Tuolumne River watershed. Local watersheds provide about 15 percent of total supplies, with the Tuolumne River providing the remaining 85 percent.

The SFPUC serves about one-third of its water supplies directly to retail customers, primarily in San Francisco, and about two-thirds of its water supplies to wholesale customers by contractual agreement. The wholesale customers are largely represented by the Bay Area Water Supply and Conservation Agency (BAWSCA), which consists of 26 member agencies in Alameda, San Mateo, and Santa Clara Counties. Some of these wholesale customers have other sources of water in addition to what they receive from the SFPUC, while others rely completely on the SFPUC for supply.

4.1.3.2 Central Valley Project and State Water Project

The development and management of California's surface water is a process that has spanned decades and has involved the participation of private companies and local, state, and federal agencies (CDWR et al. 2013). Irrigated agriculture in the San Joaquin Valley proliferated after the Gold Rush and again in 1857, when the California State Legislature passed an act to promote the drainage and reclamation of floodplains (Galloway and Riley 1999). By 1900, much of the flow of the Kern River and all flow from the Kings River were diverted and routed through canals and ditches to irrigate fields in the southern part of the San Joaquin Valley (Nady and Laragueta 1983, as cited in Galloway and Riley 1999). Because early diversions did not have associated storage facilities, agricultural water supply was limited by low summer flows.

By 1910, almost all available surface water in the San Joaquin Valley was diverted, which led to the development of groundwater for irrigation (Galloway and Riley 1999). The first groundwater development took place in areas where shallow groundwater was abundant, particularly in the central part of the valley where flowing wells were common. When the output from the flowing wells declined, pumps were installed to maintain flows. Around 1930, the development of an improved deep-well turbine pump, along with a reliable electrical supply in rural areas, allowed for further groundwater development.

The cities of Los Angeles and San Francisco began to have water shortages early in the 1900s. They recognized the need to augment local water supplies and were the first to develop distant water sources for this purpose. As California's population grew, existing projects could not meet the demand for water. As a result, the federal CVP and the California SWP were initiated in 1937 and 1957, respectively (CDWR et al. 2013). These two major statewide projects were developed to serve agricultural, environmental, and municipal water users throughout California.

The SWP and CVP water infrastructure is operated in a coordinated manner, with joint points of diversion that allow one project to use the other's diversion facility under certain conditions (CDWR et al. 2013). To some degree, both the SWP and CVP systems rely on runoff and upstream reservoir releases from the Sacramento and San Joaquin River basins to deliver contracted water via the Sacramento and San Joaquin Delta export pumps located in the south Delta to deliver water to project customers. The CDWR exports water through the Harvey O. Banks Pumping Plant (Banks pumping plant, completed in 1968), which supplies the California Aqueduct. The USBR exports water into the Delta-Mendota Canal (completed in 1951) through the C. W. "Bill" Jones Pumping Plant (Jones pumping plant, completed in 1951). The history and structure of the CVP and SWP facilities are described in the following subsections.

Central Valley Project

The CVP is the largest water supply project in the United States. It includes 18 reservoirs with a combined storage capacity of more than 11 million AF, 11 hydroelectric power plants, and more than 500 miles of major canals and aqueducts (CDWR et al. 2013). The USBR operates and maintains the CVP as an integrated project and coordinates operations with the SWP. Authorized project purposes include flood management; navigation; water supply for irrigation and domestic uses; fish and wildlife protection, restoration and enhancement; and power generation. However, not all facilities are operated to meet each of these purposes. The USBR has entered into approximately 250 long-term contracts with water districts, irrigation districts, and others for delivery of CVP water. Currently, there are eight divisions of the project and 10 corresponding units. Of the contracted water supply, approximately 70 percent goes to agricultural users, almost 20 percent is dedicated to fish and wildlife habitat, and nearly 10 percent is allocated to M&I water users (USBR 2011). In addition to water storage and regulation, the system has a hydroelectric capacity of over 2,000 MW, provides recreation, and enables flood control with its dams and reservoirs.

There are five CVP divisions/units south of the Delta in the San Joaquin River basin: Friant Division, New Melones Unit, San Luis Unit, San Felipe Division, and Hidden Unit on the Chowchilla and Fresno rivers (described below).

Friant Division[82]

The Friant Division transports surplus water from northern California through the southern part of the Central Valley. The major facilities of this division are Friant Dam, Friant-Kern Canal, and Madera Canal, all constructed and operated by the USBR.

Friant Dam, located on the San Joaquin River 25 miles northeast of Fresno, was completed in 1942. The dam is a concrete gravity structure, 319 feet high, with a crest length of 3,488 ft. The dam controls San Joaquin River flows, provides downstream releases to meet water requirements above Mendota Pool, provides flood control and conservation storage, provides diversion into the Madera and Friant-Kern Canals; prevents saltwater from degrading thousands of acres of lands in the Delta, and delivers water to 1 million acres of agricultural lands in Fresno, Kern, Madera, and Tulare Counties. The reservoir, Millerton Lake, which first stored water in 1944, has a total capacity of approximately 520,500 AF, a surface area of 4,900 acres, and an approximate length of 15 miles.

Friant Dam`s spillway was designed to pass flood water into Millerton Lake. However, due to frequent drought cycles in central California over the past 50 years, water has seldom spilled at Friant Dam. The outlet works consist of four steel pipes through Friant Dam that are controlled by four hollow-jet valves at the outlet ends. The capacity of the jet valves is 16,400 cfs; but flow through the valves rarely exceeds 100 cfs. Small releases are made to the river through two pipes branching from Penstocks 3 and 4.

Construction of the Friant-Kern Canal began in 1945 and was completed in 1951. The canal has an initial capacity of 5,000 cfs that gradually decreases to 2,000 cfs at its endpoint in the Kern River. The canal outlet works consist of a stilling basin and four steel pipes through the dam. The canal carries water 151.8 miles from Millerton Lake to the Kern River, 4 miles west of Bakersfield. Along a 113-mile reach between Friant Dam and the White River, the canal has more than 500 different structures, including overchutes, drainage inlets, irrigation crossings, and turnouts. The water is used for supplemental and new irrigation supplies in Fresno, Tulare, and Kern Counties.

The 35.9-mile-long Madera Canal carries water north from Millerton Lake to lands in Madera County to provide supplemental and new irrigation supply. The canal, which was completed in 1945, has an initial capacity of 1,250 cfs, which decreases to 625 cfs at the Chowchilla River. The outlet works consists of two pipes that discharge into a stilling basin at the upstream end of the Madera Canal. Water ran for the first time through the canal's entire length on June 10, 1945. The John A. Franchi Diversion Dam, formerly the Madera Diversion Dam, on the Fresno River, is operated by the Madera Irrigation District. Built by the USBR, the facility was completed in 1964.

In 1947, riparian landowners sued the United States government under the California Fish and Game Code, stating that Friant Dam deprived them of commercial and recreational uses related to salmon fishing. The State Attorney General concluded the United States was not required by California law to discharge water to preserve fisheries downstream of the dam. In 1988, when

[82] Source: http://www.usbr.gov/projects/Project.jsp?proj_Name=Central+Valley+Project

first contracts for the Friant Division came up for renewal, 15 environmental groups sued the federal government, maintaining that contract renewals should be subject to environmental review under NEPA and the ESA. The lawsuit culminated in the signing of the San Joaquin River Restoration Settlement Act and development of the associated San Joaquin River Restoration Program (see Section 4.1.4.11).

Hidden and Buchanan Units

The Hidden and Buchanan Units, located on the Chowchilla and Fresno Rivers, provide flood control and water supply to the Chowchilla and Madera irrigation districts. The Hidden Unit provides 24,000 AF annually from Hensley Lake to the Madera Irrigation District, and the Buchanan Unit provides 24,000 AF annually from Eastman Lake to the Chowchilla Water District.

New Melones Unit[83]

The New Melones Dam and Power Plant are located on the Stanislaus River, about 60 miles upstream of its confluence with the San Joaquin River. The dam is a 625-foot-high earth and rockfill structure that impounds New Melones Lake, which has a capacity of 2.4 million AF at a pool elevation of 1,088.0 ft. Construction of the New Melones Dam project began in 1966, about 0.75 miles downstream of the original Melones Dam, which was built by the Oakdale and South San Joaquin Irrigation Districts in 1926. Construction of the diversion tunnel was completed in 1973. Construction of the main dam began in 1974, and initial filling of the reservoir took place in 1983.

The outlet works consist of a 3,774-foot-long, 23-foot-diameter tunnel and two conduits for emergency releases. Releases for flood control and irrigation are made through a branch of the multipurpose tunnel. The outlet works have a capacity of 8,300 cfs. The spillway has an uncontrolled concrete crest, with a capacity 112,600 cfs. The New Melones Power Plant, located immediately downstream of the dam, has a dependable capacity of about 279 MW, producing about 455 million KWh of energy annually. The New Melones Unit was officially transferred to the USBR in 1979 for integrated operation as part of the CVP.

An original purpose of the New Melones Dam was flood control. New Melones Lake includes a flood control reservation of 450,000 AF. Under flood control conditions, release operations are designed not to exceed a flow of 8,000 cfs (channel capacity) in the Lower Stanislaus River from Goodwin Dam downstream to the San Joaquin River. Unit operations provide releases for downstream fisheries requirements, water quality, water rights, and a water supply yield estimated at about 180,000 AF to meet present and projected agricultural and M&I needs in the service area.

Water availability for the New Melones Project has proven to be significantly different from what had originally been expected. The USBR found that previous modeled estimates of drought and demand were significantly inaccurate. As a result, contracts negotiated with the Stockton East Water District and the Central San Joaquin Water Conservation District have not

[83] Source: http://www.water.ca.gov/swp/swptoday.cfm

always been met during drought years, and the USBR has had to purchase water from the Tri-Dam Project to meet the release requirements for the fall Chinook salmon run.

When the lake levels are lower, the old Melones Dam, which is now submerged, prevents cold water at the bottom of the lake from reaching the outlet works of the new dam, resulting in temperatures that are too high for salmonids downstream of the dam. The situation becomes most critical when the volume of the lake drops below 350,000 AF.

***San Luis Unit*[84]**

Authorized in 1960, the San Luis Unit was constructed by the USBR and the State of California. It is now jointly operated by the USBR and State of California, with some facilities operated by Westlands Water District (see below).

The joint-use facilities of the San Luis Unit include O'Neill Dam and Forebay, B.F. Sisk San Luis Dam and Reservoir, William R. Gianelli Pumping-Generating Plant, Dos Amigos Pumping Plant, Los Banos and Little Panoche reservoirs, and San Luis Canal from O'Neill Forebay to Kettleman City, together with the associated switchyard facilities. The federal/private facilities include the O`Neill Pumping Plant and Intake Canal, Coalinga Canal, Pleasant Valley Pumping Plant, and the San Luis Drain.

Los Banos (completed in 1965) and Little Panoche (completed in 1966) detention dams are located southwest of the town of Los Banos on Los Banos and Little Panoche Creeks, respectively. B.F. Sisk Dam and Reservoir, a 382-foot-tall zoned earthfill structure located on San Luis Creek near Los Banos, were completed in 1967. The reservoir has a capacity of 2,041,000 AF. O'Neill Dam, an 87-foot-high zoned earthfill structure located on San Luis Creek about 2.5 miles downstream of San Luis Dam, was completed in 1967. The O'Neill Pumping Plant was also completed in 1967. The William R. Gianelli Pumping-Generating Plant, located at San Luis Dam, was completed in 1967. The San Luis Canal, the largest earth-moving project in USBR history, extends 102.5 miles from the O'Neill Forebay to a location west of Kettleman City. Water was first released into the canal in 1967. The Dos Amigos Pumping Plant is located 17 miles south of the O'Neill Forebay.

The Pleasant Valley Pumping Plant, operated by Westlands Water District, lifts water at an intake channel leading from the San Luis Canal at mile 74. Coalinga Canal, also operated in part by Westlands Water District, extends from the turnout structure on the San Luis Canal to the Coalinga area in Fresno County. Construction of the San Luis Drain, designed to convey and dispose of subsurface irrigation return flows from the San Luis service area, began in April 1968. Construction was halted in 1975 because of high costs and concerns about the quality of the agricultural drainage that would enter the Delta.

San Luis Reservoir serves as the primary storage reservoir, and O'Neill Forebay serves as an equalizing basin for the pumping-generating plant. Pumps at the base of O'Neill Dam take water from the Delta-Mendota Canal through an intake channel and release it into the O'Neill Forebay. The California Aqueduct flows directly into O'Neill Forebay. The pumping-generating units

[84] Source: http://www.water.ca.gov/swp/swptoday.cfm

take water from the O'Neill Forebay and discharge it into the main reservoir. When not pumping, the units generate electric power by reversing flow through the turbines. Water used for irrigation is discharged into the San Luis Canal and flows via gravity to Dos Amigos Pumping Plant, where it is elevated to allow for gravity flow to its terminus at Kettleman City.

A state canal system extends to southern coastal areas. During the irrigation season, water from the California Aqueduct flows through O'Neill Forebay into San Luis Canal rather than being pumped into San Luis Reservoir. Two reservoirs, Los Banos and Little Panoche, are used to control cross drainage along the San Luis Canal and also provide flood control benefits. B.F. Sisk Reservoir is used to store surplus water of the Sacramento-San Joaquin Delta. A hydraulic junction for federal and state waters, B. F. Sisk Reservoir acts as a forebay for the Gianelli Pumping-Generating Plant. The primary purpose of the federal portion of the San Luis Unit facilities is to furnish approximately 1.25 million AF of water to supplement irrigation supply to approximately 600,000 acres in western Fresno, Kings, and Merced counties.

San Felipe Division[85]

Initial authorization for construction of elements of the San Felipe Division occurred in 1960, and the division was fully authorized in 1967. Construction began in 1964 and was completed in 1987. The division consists of the Pacheco Tunnel, 48.5 miles of closed conduits, the Pacheco and Coyote pumping plants, San Justo Dam and Reservoir, and two associated switchyards. The Santa Clara Valley Water District (SCVWD) manages the Santa Clara Tunnel and Conduit, Pacheco Tunnel and Conduit, and Pacheco and Coyote Pumping Plants. The Western Area Power Administration (WAPA) manages Pacheco Switchyard, and San Benito County Water District (SBCWD) manages San Justo Dam and Reservoir and Hollister Conduit.

Water from the Delta is transported through the Delta-Mendota Canal to O'Neill Forebay (see San Luis Unit, above), pumped into San Luis Reservoir, and then diverted through the Pacheco Tunnel Reach 1 to the Pacheco Pumping Plant. At the pumping plant, water is lifted to the Pacheco Tunnel Reach 2. The water flows through the tunnel and the 7.92-mile-long Pacheco Conduit, which extends to the bifurcation of the Santa Clara and Hollister conduits. The 22-mile-long Santa Clara Tunnel and Conduit convey water from the Pacheco conduit to the Coyote Pumping Plant, which is located at the end of the Santa Clara Conduit, near Anderson Dam. The 19.5-mile-long Hollister Conduit extends from the Pacheco Conduit to San Justo Reservoir. San Justo Dam, located about 3 miles southwest of Hollister, is a 151-foot-high earthfill structure that impounds a reservoir with a capacity of 9,785 AF.

The primary recipients of water from the San Felipe Division are municipal and industrial users. The San Felipe Division provides supplemental irrigation to 63,500 acres and about 132,400 AF of water annually for municipal and industrial uses.

State Water Project

The SWP is a complex system composed of pumping plants, hydroelectric power plants, water storage facilities with a combined capacity of approximately 5.8 million AF, and approximately

[85] Source: http://www.water.ca.gov/swp/swptoday.cfm

700 miles of pipelines and canals (CDWR et al. 2013). It is the largest state-built water storage and conveyance project in the United States. The CDWR operates and maintains the SWP, which delivers water to 29 agricultural and municipal and industrial contractors in northern California, the San Joaquin Valley, the Bay Area, the Central Coast, and southern California.

SWP facilities south of the Delta in the San Joaquin River basin include the following: (1) the San Luis Area, which includes the Gianelli Pumping-Generating Plant and the Dos Amigos Pumping Plant, (2) the Coastal Branch Area, which consists of the Devil's Den, Bluestone, and Polonio Pass pumping plants and the Las Perillas and Badger Hill pumping plants, (3) the South San Joaquin Area, which includes the Buena Vista, Teerink and Chrisman, and Edmonston pumping plants, (4) the West Branch Area, which includes the Oso and Alamo pumping plants and the Warne and Castaic power plants, and (5) the East Branch Area, which includes Lake Perris, the Pearblossom Pumping Plants, and the Mojave and Devil Canyon power plants. The Gianelli Pumping-Generating Plant and Dos Amigos Pumping Plant are joint-use facilities, described above in the context of the CVP (see preceding section). The remaining facilities are described below.[86]

As noted above, water is pumped into the California Aqueduct at the Banks Pumping Plant and flows south by gravity to the San Luis Joint-Use Complex. After leaving the San Luis Joint-Use Complex, water travels through the California Aqueduct in the central San Joaquin Valley, until it reaches the bifurcation near Kettleman City, which conveys a portion of the water into the Coastal Branch Aqueduct (completed in 1997) to serve San Luis Obispo and Santa Barbara counties. The water remaining in the mainstem of the California Aqueduct is pumped uphill by the Buena Vista, Teerink, and Chrisman pumping plants until it reaches Edmonston Pumping Plant (operational beginning in 1971), the SWP's largest pumping facility and the world's largest water lift. The Edmonston Plant pumps water nearly 2,000 feet up and over the Tehachapi Mountains through approximately 10 miles of tunnels. In so doing, it consumes 40 percent of the electricity used by the SWP.

As the water reaches the bottom of the mountain, it bifurcates into the West Branch and the East Branch aqueducts (the latter is the mainstem). Water in the West Branch is pumped by the Oso Pumping Plant into Quail Lake, from where it enters a pipeline leading into Warne Powerplant (operating since 1982). Water is then discharged into Pyramid Lake (Pyramid Dam was completed in 1973) and through Angeles Tunnel to the Castaic Powerplant (the latter two facilities are jointly operated by CDWR and the Los Angeles Department of Water and Power, which owns the facilities). At the end of the West Branch is Castaic Lake (Castaic Dam was completed in 1973) and Castaic Lagoon.

Water flowing down the East Branch generates power at Alamo Powerplant (completed in 1986) and is then pumped uphill by the Pearblossom Plant, from where it flows downhill through an open aqueduct, linked at its end to four underground pipelines that carry the water into the Mojave Siphon Powerplant, which discharges the water into Lake Silverwood. When water is needed, it is discharged into Devil Canyon Powerplant and its two afterbays. The 28-mile-long Santa Ana Pipeline then conveys the water underground to Lake Perris, the southernmost SWP facility.

[86] Source: http://www.water.ca.gov/swp/swptoday.cfm

The SWP's most recently constructed facility, the East Branch Extension, conveys water from Devil Canyon Powerplant's afterbay to Yucaipa Valley and the San Gorgonio Pass area in San Bernardino and Riverside counties. The project, which consists of 13 miles of buried pipeline, three pump stations, and a 90 AF regulatory reservoir, is expected to meet the region's water needs for 40 years. SWP water will be used to recharge groundwater basins and allow greater flexibility for local water systems. The extension, completed in 2003, is a cooperative project between CDWR, the San Bernardino Valley Municipal Water District, and the San Gorgonio Pass Water Agency.

SWP deliveries provide water to 25 million Californians and about 750,000 ac of irrigated farmland. Other project functions include flood management, water quality maintenance, power generation, recreation, and fish and wildlife enhancement. The SWP operates under long-term contracts with public water agencies throughout California from counties north of the Delta to southern California. These public water agencies in turn deliver water to wholesalers or retailers or deliver it directly to agricultural and M&I water users (USBR and CDWR 2005). Of the contracted water supply, approximately 75 percent goes to M&I users and 25 percent to agricultural users.

4.1.3.3 Water Management in the San Joaquin, Merced, and Stanislaus Rivers

There are currently more than 80 dams on the San Joaquin, Merced, Tuolumne, and Stanislaus rivers, with a total storage capacity of over 7.7 million AF. Combined, these facilities have the capacity to capture and control the entire average annual yield of the rivers they dam for the primary purposes of water supply, flood control, and hydroelectric power generation. The relatively large flows from the eastside tributaries, i.e., the Merced, Tuolumne, and Stanislaus rivers, strongly influence flow and water quality in the mainstem San Joaquin River. The westside tributaries are ephemeral, so water entering the San Joaquin River from the west side of the basin consists largely of agricultural return flows, which strongly influences the quality of water in the river.

San Joaquin River Mainstem

The flow regime downstream of Friant Dam (described as part of the Friant Division) has been managed since the implementation of the CVP (Cain et al. 2003). Friant Dam and its associated infrastructure irrigate approximately 1 million acres of agricultural land along the San Joaquin Valley's east side (Cain et al. 2003). In most years, these diversions take 95 percent of the river's average annual yield. A small fraction of the water is released according to a 1957 legal settlement to maintain flows (typically 250 cfs or less) during the irrigation season to support agricultural diversions by riparian water rights holders in the 36-mile reach between Friant Dam and the Gravelly Ford Canal. As a result, this reach of the river is wetted all year.

Below the Gravelly Ford Canal, the river channel is underlain by highly permeable bed material, and there are high rates of flow losses to infiltration. This reach has been allowed to go dry to avoid losing valuable surface water to groundwater infiltration (Cain et al. 2003). Riparian water rights holders downstream of Gravelly Ford have been served by the Delta-Mendota Canal, which delivers water from the Delta to the San Joaquin River at Mendota Pool. Mendota Pool is formed behind Mendota Dam and was originally constructed in the 1800s to divert irrigation water from the San Joaquin River to several irrigation districts now known as the San Joaquin River Exchange Contractors (Exchange Contractors). The Exchange Contractors agreed not to exercise their historic rights to the San Joaquin River's water in exchange for Sacramento River water delivered via the Delta- Mendota Canal. Today, Mendota Pool has a storage capacity of 3,000 AF and distributes Delta water into a system of irrigation canals. Some water is released downstream of Mendota Pool into the historical channel of the San Joaquin River for subsequent diversion into Arroyo Canal at Sack Dam, 22 miles downstream of the Mendota Pool. Below Sack Dam, the river is often dry for several miles except during flood events.

The San Joaquin River between Gravelly Ford and the Merced River has an unusually complex system of flood bypasses, which route most flood flows around the historical river channel and flood basin of the San Joaquin River (Cain et al. 2003). Authorized by the Flood Control Act of 1944, the San Joaquin River and Tributaries Project was constructed in the 1950s and 1960s and includes over 100 miles of levees and bypasses. Starting 35 miles downstream of Friant Dam, a levee-confined floodway between Gravelly Ford and the Chowchilla bypass is designed to convey 12,000 cfs, but due to channel aggradation and levee instability may only be able to safely convey 8,000 cfs. Approximately 45 miles downstream of Friant, large flood releases are diverted into the Chowchilla and Eastside Flood bypass systems, which route most of the river's floodwaters around the historical flood basin downstream of Mendota Pool.

There are hundreds of entities with rights to divert water from the San Joaquin River between the mouth of the Merced River and the Delta. Many of these are small, unscreened private irrigation diversions. Some diversions, such as those of the Patterson Irrigation District (at which a new fish screening facility was constructed in 2011) and the West Stanislaus Irrigation District, are capable of diverting hundreds of cfs of water.

The median annual unimpaired flow in the San Joaquin River at Vernalis from WY 1930 through 2008 was reportedly 5.9 million AF (Cain et al. 2003). The median annual actual flow was reportedly 1.9 million AF, or 32 percent of the median annual unimpaired flow. This reduction in actual flow compared to unimpaired flow is attributable to exports of water to locations outside the basin and consumptive use of water within the basin. Unimpaired flow in the San Joaquin River at Vernalis is primarily attributable to flow from the Stanislaus, Tuolumne, and Merced rivers, and during wetter water years, the upper San Joaquin River. In flood years, water from the Kings River also contributes to the flow in the San Joaquin River.

The San Joaquin River Restoration Program (see Section 4.1.4.11 for a description of the Program), includes flow releases at Friant Dam to restore and maintain fish populations in good condition in the mainstem San Joaquin River. Interim flows were first released from Friant Dam on October 1, 2009. In 2013, interim flows between 350 and 400 cfs were released from Friant Dam to maintain the flow target at Gravelly Ford.[87] Up to 1,060 cfs was released from Friant Dam in 2013 as part of spring pulse flows. On January 2, 2014, flows released from Friant Dam were increased to 475 cfs to maintain the flow target at Gravelly Ford. However, beginning in February 2014, flows released from Friant Dam were decreased to 360 cfs to begin ceasing

[87] Source: http://restoresjr.net/activities/if/index.html

restoration flows because of drought conditions (i.e., a critical low-water year beginning March 1, 2014). Flows were reduced in 50-cfs increments until all restoration flows were discontinued.

Flow releases from Friant Dam during 2017 are listed below:

- January 3, 2017: Decrease to 220 cfs to meet the flow target of 80 cfs at Gravelly Ford.
- January 4, 2017: Increased to 720 cfs and then to 1,250 cfs for flood control; releases continued to ramp up in approximately 500 cfs increments to 3,500 cfs.
- January 5, 2017: Increased to 5,000 cfs for flood control.
- January 7, 2017: Increased to 6,000 cfs for flood control.
- January 12, 2017: Reduced to 4,000 cfs due to a flash flood on Little Dry Creek.
- January 13, 2017: Increased to 5,000 cfs.
- January 30, 2017: Reduced to 2,000 cfs.
- February 6, 2017: Increased to 6,000 cfs.
- February 7, 2017: Reduced to 5,000 cfs.
- February 8, 2017: Increased to 7,000 cfs.
- February 11, 2017: Increased to 8,000 cfs.
- February 12, 2017: Increased to 9,000 cfs.
- February 16, 2017: Reduced to 8,000 cfs.
- February 17, 2017: Reduced to 7,500 cfs. Downstream tributary inflow plus Friant Dam releases were managed so total flow below Little Dry Creek remained under 9,500 cfs.
- March 20, 2017: Flood releases were scheduled to decline by 1,000 cfs per day for four days; releases for flood control were to continue at 4,000 cfs after this decrease.
- May 26–29, 2017: Releases were scheduled to increase in 500-cfs increments from 2,500 cfs to 6,500 cfs on May 29, 2017.
- May 30, 2017: Releases were scheduled to increase in 500-cfs increments from 6,500 cfs to 8,000 cfs.

Merced River

In about 1870, the Robla Canal Company, a private water company, began diverting water from the Merced River to eastern Merced County (Merced Irrigation District 2012). The Robla Canal Company was succeeded by the Farmers Canal Company, which was acquired by the Merced Canal and Irrigation Company in 1883 (Merced Irrigation District 2012).

Currently, four dams control the majority of flow in the Merced River: Merced Falls Diversion Dam, New Exchequer Dam, McSwain Dam, and Crocker-Huffman Dam (Cain et al. 2003). Merced Falls Diversion Dam (RM 55.0), constructed in 1901 by Pacific Gas and Electric Company (PG&E), generates hydroelectric power and diverts flow into the Merced Irrigation District (Merced ID) Northside Canal, which has a capacity of 90 cfs. In 1910, the Merced ID constructed Crocker-Huffman Dam (RM 52.0), which diverts flow into the Main Canal. The Main Canal has a capacity of 1,900 cfs and delivers water to lands south of the Merced River.

Exchequer Dam, the first major storage facility on the Merced River, was constructed in 1926 by the Merced ID. It stored flows during the high spring run-off period and released them during the irrigation season into the North and Main Canals at Merced Falls and at the Crocker-Huffman Diversion Dam. Due to its limited capacity of 281,000 AF, Exchequer Dam did not capture all spring run-off and therefore did not allow for inter-annual water storage. Exchequer Dam, now known as Old Exchequer Dam, was inundated in 1967 by Lake McClure, when the Merced ID constructed New Exchequer Dam immediately downstream of the old dam (RM 62.5).

New Exchequer Dam and its downstream counterpart, McSwain Dam (RM 56.0), are the primary components of the Merced River Development Project, which is owned by the Merced ID and licensed by FERC. Lake McClure, the reservoir created by New Exchequer Dam, has a storage capacity of 1.03 million AF and enables the Merced ID to store water in wet years for use during subsequent dry years. Lake McSwain, located 6.5 miles downstream of New Exchequer Dam, has a capacity of 9,730 AF and is operated as a re-regulation reservoir and hydroelectric facility. Together, the New Exchequer and McSwain projects have a combined storage capacity of 1.04 million AF, which amounts to 102 percent of the average annual runoff from the Merced River watershed. The Merced River Development Project provides agricultural water supply, hydroelectric power, flood control, recreation, and some water to maintain minimum instream flows for fish in the Merced River.

The ACOE regulates flood control operations on the New Exchequer Dam and Reservoir. According to the ACOE Water Control Manual, which dictates operations of the dam for flood control, a maximum of 400,000 AF of space is dedicated to flood control during the winter runoff season, i.e., November 1 through March 15 (Stillwater Sciences 2001). The ACOE limits maximum reservoir releases to 6,000 cfs, measured at Stevinson gage near the confluence with the San Joaquin River. The maximum physical release from the New Exchequer outlet structure is 12,400 cfs. A flood reservation storage capacity of 350,000 AF is maintained for the rain flood pool between October 31 and March 15, and an additional 50,000 AF is reserved for the forecasted spring snowmelt after March 1.

The Merced River between Crocker-Huffman Dam (RM 52.0) and Shaffer Bridge (RM 32.5) has been extensively affected by alteration of the flow regime, water withdrawals, agricultural water returns, and land use activities (Stillwater Sciences 2001). The major water withdrawals are associated with the Cowell Agreement water users and riparian water users. These water users have maintained seven main channel diversions in this reach since the mid 1800s and have the right to divert annually up to approximately 94,000 AF of water. The users divert water to private canals via small wing dams constructed in the channel each year with rock and gravel excavated from the river. Most of these diversions are unscreened. There are numerous agricultural water returns in this section of river as well. Downstream of Shaffer Bridge, CDFW identified 238 diversions, generally small pumps that deliver water for agricultural purposes (Stillwater Sciences 2001).

Stanislaus River

There are more than 30 dams in the Stanislaus River watershed, with a combined storage capacity of approximately 2.7 million AF, more than 220 percent of the river basin's average annual runoff (Cain et al. 2003). Development of dams and diversions for both mining and irrigation began soon after the Gold Rush. Beginning in 1856, a series of water and power companies constructed several water supply and power facilities in the Stanislaus River Watershed. On the South Fork Stanislaus River, Big Dam and Herring Creek, Upper Strawberry, and Lower Strawberry reservoirs were constructed in 1856, Lyons Reservoir was constructed in 1898, and Philadelphia Diversion Dam (11-ft-high concrete face rock masonry overflow spillway dam) in 1916. The Oakdale Irrigation District and San Joaquin Irrigation District were formed in 1909 and bought the Tulloch water rights and physical distribution system in 1910. The Sand Bar Diversion Dam (24-ft-high timber crib overflow spillway dam) and the Stanislaus Forebay (60-ft-high shotcrete face earthfill compacted rock overlay dam) were constructed on the Middle Fork Stanislaus River in 1908, and Relief Dam (144.5-foot-high concrete face rock masonry dam) in 1910. In 1917, Lower Strawberry Reservoir was enlarged from 1,190 AF to 17,900 AF (Strawberry Dam is a 133-ft-high concrete face rock masonry dam).

The Oakdale and San Joaquin irrigation districts built the original 80-foot Goodwin Dam in 1913 to divert water into the Oakdale and South San Joaquin Irrigation Canals. Despite its height, Goodwin Diversion Dam provided no usable storage. Oakdale Canal, with a capacity of 560 cfs, diverts water to the south, and the South San Joaquin Canal diverts up to 1,320 cfs to the north. The height of Goodwin Dam was increased in the late 1950s to create a re-regulating reservoir for the New Tulloch Dam.

In 1926, Oakland Irrigation District and San Joaquin Irrigation District constructed Melones Dam and its associated 112,500 AF reservoir 15 miles upstream of Goodwin Dam to store spring runoff and release it downstream for diversion at Goodwin Dam (Cain et al. 2003). In 1929, Spicer Meadow Dam (with a reservoir capacity of 4,060 AF) was completed on the North Fork Stanislaus River, and in 1930, Lyons Reservoir was enlarged from 839 to 5,508 AF.

In 1948, the Oakdale and San Joaquin irrigation districts agreed to investigate the cost and feasibility of constructing additional dams to increase water supply and provide power production, and in 1955 the districts agreed to construct the Tri-Dam Project, including the Donnells Dam (483 ft high) and Reservoir (64,325 AF) and Beardsley Dam (280 ft high) and Reservoir (97,802 AF) on the Middle Fork Stanislaus River upstream of Melones Dam, and the Tulloch Dam (205 ft high) and Reservoir (66,968 AF) downstream of Melones Dam. Construction of the three facilities was completed in 1957 and the facilities became operational in 1958. As part of the construction of the Tri-Dam Project, the height of Goodwin Diversion Dam was increased to 87 ft to create an afterbay to regulate discharge from Tulloch Dam. From 1985–1990, the Calaveras County Water District constructed the North Fork Stanislaus Hydroelectric Project, which included the construction of New Spicer Dam (265 ft high) and Reservoir (189,000 AF) in 1989.

Melones Dam, now known as Old Melones Dam, was replaced and inundated in 1979 when the ACOE constructed New Melones Dam. New Melones Dam is the largest reservoir in the San

Joaquin River Basin, with a storage capacity of 2.4 million AF or 2.4 times the Stanislaus River's average annual runoff. New Melones Dam is operated and maintained by the USBR for flood control, to provide water for CVP contractors in the watershed, and to maintain water quality in the Stanislaus River and Delta.

4.1.3.4 Stockton Deep Water Ship Channel

The lower San Joaquin River flows north past the City of Stockton and into the Delta. The river connects the global economy to the Port of Stockton (Port) through a 78-mile-long Deep Water Ship Channel (DWSC) (Newcomb and Pierce 2010). The DWSC, which was first dredged in the 1930s, terminates at the Deep Water Turning Basin adjacent to the Port. The channel serves as a shipping corridor for cargo ships traveling from San Francisco Bay to the Stockton Port.

Periods of low dissolved oxygen (DO) concentrations have historically been observed in the DWSC; the majority of these low DO periods have occurred during summer and fall upstream of Turner Cut. In January 1998, the State Water Resources Control Board (SWRCB) adopted the CWA Section 303(d) list that identified this DO impairment, and the CVRWQCB initiated development of a TMDL to identify factors contributing to the DO impairment and assign responsibility for correcting the low DO problem (ICF International 2010).

Since the approval of the San Joaquin River DO TMDL Basin Plan Amendment in 2005, two actions have been implemented to alleviate low DO conditions in the DWSC: (1) the City of Stockton added engineered wetlands and two nitrifying bio-towers to the Stockton Regional Wastewater Control Facility to reduce ammonia discharges to the San Joaquin River and (2) the CDWR constructed the Demonstration Dissolved Oxygen Aeration Facility (Aeration Facility) at Rough and Ready Island to evaluate its applicability for improving DO conditions in the DWSC (ICF International 2010).

A full-scale aerator was constructed (using public grant funds) in the Stockton DWSC by CDWR and was operated by CDFW until 2011. In 2011, CDWR deeded the aerator to the Port of Stockton, which now owns and operates the facility. The annual cost of operating the aerator is the subject of a multi-party agreement. Twenty five percent of the cost is provided by the San Joaquin Tributaries Authority and San Joaquin River Group Authority, a joint powers authority that includes the Districts. The other cost-share partners in the operating agreement, and their cost-share percentages, are the CDWR jointly with the State Water Contractors (17%), the San Luis Delta Mendota Water Authority (12.5%), the San Joaquin Valley Drainage Authority (12.5%), and the Port of Stockton (33%). Upon completion of the operation agreement, the Port of Stockton will continue to own and operate the aerator.

4.1.3.5 Delta Water Management and Diversions

The Delta's boundaries are defined in Water Code § 12220, and encompass a roughly triangular area extending from Chipps Island near Pittsburg on the west, to the City of Sacramento on the Sacramento River on the north, and to the Vernalis gaging station on the San Joaquin River on the south. With the construction of the CVP and SWP, the Delta became a critical link in California's complex water distribution system (CDWR et al. 2013). Delta channels transport water mostly from upstream Sacramento Valley reservoirs to the South Delta, where the Banks and Jones pumping plants divert water into the California Aqueduct and the Delta Mendota Canal, respectively. The Delta is currently a conduit for water that is used for a wide range of instream, riparian, and other beneficial uses, including critical habitat for several native aquatic and terrestrial species, drinking water for more than 25 million people, and irrigation water for 4 million acres of farmland throughout the Delta and San Joaquin Valley.

The water balance in the Delta—i.e., total inflow versus total outflow—is controlled by supply from the Sacramento and San Joaquin rivers, eastside tributary rivers and streams, contributions from Coast Range watersheds, upstream diversions, demand from in-Delta water users, outflows from the Delta to the San Francisco Bay and Pacific Ocean, and exports to agricultural and M&I users outside the Delta (CDWR et al. 2013). Precipitation in the Delta region and small tributary inflows provide some water to the Delta, but these are minor compared to the flow contributions of the large rivers. The largest volume of water exiting the Delta is outflow, which is the water that travels through the Delta, contributes to in-channel and wetland coverage, and exits through the San Francisco Bay to the Pacific Ocean. Exports of water through the SWP and the CVP, followed by in-Delta use and local diversions, constitute the next largest volumes of water exiting the Delta.

There are over 3,000 diversions that remove water from upstream and in-Delta waterways for agriculture and M&I use (CDWR et al. 2013). Of these, 722 are located in the mainstem San Joaquin and Sacramento rivers, and 2,209 diversions are in the Delta (Herren and Kawasaki 2001). Of the 2,209 diversions in the Delta, most are unscreened and used for in-Delta agricultural irrigation (Herren and Kawasaki 2001). There are also numerous water management activities and diversions in eastside rivers that affect inflows to the Delta (e.g., to support M&I uses, hydroelectric generation, agriculture, and flood control in the Calaveras and Mokelumne river watersheds).

Population Growth and Water Demand

In the past decade, California's population has increased by 25 percent, double the national average (CDWR et al. 2013). The California Department of Finance estimates that the current population of 37 million will exceed 52 million by 2030 and reach nearly 60 million by 2050. In its 2009 update of the California Water Plan, CDWR used three possible future scenarios to forecast water demands up to the year 2050. It is estimated that water demands will be as high as 10 million AF per year. In addition to the increased demand for Delta water resulting from population growth, established flow release requirements and restrictions on project operations for the protection of certain fish and wildlife species with critical life stages that depend on freshwater flows are expected to increase in the future. These current and projected future requirements all increase the competition for water supplies in the State of California.

With forecasts of reduced precipitation, shifts in timing of peak flow and runoff periods, reductions in snowpack, and impacts from a rising sea level resulting from global climate change, the struggle to meet the divergent demands for water will increase in the future. Nevertheless, the Delta will remain the center of California's water system, because the economies of major regions of the state depend on the water flowing through the Delta.

4.1.3.6 San Joaquin River and Delta Levee Construction and Maintenance

Beginning in the 1850s, the construction of levees around the San Joaquin River and Delta facilitated the conversion of lands to agricultural and other human uses. Combined with the straightening, widening, and dredging of channels, levee construction increased shipping access to the Central Valley and increased the ability to control water conveyance and prevent flooding (CDWR et al. 2013). Currently, the Delta is a highly engineered environment, composed of 57 leveed island tracts and 700 miles of sloughs and winding channels. Over 1,100 miles of levees protect 738,000 acres of Delta islands, tracts, and population centers from flooding and safeguard a large portion of California's water supply (CDWR et al. 2013). The extensive levee system supports widespread farming throughout the Delta. This has allowed farmers to drain and farm a large portion of the Delta, which in its natural state was a tidal marsh.

Most of the levees protecting the Delta (approximately 65%) are not part of the federal/state Sacramento Flood Control Project system and were constructed and now maintained by island landowners or local reclamation districts (CDWR et al. 2013). These levees are generally built to an agricultural standard and may be less stable than those constructed and maintained to protect urban areas. Improvement and maintenance of these "non-project" levees can be challenging; the peat deposits that made the Delta a fertile farming location make poor materials for constructing levees and/or their foundations. Oxidization of these peat soils has led to island and levee subsidence, which has increased the burden on the levee system. Another way that the Delta levees are distinguished from levees along rivers such as the Sacramento and San Joaquin rivers is that they are constantly exposed to water, so they often act more as dams than levees, although they are not constructed or regulated to the same engineering standards as dams.

Currently, California has several programs in place to help manage risk and improve the environment in the Delta (CDWR et al. 2013). Local reclamation districts are responsible for maintaining their levees but may be reimbursed for a portion of the cost of maintenance under the State's Delta Levees Subvention Program, which was established in 1973. The Delta Flood Protection Fund Act of 1988 and the Delta Levee's Special Project program also provide financial assistance to local levee maintenance programs.

4.1.3.7 Land Use

4.1.3.8 Mining

Known mineral resources in the western Delta are primarily sand and gravel deposits that are valuable as construction aggregate or as construction fill material (CSLC 2012). Since 1915, millions of cubic yards of sand and gravel have been mined from Bay floor shoals. Sand mining in recent decades has been conducted under mining leases granted by the California State Lands Commission (CSLC).

Based on the 2006 CGS study of aggregate availability, estimates of demand for construction aggregate in California over the next 50 years will total approximately 13.5 billion tons (Kohler 2006), not including increased demand following major bond initiatives (e.g., for public infrastructure projects, reconstruction following a major earthquake, etc.). Under the latest mining leases, for the years 1998 through 2007, an average of approximately 135,700 cubic yards per year were mined from the Delta and Carquinez Strait lease areas. Recently proposed 10-year mineral extraction leases that would enable continuation of dredge mining in the western Delta have been reviewed and approved by the CSLC.

4.1.3.9 Agriculture and Livestock Grazing

Agriculture is the primary land use along the lower San Joaquin River from its confluence with the Tuolumne River to Vernalis, with uses including fruit and nut orchards, field crops, vegetables, seed and other row crops, vineyards, and pastures (Mintier Harnish et al. 2009). The Delta's combination of highly productive soils, a climate conducive to agriculture, and readily available high quality irrigation water support a broad range of agriculture, including high value crops (CDWR et al. 2013). According to the Farmland Mapping and Monitoring Program classifications, Delta land used for agricultural purposes totals more than 575,000 acres, including approximately 395,000 acres of Prime Farmland, 33,000 acres of Farmland of Statewide Importance, 41,000 acres of Unique Farmland, 44,000 acres of Farmland of Local Importance (including locally-designated Farmland of Local Potential), and 63,000 acres of Grazing land (CDWR et al. 2013).

Over 30 types of crops are grown in the Delta region, including alfalfa, almonds, apples, apricots, asparagus, cherries, corn, squashes and melons, dry beans, grain and hay, wine and table grapes, miscellaneous truck crops, olives, peaches and nectarines, pears, rice, safflower, subtropical trees, Sudan grass, sugar beets, sunflowers, tomatoes, turf, and walnuts (CDWR et al. 2013). Areas with less productive soils such as hard pan or areas with high water tables or poor drainage are often used as pasture.

Delta agricultural production relies heavily on irrigation because there is low rainfall during the majority of the growing season (CDWR et al. 2013). Irrigation and drainage practices vary depending on the kind of crop being irrigated. Methods include drip, sprinkler, furrow, flood, border strip, basin, sub-irrigation, or a combination of these. Most crops produced in the Delta require weekly or biweekly irrigation throughout the growing season until a few weeks before harvest. In-season irrigation quantities depend on crop type, stage of crop growth, soil moisture profile, management of plant pests and diseases, and weather conditions. Generally, irrigation water is diverted directly from Delta waterways and transported to agricultural lands via canals. In some cases water is pumped directly into field furrows. Irrigation and drainage canals are operated and maintained in the Delta by reclamation districts, irrigation districts, and water agencies. Some of the agricultural surface water diversions are screened to protect fish, but many are not (CDWR et al. 2013).

Fertilizers, pesticides, and herbicides are commonly used to maximize yields and protect crops (CDWR et al. 2013). Fertilizers are used to replenish soil nutrients and may be composed of natural and/or synthetic materials with varying concentrations of plant nutrients. Although pesticides are designed to break down after a period of time, spray drift and groundwater contamination are common problems associated with applied pesticides (CDWR et al. 2013). Application methods for fertilizers, pesticides, and herbicides vary by crop and chemical type and include: chemigation (i.e., application through the irrigation system), orchard spray rigs, spray booms, brush brooms, broadcast spreaders, chemically coated seeds, and aerial applicators (crop dusters). The California Department of Pesticide Regulation has documented over 300 herbicides and pesticides that are discharged throughout agricultural regions of California's Central Valley and Delta (Werner et al. 2008).

Delta agricultural runoff percolates into the water table or is discharged into Delta waterways (CDWR et al. 2013). Within the Delta, reclamation district canals and ditches frequently function as both water supply and drainage conveyance facilities, and they are typically kept at low water levels during the drainage season and pumped out by the reclamation districts to remove drainage and stormwater. During the crop irrigation season in subsurface irrigated areas, water is diverted from the Delta into these same ditches. Agricultural drainage water is captured in the canals and ditches and reused in subsequent irrigation. Most reclamation district drainage discharged into Delta waterways is for stormwater and flood management (CDWR et al. 2013).

4.1.3.10 Industrial and Residential Development

There are no incorporated cities along the lower San Joaquin River from its confluence with the Merced River to Vernalis. Rural residential use is typically the only type of development, and much of the population resides in surrounding cities (Mintier Harnish et al. 2009).

California is presently losing agricultural land at a rate of 49,700 ac annually, due in part to urban development fueled by population growth, housing prices, and commuting patterns (Kuminoff and Sumner 2001) as well as drainage problems, loss of reliable or affordable water supply, and conversion to wildlife habitat. These circumstances suggest that the existing land use patterns in the Delta and surrounding areas (including the lower San Joaquin River watershed) may experience continuing changes in the future, with a shift to more industrial, commercial, and residential land uses. Currently, there are 64,000 ac in the Delta that support urban and commercial land uses, although this is expected to increase due to population growth and the concomitant conversion of agricultural land to urban and residential uses.

There is little infrastructure along the lower San Joaquin River aside from that which supports agriculture and rural residential development. The Delta, on the other hand, contains much infrastructure of statewide importance, including transportation facilities and power generation and transmission facilities (Mintier Harnish et al. 2009). Three interstate highways (I-5, I-80, and I-580) pass along the periphery of the Delta; Interstate-5 is one of the most important north-south transportation routes on the west coast, running from the Mexican border to the Canadian border. It also runs along the entire eastern edge of the Delta. On an average day, the segments of I-5 that pass through Stockton carry approximately 130,000 vehicles.

Ship traffic in the Delta supports interstate and international commerce. More than 300 ships and barges used the Stockton DWSC in 2005.

Electricity, gasoline, and other energy supplies for the region are provided by pipelines and transmission facilities that cross the Delta, and in 2004, there were approximately 240 operating natural gas wells in the Delta (Mintier Harnish et al. 2009). In addition, a large PG&E gas storage facility is located under McDonald Island within the San Joaquin County portion of the Delta (Mintier Harnish et al. 2009). More than 500 miles of electrical transmission lines run through the Delta, portions of which carry power to other parts of the western United States. The petroleum pipelines that cross the Delta provide approximately 50 percent of the transportation fuel used in Northern California and Nevada (Mintier Harnish et al. 2009).

4.1.3.11 Recreation

Recreational use is a critical asset to the San Joaquin River watershed and Delta region. Visitors include local residents, residents from nearby communities, and many visitors from the Bay Area and other parts of the state (CDWR et al. 2013). Along the San Joaquin River and Delta waterways and on Delta islands, activities include picnicking, swimming, fishing, boating, waterskiing, nature study, sightseeing, horseback riding, tent and RV camping, biking, hunting, and hiking. Although these recreational activities contribute to local economies, they also increase pressure on an already fragile environment.

To support the high levels and diversity of recreational use, an extensive infrastructure of public (county, state, and federal) and private providers has been established within the region (CDWR et al. 2013). Tent and RV camping sites are located throughout the area. Most of the camping areas are privately owned at marinas around the Delta. There are, however, publicly owned camping sites such as Dos Reis Park on the San Joaquin River and Caswell Memorial State Park on the Lower Stanislaus River (near its confluence with the San Joaquin River). Public picnic areas along Delta waterways can be found at Buckley Cove Park (on the DWSC), Dos Reis Park, Mossdale Crossing (on the San Joaquin River), and at Westgate Landing (on the Mokelumne River).

Habitat preserves and state and county parks (Dos Reis and Mossdale Crossing regional parks and Durham Ferry State Recreation Area) along the San Joaquin River provide recreational access (CDWR et al. 2013). The 7,000-ac San Joaquin River National Wildlife Refuge supports a mix of habitats that provide excellent conditions for wildlife and plant diversity. Visitor activities at the refuge include wildlife viewing, interpretation and environmental education, and photography. Formal fishing access and hunting opportunities are generally available in publicly owned parks or wildlife areas. Along some waterways, particularly along the DWSC, there are sandy beaches which are heavily used by boaters. Public boat launch facilities are available throughout the Delta, but a significant number of launches are associated with private marinas.

Changes in Land Use

With population growth in California above the national average, i.e., 2.1 percent versus 1.7 percent between 2010 and 2012,[88] changes in land use in the lower San Joaquin and Delta area are likely, but the nature and extent of those changes are uncertain. Urban development to accommodate population growth continues to occur in the counties of the Delta (CDWR et al. 2013). Limited housing supply and high home prices in the Bay Area have induced many Bay Area residents to relocate to Delta counties and commute long distances to work. As an example, since 1992, cities in San Joaquin County have annexed 27,769 acres, or 3 percent of the

[88] http://quickfacts.census.gov/qfd/states/06000.html

total area for urban development (CDWR et al. 2013). Additionally, population growth within and outside the Delta region will inevitably increase the amount of infrastructure that is required to support increases in residential, commercial, and industrial land development. Much of the land that will support this development will be acquired by conversion of agricultural lands.

California's focus on climate change and greenhouse gas reduction could also dramatically change the form of land use in the future (CDWR et al. 2013). Adopted on September 30, 2008, Senate Bill (SB) 375 is the State's first attempt to control greenhouse gas emissions by reducing urban sprawl. SB 375 links land use and transportation planning and encourages more compact, higher-density development through various incentives, including transportation funding and streamlined California Environmental Quality Act (CEQA) review. The bill has the potential to significantly change land use planning and growth patterns in and around the Delta region.

Increasing environmental management and recovery activities in the San Joaquin and Sacramento river basins and in the Delta region (e.g., related to water management, water quality, conservation/recovery of rare, threatened, and endangered or commercially-viable species, etc.) may also impact patterns of land use change (CDWR et al. 2013) (see Section 4.1.4.11, San Joaquin and Delta Aquatic Resources Management and Recovery Activities).

4.1.3.12 Fish Hatchery Practices

The first hatchery in the State of California, the Baird Hatchery on the McCloud River, was owned and operated by the U.S. Fish Commission from 1872-1883 and again from 1888-1935 (Leitritz 1970). During the twentieth century, hatcheries were constructed throughout the state to supplement declining native anadromous fish populations. CDFW is currently the principal agency responsible for managing and conserving fisheries in California. Fish are reared and released for recreational fishing and commercial harvest, conservation and restoration of native fish species, mitigation for habitat losses caused by development, and mitigation for fish lost at pumping facilities in the Delta. Hatchery production, particularly of Sacramento River fall-run Chinook salmon, contributes to major recreational and commercial fisheries in the ocean and inland areas (California HSRG 2012).

CDFW currently operates 21 hatcheries that raise a variety of trout and salmon. There are 11 hatcheries in California that produce Chinook salmon, coho salmon, and/or steelhead, nine of which were constructed to mitigate for the effects of dams (California HSRG 2012). Annual production of salmon and steelhead in California hatcheries approaches 50 million juveniles. During most years, over 32 million fall-run Chinook salmon are produced at five hatcheries in the Central Valley, and nearly 9 million are produced at two hatcheries in the Klamath-Trinity River basin. Initially, CDFW produced Chinook from eggs derived from out-of-state sources, but the practice was terminated due to concern over disease transmission (JHRC 2001), and for many years, California's hatcheries used out-of-basin broodstock or transferred fry among river basins (JHRC 2001).

CDFW currently stocks trout in high mountain lakes, low elevation reservoirs, and various streams and creeks. Salmon and steelhead have been stocked primarily in rivers, including direct tributaries to the Pacific Ocean. Chinook, coho, and kokanee have also been planted in reservoirs for sport fishing. CDFW currently stocks salmonids in over 500 locations in 25 counties (CDFW 2016b). Significant numbers of salmon from Central Valley hatcheries have been transported by truck to San Francisco Bay and released (JHRC 2001). For example, in 1999 the following releases of fall-run Chinook smolts were made downstream of the Delta: 5.88 million from the Feather River Hatchery; 3.8 million from the Nimbus Hatchery, and 1.72 million from the Mokelumne River Hatchery (JHRC 2001). Also in 1999, the Feather River Hatchery released 2.12 million of its spring Chinook smolts in San Pablo Bay (JHRC 2001). Releasing hatchery salmon downstream of the Delta is aimed at improving their survival and contribution to fisheries and reducing the potential for competition between hatchery smolts and naturally produced fish (JHRC 2001).

CDFW operates four hatcheries in the San Joaquin River basin: (1) the San Joaquin Hatchery in the town of Friant, (2) the Merced River Hatchery in the town of Snelling, (3) the Mokelumne River Hatchery in the town of Clements (see paragraphs below dedicated to individual hatchery programs), and (4) the Moccasin Creek Hatchery on Moccasin Creek (discussed in Section 4.1.3.6), a tributary to Don Pedro Reservoir. Fish species raised at these hatcheries include brook trout, Eagle Lake trout (*O. mykiss aquilarum*), golden trout (*O. aguabonita*), kokanee, rainbow trout/steelhead, Chinook salmon, brown trout, and Lahontan cutthroat trout (*O. clarkii henshawi*). Anadromous salmonids are also released from CDFW facilities in the Sacramento River basin, including fall-run Chinook salmon (the anadromous fish run that occurs in the Tuolumne River) produced at the Nimbus Hatchery. In addition, the San Joaquin River Restoration Program (SJRRP) operates the Interim Salmon Conservation and Research Facility (Interim Facility), located below Friant Dam on the San Joaquin River.

CDFW first stocked fish in the San Joaquin River basin in the 1930s, although planting locations were not always recorded (SCEC 2004). CDFW records indicate that 82 percent of the fish stocked in the South Fork of the San Joaquin River (above Friant Dam) were rainbow trout (SCEC 2004). Currently, only steelhead and Chinook salmon are released by CDFW into the lower San Joaquin, lower Merced, lower Mokelumne, and lower Tuolumne rivers. The SJRRP released juvenile Central Valley spring-run Chinook salmon into the San Joaquin River annually during 2014-2016.

The San Joaquin Hatchery, which began operating in 1954, is currently one of the largest hatcheries in the state (CDFW 2016c). Historical annual production was as high as 3,000,000 fingerlings, 20,000 sub-catchable fish, and 800,000 catchable fish, with a total weight of 165,000 pounds (Leitritz 1970). Currently, the hatchery raises brook trout, cutthroat trout, Eagle Lake trout, golden trout, kokanee, and rainbow trout (CDFW 2016d). Annual average production during 2004-2008 included approximately 6,000 brook trout (mostly fingerlings), 1,700 cutthroat trout (sub-catchable), 171,000 Eagle Lake trout (fingerlings, sub-catchable, and yearlings), 26,000 golden trout (fingerlings), 314,000 kokanee (fingerlings), and 1.2 million rainbow trout (primarily fingerlings and yearlings) (CDFG and USFWS 2010).

The Merced River Fish Hatchery, located just downstream of the Crocker-Huffman Diversion Dam and operated by CDFW, began production in 1970 (Merced Irrigation District 2012). The hatchery rears fall-run Chinook salmon and follows an integrated broodstock strategy. Broodstock consists of unsegregated, natural and hatchery-produced Chinook salmon that volitionally enter the hatchery's facilities. The original annual production targets for the facility were 960,000 fall-run Chinook salmon smolts and 330,000 yearlings. However the yearling program was discontinued due to losses from proliferative kidney disease. The current production target is 1 million smolts by late April to mid-May. Potential release locations include the Merced River at the hatchery, locations along the lower Merced River, and the lower San Joaquin River. A Hatchery Genetic Management Plan (HGMP) has not been prepared for the Merced River Fish Hatchery, and until a HGMP is completed, the hatchery will continue to operate according to the existing hatchery and stocking plan. Chinook salmon produced at the Merced River Fish Hatchery are routinely used for investigations in the San Joaquin River watershed, such as the previously conducted VAMP smolt survival evaluations, and have been stocked in the Stanislaus and Tuolumne rivers. The Merced Irrigation District and others voluntarily fund the coded-wire tagging of smolts produced at the hatchery.

The Mokelumne River Hatchery, constructed in 1963 by the East Bay Municipal District and remodeled in 2002, is currently used to raise Chinook salmon and steelhead (CDFW 2016e). Fish production is used to offset impacts to fisheries due to construction of Camanche Dam (ICF Jones & Stokes 2010). Chinook salmon broodstock used at the hatchery is of Central Valley origin, and steelhead broodstock is from the Feather River Hatchery, the American River, and Battle Creek (CDFW 2012). The annual smolt production target for fall-run Chinook salmon is 5 million, and approximately 2 million additional Chinook are raised to post-smolt size for an ocean enhancement program. The annual production goals for steelhead are 250,000 yearlings and smaller numbers of two-year-olds, which are released in groups of less than 2,000 individuals (California HSRG 2012). The normal Mokelumne River Hatchery release schedule is as follows: (1) fall-run Chinook salmon smolts are released from May through July into San Pablo Bay at 40–60 fish per pound and (2) steelhead yearlings are released from January through February into the lower Mokelumne River at four fish per pound.

4.1.3.13 Freshwater Salmonid Harvest

Commercial salmon fishing in California began in the early 1850s, coinciding with the influx of miners associated with the Gold Rush. By 1860, gill net salmon fisheries were well established in the lower San Joaquin River. Growth of this fishery was enhanced by the canning industry (CDFW 2013), and by 1880 there were 20 salmon canneries operating in the Sacramento and San Joaquin rivers, which increased fishing effort to maintain the supply of salmon. The salmon fishery reached its peak in 1882 when about 12 million pounds were landed and processed. Shortly thereafter, the fishery collapsed due to a sudden decline in salmon stocks caused by the pollution and degradation of rivers from mining, agriculture, and timber operations, combined with excessive fishing pressure. By 1919, the last inland salmon cannery had shutdown, and in 1957, the last remaining commercial river fishery closed in the Sacramento-San Joaquin basin (CDFW 2013).

In past years, sport fishing for trout, steelhead, and salmon was closed from the I-5 bridge at Mossdale upstream on the San Joaquin River (CDFG 2011). However, 2013–2014 regulations allow two hatchery trout or hatchery steelhead (four total possession limit) to be taken year round (CDFW 2013). Salmon fishing remains closed in the San Joaquin River, although some sport harvest takes place in the Delta.

4.1.3.14 Non-Native Species

Non-native species enter a region's aquatic systems in a variety of ways, most prominently through historical stocking by resource management agencies, illegal introductions by anglers, ballast water discharged from ships, and boating activities. The stocking of non-native fish species into California's waterways began nearly 150 years ago. Introduction of non-native species has resulted in large changes in the fish community structure of the Central Valley (Moyle 2002). Current fish communities in the lower reaches of the San Joaquin River tributaries and Delta are dominated by non-native taxa. Over 200 non-native species have been introduced in the Delta and become naturalized (Cohen and Carlton 1995), including many fish (e.g., smallmouth bass, largemouth bass, and striped bass) that prey on juvenile salmonids.

CDFW continues to manage some non-native fish species for recreational angling, such as black bass (open year round in the Delta with a five fish daily bag limit), striped bass (open year round in the Delta and lower San Joaquin River with a two fish limit), sunfish and crappie (open year round in the Delta with no size limit and a combined bag limit of 25), and catfish and bullhead (open year round in the Delta with no size or catch limit) (CDFG 2011).

The Delta, particularly the San Joaquin River between the Antioch Bridge and the mouth of Middle River and other channels in this area, are important spawning grounds for striped bass (CDFW 2014). Another important spawning area is the Sacramento River between Sacramento and Princeton (CDFW 2014). Sublegal striped bass, under 18 inches long, are found all year in large numbers upstream of San Francisco Bay, but their migratory patterns are poorly understood. After spawning, most adult striped bass move out of the rivers and into brackish and salt water for the summer and fall. However, some adult fish remain in freshwater during summer, and many anglers have caught striped bass at unexpected times and places (CDFW 2014).

4.1.3.15 San Joaquin River and Delta Aquatic Resources Management and Recovery Activities

There are numerous programs and efforts in the San Joaquin River Basin and Delta that have been completed, are currently underway, or are planned for the foreseeable future. These programs are likely to result in the establishment of new environmental mandates such as streamflow requirements, aquatic habitat restoration measures, and fish protection and recovery objectives. Cumulatively, these requirements could have effects on aquatic resources and threatened and endangered species in the lower San Joaquin River and the Delta.

Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of Central Valley Steelhead

In 2014, NMFS issued a final Recovery Plan (NMFS 2014)for the endangered Sacramento River winter-run Chinook salmon ESU, threatened Central Valley spring-run Chinook salmon ESU, and threatened Central Valley steelhead DPS. Implementation of the recovery plan is intended to improve the viability of these species so they can be removed from federal protection under the ESA. The recovery plan describes the steps, strategies, and actions projected to return the three species to viable status in the Central Valley, thereby ensuring their long-term (i.e., greater than 100 years) persistence and evolutionary potential.

The recovery plan establishes watershed- and site-specific recovery actions. Watershed-specific actions address threats occurring in each of the rivers or creeks that support spawning populations of the ESUs and/or DPS. Site-specific actions address threats to these species occurring within a migration corridor (e.g., the Delta). Recovery actions were identified using two recovery planning public workshops and a number of ecosystem and/or anadromous fish enhancement plans. Recovery actions that have been identified in the Delta include development of alternative water diversion operations and conveyance systems, large-scale habitat restoration, integration of existing restoration programs, non-native predatory fish control, Yolo Bypass floodplain and fish passage enhancements, modifications to long-term operations of the CVP and SWP, and new stream flow requirements. Recovery actions that have been identified in the mainstem San Joaquin River include restoring floodplain habitat, implementing ecological flow schedules, reducing contaminants and improving water quality, and improving juvenile outmigration for steelhead and future spring-run Chinook salmon at CVP and SWP facilities.

San Joaquin River Restoration Settlement Act

The San Joaquin River Restoration Program (SJRRP) is a direct result of a settlement reached in September 2006 to provide sufficient fish habitat in the San Joaquin River below Friant Dam. Parties to the Settlement include the U.S. Departments of the Interior and Commerce, the Natural Resources Defense Council (NRDC), and the Friant Water Users Authority (FWUA). The settlement received Federal court approval in October 2006. Federal legislation was passed in March 2009 authorizing Federal agencies to implement the settlement.

The settlement is based on two goals: (1) to restore and maintain fish populations in "good condition" in the mainstem of the San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish, and (2) to reduce or avoid adverse water supply impacts to all of the Friant Division long-term contractors that could result from the interim flows and restoration flows provided for in the settlement.

The SJRRP outlines a comprehensive long-term effort to provide flows in the San Joaquin River from Friant Dam to the confluence of the Merced River to restore a self-sustaining spring-run Chinook salmon fishery while reducing or avoiding adverse water supply impacts. The program calls for full restoration flows beginning in 2014.

Implementation of the 2009 San Joaquin River Restoration Settlement Act and SJRRP has had significant effects on stream flows in the basin.[89] Annual restoration flows in the San Joaquin River vary between 0 AF in dry years to more than 550,000 AF in wet years. Combined with other flows in the watershed upstream of the Merced River confluence, these restoration flows are anticipated to provide 275,000 to 750,000 AF of water in the San Joaquin River as measured

[89] Source: www.restoresjr.net

at the confluence with the Merced River, depending on hydrologic conditions. The flow schedule is designed to support spring-run Chinook salmon reintroduction and may not be compatible with efforts to improve conditions for other salmonid species in the Merced River and other tributaries in the San Joaquin River basin.[90]

Delta Water Quality Control Planning

Recognizing that many water issues in California involved both water quantity and quality, the California Assembly Committee on Water Pollution proposed a coordinated water regulatory program.[91] Concomitant statutory changes enacted in 1967 merged the State Water Quality Control Board and State Water Rights Board to form the SWRCB. In 1969, the California State Legislature enacted the Porter-Cologne Water Quality Control Act, which is the basis of current water protection efforts in California. In 1972, the State assumed responsibility for enforcing the federal CWA, which involved blending state and federal processes to regulate activities such as setting water quality standards and issuing discharge permits.

On August 16, 1978, the SWRCB adopted the 1978 Delta Plan and Decision 1485 (D-1485). The 1978 Delta Plan included water quality objectives intended to protect M&I, agricultural, and fish and wildlife beneficial uses in the Delta, and fish and wildlife beneficial uses in Suisun Marsh. The 1978 Delta Plan and D-1485 standards were based on the principle that Delta water quality should be at least as good as it would have been had the state and federal water projects not been constructed. The fish and wildlife standards in the 1978 Delta Plan and D-1485 were based on an agreement developed by CDWR, CDFW (then CDFG), the USBR, and USFWS. It was acknowledged that these standards did not afford a “without-project” level of protection for salmon, but the level of protection was believed to be reasonable until determinations regarding Delta mitigation measures were finalized.

D-1485 added conditions to the CVP’s and the SWP’s operating permits requiring that the projects meet applicable water quality objectives. In all SWP and CVP permits affecting the Delta, the SWRCB reserved jurisdiction to formulate or revise terms and conditions for salinity control and fish and wildlife protection, and to coordinate the terms and conditions between the two projects.

In 1985, some D-1485 standards were amended to modify or omit some monitoring stations in Suisun Marsh and to revise the schedule for implementation of salinity objectives. In May 1991, the SWRCB adopted the 1991 Bay-Delta Plan, which superseded water quality objectives in the 1978 Delta Plan and the San Francisco Bay and the Sacramento-San Joaquin Delta regional water quality control plans in instances where the existing plans conflicted with the 1991 Bay-Delta Plan. The 1991 Bay-Delta Plan contained a range of water quality objectives aimed at protecting beneficial uses. These objectives addressed (1) salinity levels for municipal and industrial intakes, Delta agriculture, water export agriculture, and estuarine fish and wildlife resources, (2) an expanded period of protection for striped bass spawning, and (3) temperature

[90] Section 10011(e) of the San Joaquin River Restoration Settlement Act requires the Secretary of Commerce to reserve its authority under Section 18 of the Federal Power Act for spring-run Chinook salmon for certain FERC projects until 2025, including those on the Tuolumne River such as the Don Pedro Project and the La Grange Project.

[91] Source: http://www.swrcb.ca.gov/about_us/water_boards_structure/history_water_policy.shtml

and DO levels for Delta fisheries. The 1991 Bay-Delta Plan did not include Delta outflow objectives and operational constraints. The flow and operational objectives in the 1978 Delta Plan remained in effect, implemented via D-1485. Beneficial uses and water quality objectives in the 1991 Bay-Delta Plan were submitted to EPA, which approved the objectives for M&I uses, agricultural uses, and DO for Fish and Wildlife in the San Joaquin River. However, all other fish and wildlife objectives were not approved by EPA, so relevant standards in D-1485 remained in effect.

In May 1995, the SWRCB adopted the 1995 Bay-Delta Plan, which was superseded by the 2006 Bay-Delta Plan, in instances where the 1995 plan conflicted with the 2006 plan. The 2006 Bay-Delta Plan included updates to address emerging issues that, because of changing circumstances or increases in scientific understanding, were either unregulated or not fully regulated by preceding plans. These issues included pelagic organism decline (pelagic fishes in the Delta Estuary and Suisun Bay), climate change, Delta and Central Valley salinity, and San Joaquin River flows. The 2006 Bay-Delta Plan included specific objectives related to the following variables: Delta outflow, flows in the Sacramento River at Rio Vista, flows in the San Joaquin River at Vernalis, export limits, Delta cross channel gates operation, and salinity.

Beginning on February 13, 2009, the SWRCB began updating and implementing the 2006 San Francisco Bay/Sacramento-San Joaquin Delta Estuary Plan (Bay-Delta Plan), particularly with regard to water quality and flow objectives and changes to water rights and water quality regulation consistent with the program of implementation. A technical report on the first phase of the project, Southern Delta Salinity and San Joaquin River flow objectives, was peer reviewed, and a final report was scheduled for release in early 2012. On January 24, 2012, the SWRCB issued a notice requesting additional information for the review of the Bay-Delta Plan.

The Bay-Delta Plan identifies beneficial uses of the Bay-Delta, water quality objectives for the reasonable protection of those beneficial uses, and a program of implementation for achieving the water quality objectives. The SWRCB recognizes that changing conditions may alter the flows needed to protect beneficial uses in the Bay-Delta. Changes in conditions that could affect flow needs include, but are not limited to, reduced reverse flows in Delta channels, increased tidal habitat, improved water quality, reduced competition from invasive species, changes in the points of diversion of the SWP and CVP, and climate change. The SWRCB will consider whether certain water quality objectives should be phased in over time and under what conditions that phasing should occur, in addition to what type of contingencies should be provided in the program if expected habitat improvements do not occur or if actions do not produce the expected results.

San Joaquin River TMDL Plans

Adoption of TMDLs required under the CWA § 303(d) has the potential to affect stream flows in the San Joaquin River. The SWRCB has initiated a comprehensive effort to address salinity and nitrate problems in the Central Valley and to adopt long-term solutions that will lead to enhanced water quality and economic sustainability. The Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) effort is a collaborative basin planning effort aimed at developing and implementing a comprehensive salinity and nitrate management program.

Additional San Joaquin River flows are being targeted to help dilute saline agricultural return waters and naturally occurring saline waters, pesticides, and other potentially toxic compounds and to reduce temperatures throughout the watershed. A partial list of San Joaquin River TMDLs is shown in Table 4.1-6 (SWRCB 2010).

Table 4.1-6. San Joaquin River TMDLs that may directly or indirectly affect flows and water quality (Source: SWRCB 2010).

Reach	Pollutant	Final Listing Decision
San Joaquin River (Tuolumne River to Stanislaus River)	Chlorpyrifos	Do Not Delist from 303(d) list (being addressed with EPA approved TMDL)
	DDT	List on 303(d) list (TMDL required list)
	Diazinon	Do Not Delist from 303(d) list (being addressed with EPA approved TMDL)
	Electrical Conductivity	List on 303(d) list (TMDL required list)
	Group A Pesticides	List on 303(d) list (TMDL required list)
	Mercury	List on 303(d) list (TMDL required list)
	Temperature, water	List on 303(d) list (TMDL required list)
	Unknown Toxicity	Do Not Delist from 303(d) list (TMDL required list)
San Joaquin River (Stanislaus River to Delta Boundary)	Chlorpyrifos	Do Not Delist from 303(d) list (being addressed with EPA approved TMDL)
	DDE	List on 303(d) list (TMDL required list)
	DDT	Do Not Delist from 303(d) list (TMDL required list)
	Diuron	List on 303(d) list (TMDL required list)
	Electrical Conductivity	Do Not Delist from 303(d) list (being addressed with EPA approved TMDL)
	Escherichia coli	List on 303(d) list (TMDL required list)
	Group A Pesticides	List on 303(d) list (TMDL required list)
	Mercury	List on 303(d) list (TMDL required list)
	Temperature, water	List on 303(d) list (TMDL required list)
	Toxaphene	List on 303(d) list (TMDL required list)
	Unknown Toxicity	Do Not Delist from 303(d) list (TMDL required list)
Sacramento-San Joaquin Delta	Chlordane	List on 303(d) list (TMDL required list)
	DDT	List on 303(d) list (TMDL required list)
	Dieldrin	List on 303(d) list (TMDL required list)
	Dioxin compounds	List on 303(d) list (TMDL required list)
	Furan Compounds	List on 303(d) list (TMDL required list)
	Mercury	List on 303(d) list (being addressed by EPA approved TMDL)
	PCBs	List on 303(d) list (TMDL required list)
	Selenium	List on 303(d) list (TMDL required list)

4.1.3.16 Bay-Delta Conservation Plan

The Bay-Delta Conservation Plan (BDCP) was developed to provide for water supply reliability and recovery of listed species through a Habitat Conservation Plan (HCP) under federal law and a Natural Community Conservation Plan (NCCP) under state law. The BDCP included a wide range of actions related to habitat restoration, protection, and enhancement; water conveyance facilities; water operations and management; monitoring, assessment, and adaptive management; costs and funding; and governance structure and decision-making.

The BDCP was developed to address ecological needs of at-risk Delta species, primarily fish, while improving and securing a reliable water supply. The BDCP was structured to be a comprehensive restoration program, consisting of conservation measures designed to improve the state of natural communities and in so doing improve the overall health of the Delta ecosystem. The BDCP attempted to balance species conservation with a variety of other important uses in the Delta. A draft of the BDCP was issued but withdrawn and replaced by the California Water Fix and EcoRestore programs (see below).

Delta Stewardship Council

In November 2009, the Sacramento-San Joaquin Delta Reform Act was passed by the California Legislature and signed by the governor. It established a State policy of coequal goals (i.e., providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem) for the Delta and created the Delta Stewardship Council as a new, independent agency to determine how goals would be met through development and implementation of the Delta Plan. The BDCP (see preceding section) is to be included in the Delta Plan providing it is approved by state regulatory agencies and meets certain additional criteria. Because the Delta is linked to many statewide issues, the Plan will address decisions pertaining to statewide water use, flood management, and the Delta watershed.

Biological and Conference Opinion on the Long-Term Operation of the CVP and SWP

On June 4, 2009, NMFS released the Biological and Conference Opinion on the Long-Term Operation of the CVP and SWP. The opinion included a series of alternatives to avoid jeopardy of the continued existence of Central Valley steelhead, among other species, and adverse modification of its designated critical habitat. Among the alternatives identified are significantly higher instream flows in the Stanislaus River, San Joaquin River minimum flow requirements at Vernalis, and Delta export limitations to protect out-migrating anadromous salmonids.

Although the opinion addressed only the combined CVP and SWP operations, it concluded that "the long-term viability of this diversity group [steelhead] will depend not only on implementation of this reasonable and prudent alternative (RPA), but also on actions outside this consultation, most significantly increasing flows in the Tuolumne and Merced rivers."

4.1.3.17 The Central Valley Project Improvement Act

As noted previously, the Ecosystem Restoration Program[92] has funded projects involving habitat restoration, floodplain restoration and/or protection, instream habitat restoration, riparian habitat restoration and protection, fish screening and passage projects, research on and eradication of non-native species and contaminants, research on and monitoring of fisheries, and watershed stewardship and outreach. An Environmental Water Account is used to offset losses of juvenile fish at the Delta pumps, and to provide higher instream flows in the Yuba, Stanislaus, American, and Merced rivers to benefit salmonids.

The Central Valley Project Improvement Act (CVPIA) added the purposes of fish and wildlife protection, restoration, and mitigation to the original CVP purposes of irrigation, domestic water use, fish and wildlife enhancement, and power augmentation. As part of the CVPIA, the following actions have been implemented: modifications of CVP operations, management and acquisition of water for fish and wildlife needs, flow management for fish migration and passage, increased flows, replenishment of spawning gravels, restoration of riparian habitats, screening of water diversions, and habitat restoration.

The Delta Pumping Plant Fish Protection Agreement and Tracy Fish Collection Mitigation Agreement

The Delta Pumping Plant Fish Protection Agreement and Tracy Fish Collection Mitigation Agreement mitigate for SWP pumping plant impacts by screening water diversions, enhancing law enforcement efforts to reduce illegal fish harvest, installing seasonal barriers to guide fish away from undesirable spawning habitat or migration corridors, and restoring salmon habitat. Mitigation has also included the removal of four dams to improve Chinook and steelhead passage on Butte Creek. Approximately one-third of the approved funding for salmonid projects specifically targets spring-run Chinook salmon and steelhead in upper Sacramento River tributaries.

4.1.3.18 CCSF Water System Improvement Program

On October 30, 2008, the SFPUC adopted a system-wide program, the Water System Improvement Program (WSIP, also known as the "Phased WSIP Variant") (SFPUC Resolution No. 08-200). The WSIP is a comprehensive program designed to improve the regional system with respect to water quality, seismic response, and water delivery based on a planning horizon through the year 2030. The WSIP also aims to improve the regional system with respect to water supply to meet water delivery needs in the service area through the year 2018.

The overall goals of the WSIP are to: maintain high-quality water, reduce vulnerability to earthquakes, increase delivery reliability and improve the ability to maintain the system, meet customer water supply needs, enhance sustainability in all system activities, and achieve a cost effective, fully operational system. To further these program goals, the WSIP also includes objectives that address system performance in the areas of water quality, seismic reliability, delivery reliability, and water supply.

[92] http://www.dfg.ca.gov/ERP

Under the WSIP, the SFPUC established the year 2018 as an interim mid-term planning horizon for its water supply strategy. Thus, the SFPUC made a decision about a water supply strategy to serve its customers through 2018, and is deferring a decision regarding long-term water supply after 2018 and through 2030 until it undertakes further water supply planning and demand analysis.

The WSIP includes the following key program elements:

- Full implementation of all 17 proposed WSIP facility improvement projects described in the Program Environmental Impact Report (PEIR).
- Water supply delivery of 265 million gallons per day (mgd) (average annual target delivery) to regional water system customers through 2018, with water supplies originating from the Tuolumne, Alameda, and Peninsula watersheds. This includes 184 mgd for wholesale customers (including 9 mgd for the cities of San Jose and Santa Clara) and 81 mgd for retail customers.
- Development of 20 mgd of conservation, recycled water, and groundwater within the SFPUC service area (10 mgd in the retail service area and 10 mgd in the wholesale service area).
- Dry-year transfer from the Modesto and/or Turlock Irrigation Districts of about 2 mgd coupled with the a conjunctive-use project to meet the drought year goal of limiting rationing to no more than 20 percent on a system-wide basis.
- Reevaluation of 2030 demand projections, potential regional water system purchase requests, and water supply options by 2018, as well as a separate SFPUC decision in 2018 regarding regional system water deliveries after 2018.

Under the WSIP, the SFPUC will deliver to customers up to 265 mgd from the SFPUC watersheds on an average annual basis. While average annual deliveries from the SFPUC watersheds would be limited to 265 mgd, such that there would be no increase in diversions from the Tuolumne River to serve additional demand, there would be a small increase in average annual Tuolumne River diversions of about 2 mgd over existing conditions to meet delivery and drought reliability goals through 2018.

Day-to-day operation of the regional water system under the WSIP would be similar to existing operations, but would provide for additional facility maintenance activities and improved emergency preparedness. This would allow the SFPUC to meet its WSIP objectives and provide for increased system reliability and additional flexibility for scheduling repairs and maintenance. The proposed operations strategy would also include a multistage drought response program. Under the WSIP, regional water system operations would continue to comply with all applicable institutional and planning requirements, including complying with all water quality, environmental and public safety regulations; maximizing the use of water from local watersheds; assigning a higher priority to water delivery over hydropower generation; and meeting all downstream flow requirements.

The California Water Fix

The California Water Fix is a proposal to improve the SWP and CVP freshwater storage and delivery systems, and involves the following primary elements: (1) construction and operation of new water conveyance facilities in the Delta, including three intakes, two tunnels, appurtenant structures, a permanent head of Old River gate, and expansion of the Clifton Court Forebay, (2) coordinated operation and maintenance of existing and new SWP and CVP Delta facilities, (3) resource conservation measures, and (4) a monitoring and adaptive management program. These improvements are being undertaken to help protect California's water supply from the effects of earthquakes, flooding, and rising sea levels; reduce waste of fresh water; and improve habitat for fish and wildlife.

California EcoRestore

The California Natural Resources Agency is implementing EcoRestore in coordination with other state and federal agencies to contribute to the restoration of at least 30,000 acres of Delta habitat by 2020. The science-driven objectives will be guided by an adaptive management program to pursue habitat restoration projects with well-defined goals and objectives and the financing needed to successfully implement the projects. Habitat types identified for restoration include tidal wetlands, floodplains, riparian areas, and uplands. Fish passage improvements and other projects are also elements of the program.

SWB Revised Draft Substitute Environmental Document

The SWB protects beneficial uses of water in the Bay-Delta via the 2006 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan). The SWB is proposing to amend two elements of the Bay-Delta Plan: (1) San Joaquin River flow objectives to protect fish and wildlife and (2) Southern Delta salinity objectives for the protection of agriculture. On September 15, 2016, the SWB released for public comment the Revised Draft Substitute Environmental Document (SED), which provides a description of these proposed amendments and the SWB's analysis of their potential effects. The flow element of the proposed amendments would, if adopted, require that increased flows remain in the San Joaquin River and its three major tributaries–the Stanislaus, Tuolumne, and Merced rivers–and would establish flow-related compliance locations on each of these major tributaries, in addition to the current flow compliance point located on the San Joaquin River at Vernalis. The Districts' comments on the SWB's September 2016 SED are included as Attachment D to this AFLA.

4.2 Geomorphology

Geomorphology in the Tuolumne River is cumulatively affected by a variety of anthropogenic actions within the Tuolumne River watershed (see Section 4.1 of Exhibit E for a discussion of in-basin actions), including in-channel and floodplain mining, hydrologic alteration resulting from water management activities associated with multiple dams, and sediment retention in reservoirs. The Don Pedro Project's primary purposes (water storage and supply for irrigation and M&I uses and flood control) contribute to these cumulative effects, but these effects diminish relative to other impacts, mainly those associated with aggregate mining, with increasing distance downstream of La Grange Diversion Dam. As a result, with greater distance downstream of the Don Pedro Project, it becomes increasingly difficult to isolate the effects of the Don Pedro Project's primary purposes on geomorphologic conditions in the river channel.

FERC's SD2 (page 35) identifies the following potential Don Pedro Project effects related to geomorphology in the Tuolumne River:

- Effects of project operation and maintenance on soil erosion and shoreline erosion at the project reservoir and stream reaches.
- Potential effects of any project-related changes in streamflow and sediment delivery to project stream reaches on stream geomorphic processes or reservoir bathymetry.
- Potential effects of project operations on large woody debris distribution and recruitment.

FERC's SD2 defines the geographic scope for geomorphology as extending upstream on the Tuolumne River to Hetch Hetchy Reservoir and downstream to the confluence of the Tuolumne and San Joaquin rivers. The temporal scope of the cumulative effects analysis includes past, present, and reasonably foreseeable future actions. FERC stated in it SD2 that based on the potential term of a new license, the temporal scope for analysis is to extend 30 to 50 years into the future, with concentration on resource effects resulting from reasonably foreseeable future actions. FERC notes that the historical discussion of cumulative effects is limited to the amount of available information for a given resource.

4.2.1 Effects of Mining, Hydrologic Alteration, and Sediment Retention on Tuolumne River Geomorphology

Prior to widespread European settlement, the channel form of the lower Tuolumne River consisted of a combination of single-thread and split channels that migrated and avulsed (McBain & Trush 2000). Variation in hydrologic and geological controls, primarily valley width and the location and elevation of underlying bedrock, resulted in variable and complex localized channel morphologies (McBain & Trush 2000). The riparian corridor was miles wide in places where the river lacked confinement (McBain & Trush 2000).

More than a century of anthropogenic impacts have altered the alluvial dynamics of the Tuolumne River. The cumulative effects of gold and aggregate mining, agricultural and urban encroachment, and a reduction in coarse sediment supply and high flows, have resulted in a relatively static channel within a floodway confined by dikes and agricultural uses.

4.2.1.1 In-Channel and Floodplain Mining

Prior to the construction of the major dams in the Tuolumne River basin, geomorphic conditions in the Tuolumne River were adversely affected by gravel and gold mining (TID/MID 2005) (see Section 4.1 for a summary of the chronology of historic and current actions within the defined geographic scope for cumulative effects).

Hydraulic mining, dredging, lode mining, and ore processing have left visible scars along the Tuolumne River and its tributaries upstream of Don Pedro Dam. Adverse impacts from acid mine drainage and ore processing have left trace metals, arsenic, iron, and mercury (Mount and Purdy 2010) at various locations in the watershed upstream of, and in the reach now impounded by, the Don Pedro Project.

In the lower Tuolumne River, stored bed material was excavated for gold and aggregate to depths below the river thalweg, resulting in sediment imbalances in the lower Tuolumne River channel, eliminating active floodplains and terraces, and creating large in-channel and off-channel pits (McBain & Trush 2000). By the end of the gold mining era, 12.5 miles of river channel and floodplain from RM 50.5 to RM 38 were dredged and converted to tailings piles, and much of the gravel-bedded zone (RM 52–24) of the river was converted to long, deep pools. More recently, in-channel excavation of sand and gravel created large, in-channel pits now referred to as Special Run Pools (SRPs). These SRPs are as much as 400 ft wide and 35 ft deep, occupying 32 percent of the channel length in the gravel-bedded zone.

Mining, in combination with other actions (addressed below), has resulted in a channel downstream of La Grange Diversion Dam that is characterized by downcutting, widening, armoring, and depletion of sediment storage features (e.g., lateral bars and riffles) (CDWR 1994; McBain & Trush 2004). Sequences of historical photos show that channel corridor width has been progressively reduced by mining and other land uses (McBain & Trush 2000), and channel migration has been substantially curtailed. Floodplain and terrace pits in the lower river are typically separated from the channel by narrow berms that can breach during high flows, resulting in capture of the river channel. The January 1997 flood caused extensive damage to dikes that separated deep gravel mining pits from the river, breaching or overtopping nearly every dike along an approximately 6-mile-long reach from RM 34.2 to RM 40.3 (TID/MID 2011).

4.2.1.2 Alteration of Hydrologic Conditions and Sediment Dynamics

Over the past 120 years, each increment of flow regulation (Wheaton, La Grange, O'Shaughnessy, old Don Pedro, and new Don Pedro dams along the mainstem and dams constructed along tributaries below O'Shaughnessy Dam, including Cherry and Eleanor Creeks) has modified the Tuolumne River's flow regime. Historically, Wheaton Dam and the present day La Grange Diversion Dam lacked the storage capacity needed to affect high flow conveyance to the lower Tuolumne River during winter and spring (McBain & Trush 2000). CCSF's Hetch Hetchy Project, the Districts' New Don Pedro Dam, and CCSF's Cherry Lake combined to reduce the magnitude and frequency of flood flows and snowmelt runoff to the lower Tuolumne River downstream of La Grange Diversion Dam.

Analyses of streamflow records from the USGS gaging station at La Grange (Station 11-289650) reveal the following alterations of hydrologic conditions: (1) annual water yield to the lower Tuolumne River below La Grange Diversion Dam has been reduced from an average unimpaired yield of 1,906,000 AF to 772,000 AF, a 60 percent reduction in volume; (2) the magnitude and variability of summer and winter baseflows, fall and winter storms, and spring snowmelt runoff have been reduced; and (3) the magnitude, duration, and frequency of winter floods have been reduced (McBain & Trush 2000). Following completion of the New Don Pedro Dam in 1971, compliance with ACOE flood control and other flow requirements reduced the estimated average annual flood (based on annual maximum series) from 18,400 cfs to 6,400 cfs. The 1.5-year recurrence event (approximately bankfull discharge) was reduced from 8,400 cfs to 2,600 cfs (McBain & Trush 2000). The reductions in flood frequency attest to the success of the Don Pedro Project's flood control purpose. At the same time, these changes in hydrology have had impacts on sediment supply and transport and, as a result, channel morphology.

Flow regulation associated with upstream dams may also affect riparian vegetation by modifying the hydrologic and fluvial processes that influence survival and mortality of riparian plants (TID/MID 2013a) As noted above, each increment of flow regulation (La Grange Diversion Dam, O'Shaughnessy Dam, Old Don Pedro Dam, New Don Pedro Dam) successively reduced the magnitude, duration, and frequency of flood flows, and removed key mortality agents, including scour, channel migration, flood-induced toppling, and inundation (McBain & Trush 2000). Reduced scour resulting from the flood control purposes of the Don Pedro Project allowed riparian vegetation to become established along the low water channel, where historically vegetation would have been absent, increasing sediment stability along the channel margin and influencing sediment dynamics in the channel as a whole.

Together, the dams on the Tuolumne River trap all coarse sediment and woody debris that would otherwise pass downstream to the lower Tuolumne River. Brown and Thorp (1947) estimated that 4,734 AF (7,637,520 yd^3) of sediment accumulated in Don Pedro Reservoir behind Old Don Pedro Dam during the 23-year period from 1923 to 1946 (McBain & Trush 2004). This estimated annual volume equates to an average total sediment and coarse-grained sediment deposition of approximately 431,601 tons/year and 43,160 tons/year, respectively. These estimates assume 100 percent trap efficiency, an average sediment density of 1.30 tons/yd^3, and an average coarse-to-total sediment ratio of 0.10 (Reid and Dunne 1996, Snyder et al. 2004). Sediment yield to Don Pedro Reservoir based on improved accuracies of measuring reservoir bathymetry conducted in 2011 is discussed in Section 4.2.2. Small tributaries downstream of La Grange Diversion Dam do not supply significant quantities of coarse sediment (McBain & Trush 2004).

Fine (predominantly <2 mm) bed material (FBM) is supplied to the lower Tuolumne River primarily by three tributaries downstream of La Grange Diversion Dam (Gasburg, Dominici, and Peaslee Creeks) and by bank and floodplain erosion. Gasburg Creek (RM 50.3) and Peaslee Creek (RM 45.5) have relatively large input potential, and Lower Dominici Creek (RM 47.8) has moderate input potential (McBain & Trush 2000). These assessments were based in part on the size of deltas observed at each of the tributary mouths, believed to have been deposited on the receding limb of the January 1997 flood.

The January 1997 flood eroded approximately 500,000 yd^3 of sediment from the spillway channel at Don Pedro Dam, depositing sediment behind La Grange Diversion Dam and a large volume of fine sediment in downstream reaches of the Tuolumne River (McBain & Trush 2000, 2004). In June 2001, discrete fine sediment deposits in the channel were mapped from the USGS gauging station near La Grange Diversion Dam (RM 52.1) downstream to Roberts Ferry Bridge (RM 39.6) (Stillwater Sciences 2002). The results of the survey were used to estimate fine sediment storage in pools and other discrete deposits and estimate the relative contribution of fine sediment from tributaries. Survey results indicate that fine sediment constituted a large fraction of the channel bed surface. Discrete fine sediment deposits were more common in pools from Basso Bridge (RM 47.5) to Peaslee Creek (RM 45.5) than in upstream reaches, and the largest volumes of fine sediment were observed from Peaslee Creek to Roberts Ferry Bridge (RM 39.5). Gasburg Creek and Peaslee Creek appeared to be the largest contributors of fine sediment in the surveyed reach.

Sediment source analyses conducted for the Gasburg Creek watershed in 2003 and 2004 indicated that the tributary supplied approximately 1,203 yd^3 of fine sediment annually to the Tuolumne River (Stillwater Sciences 2004, PWA 2004). The Gasburg Creek Fine Sediment Reduction Project was implemented in 2007 to reduce fine sediment delivery from a deeply incised gully (the dominant erosion feature identified in the watershed) and to modify the Gasburg Creek floodway extending from the MID canal culvert downstream to approximately Old La Grange Road (Laird 2005, McBain & Trush 2007). Beginning on January 6, 2008, the lower Tuolumne River experienced several episodes of high turbidity resulting from fine sediment input from the Peasley Creek watershed. Following the event, the Districts conducted turbidity monitoring, bulk sediment sampling, photo-monitoring, and benthic invertebrate sampling in the Tuolumne River in the vicinities of the Peasley Creek confluence and Bobcat Flat (located approximately 2 miles downstream of the Peasley Creek confluence) to document any effects related to the increased fine sediment supply (McBain & Trush 2008). In addition to the episodes of elevated fine sediment delivery from Peaslee Creek, several small dams that impounded fine sediment in Lower Dominici Creek failed in February 2006, releasing fine sediment to downstream reaches (CRWQCB 2006 as cited in Stillwater Sciences 2006).

Most woody debris captured in Don Pedro Reservoir is small, and it appears that the majority of it would pass through the lower river during higher flows if it were not trapped in the reservoir (TID/MID 2017b). The lower Tuolumne River between RM 52 and 26 has channel widths averaging 119 feet, and woody debris would have a limited effect on channel morphology in this reach (TID/MID 2017b). It is unknown, however, to what extent smaller pieces of wood might add to existing wood accumulations or initiate small jams in the lower river, thereby possibly influencing channel sediment dynamics.

4.2.2 2012 Spawning Gravel Study in the Lower Tuolumne River

To assess the contribution of the overall Don Pedro Project’s continued presence and operation to cumulative effects to the supply, transport, and storage of coarse and fine sediment downstream of La Grange Diversion Dam, the Districts conducted a study in 2012 of spawning gravel in the lower Tuolumne River (TID/MID 2013d). Results of this study update information from prior studies to address the following objectives:

- Estimate average annual sediment yield to Don Pedro Reservoir based on reservoir sedimentation,
- Estimate changes in the volume of coarse (> 2 mm) bed material stored in the lower Tuolumne River channel over the 2005–2012 period,
- Map current FBM (predominantly < 2 mm) in the lower Tuolumne River channel and compare results to those of surveys conducted in 2001 (Stillwater Sciences 2002), and

- Develop a reach-specific coarse sediment budget to determine any cumulative effects of the Don Pedro Project on Don Pedro Project-affected reaches of the lower Tuolumne River.

In addition, the Districts conducted the Don Pedro Reservoir Bathymetric Study (HDR 2012) to develop an accurate geometry of Don Pedro Reservoir and update the reservoir's elevation-storage curve.

The results of the Districts' 2012 Spawning Gravel in the Lower Tuolumne River study (TID/MID 2013d) and bathymetric study are provided in the following subsections.

4.2.2.1 Average Annual Sediment Yield to Don Pedro Reservoir

Comparison of storage capacity curves for Don Pedro Reservoir in 1971 and 2011 indicates that there has been 15,694 AF (25,319,653 yd^3) of storage loss due to sedimentation since closure of the Don Pedro Dam, which represents less than 1 percent of the original storage capacity of Don Pedro Reservoir in 1971 (HDR 2012; TID/MID 2013d). Average annual total and coarse (>2 mm) sediment yields to the reservoir, calculated over the 1923–2011 period, are approximately 373,966 tons/year and 37,397 tons/year, respectively. These estimates are within 13 percent of estimates based on reservoir storage capacity changes during the period 1923–1946 reported by Brown and Thorp (1947) and are comparable to sediment yields estimated for other reservoirs on the western slope of the Sierra Nevada.

4.2.2.2 Changes in Volume of Bed Material Stored in the Lower Tuolumne River, 2005–2012

Previous studies have estimated the minimum threshold for significant bed mobility in the lower Tuolumne River to be 5,400–6,880 cfs (McBain & Trush 2000, 2004), with an average annual bedload transport rate of 1,930 tons/year based on an empirically derived bedload rating curve (McBain & Trush 2004). Sediment transport modeling has estimated a similar average annual bedload transport rate of 1,412 tons/year (McBain & Trush 2004). The following indicators suggest a deficit in coarse sediment supply relative to bedload transport downstream of La Grange Diversion Dam (CDWR 1994, McBain & Trush 2004):

- Channel cross section surveys indicate that the channel is wider than expected in many reaches, lacks bankfull channel confinement, and has cross sectional dimensions that are not adjusted to the contemporary flow regime.
- SRPs deprive downstream reaches of sediment by trapping all particles larger than coarse sand (4 mm), provide little or no high quality salmonid habitat, and provide suitable habitat for non-native piscivores that prey on juvenile salmonids (McBain & Trush 2000).

The coarse sediment budget developed through sediment transport modeling and analysis of changes in bed topography (TID/MID 2013d) indicates that without gravel augmentation, the channel in the first 12.4 miles downstream of La Grange Diversion Dam would be slowly degrading in response to a reduction in coarse sediment supply by upstream dams. Between 2005 and 2012, approximately 5,913–8,720 tons of coarse (>2 mm) bed material was lost from storage between RM 45.8 and 52.1, an area that encompasses the Dominant Salmon Spawning

Reach (i.e., RM 46.6–RM 52.1) (TID/MID 2013d). Gravel augmentation has helped increase coarse sediment storage in the reach, and 94 percent of the coarse sediment added through augmentation has been retained within that reach.

Differencing of channel topography surveyed in 2005 and 2012 shows that little change in storage occurred during this period at the reach scale, but that high-flow events in WY 2006 and WY 2011 locally scoured the bed and redistributed coarse and fine sediment deposits (TID/MID 2013d). Pools commonly scoured 3 to 5 feet, mobilizing finer sediment to depositional areas in channel margins and coarser sediment to pool tails and riffles, where 1 to 3 feet of aggradation is commonly observed. The total estimated volume lost from storage in the reach that extends from RM 45.8 and 52.1 is comparable in magnitude to the quantity of coarse sediment added during any one of the augmentation projects (approximately 7,000–14,000 tons) that have occurred since 2002.

The results of sediment transport modeling and topographic differencing suggest that augmentation material is being mobilized short distances during infrequent high-flow events (e.g., during WY 2006 and WY 2011), but that routing is slow due to low bedload transport capacity. Prolonged retention of augmented coarse sediment may allow the gravel framework to fill with fine sediment.

4.2.2.3 Fine Bed Material Deposits in the Lower Tuolumne River

The total volume of discrete FBM (predominantly <2 mm) deposits in the reach from La Grange Diversion Dam (RM 52.1) to Roberts Ferry Bridge (RM 39.6) decreased by 48 percent from 2001 (Stillwater Sciences 2002) to 2012. Discrete FBM deposits mapped in 2012 were distributed nearly equally among pool margins, channel margins, and alcoves and backwaters but were more frequent and larger immediately downstream of Gasburg and Peaslee creeks, suggesting that supply from these tributaries continues to be an important source of fine sediment to the lower Tuolumne River channel (TID/MID 2013d).

4.2.2.4 Riffle Area in the Lower Tuolumne River

A total of 3,527,200 ft^2 of riffle mesohabitat was mapped from RM 52.1 to RM 23 in 2012, of which 2,967,500 ft^2 (84%) was occupied by spawning gravel (TID/MID 2013d). The particle size distribution of spawning gravel deposits was relatively uniform, with an average estimated D50 of 51 mm. Comparing the results of riffle surveys conducted in 1988 and 2012 suggests that riffle area increased by 606,200 ft^2 (21%). However, comparing the 2001 and 2012 surveys suggests a more significant increase of 709,500 ft^2 (54%). Increases in riffle area from 2001 to 2012 are largely attributed to differences in the methods used to map riffles over time (e.g., variability in the discharge and wetted channel area in aerial photographs used in desktop mapping and during field surveys, mapping criteria based on flow depth and gravel substrate, and accuracy and precision of riffle delineation [see Section 5.4.1 of TID/MID 2013d]). Although differences in riffle area are likely attributed to methodological differences, pool scour and associated deposition of coarse sediment in pool tails and riffles during high flow events in WY 2006 and WY 2011 increased the size and modified the distribution of riffle mesohabitats.

4.2.3 Cumulative Effects of the Proposed Action on Fluvial Geomorphology

Continued hydroelectric power generation at Don Pedro Dam would not contribute to cumulative effects on fluvial geomorphology in the lower Tuolumne River. Electric power is generated at the Don Pedro Hydroelectric Project using flows released for other purposes. Irrigation, municipal, and industrial water deliveries and high-flow releases are pre-scheduled based on forecasted demands and actual projected inflow and then released through the powerhouse up to its hydraulic capacity. Scheduling of these releases is adjusted, when consistent with water supply needs, to release flows for hydroelectric energy generation with a preference for on-peak power demand rather than off-peak hours. However, these "peaking" flows are modulated, being subject to water supply demand and limits on water fluctuations in the Districts main canals. Flows in the reach of the Tuolumne River below La Grange Diversion Dam are not subject to such fluctuations as the fluctuations travel down and are absorbed by the Districts' main canals and irrigation water needs, which are unrelated and non-interdependent actions e.g., providing water for irrigation and M&I uses. Hydroelectric generation at the Don Pedro Hydroelectric Project cannot impact resources in the lower Tuolumne River, because the flows released into the lower Tuolumne River are not linked to power production and, absent power production at Don Pedro Dam, the flow release schedule, including flows to the lower Tuolumne River, will remain the same as it is under existing conditions, i.e., driven by uses other than hydroelectric power production.

4.2.3.1 Augment Current Gravel Quantities through a Coarse Sediment Management Program

Although gravel availability is not currently a factor limiting salmonid spawning success in the lower Tuolumne River, Don Pedro Reservoir captures gravel, preventing its movement downstream, which has contributed to the net loss of gravel supply to the lower Tuolumne River. Also, the reservoir's ongoing operations affect flow magnitude and frequency downstream of the dam, and this affects gravel mobilization, which can lead to the deposition of fines in gravel interstices (TID/MID 2013d, W&AR-04).

The Districts propose to conduct gravel (i.e., coarse sediment) augmentation from RM 52 to RM 39 over a 10-year period following issuance of a new license. Coarse sediment to be added to the river channel would range in size from 0.125–5.0 inches in diameter. The recommended short-term gravel augmentation sites, in order of priority, would be: (1) Riffle A3/4, (2) Riffle A5/6, (3) Basso Pool, and (4) Riffle A1/2[93] (see Section 3.5.4 of this Exhibit E for more detail on site locations). Estimated preliminary gravel volumes and spawning gravel areas are shown in Table 4.2-1, and preliminary gravel augmentation designs are provided in Appendix E-1, Attachment A to this Exhibit E.

[93] Riffle A1/2 is located just downstream of the confluence of the main stem and the La Grange tailrace.

Table 4.2-1. Preliminary gravel augmentation volumes and spawning gravel areas (at 320 cfs) downstream of La Grange Diversion Dam (RM 52) in the Tuolumne River.

Riffle Location	RM	Volume (yd^3)	Tons	Wetted Area (ft^2)
A2	51.7	450	585	6,450
A3	51.5	4,300	5,590	43,640
A5	51.2	11,500	14,950	120,960
A6	51.0	18,600	24,180	100,460
Basso Upper	46.5	20,500	26,650	190,890
Basso Lower	46.2	2,300	2,990	80,269
	Totals	**57,650**	**74,945**	**542,669**

Gravel augmentation conducted at discrete locations from RM 52 to RM 39 would result in minor, localized changes in the composition of bed material at and immediately downstream of the augmentation sites, thereby contributing positively to cumulative effects in the lower river. Although gravel would route downstream during higher flows, the augmentation volumes would not be sufficient to have pronounced longitudinal effects on geomorphology.

4.2.3.2 Gravel Mobilization Flows of 6,000 to 7,000 cfs

Flows ranging from 6,000–7,000 cfs (measured at USGS gage 11289650 below La Grange Diversion Dam) would be released to mobilize gravel and fines to improve salmonid spawning habitat. These flows would be provided for at least two days during a given year at an estimated average frequency of once every three to four years, i.e., during years when sufficient spill is projected (E-1, Attachment G) (TID/MID 2017c, W&AR-02). In years when the La Grange gage spring (March through June) spill is projected to exceed 100,000 ac-ft, the Districts would plan to release a flow of 6,500 cfs for two days within the spill period, with down-ramping not to exceed 300 cfs/hr.

Potential geomorphic effects of this measure, which would contribute positively to cumulative effects in the lower Tuolumne River, include (1) reduced fine sediment storage in the low-flow channel, (2) increased fine sediment storage on floodplains, and (3) a net increase in lateral channel migration, bar formation, and large wood introduction, which together could create new floodplains and complex hydraulic environments.

4.2.3.3 Gravel Cleaning

To expand the availability of high-quality gravel for salmonid spawning, the Districts propose to conduct a five-year experimental program of gravel cleaning using a gravel ripper and pressure wash operated from a backhoe, or equivalent methodology. Each year of the program would consist of three weeks of cleaning select gravel patches. No substantial longitudinal or lateral movement of coarse substrate is expected to result from implementation of this measure, and as a result no significant contribution to cumulative effects on geomorphic conditions are expected.

4.2.3.4 Improve Instream Habitat Complexity

To improve salmonid habitat, the Districts propose to place boulder-size stone (approximately 0.7-1.5 yd^3) between RM 42 and 50 over a four-year period. A maximum of 200 boulders would be placed. This measure is expected to increase structural and hydraulic complexity and result in localized scour that will displace fines from gravel beds. Geomorphic effects of this measure would be localized but would contribute positively to overall geomorphic conditions in the lower Tuolumne River.

4.2.3.5 Outmigration Pulse Flows (April 16 – May 31)

To encourage smolt outmigration and increase survival, pulse flows would be provided to coincide with periods when large numbers of parr- or smolt-size fall-run Chinook are present in the lower river. Depending on the volume of the pulse flows, limited bed movement could occur, most likely displacement of fine material from portions of some gravel beds. The net effects of these flows on geomorphic conditions would be negligible.

4.2.3.6 Hydrograph Shaping

In spill years, the Districts would make reasonable efforts to shape the descending limb of the snowmelt runoff hydrograph to mimic natural conditions. Floodplain inundation along the lower Tuolumne River is initiated at a flow of approximately 1,100 cfs. Based on flows in the 1971–2012 period, the Proposed Action would result in flows at the La Grange gage greater than 1,500 cfs from February through July in 28 years (or more than 60 percent of the years). Flows exceeding 2,500 cfs would occur in 45 percent of the years in that period. If spill conditions allow, streamflow recession rates would be managed during the cottonwood seed dispersal period to provide soil moisture conditions that allow seeds to take up water, germinate, and form roots. Over the long-term, increased recruitment of native trees and shrubs could increase bank stability and potentially reduce the amount of fine sediment entering the channel in locations where vegetation becomes established. The measure could lead to an increase in the volume of LWD contributed to the river channel, which would influence hydraulics and result in greater channel complexity. The effects of promoting the recruitment of LWD and reducing erosion would contribute positively to cumulative geomorphic effects in the lower Tuolumne River.

4.3 Water Resources

FERC's SD2 (page 35) identifies the following potential Don Pedro Project effects related to water resources in the Tuolumne River:

- Effects of Project operation on the quantity and timing of streamflow in the project-affected downstream reach, including water storage, peaking operations, and ramping rates
- Potential effects of project operation and maintenance on water quality, water temperature, and water quantity in the project reservoir and the project-affected downstream reach

For water resources, FERC defines the geographic scope of cumulative effects as extending upstream on the Tuolumne River to Hetch Hetchy Reservoir and downstream to San Francisco Bay. FERC noted that based on the potential term of a new license, the temporal scope should include reasonably foreseeable actions extending 30 to 50 years into the future. Assessment of past actions that have contributed to cumulative effects on water resources is necessarily limited by the availability of information.

Water quantity and water quality within the geographic scope of the cumulative effects analysis are affected by a myriad of actions within and outside the Tuolumne River basin (see Section 4.1 of Exhibit E for a discussion of these actions), including in-channel and floodplain mining; water storage and diversion at numerous dams; and a variety of land uses, including agriculture and industrial development. The Don Pedro Project's primary purposes (water storage and supply for irrigation and M&I uses and water management for flood control) do contribute to cumulative effects, but these effects diminish relative to other impacts, such as those associated with other water management projects and land uses in the San Joaquin basin, with increasing distance downstream of the Don Pedro Project. As a result, with greater distance downstream of the Don Pedro Project, it becomes increasingly difficult to isolate the effects of the Don Pedro Project's primary purposes of water supply and flood control on water resources.

Within the geographic scope identified by FERC, major actions (in addition to the existing Don Pedro Project) that contribute or have contributed to cumulative effects on water quantity and/or water quality are listed below (descriptions of the history and nature of these actions are provided in Section 4.1 of this Exhibit E):

- CCSF's Hetch Hetchy water system (1923–present) on the upper Tuolumne River, which is used for water supply and hydroelectric generation, including construction of the San Joaquin Pipeline with a capacity to deliver up to 484 cfs, or 313 mgd, to the 2.6 million people CCSF supplies in the Bay Area,
- The Districts' original Don Pedro Project (1923–1971), which had about 300,000 AF of water storage for irrigation,
- Construction and operation of the Districts' La Grange Diversion Dam (1893–present) located about 2 miles downstream of Don Pedro Dam. The purpose of the diversion dam is to raise the level of the Tuolumne River to enable diversion of water into TID's and MID's canal systems, which provide water for irrigation and M&I uses,
- Flood control operations by the ACOE or under ACOE guidelines on the San Joaquin River and its tributaries,
- In-channel river dredging and modification of the Tuolumne River's floodplain for gold mining and aggregate extraction (1850–present),
- Operational spills from irrigation systems and runoff from farms into the Tuolumne River, Dry Creek, and the San Joaquin River (1890s–present),
- Diversion and pumping of water by riparian water users along the lower Tuolumne River (1880s–present),
- Groundwater accretion/depletion along the Tuolumne River (1880–present),
- Riparian diversions along the San Joaquin River and in the Delta (1880–present),
- Construction and operation of major storage reservoirs in the San Joaquin, Merced, Stanislaus, and Mokelumne river basins (1920s–present),

- Construction and operation of major water diversions, pumping, and canal delivery systems in the San Joaquin River and Delta (1940s–present), including the California Aqueduct, Friant Kern system, and Delta Mendota Canal,
- Development and operation of the Stockton Deep Water Ship Channel on the San Joaquin River (1930–present),
- Urbanization and its resulting pollution along the San Joaquin River and its tributaries and within the Delta,
- Use of pesticides, herbicides, and fertilizers to support agriculture,
- Development and expansion of wastewater systems to support urban development,
- Some of the Districts' proposed lower river aquatic resource measures, and
- Climate change.

In addition to the actions listed above, there are numerous minor actions (e.g., levees for flood control, water withdrawals and wastewater discharges for industrial use) that also contribute to cumulative effects on water resources. The complexity and co-occurrence of past, present, and potential future actions in the San Joaquin River, it tributaries, and the Delta make it very difficult, and in many instances impossible, to isolate specific contributions, particularly quantitatively, to cumulative effects on water resources associated with individual actions.

4.3.1 Water Quantity

Major factors contributing to cumulative effects on the hydrology of the Tuolumne River include the operation of CCSF's Hetch Hetchy system, the operation of the Don Pedro Project for water storage and flood control, the diversion of water at La Grange Diversion Dam to the Districts' irrigation systems for irrigation and M&I uses, irrigation return flows in Dry Creek and along the lower Tuolumne River, and riparian water withdrawals along the lower Tuolumne River.

CCSF's diversion of 250,000 AF of water from the watershed affects both the quantity of water available in the watershed and the timing of flows in the Tuolumne River. CCSF's dams and reservoirs regulate approximately 50 percent of the Tuolumne River's flows above Don Pedro Reservoir. CCSF's regulation can affect Tuolumne River flows during low, normal, and moderately high-flow conditions. CCSF's historical average diversion is about 12 percent of the total average unimpaired flow of the Tuolumne River at La Grange Diversion Dam. During drought years, if CCSF uses credits available to it in the water bank, the only inflow to Don Pedro Reservoir can be that originating in the unregulated portion of the Tuolumne River along with minimum flow releases made by CCSF.

Based on data from the Tuolumne River Operations Model, the operation of the Districts' Don Pedro Reservoir primarily affects the timing of flows in the lower Tuolumne River below Don Pedro Dam (Figure 4.3-1). Reservoir inflows can be less than 100 cfs, but outflows are very seldom less than 200 cfs. A primary function of Don Pedro Reservoir is to store water during higher flows for later release during the irrigation season, with the highest releases for consumptive use purposes occurring in July and August, when the median reservoir inflow is about 500 to 600 cfs and the median outflow is about 2,700 cfs. As Figure 4.3-1 indicates, inflows can exceed 4,000 cfs about 20 percent of the time, whereas outflows exceed 4,000 cfs about 14 percent of the time. Operation of the Don Pedro Project results primarily in seasonal differences between inflows and outflows due to monthly and annual storage carryover in the reservoir, but except for evaporation losses, long-term inflow must equal long-term outflow. These seasonal differences are illustrated by the examples shown in Figures 4.3-2 and 4.3-3, which depict the February and August flow magnitudes and frequencies of reservoir inflows and outflows.

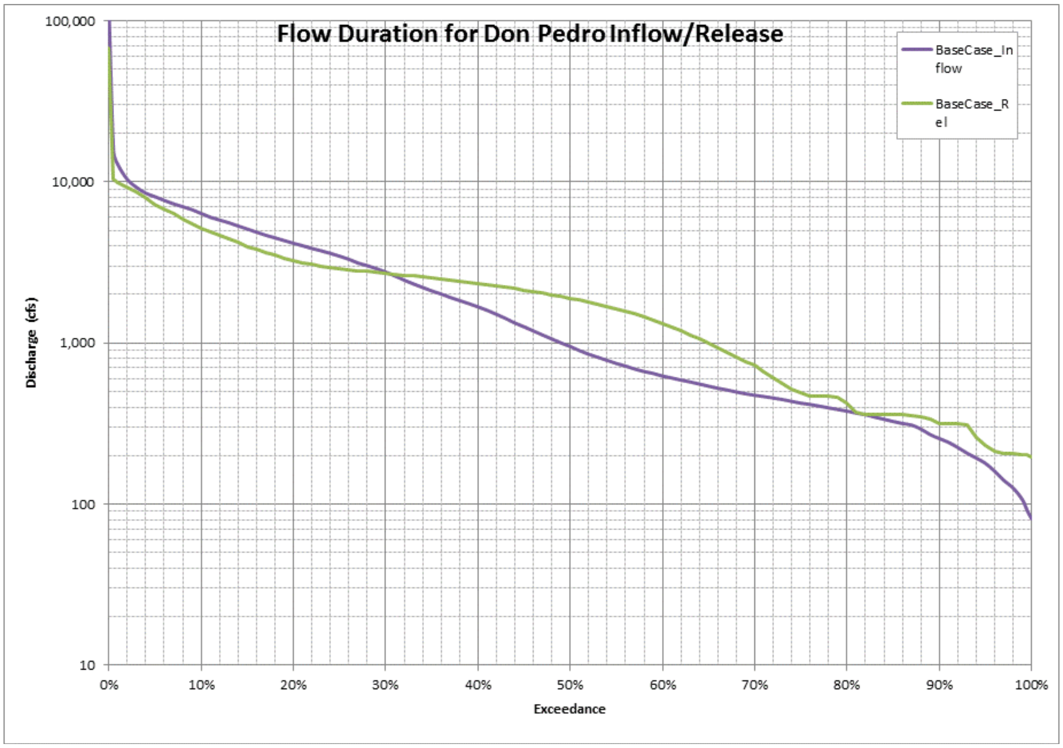

Figure 4.3-1. Don Pedro Reservoir annual inflow and outflow, 1971–2012.

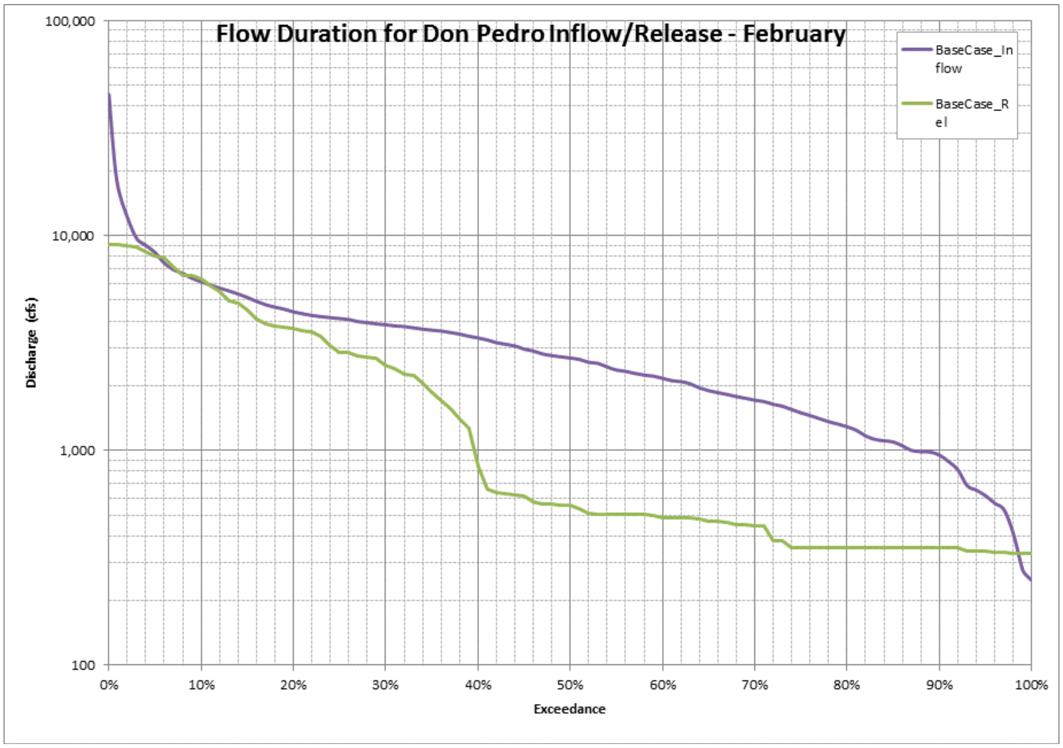

Figure 4.3-2. Don Pedro Reservoir February inflow and outflow, 1971–2012.

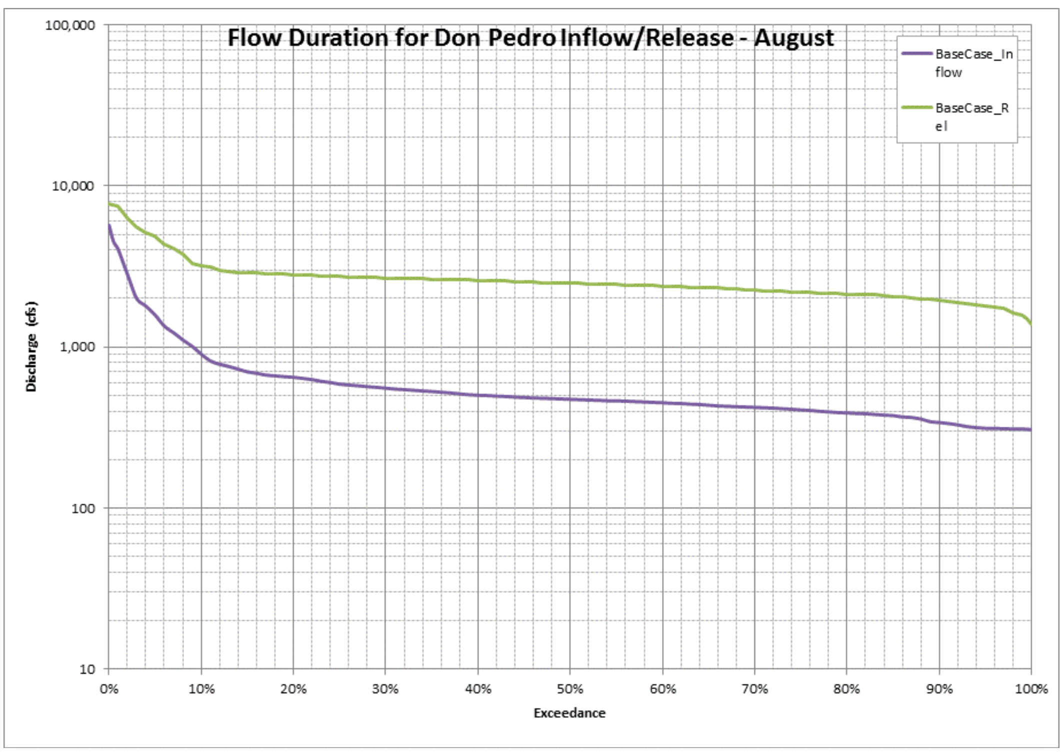

Figure 4.3-3. Don Pedro Reservoir August inflow and outflow, 1971–2012.

It is the operation of the Districts' 120-year-old La Grange Diversion Dam that has the most pronounced effects on water quantity in the lower Tuolumne River from RM 52.2 to the confluence with the San Joaquin River. This can be shown by the differences in flows released at the Don Pedro Project and those recorded at the USGS gage at La Grange. Figure 4.3-1 shows the median annual outflow from Don Pedro to be approximately 1,900 cfs. The median flow recorded at the USGS La Grange gage using 1997–2012 gage data is 325 cfs (Figure 4.3-4). The release from Don Pedro exceeds 300 cfs approximately 93 percent of the time, while the flows at the La Grange gage exceed 300 cfs 55 percent of the time (Figure 4.3-4). Inflows to Don Pedro Reservoir exceed 4,000 cfs about 20 percent of the time. Flows greater than 4,000 cfs are released from Don Pedro about 14 percent of the time, whereas flows greater than 4,000 cfs occur at the La Grange gage about 10 percent of the time.

The 1913 Raker Act required CCSF to recognize the prior water rights of the Districts. The Act requires that CCSF release 2,350 cfs or the unimpaired flow, whichever is less, year round, and up to 4,000 cfs for 60 days beginning April 15, whenever such water may be beneficially used. The Fourth Agreement requires CCSF to recognize an additional water right of 66 cfs, which is additive to the Districts' Raker Act entitlements. The Districts divert the flows they are entitled to under their water rights at La Grange Diversion Dam into the MID and TID canal systems. Therefore, absent the Don Pedro Project, the Districts are entitled to divert at La Grange Diversion Dam 100 percent of the unimpaired flow of the river, up to the capacity of their water rights. Diversions by the Districts' full water right entitlement at La Grange Diversion Dam would, absent Don Pedro Dam, leave the lower Tuolumne River without water during a substantial portion of the year (Figure 4.3-5).

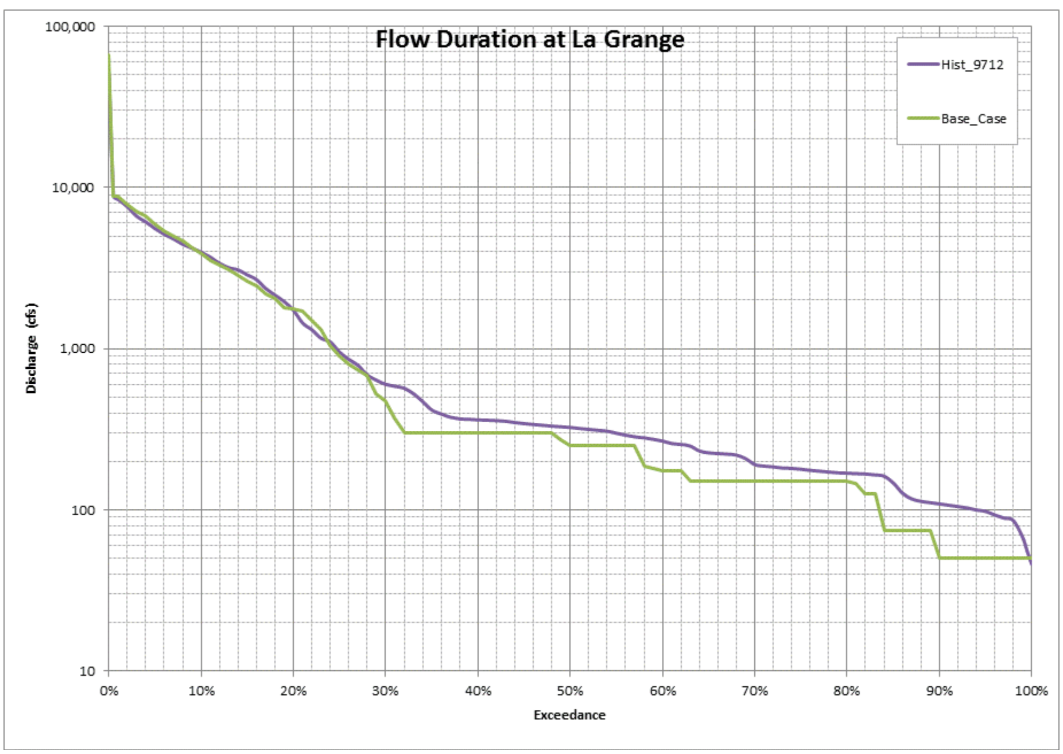

Figure 4.3-4. Historical (1997–2012) and modeled Base Case (1971–2012) flows at the USGS La Grange gage.

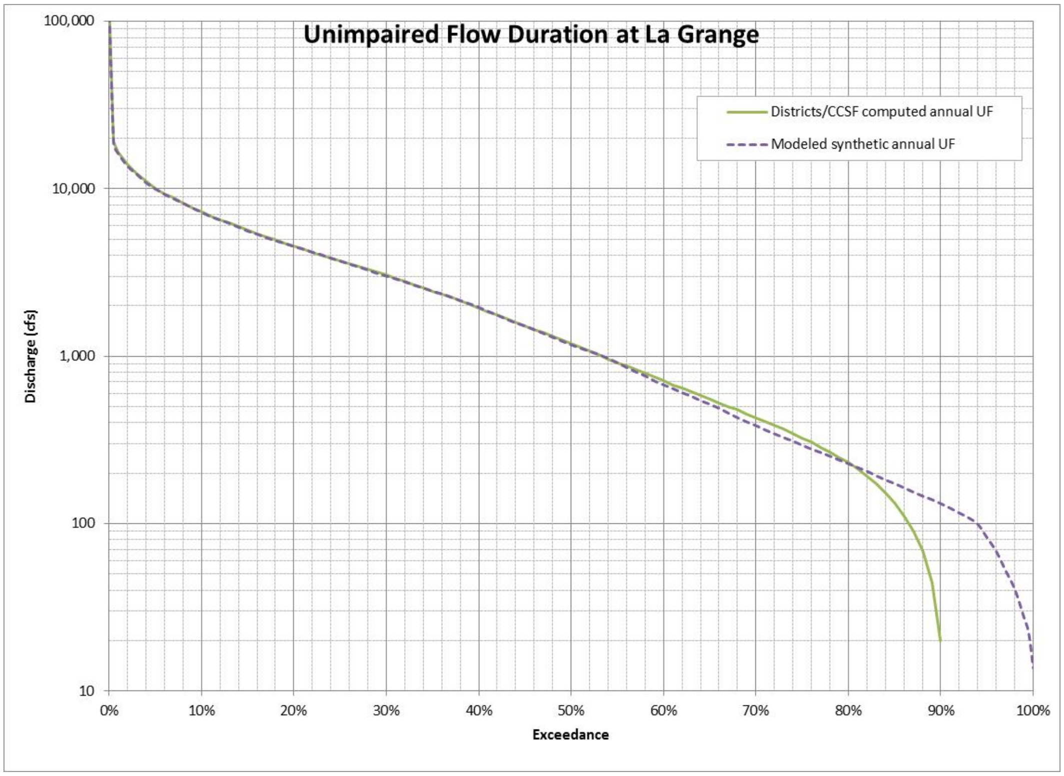

Figure 4.3-5. Estimates of unimpaired flow at USGS La Grange gage, 1971—2012.

Under the existing FERC license, the Don Pedro Project is required to provide flows to the lower Tuolumne River, as measured at the USGS gage at La Grange, which vary with water year type from an annual minimum of 94,000 AF up to 300,923 AF. By percentage, the annual minimum release of 94,000 AF to the lower Tuolumne River occurs over the long term in just 6.4 percent of the years, and the annual maximum occurs approximately 50 percent of the years. The FERC-required minimum continuous flow is 50 cfs, although flows this low have occurred less than one percent of the time since 1997. In fact, a flow greater than 100 cfs has occurred 99 percent of the time since 1997. Therefore, the Don Pedro Hydroelectric Project currently contributes positively to cumulative effects on water quantity in the lower Tuolumne River whenever the unimpaired flow would have been less than the Districts' water rights.

Water storage in Don Pedro Reservoir for flood control and irrigation and M&I uses reduces the occurrence of higher flows in the lower Tuolumne River. Don Pedro Reservoir inflow, for the period 1971 to 2012, exceeded 5,000 cfs approximately 15 percent of the time (Figure 4.3-1), and flows at the USGS La Grange gage since 1997 (post-FERC amendment to flows) exceeded 5,000 cfs 10 percent of the time (Figure 4.3-4).

Flows in the lower Tuolumne River are increased by occasional operational spills from the Districts' irrigation system, farm runoff, and groundwater accretion, and flows are decreased by riparian pumping. Quantitative values for these factors are generally unavailable, but direct accretion measurements made by the Districts as part of relicensing studies show that the lower Tuolumne River is generally a gaining river. However, riparian diversions, acting together, can contribute to significant loss of flow. There are 26 known riparian diversions with an estimated total combined withdrawal capacity of 76.6 cfs (CDWR 2013).

Factors contributing to cumulative effects on water quantity in the San Joaquin River and the Delta are numerous and are not all well quantified. Major factors include water development and diversion of flows on the San Joaquin River at Friant Dam to the Friant-Kern and Madera canals and associated facilities serving over 1 million acres of irrigated farmland. Friant Dam was constructed in 1942 and materially changed the flow regime of the San Joaquin River. In many years mean annual flows below Friant Dam are less than 200 cfs (SJRRP 2011). Construction of other major water storage and diversion projects on the Merced, Stanislaus, and Mokelumne rivers, as well as the Tuolumne River, all contribute to cumulative effects on water quantity in the San Joaquin River and Delta systems.

The total drainage area of the San Joaquin River is 31,800 mi^2, and at its entrance to the Delta (i.e., at Vernalis) the drainage area is 13,539 mi^2. The Tuolumne River has a drainage area of approximately 1,960 mi^2, or 14 percent of the San Joaquin River watershed at Vernalis and 6 percent of the total San Joaquin watershed area. In addition to water development projects associated with the SWP and CVP, numerous riparian diversions also occur along the San Joaquin River and its tributaries and throughout the Delta. Except for the State and Federal pumping plants, the total quantity of water historically diverted and pumped by these diversions is not well known.

4.3.1.1 Cumulative Effects of the Proposed Action on Water Quantity

Continued hydroelectric power generation at the Project would not contribute to cumulative effects on water quantity in the lower Tuolumne River, because the lower river flow regime is dictated by the independent, non-interrelated primary purposes of the Don Pedro Project (i.e., water supply, flood control, CCSF’s water bank) and releases to protect aquatic resources. However, the Districts’ proposed resource measures would influence flows in the lower river, as shown in Table 4.3-1, resulting in an overall benefit to resource values in the lower Tuolumne River, thereby contributing positively to in-river cumulative effects.

Table 4.3-1. Proposed lower Tuolumne River flows to benefit aquatic resources and accommodate recreational boating.

	Flow (cfs)	
Water Year/Time Period	**La Grange Gage**	**RM 25.5**
Wet, Above Normal, Below Normal		
June 1 – June 30	200	100[1]
July 1 – October 15	350	150[2]
October 15 – December 31	275	275
January 1 – February 28/29	225	225
March 1 – April 15	250	250
April 16 – May 15[3]	275	275
May 16 – May 31[3]	300	300
Dry		
June 1 – June 30	200	75
July 1 – October 15	300	75[2]
October 15 – December 31	225	225
January 1 – February 28/29	200	200
March 1 – April 15	225	225
April 16 – May 15	250	250
May 16 – May 31	275	275

Water Year/Time Period	Flow (cfs) La Grange Gage	Flow (cfs) RM 25.5
Critical		
June 1 – June 30	200	75
July 1 – October 15	300	75
October 15 – December 31	200	200
January 1 – February 28/29	175	175
March 1 – April 15	200	200
April 16 – May 15	200	200
May 16 – May 31	225	225

[1] - Cease IG withdrawal for one pre-scheduled weekend.
[2] - 200 cfs for three-day July 4 holiday, for three-day Labor Day holiday, and for two pre-scheduled additional weekends in either June, July, or August.
[3] - Fall-run Chinook outmigration pulse flows: 150,000 ac-ft (Wet, Above Normal), 100,000 ac-ft (Below Normal), 75,000 ac-ft (Dry), 45,000 ac-ft (sequential Dry[s]), 35,000 ac-ft (first Critical), and 11,000 ac-ft (sequential Critical[s]).[94]

4.3.2 Water Quality

Many of the factors listed above in Section 4.3.1 also contribute to cumulative effects on water quality in the Tuolumne and San Joaquin rivers and in the Delta. A study performed as part of relicensing (TID/MID 2013f) indicates that water quality in Don Pedro Reservoir and in the Tuolumne River immediately downstream of Don Pedro Dam meets California's water quality standards. Section 3.4 of Exhibit E describes sampling results for a range of water quality variables including, DO, pH, biostimulatory substances, turbidity, select pesticides, toxicity, mercury/methylmercury, bacteria, oil and grease, sediment, and taste and odor. Based on these results, it is apparent that the Don Pedro Project's presence and primary purposes of water supply and flood control do not contribute to adverse cumulative effects related to any of these variables.

The lower Tuolumne River accumulates pollution loadings from pesticides and wastewater discharge as it travels downstream. The section of the Tuolumne River from Don Pedro Reservoir to the San Joaquin River is included on the State of California's CWA § 303(d) list in relation to the non-point discharge of some agricultural pesticides (SWRCB 2010). Agricultural chemicals on the 303(d) list are chlorpyrifos, diazinon, and the Group A Pesticides: aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexanes (including lindane), endosulfan, and toxaphene. This reach of the Tuolumne River is also 303(d) listed for mercury, a legacy contaminant of the gold mining era, and temperature (SWRCB 2010).

Six pesticides were detected in runoff from agricultural and urban areas during a study conducted in the lower Tuolumne River, and chlorpyrifos, DCPA, metolachlor, and simazine were detected in almost every sample (Dubrovsky et al. 1998). Peak diazinon concentrations measured in the lower Tuolumne River have frequently exceeded levels that can be acutely toxic to some aquatic organisms (Dubrovsky et al. 1998).

The presence of the Don Pedro Project and its operation to satisfy the primary purposes of water supply and flood control do not contribute to cumulative adverse effects associated with

[94] This reduced pulse flow, while still greater than or equal to Base Case pulse flows, would also occur in a sequence of "D" and "C" years. For example, in a sequence of the years C, D, C, D, C, D, the second and third "critical" years and the second and third "dry" years would each have pulse flows of 11 TAF and 45 TAF, respectively.

agricultural pesticides or mercury downstream of the Don Pedro Project. Herbicides applied for control of invasive plants at some reservoir shoreline facilities are applied in such small amounts that their contribution to levels of chemical constituents in the Tuolumne River basin is negligible. For the same reason, rodenticides applied rarely to control ground squirrels near certain recreational facilities adjacent to Don Pedro Reservoir, are used in such small amounts that their effects are also considered insignificant.

4.3.2.1 Water Temperature

The section of the Tuolumne River from Don Pedro Reservoir to the San Joaquin River is also included in the State of California's CWA § 303(d) list in relation to water temperature. In addition to the natural climate characteristics of the Central Valley, factors contributing to the thermal conditions in the lower Tuolumne River include (among others) water storage in Don Pedro Reservoir; water diversions at the Hetch Hetchy Project and at La Grange Diversion Dam; substantial in-channel and floodplain habitat modifications, including removal of riparian vegetation; return flow from irrigation operations and alteration of groundwater accretion; riparian diversions; Dry Creek inflows; and wastewater discharges. The Don Pedro Project's primary purposes have a localized effect on temperature, as explained below, which is attenuated with increasing distance downstream.

Water Temperature Effects of Don Pedro Reservoir Operations

At over 400-feet deep, the Don Pedro Reservoir is a large reservoir which goes through a well-established annual cycle of temperature stratification and destratification. Temperature stratification begins to be established by early April, is well established by June, and remains until turnover in late October/early November or later. The effect of thermal stratification within Don Pedro Reservoir is to enable it to support both a robust cold-water and warm-water fishery.

The best indicator of the overall effects of the Don Pedro Reservoir on water temperatures is to compare the differences between the reservoir inflow and outflow temperatures. Figure 4.3-6 displays actual mean daily reservoir inflow and outflow temperatures recorded over the period of October 2010 through December 2012. The figure demonstrates the effects of the Don Pedro Reservoir on Tuolumne River temperatures. While reservoir inflow temperatures vary considerably due to local meteorological and geophysical conditions, outflow temperatures vary only slightly. Outflow temperatures are generally slightly higher than inflow temperatures from November to early April when inflow temperature ranged from 3 to 10°C and outflow temperatures were relatively steady at 10 to 11°C. Outflow temperatures were cooler than inflow temperatures from early April through early October when outflow temperatures are relatively steady at 11 to 12°C and inflow temperatures ranged from 12 to 22°C. In 2011, from mid-June to mid-September, daily average inflow temperatures ranged from 19 to 23°C. Reservoir inflow and outflow temperatures are relatively equal during the April through mid-May time frame and the mid-October to mid-November time at about 10 to 11°C.

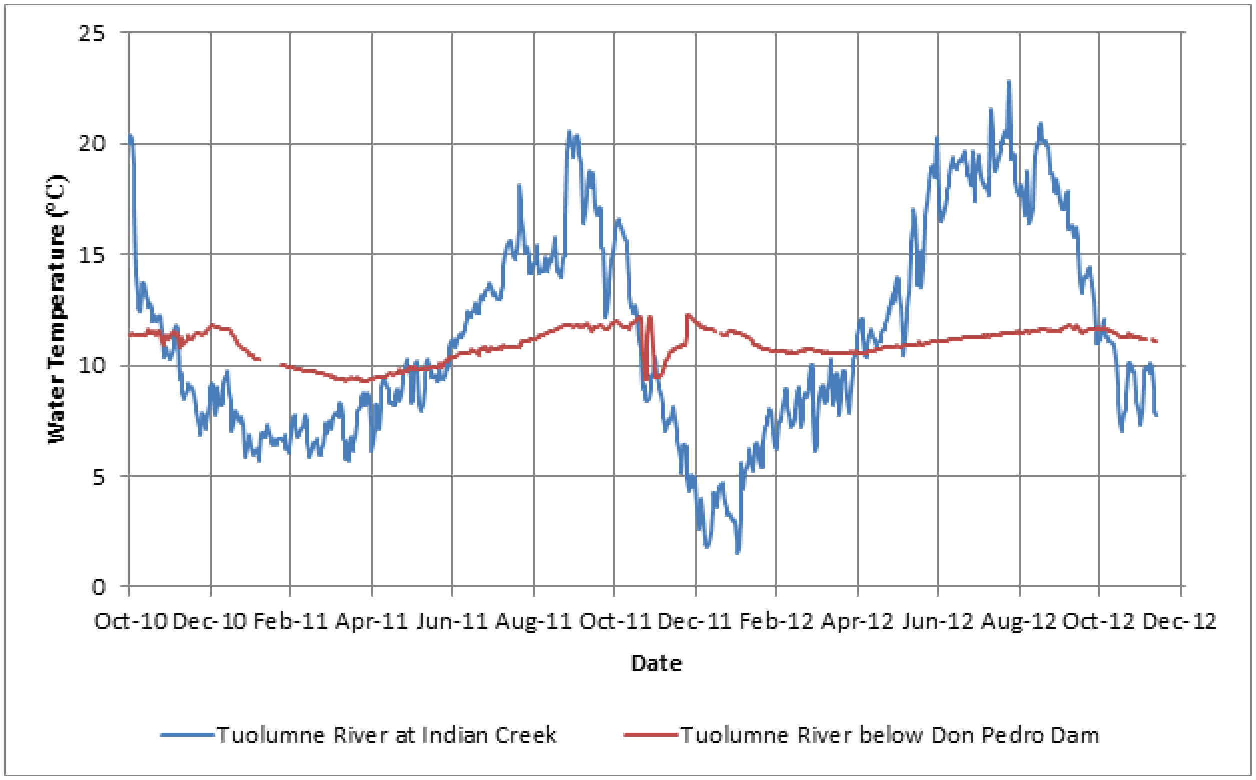

Figure 4.3-6. Don Pedro Reservoir inflow and outflow temperature.

These temperature patterns show very little change through the La Grange headpond and just below La Grange Diversion dam. La Grange headpond is shallow and short and is more riverine than lacustrine from a temperature perspective. La Grange pool does not stratify due to its shallowness and the flow-through is large relative to its volume, especially during summer months when releases for irrigation are at their highest. The contribution of the Don Pedro Project to cumulative effects to river temperature in the lower Tuolumne River would be consistent with its overall effects on water temperature; that is, Don Pedro Project operations tend to provide an initial cooling effect to temperatures in the river from June to early October, have no significant cumulative effect during the early April to mid-May and mid-October to mid-November time frames, and tend to provide a slight initial warming during the November to early April period.

The above findings of the cooling effects of Don Pedro Reservoir from the June through early October period applies only so long as the thermal stratification of the reservoir is intact. The Don Pedro Reservoir 3-D temperature model indicates that once reservoir levels reach about elevation 625 to 650 ft, the reservoir temperatures become uniform and the thermal stratification breaks down. If these reservoir levels are reached during warmer periods (May-September), outflow temperatures can be expected to rise sharply.

With- and Without-Dams Project Temperature Comparisons

As explained previously, the Districts have developed a computer simulation of the temperature regime of the Tuolumne River without dams. The focus of the Tuolumne River Flow and Water

Temperature Model: Without Dams Assessment (Jayasundara et al. 2017) was to develop a flow and water temperature model to simulate water temperatures in the Tuolumne River without the existing Hetch Hetchy (which includes Cherry and Eleanor reservoirs), Don Pedro, and La Grange projects. The model was developed to complement detailed models developed for Don Pedro Reservoir and La Grange headpond (TID/MID 2017d) and the lower Tuolumne River (TID/MID 2017a). Supporting data included the development of long-term flow and meteorological conditions to assess flow and water temperatures over a multi-decade period, i.e., 1970–2012. The following text and plots provide a characterization of with- and without-dam conditions to demonstrate the impoundments' contribution to cumulative effects on water temperatures in the Tuolumne River basin, in particular the reach between Don Pedro Dam and the San Joaquin River.

Figures 4.3-7–4.3-16 provide a comparison of simulated without-dams 7DADM temperatures to simulated (below the Don Pedro Project) and empirically derived (above the Don Pedro Project) with-dams temperatures at the following locations: (1) below the South Fork Tuolumne River (≈ RM 98), (2) the Tuolumne River below Indian Creek (≈ RM 88), (3) immediately below Don Pedro Dam (≈ RM 54), (4) RM 51.5, 46, 40, 34, and 24 in the lower Tuolumne River above Dry Creek (5) and RM 10 and RM 1 on the lower Tuolumne River below Dry Creek.

Comparison of 7DADM water temperatures under with- and without-dams conditions upstream of the Don Pedro Project indicates that during summer, water would be substantially warmer in the absence of the upstream impoundments than it is under existing conditions, particularly at RM 98 (Figures 4.3-7 and 4.3-8). With-dams temperatures are slightly warmer than without-dams temperatures during the November through February period by from 1 to 3°C at times (Figures 4.3-7 and 4.3-8). As noted in the figure captions, plots for RM 98 and RM 88 compare simulated without-dams temperatures to empirically derived with-dams temperatures.

The without-dams simulation reveals that average water temperatures in the Tuolumne River mainstem, in the absence of impoundments, would approach thermal equilibrium well upstream of the current location of the Don Pedro Project, i.e., the without-dams temperature regime at RMs 88 and 98 are very close to each other. Moreover, the highest without-dams 7DADM temperatures at RMs 88 and 98 (≈ 24°C) are similar to the highest without-dams temperatures in the lower river (≈ 25°C).

Immediately below Don Pedro Dam, with-dams 7DADM temperatures are relatively cool year-round, with little variability (Figure 4.3-9), because water is released from the reservoir's hypolimnion. Because of the thermal mass of the reservoir, water at depth is to a large degree buffered from the influence of seasonal and diel variability in air temperature and other climatic factors. With-dams 7DADM temperatures are much cooler than without-dams temperatures in summer but are slightly warmer by 1 to 5°C from about November through February.

With-dams 7DADM temperatures during summer rise rapidly with increasing distance downstream of the Don Pedro Dam, and by RM 46 temperatures during July reach 20°C (Figure 4.3-11), while without-dams 7DADM temperatures reach 24°C. By approximately RM 34, thermal equilibrium has largely been restored under with-dams conditions, and with-dams and without-dams thermal regimes are closely matched. This condition persists from this point to the above Dry Creek. With-dams summer 7DADM temperatures are 2 to 5°C warmer below Dry Creek from mid-May to mid-September (Figures 4.3-15 – 4.3-16). Also, at all locations in the lower river, except immediately below Don Pedro Dam, there is a decrease in daily average water temperatures from mid-April to mid-May under the with-dams Base Case condition, which is the result of pulse flow releases scheduled to benefit fish downstream of La Grange Diversion Dam.

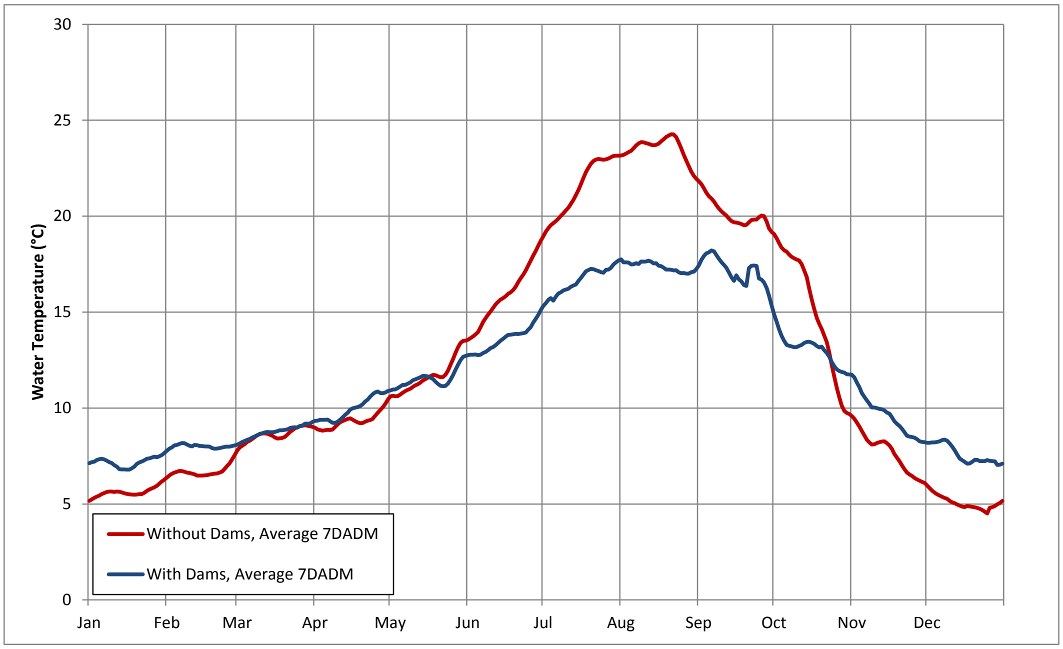

Figure 4.3-7. Comparison of 7DADM water temperatures under with- and without-dams conditions in the Tuolumne River below the South Fork Tuolumne River (≈RM 98). Without-dams temperatures are simulated based on the period 1970 - 2012 (Jayasundara et al. 2017), and with-dams temperatures are based on data collected by temperature loggers from 2005 - 2012.

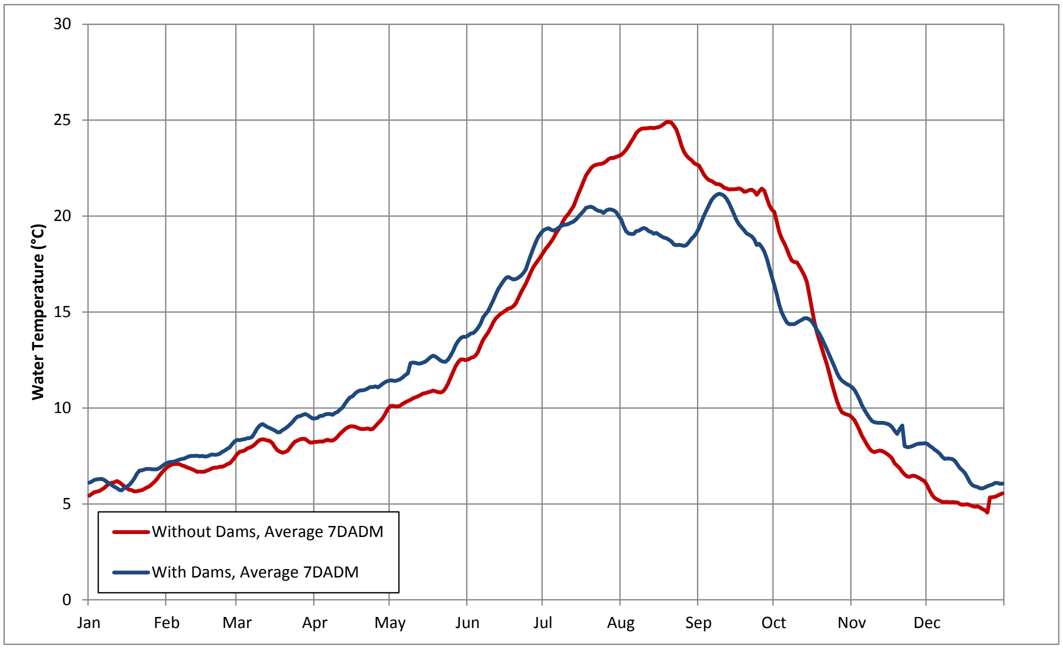

Figure 4.3-8. Comparison of 7DADM water temperatures under with- and without-dams conditions in the Tuolumne River below Indian Creek (≈RM 88). Without-dams temperatures are simulated based on the period 1970 - 2012 (Jayasundara et al. 2017), and with-dams temperatures are based on data collected by temperature loggers from 2009 – 2012.

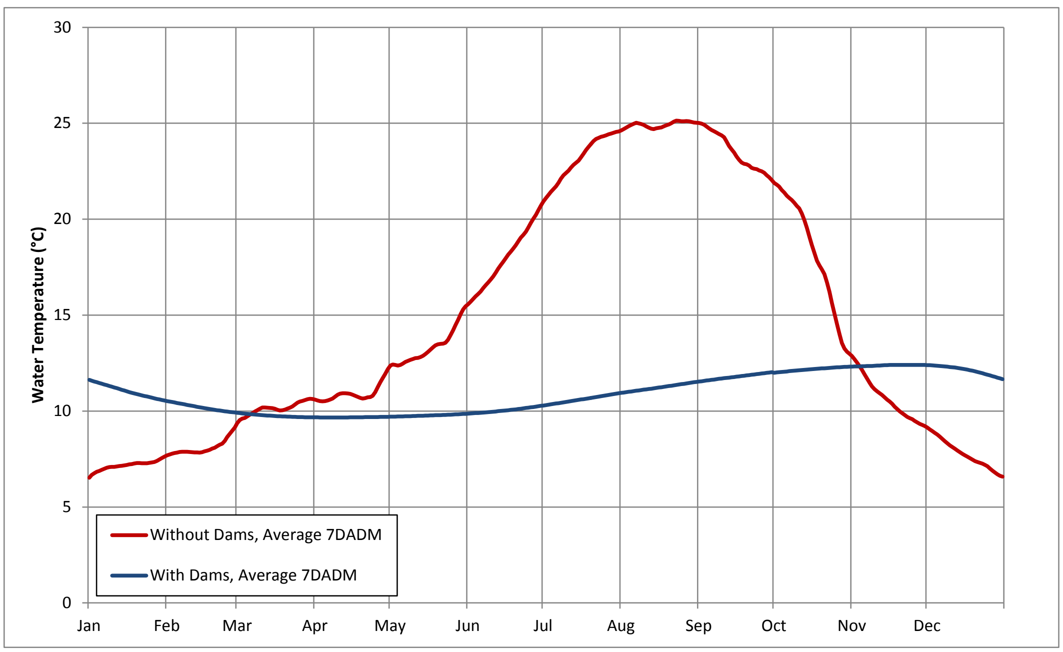

Figure 4.3-9. Comparison of 7DADM water temperatures under with- and without-dams conditions in the Tuolumne River below Don Pedro Dam (≈RM 54). Without-dams temperatures (Jayasundara et al. 2017) and with-dams temperatures (TID/MID 2017a) are simulated based on the period 1970 - 2012.

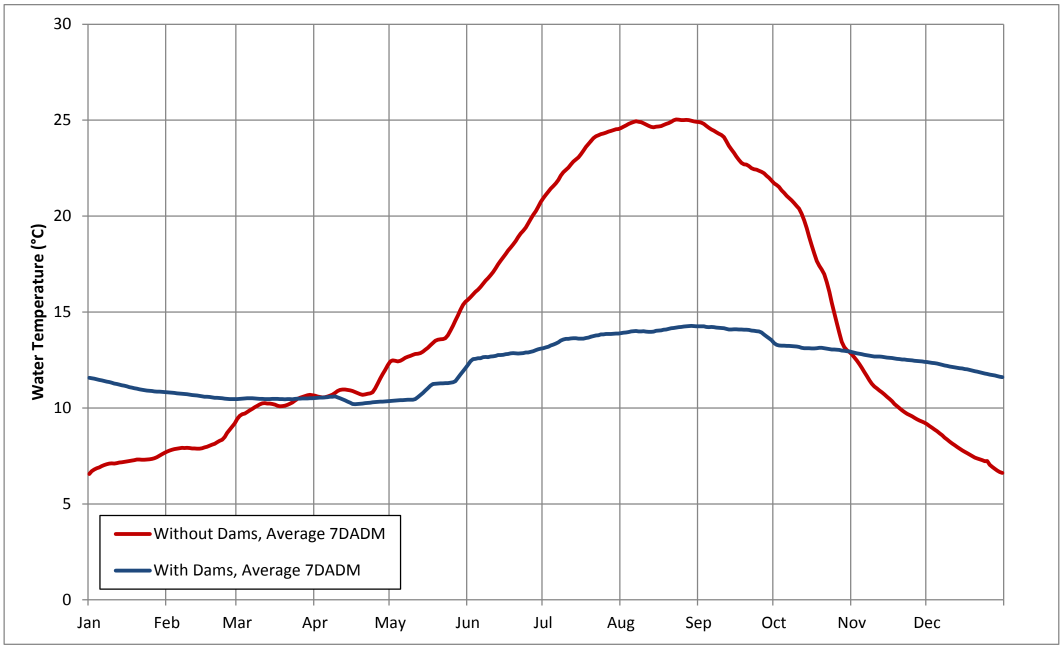

Figure 4.3-10. Comparison of 7DADM water temperatures under with- and without-dams conditions in the lower Tuolumne River at RM 51.5. Without-dams temperatures (Jayasundara et al. 2017) and with-dams temperatures (TID/MID 2017a) are simulated based on the period 1970 – 2012.

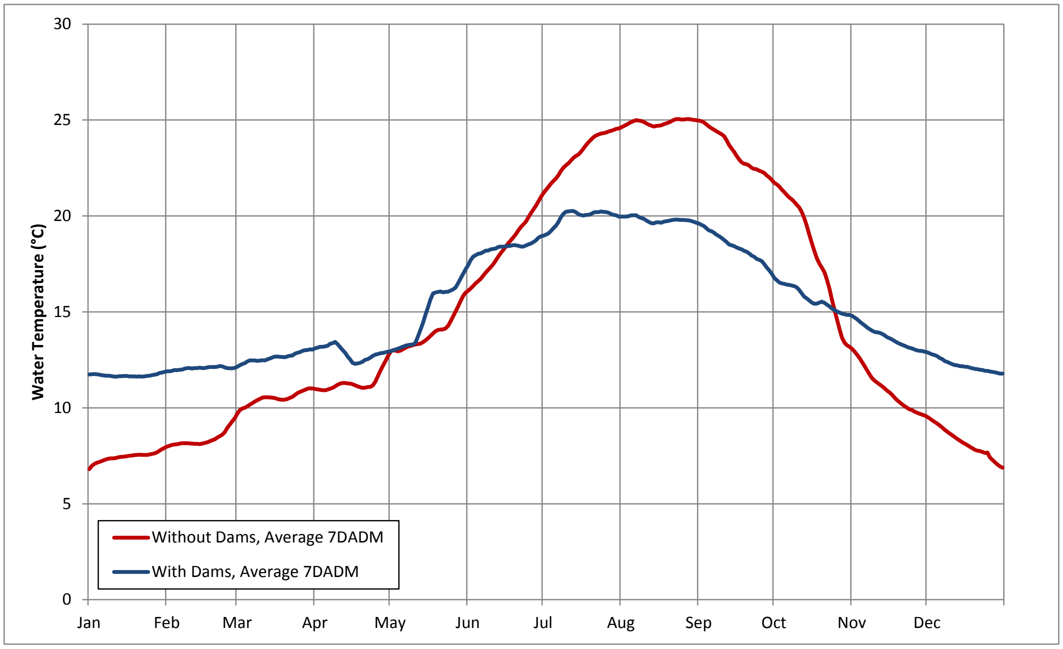

Figure 4.3-11. Comparison of 7DADM water temperatures under with- and without-dams conditions in the lower Tuolumne River at RM 46. Without-dams temperatures (Jayasundara et al. 2017) and with-dams temperatures (TID/MID 2017a) are simulated based on the period 1970 - 2012.

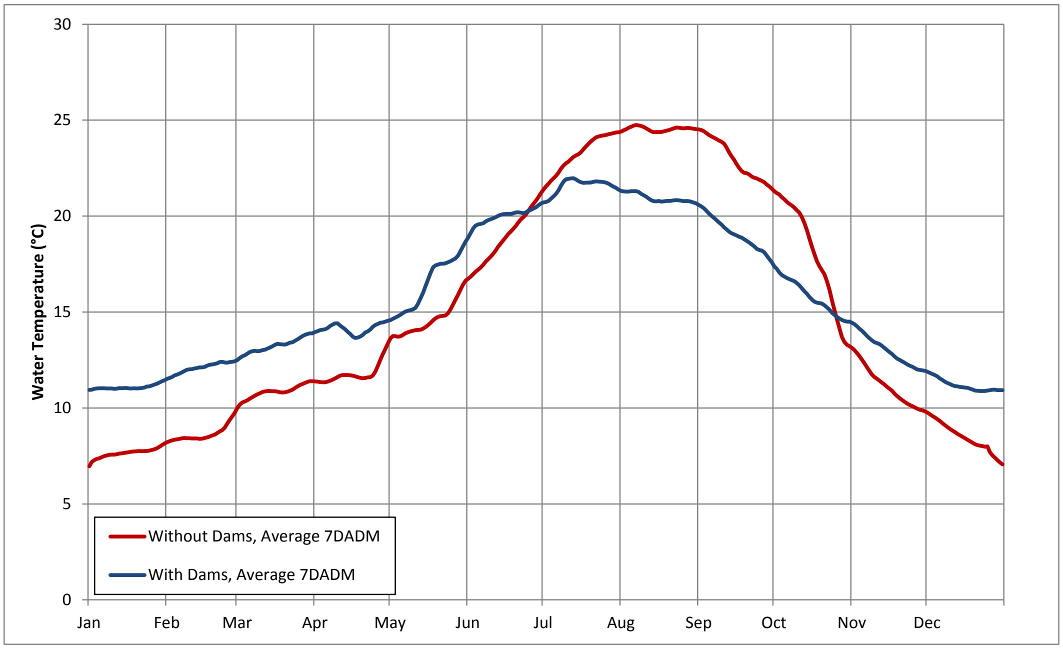

Figure 4.3-12. Comparison of 7DADM water temperatures under with- and without-dams conditions in the lower Tuolumne River at RM 40. Without-dams temperatures (Jayasundara et al. 2017) and with-dams temperatures (TID/MID 2017a) are simulated based on the period 1970 - 2012.

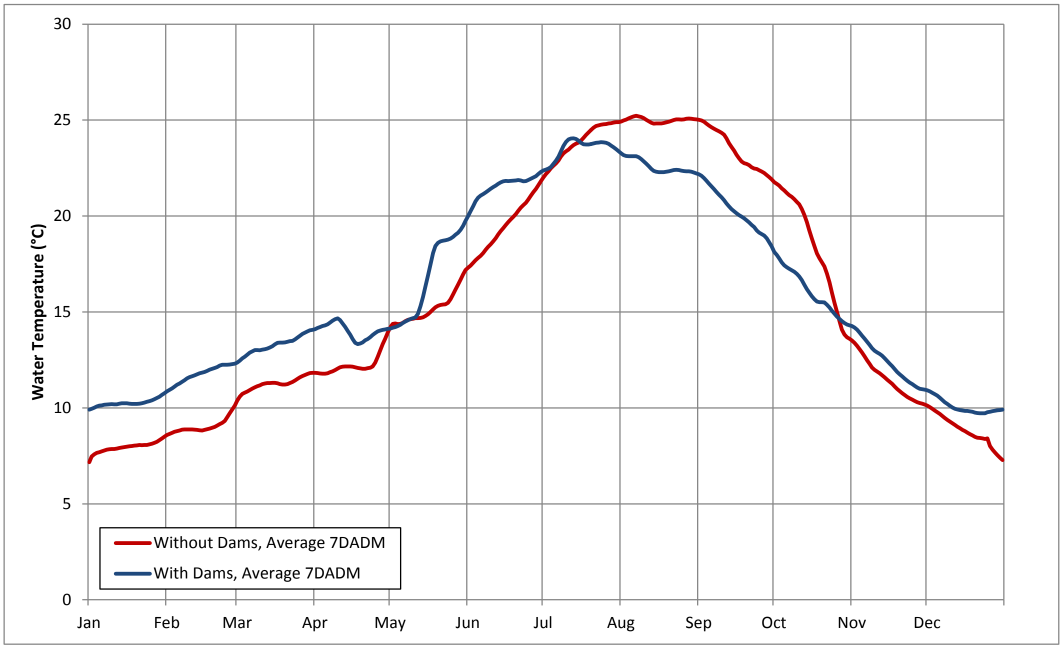

Figure 4.3-13. Comparison of 7DADM water temperatures under with- and without-dams conditions in the lower Tuolumne River at RM 34. Without-dams temperatures (Jayasundara et al. 2017) and with-dams temperatures (TID/MID 2017a) are simulated based on the period 1970 - 2012.

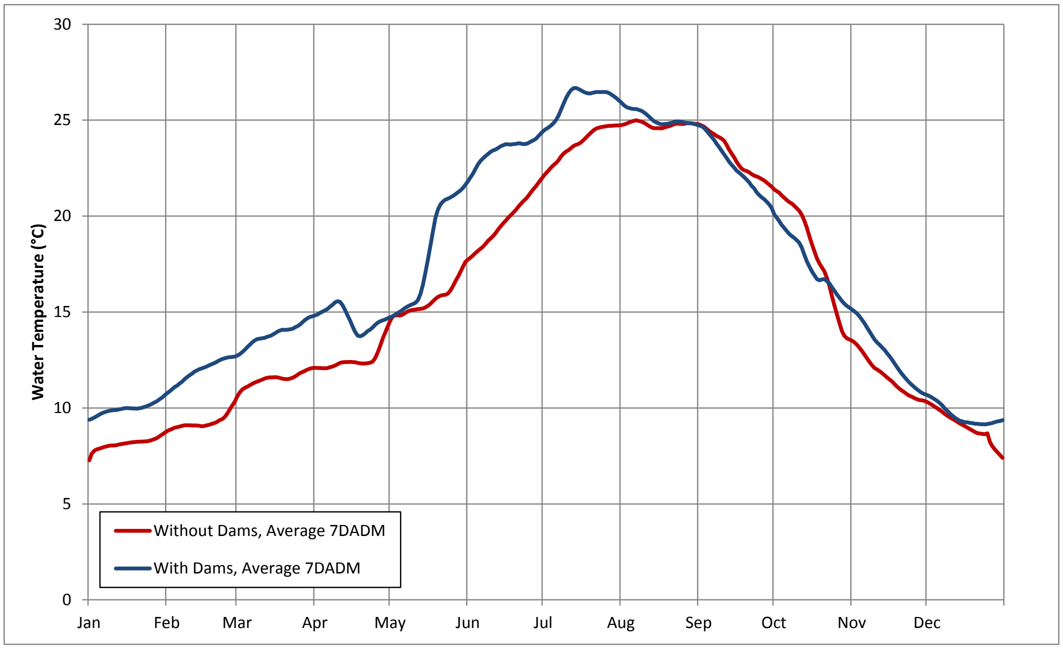

Figure 4.3-14. Comparison of 7DADM water temperatures under with- and without-dams conditions in the lower Tuolumne River at RM 24. Without-dams temperatures (Jayasundara et al. 2017) and with-dams temperatures (TID/MID 2017a) are simulated based on the period 1970 - 2012.

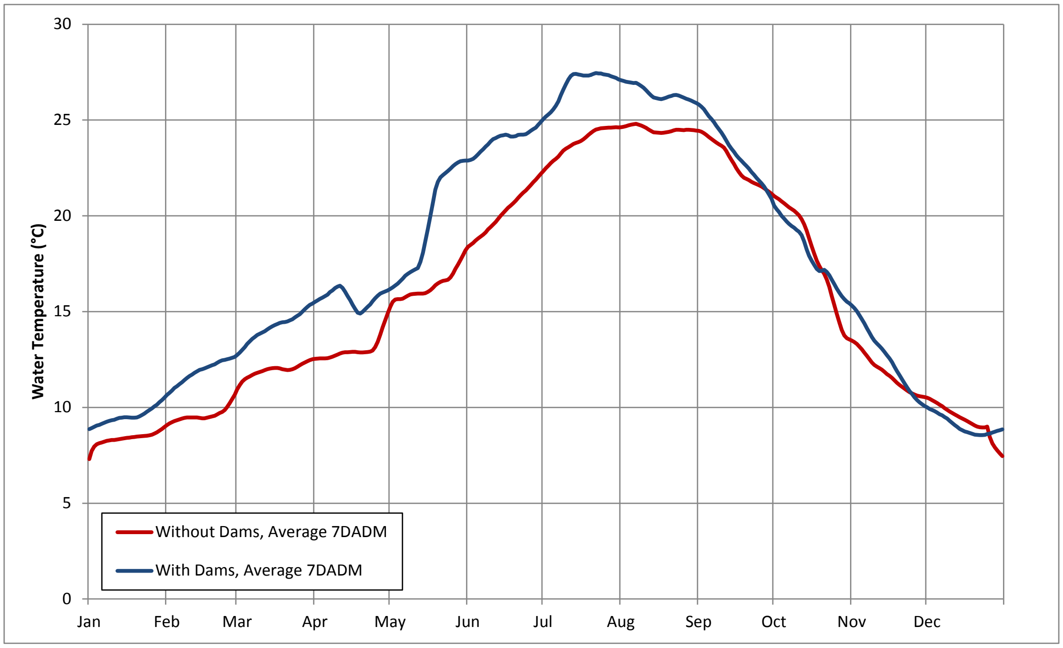

Figure 4.3-15. Comparison of 7DADM water temperatures under with- and without-dams conditions in the lower Tuolumne River at RM 10. Without-dams temperatures (Jayasundara et al. 2017) and with-dams temperatures (TID/MID 2017a) are simulated based on the period 1970 - 2012.

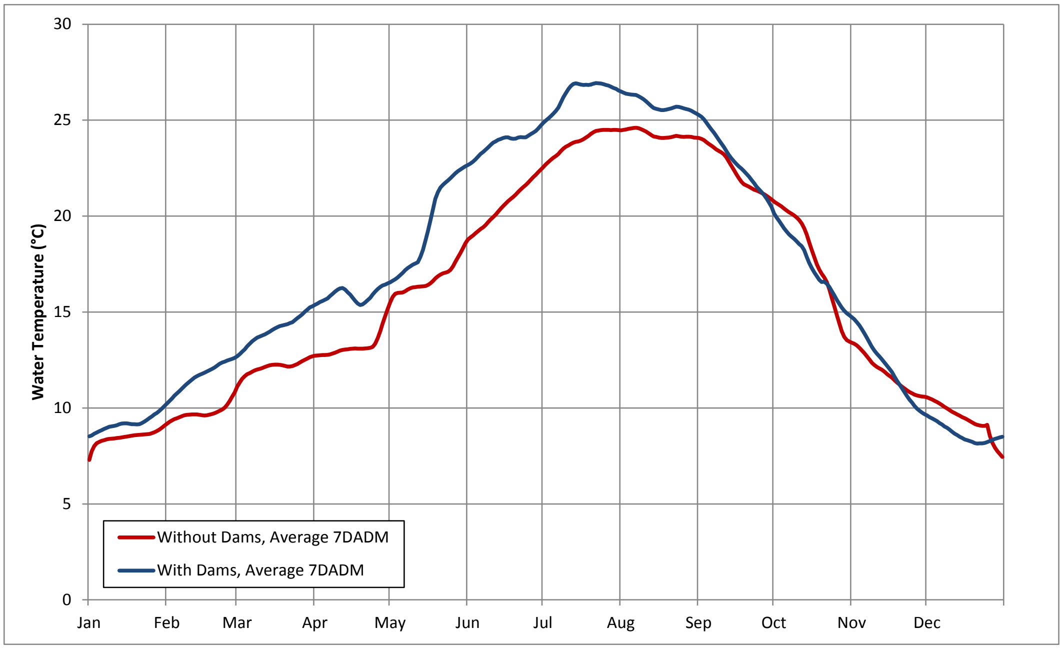

Figure 4.3-16. Comparison of 7DADM water temperatures under with- and without-dams conditions in the lower Tuolumne River at RM 1. Without-dams temperatures (Jayasundara et al. 2017) and with-dams temperatures (TID/MID 2017a) are simulated based on the period 1970 - 2012.

Effects of Ambient Air Temperatures on Tuolumne River Water Temperatures

As ambient air temperatures and the number of hours of direct sunlight increase in the Tuolumne River valley during spring and summer, water temperatures become heavily influenced by local meteorological conditions. This is demonstrated in Figures 4.3-17, 4.3-18, and 4.3-19. Based on the Districts' HEC-RAS river hydraulic and temperature model (TID/MID 2017a), these figures depict the relationship between ambient air temperatures and river flow at three locations along the lower Tuolumne River, RM 39.5, RM 30, and RM 16.5.

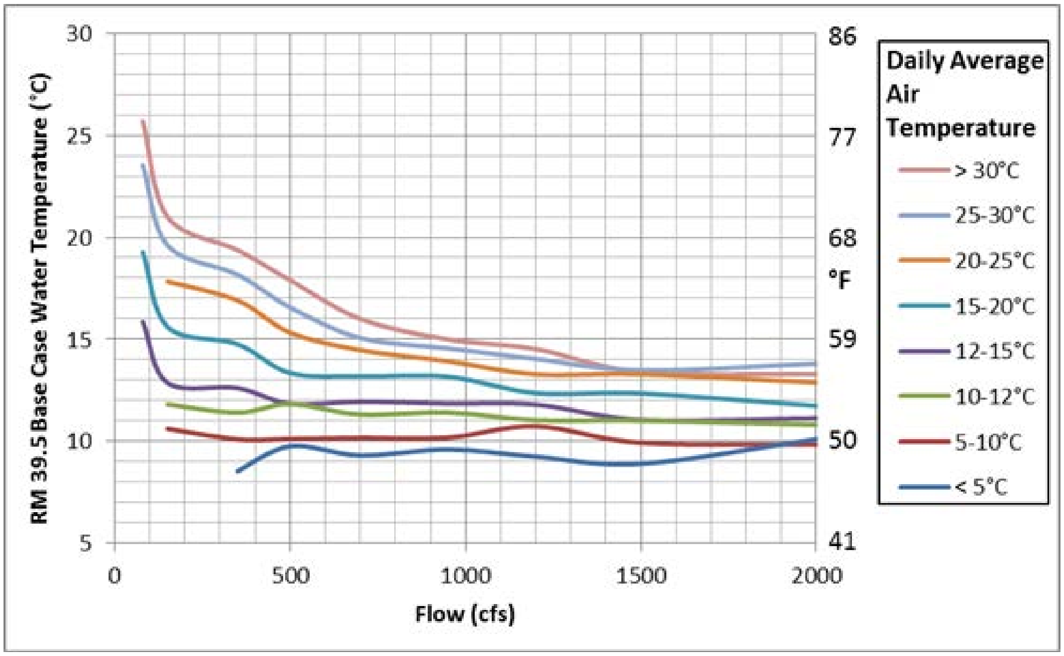

Figure 4.3-17. **Relationship between average daily ambient air temperature, water temperature and flow in the lower Tuolumne River, RM 39.5.**

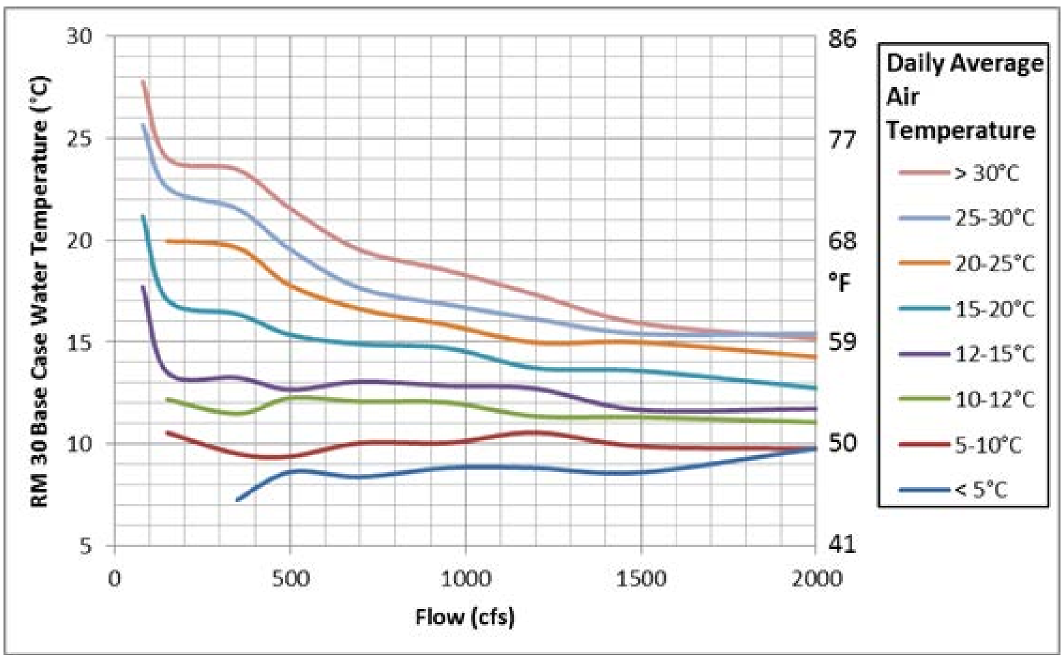

Figure 4.3-18. **Relationship between average daily ambient air temperature, water temperature and flow in the lower Tuolumne River, RM 30.0.**

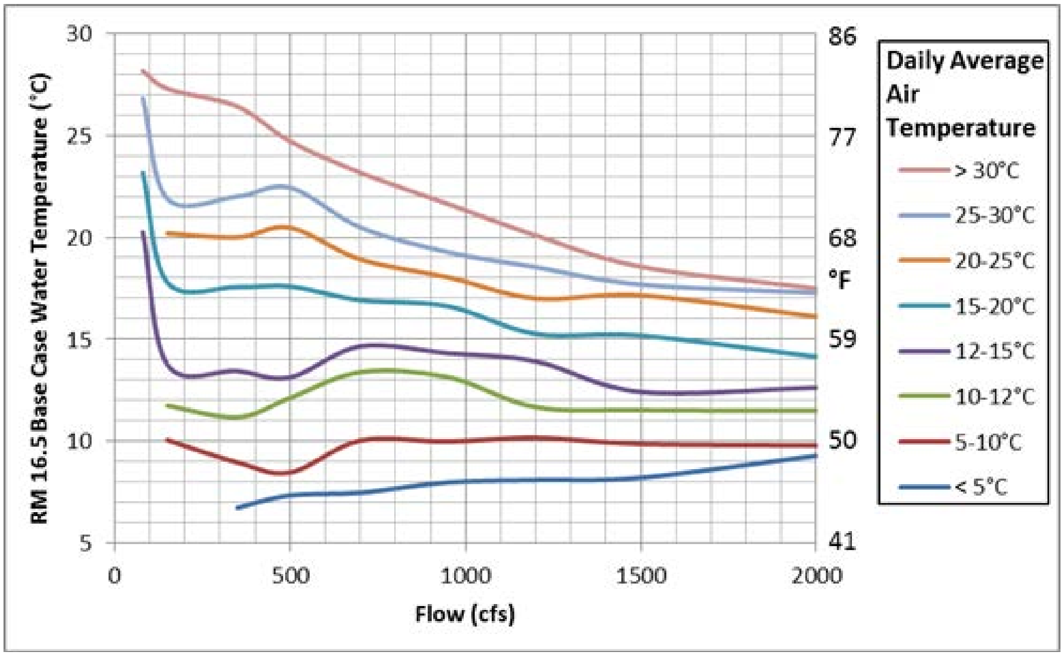

Figure 4.3-19. Relationship between average daily ambient air temperature, water temperature and flow in the lower Tuolumne River, RM 16.5.

When average daily ambient air temperatures are between 15 and 20°C (April/May), a flow of 100 cfs results in an average daily water temperature at RM 39.5 of 18°C[95] (Figure 4.3-17). A flow increase to 200 cfs would be required to reduce the water temperature by 3°C to 15°C, an increase in flow to 500 cfs would be required to reduce the water temperature to 13°C, and an increase in flow to 2,000 cfs would be required to reduce water temperature just one degree more to 12°C.

As expected, the influence of ambient air temperature is more extreme as air temperatures increase. For example, at the same RM 39.5, in the summer months when average daily air temperatures can routinely reach 25°C (July/August/September), a flow of 100 cfs results in a water temperature of 20°C (Figure 4.3-17). A flow of 300 cfs is required in order to reduce the river temperature by 3°C to 17°C, an increase in flow to 1,000 cfs would be required to reduce the water temperature to 14°C, and an increase in flow to 2,000 cfs would be required to reduce water temperature just one degree more to 13°C.

With increasing distance downstream, the influence of ambient climate on water temperature significantly increases. At just nine miles further downstream, at RM 30, when ambient air temperature is between 25 and 30°C and flow is 100 cfs, the resulting river temperature is 24°C (Figure 4.3-18). To reduce the river's average daily temperature to 20°C would require a flow increase to 800 cfs and a flow of 1,400 cfs would be required to reduce river water temperature just 2°C more to 18°C. Attaining one additional degree temperature drop to 17°C would require a flow of well over 3,000 cfs, a flow that occurs less than two percent of the time in August under unimpaired flow conditions. Therefore, it is likely that historical average daily water

[95] All starting temperatures are 10°C

temperatures were seldom, if ever, less than 18°C in the lower Tuolumne River from July through September. This result further reinforces the findings of the without-dam assessment discussed above.

Effects of Accretion Flows on Water Temperature in the Lower Tuolumne River

Accretion flows due to groundwater are normally expected to be about 12–14°C, which would be anticipated to slightly warm streamflows during cold months and cool them during warm months. Data from temperature loggers located in the lower river indicate that some cooling occurs between RM 16.2 and RM 3.5 during most months (Table 4.3-2), and based on the Districts' flow measurements this reach of river appears to receive contributions from groundwater accretion. Withdrawals by riparian water users tend to increase water temperatures during the peak of the irrigation season. The Districts' intensive water temperature data collection conducted during the summer of 2013 (TID/MID 2014) showed no apparent influence on water temperatures from groundwater accretions in the river above RM 24.

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Table 4.3-2. Monthly seven-day average daily maximum (7DADM) temperatures in the lower Tuolumne River (dates vary).

Month	Average Temperature			7-Day Average Daily Maximum Temperature																	
	Don Pedro Project Outflow			@ USGS 11289650 - Tuolumne River Below La Grange Diversion Dam			Tuolumne River at Riffle 13B			Tuolumne River at Roberts Ferry Bridge			Tuolumne River at Hughson			Tuolumne River at 9th St Bridge			Tuolumne River at Shiloh Bridge		
	RM 54.3			Near La Grange, CA												Near Modesto, CA			Near San Joaquin Confluence		
	1/1987 - 9/1988 and			RM 51.8			RM 45.5			RM 39.5			RM 23.6			RM 16.2			RM 3.5		
	5/2010 - 2/2013			Nov 2001 – Oct 2012			Nov 2001 – Nov 2012			Aug 1998 – Jul 2010			Dec 1997 – Jan 2010			Jul 68-Apr 79 and Sep 88-Jun 13			Apr 1987 – Dec 2012		
	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest
January	10.46	11.7	8.9	10.9	11.6	10.4	11.0	11.8	10.6	10.9	11.9	10.1	11.1	12.4	9.9	10.7	12.7	9.2	10.7	12.6	8.4
February	9.68	11.4	8.5	10.8	11.2	10.1	11.6	12.2	10.6	11.9	13.0	10.9	12.3	13.9	10.9	12.5	15.9	8.4	12.5	14.6	10.1
March	9.33	11.1	7.8	10.8	11.6	9.7	12.4	13.5	10.5	13.4	15.5	11.0	14.3	17.4	11.1	15.4	19.7	10.5	15.3	18.5	10.5
April	9.38	10.9	8.3	10.8	11.7	9.9	12.8	14.6	10.9	13.5	15.2	11.4	15.1	17.2	11.7	17.8	22.0	11.4	16.7	21.5	11.3
May	9.8	11.1	8.6	11.3	12.0	10.4	14.0	15.6	11.7	15.5	18.1	12.7	18.0	20.9	12.9	20.8	24.6	12.9	19.6	27.4	12.9
June	10.15	11.7	9	12.0	12.9	11.1	16.9	20.6	12.6	20.3	26.0	13.8	23.8	27.9	14.1	25.0	31.3	13.9	23.4	28.7	15.1
July	10.56	11.7	9.4	12.4	13.3	11.7	18.3	21.9	14.1	21.4	26.3	15.3	25.7	28.9	16.0	27.2	31.4	17.4	25.8	29.6	18.0
August	10.87	12.2	9.4	12.7	13.4	12.1	18.0	20.7	13.8	20.8	24.7	16.0	25.0	28.3	19.0	26.1	29.9	16.1	25.0	28.1	17.3
September	11.1	12.2	10	12.7	13.3	12.2	16.9	19.1	15.0	18.8	22.1	14.6	22.3	25.3	16.4	23.1	27.1	18.5	22.2	25.7	16.8
October	11.31	12.2	10	12.3	12.8	12.0	14.0	14.6	13.4	14.8	16.1	13.9	17.0	18.9	15.2	18.1	22.1	14.9	17.7	20.3	14.9
November	11.26	13.3	9.25	11.5	12.0	10.9	12.2	12.6	11.5	12.4	13.3	11.7	13.4	14.6	12.0	13.8	18.6	11.6	13.2	14.7	9.6
December	11.24	12.22	10.1	11.2	11.6	10.7	11.2	11.7	10.3	11.0	11.5	10.0	10.9	12.0	10.1	10.6	12.5	8.5	10.4	11.8	7.5

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4.3.2.2 Cumulative Effects of the Proposed Action on Water Quality

Continued hydroelectric power generation at Don Pedro Dam would not contribute to cumulative effects on water quality in the lower Tuolumne River. Electric power is generated at the Don Pedro Hydroelectric Project using flows released for other purposes. Irrigation, municipal, and industrial water deliveries and high-flow releases are pre-scheduled based on forecasted demands and actual projected inflow and then released through the powerhouse up to its hydraulic capacity. Scheduling of these releases is adjusted, when consistent with water supply needs, to release flows for hydroelectric energy generation with a preference for on-peak power demand rather than off-peak hours. However, these "peaking" flows are modulated, being subject to water supply demand and limits on water fluctuations in the Districts main canals. Flows in the reach of the Tuolumne River below La Grange Diversion Dam are not subject to such fluctuations as the fluctuations travel down and are absorbed by the Districts' main canals and irrigation water needs, which are unrelated and non-interdependent actions e.g., providing water for irrigation and M&I uses. Hydroelectric generation at the Don Pedro Hydroelectric Project cannot impact resources in the lower Tuolumne River, because the flows released into the lower Tuolumne River are not linked to power production and, absent power production at Don Pedro Dam, the flow release schedule, including flows to the lower Tuolumne River, will remain the same as it is under existing conditions, i.e., driven by uses other than hydroelectric power production.

Gravel Mobilization Flows of 6,000 to 7,000 cfs

Flows ranging from 6,000–7,000 cfs (measured at USGS gage 11289650 below La Grange Diversion Dam) would be released to mobilize gravel and fines. These flows would be provided for at least two days in a given year at an estimated average frequency of once every five years, i.e., during years when sufficient spill is projected.

This measure could result in short-duration pulses of turbidity, which, depending on the timing of releases, could benefit outmigrating juvenile fall-run Chinook by decreasing predators' sight-feeding effectiveness. Benefits to spawning habitat and possibly Chinook outmigration survival would outweigh any short-term effects on water quality associated with turbidity increases. Such turbidity increases are not expected to contribute significantly to cumulative effects on water quality in the basin.

Gravel Cleaning

The Districts propose to conduct a five-year program of experimental gravel cleaning to increase the availability of high quality spawning gravel for fall-run Chinook and *O. mykiss*. Cleaning would be accomplished using a gravel ripper and pressure wash operated from a backhoe, or equivalent methodology. Each year of the program would consist of three weeks of cleaning select gravel patches. Gravel cleaning would coincide with May pulse flows to aid fall-run Chinook smolt outmigration by providing increased turbidity to reduce predator sight-feeding effectiveness.

During short periods, localized increases in turbidity might exceed state water quality standards (see Section 3.4, *Water Resources*, of this AFLA), thereby contributing to cumulative adverse effects on water quality in the lower Tuolumne River. However, improvements in spawning gravel quality and potential increases in fall-run Chinook outmigrant survival due to short-duration reductions in predator efficiency are likely to significantly outweigh any short-term effects of increased turbidity. As noted in Section 3.4 of this Exhibit E, the Districts would coordinate with the SWRCB to secure necessary permits and conduct any required turbidity monitoring. If gravel cleaning is judged to be successful, the program would continue, adjusted as needed to comply with any water-quality related concerns of the SWRCB.

Contribute to CDBW's Efforts to Remove Water Hyacinth

The Districts would provide $50,000 per year to the California Division of Boating and Waterways (CDBW) for the removal of water hyacinth in the lower Tuolumne River. The contribution would be made regardless of the level of water hyacinth infestation occurring in the lower Tuolumne River during a given year, but the expectation is that CDBW would undertake removal efforts if hyacinth proliferates in the lower Tuolumne River. There would be no monitoring conducted by the Districts in association with this measure.

Water hyacinth can increase water losses from lakes and rivers because of the plant's high transpiration rate (Parsons 1992, as cited in Cal-IPC 2014) and can alter water quality beneath dense vegetation mats by reducing dissolved oxygen and affecting pH and turbidity (Penfound and Earle 1948; Center and Spencer 1981, as cited in Cal-IPC 2014). Alterations in water quality can lead to adverse effects on aquatic biota, and decaying water hyacinth beds can make water unsuitable for drinking by humans, wildlife, and livestock.

Because of the adverse effects of water hyacinth infestations on aquatic systems, removal of these introduced plants would likely improve water quality in the lower river, at least locally, particularly during summer months when plant densities and background water temperatures are higher. As such, a substantial monetary contribution to efforts aimed at controlling this invasive aquatic weed would result in a positive contribution to cumulative effects on water quality and the overall health of the aquatic ecosystem in the lower Tuolumne River.

Flow-Related Measures for Fish and Aquatic Resources

The Districts' proposed flow regime for the lower Tuolumne River, which is summarized in Table 4.3-1, would result in temperature benefits relative to baseline conditions, thereby contributing beneficially to cumulative water quality impacts in the lower river (see following sections). Reductions in temperatures could result in associated increases in dissolved oxygen concentrations.

<u>Flow-Related Measures for Fish and Aquatic Resources in the Lower Tuolumne River</u>

The Districts are proposing to implement the flow regime summarized in Table 4.3.1 (above) and described in greater detail in Section 3.5.4 of this Exhibit E for the following aquatic resource objectives: (1) flows from June 1–June 30 to benefit *O. mykiss* fry rearing (2) flows from July 1–

October 15 to benefit *O. mykiss* juvenile rearing, (3) flows from October 15–December 31 to provide habitat for fall-run Chinook spawning, (4) flows from January 1–February 28/29 to provide habitat for fall-run Chinook fry rearing, (5) flows from March 1 – April 15 to provide habitat for fall-run Chinook juvenile rearing, (6) fall-run Chinook outmigration baseflows from April 16–May 31, and (7) outmigration pulse flows from April 16–May 31. These flows would result in temperature benefits throughout much of the year, as explained in Sections 3.4 and 3.5 of this Exhibit E.

Flow Hydrograph Shaping

In spill years, the Districts would make reasonable efforts to shape the descending limb of the snowmelt runoff hydrograph to mimic natural conditions to promote seed dispersal and germination of cottonwoods and native willows. Increasing natural recruitment of snowmelt-dependent hardwoods would increase stands of trees that would eventually provide shade, which could over the long-term result in limited water temperature reduction, thereby contributing positively to cumulative effects on water quality in the lower Tuolumne River.

4.3.2.3 Cumulative Effects on Water Quality in the San Joaquin River and Delta

Factors contributing to cumulative effects to water quality expand significantly downstream of the confluence of the Tuolumne and San Joaquin rivers, with an immense number of actions affecting conditions in the mainstem San Joaquin River and the Delta. Prominent among these are river diversions at Friant Dam on the San Joaquin River, at Crocker-Huffman Dam on the Merced River, at New Melones and other dams on the Stanislaus River, and riparian withdrawals along all these waters. Intense agricultural development along the San Joaquin River and its tributaries has resulted in additional river water withdrawals and introduction of an array of pesticides and herbicides.

The California Department of Pesticide Regulation has documented over 300 herbicides and pesticides that are discharged throughout agricultural regions of the Central Valley and Delta (Werner et al. 2008). Agriculture, which is the primary land use adjacent to the Merced River downstream of the Crocker-Huffman Diversion Dam, has the potential to affect water quality and aquatic resources primarily through water returns to the river. Discharge of nutrients such as nitrogen and phosphorus from non-point runoff of agricultural fertilizer and point sources, such as water treatment facilities, stimulates algae growth, with attendant increases in the magnitude of diurnal DO variation.

Reduction in flows in the San Joaquin River, particularly between Gravelly Ford Canal and the Merced River, has increased the concentration of pesticides and fertilizers in the river, which has contributed to pollution that has impacted aquatic species (Cain et al. 2003). Hundreds of agricultural and urban drains discharge into the San Joaquin River downstream of the Merced River confluence, many of which are also designated as impaired water bodies, such as the Harding Drain, the Grayson Drain, the Newman Wasteway, and the Westley Waterway (SWRCB 2010). The San Joaquin River has been identified by the SWRCB as an impaired water body for arsenic, boron, dacthal, *Escherichia coli* (*E. coli*), dichloro-diphenyl-dichloroethylene (DDE), mercury, temperature, selenium, electrical conductivity, and several pesticides, both upstream and downstream of the Merced River confluence.

The flow of subsurface drainage water from intensively irrigated agricultural land on the west side of the San Joaquin Valley into the San Joaquin River has created a well-documented water salinity and specific ion (selenium and boron) problem in the river. The flow of water from the Tuolumne River (and the Merced and Stanislaus rivers) dilutes and improves the overall water quality, including the salinity level, of the San Joaquin River as it moves downstream toward the Delta.

Urbanization along the San Joaquin River and in the Delta has resulted in a number of water quality concerns, including adverse effects from urban runoff and M&I wastewater and stormwater discharges. The development of the Stockton Deep Water Ship Channel resulted in a zone of near-zero DO that has only just recently been addressed by adding aeration directly to the channel portion of the river and reducing nitrogen loads from the Stockton Wastewater Treatment Plant (see Section 4.1.4.4 for a discussion of the Stockton DWSC and associated mitigation measures). In general, the factors affecting water quality in the San Joaquin River and Delta ecosystems are likely proportional to the human population, amount of water development, and number of irrigated acres. The population of the San Joaquin Valley and Bay Area combined exceeds 10 million people; the population served by the Don Pedro Project is about 250,000, or about 2 percent of that total. The irrigated acreage in the San Joaquin Valley exceeds 5 million acres;[96] the Don Pedro Project serves approximately 210,000 acres, or about 4 percent of the total. There are 20 major dams on tributaries to the lower San Joaquin River and Delta that store over 20 million AF of water for irrigation, M&I uses, and flood control;[97] the total usable storage in Don Pedro Reservoir for those purposes is 1.7 million AF, or about 8 percent of the total.

With respect to pollution loadings and DO concerns in the San Joaquin River, the Don Pedro Project does not contribute to cumulative adverse effects on these water quality constituents. As discussed in Section 4.3.2.1, the Don Pedro Project has little to no influence on water temperatures by the time flows reach the confluence with the San Joaquin River, and even less by the time water reaches the Delta.

4.4 Fish and Aquatic Resources

FERC's SD2 (pages 35-36) identifies the following potential Don Pedro Project effects on fish and aquatic resources in the Tuolumne River:

- Effects of project operation and maintenance on fish populations in project reservoirs and the project-affected stream reach including fall Chinook salmon
- Effects of retention of sediment in the project reservoir on downstream fish spawning habitat and benthic macroinvertebrate populations

[96](http://www.idrinkwine.net/the-sjv/)
[97](http://cdec.water.ca.gov/cdecapp/resapp/getResGraphsMain.action)

- Potential effects of project-related changes in the recruitment and movement of large woody debris on aquatic resources and their habitat
- Potential effects of project operations on stranding or displacement of fish

For aquatic resources, FERC defines the geographic scope of cumulative effects as extending upstream on the Tuolumne River to Hetch Hetchy Reservoir and downstream to San Francisco Bay. At the time of the release of its SD2, FERC tentatively identified a cumulative geographic scope for anadromous fish and essential fish habitat (EFH) that includes the Tuolumne River basin downstream to the confluence with the San Joaquin River, and the San Joaquin River through the Delta to San Francisco Bay. FERC noted that based on the potential term of a new license, the temporal scope is 30 to 50 years into the future and any consideration of such future effects should focus on reasonably foreseeable future actions.

The fish and aquatic resources of the lower Tuolumne River are affected by a large number of past, present, and potential future anthropogenic actions and background environmental conditions, both within and outside the Tuolumne River watershed. The primary purposes (i.e., storage and release of flows for irrigation and M&I uses and flood control) of the Don Pedro Project contribute to cumulative effects on fish and aquatic resources in the lower river. However, because power generation at the Don Pedro Hydroelectric Project does not affect flows downstream of La Grange Diversion Dam (i.e., flows in the lower river are driven by the Don Pedro Project's primary purposes), generation of hydroelectric energy does not contribute to cumulative effects, positive or negative, on fish and aquatic resources in the Tuolumne River. The FERC-required flow releases linked to the Don Pedro Hydroelectric Project, however, benefit fall-run Chinook salmon and other native fish species, resulting in an overall positive contribution to cumulative effects. The Districts' proposed resource measures would increase the benefit to fish and aquatic resources beyond that associated with current baseline measures, as explained in the following effects assessment sections. Other factors that influence fish and aquatic resources in the lower river include water management activities by other entities within and outside the basin, past and present in-river and floodplain mining activities, a variety of historical and current land-use practices, introduced non-native species, and ongoing fisheries management.

The cumulative effects of the Don Pedro Project are attenuated with increasing distance downstream in the Tuolumne River and into the San Joaquin River basin and the Delta. As fall-run Chinook salmon and any Central Valley steelhead that may occur in the lower river migrate farther downstream from the Don Pedro Project, the number and complexity of contributing factors affecting the environment grow considerably, and it becomes increasingly difficult to isolate the specific effects of any individual action from all of the contributing factors affecting individual life stages of these fish.

The cumulative effects assessment for fish and aquatic resources includes an assessment of the degree to which the Don Pedro Project may contribute to the cumulatively affected resources identified by FERC. The number and complexity of co-occurring past, present, and future actions in the Tuolumne River basin make it exceedingly difficult, if not impossible, to meaningfully isolate the specific effects on aquatic resources of each of the numerous past and present individual actions, including the actions of the Don Pedro Project. To the extent that the degree of influence of any individual action on a resource is indeterminate, then the effect of modifying that action is also likely to be indeterminate.

4.4.1 Fish and Aquatic Resources Cumulative Effects Assessment

The following cumulative effects assessment section is organized according to the types of effects resulting from the actions described in Section 4.1. Topics include (1) hydrologic and physical habitat alteration, (2) temperature and water quality, (3) connectivity and entrainment, (4) hatchery propagation and stocking, (5) introduced species and predation, (6) benthic invertebrates and fish food availability, and (7) freshwater harvest. The geographic scope of the assessment, as noted above, includes the Tuolumne River from O'Shaughnessy Dam to its confluence with the San Joaquin River and the San Joaquin River downstream through the Delta.

The Don Pedro Project's primary purposes contribute to cumulative effects to fish and aquatics resources, including fall-run Chinook salmon and Central Valley steelhead, in the lower Tuolumne River and downstream in the San Joaquin River and Delta. Other actions conducted within the Tuolumne River basin that contribute to cumulative effects include (see Section 4.1) CCSF's operations of the Hetch Hetchy system, water diversions at La Grange Diversion Dam, riparian withdrawals by water users, discharge of irrigation return flows, historic and current mining activities, agricultural and urban land uses, the presence of non-native species, and stocking of hatchery salmonids. In addition, ongoing operation of reservoir and diversion facilities in the San Joaquin River and its tributaries, along with an array of other actions (see Section 4.1), also contribute to cumulative effects on aquatic organisms within the analysis area for cumulative effects.

4.4.1.1 Hydrologic and Physical Habitat Alteration

Lower Tuolumne River

Prior to widespread European settlement, the channel form of the lower Tuolumne River consisted of a combination of single-thread and split channels that migrated and avulsed (McBain & Trush 2000). Variation in hydrologic and geological controls, primarily valley width and the location and elevation of underlying bedrock, resulted in variable and complex localized channel morphologies (McBain & Trush 2000). The riparian corridor was miles wide in places where the river lacked confinement (McBain & Trush 2000). More than a century of cumulative impacts have transformed the lower Tuolumne River from a dynamic, alluvial system capable of forming its own bed and bank morphology to a river highly constrained between either man-made dikes or agricultural fields, or constrained by riparian vegetation that has encroached into the low water channel (McBain & Trush 2000).

Hydrologic Alteration

Over the past 120 years, each increment of flow regulation (Wheaton, La Grange, Dennett, O'Shaughnessy, old Don Pedro, and new Don Pedro dams along the mainstem and dams constructed along tributaries above O'Shaughnessy Dam, including Cherry and Eleanor Creeks) has modified the lower Tuolumne River's flow regime. Historically, Wheaton Dam and the present day La Grange Diversion Dam lacked the storage capacity needed to affect high flow conveyance to the lower Tuolumne River during winter and spring (McBain & Trush 2000). CCSF's Hetch Hetchy Project, the Districts' new Don Pedro Dam, and CCSF's Cherry Lake combined to reduce the magnitude and frequency of flood flows and snowmelt runoff to the lower Tuolumne River downstream of La Grange Diversion Dam. Indeed, the ACOE contributed financially to the construction of the new Don Pedro Dam for the purpose of flood control. The resulting reduction in flood-flow frequency attests to the successful implementation of that Don Pedro Project purpose.

Analyses of streamflow records from the USGS gaging station at La Grange (Station 11-289650) reveal the following alterations of hydrologic conditions: (1) the magnitude and variability of summer and winter baseflows, fall and winter storms, and spring snowmelt runoff have been reduced and (2) the magnitude, duration, and frequency of winter floods have been reduced (McBain & Trush 2000). Following completion of the New Don Pedro Dam in 1971, compliance with ACOE flood control and other flow requirements reduced the estimated average annual flood (based on annual maximum series) from 18,400 cfs to 6,400 cfs.

Physical Habitat and Riparian Alteration

Gravel and gold mining, as well as other land uses, adversely affected aquatic habitat prior to the construction of dams on the Tuolumne River (TID/MID 2005) (see Section 4.1.1 for a summary of the chronology of current and historical actions within the defined geographic scope for cumulative effects). The presence of dams, aggregate extraction, agricultural and urban encroachment, and other land uses, including hydraulic mining practices near La Grange, have resulted in imbalances of sediment supply and transport in the lower Tuolumne River channel (McBain & Trush 2000). Don Pedro Dam and La Grange Diversion Dam, combined with other dams upstream of the Project Boundary, trap all coarse sediment and LWD that would otherwise pass downstream. In the lower river, in-channel excavation of bed material to depths well below the river thalweg for gold and aggregate has significantly reduced available spawning habitat, eliminated active floodplains and terraces, and created large in- and off-channel pits that provide favorable habitat for non-native predator species.

The cumulative effect of sediment trapping by upstream reservoirs, mining, and other land uses has altered the channel downstream of La Grange Diversion Dam (CDWR 1994; McBain & Trush 2004). Sequences of historical photos show that channel corridor width has been progressively reduced by land use (McBain & Trush 2000). Sediment model simulations indicate that without gravel augmentation, the channel bed from RM 52 to 39.7 would undergo a slow loss of gravel and coarsening (armoring) in response to the reduction in coarse sediment supply (TID/MID 2013f). Gravel augmentation, however, has helped to increase coarse sediment storage in this area (TID/MID 2013f). The rate of current gravel transport compared to the stores of gravel in this reach is low and little change in overall gravel availability is expected to occur over the next license term.

Large in-channel pits (SRPs) were created where sand and gravel aggregate were extracted. Historical deposits of dredger tailings (RM 50.5–38.0) confined the active river channel, preventing sediment recruitment that would otherwise have resulted from the normal process of channel migration (McBain & Trush 2000). Under current conditions, channel migration has been substantially curtailed.

More recent aggregate mining operations have excavated sand and gravel from floodplains and terraces immediately adjacent to the river channel at several locations downstream of Roberts Ferry Bridge (RM 39.5). Floodplain and terrace pits in this reach are typically separated from the channel by narrow berms that can breach during high flows, resulting in capture of the river channel. The January 1997 flood caused extensive damage to dikes separating deep gravel mining pits from the river, breaching or overtopping nearly every dike along a 6-mile-long reach (TID/MID 2011).

Most woody debris captured in Don Pedro Reservoir is small, and it appears that the majority of it would pass through the lower river during normal high flows if it were not trapped in the reservoir (TID/MID 2013e). The lower Tuolumne River between RM 52 and 26 has channel widths averaging 119 feet, and woody debris would have a limited effect on channel morphology in this reach (TID/MID 2013e).

Historical clearing of riparian forests in the Tuolumne River basin modified vegetation and associated habitat, halting many attendant ecosystem processes (Katibah 1984, Naiman et al. 2005). Urban and agricultural encroachment and mining have resulted in the direct removal of large tracts of riparian vegetation in the lower Tuolumne River corridor. Livestock selectively graze younger vegetation, which limits the establishment of riparian plants (McBain & Trush 2000). Clearing woody plant cover has also created openings in the riparian corridor where non-native plant species have become established and proliferated (McBain & Trush 2000). Land conversion and levee construction that constrained channel migration, including alteration of meander bends and cutoff/oxbow formations, have reduced riparian complexity (McBain & Trush 2000, Grant et al. 2003).

Mining has also substantially altered riparian conditions along the lower Tuolumne River. Aggregate mining leaves large pits in the floodplain, converting floodplain vegetation to open water. Levees built to isolate mining pits from the river constrain lateral movement of the river (TID/MID 2013b). These activities preclude regeneration of riparian vegetation by eliminating habitat and limit lateral movement of the river, reducing the amount and diversity of riparian habitat surfaces (TID/MID 2013b). Dredger tailings of unconsolidated sediments on the floodplain have replaced rich soils with poor ones, resulting in changes in riparian species composition and a reduced extent and diversity of riparian vegetation (TID/MID 2013b). The reduced development of riparian vegetation on dredger spoil piles has diminished riparian habitat connectivity (TID/MID 2013b).

Flow regulation and sediment trapping associated with upstream dams indirectly affected riparian vegetation by modifying the hydrologic and fluvial processes that influence survival and mortality of riparian vegetation. As noted above, each increment of flow regulation (La Grange Diversion Dam, O'Shaughnessy Dam, Old Don Pedro Dam, New Don Pedro Dam) successively reduced the magnitude, duration, and frequency of flood flows, and removed key mortality agents, including scour, channel migration, flood-induced toppling, and inundation (McBain & Trush 2000). In some areas, reduced flood scour has allowed riparian vegetation to encroach along the low water channel, where historically vegetation would have been absent. In other areas, as noted above, the legacy of impacts has altered the structure of the floodplain and reduced the potential for establishment.

The lateral extent of riparian vegetation along the Tuolumne River remains greatly diminished from what it was prior to large-scale settlement along the river. Currently, less than 15 percent of the historical riparian forests remain along the Tuolumne River (McBain & Trush 2000). However, over the past 15 years the areal extent and location of lands dominated by non-native plants has actually decreased (TID/MID 2013b). Overall, the 52-acre average of native riparian vegetation per river mile is slowly changing, with a 419-acre increase in the net extent of native vegetation between 1996 and 2012 (an average increase of about 8 acres/mile), assisted by active restoration projects (TID/MID 2013b).

Effects on Salmonids

Anadromous fish abundance in the Tuolumne River has been reduced by habitat degradation and extensive instream and floodplain mining beginning in the mid-1800s (McBain & Trush 2000). Dams and water diversions associated with mining had affected fish migration as early as 1852 (Snyder 1993 unpublished memorandum, *as cited* in Yoshiyama et al.1996). Access to historic spawning and rearing habitat was significantly restricted beginning in the 1870s, when a number of dams and irrigation diversion projects were constructed. Wheaton Dam, built in 1871 near the site of the present-day La Grange Diversion Dam, was a barrier to salmon migration. In 1884, three years before either District was created, the California Fish and Game Commission reported that the Tuolumne River was "dammed in such a way to prevent the fish from ascending" (California Fish and Game Commission 1884, *as cited* in Yoshiyama et al. 1996).

During their upstream migration, Tuolumne River flows may affect homing of Tuolumne River origin Chinook salmon, and may also affect straying of salmonids from other rivers into the Tuolumne River (TID/MID 2013b).

Studies conducted in the Tuolumne River indicate that a lack of spawning gravel and curtailed sediment recruitment, due to in-river and floodplain mining, trapping by upstream dams, and other land uses, may result in density-dependent competition and exclusion from suitable spawning sites and may limit the number of female Chinook salmon that successfully spawn in the lower Tuolumne River (TID/MID 1992, Appendix 6; TID/MID 2000, Report 1999-1; TID/MID 2001, Report 2000-1). Model simulations indicate that Chinook salmon are limited by spawning habitat availability only at high spawning densities (TID/MID 2017e). Upstream reaches affected by gold dredger mining in the early part of the century (RM 50–47) were "reconfigured" following removal of dredger tailings for construction of the new Don Pedro Dam and this reach currently supports the majority of Chinook salmon spawning activity (TID/MID 2013b). Due to higher channel gradient, overbank habitats in this reach do not provide the same relative benefits as other river floodplain habitats studied in lowland portions of the Central Valley (Stillwater Sciences 2012a). Further, the remnant dredger pits and multiple connected backwaters along the lower Tuolumne River have been identified as an area of potential juvenile Chinook stranding (TID/MID 2001) and may actually create favorable habitat for predator species (Stillwater Sciences 2012a).

Although there is the potential for Chinook redd scouring to occur during flood events, minimum spawning flows required by FERC have reduced the risk of redd dewatering (TID/MID 2013b). The risk of mortality due to redd scour, redd dewatering, and entombment is expected to be low in the Tuolumne River due to current operations and reduced fine sediment supply (TID/MID 2013c). Egg displacement and mortality resulting from redd superimposition of spawning steelhead is not expected to occur in the Tuolumne River at current spawner levels (TID/MID 2013b).

Because current Don Pedro Project operations do not include power peaking, potential risk of juvenile Chinook salmon and *O. mykiss* stranding and entrapment are low. Some stranding may occur during flow reductions following flood control releases; however, the low frequency of these flood events in combination with ramping rate restrictions required by the current FERC license likely result in a low risk of fish mortality due to stranding and entrapment (TID/MID 2013b). A comprehensive evaluation of stranding surveys was conducted on the lower Tuolumne River (TID/MID 2000, Report 2000-6) and is summarized in the 2005 Ten-Year Summary Report (TID/MID 2005). This evaluation indicated that the highest potential for stranding occurred at flows between 1,100 and 3,100 cfs, i.e., the range of flows under which the floodplain is inundated in several areas of the Chinook spawning reach.

Floodplain access for rearing juvenile Chinook salmon is limited in the lower Tuolumne River due to flows and habitat modification. Based on analysis of historical inundation mapping, the majority of floodplain habitat available at flows ranging from 1,000–5,000 cfs is limited to several disturbed areas between RM 51.5 and RM 42 that were formerly overlain by tailings (Stillwater Sciences 2012a).

Although increased structure has been shown to reduce territory size that must be defended (Imre et al. 2002) and improve steelhead feeding opportunities (Fausch 1993), it is unlikely that the alluvial portions of the Tuolumne River downstream of La Grange Diversion Dam historically supported the large wood or boulder features that are more typically found in high gradient streams of the Central Valley and along the coasts of California and Oregon (TID/MID 2013b), so it is unclear to what degree LWD retention by upstream dams has contributed to adverse habitat effects in the lower river. Although LWD provides habitat for salmonids in some systems, there are no data available for the Tuolumne River or neighboring Merced River that specifically address the role of LWD on salmonid abundance (TID/MID 2017b). Of the 121 locations within the W&AR-12 study reach where LWD was recorded, about 80 percent of it was located in or adjacent to runs or pools, which are not typically the preferred habitat of juvenile or adult *O. mykiss* in the lower Tuolumne River. Because most LWD in the lower Tuolumne River is partially or wholly out of the channel, and due to its small size, it does not provide significant cover for fish, which in turn limits its value as protection from avian and aquatic predators. Due to its generally small size, location, and lack of complexity, most LWD from RM 52 to 24 provides little habitat value for *O. mykiss*.

SRPs, created by in-channel mining, can be up to 400 ft wide and 35 ft deep and occupy approximately 32 percent of the length of the channel in the gravel-bedded zone (RM 52–24). These habitat features harbor non-native fish, such as introduced largemouth and smallmouth bass that prey on juvenile salmonids (see Introduced Fish Species, below). Introduced predators have been, and continue to be, most abundant in large, slow-moving areas prevalent in the middle section of the lower river, downstream of the major Chinook salmon spawning areas (Orr 1997). It is likely that the present pattern and degree of predation mortality for Chinook (and also for any steelhead that may occur) in the Tuolumne River is to a large extent a result of past sand and gravel mining coupled with the deliberate introduction by CDFW of non-native piscivorous fish species (Orr 1997).

Continued hydroelectric power generation at Don Pedro Dam would not contribute to cumulative effects on aquatic resources in the lower Tuolumne River. Electric power is generated at the Don Pedro Hydroelectric Project using flows released for other purposes. Irrigation, municipal, and industrial water deliveries and high-flow releases are pre-scheduled based on forecasted demands and actual projected inflow and then released through the powerhouse up to its hydraulic capacity. Scheduling of these releases is adjusted, when consistent with water supply needs, to release flows for hydroelectric energy generation with a preference for on-peak power demand rather than off-peak hours. However, these "peaking" flows are modulated, being subject to water supply demand and limits on water fluctuations in the Districts main canals. Flows in the reach of the Tuolumne River below La Grange Diversion Dam are not subject to such fluctuations as the fluctuations travel down and are absorbed by the Districts' main canals and irrigation water needs, which are unrelated and non-interdependent actions e.g., providing water for irrigation and M&I uses. Hydroelectric generation at the Don Pedro Hydroelectric Project cannot impact resources in the lower Tuolumne River, because the flows released into the lower Tuolumne River are not linked to power production and, absent power production at Don Pedro Dam, the flow release schedule, including flows to the lower Tuolumne River, will remain the same as it is under existing conditions, i.e., driven by uses other than hydroelectric power production. However, some of the Districts' proposed measures for the lower Tuolumne River would contribute positively to cumulative effects on flow regime and physical habitat, which would influence aquatic resources, as described below. Greater detail on the measures listed below, and their direct effects, can be found in Section 3.5.4 of this Exhibit E.

Gravel Augmentation: Gravel augmentation at discrete locations from RM 52 to RM 39 would enhance the quality and quantity of fall-run Chinook and *O. mykiss* spawning habitat. Adding coarse sediment (0.125–5.0 inches in diameter) to the river channel at locations selected based on biological and geomorphic needs, would result in the following expected benefits (1) an increase in salmonid egg-to-emergence ratio, (2) reduced superimposition of salmonid redds, (3) increased benthic macroinvertebrate production, and (4) potentially improved hyporheic flow and cold water habitat downstream of La Grange Diversion Dam.

- **Gravel Mobilization Flows**: Flow releases ranging from 6,000–7,000 cfs (measured at USGS gage 11289650 below La Grange Diversion Dam) would provide the following expected benefits (1) reduced fine sediment storage in the low-flow channel and in spawning gravels, which could increase salmonid egg-to-emergence success and fry production, and benthic macroinvertebrate production, (2) increased fine sediment storage on floodplains, which could improve regeneration of native riparian plant species during wetter water years, and (3) a net increase in lateral channel migration, bar formation, and large wood introduction, which together could create new floodplains and complex hydraulic environments for improved adult salmonid holding, spawning, and juvenile rearing.

- **Gravel Cleaning:** Experimental gravel cleaning to flush fine sediments from gravel interstices has the potential to expand the availability of high quality gravel, which would improve spawning success and egg incubation for fall-run Chinook and *O. mykiss*. Gravel cleaning would coincide with the May pulse flows (see below) to aid fall-run Chinook smolt outmigration by providing increased turbidity to reduce predator sight-feeding effectiveness. To minimize potential adverse effects on *O. mykiss* redds, gravel cleaning would occur after May 1.
- **Improve Instream Habitat Complexity**: Boulders (approximately 0.7-1.5 yd^3 in size) placed between RM 50 and 42 are expected to provide favorable microhabitats for *O. mykiss* (TID/MID 2017b, W&AR-12) by increasing structural and hydraulic complexity, and improve spawning habitat for fall-run Chinook and *O. mykiss* as localized scour displaces fines from gravel beds. This measure could also result in local increases in benthic macroinvertebrate production, through substrate improvements due to the scouring of fines.
- **Contribute to CDBWs Efforts to Remove Water Hyacinth**: Providing matching funds to California DBW for the removal of water hyacinth in the lower Tuolumne River would likely benefit aquatic biota in the lower river, possibly including fall-run Chinook salmon passing through the lowermost reaches of the river where water hyacinth infestations occur.
- **Fall-Run Chinook Spawning Improvement Superimposition Reduction Program**: Installation of a temporary barrier in the lower river channel is expected to reduce rates of fall-run Chinook redd superimposition. Rates of redd superimposition are relatively high for fall-run Chinook in the lower Tuolumne River due to a strong preference for spawning upstream of RM 47 (TID/MID 2017b, 2017e), even though suitable spawning gravel exists in the lower Tuolumne River downstream to approximately RM 30.
- **Flow-Related Measures for Fish and Aquatic Resources in the Lower Tuolumne River**: The Districts are proposing to implement the flow regime summarized in Table 4.3.1 (above) and described in greater detail in Section 3.5.4 of this Exhibit E for the following aquatic resource objectives: (1) flows from June 1–June 30 to benefit *O. mykiss* fry rearing (2) flows from July 1–October 15 to benefit *O. mykiss* juvenile rearing, (3) flows from October 15–December 31 to provide habitat for fall-run Chinook spawning, (4) flows from January 1–February 28/29 to provide habitat for fall-run Chinook fry rearing, (5) flows from March 1 – April 15 to provide habitat for fall-run Chinook juvenile rearing, (6) fall-run Chinook outmigration baseflows from April 16–May 31, and (7) outmigration pulse flows from April 16–May 31.
- **Flow Hydrograph Shaping**: Shaping the descending limb of the snowmelt runoff hydrograph to mimic natural conditions to facilitate cottonwood seed dispersal would increase natural recruitment of snowmelt-dependent hardwoods that could contribute LWD to the channel over the long-term and provide cover and shade for aquatic organisms.

San Joaquin River and Delta

Flows in the San Joaquin River and its tributaries, combined with flow diversions at the SWP and CVP water export facilities, may affect homing of Tuolumne River-origin Chinook salmon during their upstream migration (TID/MID 2013b). Homing fidelity of Chinook salmon to their natal streams is related to the sequence of olfactory cues imprinted during rearing and outmigration, so attraction flows and entrainment of flows into the SWP and CVP may affect the numbers of Chinook salmon returning to the Tuolumne River. However, other than the broad relationships between Vernalis flows, water exports at the SWP and CVP facilities, and subsequent recoveries of hatchery-reared, code-wire-tagged fish recovered in Sacramento and San Joaquin River basin hatcheries (Mesick 2001), the relationship between San Joaquin River tributary homing and attraction flows remains poorly understood. Although few upstream migrant *O. mykiss* have been documented in either historical or present day monitoring in the Tuolumne River, flows in lower San Joaquin River tributaries and flows entrained by the SWP and CVP water export facilities could also affect homing of any Central Valley steelhead originating in the Tuolumne River (TID/MID 2013b). Flow alterations may also affect straying of salmonids from other rivers into the Tuolumne River (TID/MID 2013b).

The extent of historical flooding in Central Valley rivers was vast (Kelley 1989), and the timing of Chinook salmon outmigration would have allowed juveniles to exploit habitats provided by prolonged periods of floodplain inundation. Reductions in wetland and floodplain habitats in the lower San Joaquin River and South Delta, and changes in tributary flow magnitudes and timing, have reduced access to Delta floodplain habitats used by rearing and emigrating Chinook salmon from the Tuolumne River (Whipple et al. 2012; TID/MID 2013b).

Few locations in the eastern and central Delta provide suitable habitat for rearing salmonids (TID/MID 2013b). Because extended periods of floodplain inundation do not occur in most areas of the lower San Joaquin River and Delta, except as the result of large flood control releases from tributaries, it is likely that changes in Delta habitats have affected the number and growth of rearing Chinook salmon and steelhead smolts, resulting in a reduction in the number and size of smolts entering the ocean and potential reduction in ocean survival (TID/MID 2013b). However, winter inundation of some flood bypasses and floodplains along the lower portions of some San Joaquin River tributaries still provides some juvenile Chinook salmon rearing habitat (Feyrer et al. 2006; Sommer et al. 2001; Sommer et al. 2005; Moyle et al 2007). Although the Delta has generally been considered an outmigration corridor for steelhead, active feeding of juvenile steelhead has been documented in the Yolo bypass during flood conditions in some years (USBR 2008), suggesting that loss of historical floodplain habitat access in the Delta may have effects on steelhead rearing and subsequent smolt emigration.

The Delta is interlaced with hundreds of miles of waterways, and relies on more than 1,000 miles of levees for protection against flooding (Moore and Shlemon 2008). These levees have eliminated the majority of tidally exchanged marsh habitats in the Delta (Whipple et al. 2012), areas historically used as nursery areas for a variety of Delta fish species (Kimmerer et al. 2008), and few locations in the eastern and central Delta now provide suitable habitat for rearing Chinook salmon. The combined effects of continued land subsidence, rising sea level, increased seismic risk, and increased winter flooding increase the vulnerability of the extensive Delta levee system, which can result in degradation of water quality and exposure of habitat adjacent to islands to increased seepage and wave action (CDWR et al. 2013). Much of the rich Delta farmland has lost soil from oxidation, compaction, and wind erosion, resulting in lowered elevations of some islands, in some cases up to 25 ft below sea level.

Measures have been undertaken to address conditions for migratory salmonids in the lower San Joaquin River and Delta. The results of south Delta survival studies indicate that installation of the Head of Old River Barrier (HORB) increases salmon smolt survival through the Delta by 16 to 61 percent (TID/MID 2013b) (see also Temperature and Water Quality, below).

Non-salmonid special status fish species affected by flow and habitat modification in the lower San Joaquin River and/or Delta include the Sacramento splittail (*Pogonichthys macrolepidotus*), hardhead (*Mylopharodon conocephalus*), Sacramento-San Joaquin roach (*Lavinius symmetricus symmetricus*), and delta smelt (*Hypomesus transpacificus*). Historically, Sacramento splittail inhabited sloughs, lakes, and rivers of the Central Valley, with populations extending upstream to Redding in the Sacramento River, to Butte Creek/Sutter Bypass, to Oroville in the Feather River, to Folsom in the American River, and to Friant in the San Joaquin River (Moyle et al. 2004). Their current distribution is limited by dams and other barriers, and the species is largely confined to the Delta, Suisun Bay, Suisun Marsh, Napa River, Petaluma River, and other parts of the Sacramento-San Joaquin estuary (Moyle 2002). Historically, hardhead were widely distributed and locally abundant in the Central Valley. Their specialized habitat requirements coupled with widespread alteration of downstream habitats have resulted in population declines and isolation of populations (Moyle 2002). The Sacramento-San Joaquin roach, although abundant in a large number of streams, is now absent from a number of streams and stream reaches where it once occurred (Moyle 2002). The Delta smelt has been adversely affected by entrainment into the SWP and CVP (CDWR et al. 2013) and habitat and flow alteration in the Delta.

4.4.1.2 Water Quality Effects on Aquatic Resources

Water Temperature

The effects of impoundments on water temperatures in the Tuolumne River are discussed in detail in Section 4.3.2.1 of this Exhibit E. Water temperature conditions in the lower Tuolumne River are unlikely to result in mortality of upstream migrant adult salmonids, either directly or as the result of increased susceptibility to pathogens (TID/MID 2013b). No evidence of Chinook salmon pre-spawning mortality has been identified in the lower Tuolumne River (TID/MID 2013c), and no instances of water temperature related mortality of any fish species have been observed in the lower Tuolumne River (TID/MID 2013b). Because the majority of adult CCV steelhead migration occurs from November through March, when water temperatures are low, potential temperature-related effects on the arrival timing and pre-spawn mortality of any steelhead in the lower Tuolumne River would be unlikely (TID/MID 2013b) (the vast majority of *O. mykiss* in the lower Tuolumne River display a resident life history). Fall-run Chinook adults must first traverse the much warmer waters of the Delta and San Joaquin River before encountering the Tuolumne River, which has significantly cooler temperatures during the late September through November peak migration period than the San Joaquin River and Delta.

Based on assessments of seasonal water temperatures and typical spawning periods, fall-run Chinook salmon in San Joaquin River basin tributaries are unlikely to encounter unsuitable water temperatures leading to reduced egg viability (TID/MID 2013b), and Myrick and Cech (2001) suggested that only the earliest spawners arriving in San Joaquin River basin tributaries during September might encounter unsuitable temperatures. Intragravel water temperatures measured during February and March 1991 at several locations in the lower Tuolumne River ranged from 11 to 15°C (TID/MID 1997, Report 96-11), indicating that water temperature conditions are suitable for Chinook salmon egg incubation.

Rotary screw trap data indicate that two juvenile outmigration life-history strategies exist for Tuolumne River fall-run Chinook salmon: winter outmigration of fry in January-February and spring outmigration of subyearling smolts (>70 mm) from April-June. In all years, water temperatures remain well below the incipient lethal limit (25°C) during winter fry outmigration. In most years, water temperatures for spring outmigrants remain below incipient lethal temperatures, although temporally isolated events of high water temperature can occur. In general, flow releases resulting from the 1996 FERC Order help maintain appropriate water temperatures during Chinook salmon rearing and emigration.

The Central Valley steelhead spawning period extends from December through April and peaks in February and March, so if the lower Tuolumne River had a steelhead run, water temperature would be unlikely to adversely affect spawning success (TID/MID 2013b). However, available information suggests that juvenile *O. mykiss* rearing habitat may be limiting in the lower Tuolumne River during summer due to a combination of high water temperatures and potential territorial interactions with *O mykiss* of older age classes (TID/MID 2013b). Increased densities and downstream distribution of juvenile *O. mykiss* have been documented since implementation of increased summer baseflows under the 1996 FERC Order, and during years with extended flood control releases (TID/MID 2013b).

Because adult resident *O. mykiss* are generally found in upstream habitats year-round (Stillwater Sciences 2012b), temperature related mortality is unlikely to occur in the lower Tuolumne River. It is unknown, however, whether adverse temperature effects occur during potential smolt emigration that would occur late in the spring (TID/MID 2013b). Increased summer baseflows and stable summer temperatures in the Tuolumne River since 1996 appear to have selected for a largely resident *O. mykiss* life history (TID/MID 2013b).

A recently conducted study, i.e., Thermal Performance of Wild Juvenile *Oncorhynchus mykiss* in the Lower Tuolumne River: A Case for Local Adjustment to High River Temperature (Farrell et al. 2017), calls into question some of the current assertions made about temperature suitability for *O. mykiss* in the lower Tuolumne River.

As noted previously, during warmer months, the downstream extent of suitable water temperatures has been thought to limit habitat availability for age 0+ *O. mykiss* in the lower Tuolumne River (TID/MID 2013b). However, investigation of thermal performance (i.e., the "swim tunnel" study) (Farrell et al. 2017) showed that wild *O. mykiss* from the lower Tuolumne River can maintain 95 percent of peak aerobic capacity over a temperature range of 17.8°C to 24.6°C, and all fish tested could maintain sufficient aerobic capacity to properly digest a meal at temperatures up to 23°C. Video analysis of *O. mykiss* swimming activity in the Tuolumne River indicates that fish at ambient water temperatures have an excess aerobic capacity well beyond that needed to swim and maintain station against the river current in their usual habitat.

These thermal performance results are consistent with those derived for *O. mykiss* populations known to be high-temperature tolerant, such as the redband strain of rainbow trout (*O. mykiss gairdneri*) that occurs in the high deserts of eastern Oregon and Idaho. Whether the high thermal performance that was demonstrated for the *O. mykiss* of the Tuolumne River downstream of La Grange Diversion Dam arose through genetic selection or physiological acclimatization was beyond the scope of the thermal performance study.

Results of the swim tunnel study (Farrell et al. 2017) support the hypothesis that the thermal performance of wild *O. mykiss* from the Tuolumne River represents an exception to that expected based on the 18°C 7DADM guideline set out by EPA (2003) for Pacific Northwest *O. mykiss*. Given that lower Tuolumne River *O. mykiss* can maintain 95 percent of peak aerobic capacity at temperatures up to 24.6°C, a more reasonable upper performance limit is likely to be 22°C, rather than the suggested 18°C.

Water temperature in the lower San Joaquin River and Delta are unlikely to result in direct mortality of upstream migrating adult Chinook salmon and steelhead or increased susceptibility to disease (TID/MID 2013b). However, there are periods when elevated water temperatures in the lower San Joaquin River and Delta likely have substantial effects on juvenile salmonids. Baker et al. (1995) showed that water temperature explains much of the variation in Delta smolt survival studies from 1983–1992 (TID/MID 2013b). By examining the relationship between water temperature in the Delta and predation-related mortality, it is clear that high water temperatures reduce juvenile Chinook salmon survival in the Delta (Williams 2006). Temperatures of 25°C associated with increased salmonid mortality (Myrick and Cech 2001) routinely occur in the south Delta. However, suitable water temperatures for smolt emigration in the range of 18 to 21°C exist at Vernalis as late as mid-May in most years, and it is likely that Delta conditions are suitable for smolt emigration as late as June in some years. Unsuitable temperature conditions in excess of 25°C are likely exceeded at Vernalis by late June in most years, limiting successful emigration or any salmonid rearing in the Delta during summer (TID/MID 2013b).

Dissolved Oxygen

Measurements of water column and intragravel DO in artificial Chinook salmon spawning redds (TID/MID 2007, Report 2006-7) indicate that water quality conditions in the lower Tuolumne are generally suitable during the egg incubation period.

In the lower San Joaquin River, beginning in the 1960s, CDFW documented potentially adverse effects of low DO levels on adult salmon. Hallock et al. (1970) documented that low DO areas in the Delta blocked adult Chinook salmon upstream migration into the San Joaquin River. More recent water quality data and literature reviews by Newcomb and Pierce (2010) indicate that low DO at Stockton may adversely affect adult anadromous salmonids in September and October during the upstream migration period and juvenile anadromous salmonids in June during the downstream migration period. Chinook salmon are considered more likely to be exposed to low DO levels than steelhead because peak migration for steelhead occurs outside the months with low DO (i.e., during cooler months). For juvenile salmonids, literature reviews by Newcomb and Pierce (2010) suggest that low DO levels can lead to decreased swimming performance, reduced growth, impaired development, and increased susceptibility to predation, pathogens, and contaminants.

Periods of low DO concentrations observed in the Stockton DWSC in the summer and fall months upstream of Turner Cut show that this portion of the lower San Joaquin River does not meet Central Valley Basin Plan (Basin Plan) water quality objectives for DO (5 mg/l December - August and 6 mg/l September -November) (ICF International 2010). In 2008, the Department of Water Resources implemented the Stockton Deep Water Ship Channel Demonstration Dissolved Oxygen Aeration Facility Project (Aeration Facility) to increase DO levels and thereby potentially reduce adverse effects on migrating anadromous salmonids (Newcomb and Pierce 2010).

Testing showed that operating strategies for the Aeration Facility can be developed for a range of DWSC flows, depending on inflowing DO and biological oxygen demand (BOD) concentrations (ICF International 2010). At times, water column BOD exceeds the capacity of the Aeration Facility to help meet the DO objective in some portions of the DWSC. Evaluating fisheries data over time will allow researchers to assess trends in Chinook salmon and steelhead populations and the respective timings of their upstream migration runs. If populations increase and fish begin to arrive in the San Joaquin River earlier, it will be reasonable to infer that low DO is no longer a considerable stressor for migrants in the DWSC (Newcomb and Pierce 2010).

Water quality monitoring was conducted on the San Joaquin River from Mossdale Crossing to Turner Cut to assess the benefit of installing the Head of Old River Barrier (HORB) (Brunell et al. 2010). The HORB is installed by CDWR in conjunction with reservoir releases to increase flow and DO concentrations in the DWSC for migrating fall Chinook salmon; these practices can temporarily increase DO. Since 2000, DO levels in the DWSC have been observed to increase about 2 to 3 mg/l with the increased DWSC flows associated with the placement of the HORB (Brunell et al. 2010). However, low DO may recur after removal of the HORB following the spring pulse flow releases from the San Joaquin River’s tributaries (Brunell et al. 2010). However, the response of DO in the DWSC is complex and difficult to predict solely by flow management; other factors, such as BOD (see above) and temperature, also influence DO.

Nutrients and Contaminants

Shoreline protection measures at Don Pedro Reservoir, including prohibition of shoreline disturbances and off-road vehicle use on Don Pedro Project lands, reduce the potential for adverse effects on reservoir water quality, which could translate into limited downstream water quality benefits. There is no evidence that regulated herbicide and pesticide applications near Don Pedro Reservoir have adverse effects on water quality, and as a result aquatic biota, in the lower Tuolumne River.

The California Department of Pesticide Regulation has documented over 300 herbicides and pesticides that are discharged throughout agricultural regions of the Central Valley and Delta (Werner et al. 2008). Six pesticides were detected in runoff from agricultural and urban areas during a study conducted in the lower Tuolumne River, and chlorpyrifos, DCPA, metolachlor, and simazine were detected in almost every sample (Dubrovsky et al. 1998). Peak diazinon concentrations measured in the lower Tuolumne River have frequently exceeded levels that can be acutely toxic to some aquatic organisms (Dubrovsky et al. 1998). Like the Tuolumne River, agriculture is the primary land use adjacent to the Merced River downstream of the Crocker-Huffman Diversion Dam, where agricultural chemicals have the potential to affect water quality and aquatic resources primarily through water returns to the river. The return water often contains pollutants, which affect fish, BMI, and other aquatic species.

Reduction in flows in the San Joaquin River, particularly between Gravelly Ford Canal and the Merced River, has increased the concentration of pesticides and fertilizers in the river, which has contributed to pollution that has impacted aquatic species (Cain et al. 2003). Hundreds of agricultural and urban drains discharge into the San Joaquin River downstream of the Merced River confluence, many of which are also designated as impaired water bodies, such as the Harding Drain, the Grayson Drain, the Newman Wasteway, and the Westley Waterway (SWRCB 2010). The San Joaquin River has been identified by the SWRCB as an impaired water body for arsenic, boron, dacthal, *Escherichia coli* (*E. coli*), dichloro-diphenyl-dichloroethylene (DDE), mercury, temperature, selenium, electrical conductivity, and several pesticides, both upstream and downstream of the Merced River confluence.

The flow of subsurface drainage water from intensively irrigated agricultural land on the west side of the San Joaquin Valley into the San Joaquin River has created a well-known water salinity and specific ion (selenium and boron) problem in the river. The flow of water from the Tuolumne River (and the Merced and Stanislaus rivers) dilutes and improves the overall water quality, including the salinity level, of the San Joaquin River as it moves downstream toward the Delta.

Discharge of nutrients such as nitrogen and phosphorus from non-point runoff of agricultural fertilizer and point sources, such as water treatment facilities, stimulates algae growth, with attendant increases in the magnitude of diurnal DO variation. This has caused changes in the food webs of the San Joaquin River and Delta (Durand 2008), and as a result food availability for Delta fish populations (TID/MID 2013b). Large numbers of pesticides are used on lands upstream of and within the Delta (Brown 1996, Kuivala and Foe 1995), and they have been shown to inhibit olfactory-mediated alarm responses in salmonids (Scholz et al. 2000). However, it is unknown whether pesticide levels in Delta waters affect rearing or out-migrating Chinook salmon or steelhead juveniles, and no studies of predation related mortality due to chemical contaminants are available for the Central Valley rivers (TID/MID 2013b).

A range of literature sources suggests that early life history exposure to trace metals, herbicides, and pesticides may impair olfactory capabilities required for homing sensitivity in salmonids (Hansen et al. 1999, Scholz et al. 2000, Tierney et al. 2010), which could affect arrival of adult steelhead in their natal streams. However, olfactory impairment of Central Valley steelhead has not been documented in the Tuolumne or other Central Valley rivers (TID/MID 2013b).

Water Quality Related Effects on Fish and Aquatic Resources Resulting from the Districts Proposed Measures

Some of the Districts' proposed measures for the lower Tuolumne River would contribute to cumulative effects on water quality, which would influence aquatic resources, as described below. Greater detail on the measures listed below, and their direct effects, can be found in Sections 3.4.3 and 3.5.4 of this Exhibit E.

Gravel Mobilization Flows of 6,000 to 7,000 cfs

Flow releases ranging from 6,000–7,000 cfs (measured at USGS gage 11289650 below La Grange Diversion Dam) could result in short-duration pulses of turbidity, which, depending on the timing of releases, could benefit outmigrating juvenile fall-run Chinook by decreasing predators' sight-feeding effectiveness. Benefits to spawning habitat and possibly Chinook outmigration survival would outweigh any short-term effects on water quality associated with turbidity increases. Such turbidity increases are not expected to contribute significantly to cumulative effects on water quality in the basin.

Gravel Cleaning

Experimental gravel cleaning undertaken to flush fine sediments from gravel interstices and expand the availability of high quality gravel for fall-run Chinook and *O. mykiss* has the potential to result in short-duration, localized increases in turbidity that might exceed state water quality standards. However, improvements in spawning gravel quality and potential increases in fall-run Chinook outmigrant survival due to short-duration reductions in predator efficiency are likely to significantly outweigh any short-term effects of increased turbidity. As noted in Section 3.4 of this Exhibit E, the Districts would coordinate with the SWRCB to secure necessary permits and conduct any required turbidity monitoring. If gravel cleaning is judged to be successful, the program would continue, adjusted as needed to comply with any water-quality related concerns of the SWRCB.

Contribute to CDBW's Efforts to Remove Water Hyacinth

The Districts propose to provide matching funds to the CDBW for the removal of water hyacinth in the lower Tuolumne River. Partial removal of these introduced invasive plants could improve water quality in the lower river, particularly during summer when plant densities and background water temperatures are higher, which would have a beneficial effect on aquatic resources, thereby resulting in a positive contribution to cumulative effects in the lower Tuolumne River.

Flow-Related Measures for Fish and Aquatic Resources in the Lower Tuolumne River: The Districts are proposing to implement the flow regime summarized in Table 4.3.1 (above) and described in greater detail in Section 3.5.4 of this Exhibit E for the following aquatic resource objectives: (1) flows from June 1–June 30 to benefit *O. mykiss* fry rearing (2) flows from July 1–October 15 to benefit *O. mykiss* juvenile rearing, (3) flows from October 15–December 31 to provide habitat for fall-run Chinook spawning, (4) flows from January 1–February 28/29 to provide habitat for fall-run Chinook fry rearing, (5) flows from March 1 – April 15 to provide habitat for fall-run Chinook juvenile rearing, (6) fall-run Chinook outmigration baseflows from April 16–May 31, and (7) outmigration pulse flows from April 16–May 31. These flows would result in temperature benefits for salmonids throughout much of the year, as explained in Sections 3.4 and 3.5 of this Exhibit E.

4.4.1.3 Flow Hydrograph Shaping

In spill years, the Districts would make reasonable efforts to shape the descending limb of the snowmelt runoff hydrograph to mimic natural conditions to promote seed dispersal and germination of cottonwoods and native willows. Increasing natural recruitment of snowmelt-dependent hardwoods would increase stands of trees that would eventually provide shade, which could over the long-term contribute to water temperature reduction, thereby contributing positively to cumulative effects in the lower Tuolumne River.

4.4.1.4 Connectivity and Entrainment

Upstream Migration Barriers

Dams throughout the San Joaquin River and its tributaries are barriers to upstream migration of anadromous salmonids and other migratory fish species. Dams and water diversions associated with mining adversely affected fish migration in the Tuolumne River as early as 1852 (Snyder 1993 unpublished memorandum, *as cited* in Yoshiyama et al.1996). Access to historic spawning and rearing habitat was significantly restricted beginning in the 1870s, when a number of dams and irrigation diversion projects were constructed. Wheaton Dam, built in 1871 at the site of present-day La Grange Diversion Dam (RM 52.2), was a barrier to salmon and steelhead migration, and in 1884, the California Fish and Game Commission reported that the Tuolumne River was “dammed in such a way to prevent the fish from ascending” (California Fish and Game Commission 1884, *as cited* in Yoshiyama et al. 1996).

Entrainment

Anadromous fish downstream of the diversion dam are subject to entrainment in numerous intakes along the river. Irrigation withdrawals for frost protection at diversions along the lower reaches of the Tuolumne River are rare during the Chinook salmon in-river rearing period (TID/MID 2013b). Therefore, significant mortality due to entrainment of juvenile Chinook in the lower Tuolumne River is considered unlikely (TID/MID 2013b). It is unknown to what extent these diversions affect resident native and non-native fish.

Juvenile salmonid entrainment and increased exposure to predation occur at major diversion facilities on the lower San Joaquin River and in the Delta. Although entrainment in smaller irrigation diversions has not been well quantified, entrainment related mortality in the SWP and CVP export facilities is considered to be a major source of mortality for rearing and out-migrating Chinook salmon and steelhead juveniles, with effects on the number of Chinook recruits to the ocean fishery and effects on long-term population levels of steelhead.

Based on paired releases of tagged Chinook salmon in the Clifton Court forebay of the SWP, Gingras (1997) estimated pre-screen mortality to be between 63 and 99 percent. Clark et al. (2009) estimated pre-screening mortality of steelhead to be between 78 and 82 percent. Fish entrained in the Clifton Court forebay experience stress and may undergo physical damage during salvage operations (TID/MID 2013b), and salvage losses of Chinook salmon entrained into the SWP and CVP increase with increasing export flows (TID/MID 2013b).

Hatchery Propagation and Stocking

Recent studies have increasingly demonstrated potentially adverse effects of hatchery-reared fish on co-occurring wild stocks with which they may interact via interbreeding, competition, or predation. An issue of concern is genetic introgression of hatchery stocks with "natural" stocks, resulting in a decrease in the biological fitness of the natural stocks (e.g., ISAB 2003, Berejikian and Ford 2004, Kostow 2004, Araki et al. 2007, Lindley et al. 2007, CDFG and NMFS 2001). Straying of hatchery fish and out-of-basin transfers of brood fish (a practice that has been conducted by CDFW) have affected the genome of naturally reproducing fish in Central Valley rivers. Straying and out-of-basin transfers can also result in the transmittal of pathogens among populations (JHRC 2001).

Hatchery-origin fish represent a large proportion of the Central Valley fall-run Chinook salmon harvest (Barnett-Johnson et al. 2007, Johnson et al. 2011). Although the proportion of adipose-fin-clipped Chinook salmon identified as originating from hatcheries has been historically low in Tuolumne River spawning surveys, this proportion has increased dramatically from the 1990s to the present (TID/MID 2005; Mesick 2009; TID/MID 2012, Report 2011-8). Recent estimates of the composition of Chinook salmon escapement indicate that up to 50 percent of the escapement to the Tuolumne River is made up of hatchery-produced salmon from other rivers (Merced Irrigation District 2012). In the Central Valley as a whole, it is estimated that hatchery production has provided over half of the Central Valley harvest and escapement of salmon in some years (CDFG and NMFS 2001). Barnett-Johnson et al. (2007) recently estimated that only 10 percent of Central Valley Chinook salmon captured in the ocean troll fishery were not raised in a hatchery setting. Assuming roughly equivalent survival of hatchery- and natural-origin fish from the fishery to the spawning grounds, these results imply that up to 90 percent of annual escapement could consist of hatchery reared fish (TID/MID 2013b).

Facilities that produce anadromous fish whose life histories could overlap temporally or spatially with Tuolumne River anadromous salmonids include the Feather River Hatchery (spring and fall-run Chinook and steelhead), Nimbus Hatchery (fall-run Chinook and steelhead), Mokelumne River Hatchery (fall-run Chinook and steelhead), Merced River Hatchery (fall-run Chinook), and the Coleman National Fish Hatchery, a federal facility that produces fall-run Chinook (ICF Jones & Stokes 2010). Fish from the Merced and Mokelumne hatcheries, because of the proximity of these facilities to the Tuolumne River, may be more likely than fish from other facilities to stray into the lower Tuolumne River, and thereby contribute to cumulative adverse effects on aquatic resources, primarily anadromous salmonids.

To provide more accurate estimates of the proportions of hatchery reared and naturally produced Chinook salmon in Central Valley rivers, a Constant Fractional Marking (CFM) Program was initiated by the Pacific States Marine Fisheries Commission in spring 2007, with an adipose fin clip and coded-wire tag applied to at least 25 percent of the fish released from 2007 through 2012 (Buttars 2011). Although the Merced River Fish Facility does not participate in the CFM Program, observations of adipose-fin-clipped salmon have steadily risen in the Merced, Tuolumne, and Stanislaus rivers since 2007, reflecting a higher proportion of adipose-fin-clipping at the participating hatcheries[98]. Natural and hatchery contributions to historical escapements are not available prior to the CFM years (Newman and Hankin 2004).

In the absence of appropriate hatchery management practices, hatcheries may select for early run timing by spawning a disproportionately higher percentage of earlier returning fish (Flagg et al. 2000), resulting in reduced spawning success (TID/MID 2013b). There is, however, no evidence that the introduction of hatchery fish has altered the run timing of Chinook salmon in the Tuolumne River. Although the proportion of hatchery-origin Chinook salmon in Tuolumne River spawning runs has increased in recent years, size-at-return does not appear to have decreased in response to hatchery introgression for the period 1981–2010, suggesting that any hatchery influences on Tuolumne River spawner fecundity and spawning success are minor (TID/MID 2013b).

Stillwater Sciences (2017b) noted that a lack of genetic distinction between hatchery and naturally spawning fall-run Chinook salmon and loss of early life-history diversity due to inter-basin hatchery transfers and out-of-basin releases of hatchery-reared juveniles, are reducing the ability of fall-run Chinook to adapt to fluctuating environmental conditions, thereby contributing to a reduction in the ESU's reproductive fitness. Observations that estuary releases of late-stage smolts provide the basis for the majority of adult harvest, and hatchery escapement results in high rates of straying, indicate that hatchery practices are increasingly producing salmon that survive at relatively high rates but are decoupled from basin-specific selective pressures that influence the adaptive capacity of the species' freshwater life-stages (Stillwater Sciences 2017b).

In recent years hatchery Chinook have accounted for a large proportion of the annual escapement to the Tuolumne River. Results of the Chinook Salmon Otolith Study (TID/MID 2016) indicate that the total estimated hatchery contribution of adult fall-run Chinook salmon in the Tuolumne River during the years studied (i.e., 1998, 1999, 2000, 2003, and 2009,)[99] averaged 67 percent, and hatchery contribution generally increased in later years. Recognizing that some years in the otolith sample inventory over- or under-represent the typical age-class structure in the escapement record, the overall proportion was estimated using only three-year-old fish, which are expected to make up the bulk of the annual escapement. For three-year-old fish, hatchery contribution ranged from 36 to 90 percent, with a mean of 58 percent. Straying of hatchery Chinook can be linked to reduced fish size at return (Flagg et al. 2000) and as a result can reduce subsequent fry and smolt productivity per spawner. However, despite the high proportion of hatchery fish contributing to Chinook escapement into the Tuolumne River, fall run Chinook size-at-return does not appear to be declining in response to hatchery introgression (TID/MID 2013b).

[98] Hatcheries participating in the PFMC CFM Program include the Coleman National Fish Hatchery, Feather River Hatchery, Feather River Hatchery Annex, Nimbus Hatchery, and Mokelumne River Hatchery.

[99] The years evaluated for the Chinook Salmon Otolith Study, i.e., 1998, 1999, 2000, 2003, and 2009, were selected to represent "above normal" or "wet" and "below normal" or "dry" water-year types. These were also years during which the greatest number of otolith samples were available from the existing CDFW inventory.

Genetic analyses suggest that the majority of Central Valley steelhead stocks have been genetically introgressed by hatchery-produced ancestors, particularly from shared out-of-basin broodstocks (Eel River and American River) used at the Nimbus and other hatcheries (Garza and Pearse 2008). Lindley et al. (2007) suggest that hatchery introductions have altered the genetic structure of salmonid populations in the Central Valley. Although hatchery straying likely affects the number of steelhead spawning in the lower Tuolumne River, the absence of basin-specific data on spawning or straying from out-of-basin hatcheries makes it difficult to estimate the proportion of hatchery-origin steelhead that may spawn in the lower Tuolumne River (TID/MID 2013b). However, based on the low numbers of steelhead relative to resident *O. mykiss* documented in otolith analyses in the Tuolumne River (Zimmerman et al. 2009), it is likely that any effects of hatchery-origin fish would primarily be on resident *O. mykiss* (TID/MID 2013b).

Hatchery Genetic Management Plans (HGMPs) are being prepared pursuant to Section 7 of the ESA for salmon and steelhead hatcheries in California to guide the propagation of Chinook salmon and steelhead. The goal of the plans is to prevent adverse impacts on the genome of federally-listed fish and any potential effects of stocking on the size, abundance, run-timing, and distribution of wild fish.

Future SJRRP actions may result in hydrologic connectivity between the upper and lower reaches of the lower San Joaquin River (SJRRP 2016), which could increase the potential for fish released from the San Joaquin Hatchery (located on the upper reach of the lower San Joaquin River) to interact with Tuolumne River salmonids.

As part of their suite of measures, the Districts are proposing to fund a fall-run Chinook restoration hatchery, which would improve Chinook smolt production in critically dry years. The Districts propose to build, in cooperation with CDFW, a fall-run Chinook restoration hatchery to be operated by CDFW. The proposed supplementation program, like state and federal programs, would be implemented in accordance with procedures that prevent or minimize adverse impacts on the fitness, size, abundance, run-timing, and distribution of wild fish.

The proposed restoration hatchery would be structured to attempt to counter the current adverse effects of hatchery supplementation on fall-run Chinook in the Tuolumne River through the spawning and rearing of fish selected by CDFW to best represent the wild Tuolumne River stock. The program would allow for the stocking of fish within the basin and as a result produce individuals that are adapted to the extent practicable to conditions in their natal environment. No adverse effects on *O. mykiss* are predicted as the result of implementing this supplementation program. Implementation of a properly managed restoration hatchery would benefit the fall-run Chinook population, and as a result contribute positively to cumulative effects in the lower Tuolumne River.

Introduced Species and Predation

Predation on native salmonids by non-native predators introduced to the lower Tuolumne River is influenced by channel modifications that have created habitats favorable to non-native piscivores. Inter-annual variations in flows and water temperatures have been associated with variations in river-wide predator distribution (Ford and Brown 2001) and year-class strength in multi-year surveys conducted as part of the SRP 9 habitat restoration project at RM 25.7 (McBain & Trush and Stillwater Sciences 2006).

High levels of predation related mortality have been documented in direct surveys by the Districts, in multi-year Chinook smolt survival tests, and by comparisons of upstream and downstream smolt passage at rotary screw traps (TID/MID 2013b). Apparent variations in the relationship between spring flows and Chinook smolt passage (Mesick et al. 2008) and subsequent adult Chinook escapement (TID/MID 1992; Speed 1993; TID/MID 1997, Report 96-5; Mesick and Marston 2007; Mesick et al. 2008) suggest that predation, primarily by introduced fish species, is a major source of salmonid mortality, with effects on long-term population levels in the Tuolumne River (TID/MID 2013b). Studies conducted in the lower Tuolumne River identified 12 fish species that potentially prey on Chinook salmon fry and juveniles, but largemouth, smallmouth, and striped bass (all of which are introduced species) are the primary predators (TID/MID 1992, TID/MID 2013e).

Average consumption rates of juvenile Chinook salmon (i.e., number of Chinook salmon per predator) by largemouth and smallmouth bass in the lower Tuolumne River (not scaled by gastric evacuation rates) ranged from 0–0.20 during the 2012 predation study (TID/MID 2013e) and from 0–1.7 in an earlier study conducted by the Districts (TID/MID 1992). In 2012, predation rates averaged for all habitat types and sampling events were 0.07 Chinook salmon per largemouth bass per day and 0.09 per smallmouth bass per day. Striped bass predation rates in the lower river were generally higher than those of smallmouth bass and largemouth bass (TID/MID 2013e). In 2012, predation rate averaged for all habitat types and sampling events was 0.68 Chinook salmon per striped bass per day. Table 4.4-1 shows the estimated effect on fall-run Chinook predation associated with removal of black and striped bass (i.e., 10–15%) between the Grayson (RM 5.1) and Waterford (RM 30.3) rotary screw-traps (see Appendix E-1, Attachment C for greater detail).

Table 4.4-1. Estimated effect on fall-run Chinook predation rates associated with the removal of black and striped bass between the Grayson and Waterford rotary screw-traps (RM 5.1–30.3).

Species	10 Percent Removal Target	15 Percent Removal Target	Potential Reduction in Fall-Run Chinook Salmon Predation (salmon/day)
Largemouth bass	301	452	30-45
Smallmouth bass	363	544	40-60
Striped bass	24	35	26-39

Largemouth bass and smallmouth bass were estimated to have consumed about 37 percent and 49 percent, respectively, of the total potential juvenile Chinook salmon consumed by the three primary non-native predator species (i.e., largemouth bass, smallmouth bass, and striped bass). Despite making up only a small fraction (< 4%) of the total of piscivore-sized fish (> 150 mm FL), striped bass were estimated to have consumed nearly 15 percent of the total potential juvenile Chinook salmon consumed by the three predator species. There was no evidence of consumption of Chinook salmon by Sacramento pikeminnow during either the 2012 study or the Districts' previous study (TID/MID 1992).

A conservative estimate of the total consumption of juvenile Chinook salmon by striped, largemouth, and smallmouth bass is about 42,000 during March 1-May 31, 2012 based on observed predation rates and estimated predator abundance. This suggests that nearly all juvenile Chinook salmon may be consumed by introduced predators between the Waterford and Grayson rotary screw traps. Only 2,268 Chinook salmon were estimated to have survived migration through the 25 miles between the screw-trapping sites (Robichaud and English 2013) during January through mid-June, making it plausible that most losses of juvenile Chinook salmon in the lower Tuolumne River between Waterford and Grayson during 2012 can be attributed to predation by non-native piscivorous fish species.

No data exist to document the degree of piscine or avian predation on juvenile *O. mykiss* in the lower Tuolumne River. However, piscine predation risk is probably low because *O. mykiss* distribution during summer is generally restricted to cool water locations upstream of Roberts Ferry Bridge (RM 39.5), and piscine predators are found mostly downstream of this reach (Brown and Ford 2002). In addition to this habitat segregation, the larger body size of adult *O mykiss* limits their risk to predation, so mortality is most likely limited to Age 0+ fish during water-year types with low flows and warmer temperatures that allow predators to move upstream (TID/MID 2013b).

Predation in the lower San Joaquin River, Delta, and at the SWP and CVP export facilities is considered a primary cause of mortality for Chinook salmon, with effects on long-term population levels (TID/MID 2013b). The SWP and CVP facilities create lentic habitats that support the persistence of non-native fish species. Delta water exports, in combination with non-native species introductions, have resulted in dramatic changes in the Delta fish species assemblage, with numerous predatory fish species benefitting from current Delta hydrology (Lund et al. 2007). It is likely that predation has its greatest impact on Chinook salmon populations in the lower San Joaquin River and Delta when juveniles and smolts out-migrate in large concentrations during the spring through the lower reaches of rivers and estuaries on their way to the ocean (Mather 1998). Based on review of available information, predation in the lower San Joaquin River and Delta, as well as predation related mortality in the Clifton Court forebay of the SWP and CVP water export facilities, are key factors affecting the numbers of Chinook salmon recruited to the ocean fishery (TID/MID 2013b). For Chinook salmon outmigrants from the Tuolumne River, increased flows at Vernalis have been shown to reduce predation related mortality, but the relationship is highly dependent on the presence of the HORB (TID/MID 2013b).

Avian and pinniped (seals and sea lions) predation on juvenile Chinook salmon have been documented in San Francisco Bay (Evans et al. 2011) and along the California coast (Scordino 2010), respectively, and it is likely that at least avian predation occurs to some extent in or near the Delta as well. Whether and to what extent such predation is mediated by anthropogenic influences in the region is unknown.

Predation on juvenile salmonids is not the only adverse effect associated with introduced species. Introduced zooplankton species and the overbite clam (*Corbula amurensis*) in the lower Tuolumne and San Joaquin rivers (Brown et al. 2007) may have affected the availability of suitable prey for rearing salmonids (see also, Benthic Invertebrates and Fish Food Availability, below).

Predation also affects non-salmonid native fish species in the San Joaquin River and its tributaries. Predation on hardhead by smallmouth bass has resulted in population declines and isolation of populations (Moyle 2002). Hardhead have at times been abundant in reservoirs. However, most of these reservoir populations have proved to be temporary, presumably the result of colonization of the reservoir by juvenile hardhead before introduced predators became established. Brown and Moyle (1993) found that hardhead tend to disappear from water bodies following colonization by bass.

As explained in greater detail in Section 3.5.4 of this Exhibit E, the Districts' proposed predator control and suppression program would consist of constructing and operating a barrier weir coupled with active predator control and suppression.

The barrier weir, which would be located at RM 25.7, would prevent striped and black bass from moving into upstream habitats used by rearing juvenile Chinook salmon and *O. mykiss*. The weir would also provide a location where striped bass would likely congregate, thereby allowing them to be removed or isolated during Chinook smolt outmigration.

The Districts proposed comprehensive predator suppression and control program would consist of three components: (1) isolating, collecting, and/or relocating striped bass prior to spring pulse-flow releases to reduce predation on juvenile fall-run Chinook during outmigration, (2) sponsorship and promotion of black bass and striped bass fishing derbies and reward-based angling at locations above and below the barrier weir to diminish population sizes over time; other removal and/or isolation methods would include, but not be limited to, electrofishing, seining, and fyke netting, and (3) seeking and advocating for changes to current fishing regulations for the lower Tuolumne River (e.g., length of season, bag limit, catchable size, requested removal of black bass/striped bass caught, allowing a bounty program) to reduce black and striped bass numbers; educate the public on the adverse effects of predation on fall-run Chinook and *O. mykiss* in the Tuolumne River to encourage participation in the removal program and advocacy of changes to fishing regulations.

The proposed removal of striped and black bass would lead to substantial reductions in the abundance of non-native predators in the lower river, which in turn would lead to substantial increases in the survival of outmigrating juvenile fall-run Chinook salmon (see Section 3.5.4 of this Exhibit E for greater detail on expected program effectiveness). Removing these non-native predatory fish from the system would result in a significant increase in survival of fall-run Chinook outmigrants, and as a result a substantial positive contribution to cumulative effects in the lower Tuolumne River.

4.4.1.5 Benthic Invertebrates and Fish Food Availability

Analysis of historical drift samples and stomach contents of rearing juvenile Chinook salmon indicates that there are adequate food resources for juvenile rearing in the Tuolumne River (TID/MID 2013b), and analysis of long-term Hess sampling data gathered from 1988–2009 at Riffle 4A (RM 48.8) indicates that increased summer flows since 1996 have resulted in beneficial shifts in the invertebrate food supply of fishes. Overall invertebrate abundances in Riffle 4A samples declined slightly from 1996 to the present. However, community composition shifted away from pollution-tolerant invertebrate taxa and toward those with higher food value for juvenile salmonids and other fish (TID/MID 2010, Report 2009-7).

A number of factors affect aquatic food sources available to rearing juvenile Chinook salmon in the Delta: changes in flow magnitudes and timing, water exports at the SWP and CVP facilities, construction of levees and the resulting conversion of marsh habitats to agricultural and urban land uses, and anthropogenic introductions of nutrients, contaminants, and non-native species (TID/MID 2013b).

Although warmer waters in the Delta provide a higher growth rate potential for juvenile salmonids than that associated with cooler upstream tributary habitats, degradation of Delta habitat conditions has adversely affected the primary and secondary productivity that support Delta food webs, resulting in low growth rates of Chinook salmon juveniles (TID/MID 2013b) Based on documentation of reduced Chinook salmon growth rates in the Delta, as well as declines in pelagic prey species, including insect drift and zooplankton, food resources may also be limiting for actively feeding steelhead smolts outside of flood conditions (TID/MID 2013b).

As noted above, introduced zooplankton species and the overbite clam in the lower Tuolumne and San Joaquin rivers (Brown et al. 2007) may compete with native fauna and thereby affect the availability of suitable prey for rearing salmonids in these areas.

The following resource measures proposed by the Districts for the lower river have the potential to increase benthic macroinvertebrate abundance: gravel augmentation, gravel mobilization flows, experimental gravel cleaning, scour associated with placement of boulder-size stones, and increases in riparian vegetation and associated LWD recruitment resulting from shaping the descending limb of the snowmelt runoff hydrograph to mimic natural conditions. It is not clear, however, that such increases would translate into significant benefits for salmonids, because fish population modeling suggests that food availability in the lower Tuolumne River is not limiting fall-run Chinook and *O. mykiss* rearing under current conditions (TID/MID 2017a, 2017f).

4.4.1.6 Freshwater Harvest and Poaching

CDFW implemented sport fishing catch limits on salmon in the early 2000s within a portion of the Tuolumne River, and salmon fishing is currently banned in the lower Tuolumne River and San Joaquin River upstream of the Delta. There is no available estimate of the number of Chinook salmon lost to poaching in the Tuolumne or San Joaquin rivers (TID/MID 2013b).

However, poaching of Chinook salmon, to the extent that it occurs, would take place during the adult upstream migration period.

McEwan and Jackson (1996) contend that legal harvest in the years prior to the listing of Central Valley steelhead was not the cause of recent population declines. Annual fishing report cards (Jackson 2007) do not provide data to quantitatively assess hooking mortality or other sport fishing impacts on steelhead, and no information appears to be available to assess the effect of poaching on upstream migrating adult steelhead in the Tuolumne River (TID/MID 2013b). Illegal harvest of resident *O. mykiss* could occur year-round, but there is no estimate of its extent in the Tuolumne River.

4.4.1.7 Effects of Ocean Conditions on Fall-Run Chinook Salmon

As noted above, FERC defines the geographic scope of cumulative effects for aquatic resources as extending upstream on the Tuolumne River to Hetch Hetchy Reservoir and downstream to San Francisco Bay. Although the Pacific Ocean is outside the geographical limits of the analysis, environmental conditions and commercial harvest of Chinook salmon in the ocean exert a strong influence on the abundance and health of the Chinook salmon population in the Tuolumne River, in some years potentially overwhelming the effects of many in- and out-of-basin actions in the rivers or Delta (128 FERC ¶ 61,035 [2009]).

In the open ocean, seasonal and longer-term changes in meteorological and oceanographic conditions determine water temperature and coastal circulation patterns, with effects on nutrient upwelling and primary and secondary productivity of the marine food web that supports ocean feeding and growth of Tuolumne River fall-run Chinook salmon. Major climate-ocean factors such the Pacific Decadal Oscillation (PDO) and shorter-term El Niño/Southern Oscillation (ENSO) influence ocean productivity, and consequently salmon numbers through a series of complex processes (Pearcy 1992, Williams 2006). For example, the recent dramatic collapse of Sacramento fall-run Chinook stocks during the 2007 and 2008 spawning years was attributed to highly anomalous coastal ocean conditions during 2005 and 2006, i.e., late and weakened seasonal upwelling associated with warmer sea surface temperatures led to the deterioration of coastal food webs on which juvenile salmon depend (CalCOFI 2006, 2007, NMFS 2009.

Ocean harvest has the potential to reduce the number of adult Chinook salmon migrating into the Tuolumne River (Williams 2006, PFMC 2013). For many years, an annual average of 60 percent of the Central Valley Chinook salmon population has been taken in the ocean fishery, directly affecting the species' escapement to fresh water (TID/MID 2013b). Harvest mortality of larger fish generally reduces the age- and size-at-return, and consequently the fecundity, of upstream migrating spawners (Williams 2006; TID/MID 2013b). The transition from inland gill net fishing to an ocean troll fishery at the end of the nineteenth century had significant impacts on Central Valley salmon populations; fish are exposed to trolling over a period of years, resulting in younger and smaller salmon returning to California streams. There is evidence that such a reduction in the age-distribution of Central Valley fall-run Chinook salmon has occurred (Williams 2006). Chinook harvest management by the PFMC is based exclusively on meeting escapement goals for the hatchery-supported Sacramento River fall run. Because "mixed stock fisheries supported by strong stocks may overharvest weaker ones," (Williams 2006) there is a potential to overharvest already diminished San Joaquin River Basin stocks. The PFMC dropped its San Joaquin Basin escapement goal in 1984 because of the effects of Delta export pumps on those runs (Boydstun 2001).

4.5 Socioeconomics

4.5.1 Districts' Service Areas

A primary purpose of the Don Pedro Project is to provide direct water supply and consumptive use benefits for the two districts irrigation and M&I customers and for the Bay Area communities and industries served by the City and County of San Francisco's Hetch Hetchy water system. The water supply and hydropower generation benefits of Don Pedro are essential components of the economic livelihood and welfare of Stanislaus County communities and the Central Valley region as a whole. The water banking privilege acquired by CCSF through its financial contribution to the construction of the Don Pedro Project is a critical part of CCSF's water supply system which serves 2.6 million people in the Bay Area.

FERC's SD2 (page 38) identifies the following potential Don Pedro Project effects on socioeconomic resources:

- The socioeconomic effects of any proposed measures to change Don Pedro Project operations on affected governments, residents, agriculture, businesses, and other related interests.
- Water supply effects on San Francisco Public Utility Commission retail and wholesale customers that would result if the CCSF were required to provide additional water to the Districts to support a change in operation for environmental mitigation.

In order to determine the potential socioeconomic impact to the Central Valley and Bay Area regions due to alternative protection, mitigation, and enhancement (PM&E) measures proposed by the Districts, CCSF, or any other party, the Districts and CCSF have both developed economic models of the baseline conditions of their regions assessing the role that water supply plays in the economic welfare of their service areas. In addition, the Districts collaboratively developed the Tuolumne River Operations Model (Operations Model), fully described in Exhibit B of this application, to depict the Base Case water supply operations of both the Districts and CCSF. In the Base Case, under certain circumstances the Districts and CCSF share responsibility for meeting FERC license requirements in the lower Tuolumne River downstream of the Don Pedro Project consistent with the Fourth Agreement. Another use of the Operations Model is to evaluate the effects of alternative operations scenarios on water supply deliveries to the Districts and CCSF.

In response to FERC's SD2 requirements, the Districts prepared a draft Socioeconomic Study which was issued as part of the Updated Study Report, and the final report is included in this application for new license. The objectives of the Districts' Socioeconomics Study are to qualitatively and quantitatively describe local economic conditions in the regions that are directly and indirectly affected by the existing Don Pedro Project operations; assess the key factors influenced by Don Pedro Project operations that generate economic activity in affected regions; estimate the economic value generated by the water storage in various uses, both consumptive (agriculture and urban) and non-consumptive (reservoir recreation); measure the role and significance of the Don Pedro Project in the local economy; assess the role and significance of the Don Pedro Project to the general welfare of the local communities served; and develop a framework to be able to assess the socioeconomic impacts on affected groups and industries resulting from changes in water supply operations, including economic, community welfare, and environmental justice considerations.

The study area consisted of the three-county area of Stanislaus, Merced, and Tuolumne counties, which captured both the direct and indirect economic effects of the Don Pedro Project. The direct effects are associated with use of related facilities, including the reservoir (recreation) and the hydroelectric plant (power generation), and water use throughout the Districts' water service areas (agriculture and urban uses). The indirect effects of the Don Pedro Project on the broader economy are also important to recognize and are a key component of the study.

The Districts' water service areas cover approximately 300,000 acres, of which approximately 220,000 are currently irrigable with surface water. According to the 2010 census, the population in the three-county exceeds 800,000 people, with population in the Districts' water service area accounting for 466,000 people. Minority groups and Hispanics represent about 35 percent and 44 percent of the regional population, respectively. Between 2007 and 2011, the total civilian labor force averaged approximately 374,800 people with approximately 320,600 employed, which equates to an unemployment rate of 14.5 percent. Farm-level employment in the study area averaged 18,100 jobs over the same time period, or 5.5 percent of the study area total. Indirectly, agriculture also provides numerous jobs in those industries that supply inputs to farming operations (e.g., farm machinery and fertilizers) and industries that are reliant on agricultural commodities (e.g., food processing plants), which are reported in categories outside the farm sector. In Stanislaus County, eight of the 10 largest employers are in agricultural production or food processing, and the remaining two are in health-related industries.

The farmland within the two-county area is highly productive. In 2011, Merced and Stanislaus counties were the fifth and sixth largest counties in California as measured by gross value of agricultural production. Together, they contributed $6.5 billion in gross value, 12.3 percent of total gross value for the state, with a significant portion of this production coming from land irrigated with water supplies provided by MID and TID.

The Districts play key roles in the agricultural economies of Stanislaus and Merced counties and the entire San Joaquin Valley. Through the Don Pedro Project, the Districts have provided highly reliable water supplies to their customers, e.g., consistent annual deliveries of high-quality surface water to maintain crops during periods of drought. With those reliable supplies, growers and producers have invested heavily in high-valued perennial crops, such as almonds and peaches, as well as dairy production, which has resulted in the large complex of agricultural-support industries being developed in the area. In Stanislaus County, the largest crop acreages, averaged over the period 2007 through 2011, are in nuts, at 32.4 percent of the total, corn (including corn silage) at 25.8 percent, hay at 14.5 percent, and vegetables at 8.2 percent, and the gross crop production value from 2007-2011 was over $1.2 billion, with the largest contributions from nuts (at 49.2 percent of the total), vegetables (12.4 percent of the total), field and other

(10.9 percent of the total), and fruit (10.0 percent of the total). In Merced County, the largest crop acreages averaged over the period of 2007 through 2011 are in corn silage (27.7 percent), nuts (17.6 percent), hay (15.8 percent) and vegetables at 9.3 percent of total normalized average acres. Merced County gross crop production value from 2007 through 2011 was over $1.1 billion, with the largest contributions from nuts (at 30.4 percent), vegetables (28.2 percent), corn silage (10.7 percent) and field and other crops (10.1 percent).

In addition to crop production, the Districts' service area includes a large dairy sector. In 2011, the value of milk production in Stanislaus and Merced counties was $1.9 billion (Stanislaus County Agricultural Commissioner 2011 and Merced County Agricultural Commissioner 2011). For the five years from 2007-2011, the normalized average of dairy production values in the two-county area was $1.7 billion, and the value of dairy production supported by crops grown in the Districts' service areas is estimated at $537.4 million, or 31.0 percent of the two-county total.

Specifically related to the Districts' service areas, the average of gross crop production value for the period 2007-2011 totaled $527.93 million. The value of dairy production for the same period supported by crops grown in the two districts was $537.4 million. Thus, the gross value of agricultural production (both crops and dairies) for the period 2007-2011 was approximately $1.1 billion.

The Socioeconomic Study also evaluated the economic benefit of the current recreation use of Don Pedro Reservoir. Based on the average use of 378,000 visitor-days annually, recreation has a direct economic value of $6.2 million per year. Hydropower generation was also evaluated in the study and estimated to have an annual value of slightly less than $25 million per year.

The *total* economic impact, or economic contribution, of an industry represents the sum of direct, indirect, and induced effects as defined below. The measurement of total economic effects captures the multiplier (or "ripple") effect associated with direct effects.

- **Direct effects.** Represent the impacts for the expenditures and/or production values specified as direct final demand changes
- **Indirect effects.** Represent changes in output, income, and employment resulting from the iterations of industries purchasing from other industries caused by the direct economic effects.
- **Induced effects.** Represent changes in output, income, and employment caused by the expenditures associated with new household income generated by direct and indirect economic effects.

The model used to estimate total economic contribution for the Don Pedro Project was developed using IMPLAN software and data. IMPLAN (Impact Analysis for Planning) is a widely-used and accepted regional economic modeling system that can measure the effect of projects, programs, and/or policies on local economic conditions. It was originally developed by the U.S. Department of Agriculture, Forest Service in the late 1970s to assist in land and resource management planning, but its role has expanded to serve clients in Federal, state, and local governments, universities, and the private companies.

Based on IMPLAN modeling, the agricultural sector alone has a total regional economic benefit of $4.3 billion per year.

4.5.2 City and County of San Francisco Service Area

CCSF manages the San Francisco Regional Water System (RWS). The Hetch Hetchy water system supplies 85 percent of the water supply for CCSF and its 27 wholesale customers in the RWS. The water supply available in the future to the Bay Area from the Hetch Hetchy water system may be affected by the outcome of the Project relicensing. Under certain circumstances, the Districts and CCSF share responsibility for meeting FERC license requirements in the lower Tuolumne River downstream of the Don Pedro Project.

To understand this potential impact, CCSF prepared an independent study on the potential socioeconomic effects of potential changes in Don Pedro Project operations entitled *Socioeconomic Impacts of Water Shortages within the Hetch Hetchy Regional Water System Service Area.* The report documents the pattern of urban water supplies and demands that may likely occur in the San Francisco Regional Water System service area in the coming decades, and evaluates the socioeconomic impacts of water shortages relative to baseline demands under normal economic and weather conditions. The analysis in this report incorporates the effect of demand growth over the coming decades and the development of non-RWS water supplies developed by CCSF and the Wholesale Customers. Specifically, the impacts of RWS supply reductions are calculated for CCSF and SFPUC’s 27 wholesale customers receiving RWS water supplies. Socioeconomic impacts are measured in terms of lost welfare of ratepayers, and changes in business sales and employment. CCSF will be filing this study with FERC as part of the relicensing process.

5.0 DEVELOPMENTAL ANALYSIS

The Developmental Analysis section of this Exhibit E presents the Districts' preferred plan for the future operation of the Don Pedro Project (Preferred Plan).[100] Over 200 studies of the natural resources of the lower Tuolumne River and Don Pedro Reservoir have been conducted since the mid-1980s. Additional detailed resource studies were undertaken during the relicensing process to characterize and document current baseline conditions. Computer simulation models have been developed based on this body of empirical data to depict existing resource conditions in and along the Tuolumne River and predict changes to these resources under alternative scenarios of future Project operations and river conditions. The Districts' Preferred Plan, presented in detail below, represents the integration of data and studies designed to achieve the following interconnected goals:

- protect and improve the natural resources of the lower Tuolumne River, with emphasis on the native fisheries, by applying the wealth of empirical biological and physical data available on the river's resources; and
- protect and sustain the water supplies essential to the welfare and the economies of the communities served by the water resources of the Don Pedro Project, especially during the extended drought periods experienced in the southern Sierra watersheds.

The Districts' Preferred Plan demonstrates that both of these goals can be achieved, but only by a rigid adherence to being informed by the empirical, site-specific data describing the resources of the Tuolumne River. In the sections below, the Districts first provide a context and brief background of the history of prior efforts to protect and improve river resources, then describe in detail the integrated components of the Preferred Plan and the scientific and biological underpinnings of the Plan. Various proposals put forward by others are also evaluated using the same empirical data and simulation models developed from these data.

5.1 Purpose and Need of the Don Pedro Project

The Don Pedro Project is a water supply project. It is designed for the primary purpose of providing reliable water supplies for irrigation and municipal and industrial (M&I) uses. Additional Project benefits provided by its two million acre-feet of storage are flood control, hydroelectric generation, recreation, and natural resource protection. The Project provides irrigation water to more than 200,000 acres of prime[101] Central Valley farmland. The Project also contributes substantially to the water supplies of the City of Modesto (population: 210,000) and 2.6 million people in the San Francisco Bay Area. The City and County of San Francisco (CCSF) contributed financially to the construction of the Don Pedro Project in exchange for water banking privileges that benefit CCSF's Bay Area water customers.[102] Protecting the

[100] The Districts' Preferred Plan is the "Proposed Action" as referenced in this AFLA.

[101] **Prime farmland** is a designation assigned by U.S. Department of Agriculture defining land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is also available for these land uses.

[102] CCSF provides the potable water supply for 2.6 million people in the Bay Area. The Hetch Hetchy System provides 85% of the supply to San Francisco's Regional Water System. The Regional Water System meets 98% of CCSF's needs (800,000 people) and about 65% of CCSF's wholesale customers' needs (population: 1.8 million).

primary purpose of the Don Pedro Project--providing reliable water supplies, especially during drought periods--is essential not only to the welfare and economies of the Districts' service territory, but to the Central Valley region and the Bay Area.

Hydroelectric generation is a secondary and important benefit of the Don Pedro Project. As fully described in this amendment to the final license application (AFLA), the Districts are seeking a new license to continue generating hydroelectric power at the Don Pedro Project. The Districts are providing a complete description of the facilities and operation of the Don Pedro Project so the effects of the operation and maintenance of the hydroelectric facilities can be distinguished from the effects of the operation and maintenance activities of the overall Don Pedro Project's flood control and water supply/consumptive use purposes.

Being able to differentiate the effects of the hydropower operations from the effects of the flood control and consumptive use purposes and needs of the Don Pedro Project may aid FERC when considering appropriate protection, mitigation, and enhancement (PM&E) alternatives to the Districts' Preferred Plan. As FERC has previously stated in Scoping Document 2 (SD2) in a discussion related to alternative project operation scenarios:

> *"…alternatives that address the consumptive use of water in the Tuolumne River through construction of new structures or methods designed to alter or reduce consumptive use of-water are alternative mitigation strategies that could not replace the Don Pedro* ***hydroelectric*** *project [emphasis added]. As such, these recommended alternatives do not satisfy the NEPA purpose and need for the proposed action and are not reasonable alternatives for the NEPA analysis."*

5.2 Background Concerning Current Instream Flows

In November 1995, the Districts entered into a settlement agreement ('95SA) with eight parties[103] which, among other provisions, established the current instream flow requirements for the lower Tuolumne River. The goals of the '95SA set out in Section 9 of the agreement are provided below in their entirety.

> *"Many of the factors that will affect the chinook (sic) salmon population are beyond the control of the participants to the settlement. Rather than setting numeric goals in this settlement, comparative goals are identified whose attainment may be readily determined. These comparative goals are:*

- Improvements in smolt survival and successful escapement in the Tuolumne River.
- Increase in naturally reproducing chinook (sic) salmon in this subbasin.
- Barring events outside the control of the participants to this settlement, by 2005 the salmon population should be at levels where there is some resiliency so that some of the management measures described herein may be tested, on an experimental basis."

[103] The settling parties consisted of the Districts, CDFW, California Sportfishing Protection Alliance, CCSF, Friends of the Tuolumne, Tuolumne River Expeditions, Tuolumne River Preservation Trust, USFWS, and San Francisco Bay Area Water Users Association. FERC staff was also a signatory (see 1996 FEIS, pg1-6).

The ’95SA contained a set of flow and non-flow measures to improve conditions for fall-run Chinook salmon, riparian habitat, and recreational activities. The ‘95SA also set out an extensive program to monitor fall-run Chinook salmon populations and habitat in the lower Tuolumne River and initiated an adaptive management strategy to evaluate effectiveness of the various measures to be implemented.[104]

In accordance with the ‘95SA, the FERC-required fishery flows increased from the original two-tier system under Article 37 of the original 1964 license (either 64 TAF or 123 TAF,[105] depending on the previous year’s Don Pedro inflow volume) to a multi-tiered system consisting of ten water-year types with required annual instream flows ranging from 94 TAF to 300.9 TAF. In applying the scientific and empirical information on Tuolumne River resources available at the time, the ‘95SA specifically acknowledged the existence of multiple in-river factors affecting the river’s fall-run Chinook salmon population. Prominent among these factors was the history and legacy of human disturbance to the Tuolumne River including in-channel and floodplain mining which had the effect of converting extensive reaches of the lower river to slow moving ponds (termed “special-run pools” and “run-pools”) that interrupted gravel transport and increased suitability for non-native predatory species. Other factors acknowledged to be affecting the Tuolumne River fall-run Chinook population include predation by non-native species; levee construction, channelization, wetland destruction, and other land use impacts to riparian and floodplain habitats; water withdrawals; impacts to gravel quality due to erosion and resulting fine sediment deposition; and the initial Don Pedro Project instream flow requirements. The ‘95SA also recognized out-of-basin factors affecting naturally reproducing Chinook salmon including Delta exports, San Joaquin River/Bay-Delta conditions, increasing contribution of hatchery strays in the Tuolumne River escapement, and commercial and sport salmon harvest.

The proposed terms of the ’95SA were, in relevant part, filed with FERC; and in July 1996, in fulfillment of its NEPA responsibilities, FERC issued an FEIS entitled *Reservoir Release Requirements for Fish at the New Don Pedro Project, California.* The FEIS considered a number of alternative flow and non-flow measures relying on a “combination of computer simulation models, other quantitative analyses, and qualitative judgments to evaluate impacts of alternative scenarios.” Using the relevant scientific and empirical information available at the time, the FEIS concluded that “[s]almon production would be enhanced by the increased NDPP minimum flows…as indicated by physical habitat analysis and by predictions from the salmon production model.” FERC subsequently issued an amendment to the Districts’ license adopting new instream flow requirements (76 FERC ¶61,117 (1996), which were implemented in 1997 and remain in place today.

FERC also required the Districts to continue to undertake a host of monitoring studies to expand the empirical and scientific information available in order to further inform and improve future decision-making. In accordance with the terms of the amended license, the Districts completed and filed with FERC the numerous studies required to be undertaken, and have also voluntarily

[104] Also, Section 10 of the ‘95SA provided for measures to be taken if goals were not achieved based on monitoring data collected through 2005. If lack of success was due to factors beyond the control of the Districts (e.g., Delta exports, harvests, land use activities on non-Districts’ land) or measures required to be undertaken by other parties were not completed, then the Districts would not be required to undertake additional measures.

[105] FEIS, July 1996, Page 2-6, Table 2.1-3.

conducted a wide range of additional studies and data collection activities, all as described in Exhibit E of this AFLA. As a consequence, a wealth of empirical data developed through the performance of over 200 individual studies were available to relicensing participants at the outset of the FERC relicensing process. When combined with the over 30 new detailed studies specifically designed to fill remaining data gaps, the information available today regarding factors affecting in-river life stages of Tuolumne River salmonids is considerably greater than that which was available to inform the 1996 FEIS.

Nevertheless, the historical physical factors affecting salmonid populations on the Tuolumne River largely remain in place today, and some to an even greater extent. Studies performed as part of the Don Pedro relicensing confirm that many of these factors (e.g., in-river and floodplain habitat modifications, high predation levels by non-native predators, influence of hatchery strays, gravel in-filling with fine sediment) continue to pose challenges to the fall-run Chinook salmon population on the Tuolumne River.[106] It is noteworthy that since the implementation of the '95SA instream flows, site-specific densities and river-wide distribution of *O. mykiss* in the lower Tuolumne River have increased likely due to the increase in summer flows.[107,108]

5.3 Analytical Methods and Simulation Models Informing the Districts' Preferred Plan

As discussed above, a substantial body of river-specific physical and biological data is now available pertaining to the resources of the lower Tuolumne River. The Districts have placed a rigorous reliance upon this extensive site-specific, empirical data to inform the development of the Preferred Plan presented herein. Supported by this body of empirical data and the set of interrelated computer models developed using these data, the Districts have developed a suite of flow and non-flow measures which taken together will benefit fishery resources while being protective of the Districts' and CCSF's water supplies, especially during successive dry years.

The Districts recognize that there are reasonable limits to the application and use of models. The Districts have relied on the computer simulation models developed through relicensing to inform decision-making, while acknowledging that the models are depictions of biological resources and relationships intended for the purpose of comparing one scenario to another. Model results are not intended to be interpreted as highly precise projections of future outcomes, but are reliable indicators of relative effects of alternative measures on water supplies and environmental resources.

In strict accordance with the detailed study plans proposed by the Districts, reviewed and commented upon by relicensing participants, and subsequently approved or approved with modification by FERC, the Districts' science team has developed a suite of six (6) core,

[106] Further, in its April 3, 2008 Order (128 FERC ¶ 61,035), Commission staff reviewed information on the decline of fall-run Chinook salmon in the Tuolumne River. FERC found that Chinook escapement initially increased under the '95SA flow regime (4,400 fish in 196 to 17,900 in 2000), then declined to 1,900 fish in 2004 with further decline through 2006. FERC found that the dry water years in 2001 through 2004 may have contributed to the decline but also found, based on information provided by NMFS and the Pacific Management Fisheries Council, "that conditions in the marine environment were having adverse impacts to Chinook salmon populations along the entire West Coast" during the 2004–2007 period.

[107] Stillwater Sciences, 2011

[108] Ford and Kirihara, 2010

computer models of the Don Pedro Project and the Tuolumne River to evaluate alternative operational scenarios and flow and non-flow PM&E measures. These models represent Don Pedro Project operations and the resource conditions of the lower Tuolumne River to a refined level of detail and go well beyond a general treatment of the watershed. The development process for each of these models included the conduct of numerous Consultation Workshops with relicensing participants. The working models were provided to relicensing participants upon request, along with training sessions on the use of the models. The set of core models are:

- Tuolumne River Operations Model (W&AR-02),
- Don Pedro Reservoir Temperature Model (W&AR-03),
- Lower Tuolumne River Temperature Model (W&AR-16),
- Tuolumne River Fall-Run Chinook Population Model (W&AR-05 and W&AR-06),
- Tuolumne River *O. mykiss* Population Model (W&AR-05 and W&AR-10), and
- Lower Tuolumne River Floodplain Hydraulic Assessment (W&AR-21).

Each of the models went through a calibration and validation process. As approved by FERC, the geographic scope of each of the models encompassed the lower Tuolumne River. The development of each of these models included Consultation Workshops with relicensing participants to share information, encourage dialogue, and obtain interim review and comment on model architecture, parameters, and methodologies. A total of 20 Workshops were held with relicensing participants during model development. This programmatic consultation has been documented in a series of Workshop Meeting Notes, all of which have been previously provided to participants for review and comment, then filed with FERC.

To ensure an accurate representation of resource effects, all of the Districts' models maintained a rigorous focus on using the rich empirical data available on the lower Tuolumne River. Consistent with the FERC-approved study plans and the need to evaluate scenarios where the effects can be reasonably predicted, none of the computer models extend below the confluence with the San Joaquin River, located 54 miles downstream of Don Pedro Dam.

Four additional technical models have been developed that also informed the development of the Districts' Preferred Plan. The Districts' science team developed a model to evaluate in-river gravel resources and predict effects to gravel availability over the next 50 years based on observed trends recorded over the recent past. This model may also be used to assess the effects of alternative operational and enhancement scenarios on gravel availability. The Districts have developed a Physical Habitat Simulation (PHABSIM) model as approved by FERC for portions of the lower Tuolumne River to simulate and assess flow-habitat relationships for fall-run Chinook, *O. mykiss,* and certain non-native predator species; a Socioeconomic Model for estimating the effects to the economic welfare of local and regional populations resulting from alternative future operating scenarios that affect water supplies; and a mainstem Tuolumne temperature model simulating "without dams" flow and temperatures extending from the CCSF Hetch Hetchy Reservoir to the San Joaquin confluence. Together, these models provide in-depth, site-specific analyses of the Tuolumne River, the Don Pedro Project, and affected resources and fish populations. Numerous other site-specific, empirical studies have informed the development of the Districts' Preferred Plan, and these are referenced within the description of specific measures in the plan below.

In addition to depicting the operations of the Don Pedro Project, the Tuolumne River Operations Model also simulates the water supply operations of CCSF's Hetch Hetchy Water System (see Exhibit B and relevant reports included in this AFLA). The Hetch Hetchy water system on the Tuolumne River makes up 85% of CCSF's total water supply which serves 2.6 million people in the Bay Area. In accordance with the 4th Agreement between the Districts and CCSF, under certain circumstances, the Districts and CCSF share responsibility for meeting FERC license requirements related to the reach of the lower Tuolumne River downstream of the Don Pedro Project.[109] The Tuolumne River Operations Model includes the provision that 51.7% of instream flows above the current level can be allocated to, and create a debit to, CCSF water supplies. Increases to the current instream flows have the potential to substantially affect Bay Area water supplies. The Tuolumne River Operations Model is able to evaluate and enumerate these impacts.[110]

The suite of simulation models work in an integrated fashion to enable users to understand the complex interrelationships among Don Pedro Project operations, river flows, reservoir and river temperatures, salmonid habitat and in-river life stages, and the effects of alternative operations scenarios on each of these resources. The "Base Case" under FERC's procedures and protocols represents the scenario of future operations under current license conditions. Specific to the Tuolumne River Operations Model, the "Base Case" depicts the operation of the Don Pedro Project in accordance with the current FERC license, ACOE flood management guidelines, and the Districts' irrigation and M&I water management practices. For purposes of representing CCSF operations, the Base Case in addition to recent operations, also includes changes in operations resulting from construction of capital improvement projects that are permitted under CEQA, approved by CCSF, and authorized (funded), but had not been fully implemented at the time of model development. The Base Case is considered the "no action" alternative under FERC's assessment of the effects of alternative operations scenarios. Each of the six core models utilizes the same daily hydrology covering the 1971 through 2012 period, a hydrologic record which was collaboratively developed with relicensing participants. Base Case does not represent a "full supply" of water deliveries, as both the Districts' and CCSF's customers experience water shortages under the Base Case, as has occurred over the history of the Don Pedro Project operations.

Base Case flows and operations can be modified to evaluate alternative operating scenarios. Each alternative scenario provides a new Operations Model output that quantifies the changes to reservoir inflows, reservoir releases, reservoir water levels, and water supply to the Districts' and CCSF's customers as a result of the different operating regime. Operations Model output serves as the input to the Don Pedro Reservoir Temperature Model, a highly detailed three-dimensional (3D) depiction of the reservoir used to predict changes in reservoir thermal regime and outflow temperatures resulting from alternative operations. The outputs from the Reservoir Temperature

[109] Also, see Article 8 on page 2-4 of Exhibit B of the AFLA.
[110] CCSF has also developed projections of future water demand in its service territory to the year 2040. Alternative Project operation scenarios are evaluated to estimate effects to CCSF future water supplies and water demand.

Model and the Operations Model serve as the input to the Lower Tuolumne River Temperature Model, which in turn provides the flow and temperature inputs to the in-river, fall-run Chinook salmon and/or *O. mykiss* population models. Changes in water supply to the Districts or to CCSF can then be used as inputs into the respective socioeconomic models to estimate the consequences to local and regional economic welfare. Operations Model output also provides the daily flow record for input to the Floodplain Hydraulic Assessment which tracks floodplain inundation and floodplain habitat for salmon fry and juveniles.

All of the models have been completed in accordance with FERC-approved study plans. The Districts have provided user manuals and/or training in the use of the Operations Model, temperature models, and the two salmonid models. All the models were recently updated and each of the updates were presented to relicensing participants at a May 2017 Consultation Workshop. Updated models have been provided to those who requested them. In combination, these Tuolumne River-specific simulation models provide an objective basis for comparing the effects of current Don Pedro Project operations to alternative future Don Pedro Project operations related to the following parameters:

- Districts' and CCSF's Hetch Hetchy water supply;
- Don Pedro Reservoir levels and temperature regime, including outflow temperatures;
- flows in the lower Tuolumne River;
- water temperatures in the lower Tuolumne River;
- fall-run Chinook juvenile production in the lower Tuolumne River;
- *O. mykiss* juvenile production and adult replacement rate in the lower Tuolumne River; and
- floodplain habitat inundation, timing, and duration in the lower Tuolumne River.

In addition, physical in-stream resource protection measures which can be geophysically positioned and parameterized are able to be modeled to estimate their relative effect on in-river fall-run Chinook production and on juvenile and adult *O. mykiss.*

5.4 Overview of Districts' Preferred Plan

The Tuolumne River resources affected by the Districts' Preferred Plan are:

- Water supply
- Immigration, reproduction, rearing, and emigration of fall-run Chinook salmon
- Reproduction, rearing, and adult replacement rates of *O. mykiss*
- Riparian resources and floodplain habitat
- Gravel quality, supply, and transport
- Non-native aquatic plant and fish species
- Recreational boating
- Cultural resources

- Protection and monitoring of species listed under the Endangered Species Act (ESA)
- Recreation and natural resource management associated with the Don Pedro Reservoir, including federal lands under the administration of the Bureau of Land Management (BLM)

The Preferred Plan identifies the Districts' proposed changes to Don Pedro Project facilities and operations; specific flow-related and non-flow related resource protection, mitigation, and enhancement (PM&E) measures intended to benefit the resources of the lower Tuolumne River and Don Pedro Reservoir; and adaptive management provisions to inform future resource and project management. Certain of the PM&E measures address the direct Project effects of Don Pedro operations, while most of the proposed measures are resource enhancement measures not directly related to direct Project effects, but proposed by the Districts to protect and improve the overall health of the lower Tuolumne River.

Proposals to improve the native salmonid populations of the Tuolumne River, whether or not specifically related to the effects of the Don Pedro Project operations, must be based on a sound interpretation of the substantial empirical data collected and compiled on the river's resources. Proposed measures must also take into account the actual physical conditions and ongoing activities occurring along the lower Tuolumne River. Virtually the entire 52 mile reach, at one time or another, has been subjected to either in-channel and/or floodplain gold and/or gravel mining, channelization and levee development, urban encroachment, loss of floodplain and associated wetlands, water withdrawal, and/or agricultural development. Active gravel mining in the floodplain, urban encroachment, levee reconstruction, active agricultural development, large in-channel and overbank ponds, and a healthy population of non-native predators are all part of the current conditions of the lower river. Recent data and the results of otolith testing demonstrate that the Tuolumne River fall-run Chinook population is increasingly becoming dominated by hatchery strays. To have a chance at being successful, PM&E measures must recognize and deal with these realities.

5.5 Protecting and Improving River System Conditions – Non-Flow PM&E Measures

The sections below identify, describe, and provide the scientific support for the non-flow PM&E measures included within the Districts' Preferred Plan.

5.5.1 Improve Spawning Gravel Quantity and Quality

The most recent resource studies demonstrate that the Tuolumne River downstream of the La Grange tailrace has sufficient spawning gravel now and for the foreseeable future to sustain a healthy and robust population of fall-run Chinook salmon and *O. mykiss* (W&AR-04, *Spawning Gravel in the Lower Tuolumne River*, see Table 5.5-1). But while availability of spawning gravels is not a limiting factor to the fall-run Chinook population at spawning levels approaching historical maximums, competition for available habitat at upstream locations results in redd superimposition at lower levels of spawning escapement (W&AR-08, *Redd Mapping Study*, see Figure 5.5-1). Site-specific studies also demonstrate that the Don Pedro Reservoir's capture of gravel prevents its movement downstream, and this capture contributes to the net loss of gravel supply to the lower Tuolumne River. The *Spawning Gravel Study* estimated a total coarse sediment storage loss of approximately 8,000 tons based on differencing 2005 and 2012 DTM data over the 13-mile study reach covering the Dominant Spawning Reach of the lower Tuolumne River. Distributed over the channel study area, this equates to an average bed lowering of 13 mm, or less than half the average median grain size of the coarse channel bed (approximately 51 mm). The total estimated gravel volume lost from storage in the reach is comparable in magnitude to the quantity of coarse sediment added during any one of the augmentation projects that have occurred since 2002 (approximately 7,000–14,000 tons). Also, the reservoir's ongoing flood control operations[111] affect the magnitude and frequency of downstream flows, and this may affect gravel mobilization which may lead to gravel in-filling with fines[112] and overall impacts to gravel quality (W&AR-04, page 6-1). To improve the gravel resources of the lower Tuolumne River, the Preferred Plan includes the following measures:

- **Resource Protection Measure-1 (RPM-1): Augment Current Gravel Quantities through a Coarse Sediment Management Program**
    - For the purpose of enhancing spawning gravels to benefit lower Tuolumne River salmonids, this measure consists of implementing several gravel augmentation projects between River Mile (RM) 52 and RM 39 over a ten-year period following issuance of a new license (see W&AR-04, pg 6-1). Because spawning preferences are more heavily weighted towards upstream habitats, the highest priority for the gravel augmentation measures is upstream of Old La Grange Bridge. Monitoring and adaptive management activities associated with RPM-1 include (1) repeating the Spawning Gravel study (see W&AR-04) in Year 12 of the program and (2) conducting annual surveys of fall-run Chinook and *O. mykiss* spawning use of new gravel patches for five years following completion of gravel augmentation work. The specific priority sites are Riffle A5/6, Riffle A3/4, portions of Basso Pool, and Riffle A1/2.[113] The estimated amount of coarse sediment is approximately 75,000 tons, or almost 10 times the amount of coarse sediment lost over the eight-year period analyzed in the *Spawning Gravel Study*. Attachment A of Appendix E-1 contains a technical memorandum and drawing showing the proposed locations and preliminary designs of the gravel augmentation program. The Preferred Plan's improvements to coarse sediment included in this measure are part of the input to the fall-run Chinook population model for evaluating the Preferred Plan's effects on in-river salmon production.

Estimated Capital Cost: $7,500,000[114] over 10 years
Estimated Annual O&M Cost: $30,000/year
Estimated Environmental Monitoring Cost: $150,000/year for 5 years[115]

[111] Specifically, this refers to the seasonal use of the 340 TAF flood control space in Don Pedro acquired by the ACOE.
[112] It should be noted that the source of fine sediments is runoff from intermittent drainages below Don Pedro, which have been subject to increasing development for agriculture, primarily nut orchards fed by groundwater sources. The source of the fine sediments is unrelated to any Project effect.
[113] Riffle A1/2 is located just downstream of the confluence of the main stem and the La Grange tailrace.
[114] All costs are in 2016 dollars. Annual costs are related to monitoring of gravel conditions post-augmentation. Capital costs are highly dependent on location of gravel sources and their grain size distribution.
[115] Monitoring consists of both annual spawning surveys of fall-run Chinook and *O. mykiss,* plus a one-time cost to repeat the *Spawning Gravel Study* (W&AR-04) in Year 12 after license issuance.

Regarding gravel quality, the reservoir's ongoing flood control operations affect the magnitude and frequency of downstream flows, and this affects the frequency with which flows occur of sufficient magnitude to mobilize spawning gravels. The longer interval between gravel mobilization flows may lead to gravel in-filling with fines[116] with potential impacts to gravel quality (W&AR-04, page 6-1). RPM-2 provides for gravel mobilization flows to occur with greater frequency.

- **Resource Protection Measure-2 (RPM-2): Provide Gravel Mobilization Flows of 6,000 to 7,000 cfs**
  - For purposes of gravel mobilization and movement of fines, this measure directs the Districts' Project Operations staff to provide, during years when sufficient spill is projected to occur, at least two days (personal communication, Scott McBain, May 2015) of flow measured at the USGS La Grange gage of between 6,000 cfs and 7,000 cfs. Under the Preferred Plan, based on Operations Modeling, this is anticipated to occur at an average frequency of approximately once every three to four years (see Appendix E-1, Attachment B). In years where the La Grange gage spring (March through June) spill is projected to exceed 100 TAF, the Districts would plan to release a flow of 6,500 cfs for two days within the spill period with downramping not to exceed 300 cfs/hr. Monitoring associated with this measure consists of establishing and monitoring six test sites upstream of RM 43 prior to a high flow event, then examining these same test sites following the flow event to determine effectiveness. Flow magnitude and/or duration may be adjusted based on these observations. There exists the potential for conflicts with downstream interests at these flows; therefore, the Districts would publish on their respective websites with as much prior notice as is practicable, an approximate planned flow magnitude, flow duration, and dates for a gravel mobilization event. In any event, in years when the Districts' available information indicates that flows at the La Grange gage may possibly exceed 5,500 cfs, the Districts would provide notification on their respective websites of the potential for such spill levels to occur.

Estimated Environmental Monitoring Cost: $35,000/year on average

5.5.2 Improve Existing Instream Physical Habitat

Studies conducted during relicensing (W&AR-04; W&AR-08; W&AR-12; W&AR-19) and field data collected as part of fisheries studies and habitat restoration (see Table 3.5-8 of this Exhibit E) indicate the occurrence of large woody debris (LWD) is limited in the lower Tuolumne River (W&AR-12, pg 6-2). The same studies show that the woody debris captured in the Don Pedro Reservoir is too small to act as favorable LWD-induced habitat in the lower Tuolumne River (W&AR-12, pg 6-4). However, the Districts' studies also provide an indication that *O. mykiss* spawning and rearing habitat, and to a lesser extent Chinook salmon habitat, could be improved by either the introduction of LWD or suitably-sized cobble/boulder material for the purpose of introducing greater instream structure and habitat complexity (W&AR-12). The Preferred Plan

[116] It should be noted that the source of fine sediments is runoff from intermittent streams below Don Pedro. These areas that are outside of the Districts' service territories have experienced increasing development for agriculture, primarily nut orchards fed by groundwater sources. The source of the fine sediments is unrelated to any Project effect.

includes improvements to the physical habitat complexity of specific sections of the lower Tuolumne River.

- **Resource Protection Measure-3 (RPM-3): Improve Instream Habitat Complexity**
  - As indicated above, studies conducted during the relicensing process show that the occurrence of LWD is limited in the lower Tuolumne River (W&AR-12, pg 6-2). The same studies show that the woody debris captured in the Don Pedro Reservoir is too small to act as favorable LWD-induced habitat in the lower Tuolumne River (W&AR-12, pg 6-4). The woody debris collected in the Don Pedro Reservoir would be too small to be effective as habitat and short-lived if relocated to the lower Tuolumne River. However, placement of boulder-sized rock, suitably round and placed so as not to be a hazard to boating use, could provide favorable micro-habitats for *O. mykiss* and promote localized scour of fines to benefit salmon spawning. Under this measure, the Districts would identify, collect, and place boulder-size stone in select locations between RM 43 and RM 50, the preferred habitat reach of *O. mykiss*. The boulder placement program would take place over four years and proceed by completing placement in a select subreach during a summer followed by monitoring through the next fall, spring, and summer to evaluate success. Annual snorkeling surveys would be conducted over this four-year period to examine boulder-induced habitat use and localized substrate conditions. Boulder size would range from approximately 0.7 to 1.5-cubic yards. Locations for placement would be selected through collaboration with fisheries and recreational interests. A maximum of 200 boulders would be placed. Boulder placement has been shown to reduce territory size needed by rearing *O. mykiss* by up to 50%[117] due to visual isolation, thereby supporting higher fish densities and carrying capacity.[118] Overwintering habitat may also be enhanced[119] through boulder placement intermixed with cobble. These potential improvements have not been incorporated into the Districts' modeling of the Preferred Plan because the precise location of the placements have not yet been developed.

    The increased habitat complexity is expected to provide velocity refuge for *O. mykiss* as well as visual isolation and thereby increase density and thus habitat carrying capacity of the treated habitat units. A variety of material sizes is planned. The preferred locations for materials installation would be in run/glide habitat to create velocity diversity and feeding stations. Enhancing an area downstream of a riffle would likely have the greatest benefit. It is also possible to place smaller boulders (12-24 inch) along stream margins in similar run/glide habitat. This provides interstitial velocity refuges for rearing juveniles during winter and high flows. Locations between RM 48 and 50 that are run/glide habitats would be tested first. Annual snorkeling surveys would be expanded to assess differences in units with and without boulders and changes in densities through time in response to boulder placement.

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[117] See Imre et al. 2002. The territory size relates to how visual isolation by boulders or LWD reduces interactions between fish and defended areas, thereby supporting higher fish densities.

[118] Grant, J. W. A. and D. L. Kramer. 1990. *Territory size as a predictor of the upper limit to population density of juvenile salmonids in streams*. Canadian Journal of Fisheries and Aquatic Sciences 47:1724–1737.

[119] See Meyer and Griffith 1997. *Effects of Cobble-Boulder Substrate Configuration on Winter Residency of Juvenile Rainbow Trout.*

For geomorphic monitoring, in addition to as-built mapping of placements, a one-time monitoring event within five years following the completion of the boulder placement program would be conducted. This would examine both the stability of the placed materials as well as mapping of smaller gravel accumulations in relation to the large materials.

For biological monitoring, pre-and post-project redd mapping, as well as bounded count estimates in the treatment habitat units as well as some untreated areas nearby that are hydraulically similar to the pre-treatment habitats would be examined. This is a form of before-after-control-impact (BACI) assessment and the Districts would accumulate at least two years of data in treatment and control habitats prior to boulder placement and then perform data collection for three years following placement.

Estimated Capital Cost: $2,000,000
Estimated O&M Cost: $30,000/year (minor boulder relocation or removal)
Estimated Environmental Monitoring Cost: $100,000/year for 5 years

Previous studies of existing gravels of upper reaches of the lower Tuolumne River have indicated the occurrence of in-filling of gravels by fine sediments. A primary source of fine sediments is runoff events from intermittent streams below La Grange Diversion Dam, including Gasburg Creek (RM 50) and Peaslee Creek (RM 46). To improve gravel quality at and below these tributary areas, gravel cleaning would improve spawning success and egg-to-emergence survival.

- **Resource Protection Measure-4 (RPM-4): Gravel Cleaning**
    - The Districts propose to conduct a five-year program of experimental gravel cleaning using a gravel ripper and pressure wash operated from a backhoe, or equivalent methodology, in cooperation with resource agencies. Each year of experimental cleaning would consist of two to three weeks of cleaning select gravel patches. The Districts would conduct *O. mykiss* spawning and redd surveys in areas planned for gravel cleaning prior to commencing any gravel cleaning. Subject to the findings of these surveys, the gravel cleaning may coincide with May pulse flows to benefit smolt outmigration by providing increased turbidity to reduce predator sight feeding effectiveness. Gravel cleaning has the potential to expand availability of high quality gravel which would improve spawning success and egg incubation for fall-run Chinook. During short periods, increased turbidity may exceed state water quality standards, but the benefits to spawning success and smolt survival are likely to significantly outweigh any lasting effects of short-term increased turbidity to fish or macroinvertebrates.

Estimated Capital Cost: $1.2 million (equipment purchase and fabrication)
Estimated Annual O&M Cost: $0.5 million (for 5 years)
Estimated Environmental Monitoring Cost: $70,000/year (for 5 years) starting one year after first patch is cleaned.

- **Resource Protection Measure-5 (RPM-5): Contribute to CB&Ws Efforts to Remove Water Hyacinth**
  - Under the Preferred Plan, the Districts would provide $50,000 per year to California Division of Boating and Waterways (CB&W), which is the State agency responsible for implementing an Aquatic Pest Control Program to control hyacinth, to assist the CB&W program of removal of water hyacinth and other non-native flora. The annual contribution would not depend on the occurrence of an infestation in the lower Tuolumne River. The Districts would coordinate with CB&W when water hyacinth infestations occur on the Tuolumne River to schedule removal efforts.

5.5.3 Predator Control and Suppression Plan

Tuolumne River monitoring and relicensing studies have consistently demonstrated that predation of salmon juveniles by non-native black bass and striped bass has a significant impact on smolt production in the lower Tuolumne River.[120] A long-term, robust and functional predator control and suppression plan is a high priority for the lower Tuolumne River. The non-native predator population in the river and its effect on salmonids has been demonstrated over an extended time period.[121] The introduction of these species and the growing population of non-native predators is not a Project-induced problem. Absent a unified, long-term effort to advocate for and achieve a successful predator control and suppression program, all other flow and non-flow PM&E measures are likely to have little, if any, measurable benefit.

While population modeling results show that smolt survival on the lower Tuolumne River is moderately sensitive to flow rates, the same models demonstrate that, based on Tuolumne River site-specific data, smolt production is much more strongly correlated to predation levels (W&AR-05, W&AR-06, W&AR-07, and RST Reports). The presence of numerous non-native predatory fish species in the Tuolumne River has been well documented. The Predator Control and Suppression Plan developed as part of the Districts' Preferred Plan targets a reduction in predator populations of 10% below RM 25.5 and 20% above RM 25.5. Modeling confirms that a corresponding reduction in the mortality rate of Chinook salmon juveniles by just these amounts has a greater beneficial effect on smolt survival than releasing to the river 40% of the unimpaired flow in the February 1 through June 30 period.[122] These simulation modeling results are discussed in detail in sections 5.12.3 and 5.14.2 below.

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[120] These fish species were introduced into CA waters by the California Department of Fish and Wildlife (CDFW) to expand recreational fishing opportunities.

[121] See for example TID/MID 1992, Appendix 22; Ford and Brown (2001); Stillwater Science (2013 and 2015); FISHBIO (2013); McBain and Trush and Stillwater Sciences (2006); and FISHBIO (2015).

[122] In September 2016, the SWB issued its Draft Substitute Environmental Document (SED) which contained a preferred alternative consisting of requiring the release to the Tuolumne River of 40% of the February-June unimpaired flow (UIF). Reducing predation rates by the amounts in the Preferred Plan is projected to significantly increase smolt production. For example, assuming a population of 2,000 female spawners, the estimated Base Case smolt production of 6.3 smolts per female spawner would increase to 10.9 smolts per female spawner. Increasing the February-June instream flows to 40% of the unimpaired flow is projected to produce 8.7 smolts per female spawner. Average required instream flow releases in the February-June period under the Base Case is 129 TAF and under the 40% UIF would be 516 TAF, or 4 times as much as Base Case.

An effective predator control and suppression plan when combined with an appropriately-timed series of biologically-informed pulse flows has the potential to produce even greater juvenile and smolt survival results. As described in detail below, in the great majority of years, the Preferred Plan includes a significant increase in spring pulse flows over the current pulse flows. The Districts have developed a draft adaptive management plan to systematically optimize the benefit of the higher pulse flows.

The Preferred Plan includes a multi-prong approach to predator control and suppression. Specific predator population control measures are described below.

- Resource Protection Measure-6 (RPM-6): Construct a Fish Counting and Barrier Weir
  - The Districts would construct and operate a small barrier weir (less than five feet of head at normal flows) at approximately RM 25.5, roughly 1.3 miles upriver of the location of the current seasonal fish counting weir. The barrier weir will be a reinforced concrete structure consisting of the following components from river-right to river-left (looking downstream):
    - a concrete abutment merging with natural grade;
    - a fishway and counting structure containing viewing window and fish sorting capability;
    - a 8-ft long by 5-ft high bottom drop gate with a maximum hydraulic capacity of 75 cfs providing attraction flow to the fishway entrance;
    - spillway section;
    - middle abutment;
    - non-motorized craft (kayak/canoe/raft) bypass structure with flap gate control and concrete chute; and
    - left concrete abutment merging with natural grade.

    The fish counting and barrier weir would be a Project facility, non-contiguous with the current Don Pedro Project Boundary, and would serve multiple purposes as follows:

    - Provide for a permanent upstream migrant counting weir to replace the temporary seasonally-operated Alaska-type counting weir located at RM 24.5. The seasonal weir must be removed when flows reach 1,500 cfs; the new counting weir would be capable of being operated year-round and in river flows up to approximately 3,000 cfs.
    - Provide a Denil-type fishway and counting window to conduct fish counts, fish species separation, and public viewing. The ability to collect fish would also permit brood stock selection, if desired by fishery agencies, using the barrier weir fishway.
    - Provide an exclusionary barrier to exclude striped bass from upstream habitats used by rearing juvenile salmon and *O. mykiss*, while at the same time providing a location where striped bass are likely to congregate which enables removal or isolation at key times during smolt outmigration. Striped bass are known to be voracious predators and have been observed in all seasons throughout the entire lower Tuolumne River. Keeping striped bass from extending their range into the prime fry and juvenile rearing habitat above RM 26 will reduce predation on these critical life stages.

- Provide for elimination of black bass movement into sections of river upstream of RM 25.5 and provide for long-term, significant reductions in black bass populations above RM 25.5.
- The weir would be fitted with a canoe/kayak ramp to permit downstream passage without portage under normal, non-spill flow conditions.

The general location of the barrier weir is shown in Figure 5.5-1 and a plan view of the weir is provided in Figure 5.5-2.

As an example, a photo of the fish barrier weir on the Feather River near Oroville Dam is shown in Figure 5.5-3 for descriptive purposes only, as the Feather River barrier is larger and not equipped with boat bypass.

Exhibit F contains preliminary functional design drawings of the barrier weir. The capital and annual costs are provided below.

Estimated Capital Cost: $12,000,000
Estimated Annual O&M Cost: $280,000/year
Estimated Environmental Monitoring Cost: $300,000/year (fish counting and separation)

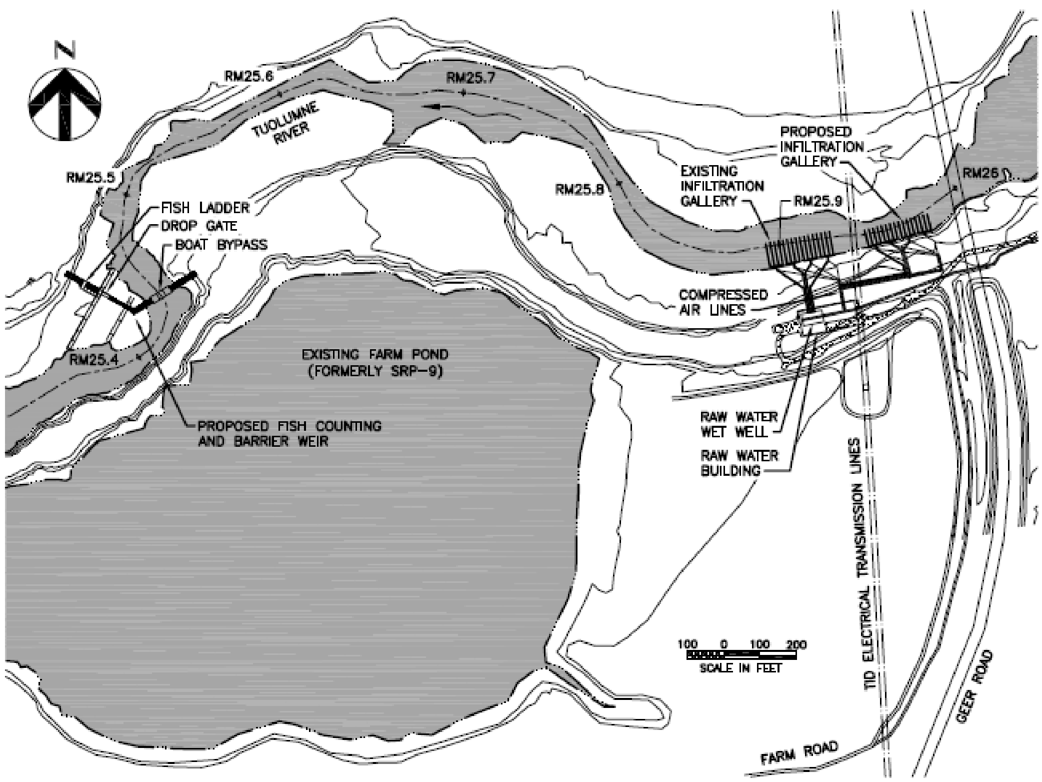

Figure 5.5-1. Site location of proposed fish counting and barrier weir and infiltration galleries downstream of the Geer Road Bridge at approximately RM 25.5.

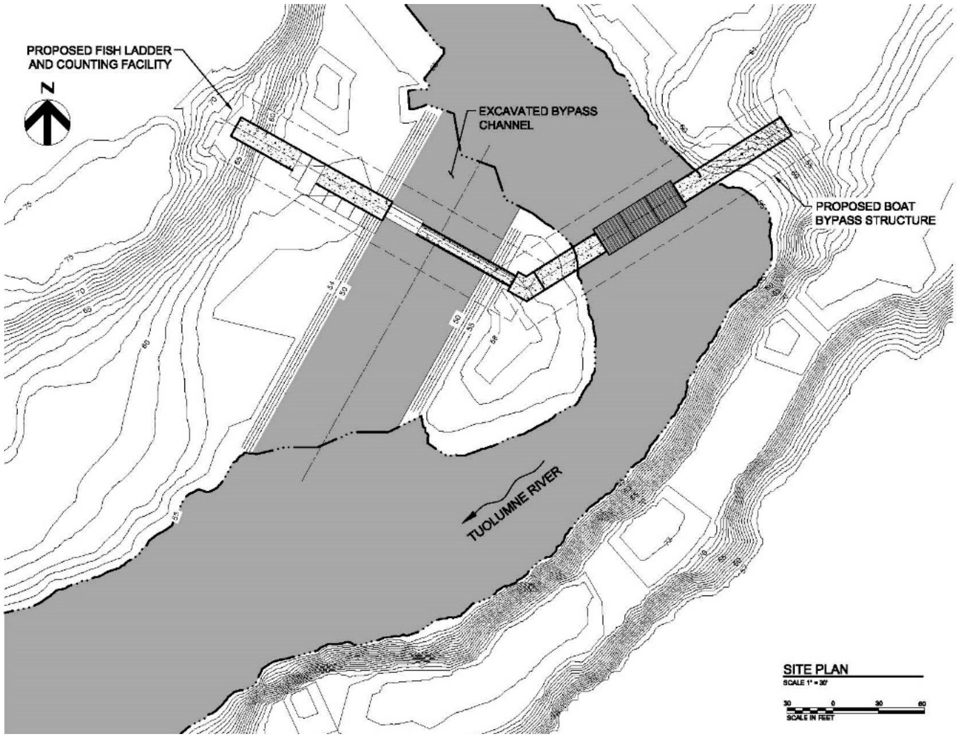

Figure 5.5-2. Plan view of the fish counting and barrier weir at RM 25.5.

Figure 5.5-3. Concrete barrier weir on the Feather River

- **Resource Protection Measure-7 (RPM-7): Predator control and suppression**
  - The Preferred Plan includes a long-term, comprehensive predator control and suppression program consisting of:

    (1) Specific incentives and measures to target an annual reduction in the population of black bass and striped bass of levels documented in 2012 by approximately 20% above the barrier weir and 10% below the barrier weir (RM 25.5). These measures include, but

are not limited to, sponsoring and promoting black bass and striped bass derbies and reward-based angling in locations both above and below the barrier weir to substantially diminish these populations over time. Other removal and/or isolation methods will include electrofishing, seining, fyke nets, and other positive collection methods. [123]

Based on the 2012 population of black bass between the two Tuolumne River RST's (RM 30 and RM 5), a 10% removal would amount to a total of about 660 fish (roughly equal numbers of smallmouth and largemouth bass).[124] To provide context only, by angling, this level of removal would take 4 anglers about 80 days of fishing. There are more efficient means of removal, including e-fishing, and the seasonal timing of such removal may be more effective at increasing smolt survival. To ensure compliance with this measure, the Districts propose to file an annual report on reduction efforts taken during the prior calendar year with respect to black bass and striped bass and the amount of bass removed through such efforts. To continue to monitor the population of black bass and striped bass in the Tuolumne River, the Districts propose to conduct a survey every five years to determine the amount of fish to be targeted in order to reduce the bass population by 10% in succeeding years.

(2) Districts will seek and advocate for changes to current fishing regulations for the lower Tuolumne River (e.g., length of season, bag limit, catchable size, required removal of any black bass/striper caught, allowing a bounty program) in order to implement a robust, maximally effective predator control program. In addition, the Districts propose to establish a fund to carry out the activities contemplated by this measure and to educate the public on the effects of predation on fall-run Chinook salmon and *O. mykiss* so as to encourage removal of predatory fish as they advocate for changes to current fishing regulations for the lower Tuolumne River to facilitate such removal. Education activities would include developing educational materials about predator fish, community outreach, kiosks or other measures. Advocacy activities will aim to maximize the effectiveness of the predator control program described by encouraging revisions to fishing regulations regarding the length of the bass season, bag limits, catchable size, mandatory removal of any bass caught, and allowing for a bounty program for bass, as well as promoting fishing as a recreation opportunity on the Tuolumne River. To ensure compliance with this measure, the Districts propose to file an annual report describing the specific educational and advocacy measures taken during a particular year.

Estimated Capital Cost: $150,000 (signage, equipment)
Estimated Annual O&M Cost: $125,000/year
Estimated Outreach and Environmental Monitoring Cost: $70,000/year

[123]Such incentives could include expansion on the Tuolumne River of the current CDFW Free Fishing Days program, which currently allows free fishing on the Labor Day and July 4th holidays, expansion of CDFW's current Fishing in the City program to promote urban youth fishing, promotion of fishing derbies and competitions, similar to NCGASA's pikeminnow derby on the Feather River, and/or sport-reward program for striped bass and black bass, similar to pikeminnow programs currently carried out in Washington and Oregon.

[124] See Districts' Predator Control and Suppression Plan (Appendix E-1, Attachment C) for more details. The barrier weir will eliminate striped bass access to key salmonid rearing areas upstream of RM 25.5. Striped bass are estimated to be responsible for approximately 15-20% of the total predation on fall-run Chinook juveniles on the lower Tuolumne River (W&AR-07).

5.5.4 Reduce Chinook Redd Superimposition

Studies have demonstrated the occurrence of redd superimposition in the Tuolumne River's Dominant Salmon Spawning reach above approximately RM 47 (FISHBIO 2013). Redd superimposition occurs when later arriving adult fall-run Chinook develop and disturb redds of prior arriving salmon. This tendency occurs with greater frequency and with larger effects at higher escapement levels. Over the long-term, reduction of adverse effects of superimposition will increase spawning success and egg-to-emergence survival.

- **Resource Protection Measure-8 (RPM-8): Superimposition Reduction Program**
  - Studies have shown (W&AR-05) that rates of spawning superimposition are relatively high for fall-run Chinook in the lower Tuolumne River at higher escapement levels (e.g., >5,000 female spawners) due to a strong preference for spawning to occur above RM 47. The reasons for this preference are uncertain, but may be correlated to the high percentage of out-of-basin hatchery strays in the Tuolumne River escapement and their lack of site fidelity. Suitable spawning gravels in the lower Tuolumne River extend from RM 51.5 to approximately RM 30. To reduce the superimposition that occurs when a newly arrived spawning female selects a spawning site on top of a previously used site, the Preferred Plan includes deployment of a temporary barrier to encourage use of suitable habitats at locations further downstream. The temporary barrier would be installed each year below the new La Grange Bridge (RM 49.9) after November 15th once passage at the RM 25.5 fish counting weir exceeds 4,000 total spawners. The temporary barrier would be similar to the Alaska-type counting weir currently employed on the Tuolumne or a picket-fence type installation similar to the one used as part of the La Grange Project Fish Barrier Assessment Study (FISHBIO 2017). Photos of such facilities are included in Appendix E-1, Attachment D. Final design and configuration of the temporary barrier would be based on consultation with state and federal resource agencies.

Estimated Capital Cost: $4.2 million (full replacement every 10-15 years)
Estimated Annual O&M Cost: $40,000/year (install, remove, repair)

5.5.5 Tuolumne River Fall-run Chinook Restoration Hatchery

Under the Preferred Plan, a fall-run Chinook salmon restoration hatchery would be developed with the goal of protecting, improving, and maintaining a Tuolumne River fall-run Chinook population. Brood stock collection of Tuolumne River fish would occur at the RM 25.5 fish barrier weir. In addition, over the long-term, hatchery strays from other watersheds would be able to be prevented from migrating further upstream to spawn, if and when this is deemed appropriate by state and federal fishery managers. The Tuolumne River fall-run Chinook population has been introgressed over the last twenty years with hatchery strays to the point where the Tuolumne population is now predominantly out-of-basin hatchery fish. The hatchery contribution of the Tuolumne River fall-run Chinook population continues to increase. The results of otolith testing (W&AR-11) in years 2000-2002, 2005-2006, and 2010-2012 indicate that hatchery straying can account for 39 - 100% of the Tuolumne River escapement. In 2015 and 2016, 23% and 24%, respectively, of the adult fall-run Chinook passing the counting weir were ad-clipped fish, approximating the 25% of fish that are ad-clipped under CDFW's constant fractional marking (CFM) program, indicating that the majority of the Tuolumne escapement likely consisted of hatchery strays. The Districts are proposing to build a fall-run Chinook restoration hatchery (to be operated by CDFW), in cooperation with CDFW, in the general vicinity of the current location of the CDFW offices on river right below La Grange Diversion Dam. The purpose of the hatchery would be to support the protection and expansion of a Tuolumne River origin fall-run Chinook population. The Districts would pay for hatchery planning, permitting, design, construction, and O&M for the first 20 years, at which time the success of the hatchery measures would be reevaluated. The hatchery is not intended to be a permanent facility. The restoration hatchery concept, plan and preliminary design are provided in Appendix E-1, Attachment E.

Estimated Capital Cost: $36,000,000
Estimated Annual O&M Cost: $1,000,000/year
Estimated Environmental Monitoring: $300,000/year

5.6 Protecting and Improving River System Conditions: Flow-Related Measures

The Districts' Preferred Plan also includes new flow measures during all water year (WY) types based on the most recent habitat and resource studies conducted since the implementation of the '95SA. As envisioned in the '95SA and the FERC amendment approving the settlement agreement flows, ongoing and new studies were intended to develop the empirical, site-specific data that would help inform the future operations of the Project. In conjunction with over 20 additional water resource studies performed during relicensing, the flow measures of the Preferred Plan incorporate what has been learned about Tuolumne River fisheries and aquatic resources over the last two decades of monitoring and study. The collective body of studies, performed to scientific standards of data collection and analysis, provide a sound and factual basis for understanding the Tuolumne River aquatic environment, thereby replacing conjecture, personal preferences, or unsubstantiated theories about factors affecting Tuolumne River fisheries. The wealth of data collected, and the models developed therefrom, provide the tools necessary for informing actions specifically designed to fit the highly modified ecological system of the lower Tuolumne River. The flow measures include a set of base flows designed to the needs of specific salmonid life stages in the Tuolumne River, and a set of pulse flows based on what is now almost 20 years of RST results and other related studies specific to the Tuolumne River. An adaptive management approach to pulse flow timing and duration is also a part of these measures.

For all flow-related measures, the flow schedules are based on using five water-year types determined using the 60-20-20 San Joaquin River Index (SJI). The five types are Wet (W), Above Normal (AN), Below Normal (BN), Dry (D), and Critical (C). Table 5.6-1 provides the classification of each water year for the 1971 to 2012 modeling period of record.

Table 5.6-1. Classification of each water year for the 1971-2012 modeling period of record.

Water Year	San Joaquin Index	Water Year	San Joaquin Index
1971	BN	1992	C
1972	D	1993	W
1973	AN	1994	C
1974	W	1995	W
1975	W	1996	W
1976	C	1997	W
1977	C	1998	W
1978	W	1999	AN
1979	AN	2000	AN
1980	W	2001	D
1981	D	2002	D
1982	W	2003	BN
1983	W	2004	D
1984	AN	2005	W
1985	D	2006	W
1986	W	2007	C
1987	C	2008	C
1988	C	2009	BN
1989	C	2010	AN
1990	C	2011	W
1991	C	2012	D

The current method used by TID operators to determine the water year type and the required flow release schedule would remain unchanged.[125] The Preferred Plan includes two monitoring locations for instream flow compliance: (1) the existing USGS Tuolumne River at La Grange gage and (2) a new "gage" consisting of the flows in the two infiltration gallery (IG) pipelines proposed to be installed and operated as discussed below. The La Grange gage would monitor compliance for flows between La Grange gage and RM 25.5. Subtracting the "IG pipeline gage" from La Grange gage yields the instream flows to be provided downstream of RM 25.5, the second flow compliance point. Flow compliance would be deemed met if flows equaled or exceeded the flows provided in the Preferred Plan over monthly time frames, with no deficit allowed of more than 10% below the minimum for more than 60 minutes, and no flow deficit allowed that is greater than 20% below the flows specified below. With the two "compliance" points being located 25 miles apart, during days where scheduled flow changes are to occur, time of travel must also be taken into account in determining compliance.

5.6.1 Early Summer Flows (June 1 – June 30)

Studies show (W&AR-05, W&AR-06, RST results) that except in wet (W) water years when high flows may extend well into June, fall-run Chinook salmon juveniles and smolts have left the Tuolumne River by the end of May (Figure 5.6-1).

Given the general absence of fall-run Chinook salmon in the river, the primary benefit of early summer (June 1 – June 30) flows is the enhancement of thermal conditions for *O. mykiss* populations. Based on *O. mykiss* redd surveys, *O. mykiss* may spawn any time from January

[125] TID operators currently determine the water year type by early April and issue, upon direction provided by resource agencies, the schedule of releases for the subsequent April 15 to April 14 of the next calendar year.

through early May, with peak redd counts in 2013 being in March and early April (Don Pedro USR, Fig 5.1-3). Years of monitoring studies indicate that *O. mykiss* are predominantly found upstream of RM 43 with peak fry densities potentially occurring into June. For the period from June 1 to June 30, base flows would be provided primarily to support *O. mykiss* fry rearing. Flow management for the benefit of *O. mykiss* in June consists of striking a balance between hydraulic habitat suitability and temperature suitability for fry and adult life stages. Higher flows in June tend to displace the weaker-swimming *O. mykiss* fry to downstream areas making them more subject to predation, poorer habitat conditions, and subsequent warmer temperatures.

IFIM study results (Stillwater Sciences, 2013; Figure 5.6-2 below) indicate that at 100 cfs, hydraulically suitable habitat for *O. mykiss* fry is 85% of the maximum weighted usable area (WUA), at 150 cfs it is 78% of maximum WUA, and at 200 cfs it is 71% of maximum WUA.

Considering thermal suitability for *O. mykiss* during summer conditions,[126] water temperature modeling shows that at RM 47, a flow of 200 cfs will maintain average daily water temperatures to less than 18°C, and at RM 43, average daily water temperatures would be less than 20°C, except when maximum daily air temperatures along the river exceed 100°F, which on average occurs 1 to 2 days in June (see Figures 5.6-3 and 5.6-4 below).

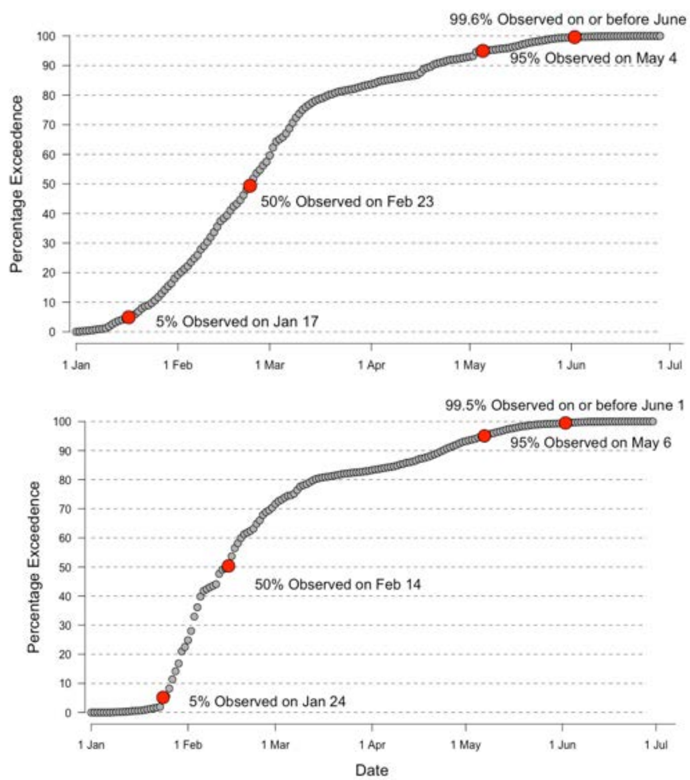

Figure 5.6-1. Long-term migration pattern of observed juvenile Chinook salmon captured at the Waterford RST (top; RM 30) and the Grayson RST (bottom; RM 5) on the Tuolumne River (2006 – 2016). Key dates of passage are highlighted with red circles.

[126] Thermal suitability for Tuolumne River *O. mykiss* is based on Tuolumne River empirical data.

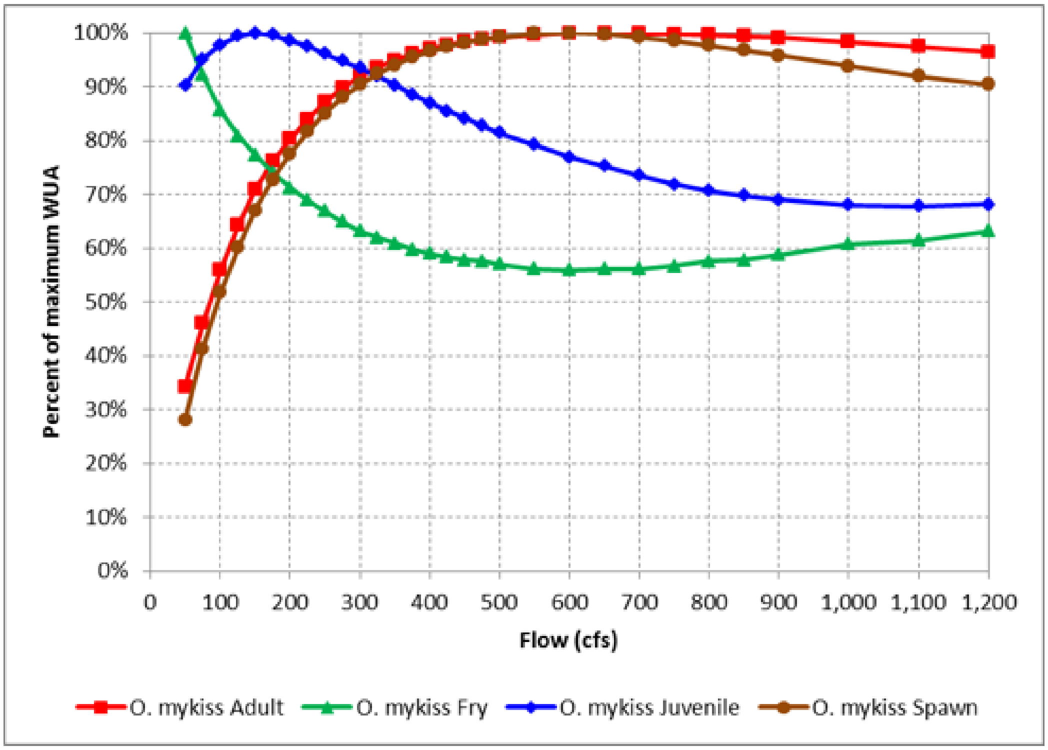

Figure 5.6-2. ***O. mykiss*** **WUA results for the lower Tuolumne River.**

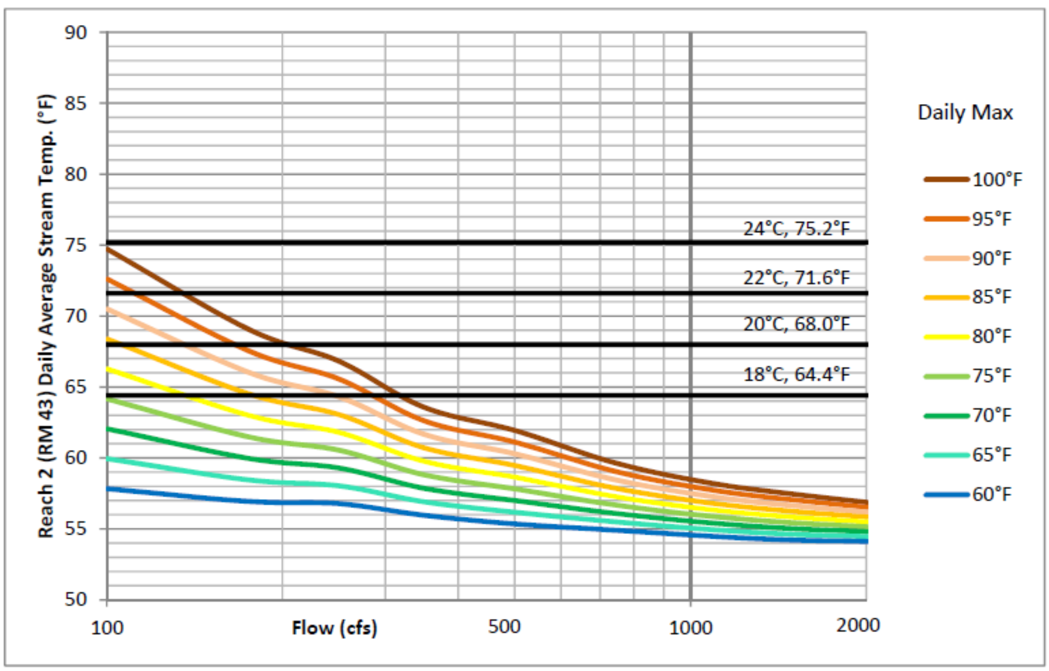

Figure 5.6-3. Estimated average daily stream temperatures at RM 43 based on river flow and maximum daily air temperature.

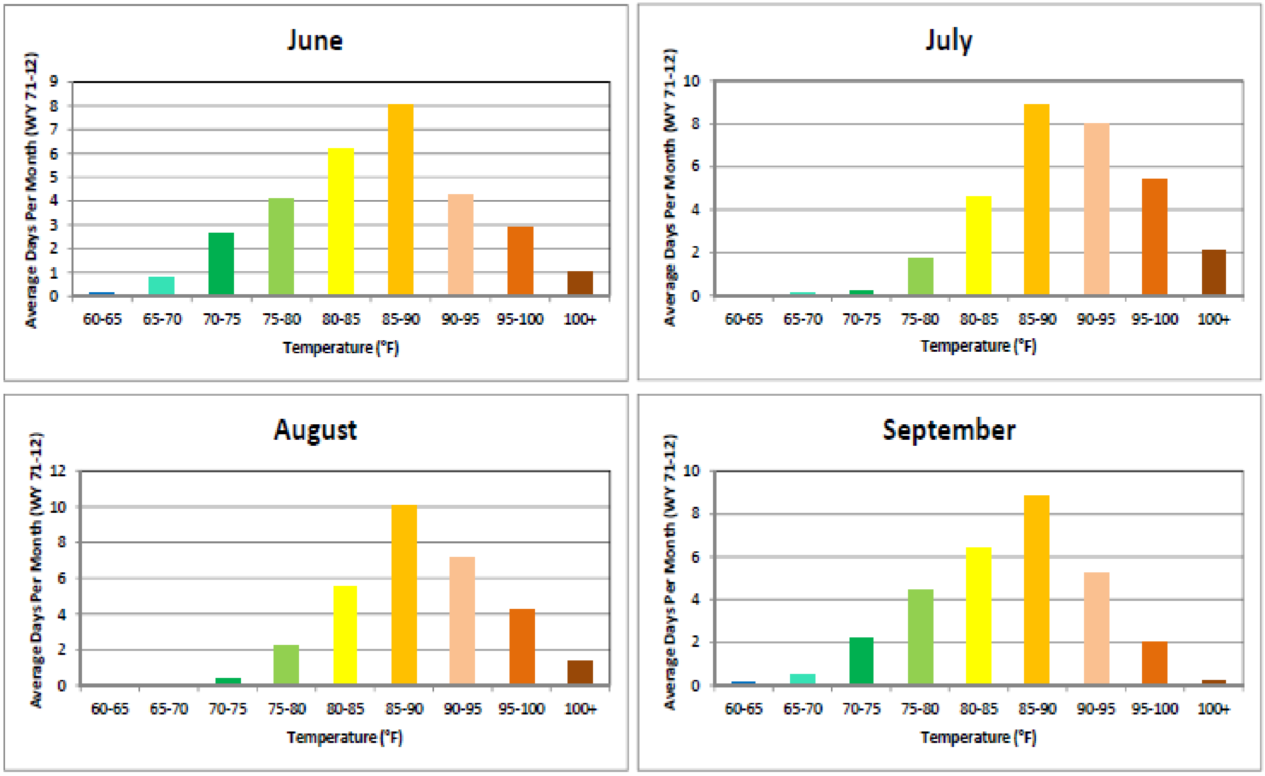

Figure 5.6-4. Average days per month when maximum daily air temperature falls within specified ranges as estimated at approximately RM 40 on the Tuolumne River (WY 71-12).

Adult *O. mykiss* habitat is 78% of maximum WUA at 200 cfs. An alternative flow of 150 cfs was considered, which improves fry habitat to 78% of maximum WUA, but decreases adult habitat to 70% of maximum WUA. At 150 cfs, average daily water temperatures at RM 43 are less than 20°C until maximum daily air temperature exceeds 95°F, which occurs on average three days in June. An alternative flow of 300 cfs increases adult WUA to 90%, but decreases fry to just over 60% of maximum WUA. Considering that adults must first successfully pass through fry stage, it is counterproductive to over-emphasize adult habitat at this sensitive period for the fry life stage. Therefore, summer flows intended to reasonably benefit *O. mykiss* fry while protective of *O. mykiss* adults are as follows:

- June 1-June 30 (all WYs): 200 cfs (as measured at La Grange gage)

5.6.2 Late Summer Flows (July 1 to October 15)

By July, *O. mykiss* life stages occurring in the lower Tuolumne River are both juveniles and adults. Juveniles are stronger swimmers than fry and can maintain position in the river at higher flows. The primary habitat concern during this period is to maintain adequate river temperatures through approximately RM 43. Fish biology researchers from the University of California at Davis (UC Davis), in conjunction with *O. mykiss* experts from University of British Columbia (UBC), conducted field tests of the thermal capacity of wild Tuolumne River *O. mykiss* juveniles (see W&AR-14). This study, and additional observations of in-situ wild juveniles (FISHBIO 2017), demonstrated that Tuolumne River *O. mykiss* juveniles had optimum metabolic capacity between 21°C and 22°C, and maintained 95% of optimum capacity between 18°C and 24°C. At a flow of 350 cfs, hydraulic habitat is 95% of maximum WUA for adults and 90% of maximum WUA for juveniles. A flow of 350 cfs will maintain average daily temperatures below 18°C at RM 43 until daily maximum air temperatures exceed 105°F. During Dry and Critical years, flow at La Grange gage would be reduced to 300 cfs, where both juvenile and adult habitat is about 91% of maximum WUA and average daily water temperatures at RM 43 would be less than 19°C until maximum daily air temperatures exceeded 100°F.

In early fall, fall-run Chinook salmon usually begin to enter the Tuolumne River. The Districts have maintained an adult counting weir at RM 24.5, near the downstream end of the gravel-bedded reach, since 2009. As indicated by Figure 5.6-5, few fish enter the spawning grounds above the counting weir until after mid-October. The run peaks in November and can extend into late December, and occasionally early January. The Preferred Plan provides a pre-season flushing flow to clean gravels of built up algae, debris, and surface fines prior to the start of substantial spawning. A flushing flow of approximately 1,000 cfs on October 5, 6 and 7 (total volume not to exceed 5,950 AF), with appropriate up and down ramps, and IGs turned off, would be provided in wet (W), above normal (AN), and below normal (BN) water years only. In D and C years, the flows at La Grange gage would continue to be 300 cfs with withdrawals of 225 cfs at the IGs leaving 75 cfs in the river below RM 25.5 through October 15. Therefore, instream minimum flows at the La Grange gage for July 1 through October 15 period are:

- For W, AN, and BN WYs: 350 cfs (at La Grange gage), except on October 5, 6, and 7
- For W, AN, and BN WYs: 5,950 AF spread over October 5, 6, and 7 (at La Grange gage)
- For D and C WYs: 300 cfs (at La Grange gage)

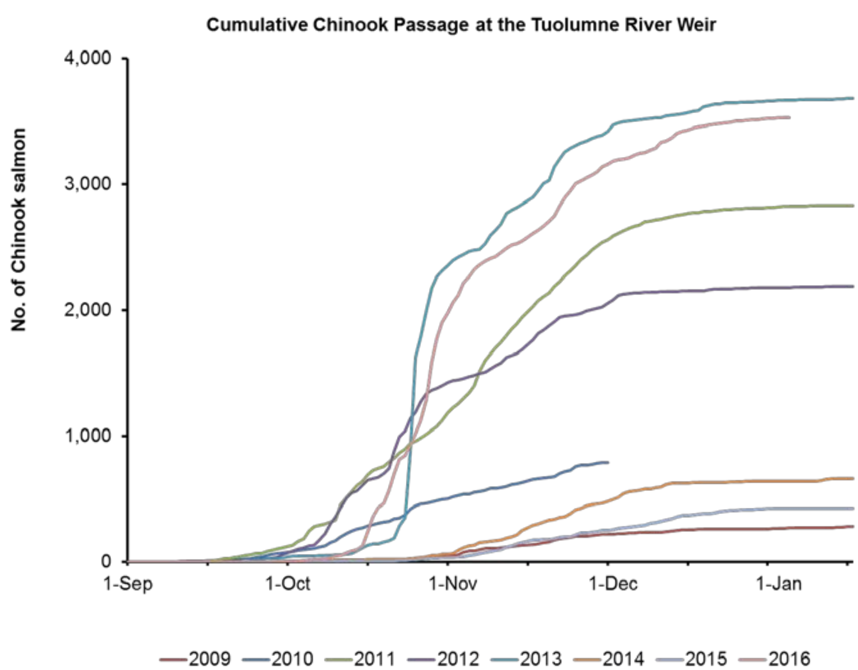

Figure 5.6-5. Adult fall-run Chinook passage at the fish counting weir at RM 24.5 for 2009 through 2016.

5.6.3 Operation of Infiltration Galleries

The Preferred Plan includes the installation and operation of two in-stream infiltration galleries (IG-1 and IG-2) for the purpose of benefiting Tuolumne River cold-water fisheries, notably *O. mykiss*, while at the same time protecting the Districts' water supplies. The gravel-bedded reach of the lower Tuolumne River extends to approximately RM 30 and habitats preferred by *O. mykiss* based on directed searches and snorkel surveys are located generally above RM 43. In the vicinity of Geer Road at RM 26, TID's Ceres Canal approaches reasonably close to the left bank of the Tuolumne River, enabling cost-effective delivery of water withdrawn from the river to TID's irrigation customers, while benefiting habitat for *O. mykiss* between RM 51 and RM 43.

Under the Preferred Plan, the Districts would complete construction of IG-1 and undertake construction of IG-2 in the same general locale as IG-1 near RM 26. IG-1 has a design capacity of approximately 100 cfs and IG-2 would have a capacity of 100-125 cfs. The IGs are considered Don Pedro Project facilities and are therefore to be included within a designated FERC Project Boundary, but non-contiguous with the current Don Pedro Project Boundary. This will be part of the same non-contiguous Don Pedro Project Boundary that encompasses the fish barrier weir as discussed above.

In 2001, TID installed IG-1 during a river improvement project constructed under the auspices of the '95SA. The primary purpose of the project was to remove the SRP-9 predator hot-spot by restoring riverine habitat to the area encompassed by SRP-9. TID, with appropriate regulatory approvals, took the opportunity to install the piping network needed for IG-1 at that time. The installed system consists of 15 perforated, horizontal stainless steel pipes, each 42-ft long and 24-inch in diameter placed within graded rock filters. The system has a capacity of 100 cfs. The gallery of pipes is connected to a manifold system which delivers water to a pump well on river left, which then would deliver water withdrawn from the river to the TID Ceres Canal. MID will receive a credit in Don Pedro Reservoir for its share of water diverted at the IGs and delivered into TID's conveyance system. The intake velocity into the gallery pipes is less than 0.01 ft/sec, well less than current fish screen criteria. IG-2 would be located upstream of IG-1 (Figure 5.6-6) and the manifold pipe would connect to TID's valve house on the upstream side of Geer Road as shown in Figure 5.6-7. IG-2 would have a capacity of approximately 100 to 125 cfs depending on final engineering.

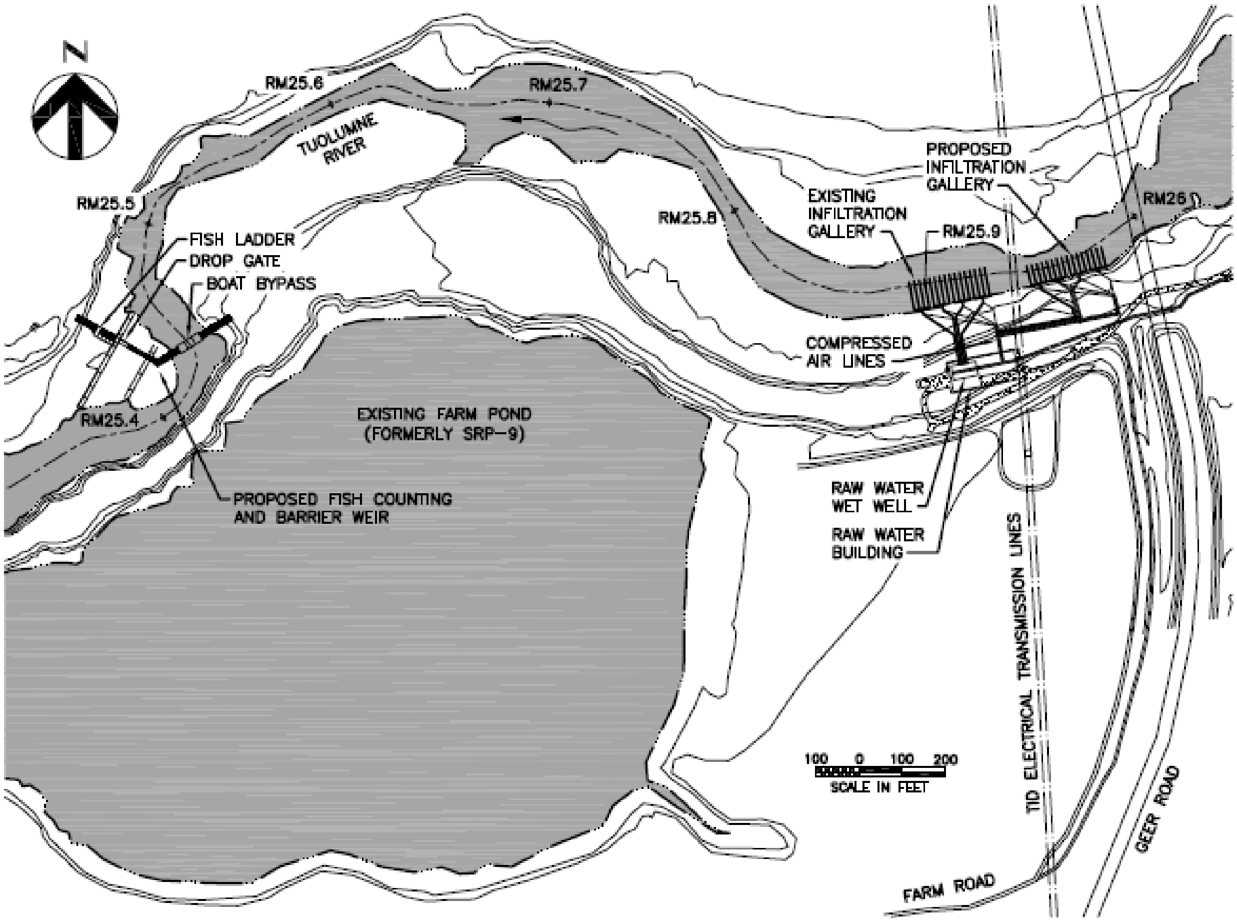

Figure 5.6-6. Proposed location of IG-2 upstream of the existing IG-1. Geer Road is located at RM 26 and the proposed fish counting and barrier is located at RM 25.5.

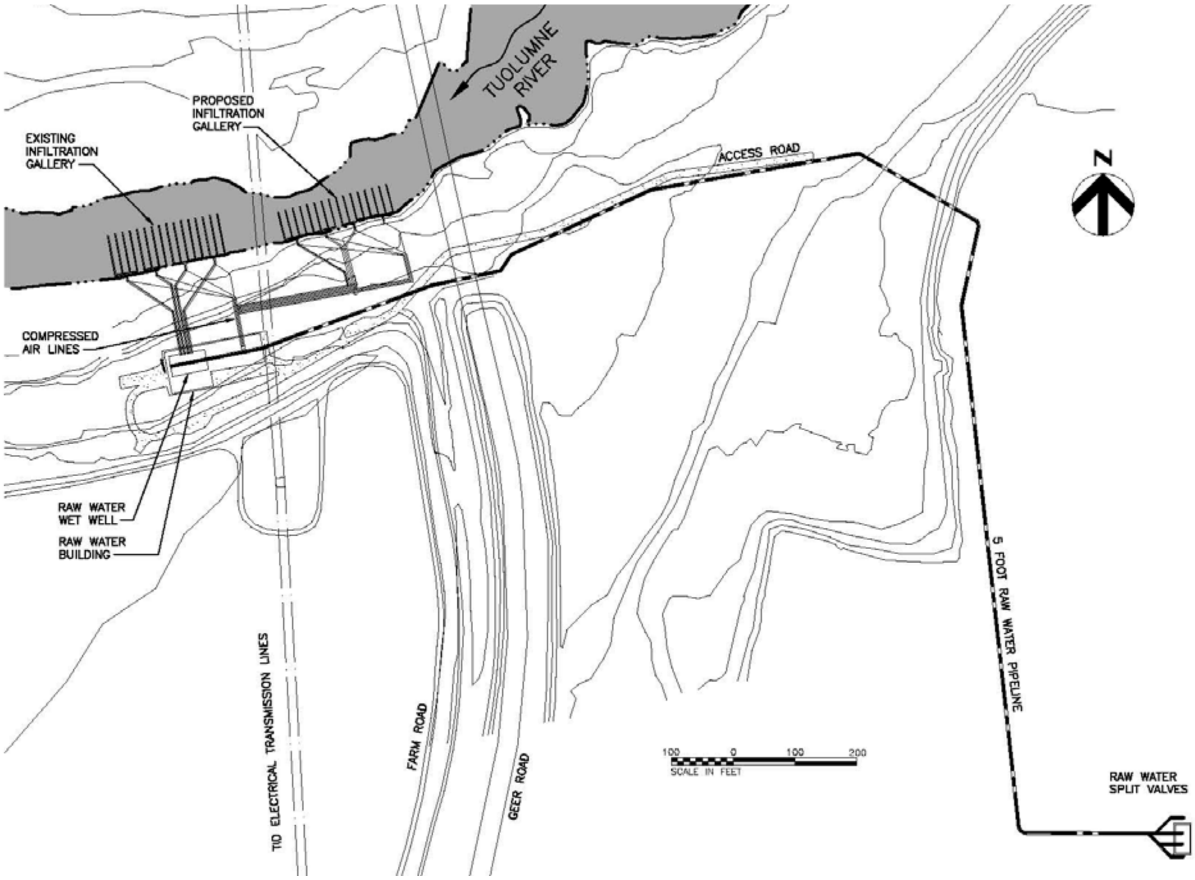

Figure 5.6-7. **Location of IG-1 and IG-2 just downstream of the Geer Road Bridge. Pipeline right-of-way leading to TID's Ceres Canal. FERC Project Boundary would extend to the raw water splitter valve.**

The IGs would be operated from June through mid-October for purposes of the Preferred Plan enabling the release of increased flows to *O. mykiss* preferred habitats above RM 42, while continuing the Districts' use of a portion of the instream flow for water supply purposes by withdrawing flows through the IGs. During wet, above normal, and below normal water years, 100 cfs (in June) and 150 cfs (in July through October 15) would remain in the river below RM 25.5. During dry and critical water years, a total of 75 cfs would remain in the river below RM 25.5 from June 1 through October 15. The below normal, dry and critical year flows *downstream* of the IGs in the Districts' Preferred Plan are greater than or equal to the required flows under the current license. In wet and above normal years, the flows downstream of the IGs are lower than the current required flows. Lower flows in the sand-bedded reach accommodate the warm-water species that inhabit this reach and slightly lower flows may improve fishing success in catching and removing some of the predator species inhabiting these reaches. Compliance with these flows would be measured at both the La Grange gage and at the IG pipeline system. For example, on June 20 in a BN water year, the La Grange gage would be measuring 200 cfs, and the TID IG pipeline would be measuring no more than 100 cfs, subject to the minimum flow compliance provisions described above.

For the same BN water year, the La Grange gage on August 15 would be measuring 350 cfs and the IG pipeline would be measuring no more than 200 cfs. There are exceptions to the Districts' water withdrawal rates at the IGs for recreational purposes as discussed below in Section 5.7.2. In addition, the IGs would be turned off for the October 5, 6 and 7 flushing flow in W, AN, and BN water years.

The IGs are proposed to be in operation withdrawing water from the river from June 1 through October 15 of each year. While there are times when both IGs will be in operation, there are also times when a single IG will be adequate to withdraw the full amount defined in the Districts' Preferred Plan. Having some redundancy minimizes the potential for the IGs to be unable to withdraw the amount of water planned. There is still the possibility, however low, that with either one or both of the IGs out of service the Districts would not be able to withdraw irrigation supply water at this location. As part of the Preferred Plan, any IG outage which prevents the planned amount to be withdrawn and lasting for more than three consecutive days will result in the minimum instream flows required at La Grange gage to be reduced by two-thirds of the amount that would have been withdrawn.

For example, if we assume that in an AN water year in July when the La Grange gage flow is the proposed 350 cfs and the flow below RM 25.5 is intended to be 150 cfs, the IGs are each withdrawing 100 cfs. If one of the IGs experienced an unexpected extended outage under these conditions, then the required flow at the La Grange gage would be reduced to 285 cfs (350 cfs-65 cfs), and the flow below RM 25.5 would be 185 cfs (285 cfs – 100 cfs). Under this arrangement, all concerned entities are motivated to put the non-functioning IG back into service promptly.

Estimated IG Capital Cost: $13 million
Estimated IG Annual O&M Cost: $300,000/year

5.6.4 Fall-run Chinook Spawning (October 16 – December 31)

Studies conducted as part of relicensing (W&AR-04 – *Spawning Gravel in the Lower Tuolumne River)* found sufficient spawning gravels currently exist in the lower Tuolumne River to support a fall-run Chinook spawning population of over 50,000 fish.[127] As shown in Figure 5.6-5 above, the timing of fall-run Chinook spawning in the lower Tuolumne River occurs predominantly from mid-October through the end of December based on data collected at the Districts' counting weir[128] located at RM 24.5. In 2012/2013, 1.4% of new redds were documented to occur after December 15; in 2014/2015, 8.5% of new redds were observed after December 31.[129] Instream flow studies (Stillwater Sciences 2013) indicate that maximum WUA for fall-run Chinook spawning occurs at approximately 300 cfs and is 90% of maximum WUA or greater from 200 to 400 cfs (Figure 5.6-8).

[127] According to this study, maximum spawning gravel area occurs at 225 cfs and gravel area is 95% of maximum at 275 cfs.
[128] Period of time between passing the counting weir to spawning varies, but is generally estimated to be about two weeks with early arrivals being longer and later arrivals being shorter.
[129] See W&AR-08 *Salmonid Redd Mapping Study* (2013). Salmonid Redd Mapping 2014/2015 and 2015/2016 Monitoring Report. Spawning flows could be adjusted in real time during the spawning period if weir passage numbers continued to be significant past December 31, as occurred in WY 2017.

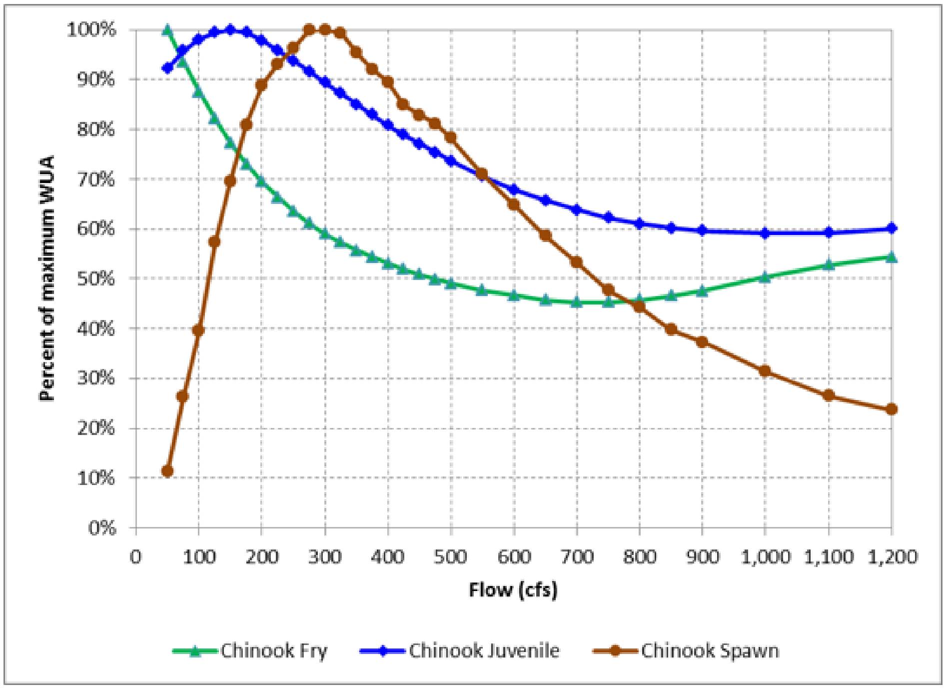

Figure 5.6-8. Chinook salmon WUA results from the 2013 lower Tuolumne River PHABSIM study.

At 275 cfs, average daily water temperatures at RM 43 are less than 14.5°C until daily maximum air temperatures exceed 75°F, which is estimated to occur about one day in November on average (see Figures 5.6-9 and 5.6-10). Average daily water temperatures generally remain below 14°C in the month of December throughout the entire gravel-bedded reach of the lower Tuolumne River.

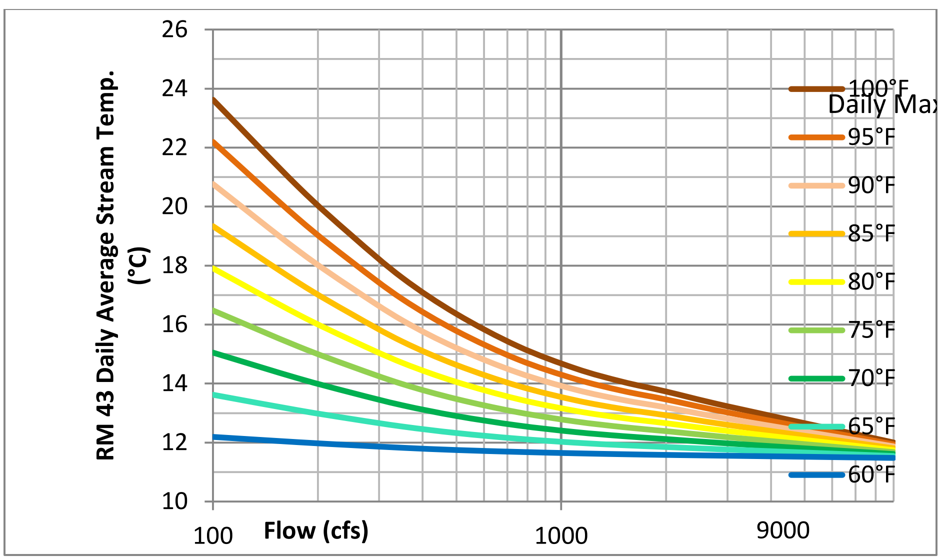

Figure 5.6-9. RM 43 daily average water temperatures versus flow and maximum air temperatures.

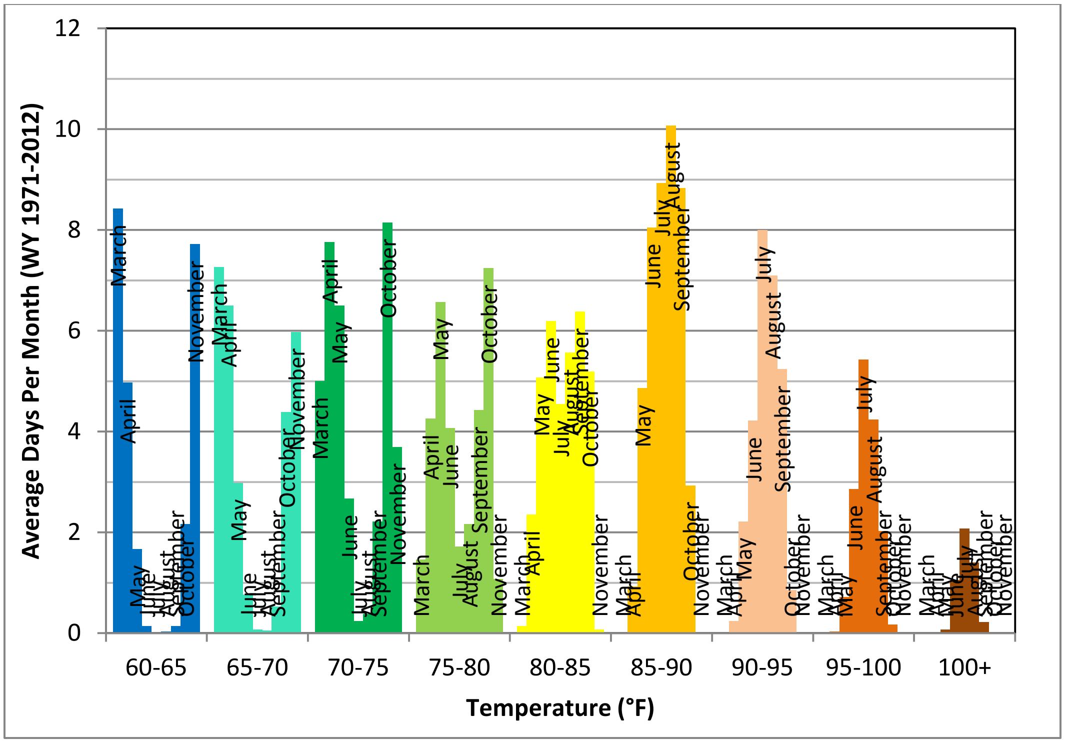

Figure 5.6-10. Frequency of occurrence of maximum daily air temperatures by month for the lower Tuolumne River (estimated for approximately RM 40).

Based on the site-specific data for the Tuolumne River, the Preferred Plan includes spawning flows for the October 16 through December 31 spawning period in accordance with the following schedule:

- For BN, AN, and W WYs 275 cfs
- For D WYs 225 cfs
- For C WYs 200 cfs

At a flow of 275 cfs, hydraulically suitable spawning habitat is 98% of maximum WUA, at 225 cfs spawning habitat is at 92% of maximum WUA, and at 200 cfs, it is 89% of maximum WUA. In combination with the other spawning habitat improvements provided in the Preferred Plan, overall spawning habitat quantity and quality will significantly improve. As mentioned above, studies of suitable spawning habitat indicate sufficient spawning gravels to accommodate over 50,000 fall-run Chinook and over 700,000 *O. mykiss*. Combined with the habitat improvements presented in Section 5.5, the quality and abundance of suitable spawning habitat in the primary spawning reach upstream of RM 39.5 (Roberts Ferry Bridge) will increase significantly under the Preferred Plan.

5.6.5 Fall-Run Chinook Fry-Rearing (January 1 – February 29)

A study of otoliths from Tuolumne River fish (W&AR-11) shows that fall-run Chinook salmon that leave the Tuolumne River as fry typically make up a very small percent (<5%) of the subsequent adult escapement.[130] Under the conditions existing in the lower reaches of the lower Tuolumne River, the San Joaquin River, and Bay-Delta, fry mortality is high;[131] therefore, efforts to increase suitable fry habitat in the upper reaches of the Tuolumne River (above RM 30) would increase the number of fall-run Chinook leaving the river as parr and smolts, and thereby increase fall-run Chinook production on the Tuolumne River and, all else being equal, increase subsequent adult returns. Based upon PHABSIM modeling of in-channel habitat conditions in the Tuolumne River, the maximum suitable Chinook fry habitat occurs at 50 cfs. At 100 cfs, Chinook salmon fry habitat is reduced to 88% of maximum WUA, at 150 cfs it is 75% of maximum, at 225 cfs it has dropped to about 67%, and at 300 cfs it is less than 60% of maximum WUA.[132] High flows in the river during the early fry rearing period (January-February) tend to result in downstream displacement of fry into the lower, more confined reaches of the Tuolumne River and potentially into the San Joaquin River, areas with higher densities of predatory fish species (W&AR-05; W&AR-06), thereby adversely affecting later adult returns and escapement.

In-channel fry rearing habitat is not a limiting factor for the Tuolumne River fall-run Chinook population. As shown in Figure 5.6-11, in-channel fry rearing capacity above Hickman Bridge (RM 31.7) exceeds 6 million fry at a flow of 100 cfs and 5 million fry at a river flow of 200 cfs.

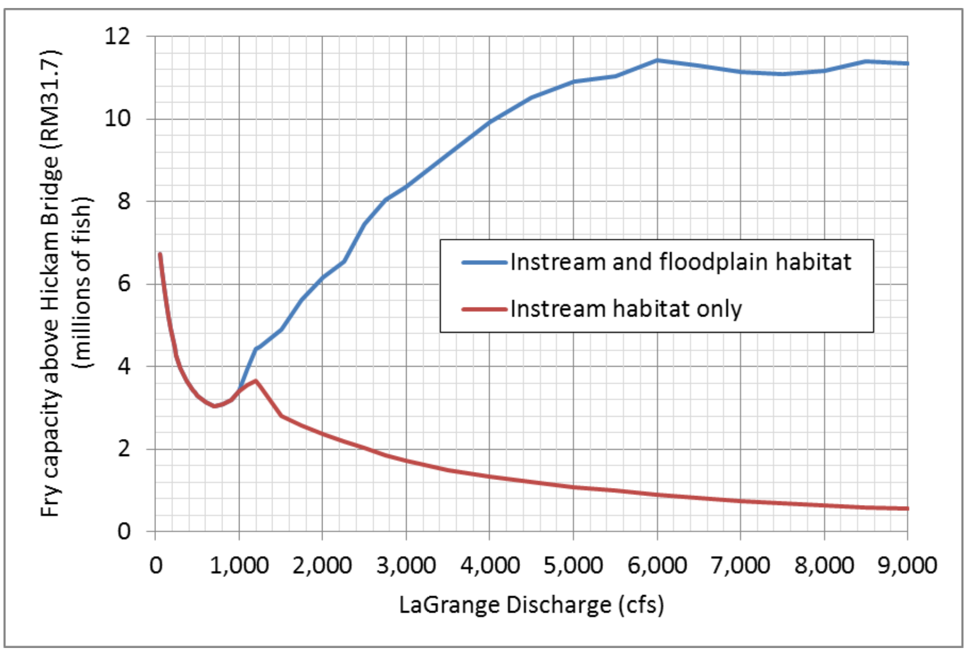

Figure 5.6-11. Fry capacity (millions of fish) in the lower Tuolumne River for both in-channel and floodplain rearing above RM 31.7.

[130] Includes wild and hatchery fish based on analyses of outmigration years: 1998-2000, 2003, and 2009.
[131] See SJRGA (2013) 2011 Annual Report and FISHBIO (2017) Outmigrant Trapping of Juvenile Chinook Salmon in the Lower Tuolumne River, 2016.
[132] See Stillwater Sciences (2013). *Lower Tuolumne River Instream Flow Study*

Based on the results of the Floodplain Hydraulic Analysis study (W&AR-21), river flows exceeding 2,000 cfs would be necessary in order to provide the same level of rearing capacity as that provided by in-channel rearing achieved at flows of about 100 cfs.[133] Additionally, measure RPM-3 described above will contribute to increasing in-channel fry habitat and densities in the upper reaches of the lower Tuolumne River. To promote fry rearing upstream of the general area of the Waterford RST (RM 30), and striking an appropriate balance between spawning and rearing flows, the following minimum instream flow releases would be adopted from January 1 through February 29:

- BN, AN, W WYs   225 cfs
- D WYs   200 cfs
- C WYs   175 cfs

These flow levels are slightly lower than those provided during the spawning period; however, they are sufficiently high so as not to result in significant riverine hydraulic changes or redd dewatering. The mean pot depth of fall-run Chinook redds found during the 2012 redd survey was 1.9 feet and the minimum observed depth was 0.9 feet (W&AR-08, Figure 5.3-4). Based on the rating curve for the USGS gage at La Grange, the change in flow from 275 cfs to 225 cfs results in a 0.4 ft (+/-) change in stage, and from 225 cfs to 200 cfs results in a 0.2 ft (+/-) change in stage (see Figure 5.6-12). These small changes in river stage when moving from spawning flow to rearing flow are unlikely to adversely affect fall-run Chinook egg incubation.

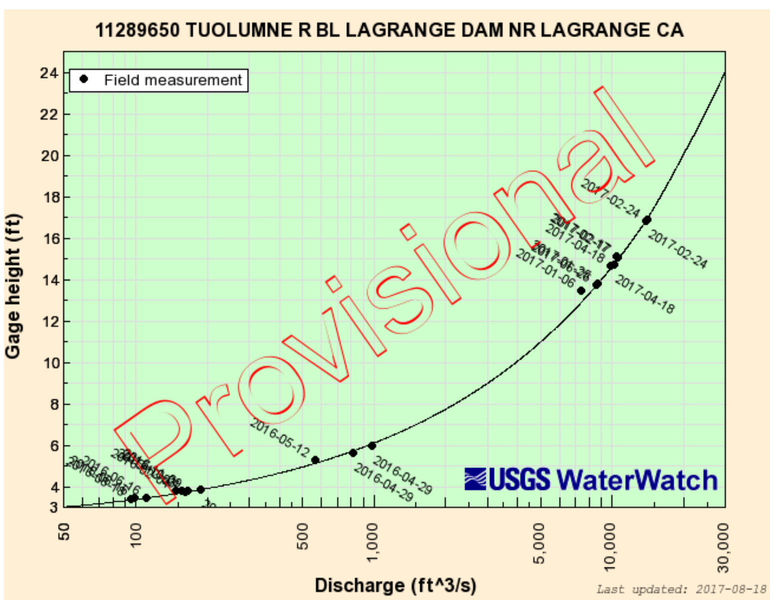

Figure 5.6-12. Stage-discharge rating curve of the USGS Tuolumne River at La Grange gage. [134]

[133] For example, as cited in Matella and Merenlender (2014), a continuous floodplain inundation of 14 days or longer is needed to be considered beneficial for rearing, the same amount of rearing habitat is produced by 3,500 AF (125 cfs) as 55,000 AF (2,000 cfs). Further, the higher flows tend to displace weaker swimming fry to poorer habitats downstream.

[134] High flows occurring in 2017 may require adjustment to the rating curve. The control section at the gage has remained stable over previous high flow periods. Minor adjustments to the rating curve have occurred from time to time.

5.6.6 Fall-Run Chinook Juvenile Rearing (March 1 – April 15)

Tuolumne River data and studies indicate that the juvenile rearing life stage dominates the time frame from March through mid-April with many fish reaching parr-size (50-64 mm) by mid-March.[135] Hydraulically suitable habitat for juvenile fall-run Chinook salmon rearing is maximized at 150 cfs and exceeds 97% at flows from 100 to 200 cfs. At 300 cfs, it drops to 90%. At 250 cfs, average daily water temperatures stay below 18°C at RM 39.5 until maximum daily air temperatures exceed about 80°F, which occurs on average about three to four days in April, and stays below 20°C at RM 39.5 until maximum daily air temperature exceeds 85°F, which occurs about one day in April (Figure 5.6-13).

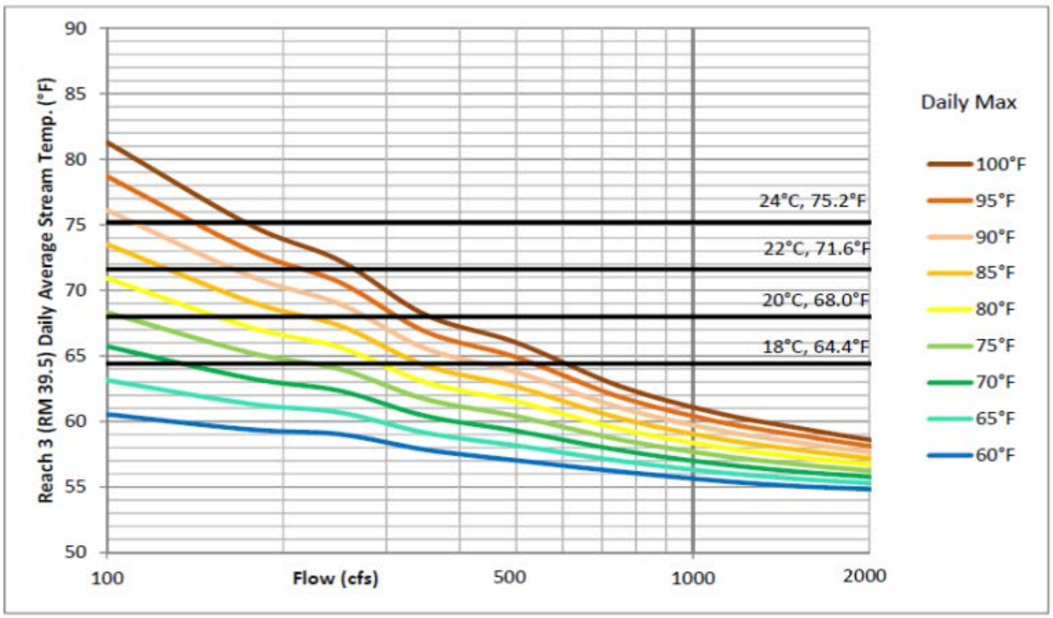

Figure 5.6-13. RM 39.5 daily average water temperatures versus flow and maximum air temperatures.

As shown in Figure 5.6-14 below, in-channel juvenile rearing habitat is not a limiting factor for fall-run Chinook salmon in the Tuolumne River. At a flow of 250 cfs, in-channel rearing habitat supports 3 million juvenile fall-run Chinook salmon. When considering floodplain rearing habitat, a flow of 2,300 cfs is required to produce the same level of rearing habitat. Using a minimum time period of floodplain inundation of 14 days to be considered effective rearing

[135] See FISHBIO.2015a. 2014 Seine Report and Summary Update Report 2014-3. In 2014 Report of Turlock Irrigation District and Modesto Irrigation District Pursuant to Article 58 of the License for the Don Pedro Project, No. 2299, March. Also see FISHBIO 2015b. Outmigrant Trapping of Juvenile Salmon in the Lower Tuolumne River, 2014. Report 2014-4 In 2014 Report of Turlock Irrigation District and Modesto Irrigation District Pursuant to Article 58 of the License for the Don Pedro Project, No. 2299, March. Also FISHBIO (2016). *2016 Seine Report and Summary Update* and FISHBIO (2016) *Outmigrant Trapping of Juvenile Salmon in the Lower Tuolumne River, 2016*

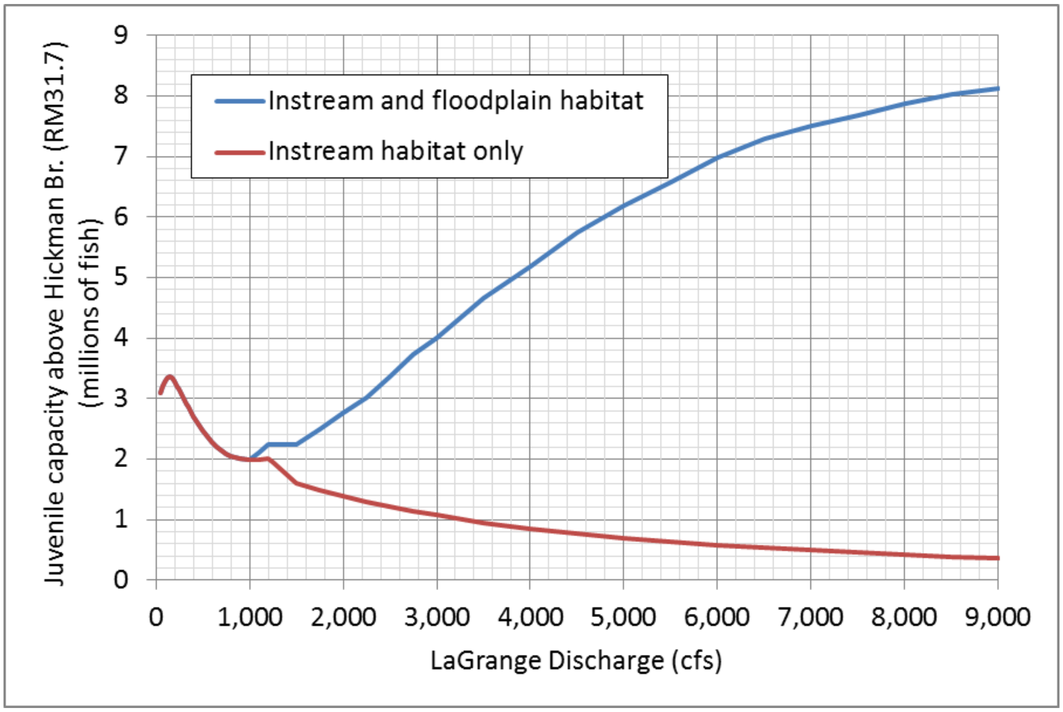

Figure 5.6-14. In-channel and floodplain juvenile rearing capacity in the lower Tuolumne River (millions of fish) above RM 31.7.

habitat (Matella and Merenlender, 2014), a flow of 7,000 AF produces the same rearing habitat as a flow of 64,000 AF.[136]

Another fisheries related consideration in the March to mid-April time frame on the Tuolumne River is *O. mykiss* spawning. As shown above in Figure 5.6-2, at a flow of 250 cfs, spawning habitat for *O. mykiss* is about 85% of maximum WUA and at 200 cfs it is about 78% of maximum WUA. At RM 43, which is the approximate downstream limit of preferred *O. mykiss* habitat, average daily water temperatures stay below 15°C at a flow of 225 cfs until maximum air temperatures exceed 75°F (on average two days in March and eight days in April). Therefore the flows in the Preferred Plan intended to promote and protect fall-run Chinook juvenile rearing are not inconsistent with protecting *O. mykiss* spawning.

To benefit fall-run Chinook juvenile rearing, while being protective of *O. mykiss* spawning, the Districts' Preferred Plan contains the following minimum instream releases to the lower Tuolumne River from March 1 through April 15:

- BN, AN, W WYs 250 cfs
- D WYs 225 cfs
- C WYs 200 cfs

In W and AN water years, which in the 1971 to 2012 period occurred about 50% of the time, flows at the La Grange gage would frequently exceed minimum flows, and provide floodplain

[136] That is, 250 cfs for 14 days = 7,000 AF and 2,300 cfs for 14 days = 64,000 AF.

access for juvenile fall-run Chinook. Under the Districts' Preferred Plan, flows of at least 3,000 cfs for 14 consecutive days in the February through June period occur in 17 of the 42 year 1971-2012 period (see Appendix E-1, Attachment G, Table 13).

5.6.7 Outmigration Base Flows (April 16 through May 15)

Fall-run Chinook salmon leaving the Tuolumne River as large parr or smolts return as adults in a much higher percentage than those leaving as fry (almost a 20:1 ratio based upon outmigration years 1998-2000, 2003, 2009; W&AR-11); therefore, maintaining favorable growth conditions and reducing predation through the smoltification life stage is beneficial to fall-run Chinook production on the Tuolumne River. As juvenile fall-run Chinook grow, their ability to hold-station and simultaneously conduct life functions under higher flows also increase. Increasing base flows above those in the March 1 to April 15 period serves to maintain favorable river temperatures during the mid-April through mid-May period. At RM 39.5, a flow of 275 cfs keeps average daily river temperatures below 21°C until maximum daily air temperatures exceed 100°F, which occurs on average one day in May. At RM 39.5, at a flow of 225 cfs, water temperatures are below 21°C[137] until maximum air temperatures exceed 95°F, which occurs on average about two days in May. In April and potentially through mid-May, incubation of *O. mykiss* may be occurring. At RM 43, a flow of 275 cfs maintains average daily water temperatures below 15°C until maximum daily air temperatures exceed 80°F, which occurs about three to four days in April and 15 days in May. However, in May *O. mykiss* fry habitat is more of a concern because this is late in the incubation period and most fry have emerged. At 275 cfs, fry habitat is 64% of maximum WUA.

Considering the balance to be struck between Chinook and *O. mykiss* life stages which are occurring at the same time in this period, the base flow schedule for this April 16 to May 15 period is shown below. These flows may be augmented by outmigration pulse flows, and these increased flows would reduce water temperatures further. Pulse flows during this time period may decrease *O. mykiss* fry rearing habitat, but as discussed below, the implementation of RPM-3 described previously is specifically intended to enhance *O. mykiss* fry rearing habitat through creating greater habitat complexity.

- BN, AN, W WYs 275 cfs
- D WYs 250 cfs
- C WYs 200 cfs

[137] Studies of fall-run Chinook salmon growth by Sommers et al. (2001; 2004) on the Sacramento River (Yolo Bypass reach) and by Jeffres et al. (2008) on the Cosumnes River both found that juvenile salmon grow well at temperatures exceeding 21°C as long as available food sources are favorable. Jeffres et al. reports "[t]emperatures on the floodplain for a 1-week period had a daily average of 21°C and reached a daily maximum of 25°C and fish continued to grow rapidly." In-river benthic macroinvertebrate studies on the Tuolumne River demonstrate healthy populations of BMI in the Tuolumne. Also see Poletto et al. (2017) reporting on thermal capability of juvenile fall-run Chinook.

5.6.8 Outmigration Base Flows (May 16 through May 31)

While in most years juvenile fall-run Chinook salmon have left the Tuolumne River by mid-May (see Figure 5.6-1 above), in some years there are still large parr and smolts in the river beyond May 15.

To reduce water temperatures during this period, the Preferred Plan includes the following increased base flow releases. This increase in flow tends to favor fall-run Chinook over *O. mykiss* fry; however, increased rearing habitat provided by RPM-3 will improve *O. mykiss* fry rearing habitat, especially if preference to placing the boulder mix is given to along the stream margins preferred by *O. mykiss* fry and juveniles.

- BN, AN, and W WYs 300 cfs
- D WYs 275 cfs
- C WYs 225 cfs

5.6.9 Summary of Minimum Instream Flows Provided by the Districts' Preferred Plan

The previous sections describe the seasonal allocation of the Districts' proposed minimum instream flows as part of the Preferred Plan. Spring pulse flows are also a major component of the flows proposed by the Districts, and these are discussed and presented in Section 5.6.10 below.

It is apparent that the IGs are an essential element of the Districts' Preferred Plan. The IGs enable a unique multiple-use of water, fulfilling with the same water resource both important environmental benefits and water supply protection during all WY types. On average over the 1971-2012 modeling period, use of the IGs allow an additional 50,000 AF of water to be released to the river to the benefit of 25 miles of Tuolumne River habitat. This reach includes the primary habitat of *O. mykiss* populations in the Tuolumne River. Recreational boating in the reach of river between La Grange gage and Geer Road (RM 26) would benefit substantially from the increased flow enabled by the IGs. Below RM 25.5, the river becomes increasingly urban and industrial to at least RM 11.

The IGs and the additional flow in the river enabled by their use are resource enhancements and not mitigation for direct Project effects to *O. mykiss*. There is no evidence that the existing flow regime adversely affects *O. mykiss* populations, which have substantially increased under the flows of the '96 amendment. Studies conducted as part of relicensing further substantiate this conclusion.[138]

The Districts acknowledge that FERC may determine that it does not have the authority to authorize the installation and operation of the IGs or may otherwise determine not to authorize them. Just as important, if not more so, additional approvals may be required by the ACOE, SWB, CDFW and/or other regulatory bodies (if not pre-empted by the Federal Power Act) even

[138] Verhille et al. (2016); FISHBIO (2017)

if FERC were to approve the installation and use of the IGs. Therefore, the proposed flow regime contained in the Districts' Preferred Plan is contingent upon receipt of all regulatory approvals needed to install and operate the IGs as proposed in the Preferred Plan. Due to the possibility that additional federal, state and local permitting may substantially delay the installation and full operation of the IGs, the Districts' proposed flow measures include a set of "interim" instream flows for the June 1 to October 15 period as provided below in Table 5.6-2 until such time as the IGs are fully operational.

Additionally, if FERC does not adopt the Preferred Plan, which includes the installation and operation of the IGs, then the interim flows are the Districts' final proposed flows absent the IGs. Table 5.6-2 below provides a summary of the Districts' flow proposals with and without the IGs.

Table 5.6-2. Summary of Preferred Plan's proposed minimum instream flows with/without IGs.

Water Year/Time Period	Proposed Instream Flows with IGs (cfs)		Proposed Interim Flows or Instream Flows Without IGs (cfs)
	La Grange Gage	RM 25.5[1]	La Grange Gage
Wet, Above Normal, Below Normal			
June 1 – June 30	200	100	150
July 1 – October 15[2]	350	150	225
October 16 – December 31	275	275	275
January 1 – February 28/29	225	225	225
March 1 – April 15	250	250	250
April 16 – May 15[3]	275	275	275
May 16 – May 31[3]	300	300	300
Dry			
June 1 – June 30	200	75	125
July 1 – October 15	300	75	175
October 16 – December 31	225	225	225
January 1 – February 28/29	200	200	200
March 1 – April 15	225	225	225
April 16 – May 15	250	250	250
May 16 – May 31	275	275	275
Critical			
June 1 – June 30	200	75	125
July 1 – October 15	300	75	150
October 16 – December 31	200	200	200
January 1 – February 28/29	175	175	175
March 1 – April 15	200	200	200
April 16 – May 15	200	200	200
May 16 – May 31	225	225	225

[1] That is, downstream of IGs.
[2] The Preferred Plan also includes a flushing flow amounting to 5,950 AF of water for the period October 5 through October 7. Ramping of this flow would likely occur on October 4 and 8 as part of the flushing flow volume.
[3] These flows do not include spring pulse flows which are discussed in Section 5.6.10.

In the case where the Commission approves the Districts' proposal to install and operate the IGs substantially as proposed by the Districts' Preferred Plan, then to address the remaining regulatory uncertainty with other needed permitting processes the FERC-issued license should require the Districts to provide the "without IGs" flows provided in Table 5.6-2 until such time as the IGs are installed and operating, at which time the required minimum flows would become the “with IGs” flows. The increased flows required at La Grange gage in the “without IGs” case maintains the Districts’ motivation to install and operate the IGs.

5.6.10 Outmigration Pulse Flows (April 16 – May 31)

The benefit of providing stream flows designed to meet the needs of critical life stages of specific fish species is well documented in the literature (Yarnell et al. 2015, Kiernan et al. 2012). Data collected on fall-run Chinook salmon outmigration on the Tuolumne River suggest that juveniles emigrate volitionally or due to one or more hypothesized cues.[139] To encourage this observed tendency for outmigration and to increase survival, pulse flows would be provided which are carefully timed to coincide with the time periods when large numbers of fall-run Chinook are of large parr or smolt size, circa 65 mm and above. The Preferred Plan includes the active monitoring of spawning timing and river temperatures, supplemented by snorkel surveys or seining, to calibrate degree days and juvenile size for the purpose of timing the spring pulse flows to coincide with the smoltification of large numbers of juveniles. Adaptive management principles will be applied to optimizing over time the timing, duration, and flow rate of the pulse flows as data is collected on the resulting outmigration survival as a ratio to the number of female spawners. A Adaptive Management Plan is provided as Appendix E-1, Attachment F. The pulse flow volumes proposed in the Districts’ Preferred Plan are substantially increased over the current levels, except in sequential “Critical” WY conditions, as follows:

- W and AN WYs 150 TAF
- BN WYs 100 TAF
- D WYs 75 TAF
- Sequential D WYs 45 TAF
- First year C WY 35 TAF
- Sequential C WYs 11 TAF

The estimated cost of implementing the adaptive management plan, including the cost of environmental monitoring, is provided below:

Estimated Capital Cost: $500,000
Estimated Annual O&M Cost: $30,000/year
Estimated Environmental Monitoring Cost: $350,000/year for first ten years

The annual pulse flow volume would continue to be determined as done under the current license; however, moving from ten to five water year types should reduce the frequency of the need for “true-up water”.

RST monitoring would continue to inform emigration timing and smolt survival estimates in response to pulse flows. Timing pulse flows to coincide with large numbers of juveniles and/or smolts being motivated to outmigrate, combined with spawning gravel improvements, habitat improvements, and predator control measures, are expected to significantly improve Tuolumne

[139] Robichaud and English 2013; Robichaud and English 2017; Sonke 2017.

River outmigration survival. The projected improvements to fisheries resulting from the Districts' Preferred Plan are presented in Section 5.12 below.

5.6.11 Flow Hydrograph Shaping

In spill years, the Districts would make reasonable efforts to shape the descending limb of the snowmelt runoff hydrograph to mimic natural conditions. This would benefit riparian native vegetation that depends on seed deposition during these periods (e.g., cottonwoods). Under the Preferred Plan, flows at La Grange gage exceeding 1,500 cfs[140] in the February through July period occur in 28 years, or more than 60% of the years in the 1971-2012 period. Flows exceeding 2,500 cfs would occur in 45% of the years in that period.

5.7 Recreation Improvements

The Don Pedro Reservoir is a major recreation destination in the region, with over 400,000 visitor days a year on average. Recreation opportunities are numerous and varied. The reservoir environment and recreational facilities are managed by the Don Pedro Recreation Agency (DPRA). Recreation at Don Pedro is described in detail in Section 3.9 and a Recreation Management Plan for Don Pedro Reservoir facilities is provided in the AFLA. The Districts have long been a cooperative steward related to the resources of the Tuolumne River and the communities served by the Districts. As such, the Preferred Plan also includes certain enhancements to recreation that are unrelated to any adverse impacts attributable to the operation of the Don Pedro Project. These are described below.

5.7.1 Whitewater Boating Take-Out Facility at Ward's Ferry Bridge

Whitewater boating in the Tuolumne River above the Don Pedro Project Boundary is a popular recreational opportunity enjoyed by individuals using personal watercraft or the services of commercial outfitters. The commercial rafting season is generally extends from Memorial Day through Labor Day. For the most part, these recreationists enter the river at the USFS Lumsden campground at about RM 97 and make use of the CCSF Holm powerhouse hydro peaking flows to traverse the Wild & Scenic section of the upper Tuolumne River down to RM 80.8 at the Don Pedro Project Boundary. The Ward's Ferry Bridge, which crosses the Tuolumne River at RM 78, is the first possible river exit below the Lumsden put-in. Commercial outfitters' trips starting at Lumsden enter the river early in the morning in close sequence coinciding with the hydropeaking schedule of CCSF's Holm powerhouse. Generally, the Tuolumne River is not floatable by commercial rafts if the Holm powerhouse is not operating.

Using the peaking flows from Holm powerhouse which generally occur from about 7 am to about 11 am,[141] many of the whitewater boaters arrive at the Ward's Ferry Bridge over a relatively short period of time resulting in substantial congestion at and on the bridge. The resulting congestion is unrelated to the operation of the Don Pedro Project, but is a result of the need for commercial outfitters to complete their float trips before the peaking flow from the Holm powerhouse subsides, which generally occurs about mid-afternoon at Ward's Ferry. The

[140] Floodplain inundation along the lower Tuolumne River is initiated at a flow of approximately 1,100 cfs.
[141] Hydropeaking flows from Holm powerhouse can vary in amount and duration depending on hydrologic conditions.

commercial rafting companies position truck cranes on the bridge to lift their rafts and equipment out of the river at Ward's Ferry. This creates considerable road blockage, traffic, and related congestion problems on the Ward's Ferry Bridge. As many as three truck cranes and associated hauling vans are on the bridge roadway for afternoon periods, potentially resulting in traffic problems and in violation of county road use ordnances.

The current boating take-out problems experienced at Ward's Ferry are not related to Don Pedro project operations. Nevertheless, the Districts are including in the Preferred Plan the construction of a deck on river left, upstream of the bridge, large enough to accommodate two or three truck cranes and hauling vehicles at one time (depending on final design) thereby eliminating the need to locate truck cranes and other vehicles/equipment on the bridge (Figures 5.7-1, 5.7-2, and 5.7-3). The Districts, unless other terms are negotiated with commercial outfitters, would charge a per-head user fee to recover its costs over the period of the new license. While the Districts would pay for the construction of the take-out, the Districts plan to

Figure 5.7.1. Proposed Ward's Ferry takeout facility general location.

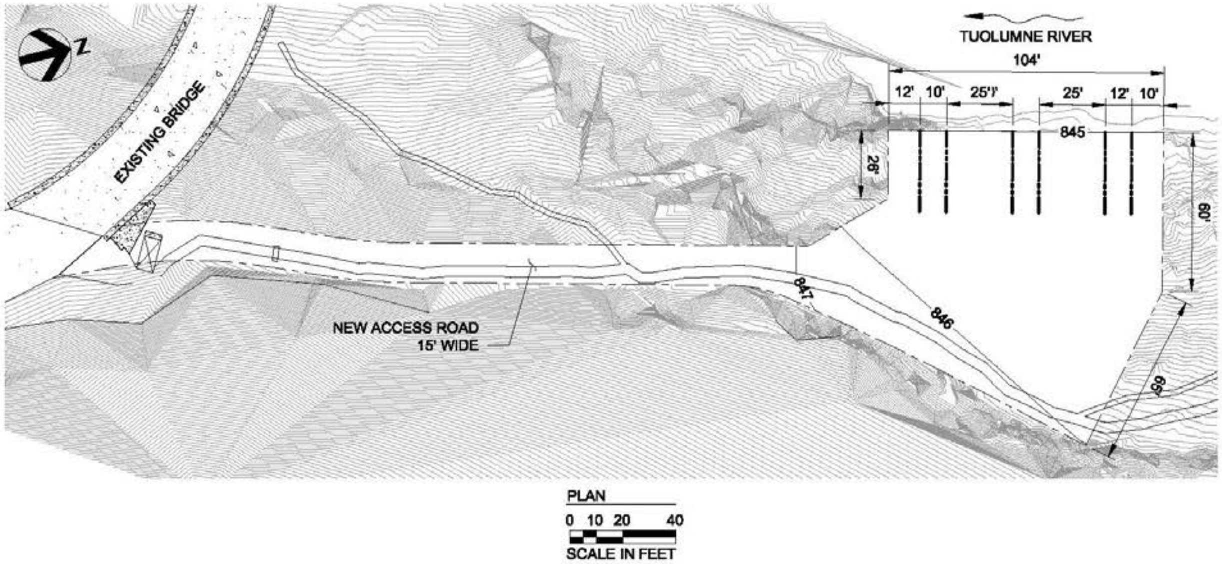

Figure 5.7.2. Proposed access road from Ward's Ferry Bridge to take-out deck.

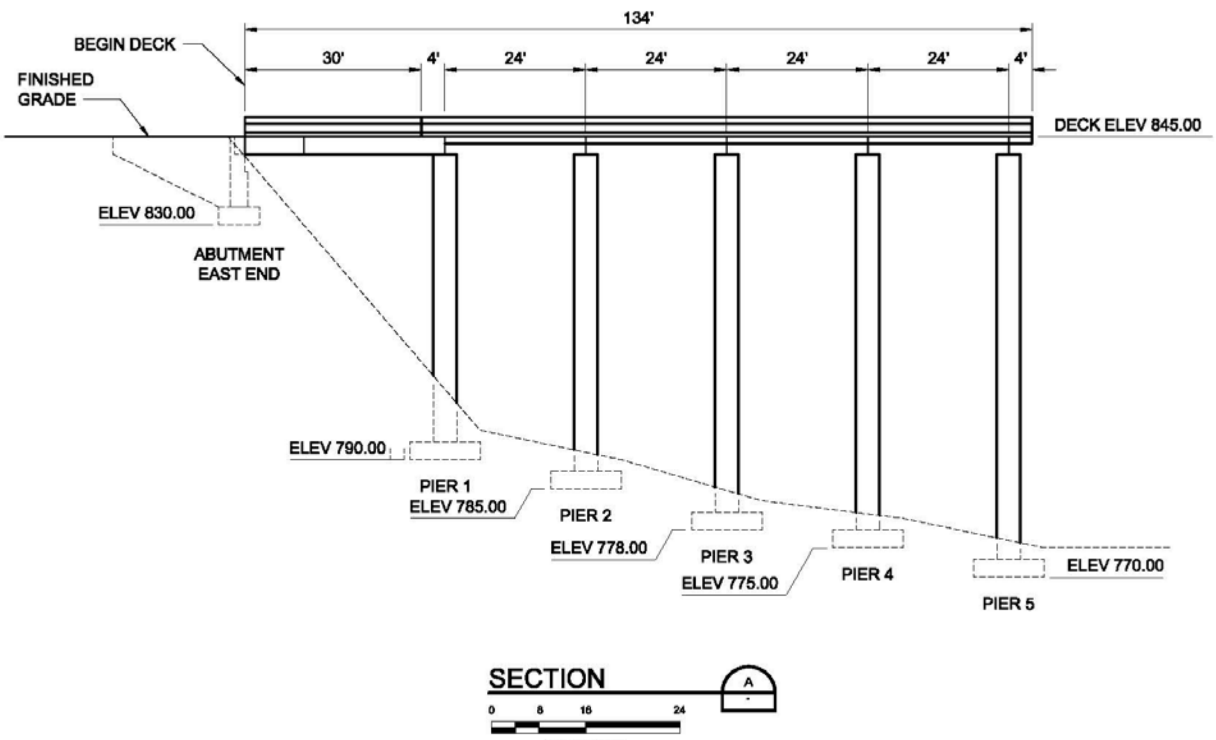

Figure 5.7.3. Proposed Ward's Ferry take-out deck looking downstream.

discuss with Tuolumne County plans for the long-term upkeep of the facility as, fundamentally, it acts as an extension of the Ward's Ferry Bridge, and is not affected by any Project operations.

Estimated Capital Cost: $6 million
Estimated Annual O&M Cost: $25,000/year

5.7.2 Enhancements to Recreational Boating in the Lower Tuolumne River

The Preferred Plan includes significant enhancements to recreational boating opportunities for non-motorized canoeing and kayaking on the lower Tuolumne River under the Districts' Preferred Plan with the IGs included. The primary boating season extends from April 1 to October 31. The Districts' Lowest Boatable Flow Study (RR-03) found that flows above 175 cfs on the lower Tuolumne River were considered to be boatable by most water users with non-motorized craft. Under the Preferred Plan with IGs, the following scheduled boatable flows would be provided:

- <u>April 1 to May 31</u>
  - Boatable flow of 200 cfs or greater, as measured at the La Grange gage, provided in all WYs to the lower Tuolumne River from RM 52 to RM 0.
- <u>June 1 to June 30</u>
  - Boatable flow of 200 cfs, as measured at the La Grange gage, occurs in all water years from RM 52 to RM 25.9 (location of IGs).
  - In W, AN, and BN, cease IG withdrawal for one pre-scheduled weekend in June to provide increased boating opportunity below RM 25.9.
- <u>July 1 to October 15</u>
  - Boatable flow of at least 325 cfs, as measured at the La Grange gage, provided at all times from RM 52 to RM 25.9 in all WYs.
  - In all but C WYs, provide a boatable flow of 200 cfs below RM 25.9 for 3-day July 4th holiday, for three day Labor Day holiday, and for two-pre-scheduled additional weekends in either July or August.
  - Provide a new take out-put in facility at RM 25.5 at the location of the fish counting and barrier weir.

5.8 Cultural Resources Protection

The Preferred Plan includes the implementation of the Don Pedro Project's Historic Properties Management Plan (HPMP) to protect cultural resources. The HPMP has been filed with FERC under separate cover.

Estimated HPMP Capital Cost: $350,000 (construction of educational kiosks)
Estimated Annual HPMP Cost: $270,000 for years 1 through 15

5.9 Don Pedro Reservoir Resource Protection

In addition to cultural resources, the Don Pedro AFLA includes management plans related to natural resources associated with the Don Pedro Reservoir. These management plans are summarized below and more fully described in the AFLA, Exhibit E. The BLM requested the development of approximately 16 individual management plans for the protection of federal lands within the Project Boundary. The Districts have adopted 11 of these plans, included with this AFLA, adopted portions of two of the plans, and not adopted three of the plans, all as described in Exhibit E of this AFLA. Several of these management plans also apply to non-federal, as summarized below.

5.9.1 Vegetation Management

The Vegetation Management Plan includes best management practices to limit the spread of existing land-based noxious weed occurrences or the establishment of new occurrences, special-status plant monitoring, employee training, and agency consultation. The implementation of the Vegetation Management Plan is expected to protect and enhance botanical resources within the Project Boundary. The Vegetation Management Plan is an element of the Terrestrial Resources Management Plan (see below).

5.9.2 Bald Eagle Management

The Bald Eagle Management Plan includes measures to protect bald eagles using the Don Pedro Reservoir through the conduct of bald eagle surveys, protection of existing nests, and providing access restrictions to prevent disturbance during bald eagle mating and rearing. It includes ongoing consultation with the USFWS regarding any planned rodenticide use, and awareness training for employees for avoidance around active nesting areas. The Bald Eagle Management Plan is an element of the overall Terrestrial Resources Management Plan.

5.9.3 Terrestrial Resources Management Plan

The Districts have prepared a Terrestrial Resources Management Plan that provides for the protection and monitoring of wildlife and botanical resources, including bald eagle, bats, noxious weeds, Valley Elderberry Longhorn Beetle, Western Pond Turtle, and special-status plants. This plan includes all components of the Vegetation Management Plan and Bald Eagle Management Plan submitted with the Districts' FLA, and provides new monitoring programs for western pond turtle and bats as requested by the BLM. Additionally, the plan provides for environmental training for the Districts' employees and contractors, annual reporting to the BLM, and a review of special status species lists for changes in listed species.

Total Estimated Annual O&M Cost for all Management Plans: $350,000/year

5.10 Power Production and Reservoir Operations

The Preferred Plan includes certain modifications to the physical plant and operations of the Don Pedro Project. The Districts are proposing to increase the hydropower capacity of the Project from the currently authorized 168 MW to the proposed new authorized capacity of 220 MW, with a maximum output of 244 MW compared to the current maximum of 203 MW at maximum head by upgrading the turbine-generator units. The estimated cost of the upgrade is $48.9 million (2016 dollars). The expected increase in annual energy production is approximately 20 million kWh. The annualized capital cost would be $2.5 million. Substantially different license conditions than those contained in the Districts' Preferred Plan may change the economic feasibility of the Districts' proposed upgrade of the turbine-generator units. Therefore, a final feasibility determination of the upgrade would be made by the Districts within two years of issuance of a new license containing all the terms and conditions of the license over the next license term.

Related to reservoir operations, the minimum pool level under the current FERC license is at elevation 600 ft, below which the powerhouse was expected to have to cease generation for technical reasons related to turbine performance. Preliminary studies indicate that a single turbine-generator unit would be able to operate at reduced loads down to water levels of about 570 ft, and the hollow jet valve in the powerhouse can operate to at least a water surface elevation of 550 ft; therefore, the Districts have designated the new minimum pool to be at elevation 550 ft. The incremental effects on recreation facilities due to changing the minimum pool from elevation 600 ft to 550 ft are limited to the loss of access to the portion of the Don Pedro Reservoir upstream of the old Don Pedro Dam. The Districts would construct a new boat launch facility to be located upstream of old Don Pedro Dam to address the lack of access. Within 18 months of the issuance of the new license, the Districts would file with the Commission for approval the plans, specifications and environmental assessment of the new boat launch.

5.11 Estimated Capital and Annual O&M Cost of New Measures.

The estimated costs (2016 dollars) of each of the measures contained in the Districts' Preferred Plan are provided in Table 5.11-1. Total capital cost of the measures contained in the Preferred Plan is $78 million and estimated annualized O&M cost of the proposed new measures is $2.7 million/year. An implementation schedule is provided in Exhibit C of this AFLA.

5.12 Projected Effects of the Districts' Preferred Plan on Tuolumne River Resources

In this section, the projected effects of the Districts' Preferred Plan on the natural resources of the Tuolumne River and on the water supplies of the Districts and CCSF are evaluated. Also in this section, measures proposed by others or anticipated to be proposed by others are also evaluated and compared to both the Base Case and the Districts' Preferred Plan. Comparisons of all alternatives use the same set of Tuolumne River-specific simulation models developed from the empirical data and studies of the Tuolumne River. In accordance with FERC's criteria for study plan approval, each of the studies undertaken as part of the relicensing process was specifically designed to inform the development of license conditions through the next license term as required by FERC's Study Plan Criteria #5. As described in section 5.3 above, the analytical models allow comparison of alternative scenarios of Don Pedro Project operations to the Base Case and to each other. While the relative differences between alternatives are relevant and meaningful, care must be taken when considering the projected benefits of any individual scenario as the models are not intended to be precise predictions of long-term outcomes.

5.12.1 Projected Effects of the Preferred Plan on Water Supplies and Natural Resources

For purposes of this section, Table 5.12-1 provides a comparison of the required instream flows of the current FERC license (Base Case) with the proposed instream flows contained in the Districts' Preferred Plan.[142] A year-by-year comparison for the period 1971 to 2012 of the required Base Case flows and Preferred Plan instream flows is provided in Appendix E-1, Attachment G.[143] Over the modeling period of record ('71-'12), the Preferred Plan's *required* flows at the La Grange gage are 35% greater than the *required* Base Case flows, increasing from 216 TAF under the Base Case to 291 TAF under the Preferred Plan. The increase in the required minimum flows, which will vary by water year type, ranges from 18% in some wet years to over 80% in some critically dry years.

[142] The Districts' Preferred Plan as described and evaluated in sections 5.12 and 5.13 include installation and operation of the IGs.
[143] As contained in Tables 4 through 7 of the standard model output.

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Table 5.11-1. Annual Capital Cost, O&M Cost, and Estimated Environmental Monitoring Cost (in thousands).

	Year (Y)																														
Resource Protection Measure (RPM)	**Y1[a]**	**Y2**	**Y3**	**Y4**	**Y5**	**Y6**	**Y7**	**Y8**	**Y9**	**Y10**	**Y11**	**Y12**	**Y13**	**Y14**	**Y15**	**Y16**	**Y17**	**Y18**	**Y19**	**Y20**	**Y21**	**Y22**	**Y23**	**Y24**	**Y25**	**Y26**	**Y27**	**Y28**	**Y29**	**Y30**	**Total**
RPM-1 Coarse Sediment Management Program																															
Estimate Capital Cost	-	750	750	750	750	750	750	750	750	750	750	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7,500
Estimate Annual O&M Cost	-	-	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	840
Estimated Environmental Monitoring Cost	-	-	-	-	150	150	150	150	150	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	750
RPM-2 Provide Gravel Mobilization Flows of 6,000 to 7,000 cfs																															
Estimated Capital Cost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Estimated Annual O&M Cost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Estimated Environmental Monitoring Cost	-	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	1,015
RPM-3 Improve Instream Habitat Complexity																															
Estimated Capital Cost	-	500	500	500	500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2,000
Estimated Annual O&M Cost	-	-	-	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	810
Estimated Environmental Monitoring Cost	-	-	-	100	100	100	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	400
RPM-4 Gravel Cleaning																															
Estimated Capital Cost	-	1,200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,200
Estimated Annual O&M Cost	-	-	500	500	500	500	500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2,500
Estimated Environmental Monitoring Cost	-	-	-	70	70	70	70	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	350
RPM-5 Contribute to CB&Ws Efforts to Remove Water Hyacinth																															
Estimated Capital Cost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Estimated Annual O&M Cost	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	1,500
Estimated Environmental Monitoring Cost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Complete Construction of Infiltration Gallery (IG) 1 and Construct IG2																															
Estimated Capital Cost	600	6,200	6,200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13,000
Estimated Annual O&M Cost	-	-	-	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	8,100
Estimated Environmental Monitoring Cost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RPM-6 Construct Fish Counting and Barrier Weir																															
Estimated Capital Cost	500	500	5,500	5,500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12,000
Estimated Annual O&M Cost	-	-	-	-	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	7,280
Estimated Environmental Monitoring Cost	-	-	-	-	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	7,800
RPM-7 Predator Control and Suppression																															
Estimated Capital Cost	-	150	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	150
Estimated Annual O&M Cost	-	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	3,625
Estimated Environmental Monitoring Cost	-	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	2,030
RPM-8 Superimposition Reduction Program																															
Estimated Capital Cost	-	1,400	-	-	-	-	-	-	-	-	-	1,400	-	-	-	-	-	-	-	-	-	1,400	-	-	-	-	-	-	-	-	4,200
Estimated Annual O&M Cost	-	-	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	1,120
Estimated Environmental Monitoring Cost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fall-run Chinook Salmon Restoration Hatchery																															
Estimated Capital Cost	1,000	17,500	17,500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	36,000
Estimated Annual O&M Cost	-	-	-	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	-	-	-	-	-	-	-	20,000
Estimated Environmental Monitoring Cost	-	-	-	-	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	-	-	-	-	-	-	-	5,700

Resource Protection Measure (RPM)	Year (Y)																														Total
	Y1[a]	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	Y25	Y26	Y27	Y28	Y29	Y30	
Resource Management Plans																															
Estimated Capital Cost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Estimated Annual O&M Cost	-	-	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	4,900
Estimated Environmental Monitoring Cost	-	-	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	4,900
Historic Properties Management Plan																															
Estimated Capital Cost	50	350	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	350
Estimated Annual O&M Cost	-	270	270	270	270	270	270	270	270	270	270	270	270	270	270	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,780
Estimated Environmental Monitoring Cost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Recreation Resource Management Plan																															
Estimated Capital Cost	167	1,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,167
Estimated Annual O&M Cost	-	307	307	307	307	307	-	-	-	-	-	-	-	-	-	-	307	307	307	307	307	-	-	-	-	-	-	-	-	-	3,070
Estimated Environmental Monitoring Cost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Totals (In Thousands)	
Capital	77,567
O&M	57,525
Environmental Monitoring	22,945
Annualized	
Capital	3,900
O&M	1,900
Environmental Monitoring	760
Total Annualized Cost	6,560

[a] Year one after license issuance. Capital costs for Y1 expenditures are for permitting and design.

Table 5.12-1. Base Case and Districts' Preferred Plan required minimum instream flows by WY type.

	Units	Critical[1]			Dry[2]			Below Normal[3]			Above Normal			Wet		
		Base Case at La Grange	Preferred Plan at La Grange	Preferred Plan at RM 26	Base Case at La Grange	Preferred Plan at La Grange	Preferred Plan at RM 26	Base Case at La Grange	Preferred Plan at La Grange	Preferred Plan at RM 26	Base Case at La Grange	Preferred Plan at La Grange	Preferred Plan at RM 26	Base Case at La Grange	Preferred Plan at La Grange	Preferred Plan at RM 26
Early Summer 6/1-6/30	cfs	50	200	75	75	200	75	75	200	100	250	200	100	250	200	100
Late Summer 7/1-10/15	cfs	50	300	75	75	300	75	75	350	150	250	350	150	250	350	150
Flushing Pulse (10/1-10/15)	ac-ft	0	0	0	0	0	0	1736	5950	5950	5950	5950	5950	5950	5950	5950
Chinook Spawning Flow 10/16-12/31	cfs	150	200	200	150	225	225	175	275	275	300	275	275	300	275	275
Chinook Fry Rearing 1/1-2/29	cfs	150	175	175	150	200	200	175	225	225	300	225	225	300	225	225
Chinook Juv Rearing 3/1-4/15 *O.mykiss* Spawning	cfs	150	200	200	150	225	225	175	250	250	300	250	250	300	250	250
Chinook Rearing-Outmigration *O.mykiss* Fry Rearing 4/16-5/15	cfs	150	200	200	150	250	250	175	250	250	300	275	275	300	275	275
Chinook Outmigration 5/16-5/31 *O.mykiss* Fry Rearing	cfs	150	225	225	150	275	275	175	300	300	300	300	300	300	300	300
Chinook Outmigration Apr-May	TAF	11	35/11[4]	35/11[4]	37	75/45[4]	75/45[4]	60	100	100	90	150	150	90	150	150

[1] Under Base Case, critical flow requirements are taken as "critical below normal"
[2] Under Base Case, dry flow requirements are taken as "median dry"
[3] Under Base Case, below normal is taken as "median below normal"
[4] To provide water supply protection in extended droughts. In sequential Critical WYs, the required outmigration pulse flow is reduced from 35 TAF to 11 TAF. In sequential Dry WYs, it is reduced from 75 TAF to 45 TAF. Any combination of "C" and "D" WYs also result in pulse flow reductions. For example, in a six-year sequence of C-D-C-D-C-D WYs, the second and third "C" and "D" WYs would have reduced pulse flows.

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5.12.2 Districts' Proposed Plan's Effects on Water Supplies

Section 5.3 above provides a summary of the analytical tools and models developed by the Districts as part of the relicensing process to evaluate alternative scenarios of future operations of the Don Pedro Project.

The Tuolumne River Operations Model depicts the hydropower and water supply operations of the Districts and the water supply operations of the CCSF Hetch Hetchy water supply system. CCSF financially participated in the construction of the new Don Pedro Project in return for securing water banking privileges of 570 TAF[144] in the new reservoir. Using the hydrology experienced from 1971 to 2012, the Operations Model compares existing water supply conditions (Base Case) to projections of available water supplies and water supply impacts to both the Districts' and CCSF's customers under alternative future Project operation scenarios.

The standard output of the Operations Model consists of the following information in sequence:

- Narrative "Summary of Scenario"
- Table 1. Don Pedro Generation by Month in MWh
- Table 2. TID and MID Canal Water Deliveries for each year of the '71-'12 period
- Table 3. SFPUC Water Supply and San Joaquin Pipeline Deliveries to Bay Area for each year of the '71-'12 period
- Figure 1. Don Pedro Reservoir Volume and Total TID and MID Canal Shortages
- Figure 2. Hetch Hetchy Total System Storage, Water Bank Storage, and Total San Joaquin Pipeline (SJPL) Shortages
- Table 4. Flows at La Grange gage for each year of the '71-'12 period
- Table 5. February - June Flows at La Grange gage for each year of the '71-'12 period
- Table 6. Flows below RM 26 (below IGs) for each year of the '71-'12 period
- Table 7. February - June Flows below RM 26 (below IGs) for each year of the '71-'12 period

Each of the tables and figures provided by the Operations Model output described above depicts the comparison of the Base Case and the scenario being analyzed and, except for Table 1, show each year of the 1971 to 2012 period. Analyzing each year of the 1971 to 2012 period is necessary to understand the impacts of each scenario on the Districts' and CCSF's water supplies during normal and, especially, dry hydrologic periods. A number of additional tables and plots are provided with each scenario's model output summarizing flow magnitude and duration occurring by year and the river temperatures at a number of locations along the lower Tuolumne River for the Base Case and the scenario as depicted by monthly temperature duration curves.

Planning for drought conditions is at the core of water supply system design and water supply impact analysis. Considering water supply impacts by comparing "*average*" annual water

[144] This can be increased to 740 TAF during certain annual time periods (see Exhibit B of the AFLA).

supply effects over the long-term has little meaning or value if reliable water supplies are not available during extended droughts. A single extended drought can have catastrophic and irreversible effects on local and regional economies and on affected jobs, populations, communities, and businesses. Properly designed water supply projects have to be able to deliver reliable water supplies during drought and extended drought conditions. The nut and fruit orchards, the dairy farm operations, and the food processing industries that dominate the agricultural economy of the Districts' service areas and account for a substantial percent of the areas employment, are long-term investments which require reliable and sufficient water supplies year after year in normal and drought conditions. The commercial and industrial sectors in the Bay Area served by the CCSF Hetch Hetchy water system also require reliable water supplies. CCSF's Hetch Hetchy system serves 85% of the water supply to CCSF's customers and innumerable business and industrial concerns in the Bay Area. Therefore, the effects of the Districts' Preferred Plan, as well as alternative scenarios provided by others, are examined by how they impact water supplies during drought conditions. In the 1971 through 2012 period, the longest drought occurred in the six-year period extending from 1987 through 1992.[145]

The Districts' Preferred Plan, consisting of an integrated program of flow and non-flow measures, was developed through the application of the Tuolumne River empirical data collected, compiled, and analyzed through the relicensing process. The Districts are responsible for the protection of the water supply benefits of the Don Pedro Project and are acutely aware of the importance of water supplies to the economic health and well-being of the Central Valley communities they serve. The PM&E measures of the Preferred Plan, presented previously in this section, demonstrate that the dual goals of protecting water supplies and promoting healthy fisheries in the Tuolumne River are achievable through the application of the large body of scientific data and information available for the Tuolumne River.

The assessment of the effects of the Districts' Preferred Plan on water supplies over the 1971 through 2012 period, and, more importantly, the 1987 through 1992 period, is provided in Appendix E-1, Attachment G. Compared to the Base Case, the Preferred Plan provides a 35% increase, on average, in the required instream flows as measured at the La Grange gage. During the 1987 through 1992 drought period, the Preferred Plan provides a 55% increase in instream flows over the Base Case. The potential adverse effects to the Districts' water supplies of the increase in minimum instream flows are partially mitigated by the summer time (June through mid-October) operation of the two infiltration galleries at RM 25.9. The installation and seasonal operation of the two IGs contained in the Districts' Preferred Plan change the average required instream flow from 291 TAF to 242 TAF as measured at the IGs downstream of RM 25.9 over the '71 to '12 period. The Preferred Plan's minimum instream flows of 242 TAF as measured below the IGs represents an average annual flow increase of 12% over the Base Case. During the 1987 through 1992 drought period, the Preferred Plan's increase in instream flow is 8% over the Base Case as measured at RM 25.9.

Related to water supplies during the critical drought period of '87 to '92, under Base Case conditions, the Districts' water supplies in each of four consecutive years ('88-'91) experience a 12% shortage of water, and a 23% shortage the following year ('92). Under the Preferred Plan,

[145] Since 1901, other severe droughts occurred from 1924-1934, inclusive, in which there were five "C", two "D", two "BN", and two "AN" water years, and 1959-1964, inclusive, in which there were two "C", two "D", one "BN" and one "AN" water years.

the shortage would increase to 13% in each of the years ’88-’91 and increase to 27% in ’92. As depicted in Table 5.12-1, the Districts’ Preferred Plan also protects water supplies during sequential dry years by including a pulse flow of 11 TAF in sequential “critical” years and 45 TAF in sequential “dry” years, as compared to the first “C” or “D” pulse flow of 35 TAF and 45 TAF, respectively.[146] Multiple years of sequential water shortages have significant impact on the local communities and economies of the Districts’ service territories, as further discussed below in section 15.4.3, Socioeconomic Impacts.

Under the Districts’ Preferred Plan, with CCSF contributing 51.7% of required instream flows above the Base Case, water supplies to the Bay Area would also experience additional shortages over and above the Base Case shortages during the ‘87 to ’92 drought.[147] Under the Base Case, CCSF’s total water supply shortages to its Bay Area customers would be 10% in each of the years ’88 through ’92. Additionally, 10% shortages would occur in ’77. Under the Districts’ Preferred Plan, water shortages to CCSF customers would be 10% in ’88 and ’89, but increase to 15% in ’90, ’91, and ‘92. All other years would remain the same as the Base Case. These levels of annual and sequential water shortages are likely to affect the Bay Area economy and communities.

According to the most recent projections of water demand for the CCSF service territory, the expected demand for water will increase from the current 238 million gallons per day (mgd) to 265 mgd by the year 2040,[148] which is less than half-way through the potential term of the new FERC license for the Don Pedro Project. Using the projected 2040 demand for water, CCSF Bay Area customers would experience increased water shortages under the Districts’ Preferred Plan (see Appendix E-1, Attachment H-9). Under the Base Case, CCSF’s total water supply shortages to its Bay Area customers would be 10% in each of the years ’88 and ’89 and 20% in ’90, ’91, and ’92, as well as 10% in ’76 and ’07 and 20% in ‘77. Using the projected demand in 2040 of 265 mgd, total water supply shortages to CCSF’s Bay Area customers under the Preferred Plan would be 10% in ’87 and 20% in ’88 with other shortages remaining the same.

5.12.3 Districts’ Preferred Plan’s Effects on Resources

The resources of the lower Tuolumne River have been intensively studied over the last twenty years, following the full implementation of the flow measures contained in the ’95SA. Over two dozen additional studies of the lower Tuolumne River environment have been completed in just the last six years as part of the Don Pedro and La Grange licensing processes. Each of these studies contributes to the knowledge base regarding the existing condition and the factors affecting the natural resources in the study area. Considering and understanding these empirical data provide the best opportunity to improve the target fishery species of the lower Tuolumne River, while also protecting the substantial resource values associated with the Don Pedro

[146] This reduced pulse flow, while still greater than or equal to Base Case pulse flows, would also occur in a sequence of “D” and “C” years. For example, in a sequence of the years C, D, C, D, C, D, the second and third “critical” years and the second and third “dry” years would each have pulse flows of 11 TAF and 45 TAF, respectively.

[147] As discussed previously in this AFLA, based on the current Side Agreement between the Districts and CCSF, the Operations Model provides for 51.7% of any instream flows above the Base Case to be allocated to CCSF. See also, Exhibit B, pg 2-4, reference to Article 8 of the Fourth Agreement.

[148] As reported by CCSF in its comments to the SWB’s Draft SED in Appendix 3: Bay Area Socioeconomic Impacts Resulting from Instream Flow Requirements for the Tuolumne River.

Reservoir. For the lower Tuolumne River (i.e., RM 52 to confluence), the primary focus of resource management by resource agencies continues to be placed on the protection and improvement of conditions for fall-run Chinook salmon and *O. mykiss*. For the reservoir area, resource management concerns include cultural, terrestrial, shoreline and recreation resources. In this section of the AFLA, the effects of the Districts' Preferred Plan on lower Tuolumne River resources are evaluated first, followed by effects on reservoir-related resources.

5.12.3.1 Preferred Plan's Effects on Resources of the Lower Tuolumne River

The evaluation of the effects to the lower Tuolumne River of the Districts' suite of proposed PM&E measures contained in the Preferred Plan encompasses effects to fall-run Chinook salmon, *O. mykiss*, and river recreation. While flows and water temperatures in the lower Tuolumne River have been raised as concerns, the primary concern regarding both are related to the effects of flows and temperature on fall-run Chinook salmon and *O. mykiss*. Flows and temperatures are input parameters to the respective fish population models; therefore, the effects of Tuolumne River flows and temperatures on these species are explicitly incorporated in the results of the population models.[149] Neither flow nor temperature is an end unto itself, but a means to end; that is, protection of native salmonid species. Changes in river temperatures compared to the Base Case are provided in the model output for each alternative scenario of future Project operations.

As a preface to the evaluation of the measures contained within the Districts' Preferred Plan, it is important to consider and understand the cumulative effects of past, present and continuing activities on the target fisheries, and how these activities, many of which are not related to the operation of the Don Pedro Project, all contribute to the condition of the existing fishery resources.

Legacy in-channel and floodplain mining of gold and gravel have left a reconfigured and restructured river and floodplain along the lower Tuolumne River. The main river channel contains a number of deep and elongated pools, termed "special-run pools" (SRPs) and "run-pools", which affect river hydraulics, geomorphology, and floodplain inundation and configuration. Large numbers of predatory non-native species, primarily black bass, which feed on young salmonids, now find these SRPs to be favorable habitat. Floodplains along much of the river have been, and continue to be, substantially modified by gravel operations, levee construction, urban development, and agricultural use. Escapement of hatchery strays to the Tuolumne River have increased in numbers, to the point where the Tuolumne River's fall-run Chinook population is predominantly hatchery strays which lack fidelity to spawning areas in their natal river. Water resource development of the Tuolumne River by the Districts and CCSF have also played a role in bringing changes to the lower Tuolumne River. This includes their role in water supply and in Don Pedro's role in providing flood control benefits acquired by the Army Corps of Engineers (ACOE) to reduce flooding along the Tuolumne and the San Joaquin rivers.

[149] See W&AR-05, -06, and -10.

The sum of all these factors produces what can only be characterized as a "*highly modified river*."[150] Only by realistically taking into account the existing river environment and all of the in-river factors known to be affecting the fisheries resources can a plan of protection and improvement be implemented with a reasonable expectation of achieving success. The fisheries literature over the last 10-15 years contains numerous examples of the value of targeted flows designed to address critical life stages and biological needs of fish residing in altered river environments.[151] The Districts' Preferred Plan combines the concept of biologically-designed flows with the empirical data and information collected on the lower Tuolumne River to provide an applied science basis to protect and improve lower river fisheries. While a number of alternative hypotheses of how to manage the salmonid species of the lower river may be popular or intended to achieve some other goal, alternative resource management concepts must demonstrate support within the body of empirical evidence compiled for the Tuolumne River.

5.12.3.2 Effects of the Preferred Plan on Fall-run Chinook Salmon

Estimates of the effects of the Districts' Preferred Plan on fall-run Chinook salmon in the Tuolumne River are developed by incorporating into the in-river Chinook population model the changes proposed to occur under the Districts' Preferred Plan. Each element of the Preferred Plan that represents a change to the existing Base Case conditions is input as a change to the relevant parameter(s) in the model. For example, the gravel augmentation plan included in Preferred Plan will provide improved egg survival-to-emergence, estimated to increase from the current 32% survival under existing conditions to 50% for new gravels.[152] Gravel cleaning provides a boost in egg survival-to-emergence of fry on the order of 40% compared to 32% estimated by emergence trapping studies. The combined effects to in-river fall-run Chinook salmon productivity of the flow and non-flow measures contained in the Districts' Preferred Plan are shown in Figure 5.12-1. At the level of 2,000 female spawners, the Districts' Preferred Plan would produce over 2½ times more smolts per female spawner than the Base Case.

As described previously, the Tuolumne River fall-run Chinook population model is developed from empirical data produced by the large number of studies and investigations undertaken over the last twenty-plus years, including the most recent relicensing-related studies. The in-river population model is able to estimate the effects of individual flow and non-flows measures which can be defined numerically. In Figure 5.12-2, the effects of the individual measures of the Preferred Plan are shown separately and also as the entire Preferred Plan. The model results indicate the Districts' Preferred Plan will substantially increase the production of fall-run Chinook salmon on the Tuolumne River compared to existing conditions for both the case of 2,000 female spawners and 10,000 female spawners.

[150] Yarnell et al. (2015)

[151] See for example Richter et al. 1996, Yarnell et al. 2015, Kiernan et al. 2012. Also see Districts' response to SWB's Draft SED, "Joint Comments", Table TR-1 of Attachment 1.

[152] Parameterization of the fall-run Chinook and *O. mykiss* population models is discussed and presented in W&AR-05, W&AR-06, and W&AR-10 study reports.

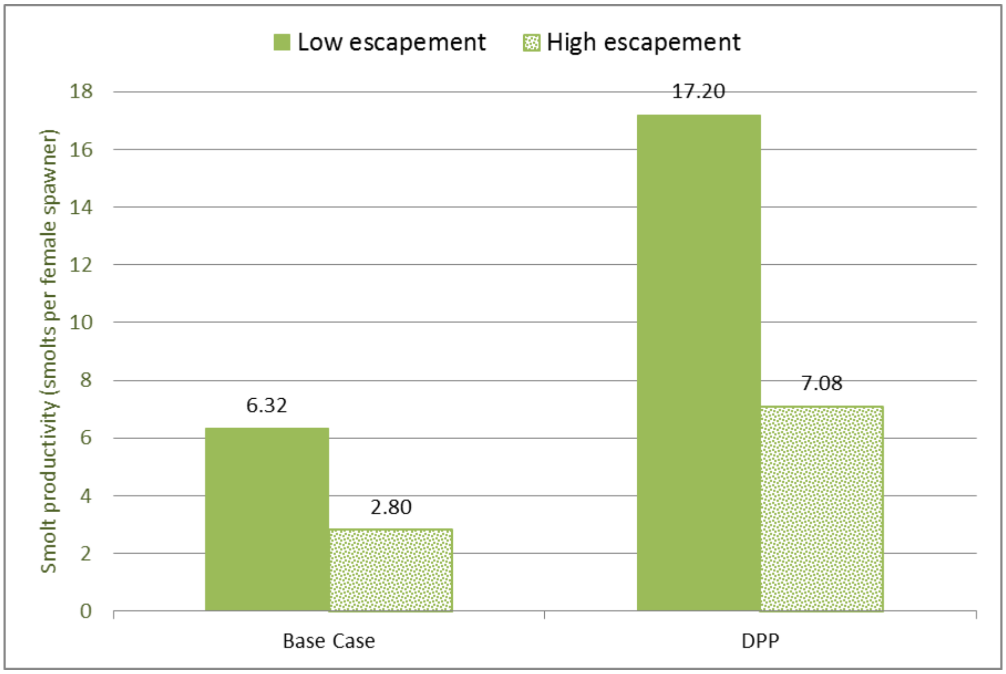


Figure 5.12-1. Overall effects to fall-run Chinook salmon productivity of Districts' Preferred Plan compared to the Base Case measured as smolts per female spawner at two escapement levels: low density (2,000 female spawners) and high density (10,000 female spawners), expressed as the geometric mean for WYs 1971-2012.

For discussion purposes in the sections below, the case of 2,000 female spawners is presented because this reflects more closely the present escapement levels. The significant increase in fall-run Chinook salmon production in the Tuolumne River is the result of addressing the specific needs of Tuolumne River fall-run Chinook population with the greatest improvement being attributable to the Districts' predator control and suppression measures and the least to the flow measures, even with flows being near optimum during spawning and through the juvenile growth periods. Including the April/May pulse flows, the Preferred Plan's minimum instream flows in the critical February through June period, on average, are over 30% greater than Base Case flows,[153] and yield a 9% increase in smolt productivity. The relationship between flow and smolt survival was developed directly from years of RST data collected on the Tuolumne River at the Waterford and Grayson RSTs.

As shown in Figure 5.12-2, gravel augmentation, in and of itself when fully implemented to the level defined in the Preferred Plan, is expected to increase smolt productivity by almost 40% over Base Case conditions from 6.32 to 8.72 smolts per female spawner. The largest improvement to smolt productivity results from predator control measures.

[153] See Appendix E-1, Attachment G, Table 5.

Figure 5.12-2. **Tuolumne River smolt productivity under the Base Case and Districts' Preferred Plan (DPP) assuming 10,000 female spawners (top) and 2,000 female spawners (bottom).**[154]

The modest reduction in predator populations, 20% above the barrier weir (due to exclusion of striped bass and long-term elimination of smallmouth bass) and only 10% below the barrier weir,

[154] Each non-flow measure is examined under both the Base Case flow regime (first bar) and the Preferred Plan flow regime (second bar). For example, the gravel augmentation measure when considered just under the Base Case flows increases smolt productivity from 6.32 to 8.72 smolts per female spawner. When combined with the Preferred Plan flow regime, the increase is to 9.36 smolts per female spawner.

yields an 70% increase in smolt productivity under the Base Case flow regime from 6.32 to 10.89 smolts per female spawner. Under the Preferred Plan's flow regime, the increase is 80% compared to the Base Case, reflective of the very significant impact predation has on Tuolumne River fall-run Chinook salmon.

Analysis of RST data (Robichaud and English 2013; Robichaud and English 2017) suggests a relationship between the occurrence of pulse flows and increased smolt survival. The timing of pulse flows either to help trigger smolt outmigration or to coincide with large numbers of smolts being ready to volitionally outmigrate may increase the biological value of pulse flows beyond what is able to be estimated by the population model. The full value of pulse flows is difficult to test in the Chinook salmon population model because the pulse volume is input as a flow over the same time frame in each year of the 42-year model. Typically, model simulations are run first to establish emigration timing based on spawner timing. A second simulation is run to center the pulse flow on the peak outmigration. In practice, real time data on the status of fall-run Chinook juveniles, as well as predators, in the Tuolumne River would help to increase the biological benefit of pulse flows. This potential benefit of using real time information to maximize the value of the Preferred Plan's pulse flows is the basis for the Pulse Flow Adaptive Management Plan provided herein at Appendix E-1, Attachment F.

As presented in the USFWS' *Final Restoration Plan for the Anadromous Fish Restoration Program* (USFWS 2001), the goal set forth under the AFRP was a doubling of the natural production of anadromous fish populations of the Central Valley. Although the basis for the "doubling goal" has been shown to contain statistical errors,[155] resource agencies continue to place importance on the "doubling goal" for the management of fall-run Chinook populations. Under the Preferred Plan, in-river smolt productivity is estimated to more than double when compared to the Base Case.

5.12.3.3 Effects of the Preferred Plan on *O. mykiss*

For reasons discussed in reports W&AR-05 and W&AR-10, population modeling of *O. mykiss* on the Tuolumne River focused on modeling the resident form of *O. mykiss*. There is not a steelhead run on the Tuolumne River; therefore, reliable empirical data on the seasonal behavior of steelhead on the Tuolumne River are not available. Data are available on the local population of resident *O. mykiss*, and these data were used in the development of the *O. mykiss* population model. With the assumption that any steelhead in the Tuolumne River would be expected to benefit from measures affecting resident *O. mykiss*, the results of *O. mykiss* population modeling under the Base Case and the Districts' Preferred Plan at two population levels are shown in Figure 5.12-3 and 5.12-4. Population effects to *O. mykiss* were evaluated for both juvenile life stage (young-of-the-year per spawner, or YOY) and the adult life stage (by adult replacement rate).

[155] In 2004, the USFWS contracted for an independent methods review for procedures needed to reliably detect attainment of the doubling goal in California's Central Valley (Newman and Hankin 2004). Newman and Hankin (2004) found numerous statistical errors in the original Mills and Fisher (1994) estimates of long-term average populations. The review suggested that the magnitude of errors of existing point estimates of natural production in California's Central Valley during the period of 1967–1991 and since 1992 may be very large and have not been properly estimated.

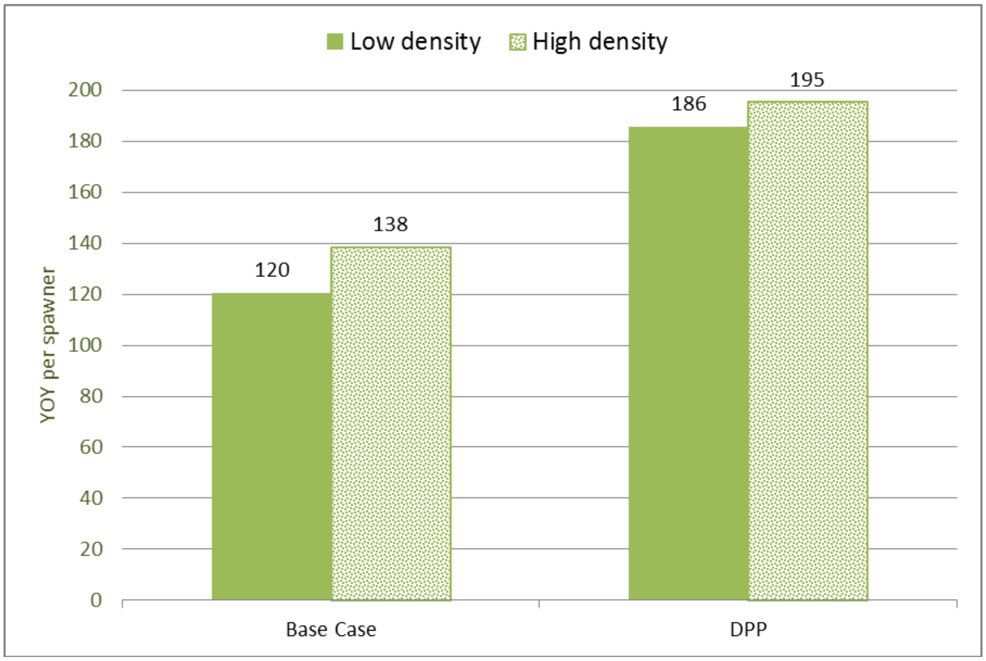


Figure 5.12-3. Effects of the Preferred Plan on Tuolumne River O. mykiss juveniles measured as YOY per spawner at two population levels: low density (500 adults) and high density (10,000 adults).

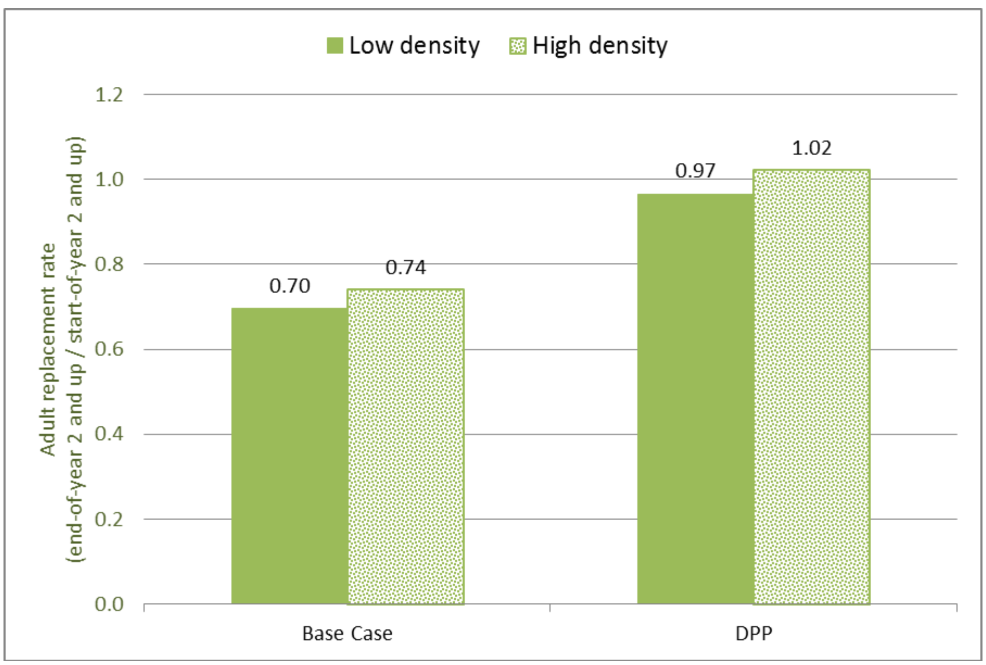


Figure 5.12-4. Effects of the Preferred Plan on Tuolumne River O. mykiss adults measured as adult replacement rate at two population levels: low density (500 adults) and high density (10,000 adults).

Implementation of the flow and non-flow measures of the Districts' Preferred Plan would result in a 55% increase in YOY *O. mykiss* and a 39% increase in adult replacement rate at the population level of 500 adults and 41% and 38% increase, respectively, at a population level of 10,000 adults.

The *O. mykiss* population model evaluated the effects of the individual measures contained in the Districts' Preferred Plan and the results are shown in Figures 5.12-5 and 5.12-6 below. As measured at the La Grange gage, the Preferred Plan provides a 50% increase in the minimum instream flow in the critical March through September period when compared to the Base Case.[156] The model results indicate the 50% increase in flows under the Preferred Plan would have a negligible effect on YOY per spawner at the level of 500 resident adults, but a 37% increase in adult replacement rate. However, the Preferred Plan's measures to improve gravel quantity and quality provide a substantial improvement in YOY per spawner, combining to produce a 40% increase when fully implemented from 123 YOY per spawner to 172 YOY per spawner (at a population level of 500 adults).

At higher population levels as shown in Figure 5.12-5, the benefits of the Preferred Plan's increased flow on YOY per spawner become marginally better with the 50% increase in flow providing just greater than a 10% increase in YOY per spawner (from 138 to 154 YOY per spawner). At higher population levels, the 50% increase in minimum flows increases adult replacement rate by just under 40% compared to the Base Case (from 0.74 to 1.02; Figure 5.12-6). Based on the Tuolumne River data, *O. mykiss* appear less vulnerable to predation than fall-run Chinook salmon.

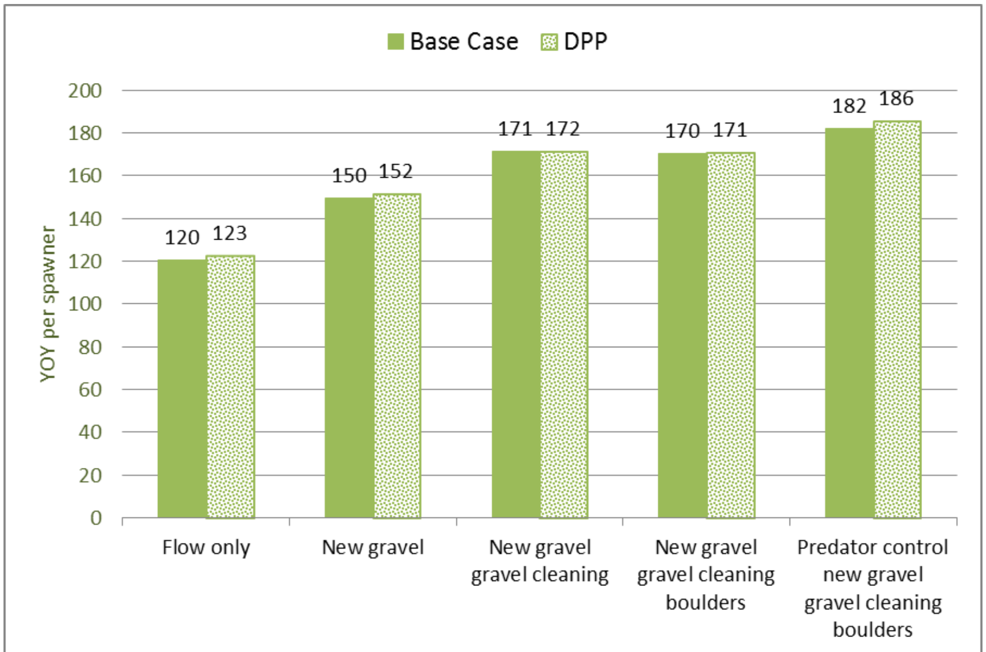
Overall, at a population level of 500 adult fish, the Preferred Plan's 50% increase in required instream flow when combined with the Preferred Plan's non-flow measures is estimated to increase *O. mykiss* juvenile production by 55% from 120 to 186 YOY per spawner (Figure 5.12-5), and the adult replacement rate by 39% from 0.70 to 0.97 (Figure 5.12-6). At a population level of 10,000 adult fish, the Preferred Plan is estimated to increase *O. mykiss* juvenile production by 41% from 138 to 195 YOY per spawner and the adult replacement rate by 38% from 0.74 to 1.02.

5.12.3.4 Effects of the Preferred Plan on River Recreation

The lower Tuolumne River currently supports shoreline fishing at publicly accessible locations, swimming in the City of Modesto's urban settings around RM 16, and canoe and kayak boating opportunities using public put-ins and take-outs, with the reaches above RM 26 being more popular for boating.

River fishing from motorized craft also occurs primarily above RM 26. Motorized boating use is generally limited to small craft. Overall boating use is relatively light, and organized commercial boating is infrequent.

[156] The March through September average required minimum flow for the 1971 to 2012 period is 144 TAF under the Base Case and 217 TAF under the Preferred Plan as measured at the La Grange gage.



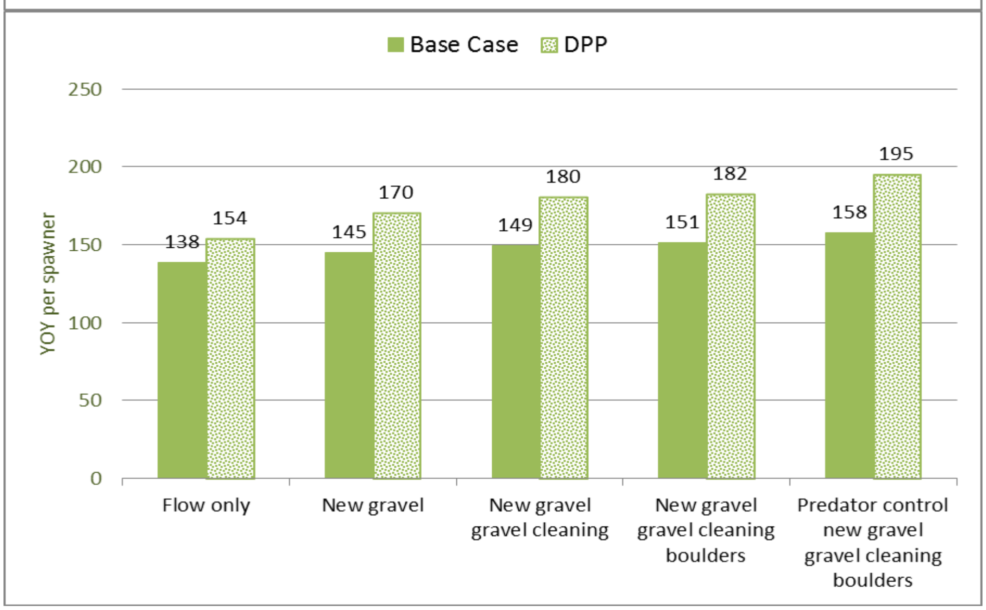


Figure 5.12-5. Effects of the Districts' Preferred Plan on Tuolumne River O. mykiss YOY compared to the Base Case at a population level of 500 adults (top) and 10,000 adults (bottom).

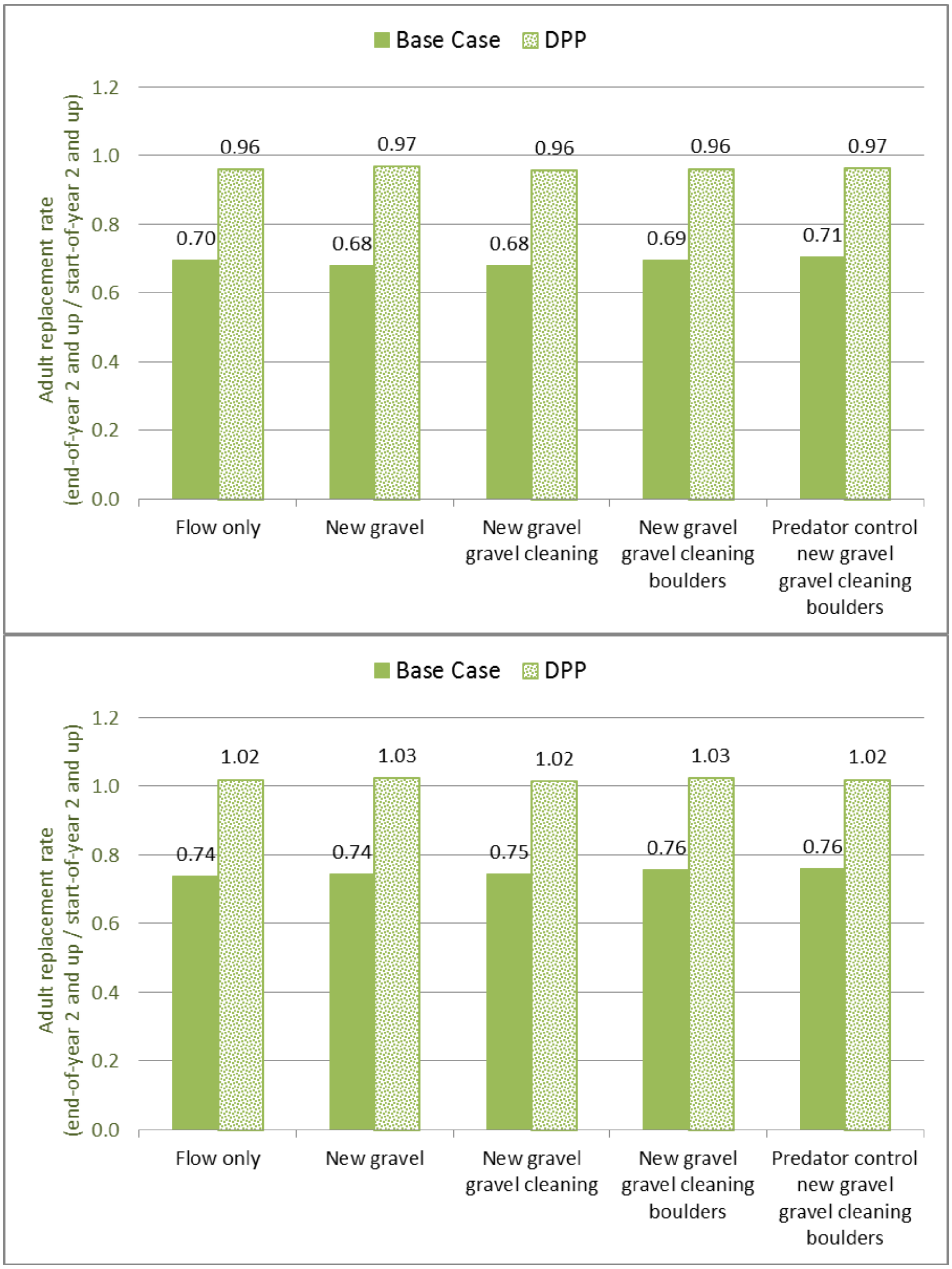


Figure 5.12-6. Effects of the Districts' Preferred Plan on Tuolumne River *O. mykiss* adult replacement rate compared to the Base Case at a population level of 500 adults (top) and 10,000 adults (bottom).

A boating study of the lower river intended to identify the lowest flow that would be boatable by non-motorized craft, primarily canoe and kayak, found that a flow of 200 cfs supports non-motorized craft. Pre-scheduled, announced releases of specific boatable flows do not presently occur, but flows being recorded by the USGS gages at La Grange and Modesto are available through the internet and the Districts publish and file with FERC the planned minimum flows for the entire subsequent 12-month period by April 15 of each year.

To promote and improve the use of the lower Tuolumne River for recreational, non-motorized craft, the Districts' Preferred Plan includes a substantial increase in *pre-scheduled* releases for recreational boating. These are enumerated below:

- April 1 to May 31
  - Boatable flow of 200 cfs or greater as measured at La Grange gage provided in all water years for the lower Tuolumne River from RM 52 to RM 0. Under Base Case, scheduled boatable flows would occur in 50% of the years.
- June 1 to June 30
  - Boatable flow of 200 cfs or greater as measured at La Grange gage occurs in all water years from RM 52 to RM 25.7, compared to 50% of the water years under the Base Case.
  - In W, AN, and BN, cease IG withdrawal for one pre-scheduled weekend in June to provide boating opportunity below RM 25.5.
- July 1 to October 15
  - Provide boatable flow of at least 325 cfs as measured at the La Grange gage in all water years from RM 52 to RM 25.7.
  - In all but C WYs, provide a boatable flow of 200 cfs below RM 25.7 for 3 days on the July 4th holiday, for the three-day Labor Day holiday, and for two pre-scheduled additional weekends in either July or August.

In addition, a new take out-put in facility for non-motorized craft would be provided along with day-time picnic facilities at RM 25.5 (as part of the fish counting and barrier weir). Promoting boating, especially upstream of the barrier weir and infiltration galleries, complements actions proposed to increase fishing and fishing opportunity for non-native and native predator species in the upstream reaches containing the preferred habitat for salmon and *O. mykiss* fry and juvenile rearing. The availability of viewing adult migrating salmon is a popular activity at many dams equipped with fishways with viewing windows. The Districts would set aside scheduled times for such viewing at the Fish Counting and Barrier Weir.

5.12.4 Effects of Preferred Plan on Don Pedro Reservoir Resources

In addition to the Don Pedro Project's water supply benefits, emissions-free hydropower production, and flood control benefits, the natural resources supported and protected within and along the Don Pedro Reservoir are substantial and varied, encompassing aquatic, terrestrial, cultural, and recreation resources. With a total shoreline of 106 miles being either in the fee title ownership of the Districts or federal lands, over 90% of the reservoir shoreline is undeveloped. Except for those areas specifically dedicated to organized recreation activities, shoreline management practiced by the Districts prohibits development within its lands and has served to discourage direct development along the shoreline by its stringent shoreline access policies. The Districts' studies during relicensing have provided an in-depth understanding of the areas resources and informed protection and enhancement measures, as discussed by resource area below.

5.12.4.1 Cultural Resources

Perhaps the most intensely studied of any resource area, the Districts undertook a multi-year investigation of the cultural and historical resources within the current Don Pedro Project Boundary. These studies were carried out with close coordination and cooperation with local tribal interests who were actively engaged in the planning and conduct of the entire investigation. The resulting findings and report led to the development of a Historic Properties Management plan (HPMP) containing detailed recommendations for the protection of cultural resources over the next license term and an educational program promoting the cultural history of the Don Pedro region. The HPMP has been submitted for approval of the State's historic and cultural resources office, BLM, and FERC.

5.12.4.2 Terrestrial Resources

The Districts' studies included investigations of botanical, wildlife, and wetland-related resources, including special-status and federally-listed species. Applying the most recent information gained on the existing condition of these resources, the Districts have developed management plans tailored to the protection and continued monitoring of individual species with site-specific actions. Specific resources to be protected and monitored include bald eagles, bats, western pond turtle, and Valley elderberry longhorn beetle. Additionally, the Districts have developed management plans specific to fire prevention and response, hazardous materials, and aquatic invasive species; each of these plans will benefit terrestrial resources within the Project Boundary during a new license term for the Don Pedro Project. Scheduled and frequent shoreline monitoring carried out by trained DPRA staff will ensure protection for the undeveloped 90% of the reservoir shoreline and will rapid response to any unauthorized disturbance.

5.12.4.3 Recreation Resources

The Don Pedro Reservoir has historically provided about 400,000 visitor days of recreation per year. Recreational opportunities are numerous and range from shoreline tent camping to group picnicking to fishing to house boating and skiing. The overwhelming majority of recreational opportunities provided at Don Pedro Reservoir are also affordable, making available recreation opportunities to all. While the reservoir's primary purpose continues to be providing reliable water supplies, the Districts' Operations Modeling results demonstrate that reservoir levels under the Preferred Plan compare favorably to the Base Case. The Preferred Plan includes the implementation of the Don Pedro Recreation Resource Management Plan provided with this AFLA. The Preferred Plan also includes the design and construction of a new whitewater take-out facility at the Ward's Ferry Bridge to relieve the congestion on Ward's Ferry Bridge caused by the almost simultaneous arrival of numerous whitewater trips which take advantage of the CCSF's Holm powerhouse hydro peaking flows.

5.12.4.4 Resource Management Plans Protective of Federal Lands

Public lands within the Don Pedro Project Boundary fall under the administration of the BLM, including a portion of the Red Hills Area of Critical Environmental Concern (ACEC). BLM carries out a number of resource management activities on the federal lands under its administration in the Sierra Resource Management unit. The Districts' Terrestrial Resource Management Plans include management, monitoring, and reporting components that provide for protection of terrestrial resources within the Project Boundary, including BLM lands. Individual plans are provided in Attachment C of this AFLA.

5.13 Effects of Districts' Preferred Plan on Cost of Power

The estimated capital and annual costs of the measures contained in the Districts' Preferred Plan are summarized in Table 5.11-1. The Don Pedro Project's average annual power production from 1997 through 2016 was approximately 550,000 MWh. The average cost of power production in 2016 was estimated to be $9.3 million, including costs of recreation management by DPRA and annualization of capital cost. The current annual cost of power is therefore estimated to be $16.91/MWh. In accordance with California Health and Safety Code (38500-38599), Don Pedro hydropower generation does not qualify towards meeting TID's or MID's 33% RPS standard established in CA. At a cost of roughly $7/MWh, the cost of hydropower generation at Don Pedro in 2016 is therefore $23.91/MWh. Including the annualized cost of the Preferred Plan's measures ($6.6 million), the estimated future average annual cost would increase from $9.3 million to $15.9 million. The estimated cost of power is therefore estimated to be $35.90/MWh, inclusive of the $7/MWh for the RPS penalty.

5.14 Evaluation of Alternatives Proposed by Others

5.14.1 Management Plans and Non-Flow Measures Proposed by Others

The great majority of the comments received on the Don Pedro DLA were general in nature, and did not propose specific resource PM&E measures. Many suggestions are made that appear to be opinions because there is little to no supporting evidence included to support the need for or benefit of the measure. The AFLA does not address ideas, general concepts, or statements of disagreement with studies that lack evidence or information that can be evaluated. Specific measures not directly involving flow have been put forth by the BLM, USFWS, the Lower Tuolumne Farmers, and whitewater boating interests. Comments on the DLA that proposed the Districts undertake general, non-specific improvements are addressed in the Districts' Response to DLA Comments in this AFLA.

5.14.1.1 BLM Proposed Management Plans

BLM has recommended a total of 16 separate management plans be adopted for protection and use of BLM-administered lands in the Project Boundary, including terrestrial, recreation, and cultural resources. The Districts' Preferred Plan includes adoption of 12 of these, either as stand-alone plans or components of larger plans addressing multiple resources (e.g., the Districts' Terrestrial Resources Plan provides for protection and monitoring of vegetation, special-status plans, bald eagle, bats, and Western pond turtle), including periodic reporting provisions and annual meetings with BLM staff. The recommended plans not adopted are discussed below.

- Erosion Control and Restoration – the precise scope intended by BLM for this recommended measure is not yet specified. To the extent the erosion control and restoration plan is intended to apply to future individual construction projects or non-routine ground disturbing activities potentially affecting BLM lands, a project-specific plan will be developed by the Districts and submitted to the BLM for consultation purposes prior to the start of any work.
- Riparian vegetation – the Districts' studies and AFLA analyses found little riparian vegetation within the normal maximum water surface elevation of the impoundment. Vegetated areas above the normal maximum pool are not affected by Project operations. Nonetheless, any non-routine activities by the Districts to be conducted in the general vicinity of the Red Hills ACEC will be reviewed with BLM staff prior to initiation of any work.
- Visual resources – analysis of visual attributes demonstrates the Project's general consistency with BLM's visual objectives.
- Transportation – Article 17 of the existing license, which requires BLM approval of Project activities involving construction or maintenance occurring on federal lands, has worked well and should be continued, and the Districts propose to include and discuss at the proposed annual planning meeting with BLM staff the location and type of planned road maintenance projects that could affect BLM lands.

5.14.1.2 USFWS Proposed Resource Protection Plans

Several resource protection measures were recommended by the USFWS in comments provided to the DLA. Monitoring of bald eagle along the reservoir was recommended. The Districts have included bald eagle management measures in the AFLA. The USFWS recommended certain measures to reduce mortality to bald eagles due to collisions. The Project does not include any transmission or distribution lines, therefore, this provision was not included as part of the Districts' bald eagle management measures. The USFWS comments also discouraged use of rodenticides; the Districts no longer use rodenticides as part of Project O&M.

With regard to ESA-listed amphibians (California red-legged frog; California tiger salamander), the USFWS commented that when potential habitat has not been surveyed, the USFWS must assume the habitat is occupied. The Districts' FERC-approved studies performed as part of relicensing assessed all lands within 1.24 miles of the current Project Boundary for the presence of potential habitat for ESA- listed amphibians, and identified a small number of these habitats with the potential to be affected by Project operations. These studies provide sufficient information for FERC to complete its responsibilities under the ESA. Future construction projects or other non-routine activities, not yet approved or sufficiently defined, will likely warrant individual survey efforts for ESA-listed species.

5.14.1.3 Lower Tuolumne River Farmers' Flow Forecasting Measures

During the development of the initial study plans, the Lower Tuolumne Farmers (LTF), a group of irrigators on the Tuolumne River located primarily below the City of Modesto (RM 13) with farmland along the Tuolumne River, raised concerns that the Districts' manner of operating the Don Pedro Project may result in the occurrence of higher spring flows than necessary. LTF asserts that these higher flows can lead to property damage and crop loss. LTF requested that the Districts consider earlier and more frequent snow surveys, additional weather stations, or other means of reliably predicting future flows over the long-term. FERC's December 2011 Study Plan Determination recommended that the Districts evaluate whether obtaining early-season (December, January, February) snowpack information or alternative operational strategies could "improve operations"; that is, reduce the occurrence of higher late spring flows.

In September 2011, the Districts contacted the California Department of Water Resources (CDWR) to research the potential usefulness and feasibility of earlier-season snowpack measurements and flow forecasting. CDWR is the California agency responsible for developing snowpack and runoff forecasts for the state. CDWR responded to the Districts' inquiry on January 31, 2012. CDWR reported that the LTF proposals for earlier season snowpack measurement and flow forecasting were not viable, indicating that "*… quantitatively, January surveys add no value to the way DWR produces seasonal runoff..*" and further that "*…statewide, only a handful of January 1 surveys are completed, and those that are mostly just satisfy a media curiosity for an "early season look" at water conditions. My opinion is that paying for January snow surveys boils down to a curious and costly look at conditions; something that can already be obtained by our remote snow sensor network. The idea of more frequent surveys is also one that is not a viable solution.*"

The Districts also considered whether operational changes could be used to potentially reduce flow occurrences above 6,000 cfs, a flow guideline provided by LTF. By examining historical and Base Case flow conditions, it was determined that from 1971 to 2012 flows in the lower Tuolumne River exceeded 6,000 cfs in 18 years of this 42-year period. In 12 of these 18 years, flows exceeding 6,000 cfs occurred in November, December, January, and/or February ('80, '82, '83, '84, '86, '96, '97, '98, '99, '00, '06, '11). High flows in the early part of the water year should serve as an indication not to plant crops in the floodplain prior to the June/July time frame because the occurrence of spill indicates the reservoir is already within or near the flood control pool. As CDWR points out in its letter, additional early season snowpack measurements (December, January) or flow forecasts would not be useful or helpful because the uncertainty associated with such forecasts result in a very large range of potential future flows. This leaves six of 42 years in which a different reservoir operation may have potentially resulted in being able to keep flows in the lower Tuolumne River at less than 6,000 cfs. Further examination of the Base Case model output indicated when Don Pedro water levels were below 784 ft on February 1, the Tuolumne River flows did not exceed 6,000 cfs with only one exception (1983).

By inspection of the Base Case model, the combination of the Districts adopting an initial flow target of less than 6,000 cfs (say, 5,500 cfs) when February 1 water levels are less than 784 ft, and the LTF farmers not planting in the floodplain when February 1 Don Pedro water levels are above 784 ft, substantially reduces the possibility of any damage to crops (once in 42 years according to the Base Case model). However, it must be recognized by all parties that there will always be risks associated with planting in historical floodplains.

5.14.1.4 Measures Associated with Whitewater Boating in the Upper Tuolumne River.

Whitewater boating is a popular recreation opportunity in the Wild & Scenic reach of the Tuolumne River between Lumsden Campground (RM 97) and the Don Pedro Project Boundary (RM 80.8). Commercial outfitters use Ward's Ferry Bridge (RM 79) as the point of river egress for their customers, equipment and rafts. The usual and customary method of removing rafts and equipment is to position a truck crane on the two-lane bridge roadway and lift gear and rafts from the river. The water surface at Ward's Ferry Bridge can range from riverine at elevation 780 ft (+/-) to reservoir at circa 830 ft. The bridge deck is at approximate elevation of 880 ft. Positioning a truck crane on the bridge closes one of the two road lanes. There can be as many as three truck cranes on the bridge deck at one time, and they may need to be there for hours as groups of boaters arrive. The essential problem with take-out at Ward's Ferry is the resulting congestion and extensive road blockage, with the additional congestion on the bridge caused by the exiting customers. The congestion results from the fact that the commercial rafters must catch and ride the flows delivered by the peaking operation of the CCSF Holm powerhouse which normally operates during the summer from about 6 am to 11 am.

Ward's Ferry Bridge is the first possible egress site downstream of the Wild & Scenic reach of the Tuolumne River. Ward's Ferry is located in a steep canyon section of the river, and is a relatively remote location. Except for a cinder block vault toilet facility provided by the Districts, there are no other facilities in the canyon at this location. Vandalism, sometimes at extreme levels, is common. For example, it is inadvisable to leave overnight a vehicle at or near Ward's Ferry Bridge.

American Whitewater and commercial boating interests provided comments to the DLA. Included within the general comments were recommendations that the Districts provide multiple, multi-lane boat ramps, pedestrian safety measures, improved toilet facilities, secure parking, reliable communication links, security patrols, showers, potable water, shuttle transportation to and from the site, and radio repeaters or cell towers to assist law enforcement agencies, among other things.

The congestion and congestion-related challenges experienced at Ward's Ferry Bridge are not related to any Project effects, and the congestion-related issues exist at all reservoir levels. The Ward's Ferry Bridge is not a Project-sponsored recreation site. Ward's Ferry is the end of a recreation opportunity, and the primary activities are associated with exiting the area. Providing security, law enforcement, adequate communications facilities, ensuring public safety, and protection against vandalism are the responsibilities of the local law enforcement agencies. Guaranteeing access to cell phone service is not a Project-related obligation, nor is ensuring public safety associated with potentially unauthorized use of a county roadway. Nonetheless, the Districts have proposed to design and construct, but not own, a river-left egress platform to minimize the need to locate truck cranes on the bridge deck. The Districts hope to develop with Tuolumne County officials a mutually agreeable plan providing for long-term upkeep and maintenance of the proposed take-out facility.

5.14.2 Alternative Flow Scenarios

On September 15, 2016, the California State Water Resources Control Board (SWB) released for public comment the Revised Draft Substitute Environmental Document ("SED"). The SED consisted of over 3,500 pages of text, tables, graphs, and computer models describing and analyzing the SWB's proposed Amendments to the Bay-Delta Water Quality Control Plan ("Amended Plan"). The geographic scope of the SWB's Amended Plan encompasses the lower San Joaquin River (LSJR) and the three east-side tributaries draining into the LSJR – the Stanislaus, Tuolumne, and Merced rivers. The stated purpose of the proposed revisions to the SWB's Amended Plan is to "*support and maintain native fish populations*" (pg ES-18), improve "*productivity as measured by population growth rate*" (ES-19), and to "*support and maintain the natural production of viable native San Joaquin River Watershed fish populations migrating through the Delta*". For purposes of evaluating a range of flow-based alternatives intended to achieve the SED's goals, the SWB adopts for analysis an "indicator species" -- fall-run Chinook salmon – and devotes most of the SED to analyzing and describing the effects of the flow alternatives on this species. However, specific fall-run Chinook tributary production goals to be met by the alternatives are not identified, nor are the effects to fall-run Chinook salmon populations on each of the east-side tributaries enumerated in any of the SED's alternatives.

The SED identifies its preferred alternative as each of the east-side tributaries providing 40% of that stream's estimated unimpaired flow[157] (UIF) for the months of February through June, inclusive, to the SJR as measured at the mouth of each tributary. However, the SED also suggests that the goals of the SWB's Amended Plan may potentially be able to be met with tributary flows in the range of 30% to 50% of the February through June unimpaired flow, and further states that a minimum flow of 60% of the February through June UIF was previously shown to be needed to protect SJR and Delta fisheries.[158] In a meeting between the FERC staff and the SWB staff in March 2014, prior to the issuance of the SED, the SWB requested that FERC also evaluate a 20% UIF alternative.[159]

This section of the AFLA evaluates each of the percent UIF flow alternatives put forward in the SED and compares their resulting effects to fall-run Chinook salmon to both the Base Case and the Districts' Preferred Plan.[160] Although the SED discusses non-flow measures, it does not

[157] The SED discusses the need for a return to a natural flow regime in the east-side tributaries, then presents the "unimpaired flow regime", and a percent thereof, as mimicking the natural flow regime. The California Department of Water Resources disagrees with the SWB's assertion that the "unimpaired flow", as it is defined in the SED, mimics the natural flow regime. The Districts also disagree with the SWB's use of "unimpaired flow" as an indicator of each tributaries historical contribution to Delta flows. The Districts' comments to the SED discuss this issue in considerable detail. The Districts' response to the SED in its entirety is included as an attachment to this AFLA.

[158] However, the SWB's own analysis in the SED shows that the 60% UIF alternative actually produces fewer fall-run Chinook salmon than the 40% UIF alternative.

[159] Although is it was not clearly specified that this should be for the same February through June period, it seems reasonable that was the intent because the SWB's SED was underway by that time.

[160] It should be noted that the SED's apparent preferred alternative is actually an adaptive management approach intended to develop and define for each tributary a set of functional flows that could be released at any time during the year using the volume of water computed for the February-June period. This version of the SWB's preferred "Amended Plan" prompts the SWB to state *"[t]he LSJR alternatives entail a **virtually unlimited number** of possible functional flow regimes, limited **only** by the upper and lower bounds of the analyzed range of flows"* (ES-17) [emphasis added]. Without guidance as to what is actually trying to be achieved, it is unreasonable for the AFLA to analyze a "virtually unlimited number" of functional flows. Therefore, the AFLA evaluations have included the basic UIF alternatives identified in the SED.

endorse or include any specific non-flow measure in any alternative scenario, and according to the SED, the minimum required flow to be adopted under the SWB's amended Bay-Delta plan would be no less than 30% and no more than 50%[161] of the February through June UIF. There have been additional flow scenarios suggested by other parties during the relicensing process, and each of these are presented and discussed below. Each of the specific alternative proposals put forward by other parties has consisted only of alternative flows, and none have included any specific non-flow measures. Therefore, the alternative flow scenarios are each considered as complete alternative scenarios comparable to the Base Case and the Districts' Preferred Plan.

Each of the alternative flow scenarios identified in the SED defined the minimum flows to be delivered from February through June because the SWB identified this period as being the critical period for fall-run Chinook salmon and, presumably, *O. mykiss* in the SJR tributaries. The SED contained no quantitative analysis of population effects to *O. mykiss* of the various unimpaired flow alternatives, and the minimum flow regime for the remainder of the year was left undefined. To supplement each of the SED's flow scenarios in order to develop a complete model run, the Base Case minimum flow schedule was applied those annual periods where the SED did not specify a minimum required flow. This seems reasonable considering the SED identified the February through June period as being the critical period for fall-run Chinook salmon.

There were other aspects of the SWB's flow scenarios, as listed below, that were part of each of the SED's alternatives, and important to consider when modeling the SED's various options based on percentages of UIF:

- as specified in the SED, the Districts' modeled inflows to Don Pedro Reservoir are computed as a running 7-day average of the unimpaired flow for February through June and the unimpaired flow to be released by the Don Pedro Project as measured at the La Grange gage is the associated percent of UIF;[162]
- in the Districts' Operations Model, accretion estimates in the reach between La Grange gage and the mouth of the Tuolumne River were based on actual accretion measurements and hydrologic analysis conducted by the Districts during relicensing as part of the development of the Tuolumne River Operations Model through the collaborative Workshop Consultation process;[163]
- each of the SED's scenarios also included a continuous minimum flow requirement of 1,000 cfs for the San Joaquin River (SJR) at Vernalis which the Tuolumne River was assigned by the SWB to be responsible for 47% of the flow; and

[161] The SED states that while some non-flow measures may have merit, they are not essential to the SJR fall-run Chinook salmon populations. Resource agency comments provided during the SED process specifically discounted the importance of non-flow measures (see CDFW presentation on January 3, 2017).

[162] For example, for the 30% February-June UIF alternative, the Tuolumne River Operations Model daily minimum flow at La Grange gage was computed as 30% of the 7-day running average unimpaired inflow to Don Pedro Reservoir for the February-June period.

[163] In the Districts' Joint comments on the SED, the SED's estimated accretion estimates were shown to be significantly overestimated (see Figure TR-16 of the SED), which has the effect of reducing the flow releases required at Don Pedro for purposes of the SED's modeling of required releases, which also reduces the SED's reported impacts on the Districts' water supplies.

- each of SED's scenarios also included "flow shifting" during "Wet" water years, and the Districts' modeling of the various UIF scenarios includes this provision.

Each of these aspects of the SED's scenarios has been incorporated into the Districts' modeling of alternative scenarios so as to reasonably depict the SWB's various flow alternatives.

5.14.2.1 SWB's Requested 20% February-June Unimpaired Flow Scenario

In a meeting on March 27, 2014, between staff of SWB and FERC, the SWB staff requested that the 20%, 40% and 60% unimpaired flow scenarios each be evaluated in FERC's environmental analysis.[164] At that time, the SWB was in the process of preparing the SED which was eventually issued in September 2016 and which considered various UIF scenarios for the February through June period and the current FERC-required flows for the remainder of the year. Therefore, for the 20% UIF scenario, the various Don Pedro simulation models were run with a required minimum flow at the La Grange gage of 20% of the February through June unimpaired flow, the various flows mentioned immediately above, and the current FERC-required flows for the reminder of the year.[165]

Under the 20% UIF February through June alternative, the Districts' and CCSF's water supplies would be significantly reduced compared to the Base Case and the Preferred Plan (see Appendix E-1, Attachment H-1 for Operations Model and River Temperature Model results).[166] For the Districts, the 6-year '87 to '92 drought a consecutive eight-year period of water shortages from '87 to '94. Water shortages of 12% to 27% would be experienced in this eight year period, including three consecutive years of 15% shortage followed consecutively by a 25%, then 27% water shortage. Over the five-year hydrology from '88-'92, the Districts' customers would experience a cumulative shortage of 827,000 AF of water compared to the Base Case shortage of 607,000 AF, a 36% greater water shortage during the drought.[167] Water shortages of 12% and 26% also occur consecutively in '76-'77. A 14% shortage occurs in 2008, where under the Base Case and Preferred Plan conditions there was no water shortage in either 1976 or 2008 hydrology.

Total water supply shortages to the CCSF's Bay Area customers are significant under the 20% UIF alternative, increasing from the Base Case shortages of 10% per year in the five consecutive years of '88 through '92 to 35% per year for each of those years. CCSF's Bay Area customers would receive only 65% of their normal total supply of water for five consecutive years under the '88 to '92 hydrology. Total water supply shortages to CCSF's customers of 20% and 35% would also occur in'76 and '77, respectively, and a 20% shortage would occur in '08 hydrology. Under the Base Case, a total water shortage of 10% occurred in '77 with no water shortages in '76 or '08.

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[164] See March 28, 2014 memo to the Public Files on the Don Pedro Project, P-2299-075.

[165] The SWB has explained, "[r]esponsibility for implementing flow objectives will be assigned through water right actions and water quality actions, *including Federal Energy Regulatory Commission (FERC) hydropower licensing processes."* (SED at Es-1ES-2[emphasis added].) As the SWB acknowledges, pursuant to the Fourth Agreement, revised minimum instream water release requirements for the Don Pedro Project ordered by FERC could result in CCSF being responsible to bypass approximately 51.7% of the requisite flows. *(Id. At L-3—L-5.)*

[166] Detailed flow, water supply, and temperature output for each alternative is provided in Appendix E-1, Attachment H.

[167] Districts' full supply canal deliveries during the '88 through '92 period averages 860,000 AF per year.

Using the projected water demands of the CCSF service territory of 265 mgd by 2040, the 20% February-June UIF would have pronounced effects on CCSF water supplies to Bay Area customers. In the period from ’87 through ‘92, total water shortages would be 30% to 40% in each of the six consecutive years. A total water shortage of 30% would also occur in ’94. In the ’76-’77 dry years, water shortages would be at least 30% in each year. A water shortage of 30% would also now occur in ’07 and ’08 (see Appendix E-1, Attachment H-9 for detailed model output).

Under the 20% February-June UIF scenario, Don Pedro Reservoir levels would be similar to the Base Case, except in ‘94 and the entire ’02 through mid-’05 period with water storage levels being reduced by about 200 to 400 TAF compared to Base Case. It is likely that recreation levels would be affected during a ’02 to ’05 hydrologic period.

The effects to fall-run Chinook salmon and *O. mykiss* under the 20% February-June UIF scenario are depicted in Figures 5.14-1, 5.14-2, and 5.14-3. Smolt productivity of fall-run Chinook salmon would increase from 6.3 under the Base Case to 7.1 smolts per female spawner, an increase of 12%.[168] The February through June minimum flow requirement would increase from the current 129,000 AF on average under the Base Case to 319,000 AF on average, or 147%, under the 20% UIF scenario. Under the 20% February-June UIF scenario, a 147% increase in required instream flows yields a 12% increase in smolt productivity. Under the Districts’ Preferred Plan, the February-June required flows are 31% greater than Base Case and the increase in smolt productivity is 172%.

The Districts’ Preferred Plan produces 2.5 times as many smolts per female spawner as the SWB’s 20% UIF scenario while requiring about one-half the amount of water.

[168] All descriptions of the comparisons of effects on fall-run Chinook salmon refer to the escapement size of 2,000 female spawners.

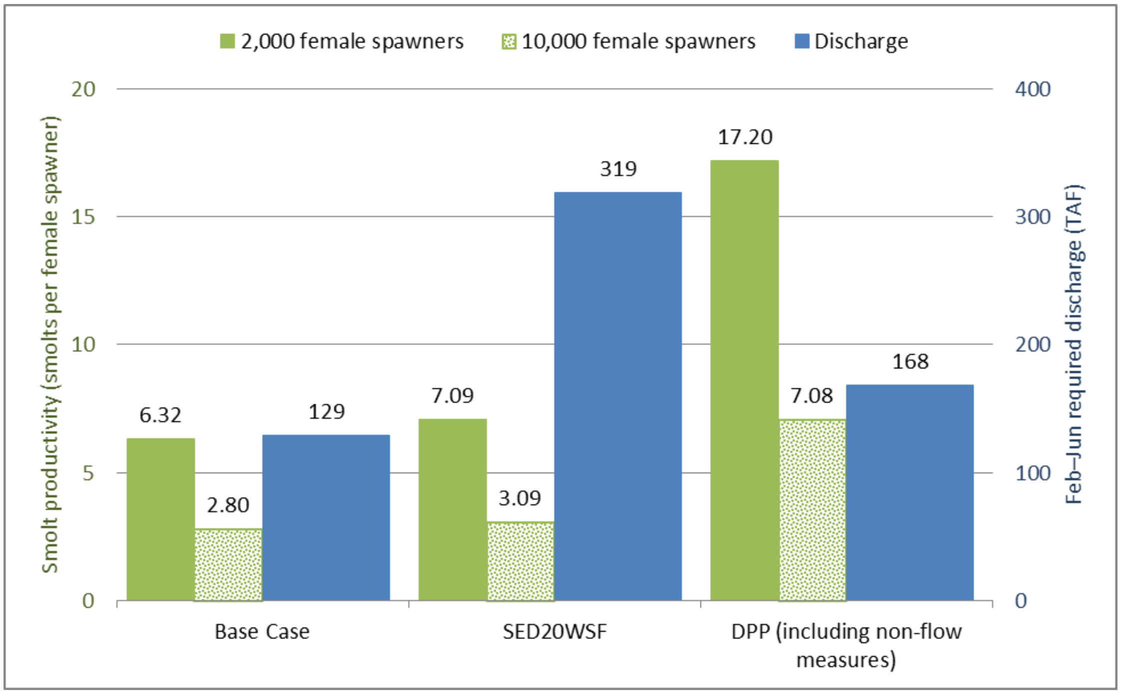

Figure 5.14-1. Fall-run Chinook smolt production and February through June required instream flow for Base Case, SWB's 20% February-June UIF scenario, and Districts' Preferred Plan.

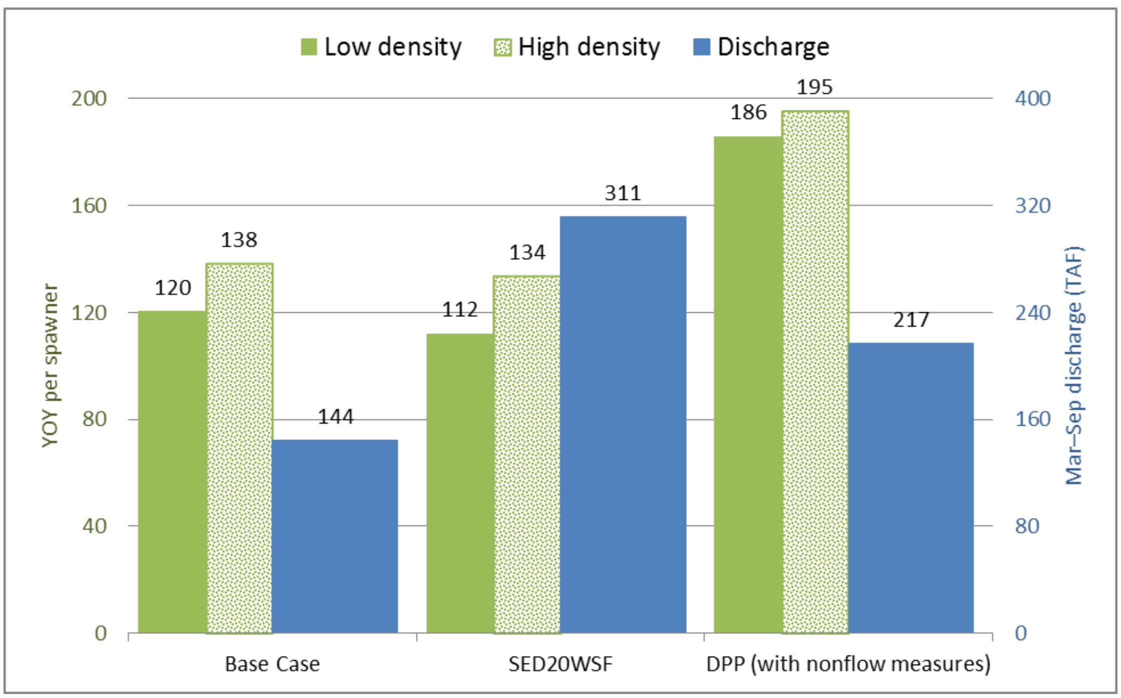

Figure 5.14-2. *O. mykiss* young-of-the-year per spawner production and March through September required flows for Base Case, SWB's 20% February-June UIF scenario, and Districts' Preferred Plan.

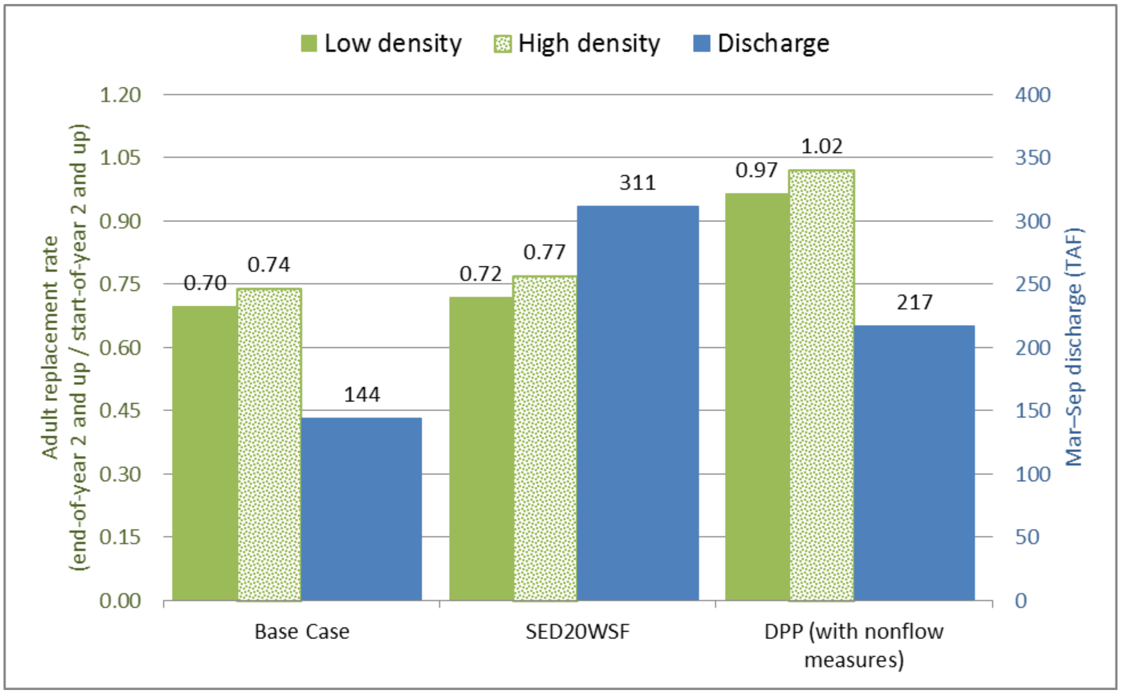

Figure 5.14-3. ***O. mykiss*** **adult replacement rate and March through September requiredinstream flow for Base Case, SWB's 20% February-June UIF scenario, and Districts' Preferred Plan.**

Regarding *O. mykiss* populations on the Tuolumne River, the SWB's 20% February-June UIF scenario is projected to produce 112 YOY per female spawner[169] (Figure 5.14-2). The Base Case produces 120 YOY per female spawner, or 7% more than the SWB's 20% UIF scenario, indicating the SWB's 20% UIF scenario is projected to have an adverse impact on this ESA-listed species. Though producing 7% fewer YOY per female spawner, the 20% UIF scenario's minimum required instream flows are 311,000 AF for the March through September period, which is more than twice the Base Case's 144,000 AF. The Districts' Preferred Plan would produce 186 YOY per female spawner while having a minimum flow requirement of 217,000 AF in the March through September period, equating to a 54% increase in *O. mykiss* YOY for a 50% increase in the minimum flow compared to the Base Case. The Districts' Preferred Plan projects that *O. mykiss* YOY production would be 66% greater than the SWB's 20% UIF, while requiring 30% less water.

O. mykiss adult replacement rate under the Base Case is 0.70, while under the 20% UIF scenario it is 0.72, or an increase of 3%, while requiring over two times the water (Figure 5.14-3). The Districts' Preferred Plan increases adult replacement 39% over the Base Case and 37% over the 20% UIF scenario.

5.14.2.2 SWB 30% Unimpaired Flow Scenario

For the 30% February through June UIF alternative, the Districts and CCSF water supplies would be significantly reduced during critical drought periods (see Appendix E-1, Attachment

[169] *O. mykiss* comparisons all refer to the low density population assumption of 500 fish.

H-2). For the Districts, the five-year ’88 to ’92 drought is extended three years to become an eight-year drought from ’87 to ‘94. Water shortages of 19% to 22% occur in each of six consecutive years (’87-’92) during the eight-year period. In those six years, there is an 84% greater shortage of water supplies than under the Base Case for the same six-year period. Over the five-year ’87-’92 period, the Districts’ customers would experience a cumulative shortage of 1,100,000 AF of water. Water shortages of 20% also occur in ’76, ’04, and ’08, where under the Base Case conditions and the Preferred Plan there were no water shortages in those years.

Total water supply shortages to the CCSF’s Bay-Area customers are severe under the 30% UIF scenario, increasing from 10% per year in the five consecutive years of ’88 through ’92 to 45% per year for each of those years. CCSF’s Bay Area customers would receive only 55% to 60% of their normal total supply of water for six consecutive years under the ’87 to ’92 hydrology. This same level of shortage to CCSF customers would also occur in the ’76-’77 and in ’08 hydrology, where no shortages occur under the Base Case or the Districts’ Preferred Plan.

Under the 30% February-June UIF scenario, Don Pedro Reservoir levels would not rise above elevation 740 ft, 90 feet below the normal maximum level, for five consecutive years, and the mean water level over that five year period would be about 685 ft, or 145 feet below normal maximum. Impacts to recreation would be significant.

The effects to fall-run Chinook salmon and *O. mykiss* under the 30% February-June UIF scenario are shown in Figures 5.14-4, 5.14-5, and 5.14-6. Smolt productivity of fall-run Chinook salmon would increase from 6.3 under the Base Case to 8.3 smolts per female spawner, an increase of 32%. The February through June minimum flow requirement would increase from 129,000 AF on average under the Base Case to 446,000 AF on average, or more than three-fold, under the 30% UIF scenario. Under the Districts’ Preferred Plan, the February-June minimum required flows are 31% greater than Base Case and the increase in smolt productivity is almost 175% greater than Base Case. The Districts’ Preferred Plan produces twice as many smolts per female spawner as the 30% UIF scenario while using only about 40% as much water.

Regarding *O. mykiss* populations on the Tuolumne River, the SED’s 30% February-June UIF scenario is projected to produce 104 YOY per female spawner[170] while the Base Case produces 120, or 13% more than the SED’s 30% UIF scenario, indicating the SED’s 30% UIF scenario is likely to have a significant adverse impact on this ESA-listed species (Figure 5.14-5). The 30% UIF scenario’s minimum required instream flows are 427,000 AF for the March through September period, compared to the Base Case’s 144,000 AF, a three-fold increase in flow which produces less fish.[171] The Districts’ Preferred Plan would produce 186 YOY per female spawner while having a minimum flow requirement of 217,000 AF, equating to a 55% increase in *O. mykiss* YOY for a 51% increase in the minimum flow compared to Base Case. The Preferred Plan increases *O. mykiss* YOY more than 75% over the SED’s 30% UIF, while requiring just half the water.

[170] *O. mykiss* comparisons all use a low density population assumption of 500 fish.

[171] High flows during *O. mykiss* emergence and fry life stage tend to displace *O. mykiss* downstream into areas of higher predation and subsequently warmer temperatures. Maximum WUA for the fry life stage occurs at 50 cfs (see Figure 5.6-2).

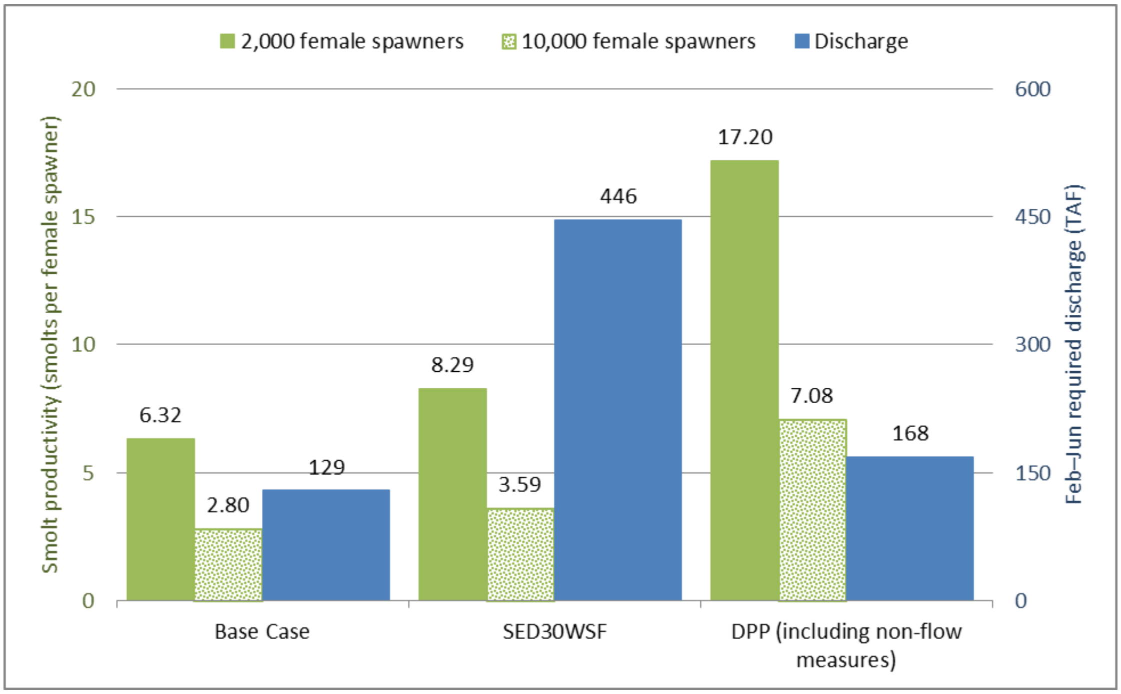

Figure 5.14-4. Fall-run Chinook smolt production and February through June required instream flow for Base Case, SWB's 30% February-June UIF scenario, and Districts' Preferred Plan.

O. mykiss adult replacement rate under the Base Case is 0.70, while under the 30% UIF scenario it is 0.72, or an increase of 3%, achieved through a three-fold increase in the required minimum flow (Figure 5.14-6). The Districts' Preferred Plan increases adult replacement rate 38% over the Base Case and 35% over the 30% UIF scenario, while requiring half the water of the 30% UIF scenario.

5.14.2.3 SWB 40% Unimpaired Flow Scenario without SED Reservoir Use Restrictions

The 40% February through June UIF scenario applies the same consistent analytical basis as the Districts' Preferred Plan and the 20% and 30% February-June UIF scenarios. Detailed model output for this scenario is provided in Appendix E-1, Attachment H-3.

Under the 40% February through June UIF alternative, the Districts and CCSF water supplies would be severely impacted. For the Districts, the five-year '88 to '92 drought is extended three years to become an eight-year drought ('87-'94). Water shortages of 27% to 30% occur in seven of these eight years and are 30% for five consecutive years during the eight-year period. The total water shortage over the '87-'92 period would be 1,500,000 AF, 2½ times the Base Case shortage. Water shortages of 27% and 52% would occur consecutively in the '76-'77 drought. Water shortages of 25% would occur in both 2003 and 2004 and another 27% shortage occurs in 2008, where under the Base Case or the Preferred Plan there were no water shortages in any of those three years. Irrigation water shortages would occur in 30% of the years in the 1971-2012 hydrologic period, whereas shortages occurred in about 15% of the years under the Base Case and Preferred Plan, and in those years the shortages were less severe.

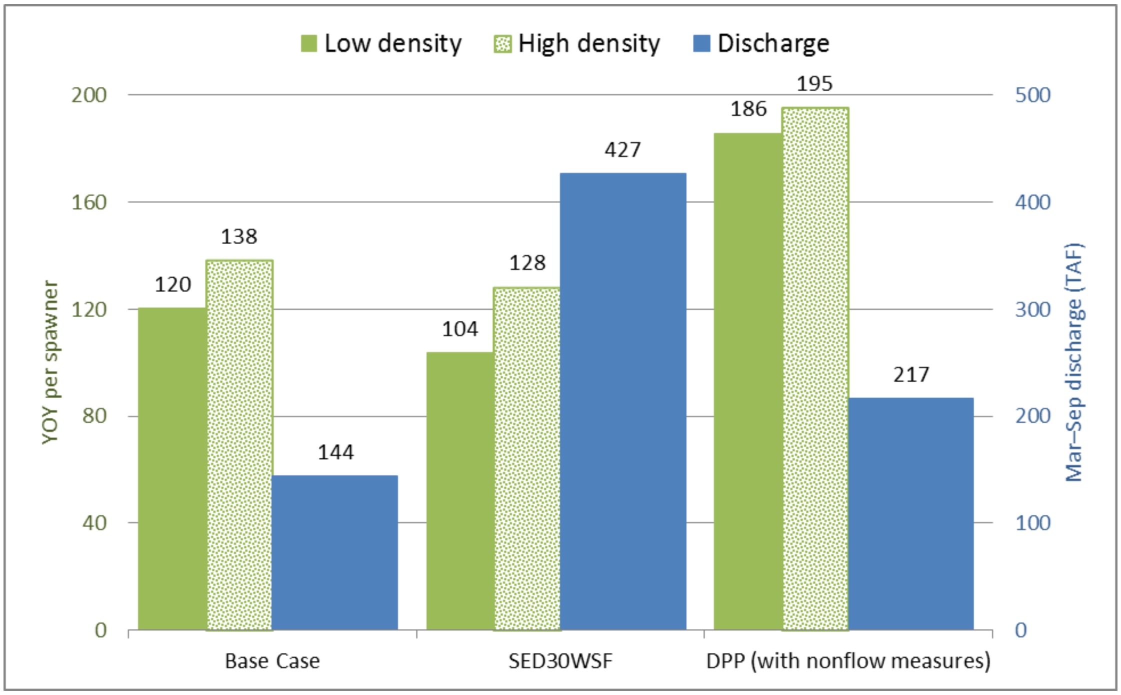

Figure 5.14-5. ***O. mykiss*** **young-of-the-year per spawner production and March through September required flows for Base Case, SWB's 30% February-June UIF scenario, and Districts' Preferred Plan.**

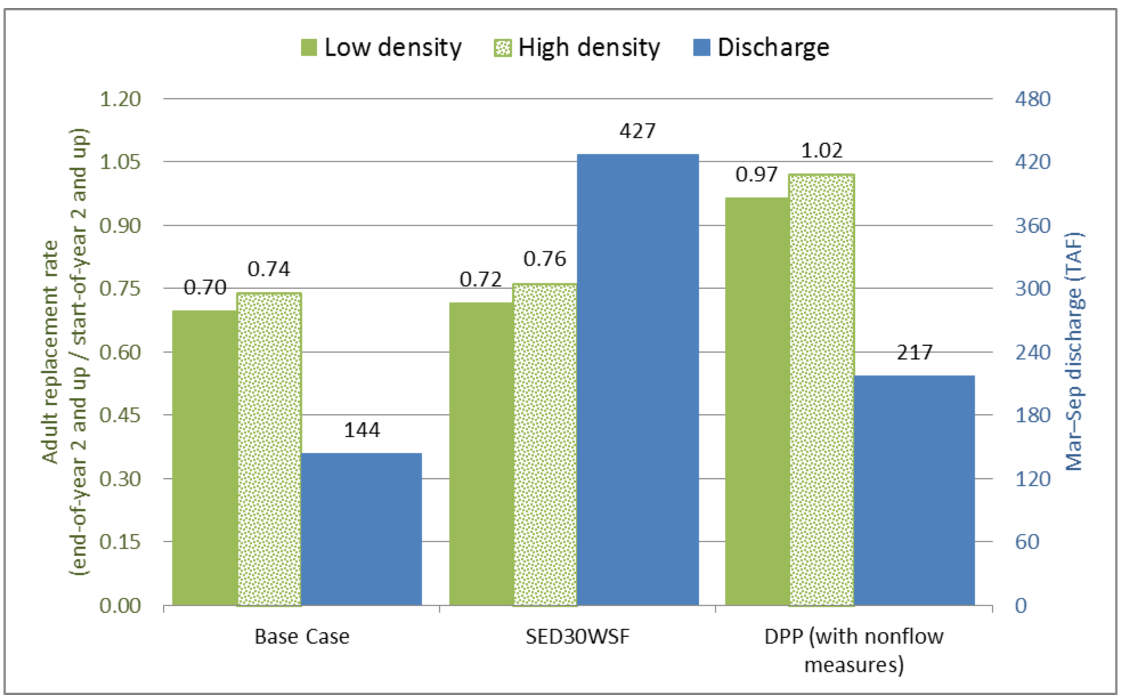

Figure 5.14-6. ***O. mykiss*** **adult replacement rate and March through September instream flow requirement for Base Case, SWB's 30% February-June UIF scenario, and Districts' Preferred Plan.**

Total water supply shortages to the CCSF's Bay-Area customers are extreme under the 40% February-June UIF scenario, increasing from 10% per year in the five consecutive years of '88 through '92 under the Base Case to 65% per year for each of those years. CCSF's Bay Area customers would receive only 35% to 45% of their normal total water supply in seven of eight years under the '87 to '94 hydrology. This same level of total water shortage to Bay Area customers would also occur in '76-'77 and again in 2008.

Using the projected water demands of the CCSF service territory of 265 mgd by 2040, the 40% Feb-Jun UIF scenario again would have severe effects on CCSF water customers. In the period from '87 through '92, total water supply shortages to the CCSF's Bay-Area customers would range from 50% to 65% each of the six consecutive years, followed by a 50% shortage in '94. Overall, in 13 years of the 42-year period from '71 through '12, CCSF customers would face a water shortage of at least 50%. In an additional eight of the years, the total water shortage would be 20%. Therefore, in almost half the years, CCSF Bay Area customers would be in a severe water shortage (see Appendix E-1, Attachment H-9).

Don Pedro Reservoir levels would not rise above elevation 740 ft, 90 feet below the normal maximum level, for six consecutive years, and the mean water level over that six-year period would be about 685 ft, or 145 feet below normal maximum. In the period extending from WY 1999 to 2012, the reservoir would reach its normal maximum level only twice in the entire 14-year period. Impacts to recreation use would be significant.

The effects to fall-run Chinook salmon and *O. mykiss* under the 40% February-June UIF scenario are shown in Figures 5.14-7, 5.14-8, and 5.14-9. Smolt productivity of fall-run Chinook salmon would increase from 6.3 under the Base Case to 8.7 smolts per female spawner, an increase of 38% (Figure 5.14-7). The February through June minimum flow requirement would increase from 129,000 AF on average under the Base Case to 516,000 AF on average, representing a four-fold increase in flow to achieve a 38% increase in smolt production under the 40% UIF scenario. Under the Districts' Preferred Plan, the increase in February-June required minimum flows is 31% over the Base Case, on average, and the increase in smolt productivity is almost 172%. The Districts' Preferred Plan produces twice as many smolts per female spawner as the 40% UIF scenario while requiring, on average, roughly one-third of the water in the same February through June period.

Regarding *O. mykiss* populations on the Tuolumne River, the 40% February-June UIF scenario is projected to produce 121 YOY per female spawner while the Base Case produces 120, resulting in no increase in production under the 40% UIF scenario (Figure 5.14-8).

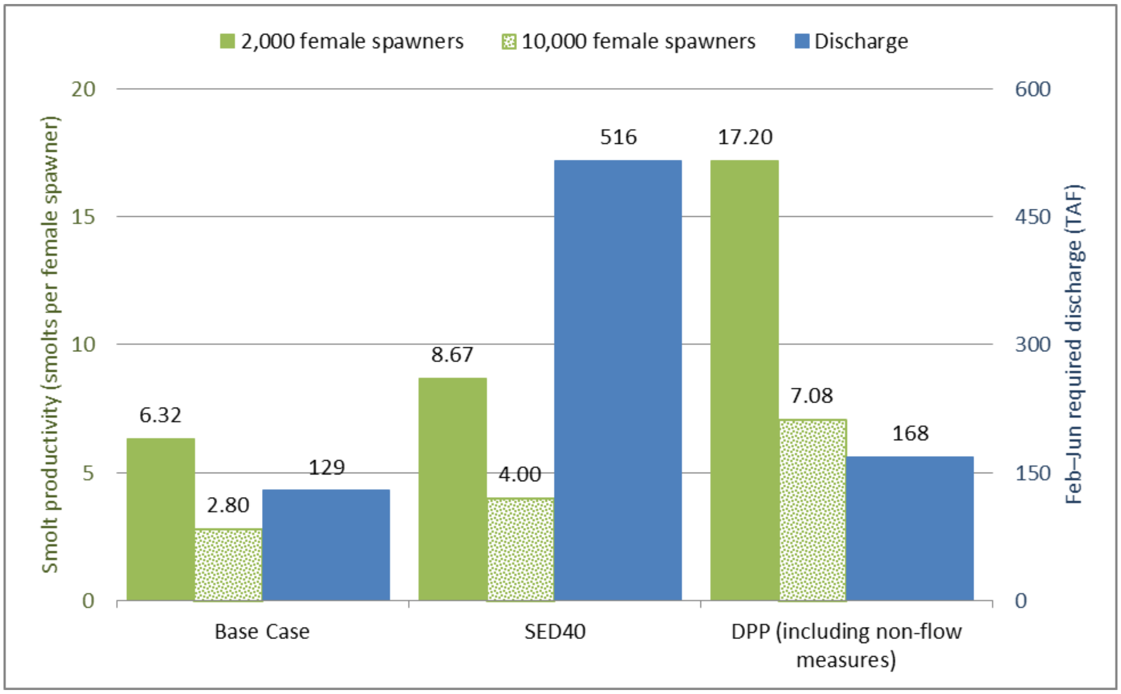

Figure 5.14-7. Fall-run Chinook smolt production and February through June required instream flow for Base Case, SWB's 40% February-June UIF scenario, and Districts' Preferred Plan.

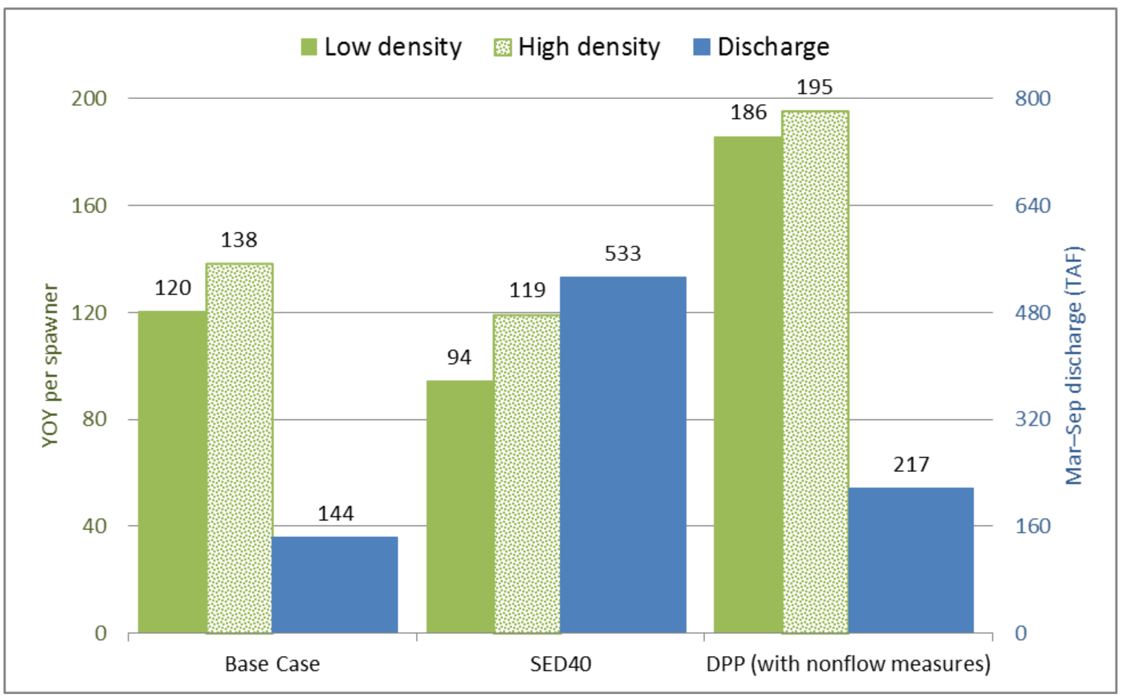

Figure 5.14-8. *O. mykiss* young-of-the-year per spawner production and March through September required flows for Base Case, SWB's 40% February-June UIF scenario, and Districts' Preferred Plan.

The 40% UIF scenario minimum required instream flows are 533,000 AF for the March through September period, compared to the Base Case's 144,000 AF, an almost four-fold increase in required flow. The Districts' Preferred Plan would produce 186 YOY per female spawner while having a minimum flow requirement of 217,000 AF, equating to a 55% increase in *O. mykiss* YOY per spawner for a 51% increase in the required minimum flow. The Preferred Plan increases *O. mykiss* YOY more than 75% over the SWB's 40% UIF, while requiring just 40% as much water.

O. mykiss adult replacement rate under the Base Case is 0.70, while under the 40% UIF scenario it is 0.77, or an increase of 10%, achieved through an almost four-fold increase in required minimum flow (Figure 5.14-9). The Districts' Preferred Plan increases the adult replacement rate by 38% over the Base Case and 26% over the 40% UIF.

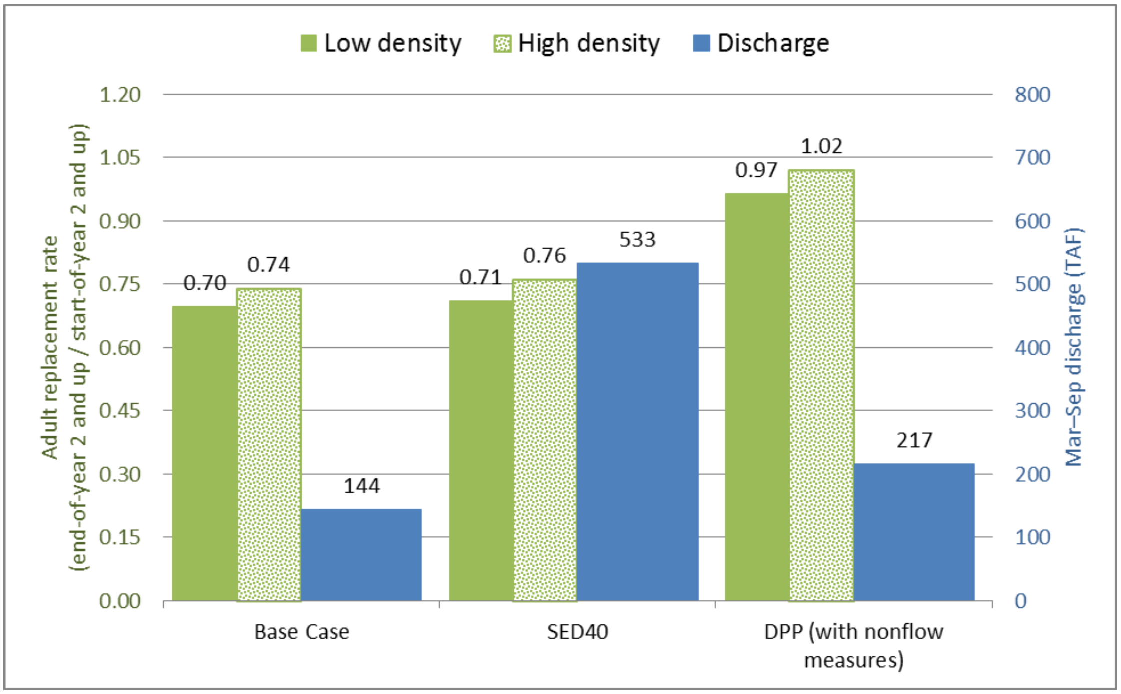

Figure 5.14-9. *O. mykiss* adult replacement rate and March through September instream flow requirement for Base Case, SWB's 40% February-June UIF scenario, and Districts' Preferred Plan.

5.14.2.4 SWB 40% Unimpaired Flow Scenario with SED Reservoir Use Restrictions

Though not explicitly indicated in the SED to be part of the SWB's 40% February-June UIF preferred alternative, the SWB's modeling supporting the 40% February-June UIF scenario included a number of restrictions on the use of the Don Pedro Reservoir storage. The SWB provides little explanation for the purpose of and need for these restrictions, but it is presumed to be to maintain a cold water pool in the Don Pedro Reservoir. Without providing any supporting analysis, the SWB randomly selects an end-of-September minimum storage requirement of 800,000 AF.[172] The SWB does allow this storage restriction to be violated, but only enough to ensure a minimum water supply delivery to the Districts of at least 363 TAF, which represents about a 60% water shortage to the Districts' customers. The SED provides no explanation for

[172]The "minimum pool" under the current FERC license corresponds to about 309,000 AF of "dead storage".

the basis for the 363 TAF amount. A number of other reservoir operation restrictions were applied in the SED, and these are enumerated in the description of the scenario in Appendix E-1, Attachment H-4. All of these SED's restrictions are incorporated into the Districts' model results reported below and detailed in Attachment H-4.

As to be expected, the SED's restrictions placed on use of the Don Pedro Reservoir have catastrophic water supply effects on the Districts customers. For the Districts, the five-year '88 to '92 drought becomes a 10-year drought, extending from '86 through '95, inclusive. Water shortages of almost 55% occur in consecutive years '88 and '89, and shortages of 30% or more occur in each year of the '88 through '93 period hydrology. Water shortages greater than 50% occur consecutively in '77 and '78 and then in '08 and '09. The '02 to '09 period becomes an eight-year drought with six of the years having water shortages exceeding 25% and two exceeding 50%. Under the Base Case and Preferred Plan there were no water shortages in any year of the '02 to '09 period. Under the SED's 40% UIF scenario with reservoir use restrictions, irrigation water shortages would occur in 50% of the years in the 1971-2012 hydrologic period, whereas shortages occurred in about 15% of the years under the Base Case and Preferred Plan, and in those years the shortages were much less severe.

Because the Don Pedro Reservoir restrictions only affects the Districts' use of water, the total water supply shortages to the CCSF's Bay-Area customers remain at the same catastrophic level as in the 40% February-June UIF scenario without reservoir restrictions. Under the 40% February-June UIF scenario with and without Don Pedro Reservoir restrictions, total shortages increase from 10% per year in the five consecutive years of '88 through '92 under the Base Case to 65% per year for each of those years. CCSF's Bay Area customers would receive only 35% to 45% of their normal total water supply in seven of eight years under the '87 to '94 hydrology. This same level of shortage would also occur in '76-'77 and again in 2008.

Don Pedro Reservoir levels would be lower in most years, except during the '89 to '92 drought where they would be higher due to the SWB's requirement to maintain 800,000 AF of storage in Don Pedro Reservoir. As shown in Appendix E-1, Attachment H-4, water levels would be much lower from 2001 through mid-2005 than in the Base Case and Preferred Plan.

The effects to fall-run Chinook salmon and *O. mykiss* under the 40% February-June UIF scenario with reservoir restrictions are shown in Figures 5.14-10, 5.14-11, and 5.14-12. Smolt productivity of fall-run Chinook salmon is unchanged at 8.7 smolts per female spawner compared to the "without reservoir restrictions" scenario. This represents an increase of 38% from the 6.3 smolts per female spawner under the Base Case. The February through June minimum flow requirement would increase from 129,000 AF on average under the Base Case to 516,000 AF on average, representing a four-fold increase in required flow under the 40% UIF "with reservoir restrictions" scenario. Under the Districts' Preferred Plan, the February-June required minimum flows are 31% greater than Base Case, on average, and the smolt productivity is greater by almost three times. The Districts' Preferred Plan produces twice as many smolts per female spawner as the 40% UIF "with reservoir restrictions" scenario while requiring roughly one-third of the water (Figure 5.14-10). The fall-run Chinook model results indicate no benefit to fall-run Chinook with the reservoir restrictions. This is not unexpected because as shown previously in this AFLA, over 95% of fall-run Chinook salmon have exited the Tuolumne River by the middle of May (see Figure 5.6-1).

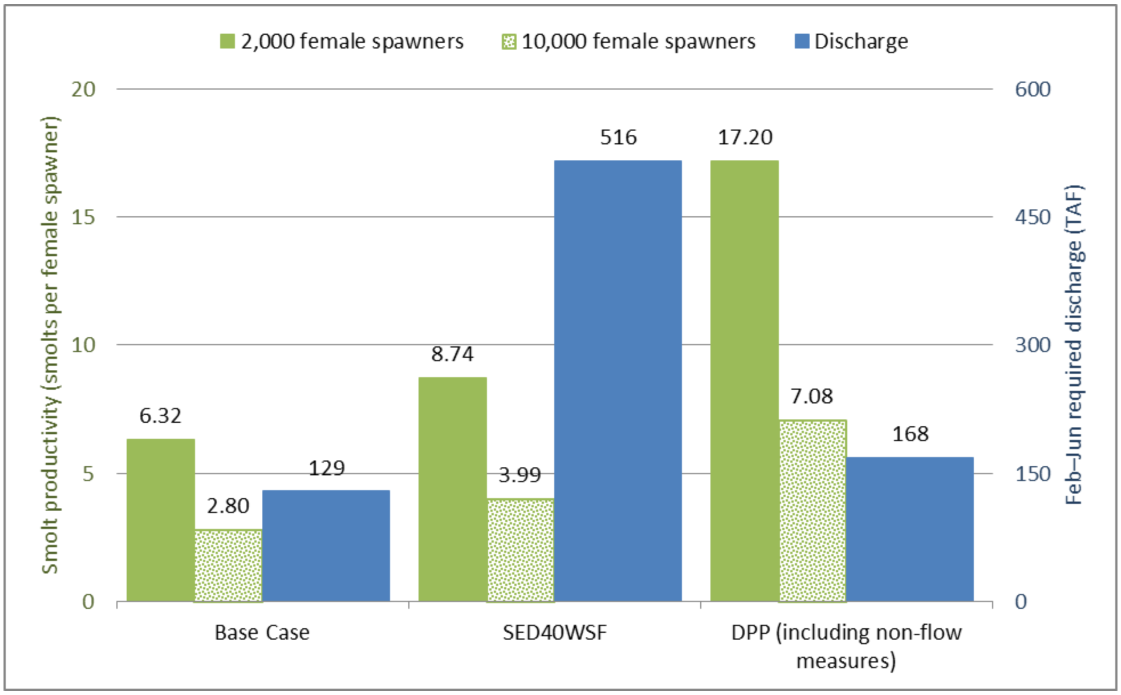

Figure 5.14-10. Fall-run Chinook smolt production and February through June required instream flows for Base Case, SWB's 40% February-June UIF scenario with SWB's additional reservoir restrictions, and Districts' Preferred Plan.

There is no evidence that Tuolumne River water temperatures are unsuitable for juvenile fall-run Chinook during the great majority of the emigration period under existing conditions. Furthermore, as shown in the modeling results provided in Appendix E-1, Attachment H-4, water temperatures are cooler under the Districts' Preferred Plan than the Base Case in May. While the 40% UIF flows yield lower water temperatures, such low temperatures may not optimize juvenile growth when robust food supplies are present.[173]

Regarding *O. mykiss* populations on the Tuolumne River, the 40% February-June UIF scenario "with reservoir restrictions" is projected to produce 121 YOY per female spawner while the Base Case produces 120, indicating no increase in production under the 40% UIF scenario "with reservoir restrictions" (Figure 5.14-11).

The 40% UIF scenario minimum required instream flows are 533,000 AF for the March through September period, compared to the Base Case's 144,000 AF, an almost four-fold increase. The Districts' Preferred Plan would produce 186 YOY per female spawner while having a minimum flow requirement of 217,000 AF, equating to a 55% increase in *O. mykiss* YOY per spawner and a 51% increase in the required minimum flow compared to the Base Case.

[173] Sommers et al. (2001); Sommers et al. (2004), Jeffres et al. (2008) report favorable juvenile growth at temperatures up to and greater than 21°C.

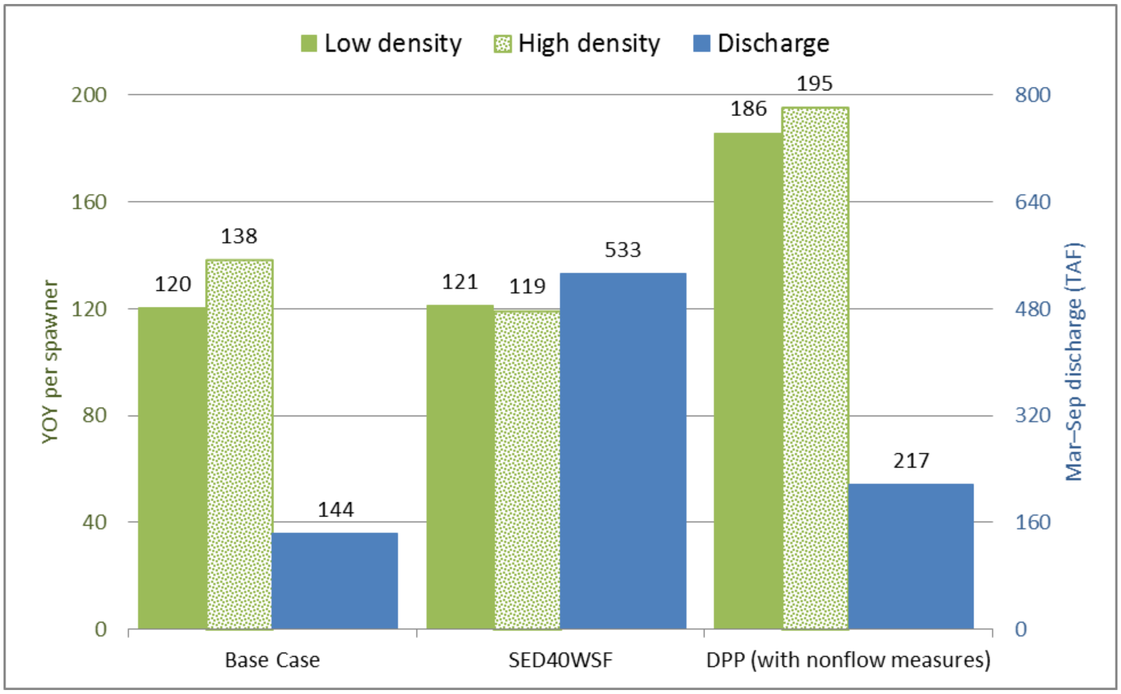

Figure 5.14-11. ***O. mykiss*** **young-of-the-year per spawner production and March through September required flows for Base Case, SWB's 40% February-June UIF scenario with SWB's additional reservoir restrictions, and Districts' Preferred Plan.**

The Preferred Plan increases *O. mykiss* YOY more than 75% over the SED's 40% UIF, while requiring just 40% as much water.

O. mykiss adult replacement rate under the Base Case is 0.70, while under the 40% UIF scenario "with reservoir restrictions" the rate is 0.71, providing a 10% increase (Figure 5.14-12). The almost four-fold increase in required minimum flow yields a 10% increase in *O. mykiss* adult replacement rate. The Districts' Preferred Plan increases the adult replacement by 38% over the Base Case and 37% over the 40% UIF "with reservoir restrictions" scenario with a 60% lower required minimum flow.

Reservoir outflow temperatures remain low under Base Case conditions and Districts' Preferred Plan because reservoir levels very infrequently reach levels which would disturb the thermal stratification of Don Pedro Reservoir. Scenarios requiring very high minimum flows have been shown by the in-river population modeling to yield minimal benefit to fall-run Chinook or *O. mykiss* while requiring large amounts of water to be released, which would result in extended low reservoir levels which could cause increases in outflow temperature.

The lowest Don Pedro reservoir levels under existing conditions, and under the Preferred Plan, generally remain sufficiently high even during drought years to maintain a cold water pool, except when reservoir levels drop below approximately 630 ft during summer time conditions.

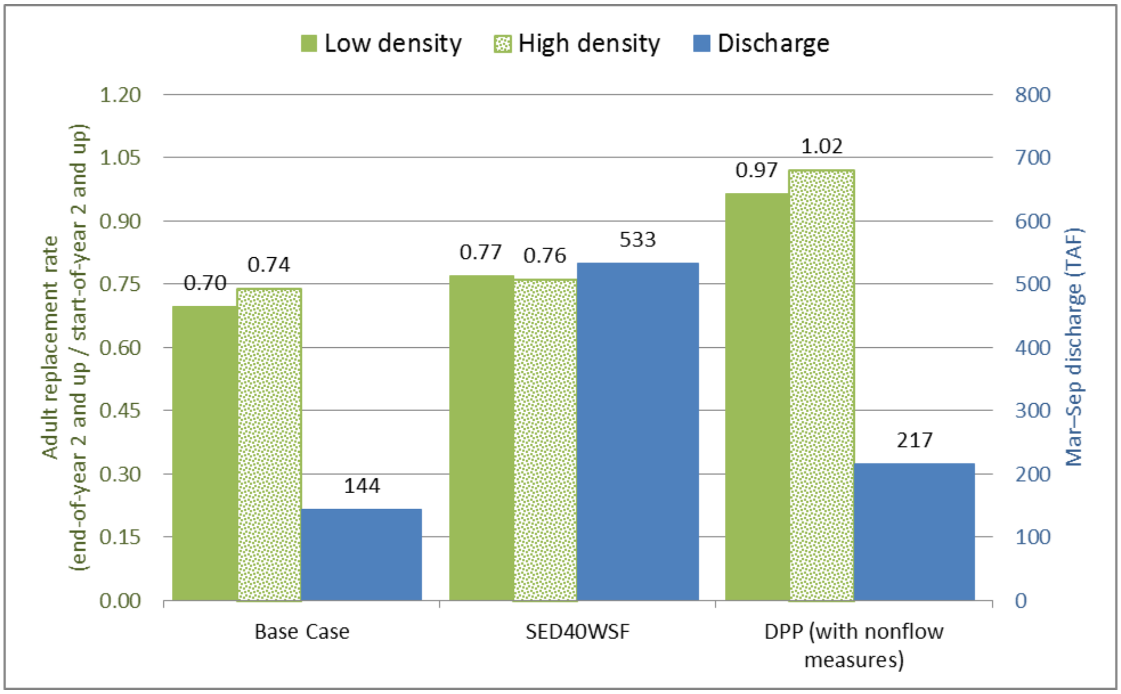

Figure 5.14-12. *O. mykiss* adult replacement rate and March through September Instream flow requirement for Base Case, SWB's 40% February-June UIF scenario with SWB's additional reservoir restrictions, and Districts' Preferred Plan.

Under Base Case and Preferred Plan conditions, this would occur three times in the 1971-2012 period ('78, '92, and '93), generally in the late October to November time frame. The SEB provided no justification for restricting reservoir levels to an elevation of 700 ft (800 TAF).

5.14.2.5 SWB 50% Unimpaired Flow Scenario

The 50% February through June UIF scenario applies the same consistent analytical basis as the Districts' Preferred Plan, and the 20% and 30% February-June UIF scenarios. In the SED, the 50% February-June UIF scenario was the upper limit of the SWB's preferred alternative. Detailed model output for this scenario is provided in Appendix E-1, Attachment H-5.

Under the 50% February through June UIF alternative, the Districts' and CCSF's water supplies would be severely impaired. For the Districts, the five-year '88 to '92 drought is extended three years to become an eight-year drought. Water shortages greater than 30% occur in seven of these eight years and are 35% for five consecutive years from '87 to '91, followed by a 60% shortage in '92. Water shortages of 56% and 64% would occur consecutively in the '76-'77 drought. Water shortages of 30% would occur in '01, '02, '04, and '07, where under the Base Case and Preferred Plan there were no water shortages in any of those four years. Irrigation water shortages would occur in 36% of the years in the 1971-2012 hydrologic period, whereas shortages occurred in about 15% of the years under the Base Case, and in the Base Case the shortages were less severe.

Total water supply shortages to the CCSF's Bay Area customers are at catastrophic levels under the SED's 50% February-June UIF scenario, increasing from 10% per year in the five consecutive years of '88 through '92 under the Base Case to 80% total water shortage per year for each of those five years. CCSF's Bay Area customers would receive only 20% of their normal total water supply in '76, '77, '88, '89, '90, '91, '92, '94, and '08 and 30% of their normal water supply in '72, '87, '02, '04, and '07. CCSF's Bay Area customers' total water supply would face extreme water shortages in 33% of the years from 1971 to 2012.

Don Pedro Reservoir levels would be significantly affected. As an example of the impact to reservoir levels, under the Base Case, reservoir levels do not fall below elevation 770 ft from WY 2001 through mid-2005, inclusive, while under the 50% February-June UIF, they do not rise above elevation 755 ft. In addition, water levels would not rise above elevation 700 ft, or 130 feet below normal maximum level, for five consecutive years from WY '88 through '92, inclusive. Impacts to recreation and other natural resources would be significant.

The effects to fall-run Chinook salmon and *O. mykiss* under the 50% February-June UIF scenario are shown in Figures 5.14-13, 5.14-14, and 5.14-15. Smolt productivity of fall-run Chinook salmon would increase from 6.3 under the Base Case to 9.8 smolts per female spawner, an increase of 56% (Figure 5.14-13). The February through June minimum flow requirement would increase from 129,000 AF on average under the Base Case to 652,000 AF on average, or about five-fold, under the 50% UIF scenario. Under the Districts' Preferred Plan, the increase in February-June required minimum flows is 31%, on average, and the smolt productivity is almost 3 times greater. The Districts' Preferred Plan produces 70% more smolts per female spawner as the 50% UIF scenario while requiring roughly one-quarter of the water.

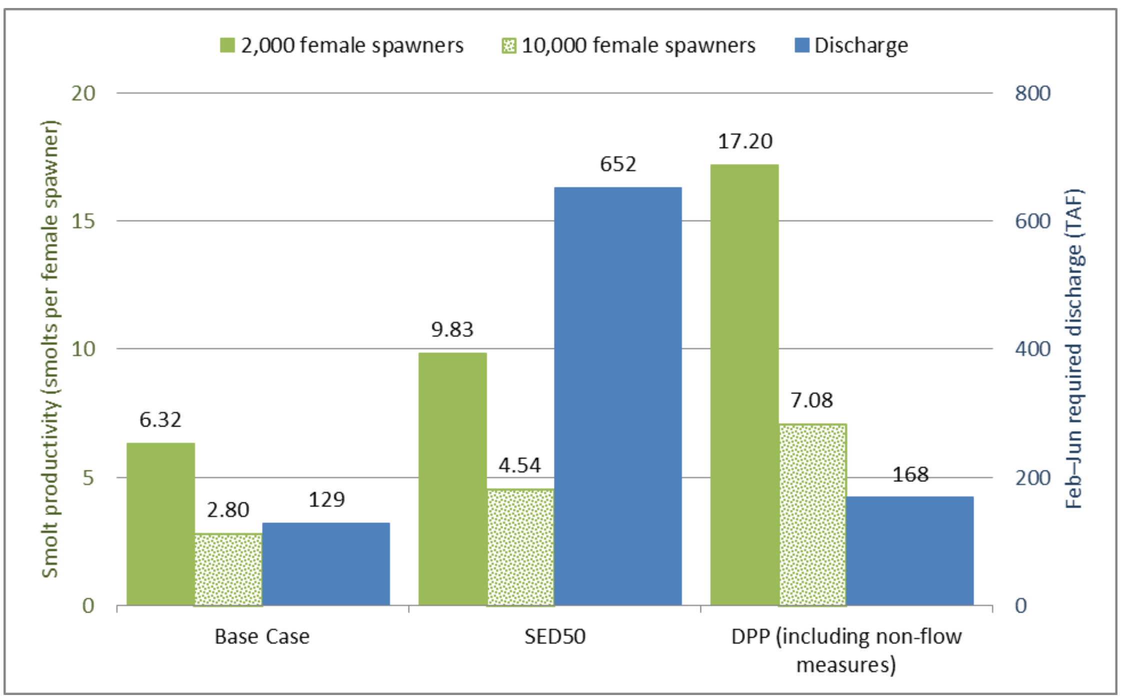

Figure 5.14-13. Fall-run Chinook smolt production and February through June required instream flows for Base Case, SWB's 50% February-June UIF scenario, and Districts' Preferred Plan.

Regarding *O. mykiss* populations on the Tuolumne River, the 50% February-June UIF scenario is projected to produce 85 YOY per female spawner while the Base Case produces 120, resulting in a 25% decrease in production under the 50% UIF scenario (Figure 5.14-14). The 50% UIF scenario minimum required instream flows are 658,000 AF for the March through September period, compared to the Base Case's 144,000 AF, a greater than 4-fold increase in water. The Districts' Preferred Plan would produce 186 YOY per female spawner while having a minimum flow requirement of 217,000 AF, equating to a 55% increase in *O. mykiss* YOY per spawner for a 51% increase in the required minimum flow over the Base Case. The Preferred Plan increases *O. mykiss* YOY more than 100% over the SED's 50% UIF, while the required minimum flow is just one-third SED's 50% UIF.

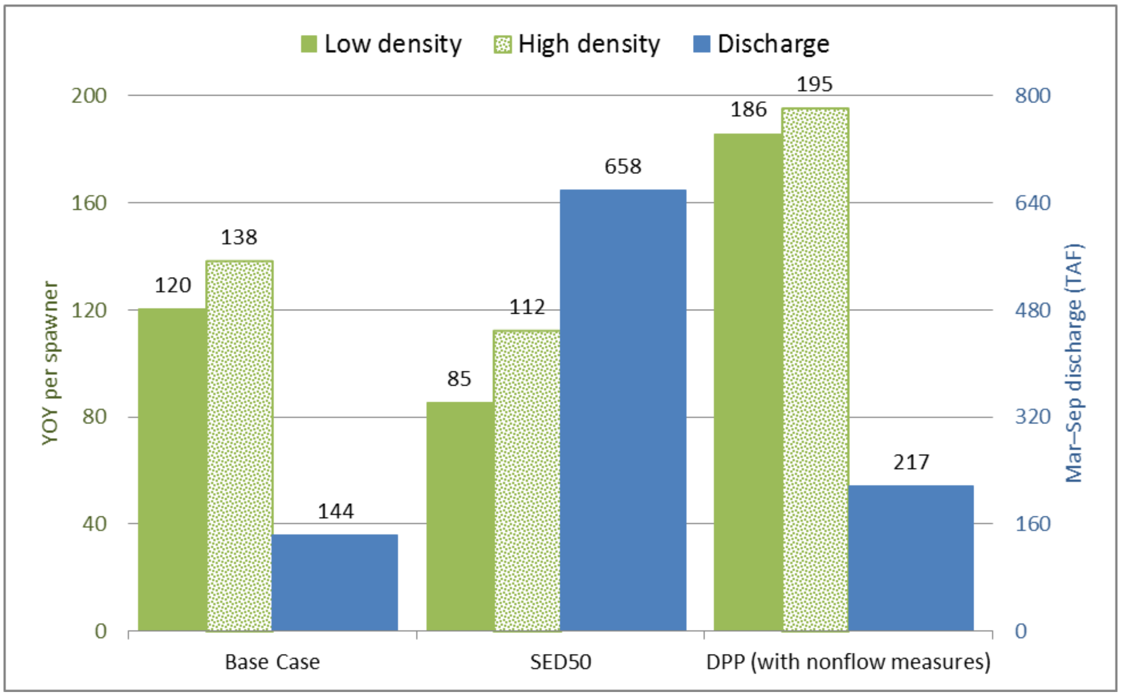

Figure 5.14-14. *O. mykiss* young-of-the-year per spawner production and March through September required flows for Base Case, SWB's 50% February-June UIF scenario, and Districts' Preferred Plan.

O. mykiss adult replacement rate under the Base Case is 0.70, while under the 50% UIF scenario it is 0.71, or no change, even though the minimum required flow has increased over 4½ times (Figure 5.14-15). The Districts' Preferred Plan increases the adult replacement rate by 38% over the Base Case and 37% over the 50% UIF.

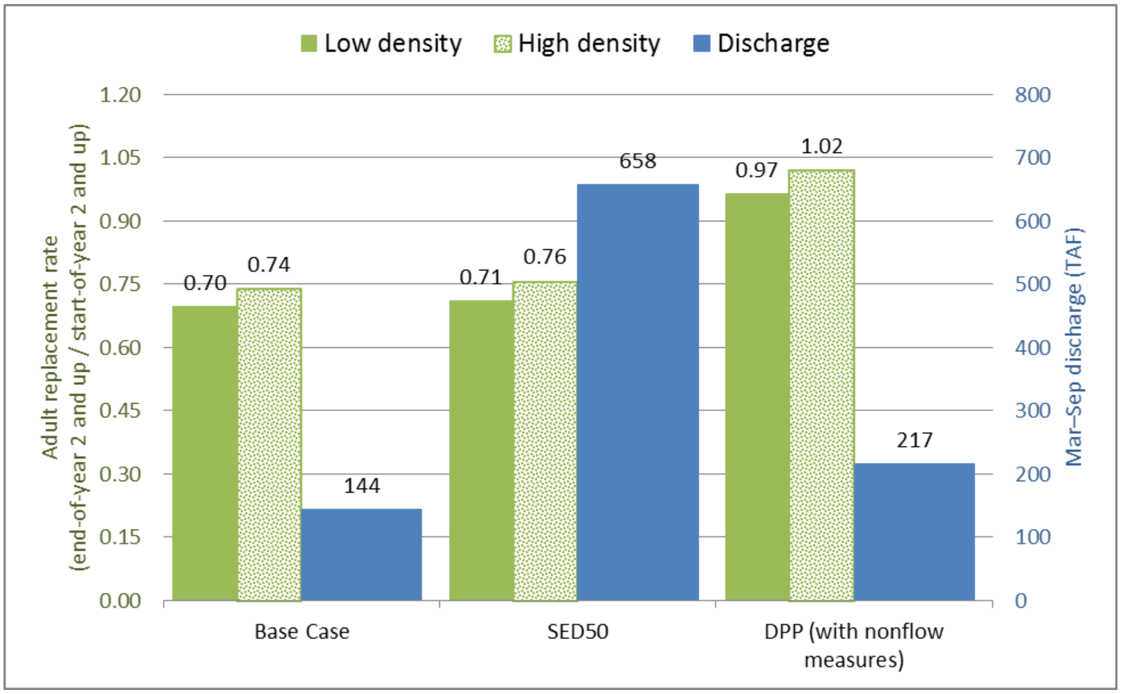

Figure 5.14-15. *O. mykiss* adult replacement rate and March through September instream flow requirement for Base Case, SWB's 50% February-June UIF scenario, and Districts' Preferred Plan.

5.14.2.6 SWB 60% Unimpaired Flow Scenario

The 60% February through June UIF scenario applies the same consistent analytical basis as the Districts' Preferred Plan and the other alternative scenarios that are without additional reservoir restrictions. The 60% February-June UIF scenario is evaluated herein because in the SED the SWB specifically refers to a report produced in 2010 entitled *Development of Flow Criteria for the Sacramento–San Joaquin Delta Ecosystem* (i.e., 2010 Flow Criteria Report) wherein the 60% February-June UIF alternative was evaluated. Based on the evaluation contained in the 2010 Flow Criteria Report, the SWB concludes that, if one were to consider only the needs of the SJR and Delta fisheries, then 60% of the unimpaired flow from February–June would be the SWB's preferred alternative. The conclusion of the 2010 Flow Criteria Report is asserted without any quantitative assessment of effects of the 60% February-June UIF at the fish population level. In fact, in the SED itself, the SWB uses the CDFW SalSim fish population model to assess effects on fall-run Chinook salmon--the indicator species--at the population level. By the SWB's own analysis in the SED, the 60% February-June UIF scenario produces fewer fall-run Chinook fish than the 40% February-June UIF scenario.[174] Neither the SED nor the 2010 Flow Criteria Report considered the effects of the 60% UIF scenario on ESA-listed *O. mykiss*.

Under the 60% February through June UIF alternative, the Districts and CCSF water supplies would be catastrophically and irreversibly impaired (see Appendix E-1, Attachment H-6). For the Districts, the five-year '88 to '92 drought is extended five years to become a 10-year drought. Water shortages of more than 40% occur for five consecutive years and in six of the 10 years,

[174] See SED, Figure 19-3 and Table 19-32.

with a shortage of 70% occurring in ’94. Water shortages exceeding 70% occur consecutively in ’76 and ‘77. Water shortages of 40% would occur in ’01, ’02, ‘03 ’04, ‘07, and ‘08 where under the Base Case there are no water shortages in any of those years. Irrigation water shortages would occur in 45% of the years in the 1971-2012 hydrologic period, whereas shortages occurred in about 15% of the years under the Base Case, and in the Base Case the shortages were less severe.

Total water supply shortages to the CCSF’s Bay Area customers are likewise catastrophic. Under the SED’s 60% February-June UIF scenario, water shortages increase from 10% per year in the five consecutive years of ’88 through ’92 under the Base Case to 95% total shortage per year for each of those five years. CCSF’s Bay Area customers would receive only 10% or less of their normal water supply in ’72, ’76, ’77, ’87, ’88, ’89, ’90, ’91, ’92, ’94, ’02, ’04, ’07 and ’08. CCSF’s Bay Area customers’ water supply would face extreme water shortages in 33% of the years from 1971 to 2012.

Don Pedro Reservoir levels would be significantly affected. As an example of the impact to reservoir levels, under the Base Case, reservoir levels do not fall below elevation 770 ft from WY 2001 through mid-2005, inclusive, while under the 60% February-June UIF, they do not rise above elevation 725 ft, from mid-WY ’87 to mid-WY ‘95. Impacts to recreation and other natural resources would be significant.

The effects to fall-run Chinook salmon and *O. mykiss* under the 60% February-June UIF scenario are shown in Figures 5.14-16, 5.14-17, and 5.14-18. Smolt productivity of fall-run Chinook salmon would increase from 6.3 under the Base Case to 11.1 smolts per female spawner, an increase of 76% (Figure 5.14-16). The February through June minimum flow requirement would increase from 129,000 AF on average under the Base Case to 795,000 AF on average, or more than 6 times, under the 60% UIF scenario. Under the Districts’ Preferred Plan, the increase in February-June required minimum flows is 30% more than the Base Case, and the smolt productivity is almost 3 times greater. The Districts’ Preferred Plan produces 55% more smolts per female spawner than the 60% UIF scenario with a required minimum flow of roughly one-fifth of the 60% UIF scenario.

Regarding *O. mykiss* populations on the Tuolumne River, the 60% February-June UIF scenario is projected to produce 81 YOY per female spawner while the Base Case produces 120, resulting in a 30% decrease in production under the 60% UIF scenario (Figure 5.14-17). Based on the modeling results, the SED’s 60% February-June UIF has an adverse impact on ESA-listed *O. mykiss.* This finding indicates the 2010 Flow Criteria Report did not adequately consider potential impacts to this listed species.

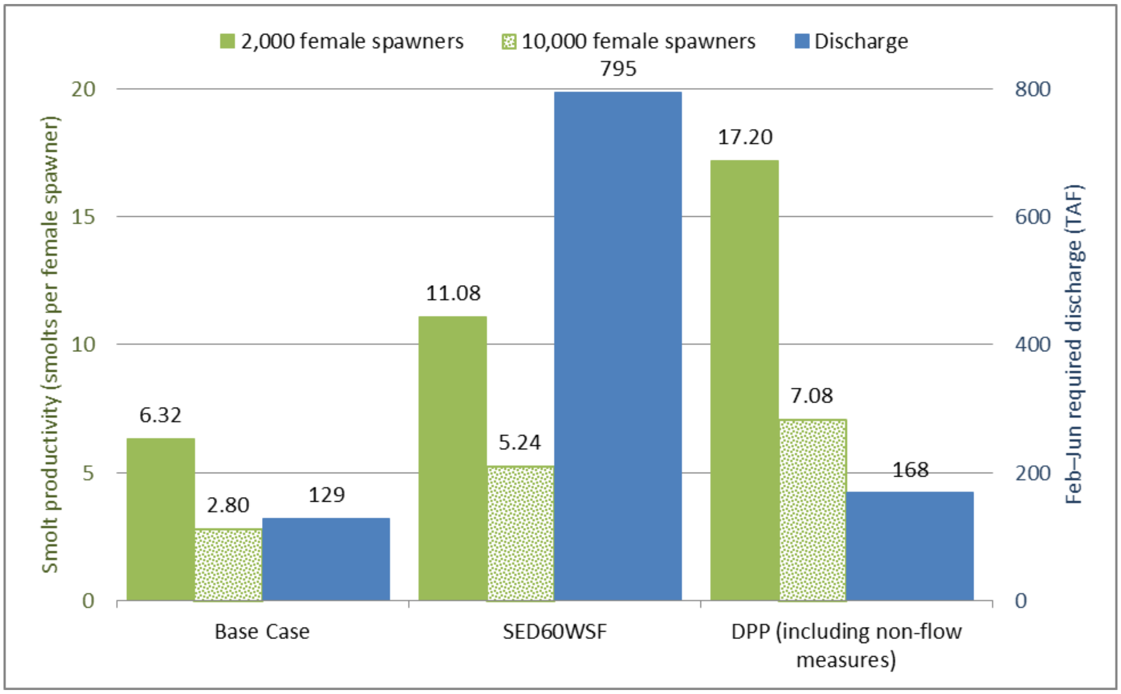

Figure 5.14-16. Fall-run Chinook smolt production and February through June required flows for Base Case, SWB's 60% February-June UIF scenario, and Districts' Preferred Plan.

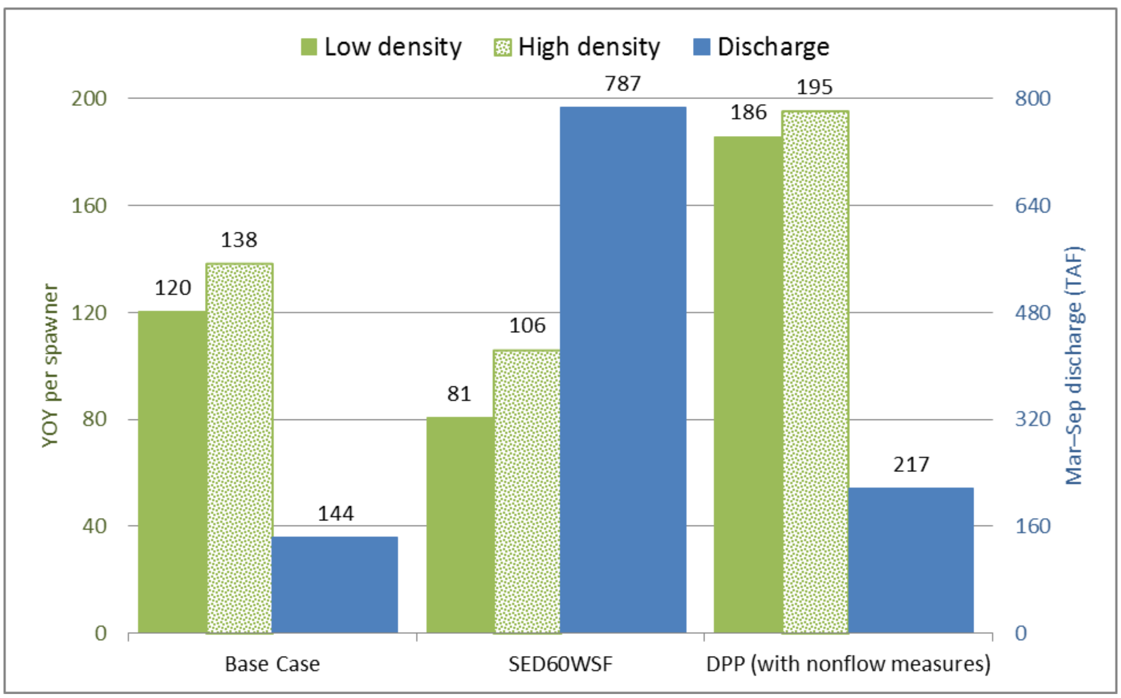

Figure 5.14-17. *O. mykiss* young-of-the-year per spawner production and March through September required flows for Base Case, SWB's 60% February-June UIF scenario, and Districts' Preferred Plan.

The 60% UIF scenario minimum required instream flows are 787,000 AF for the March through September period, compared to the Base Case's 144,000 AF, a greater than 5-fold increase. The

Districts' Preferred Plan would produce 186 YOY per female spawner while having a minimum flow requirement of 217,000 AF, equating to a 55% increase in *O. mykiss* YOY per spawner and a 51% increase in the required minimum flow over the Base Case. The Preferred Plan increases *O. mykiss* YOY more than 100% over the SED's 60% UIF, while the required minimum flow is just one-fourth the SED's 60% UIF.

O. mykiss adult replacement rate under the Base Case is 0.70, while under the 60% UIF scenario it is also 0.70, or no change, even though the minimum required flow has increased over 6 times Figure 5.14-18). The Districts' Preferred Plan increases the adult replacement rate by 38% over the Base Case and the 60% UIF.

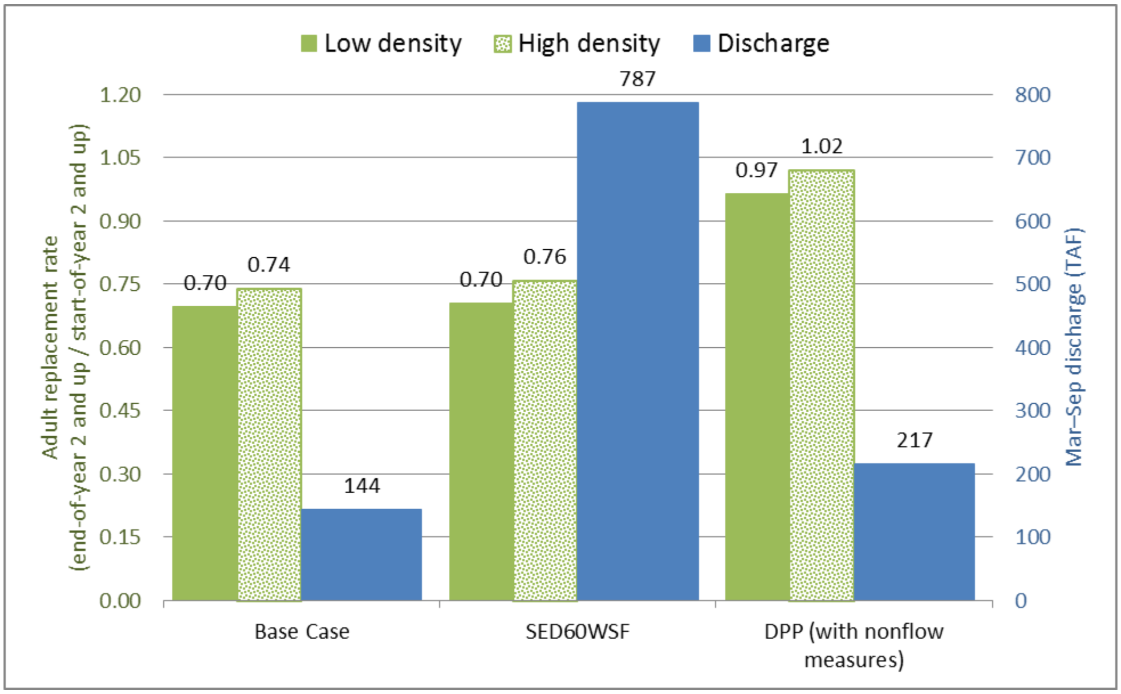

Figure 5.14-18. *O. mykiss* adult replacement rate and March through September Instream flow requirement for Base Case, SWB's 60% February-June UIF scenario, and Districts' Preferred Plan.

5.14.2.7 USFWS Flow Scenario

Comments on the Don Pedro Draft License Application submitted by the USFWS requested FERC to evaluate a number of proposed flow scenarios. The suggested flow scenarios consist of a set of base flows augmented by seasonal flows, with the seasonal flows intended to maintain certain temperatures at specific locations along the lower Tuolumne River. The suggested flow scenarios conflict with one another at times, and the USFWS was not clear as to which flow objective was the highest priority. For purposes of this AFLA, two of the suggested scenarios are evaluated independent of one another:

- Base flow scenario
- Spawning flow scenario

According to the USFWS, the "base flow" scenario is intended to *"improve the quantity, suitability, and consistency (including thermal conditions) of the aquatic habitat for all stages of steelhead"*. The flow scenario consisted of a year--round minimum flow of 275 cfs, during all water year types. In addition, water releases to the river were to be the greater of the year-round minimum flow (275 cfs) or the flow required to maintain stream water temperatures of 18° C or less from RM 52 downstream to Robert's Ferry Bridge (about RM 40).

The "spawning flow" scenario, according to the USFWS, is intended to *"improve the habitat (including thermal conditions) for spawning, egg incubation, and alevin stages of fall-run Chinook salmon and steelhead"*. This scenario consisted of providing during all WY types, from October 15 through February 15, the greater of the 275 cfs "base flow", a 1,200 cfs mid-October immigration flow, or the flow required to maintain stream water temperatures of 13°C or less from RM 52 to Robert's Ferry Bridge at RM 40 during the October 15 through February 15 period. For purposes of performing the Operations Model simulations, minimum instream flows at La Grange were capped at 2,000 cfs because as Don Pedro outflow temperatures approach 12 or 13°C, there may be no amount of flow release below a flood-flow level (9,000 cfs) which would achieve a 13°C temperature at RM 40. Detailed modeling results for these scenarios are provided in Appendix E-1, Attachment H-7.

With the "base flow" scenario, the Districts' water supplies would be severely impacted. The six-year drought of '87 to'92 would be extended two additional years. The water shortage would be 40% or greater in seven of the eight years, including 80% water shortages in '88, '91 and '92. Water shortages of 70% or more would also occur in '76, '77, '02 and '04, with shortages of 40% and 50%, respectively, in the '07 and '08 hydrology. Under the existing Base Case or Preferred Plan, there were no water shortages in '87, '94, '02' 04, '07, or '08.

Under the USFWS "base flow" scenario, there would be no water delivered from the CCSF Hetch Hetchy system to the Bay Area, which provides 85% of the water supply for CCSF's Bay Area customers, for seven consecutive years from '88 through '94.

Because of the magnitude of the water supply impacts, the effects of the USFWS "base flow" scenario on fall-run Chinook salmon and *O. mykiss* were not evaluated.

Under the "spawning flow" scenario, the Districts' water supplies would be significantly impaired as well. Water shortages during the '87 to '92 period would be more than 25% each year, and would be 30% for each year of the '88 to '92 period. Under the Operations Model's Base Case, the Districts' customers would experience no shortage in '87 and 10% to 12% shortage in each year from '88 through '91 and a 23% shortage in '92. The modeled total water shortage under the Base Case in the '87 to '92 design drought period amounts to 607,000 AF and under the USFWS "spawning flow" scenario it was 1,537,000 AF, or 2½ times greater. Under the Preferred Plan the cumulative water shortage in the '87-'92 drought amounts to 659,000 AF.

Under the USFWS "spawning flow" scenario total water shortages for the CCSF Bay Area customers would be extreme, increasing from the Base Case total shortages of 10% per year in the five consecutive years of '88 through '92 to 70% per year for each of those years. CCSF's Bay Area customers would receive only 30% of their normal total supply of water for five consecutive years under the ’88 to ’92 hydrology. Total water supply shortages to CCSF customers would also occur in the ’76-’77 hydrology, being 50% and 70%, respectively, and a 50% shortage would occur each year of the ’07-’08 hydrology. Under the Base Case, a total water shortage of 10% occurred in ’77 with no water shortages in ’76, ‘07 or ’08. Under the Preferred Plan, a water shortage of 27% occurred in ’77 with no water shortages in ’76, ’07, or ’08.

Under the USFWS “spawning flow” scenario, Don Pedro Reservoir levels would be substantially lower during the 2002 through mid-2005 period, and during the 2008 through 2010 period. Under the Base Case during the 2002 to 2005 period, the Don Pedro Reservoir level stays above 775 ft for the entire period, while under the “spawning flow” scenario, the reservoir level does not rise above 755 ft for the entire period (that is, always more than 75 ft below normal maximum). Impacts to recreation would likely be significant during that time period.

The effects to fall-run Chinook salmon and *O. mykiss* under the USFWS “spawning flow” scenario are shown in Figures 5.14-19, 5.14-20, and 5.14-21. Smolt productivity of fall-run Chinook salmon would *decline* significantly from 6.3 smolts per female spawner under the Base Case to 4.2 under the USFWS proposal, a reduction of 34% compared to the Base Case, and only 25% of the Preferred Plan’s 17.2 smolts per female spawner (Figure 5.14-19).

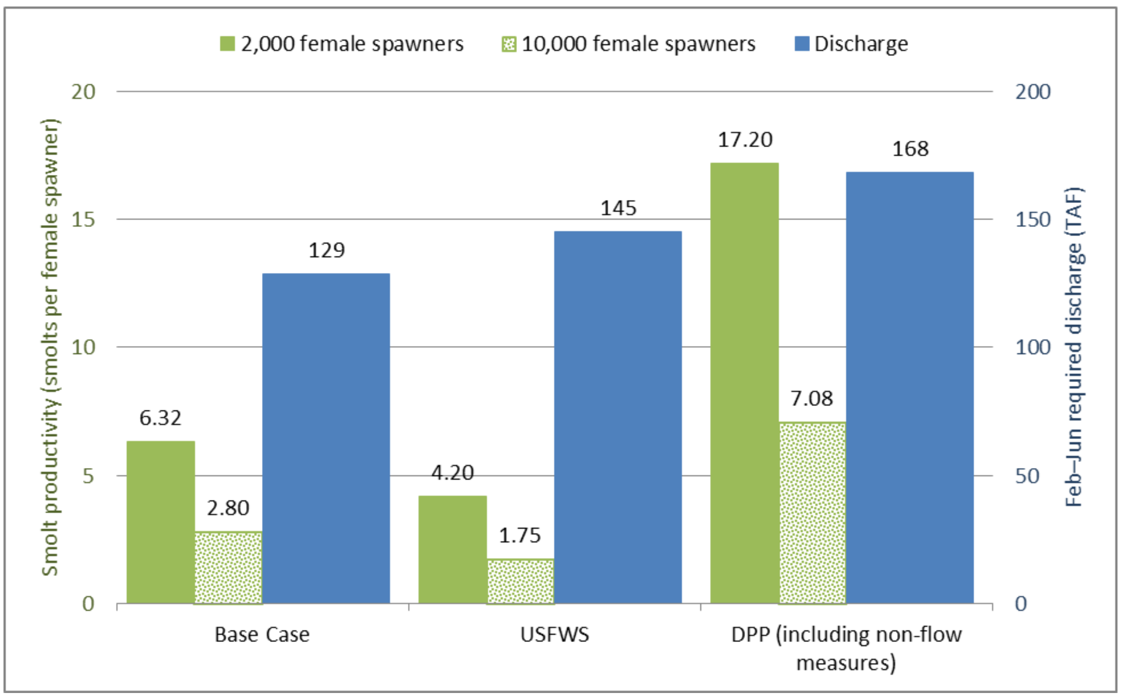

Figure 5.14-19. Fall-run Chinook smolt production and February through June required instream flow for Base Case, USFW’s “Spawning Flow” scenario, and Districts’ Preferred Plan.

The average annual required minimum flow under the USFWS “spawning flow” scenario is 445,000 AF, more than double the Base Case average annual required flow, and over 50% greater than the Preferred Plan’s. The USFWS “spawning flow” scenario does not improve overall conditions for fall-run Chinook salmon on the Tuolumne River, and is more likely to result in an adverse impact to these fish. One prominent reason for this is that the flow required to maintain 13°C at RM 40 is extremely high during the October to mid-November prime spawning season, which significantly impairs fall-run Chinook spawning habitat. It is apparent from empirical data on the Tuolumne that 13°C for the time period specified in the USFWS scenario is not an appropriate temperature benchmark for the Tuolumne River and USFWS offers no empirical data to support the need for a 13°C temperature at RM 40.

O. mykiss populations on the Tuolumne River would fare better than fall-run Chinook under the USFWS "spawning flow" scenario, but this is primarily because the October 15 through February 15 period does not represent a critical life stage period for *O. mykiss* on the Tuolumne River. The "spawning flow" scenario is projected to produce 130 YOY per female spawner, or 8% more than the 120 under the Base Case (Figure 5.14-20), but only 70% of the Preferred Plan's 186 YOY.

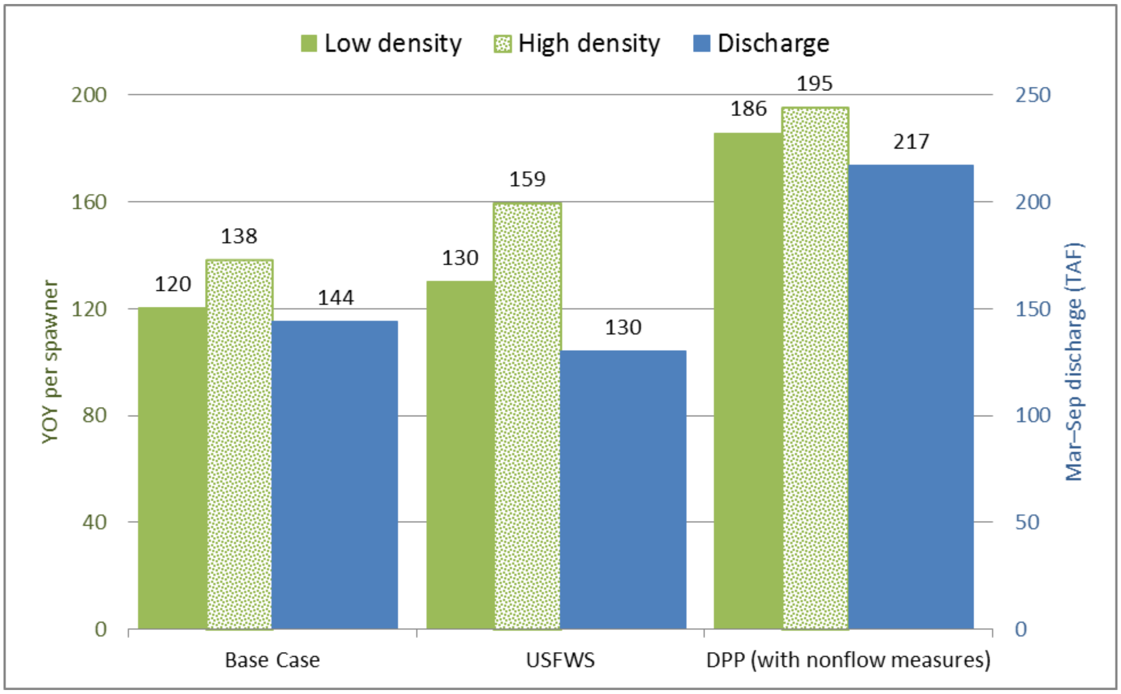

Figure 5.14-20. *O. mykiss* young-of-the-year per spawner production and March through September required flows for Base Case, USFWS's "Spawning Flow" scenario, and Districts' Preferred Plan.

Adult replacement is estimated to be 0.97, the same as the Districts' Preferred Plan, and 40% greater than the Base Case, though the "spawning flow" scenario calls for a minimum flow requirement 50% higher than the Preferred Plan and more than twice the Base Case (Figure 5.14-21).

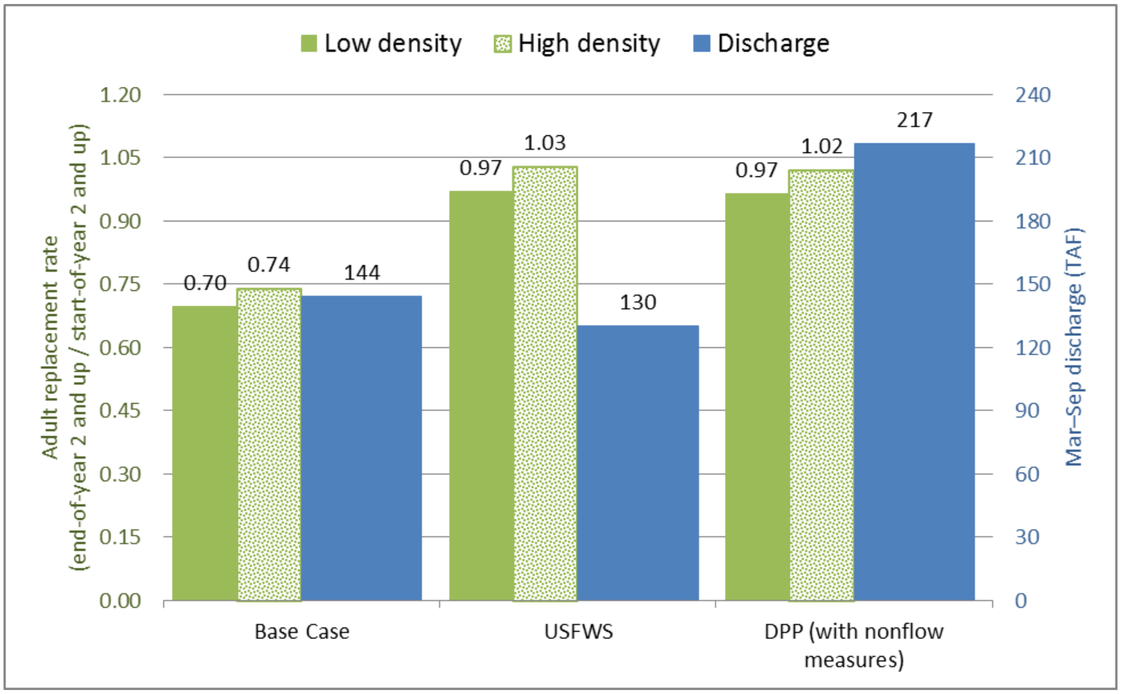

Figure 5.14-21. ***O. mykiss*** **adult replacement rate and March through September instream flow requirement for Base Case, USFWS's "Spawning Flow" scenario, and Districts' Preferred Plan.**

5.14.2.8 EPA 2003 Temperature Benchmarks: Scenario 1

In comments to the DLA, the SWB asserts that the Don Pedro Reservoir is a major contributor to elevated summer water temperatures in the lower Tuolumne River and indicates a need for a discussion of temperature impairments in the EIS to be prepared by FERC. The SWB comments noted the Project's influence on river temperature impairments will be examined in the Districts' water quality certification application when submitted to the SWB.

FERC's staff also provided comments on the DLA[175] regarding water temperatures in the lower Tuolumne River. FERC indicated that the Don Pedro FLA should include results of temperature model runs using the *"EPA (2003) criteria"* and a hydrologic period sufficient to cover the range of WY classifications provided by the San Joaquin Basin Water Supply Index. FERC staff also requested that the resulting temperature model runs be used as input to the fall-run Chinook salmon population model and the *O. mykiss* population model to examine the effects on these Tuolumne River fish species.

As reported in the April 2014 Don Pedro FLA and expanded on here in the AFLA, an evaluation has been completed of the Don Pedro Project's effects on lower Tuolumne River water temperatures and the ability of the Don Pedro Project to meet the EPA (2003) temperature benchmarks. The study approach to address the information requests of FERC and SWB staff consisted of the following steps:

[175] See FERC comments dated March 4, 2014.

- define the specific EPA (2003) temperature benchmarks to be used and when and where each applies;
- examine the effects of the "Don Pedro Reservoir" on summer water temperatures (as requested by SWB) by comparing "with dams" and "without dams" conditions on the Tuolumne River;
- using the Tuolumne River Operations Model and lower Tuolumne River Temperature Model developed during the relicensing pre-filing process, evaluate the Project's ability to meet the EPA (2003) temperature benchmarks defined in the first bullet above;
- use the flows and temperatures from the operations and temperature models to investigate effects on Tuolumne River salmonids; and
- summarize findings and conclusions.

Benchmark Temperatures

On November 12, 2010, EPA approved the California State Water Resource Control Board's 2008-2010 Section 303(d) List of Impaired Waters and disapproved the omission of several water bodies and associated pollutants that meet federal listing requirements. On October 11, 2011, EPA issued its final decision regarding the waters EPA added to the State of California's 303(d) list (EPA 2011). Included in Enclosure 2 to that decision is EPA's determination that the Tuolumne River from Don Pedro Reservoir to the San Joaquin River has *"water quality-limited segments still requiring TMDLs for temperature pursuant to CWA, sec. 303(d) and 40 CFR 130.7(b)"*. According to EPA, the water quality limited segments and their temperature benchmarks[176] for the Tuolumne River are:

- River Mile (RM) 52 (La Grange powerhouse) to RM 3.4 from Sept 1 to Oct 31, 7DADM of 18°C (adult Chinook salmon migration);
- RM 52 to RM 26 from Oct 1 to Dec 15, 7DADM of 13°C (Chinook salmon spawning);
- RM 52 to RM 3 from March 15 to Jun15, 7DADM of 16°C (Chinook juvenile rearing and smoltification); and
- RM 52 to RM 42.6 from June 15 to Sept 15, 7DADM of 18°C (*O. mykiss* summer rearing).[177]

It is noteworthy that the EPA did not identify any temperature impairment at the discharge from Don Pedro powerhouse or La Grange powerhouse at RM 52, the points of compliance under Section 401 of the Clean Water Act.

[176] The EPA determination specifically refers to the temperatures used to judge "impairment" as "benchmarks", not water quality "criteria". The California water quality control standards applicable to the Tuolumne River do not contain numeric temperature criteria. Apparently the temperature "benchmarks" EPA applied were from *Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards. EPA 910-B-03-002*.

[177] EPA identifies this temperature benchmark as applying to "steelhead trout".

Effect on the Don Pedro Reservoir on Tuolumne River Water Temperatures

To evaluate the influence of the Don Pedro Reservoir on summer water temperatures and potential temperature impairments in the lower Tuolumne River, it is helpful to begin by developing an understanding of the river's temperature regime if there were no dams in the watershed. Watercourse Engineering undertook a study to simulate water temperatures in the main stem Tuolumne River without the Hetch Hetchy, Don Pedro, or La Grange projects in place; that is, without reservoirs or regulation in the watershed (Jayasundara et al. 2017). These temperatures could then be compared to the existing temperature regime of the lower Tuolumne River. In summary, Jayasundara et al. found that equilibrium temperatures in the Tuolumne River were likely to have occurred well above RM 81, upstream of the upper end of the current Don Pedro Reservoir.

A model update of "without dams" was prepared using the expanded temperature and river geometry data available since the 2013 report (Jayasundara et al. 2017). The report shows that summer 7DADM temperatures would have typically reached an equilibrium temperature exceeding 25°C by August 1 as far upstream as the present location of Early Intake at RM 106, more than 50 miles upstream of Don Pedro Dam. At RM 54, Don Pedro Dam, outflow temperatures under "with" dams normally range from 9 to 12°C under existing conditions, and are always less than "without" dams except from November through February, when "without" dams would have fallen below 9°C. Therefore, regarding the SWB's request to evaluate the effects of the Don Pedro Reservoir on summer temperatures in the Tuolumne River, it is concluded that the effect is to reduce the summer temperatures in the lower Tuolumne River by more than 13°C in the late July through early September period. Further, July through October temperatures under existing conditions generally would be cooler than "without dams" until about RM 34, which corresponds to roughly the downstream limit of the gravel-bedded reach, and is downstream of the *O. mykiss* preferred habitats. Further discussion of these results are contained in Attachment C of this AFLA.

Flows Required to Meet EPA (2003) Temperature Benchmarks on the Tuolumne River

To address FERC's comment to the DLA regarding modeling EPA (2003) temperature benchmarks, a study was conducted to investigate the amounts of water needed to meet the four specific temperature benchmarks identified in the EPA's October 2011 Tuolumne River impairment ruling. This alternative flow scenario is referred to herein as "EPA 2003: Scenario 1", as the Districts have modeled the EPA (2003) scenario under two alternate simulation approaches. The "EPA 2003: Scenario 1" analysis was performed using the Tuolumne River-specific operations and river temperature models developed as part of the relicensing process and placed no upper limit on flow releases when attempting to "comply" with the EPA temperature benchmarks, except that flow releases must not exceed the flooding limit of 9,000 cfs. This analysis was presented in the April 2014 Don Pedro FLA and is also included in Attachment A to this AFLA.

In summary, the EPA 2003: Scenario 1 analysis demonstrated that even with both the Don Pedro Reservoir and all of the Hetch Hetchy system reservoirs devoted *solely* to trying to meet the referenced EPA temperature benchmarks, not all of the EPA (2003) temperatures could be met in

41 of the 42-year period of analysis. Temperature exceedances of more than 50 days would occur in 70 percent of the years. This EPA 2003: Scenario 1 eliminated all deliveries of water to the Districts' irrigation and M&I customers, and eliminated all of CCSF's San Joaquin Pipeline deliveries to the Bay Area for the full 42-year period of analysis. Even with the complete elimination of all consumptive uses of Tuolumne River water, including the elimination of irrigation of 200,000 acres of Central Valley farmland and 85 percent of the water supply to CCSF's customers in the Bay Area, the EPA temperature benchmarks could not be met.

Effects on Salmonids of EPA (2003): Scenario 1 Flows

In accordance with the comments on the Districts' 2013 DLA provided by FERC, the Districts also modeled the effects to fall-run Chinook and *O. mykiss* of the reservoir outflows resulting from the "EPA (2003): Scenario 1" analysis. The Operations Model results show that even with dedicating the entire CCSF Hetch Hetchy system and the Districts' Don Pedro Project to the purpose of temperature management to meet the EPA 2003 temperature benchmarks, compliance with the temperature benchmarks cannot be met in 41 of the 42 year 1971-2012 period. An analysis of the effects of these outflows on fish was completed and results reported in the April 2014 FLA and are provided again in the AFLA (see Attachment C). It should be pointed out that the April 2014 fish populations assessments did not include the effects to water temperatures that occur when the Hetch Hetchy and Don Pedro reservoirs are drawn to extremely low levels for extended periods of time, which would likely result in warmer reservoir outflows and river temperatures, and therefore, may affect the target species beyond the results of the analysis provided in Attachment C.

Findings and Conclusions

The temperature benchmarks applied by EPA to Tuolumne River Chinook salmon and *O. mykiss* were derived from its 2003 report entitled *Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards*. Based on these benchmark temperatures, EPA has classified certain reaches of the lower Tuolumne River as impaired for temperature. In comments to the Don Pedro DLA, FERC requested the Districts evaluate EPA (2003) temperature benchmarks using the set of models developed as part of the Don Pedro Project relicensing. Considering the EPA (2003) temperature benchmarks as presumed temperature "compliance points", the Operations and River Temperature models were run for the 42-year period of record from 1971 to 2012. The Operations Model was run with the EPA temperature benchmarks as the first priority to be met before any water supply needs could be served. Results indicate that even when the only purposes of the CCSF Hetch Hetchy water supply system and the Districts' Don Pedro Project are dedicated to meeting the EPA (2003) temperature benchmarks, there are more than 50 days of temperature exceedances in 70% of the 42-year period, and temperature exceedances occur in 41 of 42 years. Eliminating all consumptive use purposes of the Tuolumne River and operating the existing reservoir systems only for temperature compliance is not sufficient to meet the EPA (2003) temperature benchmarks applied by the EPA to the Tuolumne River.

Applying a "without dams" temperature model of the Tuolumne River (Jayasundara et al. 2017) demonstrated that the only temperature benchmark that would have been met routinely with no dams or flow regulation in the Tuolumne watershed is the March 15 to June 15 7DADM temperature of 16°C. Even as far upstream as RM 106 in the upper Tuolumne River, the EPA (2003) *O. mykiss* over-summering 7DADM temperature of 18°C, the fall-run Chinook adult upmigration 7DADM temperature of 18°C, and the spawning 7DADM temperature of 13°C would have been routinely exceeded, in many years by more than 5°C. A direct application of EPA (2003) temperatures to the accessible reaches of the upper Tuolumne River would lead to a finding that historically the upper river, above Don Pedro Reservoir, would have been unsuitable for anadromous Chinook salmon and steelhead due to temperature impairment.

If dedicating all the water storage and flow in the Tuolumne River to meeting the EPA (2003) temperature benchmarks is not sufficient to do so, and if "without dams" temperatures consistently violated the temperatures reportedly necessary to protect salmonids in the upper river, then it must be concluded that either the EPA (2003) temperature benchmarks are not relevant to the Tuolumne, or there were few, if any, salmonid populations ever in the Tuolumne River, given the natural barriers in the river which prevent fish from ascending the main stem and the major tributaries.[178]

5.14.2.9 EPA 2003 Temperature Benchmarks: Scenario 2

A review of the output of the modeling results for "EPA 2003: Scenario 1" revealed that high flows were frequently called for from the Don Pedro and Hetch Hetchy reservoirs to meet EPA temperature benchmarks which were essentially impossible to meet on the Tuolumne River no matter what flow was released. Therefore, the Districts attempted a second simulation of the EPA 2003 temperature benchmarks scenario. This additional attempt applied a capped flow of 2,000 cfs when trying to meet a temperature benchmark, as was applied in the USFWS "spawning flow" scenario. Using the same temperature benchmarks as in "EPA 2003: Scenario 1" and the capped flow, the "EPA 2003: Scenario 2" simulation evaluated the effects on water supplies and salmonid fisheries. Detailed modeling results for the scenario is provided in Appendix E-1, Attachment H-8.

Under the "EPA 2003: Scenario 2", the Districts' water supplies would be significantly impacted. Water shortages during the '87 to '92 period would be at least 50% in five of the six years, and 40% the remaining year and would be at least 30% for each year of the '88 to '92 period. Under the Base Case, the Districts' customers would experience no shortage in '87 and 10% to 12% shortage in each year from '88 through '91 and a 23% shortage in '92.

Under the "EPA 2003: Scenario 2", the Districts would experience additional water shortages of 50% and 80%, respectively, in '76 and '77, and 50% in '02, '03, and '04, '07, and '08. The modeled total water shortage under the Base Case in the '87 to '92 design drought period is 607,000 AF and under the USFWS "spawning flow" scenario is 2,872,000 AF, or almost five times greater.

Assuming that CCSF was responsible for contributing 51.7% of any required instream flow releases above the Bas Case under the EPA 2003: Scenario 2", water shortages for the CCSF's Bay Area customers would again be catastrophic, increasing from the Base Case shortages of

[178] As reported in the La Grange Hydroelectric Project's Final License Application to FERC, October 2017.

10% per year in the five consecutive years of ’88 through ’92 to essentially 100% from ’87 through ’92. CCSF’s 2.6 million Bay Area customers would be without Hetch Hetchy water supply for six consecutive years under the ’87 to ’92 hydrology. Water supply shortages to CCSF customers from Hetch Hetchy would be 100% as well in the ’76, ’77, ’94, ’02, ’07, ’08, and ’09.

Under the “EPA 2003: Scenario 2” scenario, the Don Pedro Reservoir level would rise above approximate elevation 728 ft , or 100 feet below the normal maximum, just once in the eight-year period from mid-1987 to mid-1995. Extremely low water levels would occur continuously from 2001 through 2005, and during the 2008 through 2010 period. Under the Base Case during the 2002 to mid- 2005 period, the Don Pedro Reservoir level stays above 775 ft for the entire period, while under the “spawning flow” scenario, the reservoir level does not exceed about 750 ft for the entire period. Impacts to reservoir recreation and reservoir-related cultural, terrestrial, and aquatic resources would likely be significant during that time period.

The effects to fall-run Chinook salmon and *O. mykiss* under the “EPA 2003: Scenario 2” are shown in Figures 5.14-22, 5.14-23, and 5.14-24. Smolt productivity of fall-run Chinook salmon would improve from the Base Case value of 6.3 to 7.6 smolts per female spawner, an increase of 21% compared to the Base Case, but only 44% of the Preferred Plan’s 17.2 smolts per female spawner (Figure 5.14-22). The average annual required minimum flow under the EPA 2003: Scenario 2 is 735,000 AF, almost 3.5 times more flow than the Base Case average annual required flow, and over three times greater than the Preferred Plan’s. Therefore, the “EPA 2003: Scenario 2” improves fall-run Chinook smolt productivity by 21% by using 3.5 times more flow than the Base Case, while producing just 44% of the Preferred Plan’s smolt production and using more than 3 times the required flow.

“EPA 2003: Scenario 2” is projected to produce 114 YOY *O. mykiss* per female spawner, or 5% *fewer* than the 120 under the Base Case (Figure 5.14-23).

Adult replacement rate is estimated to be 0.99, slightly greater than the Districts’ Preferred Plan of 0.97, and 43% greater than the Base Case, though the “EPA 2003: Scenario 2” calls for a minimum flow requirement three times greater than the Preferred Plan; that is, the additional 500,000 AF of water per year, or enough to irrigate 125,000 acres of prime farmland, would improve the adult replacement rate of *O. mykiss* by 2% (Figure 5.14-24).

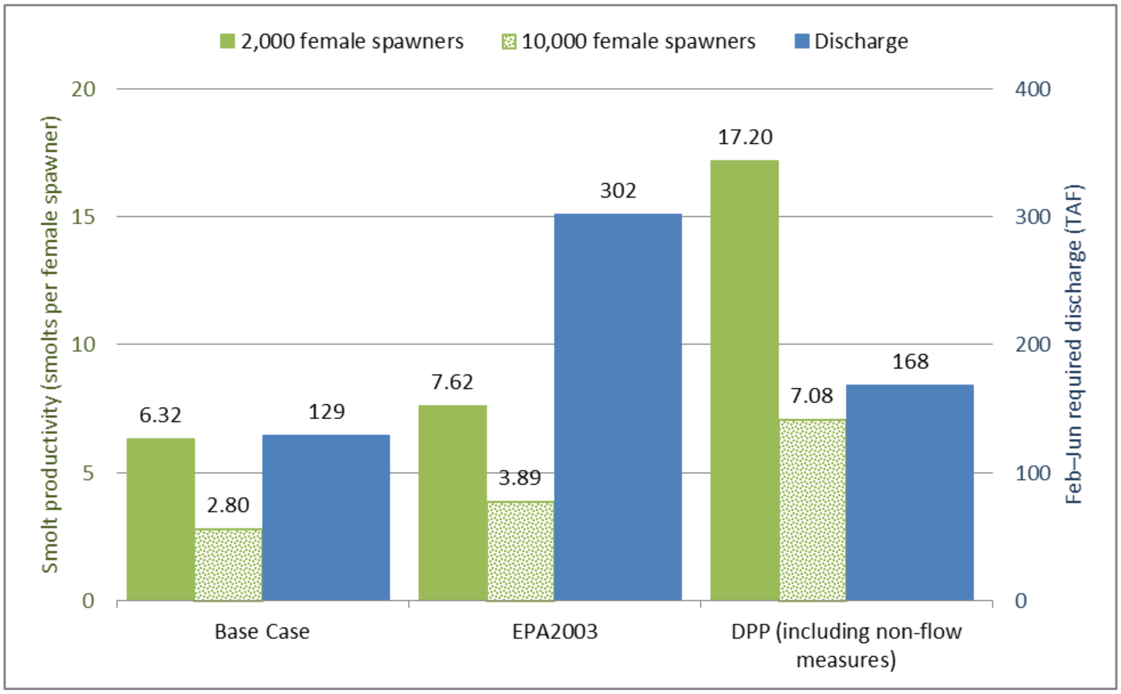

Figure 5.14-22. Fall-run Chinook smolt production and February through June required instream flows for Base Case, "EPA 2003: Scenario 2", and Districts' Preferred Plan.

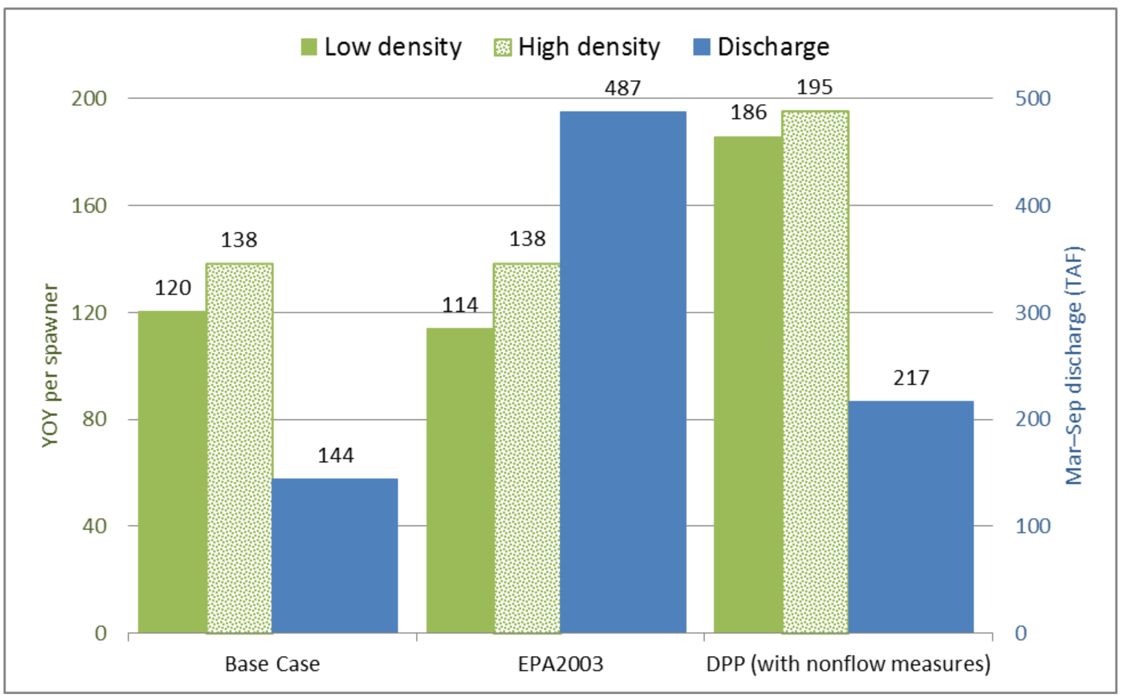

Figure 5.14-23. *O. mykiss* young-of-the-year per spawner production and March through September required flows for Base Case, "EPA 2003: Scenario 2", and Districts' Preferred Plan.

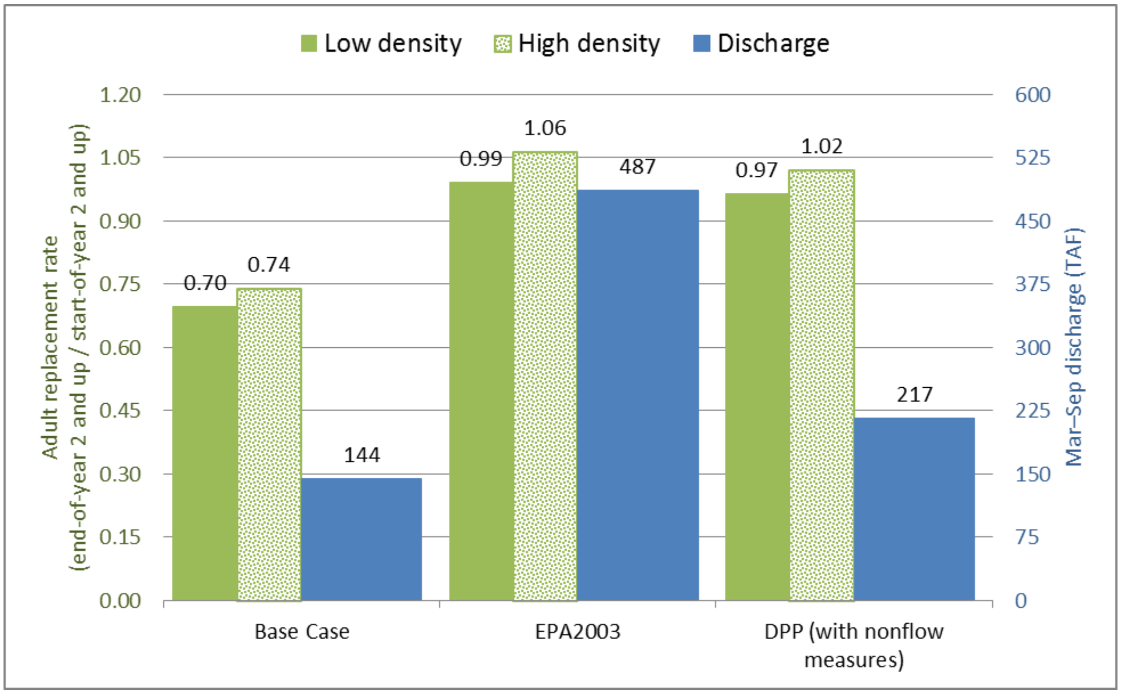

Figure 5.14-24. ***O. mykiss*** **adult replacement rate and March through September instream flow requirement for Base Case, "EPA 2003: Scenario 2", and Districts' Preferred Plan.**

5.14.2.10 Summary of Modeling Results of Alternative Flow Scenarios

A total of nine alternative flow scenarios were modeled using the Tuolumne River Operations Model, the Tuolumne River Temperature Model, and the fall-run Chinook and *O. mykiss* in-river fish population models developed as part of the FERC relicensing process. The water supply impacts of the alternatives are provided in the individual run summaries provided in Appendix E-1, Attachment H.

A summary of the water supply effects of the alternative flow scenarios are provided in Table 5.14-1.

A summary of the effects of each alternative to fall-run Chinook and *O. mykiss* is provided below in Table 5.14-2. The socioeconomic effects of alternative flow scenarios are discussed below.

Table 5.14-1. Summary of water supply effects of alternative flow scenarios.

Option	Required Minimum Flow		Water Supply Effects			
	Average Annual		Districts Shortage		CCSF Shortage	
	'71-'12 (TAF)	'88-'92 (TAF)	'88-'92[1] (%)	88-'92 (TAF)	'88-'92 (%)	88-'92 (TAF)
Base Case	216	107	14%	608	10%	99
Districts' Preferred Plan	291[2]	175[2]	15%[3]	661[3]	13%	130
20% Feb - Jun Unimpaired Flow (UIF)	406	234	19%	828	35%	427
30% Feb - Jun UIF	534	307	22%	948	45%	580
40% Feb - Jun UIF	673	386	30%	1,273	65%	841
40% Feb - Jun UIF with Reservoir Restrictions	673	386	42%	1,790	65%	841
50% Feb - Jun UIF	813	466	41%	1,753	80%	1,044
60% Feb - Jun UIF	956	548	42%	1,795	95%	1,246
USFWS Flow Scenario	445	364	30%	1,294	70%	890
EPA 2003 Temperature Benchmarks: Scenario 2	735	716	49%	2,412	100%	1,335

[1]The ’88–’92 period is a series of consecutive drought years representing the Districts’ design drought period within the ’77-’12 modeling period of record. More severe droughts may have occurred over a longer period of record. CCSF’s design drought is the ’87-’92 hydrology followed by the ’76-’77 hydrology.
[2]As measured at the La Grange gage.
[3]Assumes IG-1 and IG-2 are installed and operational. If the IGs are not operational, shortage is 19% and 800 TAF.

Table 5.14-2. Summary of the effects of each alternative to fall-run Chinook and *O. mykiss*.

Option	Required Minimum Flow		Fall-Run Chinook Salmon					*O. mykiss* Juveniles					*O. mykiss* Adult Replacement				
	Average Annual		Smolts Per Female Spawner[2]	Feb-Jun Required Flow (TAF)	Change From Base Case		Smolts Per 1,000 AF	YOY Per Female Spawner[3]	Mar-Sep Required Flow (TAF)	Change From Base Case		YOY Per 1,000 AF	Replacement Rate	Mar-Sep Required Flow (TAF)	Change From Base Case		Replacement Rate Per 1,000 AF[4]
	'71-'12 (TAF)	'88-'92 (TAF)			Smolts (%)	Flow (%)				YOY (%)	Flow (%)				Adults (%)	Flow (%)	
Base Case	216	107	6.3	129	N/A	N/A	98	120	144			418	0.70	144			N/A
Districts' Preferred Plan	291[1]	175[1]	17.2	168	172%	31%	204	186	217	54%	50%	428	0.97	217	39%	50%	0.0033
20% Feb - Jun Unimpaired Flow (UIF)	406	234	7.1	319	12%	147%	45	112	311	-7%	116%	180	0.72	311	3%	116%	0.0018
30% Feb - Jun UIF	534	307	8.3	446	31%	246%	37	104	427	-14%	196%	122	0.72	427	3%	196%	0.0014
40% Feb - Jun UIF	673	386	8.7	516	38%	300%	34	121	533	1%	270%	114	0.77	533	11%	270%	0.0011
40% Feb - Jun UIF with Reservoir Restrictions	673	386	8.7	516	37%	300%	34	94	533	-22%	270%	88	0.71	533	2%	270%	0.0011
50% Feb - Jun UIF	813	466	9.9	652	57%	406%	30	87	658	-28%	357%	66	0.71	658	2%	357%	0.0009
60% Feb - Jun UIF	956	548	11.1	795	75%	517%	28	81	787	-33%	446%	51	0.70	787	1%	446%	0.0007
USFWS Flow Scenario	445	364	4.2	145	-34%	13%	58	130	130	8%	-10%	500	0.97	130	39%	-10%	0.0022
EPA 2003 Temperature Benchmarks-Scenario 2	735	716	7.6	302	21%	135%	50	114	487	-5%	238%	117	0.99	487	43%	238%	0.0014

[1]As Measured at the La Grange gage.
[2]Based on 2,000 female spawners.
[3]Based on 500 adults.
[4]Adult replacement rate per spawner per 1,000 AF is based on "replacement rate" divided by "average annual required minimum flow" because, while YOY life stage critical period spans the March through September period, adults are subject to year-round flows.

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5.14.3 Summary of Socioeconomic Impacts

The Don Pedro Project is an essential element to the economy of the San Joaquin Valley. The Project's primary purpose is to provide irrigation water to more than 200,000 acres of highly-productive farmland, drinking water to residential and business customers, storage for flood management, recreation, and protection of aquatic resources. In addition, the Project provides important benefits to the Bay Area by allowing operational flexibility and increased reliability for CCSF's water supply system. Any changes in the Project operations which reduce historical water supplies, especially during drought and extended drought periods, will have important effects on the many uses of Project water. Those changes in turn may have important socioeconomic impacts on many communities, businesses, and key industries throughout Stanislaus, Merced, and Tuolumne counties, along with the San Francisco Bay Area. The water supplies provided by the Project sustains almost 20,000 jobs in Stanislaus and Merced counties, an area with a 2016 unemployment rate of 11.7% in 2014, 10.1% in 2015 and 9.1% in 2016. [179] On average over these three years, the local unemployment rate was 62% higher than the State's average unemployment rate.

The Districts' April 2014 application to FERC for a new license included the Socioeconomics Study report which provides the baseline against which those impacts can be measured. The report describes in detail the economic and community profiles of the study area, including the populations and industries which are directly and indirectly affected by the Project. The Don Pedro Project is shown to be a major force by supporting agriculture and many other industries which provide thousands of jobs and millions of dollars of output and income in the central San Joaquin Valley. Many parts of the study area are environmental justice communities, and changes in Project operations which result in reduced water supplies for agriculture and other industries can be expected to have disproportionate adverse effects on those communities and the businesses which serve and are served by them.

Agriculture has been, and remains, the economic backbone of the region, particularly in Merced and Stanislaus counties. Agriculture has been a foundation industry of the San Joaquin Valley for more than 150 years. Agriculture in the area began as land-extensive livestock and grain centric; but with early development of groundwater supplies, agriculture became increasingly land intensive. However, then, as now, groundwater overdraft demonstrated the limits of such supplies. Development of surface water supplies encouraged additional land cultivation and offset the groundwater overdraft problems that resulted from widespread pumping in many parts of the Valley.

Water supply reliability has been a critical issue for agriculture in the San Joaquin Valley. In this respect, the Don Pedro Project has been crucial to the development of crop and dairy production in the MID and TID service areas. Water supply reliability has been one of the most important factors supporting the large investments made by farmers in such permanent crops as almonds, peaches, and grapes; and in the livestock operations which rely on the associated production of corn silage, alfalfa, and other forage crops.

[179] California Employment Development Department (EDD) n.d.

Agricultural operations in the Districts' service areas represent a cornerstone in the regional economy of Stanislaus and Merced counties. In revenue alone, farmers in the Districts' service areas contribute an estimated $1.2 billion annually into the local economy; $527.9 million from crop production and $665.5 million from livestock operations. In addition to supporting about 7,500 on-farm (direct) jobs generating $202.5 million in labor income.

The development of agriculture stimulated the concurrent development of a plethora of businesses in the agricultural sector which both support and are supported by agriculture. Consequently, the estimated $1.2 billion in annual direct gross agricultural production within the Districts' service areas supports an additional $2.9 billion in annual output, taking into account both the businesses that support and which are supported by production agriculture. These industries create another 11,400 jobs generating $532.3 million in labor income. Among major employers in Stanislaus and Merced counties, half are directly related to agriculture.

The current local and regional economies are dependent on reliable water supplies. Drought periods can cause major economic disruption to employment and economic output. Neither Stanislaus County nor Merced County would have the agricultural strength they have absent the reliability of consistent irrigation water provided by the Don Pedro Project. Groundwater availability and quality are not sufficient to independently support the large, highly-productive agricultural land base in the area.[180] Thus, Tuolumne River water provided through the Don Pedro Project is critical to the success of agriculture and the communities supported by it.

Land values, particularly agricultural land values, are affected by the availability and reliability of affordable water and electricity from the Project. Irrigators who have access to reliable water supplies at reasonable costs will be able to deal with global market pressures and future risks. The availability of low-cost, reliable water supplies is capitalized into land values because those values frequently reflect the stream of net income available from the land. Land values in the Districts' service areas have been relatively stable despite the economic recession, the effects of which have been offset by high crop prices, low interest rates, and reliable water supplies. Currently, cropland in the Districts' service areas is valued higher than similar cropland in other districts served by both surface water and groundwater. The land valuation is important in supporting the decisions by irrigators to invest in permanent and other high-value crops that account for such a large part of overall agricultural value in the area.

The Don Pedro Project has many positive direct and indirect economic effects on the entire regional economy within Stanislaus, Merced, and Tuolumne counties. With reliable irrigation water supplies, it directly supports the vibrant agricultural sector which has evolved in the Districts' service areas. And by extension, it indirectly supports the large agribusiness complex that has developed around crop and dairy farm production, including input suppliers, dairy plants, food processing businesses, and many others. The Don Pedro Project also supports reasonably-priced M&I water supplies that are essential to meet population and business growth in the area.

[180] For a discussion of groundwater conditions and availability now and for the foreseeable future in the Modesto and Turlock groundwater basins, see Exhibit B of this AFLA.

Recognizing the primary purpose and need of the Don Pedro Project being water supply, FERC's Scoping Document 2 (SD2) dated July 25, 2011, stated that the environmental assessment of the Project would examine "the socioeconomic effects of any proposed measures to change Don Pedro Project operations on affected governments, residents, agriculture, businesses, and other related interests." SD2 also references the potential for "water supply effects on San Francisco Public Utility Commission's retail and wholesale customers if the CCSF were required to provide additional water to the Districts to support a change in operation for environmental mitigation." Accordingly, the Districts prepared a study plan addressing socioeconomic resources directly affected by Project operations. In addition, CCSF indicated that it would prepare a socioeconomic study of the effects of potential changes in water supplies to its Bay Area customers as a result of relicensing; CCSF filed a study plan with FERC for information purposes on December 8, 2011.

The Districts' Preferred Plan is specifically designed to achieve the dual goals of protecting the surface water supplies of the Districts' customers and significantly improving the in-river habitat and productivity of the native salmonids of the Tuolumne River. At the same time, the Districts' Preferred Plan recognizes and protects the critical role of the Don Pedro Project for providing reliable water supplies to CCSF's Bay Area customers. In accordance with the requirements described in the SD2, the economic impacts of the Preferred Plan and alternative Don Pedro Project operations scenarios were evaluated to examine the range of economic effects resulting from the various scenarios. A summary of the resulting economic analyses is provided in Figures 5.14-25 and 5.14-26.

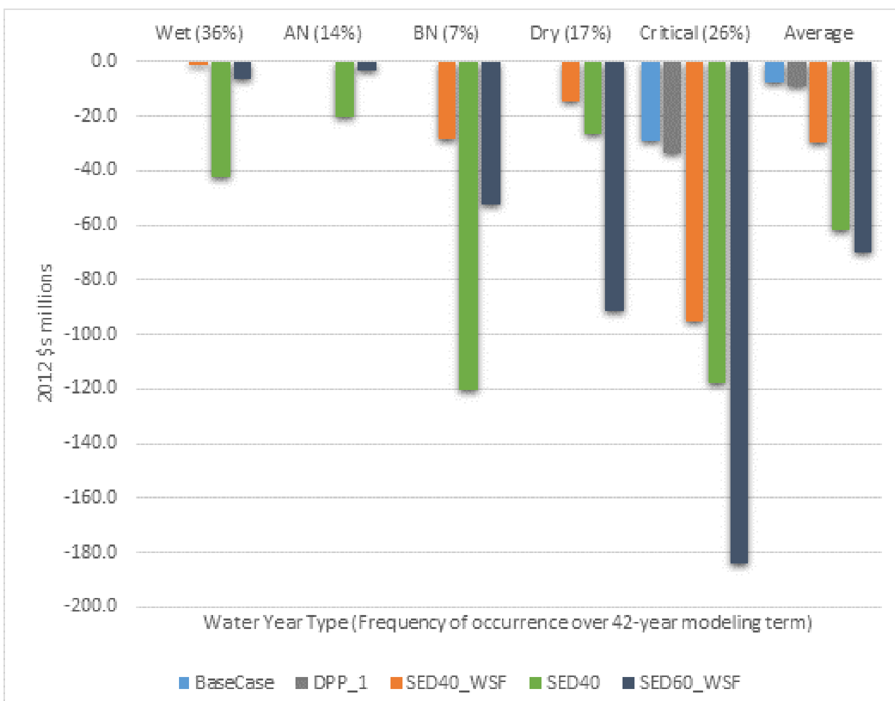

Figure 5.14-25. Average farmgate loss, in millions of dollars, for alternative Project operation scenarios grouped by water year type; difference from Full Demand (2012 $).

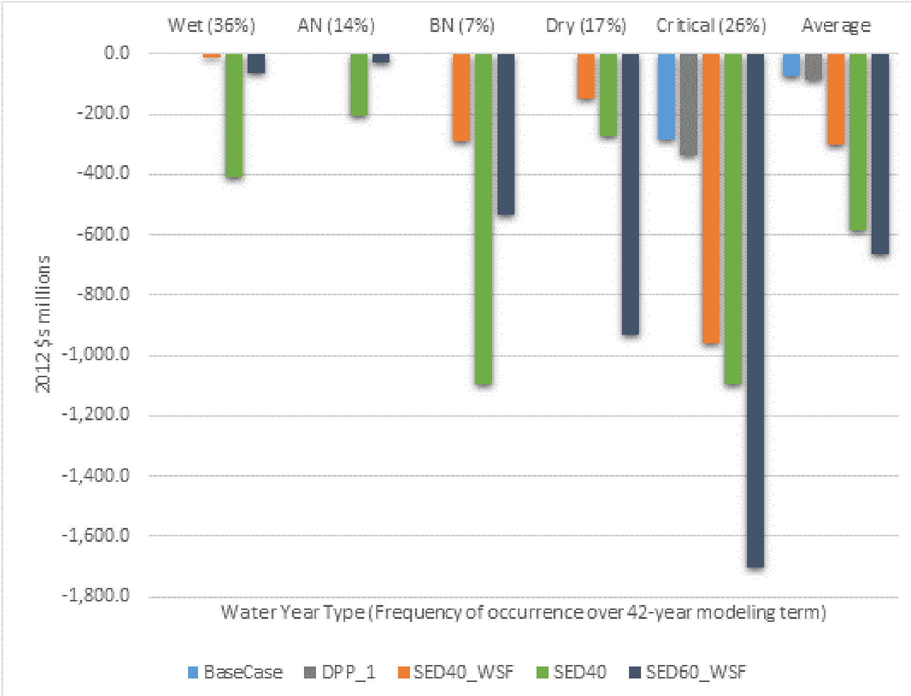

Figure 5.14-26. Average output loss, in millions of dollars, for alternative Project operation scenarios grouped by water year type difference; from Full Demand (2012 $).

Economic impacts of the Districts' Preferred Plan and alternative Project operation scenarios put forward by others are shown by water year type. Using the Districts' full supply as the basis of comparison, the plots demonstrate the very significant effect of "Dry" and "Critical" water years as measured at the farmgate and as regional economic output. When these WY types occur in sequence, as is not uncommon in the hydrologic record of the Tuolumne River, the economic impact of the options consisting of a "percent of unimpaired flow" have large, and likely irreversible, adverse economic effects to the communities served by the Districts and the region, as well as potentially to the Bay Area.

As would be expected, in Wet ("W") and Above Normal ("AN") water years, the Districts Preferred Plan would provide a full water supply, and even under a scenario consisting of a requirement for the Don Pedro Project to release fully 40% of the February through June UIF, there is unlikely to be measurable economic impact under the Districts' reservoir operations rules. In an average "D" water year, however, the 40% February-June UIF scenario produces an economic loss of output of almost $200 million, and in an average "C" water year, the 40% February-June UIF produces a loss of economic output of $950 million. The SWB's restrictions on reservoir storage in its preferred 40% February-June UIF option increases the estimated average annual loss of economic output to $1.1 billion. Under the 60% February-June UIF scenario, the loss of economic output is $1.7 billion in just a single year. Due to the fact "D" and "C" water years can, and do, occur in sequence, the real effects of the 40% and 60% Feb-Jun UIF scenarios are farmgate and regional losses that are permanent and from which recovery would not be possible; that is, a regional economic contraction of the agricultural sector. Losses in the Bay Area would also likely be catastrophic and irreversible as well based on the estimated water supply shortages described previously.

Even under the Districts' Preferred Plan, the loss of economic output is significant in "C" water years, amounting to more than $300 million per year. Sequential years of economic losses of this magnitude are large, but area and regional economic recovery is likely. Protecting water supplies during sequential "D" and "C" water years is essential to sustaining a productive agricultural economy in the region served by the Districts, as well as sustaining the welfare and economy of the Bay Area. This is the fundamental purpose of and need for the Don Pedro Project.

5.14.4 Flow and Fisheries Concepts Proposed by Others

During the relicensing pre-filing process for the Don Pedro Project, a number of general, non-quantitative concepts for improving conditions for salmonids in the lower Tuolumne River were put forward by relicensing participants. While these general recommendations for improving the cold water fisheries of the lower Tuolumne River did not reference or appear to apply the empirical data available on the Tuolumne River, some of these concepts referenced studies performed on other California rivers. In large part, the SWB's September 2016 SED adopted these general recommendations, prominent among them being:

- returning the river to a "natural flow regime" will improve fisheries;
- access to floodplain habitat is a "limiting factor" and a likely population bottleneck for Tuolumne River salmonids; and
- related to water temperature, the adage "the-colder-the-better" applies.

Each of these general precepts was thoroughly critiqued by a number of parties, including the Districts, in the comments provided to the SWB on the SED. While each is briefly discussed below, the complete set of comments provided by the Districts in a joint response to the SED is submitted with the AFLA.

5.14.4.1 Benefits Attributed to a Natural Flow Regime

The SWB asserts requiring flows in the Tuolumne River, as well as the other east side tributaries to the SJR, to mimic the natural flow regime will improve anadromous fish populations. In the SED, a number of literature sources are cited presumably in support of this assertion. The "natural flow regime" is achieved by requiring each east side tributary to deliver to the SJR a percent of "unimpaired flow" from February through June. According to the SED proposal, the daily flow to be released by the Don Pedro Reservoir to the lower river would be a certain, as yet unspecified, percent of the 7-day running average of the river's daily unimpaired flow.

In comments on the draft SED, the Districts first point out that "unimpaired flow" as defined and used by the SWB in the SED is not the same as or mimic the historical natural flow regime of the east side tributaries, the SJR, or the Delta. "Unimpaired flow" is a completely human invention, and by its definition in the SED does not consider the effects of many of the various human interactions with the river, including levee construction, channelization, in-channel gold and gravel mining, and the vast disturbance to the historical floodplain, wetland, and vegetative ecology of the lower Tuolumne River's pre-European condition. The SWB's sister agency, the California Department of Water Resources (DWR), has advised the SWB that "unimpaired flows" are not "natural flows" and do not necessarily mimic natural flows. In March, 2016, the DWR issued a draft report entitled *"Estimates of Natural and Unimpaired Flows for the Central Valley of California: Water Years 1922-2014"*. DWR is the California state agency responsible for the management and regulation of the state's water usage and is widely recognized for its expertise in compiling the quantitative estimates and records of the water resources of the state. DWR's March 2016 report on page 1 of the Executive Summary states unequivocally: *"Unimpaired flow estimates are theoretical in that such conditions have not occurred historically"*, and on the same page 1 provides this conclusion: *"In sum, the findings of this report show that unimpaired flow estimates are poor surrogates for natural flow conditions."*

The Tuolumne River has undergone a tremendous transformation in the past 150 years from being a natural riverscape to being a *highly modified river*.[181] While the draft SED acknowledges the significant degree of disruption of the natural environment that has taken place, it neglects to consider how this major transformation of the river environment affects the anadromous fish populations that are at the core of the SWB's proposed amended water quality plan. Even aside from the fact that "unimpaired flows" are not natural flows, the Districts contend that is not reasonable to expect significant improvements to native salmonid populations simply by providing a "more natural" flow regime to what is otherwise a highly modified river-floodplain system.

The vast majority of the references cited in the SED to support the need for a "natural flow regime" in fact endorse the use of biologically-based flow regimes for highly modified rivers, especially a set of flows based on sound, empirical, river-specific data. In fact, a number of the references provided by the SWB intended to support its contention provide precise descriptions of why "unimpaired flows" as defined in the SED are *not* representative of the natural flow regime (Sparks 1995; Walker et al. 1995). For the most part, the references provided in the SED, when reviewed in detail, cite the need to treat each river as a unique system, requiring substantial study to understand each river's conditions and ecology, and then based on this understanding, develop flows regimes fitted to the specific biological and geomorphological conditions of the river and designed for that unique river-floodplain environment. This is the approach reflected by the Districts' Preferred Plan.

[181] Yarnell et al (2015) defines *highly modified rivers* "to be those that (1) have a high proportion of their total length converted to reservoirs, (2) have a high proportion of their total annual stream flow diverted and/or managed for societal uses, (3) have a high proportion of their total annual stream flow stored in reservoirs, and/or (4) have a large proportion of their total length channelized or lined by levees. These four characteristics rarely occur in the same river, but even one of these characteristics can greatly affect the riverscape, particularly in terms of sediment transport, and floodplain extent and constrain e[nvironmental]-flow implementation and ecosystem restoration potential."

5.14.4.2 Access to Floodplain Habitat

The SED concludes that providing sufficiently high flows to inundate the Tuolumne River's floodplain will result in improvements to the river's salmonid populations. According to the SWB, the benefits to be derived from floodplain flows are access to more usable habitat and greater juvenile fish growth rates, which would lead to larger fish at the time of outmigration and an improved ability to avoid predators.

The primary evidence put forward in the SED to support the presumed benefits of floodplain access for Tuolumne River fisheries are studies of the Yolo Bypass on the Sacramento River, especially studies reported in Sommer et al (2004). Aside from the fact of there being little to no similarity between the Sacramento River's 60,000 acre Yolo Bypass floodplain and the 600-acre, highly disturbed and to some extent industrialized Tuolumne River floodplain, the Sommer et al (2004) findings were based on a thorough analysis of a number of factors known to affect the amount of suitable fish habitat on a floodplain, including water depth, velocity, and hydraulic residence time. Sommer et al (2004), recognizing as well the importance of food availability on the floodplain, investigated two trophic levels associated with the floodplain and the river: primary producers (phytoplankton) and primary consumers (zooplankton and drift invertebrates). The SWB did not attempt to assess either habitat or food availability on the Tuolumne River's floodplain.

The Districts' comments on the draft SED identified a number of shortcomings related to the SED's assertions about floodplain benefits as applied to the Tuolumne River. Suffice it to say, unlike the intensive, data-driven study efforts reported by Sommer et al., the SED presents no information on either the suitability or amounts of Tuolumne River floodplain habitat nor availability of food on the Tuolumne floodplain. As far as the SED goes is to estimate the amount of floodplain ***area*** inundated at various flow levels, as if every acre of inundation is an acre of suitable habitat with suitable food availability. The SED's own description of the highly disturbed condition of the Tuolumne River floodplain is reason enough to question whether, and to what extent, the highly modified floodplains along the Tuolumne River are likely to provide suitable habitat or food supply for fry or juvenile fall-run Chinook salmon. Yet the SED assumes, without citing a single source of site-specific evidence that every acre of this highly disrupted floodplain, once inundated, would be suitable fish habitat for anadromous fish and that an abundant supply of food would be available for these fish.

As to the SED's use of the work by Sommer et al. on the Yolo Bypass to assert that floodplain access on the Tuolumne River would provide greater growth for Chinook fry and juveniles, the SWB's reliance lacks any scientific support simply because the SED does not put forth any evidence that the Tuolumne floodplains are similar to those of the Yolo Bypass. While the SED wants to rely on findings by Sommer et al. when citing the favorable growth of juvenile salmon on the Yolo Bypass floodplain, it ignores other relevant findings of the Yolo Bypass work. As reported in Sommer et al. (2001), temperatures observed on the Yolo floodplain were up to 5°C higher than the adjacent Sacramento River. Sommer et al. (2001) found that "[a]pparent growth differences between the two areas [Sacramento River channel and floodplain] are consistent with water temperatures and stomach-content results. We found that the Yolo Bypass floodplain had significantly higher water temperatures and that young salmon from the floodplain ate significantly more prey than those from the Sacramento River". Further, Sommer et al. (2001) reported that prey availability in Yolo Bypass was sufficient to offset increased metabolic requirements from higher water temperatures. The various studies of the Yolo Bypass relied upon by the SWB suggest that greater growth of juvenile salmon resulting from floodplain access is due to *both* increased temperatures on the floodplain compared to the adjacent river channel and substantial food availability. Jeffres et al. (2008) reports similar findings on the Cosumnes River, which are discussed further below. Temperature data collected on the Tuolumne River floodplain has shown no difference between river temperatures and floodplain temperatures during rearing periods of fry and juveniles (Stillwater Sciences 2012), and the SED states explicitly that no food web studies are available for the Tuolumne River floodplain.

Studies conducted on the Tuolumne River by the Districts as part of the W&AR-21: Floodplain Hydraulics Study analyzed floodplain *habitat*, and not just floodplain area. The differences between floodplain area and floodplain usable habitat on the Tuolumne River are substantial. For example, at a flow of 5,000 cfs, the Tuolumne River total inundated floodplain area is approximately 650 acres, and the floodplain's suitable fall-run Chinook fry rearing habitat is 180 acres, or just 27% of the inundated acreage. Suitable fall-run Chinook juvenile rearing habitat is estimated to be 300 acres or less than half the inundated acreage.[182]

Studies on the Tuolumne River also included detailed investigations of in-channel habitat. As reported previously in this Section E 5.6 (see Figures 5.6-11 and 5.6-14), at a flow of 100 to 150 cfs, the estimated Chinook salmon fry rearing habitat in the Tuolumne River above Hickman Bridge (RM 31.7) is sufficient to support 5 to 6 million Chinook fry, while at a flow of 250 cfs, the Tuolumne River would support a rearing population of 3 million Chinook juveniles, demonstrating that the in-channel habitat for these life stages in the Tuolumne River are not limiting.

In the lower Tuolumne River above Hickman Bridge (RM 31.7), floodplain inundation generally begins to occur at about 1,100 cfs. The same plots used to enumerate fry and juvenile rearing also show that a flow of about 1,800 to 2,000 cfs is needed to provide fall-run Chinook fry rearing habitat equivalent to that which occurs at 175 cfs, and a flow of almost 2,300 cfs is needed to provide fall-run Chinook juvenile rearing habitat equivalent to that which occurs at 250 cfs. Flow velocities and depths are limiting for fry and juveniles. Higher in-channel flows diminish suitable fry and rearing in-channel habitat, while not contributing substantially to floodplain habitat (as compared to just floodplain area) until much higher flows occur.

An additional component of any assessment of potential floodplain benefits for fish must consider the duration of time of continuous inundation. Inundation of floodplain habitat that occurs for short periods of time may potentially have adverse impacts to fry and juvenile fall-run Chinook salmon either due to stranding risk or due to the tradeoff with energy use because of the need for frequent movements to suitable habitat if frequent flow fluctuations are occurring. Guidance from the literature seems to indicate that a continuous inundation period of at least 14 days may be necessary for benefits to accrue.[183] The SED failed to assess the aspect of floodplain inundation duration under the SED's preferred alternative of 40% February-June UIF.

[182] See Figure TR-15, pg 56, of the Districts' Joint Response to the SWB's SED.
[183] As cited in Matella and Merenlender, 2014.

While the SED's preferred plan called for daily instream flows to be based on the 7-day running average of the unimpaired flow, the SWB's analysis only considered *average monthly* flows, and never analyzed the SED's proposed alternative. In section 5.14.2 above, the results of modeling alternative flow proposals are presented. Under the Districts' Preferred Plan, a flow of at least 3,000 cfs for 14 continuous days occurs in 17 years of the 42-year POR, while under the SED's 40% UIF proposal it would occur in 24 of the 42 years. A flow of at least 4,000 cfs for 14 consecutive days would occur in 14 of the 42 years under the Districts' Preferred Plan, and 16 of 42 years under the SED's preferred option (Appendix E-1, Attachment G, Table 12).

Floodplain inundation for the WY 1971–2012 hydrology on the lower Tuolumne River was also considered in W&AR-21: Floodplain Hydraulic Assessment as cited above. Area-duration-frequency analyses for the period were conducted on the basis of the 2-D modeling of floodplain habitat vs flow relationships provided by that study. The results show that floodplain inundation (e.g., at least 14 continuous days) analyzed during the rearing period of Chinook salmon (February through May) currently occurs at a 2- to 4-year recurrence interval on the lower Tuolumne River consistent with the typical return periods of fall-run Chinook salmon and Sacramento River suggested to be supportive of salmon by Matella and Merenlender (2014). As indicated above, this same frequency of inundation duration will occur under the Districts' Preferred Plan.

Flow management during spill years can yield greater benefit to floodplain habitat and floodplain rearing by avoidance of frequent fluctuations in flow under a managed flow regime. During non-spill years, in-channel habitat is optimized to yield the greatest rearing benefit for the target species. The Districts' Preferred Plan provides a suite of flows informed by the substantial body of empirical information available on the lower Tuolumne River.

Regarding *O.* mykiss use of floodplains, data from California steelhead streams indicate that juvenile steelhead are not known to rear in floodplain habitats to any great degree at any time of year (Bustard and Narver 1975, Swales and Levings 1989, Keeley et al. 1996, Feyrer et al. 2006, Moyle et al. 2007). Based on multi-year studies in the Cosumnes River, Moyle et al. (2007) concluded that steelhead were not adapted for floodplain use and the few steelhead observed were inadvertent floodplain users (i.e., uncommon and highly erratic in occurrence) that were "presumably...carried on to the floodplain by accident." Tuolumne River floodplains do not provide favorable rearing and growth conditions for O. mykiss due to topography and inundation timing.

5.14.4.3 Temperature Preferences

Tuolumne River water temperatures and their relationship to the river's salmonids are discussed in section 5.14.2.8 above and addressed by river-specific, empirical studies conducted as part of the relicensing process and discussed in other sections of this AFLA. The SWB's SED tends to reference and apply the temperature benchmarks developed in the EPA's assessment of temperature impairment. The SED offers no specific evidence that the current temperature regime of the Tuolumne River is adversely affecting either fall-run Chinook salmon or *O. mykiss.* There is no empirical evidence presented of adult fall-run Chinook pre-spawn mortality or juvenile mortality or physical impairment due to temperatures experienced on the Tuolumne

River and the SWB does not attempt to make such a case. The only evidence put forward is citing to USFWS' assessments of disease, which the SWB seriously misinterprets and misrepresents. The USFWS reports on disease actually indicate sampled Tuolumne River fish are disease free.

Lacking any evidence of adverse effects, the SED adopts the assertion that any temperatures above the EPA (2003) temperature benchmarks represent an adverse impact to fisheries, and are labeled as occurrences of "non-compliance". Several of the literature citations heavily relied upon by the SWB provide evidence directly contrary to the assertions put forward in the SED related to temperatures and their effects to Central Valley salmonids. A number of these citations document favorable conditions for rearing salmonids at temperatures significantly higher than the EPA 2003 temperature benchmarks. Local adaptation, physiological acclimation, and food availability are among the explanatory factors for this well-documented phenomenon (Myrick and Cech 2004).

Sommer et al. (2001) and Jeffres et al. (2008) report on studies performed on Central Valley fall-run Chinook juveniles. Sommer et al. (2001) reports greater growth rates for juveniles that reared on the Yolo Bypass floodplain and attributes the greater growth rate to food availability, but also notes that in both 1998 and 1999 "temperature levels in Yolo Bypass were up to 5°C higher than those in the adjacent Sacramento River during the primary period of inundation, February-March". Figure 2 of the Sommer et al. (2001) report shows that juvenile fish grew to large size at temperatures up to and exceeding 20°C**,** well above the SED's temperature criteria presented in Table 19-1 of the SED of 16°C. Other sources cited by the SWB in the SED (e.g., Myrick and Cech 2001; Marine and Cech 2004) indicate that juvenile fall-run Chinook with adequate food sources, while not differentiating between floodplain or in-river rearing, grow well at temperatures up to 20°C, and can continue to grow at temperatures approaching 24°C. These temperatures far exceed the "temperature threshold" of 16°C applied in the SED's assessment of temperature benefits. By relying on Sommer et al. (2001), Myrick and Cech (2001), and Marine and Cech (2004), it appears the SED is supportive of juvenile rearing at these higher temperatures, far in excess of the EPA (2003) temperature benchmarks.

Jeffres et al. (2008) reports higher growth rates for juvenile fall-run Chinook using the Cosumnes River floodplains compared to juveniles using an *intertidal* channel. Jeffries et al. also reports the maximum daily temperatures at the floodplain study site supporting the higher growth was in excess of 22°C for ten consecutive days and the juveniles continued to grow. The draft SED neglected to cite or mention this finding reported by Jeffres et al. (2008). Both citations relied upon by SWB -- Jeffres et al. (2008) and Sommer et al. (2001) -- attribute improved growth of juvenile salmon on floodplains to higher temperatures in combination with adequate food supplies as physically observed on the floodplains investigated. In both cases, the temperatures contributing to higher growth significantly exceeded the "compliance" temperatures applied to river temperatures by SWB, but the SWB chose to ignore this aspect of the two reports, possibly because this does not support the "colder-is-better" paradigm.

Recent studies reported by Poletto et al. (2017) related to the thermal performance of fall-run Chinook juveniles from CDFW's Mokelumne River Hatchery found impressive aerobic capacity in these fall-run Chinook juveniles when acutely warmed to temperatures close to their upper thermal tolerance limit (~24°C), regardless of the acclimation temperatures (15 or 19°C).

Empirical studies of wild Tuolumne River *O. mykiss* reported in this AFLA found evidence of local acclimation to the temperatures experienced in the Tuolumne River. These studies, and a large body of research conducted over the last 10 to 15 years as cited herein, provide consistent evidence of fish species acclimated to local conditions, refuting the idea suggested in EPA 2003 that a single set of temperature benchmarks can be applied across widely different and unique physical environments.

6.0 CONSISTENCY WITH COMPREHENSIVE PLANS

The Districts have reviewed relevant comprehensive plans during conduct of relicensing studies and development of the proposed measures, and have included applicable information in this AFLA. Section 6.1.1 below describes comprehensive plans that Section 10(a) of the FPA requires FERC to consider. These plans are referred to as Qualifying Comprehensive Plans. Section 6.1.2 references the Districts approach to addressing additional resource management plans related to resources in the vicinity of the Don Pedro Project.

6.1 Qualifying Comprehensive Plans

As described above, Section 10(a) of the FPA requires FERC to consider the extent to which a project is consistent with federal and state comprehensive plans for improving, developing, or conserving a waterway or waterways affected by the Project. On April 27, 1988, FERC issued Order No. 481-A which revised Order No. 481, issued October 26, 1987, establishing that FERC will accord FPA Section 10(a)(2)(A) comprehensive plan status to any federal or state plan that meets the following three criteria:

- Is a comprehensive study of one or more of the beneficial uses of a waterway or waterways,
- Specifies the standards, the data, and the methodology used to develop the plan, and
- Is filed with FERC.

A review of FERC's *Revised List of Comprehensive Plans* (July 2017) shows that 76 comprehensive plans have been filed with FERC specifically for the State of California and six plans that apply to multiple states have been filed by U.S. governmental agencies (FERC 2013). The Districts identified 23 of these qualifying comprehensive plans that have the potential to be related to the Don Pedro Project. Each of these plans is discussed below by resource area. It is important to note that all of the qualifying comprehensive plans that may apply to the Don Pedro Project were developed after project construction. Consequently, the Don Pedro Project was an existing condition during each qualifying comprehensive plan's development. The comprehensive plans have been listed in the order they were presented in FERC's 2011 SD2. Additional Comprehensive Plans from FERC's list dated July 2017 have been added to the end of this list.[184]

6.1.1 Restoring the Balance (California Advisory Committee on Salmon and Steelhead Trout 1988)

The California Advisory Committee on Salmon and Steelhead Trout was established by California legislation in 1983 to develop a strategy for the conservation and restoration of salmon and steelhead resources in California. To streamline its process, the committee divided California's steelhead and salmon resources into 11 groups—the Tuolumne River is located in the San Joaquin River System. The report focuses mostly on the Central Valley, and the Don Pedro Project Boundary was not specifically identified. The committee recommended among

[184] FERC's 2011 SD2 referenced FERC's January 2011 *List of Comprehensive Plans*; the Districts have reviewed FERC's most recent *List of Comprehensive Plans* from December 2013, and did not identify any additional qualifying plans.

other things that California should seek to double its steelhead and salmon populations, and recommended strategies to do so. Many of the recommendations were advanced and discussed in subsequent related publications described below.

6.1.2 Central Valley Salmon and Steelhead Restoration and Enhancement Plan (CDFG 1990)

This plan was released by CDFW in April 1990. This plan is intended to outline CDFW's restoration and enhancement goals for salmon and steelhead resources of the Sacramento and San Joaquin river systems and to provide direction for various CDFW programs and activities. This plan is also intended to provide the basis for the restoration and enhancement of the state's salmon and steelhead resources.

6.1.3 Restoring Central Valley Streams (CDFG 1993)

This plan was released by CDFG in November 1993. The goals of the plan, all targeted toward anadromous fish, are to restore and protect California's aquatic ecosystems that support fish and wildlife, to protect threatened and endangered species, and to incorporate the state legislature mandate and policy to double populations of anadromous fish in California. The plan encompasses only Central Valley waters accessible to anadromous fish, excluding the Sacramento-San Joaquin Delta.

6.1.3.1 Steelhead Restoration and Management Plan for California (CDFG 1996)

This plan was released by CDFG in February 1996. This plan focuses on restoration of native and naturally produced (wild) stocks because these stocks have the greatest value for maintaining genetic and biological diversity. Goals for steelhead restoration and management are: (1) increase natural production, as mandated by The Salmon, Steelhead Trout, and Anadromous Fisheries Program Act of 1988, so that steelhead populations are self-sustaining and maintained in good condition and (2) enhance angling opportunities and non-consumptive uses. Information presented in Sections 3.5 and 4.0 of this Exhibit E may be used to determine consistency with CDFW's restoration goals.

6.1.3.2 Public Opinions and Attitudes in Outdoor Recreation (CDPR 1998)

CDPR's Public Opinions and Attitudes in Outdoor Recreation survey (POAOR), the most recent version of which is 2002, provides information used in the development of the CDPR's CORP. The POAOR identifies: (1) California's attitudes, opinions, and values with respect to outdoor recreation; and (2) demand for and participation in 42 selected outdoor recreation activities.

6.1.3.3 California Outdoor Recreation Plan (CDPR 1994)

The objectives of California Department of Parks and Recreation (CDPR) California Outdoor Recreation Plan (CORP, the most recent version of which is 2008, are to determine outdoor recreation issues that are currently the problems and opportunities most critical in California, and to explore the most appropriate actions by which State of California, federal and local agencies might address these issues. The CORP also provides valuable information on the state's recreation policy, code of ethics, and statewide recreation demand, demographic, economic, political, and environmental conditions. The plan lists the following major issues: (1) improving resource stewardship; (2) serving a changing population; (3) responding to limited funding; (4) building strong leadership; (5) improving recreation opportunities through planning and research; (6) responding to the demand for trails; and (7) halting the loss of wetlands. The CORP applies to state and local parks and recreation agencies, and does not apply to federal and private-sector recreational providers.

Because the recreation facilities in the Project Boundary are not state or local parks, the CORP has little direct application other than general guidance. However, information on regional trends in recreation from the most recent version of the CORP was incorporated into the Recreation Facility Condition and Public Accessibility Assessment, and Recreation Use Assessment (TID/MID 2013).

6.1.3.4 California Water Plan (CDWR 1983) and California Water Plan Update (CDWR 1994)

The CDWR first published the California Water Plan in 1957. The plan focused on the quantity and quality of water available to meet the State of California's water needs, and management actions that could be implemented to improve the state's water supply reliability. Since then, CDWR has updated the plan numerous times including in 1983 (the reference used in FERC's July 2010 List of Comprehensive Plans for the California Water Plan) and 1994 (the reference used in FERC's July 2010 List of Comprehensive Plans for the California Water Plan Update). The most recent update was in March 2009. The Don Pedro Project is located in what the Water Plan calls the "San Joaquin River Hydrologic Region." The Don Pedro Reservoir represents a small portion of the water supply in the hydrologic region.

6.1.3.5 Final Programmatic Environmental Impact Statement/Environmental Impact Report for the CALFED Bay-Delta Program (CDWR 2000)

The California Water Policy Council and the Federal Ecosystem Directorate united in June 1994 to form CALFED. In June 1995, CALFED established its Bay-Delta Program (Program) to develop a long-term, comprehensive solution to environmental issues in the Sacramento-San Joaquin Delta and San Francisco Bay. The Program is a cooperative, interagency effort involving 15 state and federal agencies with management and regulatory responsibilities in the San Francisco Bay-San Joaquin Delta Estuary (Bay-Delta).

The Program was divided into three phases. In Phase I, completed in September 1996, the Program identified the problems confronting the Bay-Delta, developed a mission statement, and developed guiding principles. Following scoping, public comment, and agency review, the Program identified three preliminary alternatives to be further analyzed in Phase II. The three Phase II preliminary alternatives each included Program elements for levee system integrity, water quality improvements, ecosystem restoration, water use efficiency, and three differing approaches to conveying water through the Bay-Delta.

In Phase II, completed in July 2000, the Program refined the preliminary alternatives, conducted a comprehensive programmatic environmental review, and developed implementation strategies. The Program added greater detail to each of the Program elements and crafted frameworks for two Program elements: water transfers and watershed management. The Phase II report contains a general summary of the Program plans. More fundamentally, the report also describes the Program process, the fundamental Program concepts that have guided their development, and analyses that have contributed to Program development. Further, this report describes how this large, complex Program may be implemented, funded, and governed in the future. The following plans outline Program actions:

- Ecosystem Restoration Program Plan (Volumes 1, 2, and 3)
- Water Quality Program Plan
- Water Use Efficiency Program Plan
- Water Transfer Program Plan
- Levee System Integrity Program Plan
- Watershed Program Plan

The goals of the Water Quality and Watershed programs under CALFED include improving overall water quality by reducing the loadings of many constituents of concern that enter Bay-Delta tributaries from point and non-point sources. Principal targeted constituents include heavy metals (such as mercury), pesticide residues, salts, selenium, pathogens, suspended sediments, adverse temperatures, and disinfection byproduct precursors such as bromide and total organic carbon. The remaining Program plans include the:

- Implementation Plan
- Multi-species Conservation Strategy (MSCS)
- Comprehensive Monitoring, Assessment, and Research Program

Phase II was completed, with publication of the final programmatic EIS/EIR in July 2000.

Phase III is on-going and consists of implementation of the Preferred Program Alternative over 20-30 years. Information from the final programmatic EIS/EIR will be incorporated by reference into subsequent tiered environmental documents for specific projects in accordance with NEPA and California Environmental Quality Act (CEQA) guidelines. The Don Pedro Reservoir does not flow directly into the Bay-Delta. Agencies participating in the Bay-Delta Plan are also participating in the relicensing. The Bay-Delta Plan is discussed further in the cumulative effects Section 4 of this Exhibit E.

6.1.3.6 Water Quality Control Plan Report (SWRCB 1995)

This reference is to the first edition of the water quality control plans adopted by the California SWRCB pursuant to the CWA. The nine plans, which apply to different areas of California, formally designate existing and potential beneficial uses and water quality objectives. The water quality control plan applicable to the Project area is the CVRWQCB Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (referred to as the Basin Plan in this document). The SWRCB has updated the water quality control plans a number of times since 1995 and details of the current plan relevant to the Don Pedro Project are included in Section 3.4 of this Exhibit E.

6.1.3.7 Recreation Needs in California (The Resources Agency 1983)

In response to the Roberti-Z'berg Urban Open Space and Recreation Program Act of 1976, the CDPR conducted a statewide recreational needs assessment. The report consisted of two major elements: (1) the Recreation Patterns Study that surveyed current participation and projected recreation demand; and (2) the Urban Recreation Case Studies that examined the leisure behavior and needs of seven underserved populations. The purpose of the needs analysis was to: (1) develop statewide recreation planning data; (2) analyze the recreation needs of California's urban residents; and (3) modify project selection criteria used in the administration of grants to local agencies under the Roberti-Z'berg Act.

In general, this report is a wide-ranging, programmatic document providing guidance for statewide planning. The urban-specific study has little relevance to the Project Boundary, which is mostly remote.

6.1.3.8 The Nationwide Rivers Inventory (NPS 1982)

The Nationwide Rivers Inventory (NRI) is a listing by the USDOI, NPS of more than 2,400 free-flowing river segments in the U.S. that are believed to possess one or more "outstandingly remarkable" natural or cultural values (ORV) judged to be of more than local or regional significance. In addition to these eligibility criteria, river segments are divided into three classifications: Wild, Scenic, and Recreational river areas. Under a 1979 Presidential Directive and related Council on Environmental Quality procedures, all federal agencies must seek to avoid or mitigate actions that would adversely affect one or more NRI segments. Such adverse impacts could alter the river segment's eligibility for listing and/or alter their classification. This Exhibit E includes information in Section 1 and Section 3.9 regarding Wild and Scenic designation in the upper Tuolumne River.

6.1.3.9 Water Quality Control Plans and Policies (SWRCB 1999)

This reference refers to an April 1999 submittal by the SWRCB to FERC of a listing of all SWRCB plans and policies. This submittal stated that all of the listed plans and policies are part of the "State Comprehensive Plan," even though it does not exist as a single plan. Relevant SWRCB plans are discussed in Section 3.4 of this Exhibit E.

6.1.3.10 Central Valley Habitat Joint Venture Implementation Plan (USFWS 1990) and North American Waterfowl Management Plan (USFWS 1986)

The California Central Valley Habitat Joint Venture (CCVHJV) is one of 12 current joint ventures charged with implementation of the North American Waterfowl Management Plan, an agreement between Canada, Mexico, and the U.S. to restore waterfowl populations through habitat protection, restoration, and enhancement (USFWS 1986). The CCVHJV was formally established by a working agreement signed in July 1988 and is guided by an Implementation Board comprised of representatives from the California Waterfowl Association, Defenders of Wildlife, Ducks Unlimited, National Audubon Society, Waterfowl Habitat Owners Alliance, and The Nature Conservancy. Technical Assistance is provided to the Board by the USDOI, USFWS, CDFG, CDFA, and other organizations and agencies.

The Central Valley of California is the most important wintering area for waterfowl in the Pacific Flyway, supporting 60 percent of the total population. Historically, the Central Valley contained more than four million acres of wetlands; however, only 291,555 acres remained in 1990 when the CCVHJV was first implemented. The primary cause of this wetland loss was conversion to agriculture, flood control, and navigation projects, and urban expansion.

When completed, the CCVHJV will (1) protect 80,000 acres of existing wetlands through the fee acquisition or conservation easement; (2) restore 120,000 acres of former wetlands; (3) enhance 291,555 acres of existing wetlands; (4) enhance waterfowl habitat on 443,000 acres of private agricultural land; and (5) secure 402,450 ac-ft of water for existing State Wildlife Areas, National Wildlife Refuges, and the Grasslands Resource Conservation District. These habitat conservation efforts are intended to result in a fall flight of one million ducks and 4.7 million wintering ducks. The wintering bird totals will include 2.8 million pintails, a species whose wintering population is vitally dependent on the Central Valley.

The CCVHJV is a regional approach to conservation and management of waterfowl populations in the Central Valley, but has no specific relevance to operation and management of the Don Pedro Project.

6.1.3.11 Final Restoration Plan for Anadromous Fish Restoration Program (USFWS 2001)

This plan was released by USFWS as a revised draft on May 30, 1997 and adopted as final on January 9, 2001. This plan identifies restoration actions that may increase natural production of anadromous fish in the Central Valley of California. This plan is split up into watersheds within the Central Valley and restoration actions are identified for each watershed. It also lists the involved parties, tools, priority rating, and evaluation of each restoration action. The plan encompasses only Central Valley waters accessible to anadromous fish, including the Sacramento-San Joaquin Delta.

6.1.3.12 The Recreational Fisheries Policy of the USFWS (USFWS Undated)

This is a 12-page policy signed by John F. Turner, then Director of the USFWS, on December 5, 1989. Its purpose is to unite all of the USFWS' recreational fisheries capabilities under a single policy to enhance the nation's recreational fisheries. Regional and Assistant directors are responsible for implementing the policy by incorporating its goals and strategies into planning and day-to-day management efforts. The USFWS carries out this policy relative to FERC-licensed hydroelectric projects through such federal laws as the Fish and Wildlife Coordination Act (FWCA), the CWA, the ESA, NEPA, and the FPA, among others.

Strategic Plan for Trout Management: A Plan for 2004 and Beyond (CDFG 2003)

This plan identifies key issues and concerns relative to trout resources and fisheries in California, with strategies aimed at addressing these issues during the next 10 to 15 years and beyond. The plan considers resource management strategies that will enable trout managers to meet their public trust responsibilities of protecting and maintaining California's native trout and other aquatic resources. Section 3.5 of this Exhibit E discusses trout population and habitat in the Project area, as well as the Districts' efforts to protect and conserve these resources.

Habitat Restoration Plan for the Lower Tuolumne River Corridor (CDFG 2000)

The Tuolumne River Technical Advisory Committee (TRTAC) prepared this plan to assist in identifying and implementing habitat restoration projects to benefit the Tuolumne River's Chinook salmon population. The plan provides historical information about the Tuolumne River basin and development of the region over time. The plan discusses current and future restoration plans that may benefit Chinook salmon. Section 3.5 of this Exhibit E further discusses Chinook salmon populations in the vicinity of the Don Pedro Hydroelectric Project, and measures intended to benefit this resource.

Final Hatchery and Stocking Program Environmental Impact Report/Environmental Impact Statement (CDFG 2010)

CDFG operates a statewide system of fish hatchery facilities that rear and release millions of trout, salmon, and steelhead of various age and size classes into state waters. In 2006, CDFG initiated an internal environmental review of its stocking program, and prepared this document to describe potential impacts associated with its hatchery and stocking activities.

California Aquatic Invasive Species Management Plan (CDFW 2008)

This plan, developed by CDFW, proposes management actions for addressing threats to the State of California due to aquatic invasive species. It focuses on the non-native algae, crabs, clams, fish, plants and other species that continue to invade California's creeks, wetlands, rivers, bays and coastal waters. The plan identifies and prioritizes actions that should be undertaken to minimize impacts from established aquatic invasive species and prevent new species invasions. Aquatic invasive species in the Project vicinity are discussed extensively in Section 3.5.2. of this Exhibit E.

California Wildlife: Conservation Challenges: California's Wildlife Action Plan (CDFG 2007)

This plan was developed as a partnership between the CDFW and the Wildlife Health Center at the University of California, Davis. The plan is aimed at answering three primary questions (1) what are the species and habitats of greatest conservation need; (2) what are the major stressors affecting California's native wildlife and habitats; and (3) what are the actions needed to restore and conserve California's wildlife, thereby reducing the likelihood that more species will approach the condition of threatened or endangered? The plan recommends region-specific conservation actions to protect, restore, and conserve California's native wildlife and habitats. The Don Pedro Hydroelectric Project is located in the Central Valley and Bay-Delta Region. The plan recommendations include a number of actions that are discussed throughout this license application, and are addressed by the Districts' PM&E measures.

Recovery Plan for the Evolutionarily Significant Units of Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon and the DPS of CCV Steelhead (NMFS 2014)

This recovery plan was developed for three salmon and steelhead species: the Sacramento River winter-run Chinook salmon Evolutionarily Significant Unit (ESU), the Central Valley spring-run Chinook salmon ESU, and the CCV steelhead DPS. The purpose of this recovery plan is to provide a framework for the conservation and survival of the listed species addressed in the plan that focuses and prioritizes threat abatement and restoration actions necessary to recover, and eventually delist, a species. This recovery plan covers the geographic area of the CCV, including the Sacramento and San Joaquin River Basins. The species addressed in this recovery plan are discussed further in Section 3.5 and 4.0 of this Exhibit E.

6.1.4 Additional Resource Management Plans and Agreements

In addition to the FERC approved qualifying comprehensive plans, Section 4.0 -- Cumulative Effects Analysis -- includes discussion of a number of additional plans relevant to the assessment of cumulative impacts on the lower Tuolumne River.

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Section 6.0: Consistency with Comprehensive Plans

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8.0 CONSULTATION RECORD

The following excerpt from the Code of Federal Regulations (CFR) at 18 CFR § 5.18(b)(5)(G) describes the required content of the Consultation Record.

> *5.18(b)(5)(G) Consultation Documentation. Include a list containing the name, and address of every Federal, state, and interstate resource agency, Indian tribe, or member of the public with which the applicant consulted in preparation of the Environmental Document.*

In accordance with the communications guidelines outlined in sections 2.4.3 and 2.5.3 of PAD filed with FERC on February 10, 2011, the Districts have established and maintained an extensive Relicensing Participants Email Group, which has been used to keep all relicensing participants, including agencies, tribes, non-governmental organizations (NGOs), and interested members of the public, advised of all relicensing activities. The current list of relicensing participants, by name and affiliation, is contained in Attachment B to this AFLA.

The total relicensing Consultation Record, to date, consists of:

- Previously filed with FERC:
  - Consultation Record filed as Appendix A to the PAD on February 10, 2011 (FERC E-Library Accession No. 20110210-5159)
  - Consultation Workshops Record filed as Attachment A to the Draft License Application (DLA) on November 26, 2013 (FERC E-Library Accession No. 20131126-5015)
- Filed with this AFLA:
  - Relicensing Participants Consultation Record Part 1 - since the filing of the PAD on February 10, 2011 through April 28, 2014
  - Relicensing Participants / Agency Consultation Record Part 2 – since April 28, 2014
  - Relicensing Website Announcements Record
  - Agency Consultation Record (by Study Plan) through April 28, 2014
  - Cultural Resource Work Group Communications being filed as Privileged material

Attachment B, Appendix A, Part 1 and Part 2, are the records of the Districts' advisories and other communications with the Relicensing Participants since the filing of the PAD on February 10, 2011. Copies of the documents recorded are either attached to the Amendment of Application,reference is made to their location on FERC's E-Library (www.ferc.gov), and/or on the Don Pedro relicensing website (www.donpedro-relicensing.com).

Attachment B, Appendix B is the record of the Districts' consultation with agencies and other interested parties in the various studies associated with the relicensing. Copies of these documents are attached to the Amendment of Application.

Appendix C, Part 1 and Part 2 are the records of the Districts' announcements to all interested parties published under the ANNOUNCEMENT tab on the Don Pedro relicensing website at www.donpedro-relicensing.com.

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