DON PEDRO PROJECT
FERC NO. 2299

DRAFT LICENSE APPLICATION

EXHIBIT C – CONSTRUCTION HISTORY AND PROPOSED CONSTRUCTION SCHEDULE

WATER & POWER
Serving Central California since 1887

Modesto Irrigation District

Prepared by:
Turlock Irrigation District
P.O. Box 949
Turlock, CA 95381

And
Modesto Irrigation District
P.O. Box 4060
Modesto, CA 95352

November 2013

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EXHIBIT C - CONSTRUCTION HISTORY AND PROPOSED CONSTRUCTION SCHEDULE

The following excerpt from the Code of Federal Regulations (CFR) at 18 CFR § 4.51 (d) describes the required content of this Exhibit.

Exhibit C is a construction history and proposed construction schedule for the project. The construction history and schedules must contain:

- *(1) If the application is for an initial license, a tabulated chronology of construction for the existing projects structures and facilities described under paragraph (b) of this section (Exhibit A), specifying for each structure or facility, to the extent possible, the actual or approximate dates (approximate dates must be identified as such) of:*
  - *(i) Commencement and completion of construction or installation;*
  - *(ii) Commencement of commercial operation; and*
  - *(iii) Any additions or modifications other than routine maintenance; and*
- *(2) If any new development is proposed, a proposed schedule describing the necessary work and specifying the intervals following issuance of a license when the work would be commenced and completed.*

1.0 CONSTRUCTION HISTORY

Because 18 CFR § 4.51 (d)(1) requires a construction history only for applications for an initial license, a construction history is not required for this relicensing application for the Don Pedro Hydroelectric Project. For general information, however, it is useful to summarize that the construction of the new Don Pedro Project commenced in October 1967, reservoir filling began in November 1970, power generation commenced in early 1971, and the Project was formally dedicated in May 1971. It was not until March 1974 that the reservoir first filled to the flood storage space of 801.9 ft.

In January,1985, the Districts filed an amendment with Federal Energy Regulatory Commission (FERC) to add the fourth generating unit. FERC amended the license to authorize the construction of the fourth unit on February 2, 1987 (38 FERC 61,097). Construction of the fourth unit was completed in April 1989. Numerous capital improvements have occurred at the Project since commencement of Project operations. These are generally considered as minor compared to the original Project construction. The more recent of these capital improvements are discussed in Exhibit D of this draft application.

2.0 PROPOSED CONSTRUCTION SCHEDULE

The Districts are not proposing any new Project structures at this time. Therefore, there are no construction schedules provided as part of this draft application.

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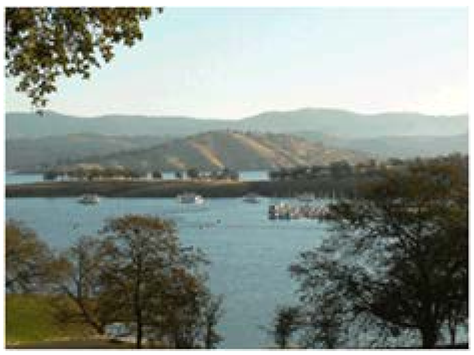

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EXHIBIT D - STATEMENT OF COSTS AND FINANCING

The following excerpt from the Code of Federal Regulations (CFR) at 18 CFR § 4.51 (e) describes the required content of this Exhibit.

Exhibit D is a statement of costs and financing. The statement must contain:

(1) If the application is for an initial license, a tabulated statement providing the actual or approximate original cost (approximate costs must be identified as such) of:
   - *(i) Any land or water right necessary to the existing project; and*
   - *(ii) Each existing structure and facility described under paragraph(b) of this section (Exhibit A).*

(2) If the applicant is a licensee applying for a new license, and is not a municipality or a state, an estimate of the amount which would be payable if the project were to be taken over pursuant to section 14 of the Federal Power Act upon expiration of the license in effect [see 16 U.S.C. 807], including:
   - *(i) Fair value;*
   - *(ii) Net investment; and*
   - *(iii) Severance damages.*

(3) If the application includes proposals for any new development, a statement of estimated costs, including:
   - *(i) The cost of any land or water rights necessary to the new development; and*
   - *(ii) The cost of the new development work, with a specification of:*

(A) Total cost of each major item;

(B) Indirect construction costs such as costs of construction equipment, camps, and commissaries;

(C) Interest during construction; and

(D) Overhead, construction, legal expenses, taxes, administrative and general expenses, and contingencies.

(1) A statement of the estimated average annual cost of the total project as proposed specifying any projected changes in the costs (life-cycle costs) over the estimated financing or licensing period if the applicant takes such changes into account, including:
   - *(i) Cost of capital (equity and debt);*
   - *(ii) Local, state, and Federal taxes;*
   - *(iii) Depreciation and amortization;*
   - *(iv) Operation and maintenance expenses, including interim replacements, insurance, administrative and general expenses, and contingencies; and*
   - *(v) The estimated capital cost and estimated annual operation and maintenance expense of each proposed environmental measure.*

(2) A statement of the estimated annual value of project power, based on a showing of the contract price for sale of power or the estimated average annual cost of obtaining an equivalent amount of power (capacity and energy) from the lowest cost alternative source, specifying any projected changes in the cost of power

from that source over the estimated financing or licensing period if the applicant takes such changes into account.

(3) A statement specifying the sources and extent of financing and annual revenues available to the applicant to meet the costs identified in paragraphs (e) (3) and (4) of this section.

(4) An estimate of the cost to develop the license application;

(5) The on-peak and off-peak values of project power, and the basis for estimating the values, for projects which are proposed to operate in a mode other than run-of-river; and

(6) The estimated average annual increase or decrease in project generation, and the estimated average annual increase or decrease of the value of project power, due to a change in project operations (i.e., minimum bypass flows; limits on reservoir fluctuations).

1.0 INTRODUCTION

This Exhibit describes the recent costs for operation, maintenance and capital replacement costs for the Don Pedro Project and the current estimated value of hydroelectric power that the Project will generate. The draft license application does not contain specific proposals for future Project operations or potential additional resource protection, mitigation, and enhancement measures. However, the Districts are currently developing a draft Historic Properties Management Plan (HPMP), Bald Eagle Management Plan, and Vegetation Management Plan. The Districts are anticipating that these draft plans will be part of the Final License Application (FLA). Until all the Federal Energy Regulatory Commission (FERC)-approved resource studies and their associated reports are completed and have been reviewed and commented upon by relicensing participants, it is premature to propose any other specific resource protection measures. Modeling of potential future operating scenarios using the project-specific and river-specific Tuolumne River Operations Model, Don Pedro Reservoir Temperature Model, Lower Tuolumne River Temperature Model, Chinook Population Model, and *O.Mykiss* Populaion Model is presently underway. No specific proposals for Protection, Mitigation, and Enhancement (PM&E) measures have yet been put forth by any relicensing participant at this time. The Districts anticipate that the FLA will contain the Districts' proposed operating plan under the new license. In the FLA, the Districts will analyze the economics of the Project using an approach that is consistent with the Commission's current practices (Mead Corp., 72 FERC ¶ 61,027 (1995)). Current and anticipated costs will be analyzed over a 30-year Project cycle and annualized to develop an estimated annual cost.

2.0 ORIGINAL COST OF PROJECT

The cost of the original construction of the Don Pedro Project facilities was $105 million.

3.0 PROJECT TAKEOVER COSTS

Both Turlock Irrigation District (TID) and Modesto Irrigation District (MID) are political subdivisions of the State of California. The Districts are also municipalities within the meaning of Section 3(7) of the Federal Power Act (FPA). Because the Districts are subdivisions of the state, the Project is not subject to the takeover provisions of Section 14 of the FPA. Accordingly, FERC's regulations (18 CFR § 4.51(e)(2)) do not require the Authorities to include an estimate of takeover costs.

4.0 ESTIMATED COSTS OF NEW MEASURES AND DEVELOPMENT

New development costs include any new capital expended to upgrade the Project and to provide environmental enhancements for the new license term.

As stated above, the Districts are not proposing any new upgrades, structures or modifications to Project operations as part of this draft license application. However, the Districts are proposing to develop and implement a Bald Eagle Management Plan, Vegetation Management Plan, and an Historic Properties Management Plan during the next license term. These are yet to be fully drafted; therefore, the costs of these measures have not yet been estimated.

5.0 ESTIMATED AVERAGE ANNUAL COSTS OF THE DON PEDRO PROJECT

The current average annual costs of the Project include operations and maintenance (O&M), administration, legal, accounting, insurance, and capital costs. The annual Project O&M costs were approximately $7.9 million in 2012, including O&M costs associated with providing recreation management at Don Pedro Reservoir. Capital costs in 2012 were approximately $6.1 million, or $620,000 annual cost computed assuming a 6 percent discount rate and 15 year term. The FLA will include costs associated with the Districts proposed future operating plan and any additional PM&E measures.

5.1 Federal, State, and Local Taxes

The Districts are political subdivisions of the State of California. As municipal entities, the Districts are exempt from federal, state, and local taxes.

6.0 ESTIMATED ANNUAL VALUE OF PROJECT POWER

The Districts operate the Project primarily for purposes of providing reliable water supplies and flood flow management. In operating the Project, the Districts also ensure dam safety and comply with all license requirements. Both TID and MID also are retail electric service providers in their designated service territories. The Project's average annual energy production since 1997 is 622,440 megawatt hour (MWh). Based on the 2012 total estimated annual cost of power of $8.5 million, the current annual value of the Project power is approximately $14/MWh. In accordance with California Health and Safety Code (38500-38599), the Don Pedro hydropower generation does not qualify towards meeting TID's or MID's 33 percent RPS standard. Therefore, greenhouse gas allowances must be purchased as an offset. The present cost of the greenhouse gas allowances is approximately $7/MWh, raising the cost of production to the Districts by almost 50 percent to $21/MWh.

7.0 SOURCES OF FINANCING AND REVENUE

As governmental entities, the Districts finance major capital expenditures by the issuance of long-term bonds. The Districts' Project costs are included in each District's rate base for water and power services.

8.0 COSTS TO DEVELOP THE LICENSE APPLICATION

The costs of relicensing will be provided in the FLA.

9.0 ESTIMATED VALUE OF ON-PEAK AND OFF-PEAK POWER

Rates for off-peak power and on-peak power in California vary widely by season. Recent off-peak power rates have been approximately $25/MWh and on-peak power rates have been $85/MWh, according to information available from CAISO provided to FERC in its Market Reports.

10.0 CHANGES IN THE AMOUNT AND VALUE OF PROJECT POWER DUE TO PROPOSED CHANGES IN OPERATIONS

The FLA will provide an estimate of any change in the the future annual energy production of the Project and any change to the annual value of the Project power.

11.0 LITERATURE CITED

None.

DON PEDRO PROJECT
FERC NO. 2299

DRAFT LICENSE APPLICATION

EXHIBIT E – ENVIRONMENTAL REPORT



Prepared by:
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November 2013

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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)
AED ....automated external defibrillator
AF ....acre-feet
AGR...........................agricultural supply
AGS............................Annual Grasslands
ALJ.............................Administrative Law Judge
AMF...........................Adaptive Management Forum
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
BOR ....Bureau of Reclamation
BOW ....Blue Oak Woodland
ºC................................celsius
CalCOFI.....................California Cooperative Oceanic Fisheries Investigations
CalEPPC ....California Exotic Pest Plant Council
CalSPA.......................California Sports Fisherman Association
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
CCVHJV ....California Central Valley Habitat Joint Venture
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
CPR ....cardiopulmonary resuscitation
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
EL...............................Elevation
ENID..........................El Nido Irrigation District
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 ....kilowatt-amps
kW.............................kilowatt
LTAM ....Ladenburg Thalmann Asset Management
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
NGVD ....National Geodetic Vertical Datum
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
NGVD 29 ....National Geodetic Vertical Datum of 1929
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
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
PRISM........................Probabilistic Symbolic Model Checker
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
RSP ....Revised Study Plan
RST ....Rotary Screw Trap
RWF...........................Resource-Specific Work Groups
RWG..........................Resource Work Group
RWQCB.....................Regional Water Quality Control Board

SC...............................State candidate for listing under CESA
SCADA......................Supervisory Control and Data Acquistion
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
VRM ....Visual Resource Management
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

1.0 INTRODUCTION

By April 30, 2014, the Turlock Irrigation District (TID) and the Modesto Irrigation District (MID) (collectively, the Districts), will file an application for a major new license for the existing Don Pedro Hydroelectric Project (Don Pedro Project or Project) with the Federal Energy Regulatory Commission (FERC). The Districts initiated relicensing under the Integrated Licensing Process (ILP) promulgated by FERC at 18 Code of Federal Regulations (CFR) Part 5. This document is Exhibit E, the Environmental Report of the Draft License Application (DLA), which is prepared in the form of an Applicant-Prepared Environmental Assessment (APEA) as provided for in 18 CFR §5.18. This Exhibit E is supported by data and analysis from 35 resource studies conducted as part of the relicensing process, Exhibits A, B, C, D, F, G, and H (all collectively comprising the Districts' DLA), and numerous prior studies conducted by the Districts in support of the existing license terms.

The 168 megawatt (MW) Don Pedro 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. The Don Pedro Reservoir provides 2,030,000 acre-feet (AF) of total water storage for the primary purposes of irrigation, municipal and industrial (M&I) water supply, and flood management. Other important uses supported by the Project's water storage are recreation, power generation, and the protection of the downstream anadromous fishery. Approximately 14,328 acres, or 78 percent, of lands within the Project Boundary are owned by the Districts. The remaining lands, about 4,040 ac, are federal lands located within the Bureau of Land Management (BLM) Sierra Resource Management Area.

This Exhibit E provides environmental analysis by resource area of the impacts of the Districts' proposal to continue operating the Don Pedro Project. The Districts have developed environmental information in support of this DLA in consultation with state and federal fish and wildlife agencies, local governments, Indian Tribes, and other members of the public. Table 1.0-1 summarizes current studies conducted in support of the relicensing and their status.

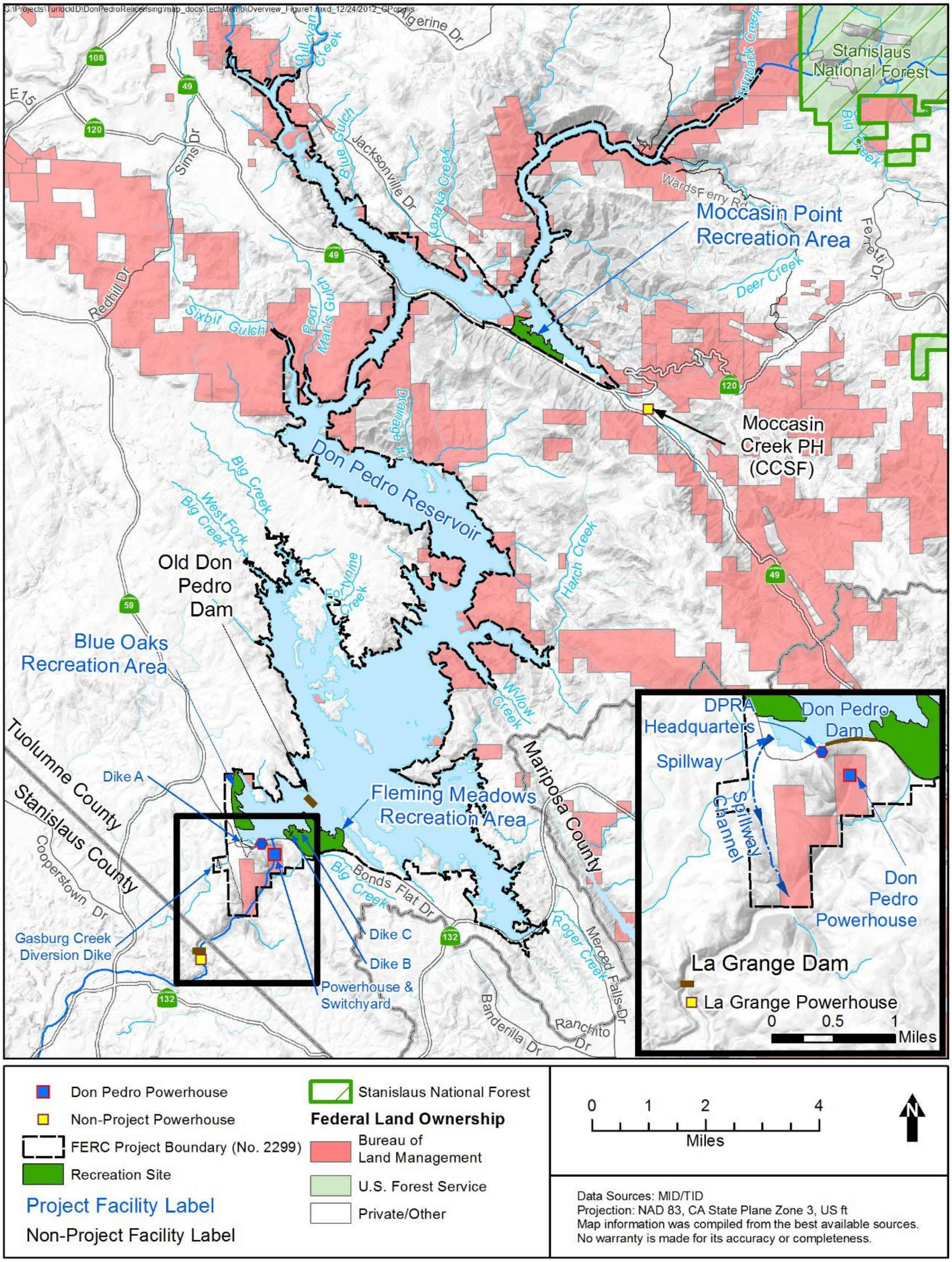


Figure 1.0-1. Don Pedro Project Boundary and major facilities.

Table 1.0-1. Status of studies conducted in support of the Don Pedro Project relicensing.

Study Number	Study Title	Report Status in ISR	Report Status in DLA	Report Status in USR	Study Status
Cultural Resources (CR)					
CR-01	Historic Properties Study	Progress	NA*	NA	Ongoing; study report will be issued April 2014
CR-02	Native American Traditional Cultural Properties Study	Progress	NA	NA	Ongoing; study report will be issued April 2014
Recreation Resources (RR)					
RR-01	Recreation Facility Condition and Public Accessibility Assessment, and Recreation use Assessment	Progress	NA	Final Draft	Complete
RR-02	Whitewater Boating Take Out Improvement Feasibility Study	Final Draft	NA	Revised Final[1]	Complete
RR-03	Lower Tuolumne River Lowest Boatable Flow Study	Final Draft	NA	Revised Final[1]	Complete
RR-04	Visual Quality Study	Final Draft	Final	NA	Complete
Terrestrial Resources (TR)					
TR-01	Special-Status Plants Study	Final Draft	Revised Final[2]	NA	Complete
TR-02	ESA- and CESA-Listed Plants Study	Final Draft	Revised Final[2]	NA	Complete
TR-03	Wetland Habitats Associated with Don Pedro Reservoir Study	Final Draft	Final	NA	Complete
TR-04	Noxious Weed Survey	Final Draft	Final	NA	Complete
TR-05	ESA-Listed Wildlife - Valley Elderberry Longhorn Beetle Study	Final Draft	Revised Final[2]	NA	Complete
TR-06	Special-Status Amphibians and Aquatic Reptiles Study	Final Draft	Final[3]	NA	Complete
TR-07	ESA-Listed Amphibians - California Red-Legged Frog Study	Final Draft	Final	NA	Complete
TR-08	ESA-Listed Amphibians - California Tiger Salamander Study	Final Draft	Final	NA	Complete
TR-09	Special-Status Wildlife - Bats Study	Final Draft	Final	NA	Complete
TR-10	Bald Eagle Study	Final Draft	NA	Revised Final[1]	Complete
Water and Aquatic Resources (W&AR)					
W&AR-01	Water Quality Assessment	Final Draft	Revised Final[2]	NA	Complete
W&AR-02	Project Operations/Water Balance Model	Final Draft	NA	Revised Final[4]	Complete

Study Number	Study Title	Report Status in ISR	Report Status in DLA	Report Status in USR	Study Status
W&AR-03	Reservoir Temperature Model	Progress	NA	Final Draft	Complete
W&AR-04	Spawning Gravel in the Lower Tuolumne River Study	Progress	NA	Final Draft	Complete
W&AR-05	Salmonid Population Information Integration and Synthesis Study	Final Draft	Final	NA	Complete
W&AR-06	Tuolumne River Chinook Salmon Population Model	Progress	NA	Final Draft	Complete
W&AR-07	2012 Predation Study	Final Draft	NA	Revised Final[5]	Complete
W&AR-07	2014 Predation Study[6]	NA	NA	Progress	Ongoing; study report will be filed March 2015
W&AR-08	Salmonid Redd Mapping Study	Progress	NA	Final Draft	Complete
W&AR-10	*Oncorhynchus mykiss* Population Study	Progress	NA	Draft	Ongoing; study report will be filed April 2014
W&AR-11	Chinook Salmon Otolith Study	Progress	NA	Progress	Ongoing; study report will be filed September 2014
W&AR-12	*Oncorhynchus mykiss* Habitat Survey	Final Draft	NA	Revised Final[1]	Complete
W&AR-13	Fish Assemblage and Population Between Don Pedro Dam and La Grange Dam Study	Final Draft	Final	NA	Complete
W&AR-14	Temperature Criteria Assessment (Chinook Salmon and *Oncorhynchus mykiss*)	Progress	NA	Progress	Ongoing; study report will be filed December 2014
W&AR-15	Socioeconomics Study	Progress	NA	Final Draft	Complete
W&AR-16	Lower Tuolumne River Temperature Model	Progress	NA	Final Draft	Complete
W&AR-17	Don Pedro Fish Population Survey	Final Draft	Final	NA	Complete
W&AR-18	Sturgeon Study	Final Draft	Revised Final[2]	NA	Complete
W&AR-19	Lower Tuolumne River Riparian Information and Synthesis Study	Final Draft	Revised Final[2]	NA	Complete
W&AR-20	*Oncorhynchus mykiss* Scale Collection and Age Determination Study	Final Draft	Revised Final[2]	NA	Complete

Study Number	Study Title	Report Status in ISR	Report Status in DLA	Report Status in USR	Study Status
W&AR-21	Floodplain Hydraulic Analysis	NA	NA	Progress	Ongoing; study report will be filed September 2014
NA	Description of La Grange Facilities and Potentially Affected Environment of Anadromous Fish in the Vicinity of the La Grange Facilities	NA	NA	Final Draft	Complete
NA	Lower Tuolumne River Instream Flow Study	NA	Final	NA	Ongoing, supplemental assessments will be complete in April 2014[8], August 2014[9], and March 2015[10]

* NA means the category is not applicable to the study.

1 A revised final study report will be filed in the Updated Study Report (USR) to address relicensing participants' Initial Study Report (ISR) comments.

2 A revised final study report is being filed with this DLA to address relicensing participants' ISR comments.

3 An errata sheet is filed with the report with the DLA to clarify information in the final study report.

4 The Districts completed the base case in March 2013 and updated the model with 2012 hydrology data in November 2013. Therefore, a revised final study report is appended to DLA Exhibit B and will be filed with the USR.

5 A revised final study report will be filed in the USR to address relicensing participants' ISR comments and FERC's May 21, 2013 Determination on Requests for Study Modifications and New Studies for the Don Pedro Hydroelectric Project (May 2013 Determination).

6 Per FERC's May 2013 Determination, the Districts will complete an additional year of study in 2014.

7 The final study report of the Lower Tuolumne River Instream Flow Study, originally filed on April 26, 2013, is filed with this DLA.

8 The habitat investigations for Pacific lamprey and Sacramento splittail will be complete in April 2014.

9 The effective usable area assessment will be complete in August 2014.

10 The habitat investigations for non-native predatory fish, including smallmouth bass, largemouth bass, and striped bass will be complete in March 2015.

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), FERC is able to issue such licenses for a period not less than 30 years, but no more than 50 years. 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, and fish and wildlife. As the federal "action agency", FERC must also comply with the requirements of the National Environmental Policy Act (NEPA). Under NEPA, FERC must clearly define the specific proposed action it is considering and define the purpose and need for the proposed action.

In the case of the Don Pedro 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. As such, and as generally described in FERC's Scoping Document 2 (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 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 a non-polluting, renewable resource.

The California Energy Commission (CEC) issued an Updated California Energy Demand Forecast 2011–2022 in May 2011. The staff 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 is 1.13 percent, 1.28 percent, and 1.53 percent, respectively (CEC 2011).

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 acts and related requirements are summarized below in chronological order based on date of enactment of the act. 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 Dam.

1.2.1.2 Section 4(e) Conditions

The Don Pedro Project occupies approximately 4,040 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 impose 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 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 Don Pedro 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. The Project falls within the jurisdiction of the Central Valley RWQCB.

Within 60 days following FERC’s Notice of Acceptance and Ready for Environmental Analysis, the Districts will 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 ensure that its actions and authorizations do not 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 representative 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] and two federally-listed plant species, Layne's ragwort (*Packera layneae*) and California vervain (*Verbena californica*), are known to occur within the Project Boundary. No federally-listed wildlife species are known to occur within the Project Boundary. However, habitat for the federally-listed wildlife species, valley elderberry longhorn beetle (*Desmocerus californicus dimorphus),* Valley Elderberry Longhorn Beetle (VELB) is known to occur within the Project Boundary. Draft BAs for each of these species will be provided with the final license application (FLA).

1.2.4 Coastal Zone Management Act

Under § 307(c)(3)(A) of the Coastal Zone Management Act of 1972, as amended, (CZMA), (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 CZMA agency concurs with the license applicant's certification of consistency with the state's CZMA program, or the agency's concurrence is conclusively presumed by its failure to act within 180 days or its receipt of the applicant's certification.

The Project is not located within the coastal zone boundary, which extends from a few city blocks to five miles inland from the sea (www.ceres.ca.gov/coastal.com), and would not affect

[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

resources located within the boundary of a coastal zone. Therefore, the Project is not subject to California coastal zone program review and no consistency certification is needed.

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 require any federal department or independent agency having authority to license any undertaking to take into account the effects of the undertaking on historic properties.

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).

On April 8, 2011, FERC designated the Districts as its non-federal representative 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 representative, 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. Consultation efforts further included six meetings among the Districts, the tribes, BLM, and the SHPO that focused on the collaborative development of study plans and preliminary study results. 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, as required under Section 106, a comprehensive and intensive field survey of the APE was completed between January 2012 and September 2012 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 field survey. In addition, a study was undertaken to identify traditional cultural properties (TCPs) within the APE, of which the results are still pending.

The Districts are planning to develop and implement a Historic Properties Management Plan (HPMP) that considers and manages effects on historic properties throughout the term of the license. FERC typically completes Section 106 by entering into a Programmatic Agreement or Memorandum of Agreement with the license applicant, the Advisory Council on Historic Preservation, and the SHPO that typically require the applicant to develop and implement an HPMP. Additionally, FERC requires that the HPMP be developed in consultation with various federal, state, tribal, and non-government parties who have interests in the Project. The Districts plan to prepare and submit a draft HPMP to tribes and BLM for review and to the SHPO for review and concurrence.

1.2.6 Wilderness Act/Wild and Scenic Rivers Act

There are no areas within the Project Boundary that are included in, or have been designated for study for inclusion in, the National Wild and Scenic Rivers System, or that have been designated as wilderness area, recommended for such designation, or designated as a wilderness study area under the Wilderness Act. There is one segment of the Tuolumne River, the Wild and Scenic Tuolumne River, designated as a Wild and Scenic River. There are six Wilderness Areas located within 50 mi of the Project Boundary.

1.2.6.1 Wild and Scenic Rivers Act

In 1984, Congress designated portions of the upper Tuolumne River as Wild & Scenic. A total of 54 mi 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 U.S. Forest Service (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, including 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 U.S. Department of Agriculture (USDA undated).

In all, 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. No specific reaches of the Tuolumne River within the 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 overlapped with the 1966 FERC-authorized Project Boundary for a distance of about one mile. This USFS description is contrary to the 1984 designating act which 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 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].

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 and Clavey River join with the Tuolumne River upstream of Don Pedro Reservoir and are included in the NRI. Cherry Creek 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 the NMFS for waters in California supporting anadromous fish. The Act requires that all federal agencies, including FERC, consult with the 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 the NMFS following consultation are advisory only; however, a written explanation must be submitted to the NMFS if the implementing federal agency does not agree with the NMFS' recommendations.

The Districts are developing an applicant-prepared EFH Assessment (to be provided with the FLA) 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 that are designated as EFH for Chinook salmon. These include the lower Tuolumne River downstream of La Grange Dam and the San Joaquin River downstream of the Tuolumne River confluence to Vernalis. Descriptions of fall-run Chinook abundance, distribution, available habitat, and habitat use are provided in sections 3.5 of this DLA.

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 the 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 relevant to the Project, familiarize interested parties with 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 others 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 Project and any potential Project effects on resources.

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 potential Project effects on water quality, terrestrial, wildlife, historic properties, and cultural and TCP 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, non-governmental organizations (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 that did not require detailed analysis include those that have already undergone study outside of the licensing process. The Don Pedro Project and its potential environmental effects have undergone continuous study and evaluation since the Project's 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 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 fisheries, especially fall-run Chinook salmon.

The Don Pedro Project has 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 time, the 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, City and County of San Francisco (CCSF), and NGOs. On an annual basis, the Districts file with FERC and share with the TAC results of on-going monitoring below the Project Boundary. 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 since the 1995 Settlement Agreement.

Study No.	Study Name
Salomon 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

Study No.	Study Name
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
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
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

Study No.	Study Name
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
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
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
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
Report 1998-5	CWT Summary Update

Study No.	Study Name
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	1989 Report
Report 1996-4	1990 Report
Report 1996-4	1991 Report
Report 1996-4	1992 Report
Report 1996-4	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
1992 Appendix 6	Spawning Gravel Availability and Superimposition Report (incl. map)
1992 Appendix 7	Salmon Redd Excavation Report

Study No.	Study Name
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
Report 2006-11	Tuolumne River La Grange Gravel Addition, Phase II Geomorphic Monitoring Report

Study No.	Study Name
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 and 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 and state 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 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) and results will be reported in the FLA.

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 relicensing studies, several on-going studies provide information in support of the Districts license application. In July 2009, FERC directed the Districts to develop and implement an instream flow incremental methodology (IFIM) study to determine instream flows necessary to maximize Chinook salmon and *O. mykiss* production and survival in the Tuolumne River. In addition to studies required under the relicensing proceedings, the Districts adapted the IFIM study to develop criteria for habitat suitability and to model habitat suitability at different flow rates. The Lower Tuolumne River Instream Flow Studies – Final Study Plan (Stillwater Sciences 2009) was filed with FERC on October 14, 2009. The study plan was approved, pursuant to Ordering paragraphs (A) through (E) of FERC's May 12, 2010 order. In order to examine the broad flow ranges identified in FERC's July 16, 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. The Lower Tuolumne River Instream Flow Study–Final Report was filed with the Commission on April 26, 2013 (Stillwater Sciences 2013). The Pulse Flow Study Report was submitted to FERC on June 18, 2012 (Stillwater Sciences 2012).

Subsequent to the original Study Plan approval, in their December 22, 2011 SPD, FERC required the scope of the Lower Tuolumne Instream Flow Study be expanded to include Pacific lamprey (*Entosphenus tridentatus*) and Sacramento splittail (*Pogonichthys macrolepidotus*), if existing habitat suitability criteria (HSC) were available. Within their April 8, 2013 comments on the Draft 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.

An additional component of the Lower Tuolumne River Instream Flow Studies 1-D PHABSIM investigation is the effective habitat analysis to be completed following the completion of the Lower Tuolumne River Temperature Model (TID/MID 2013). Subsequently, the results of the effective habitat assessment is now expected to be complete by April 2014 (including a 30-day resource agency review period), following the completion of Lower Tuolumne River Temperature Model. Both the effective habitat analysis and the additional HSC will be provided as addendums to the Lower Tuolumne River Instream Flow Study Report (Stillwater Sciences 2013).

1.3.3 Consultation Workshop Process

As part of certain studies undertaken in the Don Pedro Project relicensing, the Districts proposed a series of workshops to share and discuss relevant data with relicensing participants. FERC recommended that the Workshop Consultation process be formalized. In accordance with Appendix B of FERC's December 22, 2011 SPD, a workshop consultation process was developed to provide guidance for the decision-making process involved within the following studies:

- W&AR-02: Project Operations Model,
- W&AR-03: Reservoir Temperature Model,
- W&AR-05: Salmonid Population Information Synthesis,
- W&AR-06: Chinook Population Model,
- W&AR-10: *O. mykiss* Population Model, and
- W&AR-16: Lower Tuolumne River Temperature Model.

The purpose of the workshops is to provide the 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 these study plans. The goal of the workshop process is for relicensing participants and the Districts to reach agreement where possible after thorough discussion of data and methods. FERC directed the Districts to formalize this workshop process to define how decisions will be arrived at throughout development of these studies. The Districts filed a final workshop process with the commission on May 18, 2013. Throughout 2012 and 2013, the Districts conducted a total of 16 workshops. In addition, the Districts conducted model training sessions for several of the studies. 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 A as an electronic attachment to this DLA.

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. In January 2014, the Districts will file the Updated Study

Report (USR) and hold a USR meeting. A meeting summary will be filed within 15 days of the USR meeting.

1.3.5 Draft and Final License Application

This DLA is being filed on November 26, 2013, which will be followed by a 90-day public comment period. The Districts will file a FLA no later than April 30, 2014.

1.3.6 Interventions

FERC will solicit interventions after the FLA is filed.

1.3.7 Comments on the License Application

FERC will solicit and compile comments on the FLA and develop a draft EIS.

1.3.8 Comments on the Draft Environmental Impact Statement

FERC will solicit, compile, and respond to comments received on the draft EIS in the final environmental document.

2.0 PROPOSED ACTION AND ALTERNATIVES

This section describes the Districts' licensing proposal for continuing to operate the Don Pedro Project under a new license. This Exhibit describes current and proposed operations of the existing Project, including the facilities, lands, waters, biological resources, and historical and cultural, recreation, and aesthetic resources. Results of relicensing studies are also described, including Project and cumulative effects, followed by a summary of the environmental measures proposed with respect to each resource area. This Exhibit 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 Project would continue to operate in the future under the terms of the existing license (i.e., there would be no change to the existing environment). No new environmental protection, mitigation, or enhancement (PM&E) measures would be implemented under the new license. Any ongoing effects of the Project not addressed by current measures would continue. This alternative is used to establish baseline environmental conditions for comparison with other alternatives.

2.1.1 Existing Project Facilities

The primary Project facilities include (1) Don Pedro Dam and Reservoir, (2) controlled and uncontrolled spillways on the right (west) abutment of the main dam, (3) controlled 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. Project facility specifications are provided below. The Project also includes three developed recreation areas and other small recreation facilities (restrooms and buoys) outside of the developed areas. Detailed descriptions of Project facilities and features are in Exhibit A of this DLA.

The Project Boundary encompasses all Project facilities and features as well as all land needed for the operation and maintenance of the Project. Approximately 78 percent of all land within the Project Boundary, or 14,328 ac, is owned by the Districts. The remaining land, about 4,040 ac, is 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 Sports Fishing 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.

CCSF obtains over 85 percent of its water supply from its Hetch Hetchy Water and Power System located on the Tuolumne River upstream of the Don Pedro Project. Under agreement with the Districts, and in return for CCSF financing a portion of the cost to build the Don Pedro Project, CCSF obtained the ability to "pre-release" water from its upstream facilities into a "water bank" in Don Pedro Reservoir. The cooperative relationship between the Districts and CCSF serves to optimize the water resources of the Tuolumne River to provide water storage for irrigation, M&I use, flood control, recreation, and fish and wildlife resources. The Districts and CCSF alike have been active and willing partners in efforts to improve and protect the anadromous fisheries in the lower Tuolumne River and they intend to continue this active involvement in the future.

2.1.2.2 Vernalis Adaptive Management Plan

The Districts have demonstrated their willingness to cooperate with federal and state fishery resource agencies to benefit anadromous fish in the lower Tuolumne River and downstream in the San Joaquin and Bay-Delta. For example, the Districts reached an agreement with resource agencies and conservation groups in 1995 which led to FERC issuing in 1996 an amendment to the existing Don Pedro license that increased minimum and pulse flows to the lower Tuolumne River that benefit fall-run Chinook salmon and rainbow trout/steelhead (*Oncorhynchus mykiss)*. The Districts also participated in the recently completed Vernalis Adaptive Management Plan (VAMP), more fully described in Exhibit H and summarized below.

The California SWRCB adoption of the 1995 Water Quality Control Plan (WQCP) for the Sacramento-San Joaquin Delta and Estuary was tracked with great interest by the Districts, given that the Districts hold senior appropriative water rights on the Tuolumne River.

The Districts were particularly concerned since (1) the 1995 WQCP required additional flow for the San Joaquin River at Vernalis, and (2) it was extremely unlikely that such water could be obtained from any source other than the Districts and other San Joaquin Basin tributaries. Since there are no large tributaries to the San Joaquin River capable of providing the quantity of water necessary to meet the flows at Vernalis required by the 1995 WQCP other than the Stanislaus, Tuolumne and Merced rivers, it was clear that the vast majority of the water necessary to meet the new Vernalis flow requirements would have to come from the Districts along with other water rights on the Merced and Stanislaus rivers.

Given their joint interest in the water quality standards contained in the 1995 WQCP, TID and MID, CCSF, along with the other major water right holders on the Merced, Stanislaus and San Joaquin rivers formed the San Joaquin River Group Authority (SJRGA). The SJRGA felt that there was not enough scientific evidence in the administrative record regarding the relationship of Chinook salmon survival and increased flow in the San Joaquin River to justify the adoption of the specific flow objectives for the San Joaquin River contained in the 1995 WQCP.

The SWRCB suggested that the SJRGA should attempt to resolve its concerns about the adequacy of the scientific underpinnings of the Vernalis flow requirements contained in the 1995 WQCP through the development of an implementation strategy which would provide for the acquisition of data regarding the effect such flow would have on Chinook salmon survival. The

SJRGA's members were interested in making certain that the Vernalis flow requirements were based upon sound science and a detailed experimental plan was developed and implemented, as summarized in Exhibit H. The VAMP experimental plan began in 1999 and extended through 2011. The Districts provided a share of the water to the lower Tuolumne River to support meeting the called for pulse flow at Vernalis. The VAMP experiment was not extended past 2011.

2.1.3 Project Safety

The Project has been operating for more than 40 years under the existing license and during this time, FERC staff has conducted operational inspections which evaluated 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 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 report was filed with FERC in January 2013.

As part of the relicensing process, FERC staff evaluates the continued adequacy of the proposed Project facilities under a new license. Special articles would be included in any license issued, as appropriate. FERC staff will continue to inspect the 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 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 anadromous fish. 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)[2] 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 Project construction. Beginning on October 1 of each year, minimum flows provided by the Project to the lower Tuolumne River, as measured at the U.S. Department of the Interior, Geological Survey (USGS) gage at La Grange, are adjusted to meet license requirements to benefit upmigrating adult Chinook salmon. This includes in certain years providing a pulse flow, the amount of which varies depending on the water year type.

Minimum 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 development, and smolt outmigration of fall 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.

[2] All elevations are NGVD 29.

Throughout the winter months, 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), almost 40 miles below the Don Pedro Project.

Minimum flows to the lower Tuolumne River are adjusted again on June 1 and extend through September 30. Irrigation and M&I deliveries normally continue through October, but may also extend through November depending on moisture conditions. M&I deliveries occur year-round.

2.1.5 Current Project Maintenance

2.1.5.1 Facilities and Road Maintenance

The Districts maintain developed facilities and Project roads using a combination of mechanical mowing and periodic use of pre-emergent herbicides 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 vegetation, or aquatic weeds and algae. Mechanical removal of aquatic weeds is also employed when growth is excessive. Main access road shoulders are mechanically mowed (all herbicide and pesticide use is conducted by licensed applicators in accordance with label requirements). In contrast, unpaved roads leading to Don Pedro Dam from off the main road are rarely used, and no formal management is conducted. Additionally, some roads may be treated for specific uses. For example, a small access road leading toward La Grange Dam is typically unmanaged but was mowed in 2012 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 vegetation and the 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 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. Additionally, the Districts may engage in ground squirrel control via two methods:

(1) Burrow blasting: This poison-free management approach uses near pure oxygen and a small amount of propane that is injected into the squirrel burrow. Once a correct amount of oxygen and gas is injected it is shut off and then ignited. This method has been utilized in 2012–2013.

(2) Targeted use of pelleted rodent bait in developed recreation areas. The last such application was during the 2009–2010 season. The Districts will notify the USFWS of any rodenticide use and locations on an annual basis.

The Districts have a Prescribed Burn Program that allows the use of prescribed burns for vegetation management. The Prescribed Burn Program specifies limitations on timing, weather conditions, and frequency so as to minimize fire risk and the potential for damage to adjacent habitats. The Districts use prescribed burn as a management tool infrequently; the last burn under the Program was in 2009, but the Districts will continue to use prescribed burns as conditions permit.

2.1.5.3 Woody Debris Management

Article 52 in the existing license for the Project requires the implementation of the Districts' Log and Debris Removal Plan. Under the Plan, the Districts collect and remove debris collecting at Don Pedro Dam in the upper Tuolumne River Canyon and other dispersed areas of the reservoir as needed in as an ongoing effort. Debris is collected in boom rafts, piled in unvegetated areas below the high water mark along the reservoir edge, and burned during fall and winter.

2.1.6 Existing Resource Measures

The following measures represent ongoing Project obligations which affect the quality of the environment and/or Project operations. Under the no-action alternative, these obligations are assumed to continue during the term of the new license.

2.1.6.1 Don Pedro Project Public Safety Plan

Last updated in 2007, the Project Public Safety Plan describes safety devices located throughout the Project vicinity, such as signage, buoys, fencing, and floating booms, as well as the locations of many 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 preplanned actions to be followed to minimize property damage and loss of life. The Districts update the Emergency Action Plan each year.

2.1.6.3 Recreation Facilities

Authorized under Article 45 of the existing license, the Don Pedro Project has three developed recreation areas, and primitive and semi-primitive lakeshore camping on much of the rest of its shores. The Project provides both floating and shoreline restrooms in addition to those at the developed recreation areas. Facilities also 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 of the Project is contained in Exhibit A.

2.1.6.4 DPRA Rules and Regulations

DPRA Rules and Regulations (Exhibit H, Appendix H-4) govern the use of Project lands and waters. Within these rules and regulations, the Districts' land use policy prohibits any placement of developed improvement along the Don Pedro Reservoir shoreline (e.g., dredging, docks, moorings, piers) and prohibits all vehicular use of undeveloped Project lands. DPRA Rules and Regulations also govern visitor use to prohibit, restrict, control, and manage as appropriate camping, fires, noise, group size, and other aspects of visitor use that have the potential to impact natural resources.

2.1.6.5 Non-Project Uses of Project Lands

All of the lands within the Project Boundary are owned by the Districts with the exception of approximately 4,040 ac 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 very limited non-Project uses of Project lands; however, the Districts permit limited grazing and apiary uses within the Project Boundary as described below.

2.1.6.5.1 Apiaries

The Districts have issued five permits for apiaries within the Project Boundary. A total of 1760 total hives are permitted (200, 120, 120, and 120, and 1200 hives, respectively, are allowed by the individual permits). The permits specifically prohibit any use of the permitted lands for the purposes of accessing Don Pedro Reservoir. The apiary permits were issued on September 1, 2010, and are active through August 31, 2015.

2.1.6.5.2 Livestock Grazing

The Districts have issued four permits for livestock grazing within the Project Boundary, covering a total of 559 ac of upland habitats. A total of 240 total animals are permitted to graze these lands (40, 100, 40, and 60 animals, respectively, are allowed by the individual permits). The permits require that no grazing is to occur below 830 ft, the currently licensed normal maximum water surface elevation for Don Pedro Reservoir. The grazing permits were issued on November 1, 2010, and are active through October 31, 2015.

2.2 Districts' Proposal

The Districts are not proposing any changes to the operation of the Don Pedro Project at this time. The Districts are proposing to develop several resource management plans identified in Section 2.2.3.

2.2.1 Proposed New Project Facilities

The Districts are not proposing any new facilities at this time.

2.2.2 Proposed Project Operations

The Districts are not proposing any changes to Project operations at this time as several studies continue to be performed by the Districts and reviewed by relicensing participants. The FLA may contain proposals for future Project operations.

2.2.3 Proposed Resource Measures

The Districts propose to develop PM&E measures in consultation with relicensing participants. These proposed measures will be included in the FLA and will be based upon the Districts' assessment of the Project effects and consultation with conditioning agencies and other relicensing participants. The Districts anticipate submitting the following draft management plans with the FLA:

- Vegetation Management Plan,
- Bald Eagle Management Plan, and
- Historic Properties Management Plan.

In addition, the Districts will prepare draft BAs for federally listed species that may occur in the Project Boundary.

2.3 Other Alternatives

The DLA presents the current conditions in the Project Boundary. Alternatives to be considered will be developed in consultation with relicensing participants between DLA and FLA.

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 is not being considered.

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. At this time, no 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 was not considered a reasonable alternative to relicensing the Project.

2.4.3 Retiring the Project

Decommissioning of the Project could be accomplished with or without removal of Project facilities. Either alternative would require denying the relicensing application and surrender or termination of the existing license with appropriate conditions. Under the decommissioning alternative, the Project would no longer be authorized to generate power, however the primary use of Don Pedro Dam for water supply would continue.

There would be significant costs involved with decommissioning the Project and/or removing any Project hydroelectric facilities. Decommissioning would foreclose any opportunity to add environmental enhancements to the existing hydroelectric Project.

3.0 ENVIRONMENTAL 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 down the slopes of Mount Lyell and Mount Dana join to form the river's headwaters. After traversing westward 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 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 on 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. Tributaries in the lower elevations are primarily rain-driven.

Table 3.1-1. Location of confluence and drainage basin size of major tributaries to the Tuolumne River.

Major Tributary (listed upstream to downstream)
Above the Project Boundary
Lyell Fork
Dana Fork
Cathedral Creek
Return Creek
On Tuolumne River mainstem: Hetch Hetchy Reservoir
South Fork Tuolumne
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

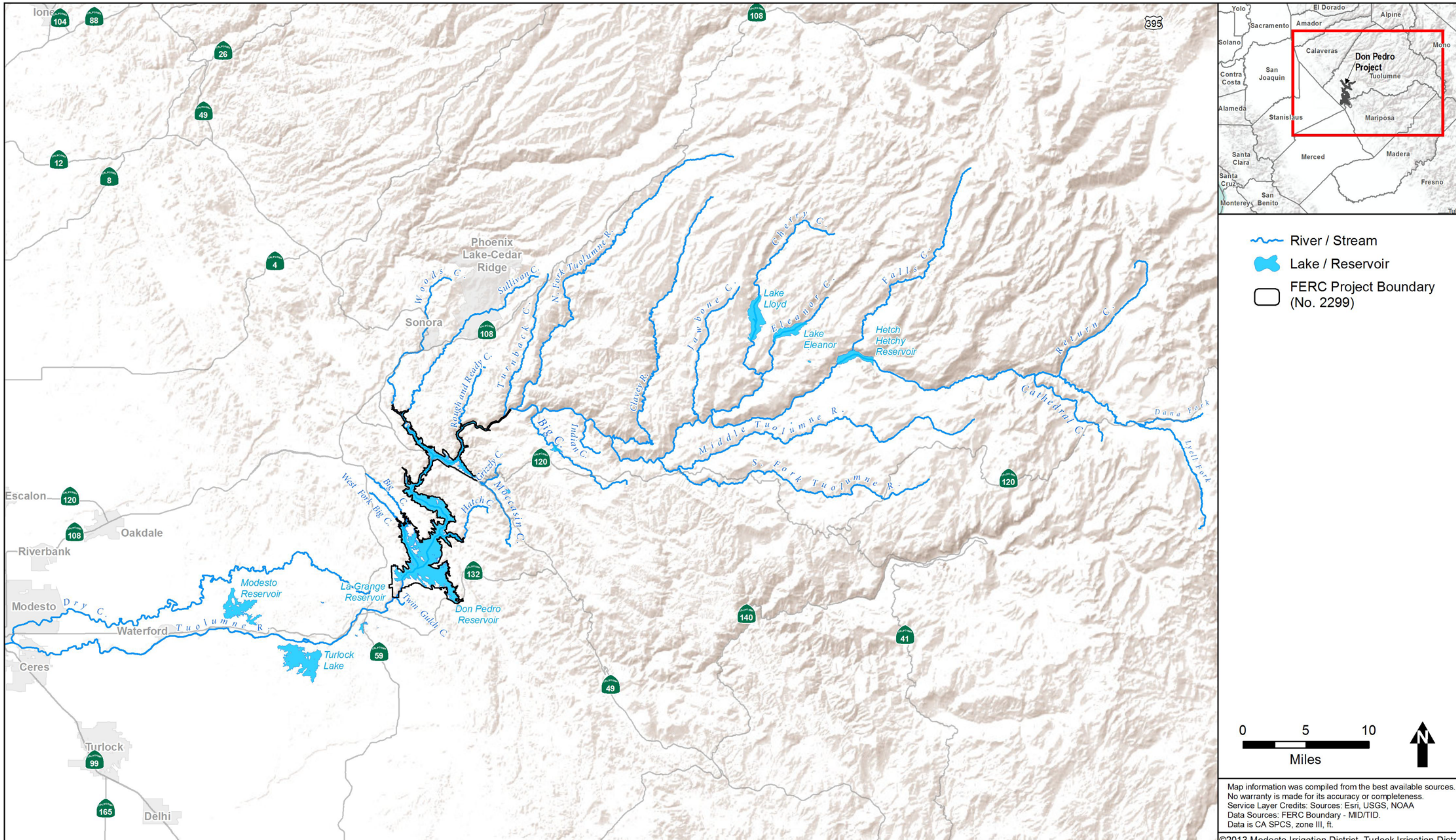


Figure 3.1-1. **Location of major tributaries to the Tuolumne River.**

Other than the Don Pedro Dam, there are three diversions on the Tuolumne River. Upstream of Don Pedro at RM 118, O'Shaughnessy Dam impounds Hetch Hetchy Reservoir. Owned and operated by CCSF, the 360,400 AF Hetch Hetchy Reservoir is an integral component of the larger Hetch Hetchy system, which provides about 85 percent of the CCSF's drinking water and produces an average of 1,700,000 megawatt (MWh) a year. In addition to O'Shaughnessy Dam, CCSF owns and operates Early Intake, located at RM 105. This facility is used only for emergency diversions from Cherry Creek. Located below the Project at RM 52.2, La Grange 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 onto 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 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 upperbasin 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 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 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. All of the lands within the Project Boundary are either owned by the Districts or are federal lands managed by BLM.

Downstream of the Project, in the Central 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 in the communities such as 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 Project is located, has a diverse economic base. From 2007 to 2011, the four largest employment sectors were (1) Educational services, and health care and social assistance; (2) Arts, entertainment, and 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 and hunting, and mining was 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 Project is included in Section 3.12.

3.2 Scope of Cumulative Effects Analysis

As described in FERC's SD2 (FERC 2011), the scope of FERC's EIS for the Don Pedro Project relicensing must include an assessment 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 what 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 scoping meetings, comments FERC 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 Project: water; geomorphology; fish and aquatic, including anadromous fish and their habitat; and socioeconomic.

Section 4 of this DLA includes sections for each of the aforementioned resources that address relevant actions within and outside[1] 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 non-Project private actions are addressed, as appropriate, in this assessment. Because actions undertaken by the government and/or other private entities have occurred, or may occur, independently of the Districts' Proposed Action, they are neither direct nor indirect effects of Project operations. Following the description of relevant actions for a given resource (i.e., water, geomorphology, fish and aquatic, and socioeconomic), Section 4 includes an assessment of cumulative effects on that resource.

The effects of the Project are attenuated with increasing distance downstream in the Tuolumne River and into the San Joaquin River basin and Delta. With increased distance downstream of the 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, including the Proposed Action, 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 related to the Project. Existing, relevant, and reasonably available information regarding each of these is also presented in the PAD for the Project (TID/MID 2011) and summarized here. Consultation with agencies and relicensing participants did not result in the identification of any potential direct Project effects to resources due to erosion, nor were any studies requested or required related to geology and soils.

3.3.1 Affected 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 where characteristic rocks of the Sierra Nevada are abruptly truncated by this east-

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

west fault system. The 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 Don Pedro 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, 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 Project vicinity.

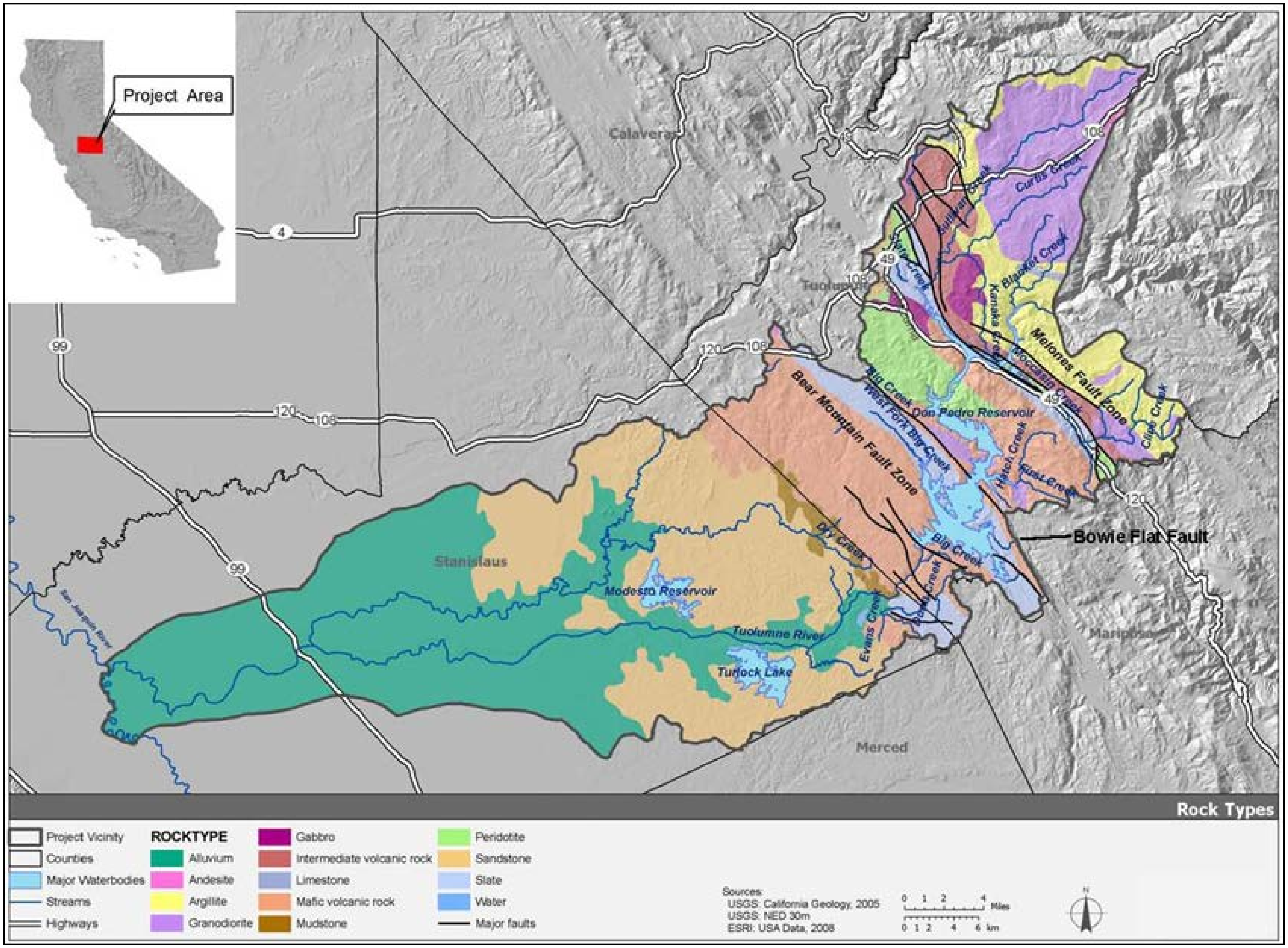


Figure 3.3-1. **Rock types in the Project vicinity.**

3.3.1.2.1 Bear Mountains Fault Zone

The Bear Mountains Fault Zone is a northwest-southeast trending fault that extends through the central part of Don Pedro Reservoir. It is generally reported that the Bear Mountains Fault Zone represents a splay of the Melones Fault zone, and that the two likely merge at depth (Clark 1960).

3.3.1.2.2 Bowie Flat Fault

The Bowie Flat Fault is located in the northern part of the Project and is a zone of intense deformation several hundred feet in width. Quaternary Period movement along the Bowie Flat Fault has been documented on a segment of the fault located approximately eight miles northwest of Don Pedro Dam (Jennings 1994).

3.3.1.2.3 Melones Fault Zone

The nearby Melones Fault is located north of the Project, and marks a division of dominantly oceanic rocks to the southwest and continental rocks to the northeast. The fault zone varies in width in the vicinity of the Project from less than 1,000 ft to over 3,000 ft.

The California Geological Survey (CGS) does not classify any of these faults as active, but does consider them to be "potentially active" because they exhibit evidence of movement within the last 1.8 million years. California Division of Safety of Dams (CDSOD) classifies the Bear Mountains Fault, the Bowie Flat Fault, and the Melones Fault as "conditionally active" (TID/MID 2011).

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 Project from 1769 through the 2013. The source of information on historic 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 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 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 had a long history of production prior to 1941, and two plants are at present 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 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.

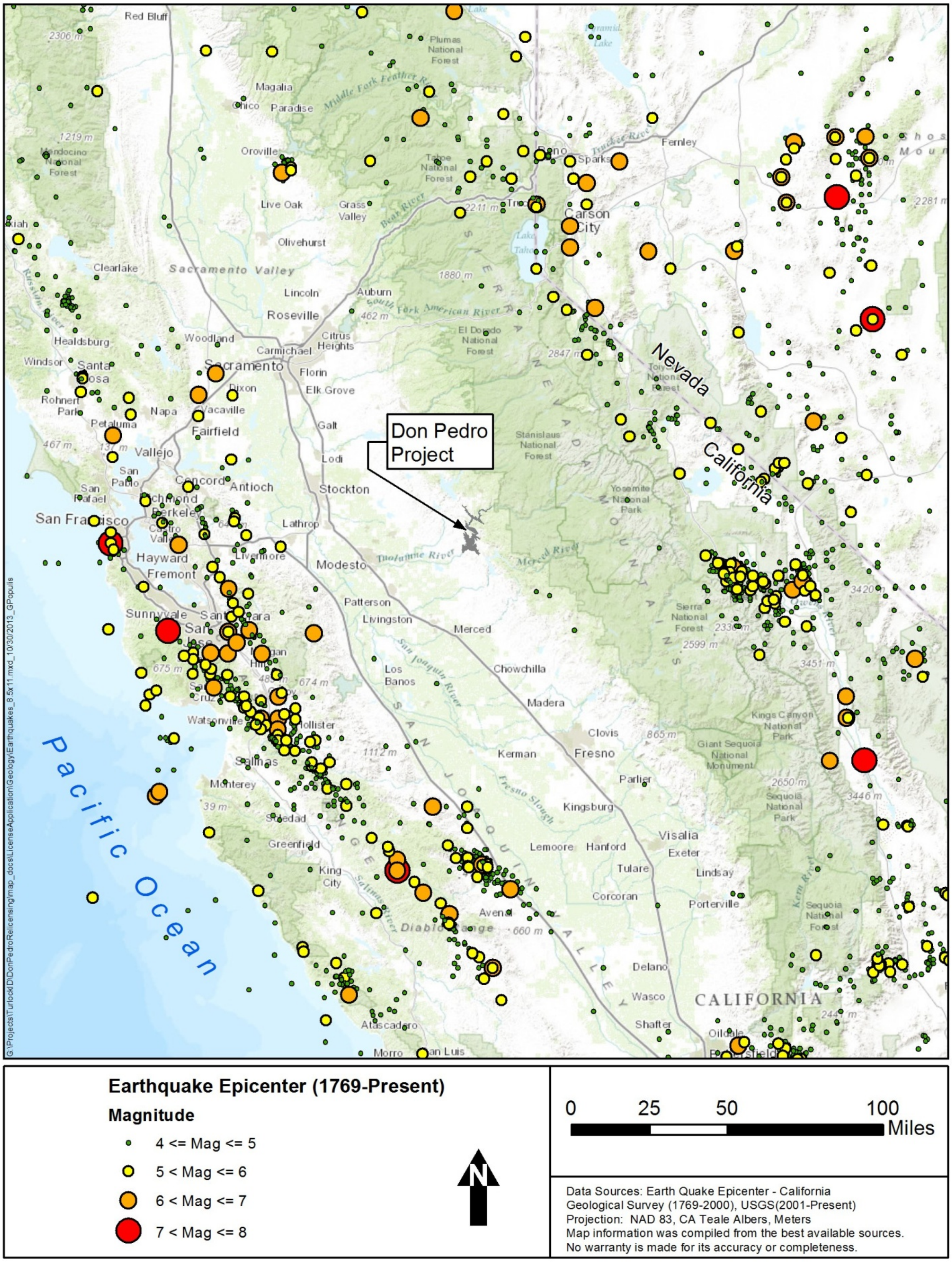


Figure 3.3-2. Historical Seismicity 1769 to 2013.

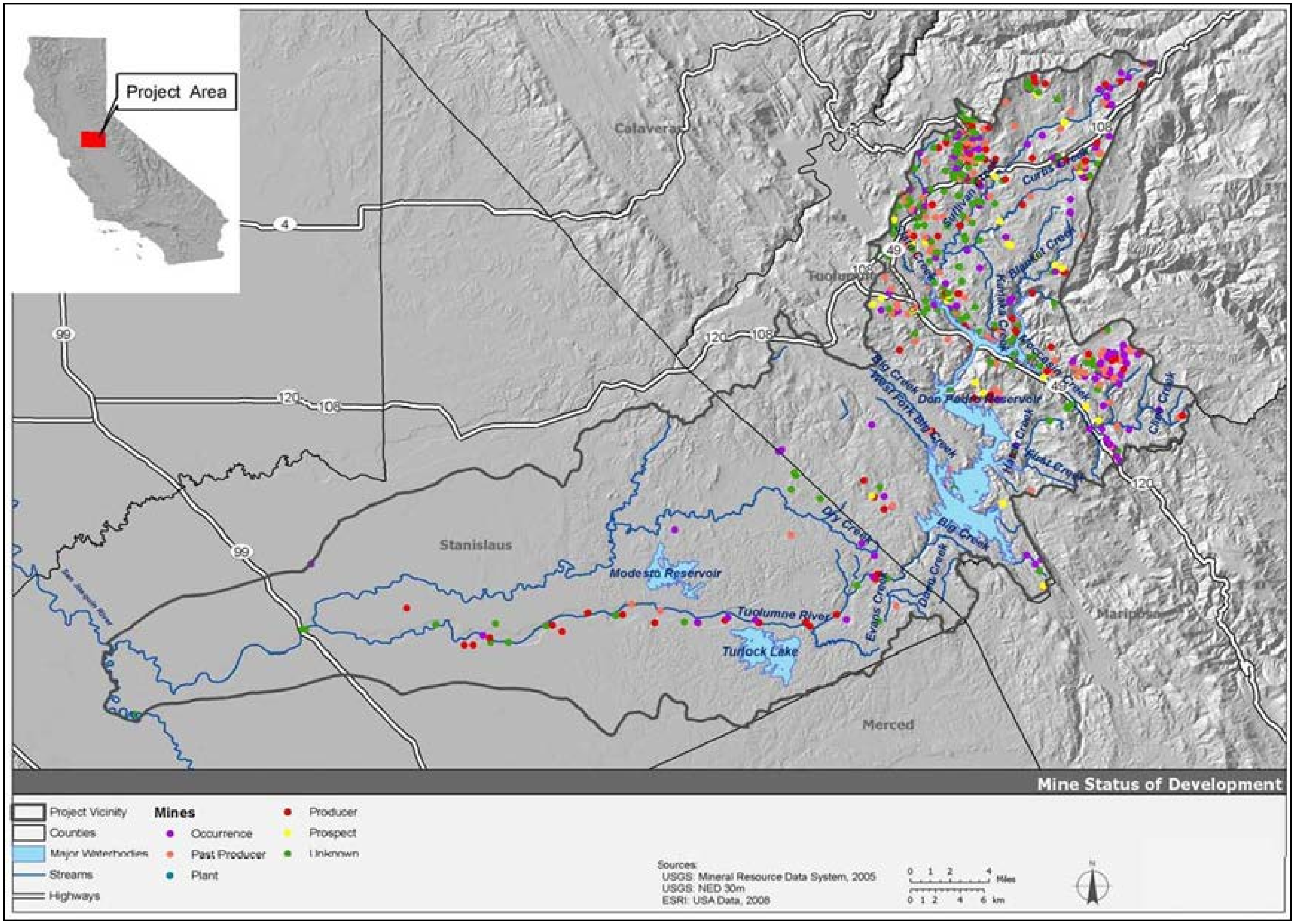


Figure 3.3-3. **Past and present mines in the general Project vicinity.**

3.3.1.5 Soil Resources

3.3.1.5.1 Soil Associations

Two soil associations cover nearly 90 percent of the Project Boundary, Whiterock-rock outcrop-Auburn at 70.6 percent and rock outcrop-Henneke-Delpiedra at 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 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 through the Project, 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.

3.3.1.5.2 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). Mild slopes, less than eight percent, are generally soil (Figure 3.3-5). Mild slopes, less than eight percent, are generally soil. There have been no large movements or mass movements of soil along the reservoir shoreline since the 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 moving 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 2013).

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, 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 also 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 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 Project 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 Project related O&M or recreation activities, including high-use shoreline areas, the Red Hills ACEC, and all Project facilities.
TR-02	ESA and CESA-listed Plants	Field survey. Lands within the Project Boundary that are subject to Project related O&M or recreation activities, including high-use shoreline areas, the Red Hills ACEC, and all Project facilities.
TR-03	Wetlands	Field survey. Wetland and riparian habitats within ten drainagesto Don Pedro Reservoir.
TR-04	Noxious Weeds	Field survey. Lands within the Project Boundary that are subject to Project related O&M or recreation activities, including high-use shoreline areas, the Red Hills ACEC, and all Project facilities.
TR-05	ESA-listed Wildlife - VELB	Field survey. Lands within the Project Boundary that are subject to Project related O&M or recreation activities, including high-use shoreline areas, the Red Hills ACEC, and all Project 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 up to RM 79, 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 Project 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

FERC's SD2 identifies the following potential resource issues associated with geologic, geomorphic, and soil resources:

- effects of Project O&M to soil erosion and shoreline erosion at the reservoir and stream reaches,
- potential effects of any Project related changes in streamflow and sediment delivery to stream reaches to stream geomorphic processes or reservoir bathymetry,
- potential effects of runoff from Project roads and other hard surface runoff to erosion and sediment transport,

- potential effects of the use of Project spillways and dam outlet facilities to soil erosion,
- potential effects of Project operations to large woody debris (LWD) distribution and recruitment, and
- effects of Project related recreation to soil compaction or erosion.

Project O&M has the potential to directly affect resources within the Project Boundary; those effects related to geology and soils are discussed below. Additionally, the Project is one among many influences affecting resources of the lower Tuolumne River downstream of the Project. 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, Project Spillway, and Outlet Works

The effects of the Project to erosion and shoreline resources are minor, limited in scope and degree, and not affecting other resource areas. 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 Project's three developed recreation sites. During completion of relicensing studies, 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 observed to be affecting any non-geologic resources, including special-status species or cultural resource sites, above the normal maximum water surface elevation.

Additionally, the bulk of the Project lands are undeveloped, and geographically removed from any Project 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 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 Project spillway and dam outlet facilities is minimal, and not likely to result in any environmental effects. The Project spillway, founded on rock, discharges directly to a bedrock-confined channel, and the Project 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 Project went into service, there has been one spill event, which occurred during the January 1997 New Year's flood. Project outflows at the spillway exceeded 50,000 cfs. This initial and only use of the spillway 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 of this event to resources is unknown, but are believed to have been minor, as there were no known occurrences of special-status species. 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 Project Recreation

Based on observations by DPRA staff and extensive relicensing studies covering the entirety of the reservoir shoreline, runoff related to Project 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 Project 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 Project includes three developed recreation areas that receive substantial use during much of the year. The recreation areas are largely unpaved, and soils in each are subject to compaction and related effects. Additionally, DPRA maintains a trail system in parts of the Project Boundary; these trails are compacted but serve to focus recreational use on already-compacted lands. Outside these areas, Project lands receive little foot traffic: the majority of dispersed recreational uses are boat-based.

3.3.3 Proposed Environmental Measures

No environmental measures are proposed in this DLA related 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 Project spillway during flood conditions is an unavoidable Project effect that has occurred only once since Project construction, but could occur in the future. Erosion in Twin Gulch downstream of the spillway channel is an unavoidable effect with little to no adverse impact due to the limited occurrences during extreme high water events and the lack of sensitive resources in Twin Gulch.

3.4 Water Resources

This section describes water resources of the Tuolumne River relevant to the Project’s operations and maintenance activities. The information provided in the Districts’ PAD was augmented by four studies conducted during the relicensing process: (1) Study W&AR-01: Water Quality, (2) Study W&AR-02: Tuolumne River Operations Model, (3) Study W&AR-03: Reservoir Temperature Model, and (4) Study W&AR-16: Lower Tuolumne River Temperature Model. The Districts are continuing an intensive monitoring study of river temperatures through 2013. Additional data and analyses conducted using this additional information will be provided in the FLA.

3.4.1 Affected Environment

The Don Pedro Project Boundary extends from RM 80.8 to RM 53.2 on the Tuolumne River in the central portion of California. The Tuolumne River originates in Tuolumne Meadows in Yosemite National Park by the confluence of streams running off the slopes of Mount Lyell and Mount Dana, both over 13,000 ft in elevation. From there, the Tuolumne River flows for roughly 140 miles where it feeds into the San Joaquin River. Over those 140 miles the river falls over 8,000 ft in elevation.

Like other rivers of the Sierra Mountains 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"[2] to facilitate in-channel gold mining operations. The first major dam constructed on the Tuolumne, Wheaton Dam, was completed in 1871 near the location of the current La Grange Dam. Wheaton Dam was used to divert river flow for irrigation and domestic use.

Community interest in developing the water resources of the Tuolumne River extends back to 1887 when both 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 two districts agreed to build a jointly-owned diversion dam, La Grange Dam, which was subsequently 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 1960s (Cherry Dam - 1955; Kirkwood powerhouse - 1967; new Don Pedro Dam - 1971). TID, MID, and CCSF have been involved in managing the waters of the Tuolumne River for well over 100 years.

3.4.1.1 Water Quantity

This section provides information on the environmental setting and hydrology that affect Project inflow, outflow, and reservoir levels; describes the development of the hydrology used for the Tuolumne River Operations Model; and discusses existing and proposed uses of Project waters.

3.4.1.1.1 Drainage Area

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

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

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

Subbasin	Total 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

The upper Tuolumne River can be further subdivided into Hetch Hetchy Reservoir watershed (459 mi^2) and Cherry Lake /Lake Eleanor Reservoir combined (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, Lake Eleanor has a normal pool elevation of 4,657 ft. The Don Pedro Project Boundary is at elevation 845 ft.

3.4.1.1.2 Climate

The climate and hydrology of the 1,960 mi^2 Tuolumne River basin varies considerably over the river's 140 mile length. As an illustration of this variation, annual precipitation in the higher 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 lower lying Central Valley area, 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 lying reaches of the Tuolumne River, the average precipitation from May through September, inclusive, is less than one inch. Year-to-year variation is also dramatic. In the period of 1971 to 2012, the lowest estimated unimpaired flow of 382,000 AF (WY 1977) to 4.6 million AF (WY 1983). This represents a hydrology with an 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 to 2012 period was WY 1976 (672,000 AF), the year before the driest year, and the third wettest year was WY 1982 (3.8 million AF), the year before the wettest year.

The range in climatological conditions across the basin is demonstrated by the temperature and precipitation statistics provided in Table 3.4-2. These conditions result in the evapotranspiration rates along the lower Tuolumne River valley 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 table also serves to demonstrate the dependence of the agricultural industry in the Central Valley on the availability of irrigation water. Cumulative precipitation through the hot summer months of May through September is less than one inch of moisture for the entire period.

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. Precip. (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. Precip. (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
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. Precip. (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 - http://www.wrcc.dri.edu/summary/climsmnca.html.

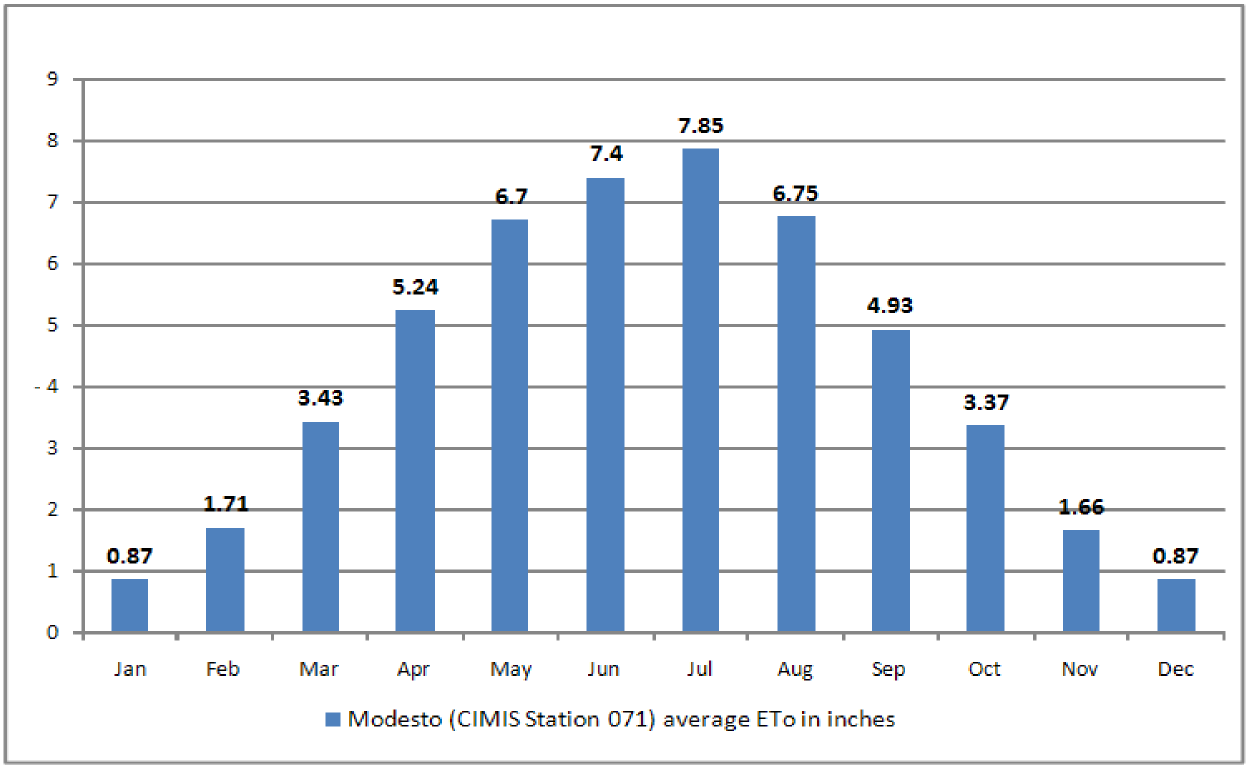


Figure 3.4-1. Modesto monthly average evapotranspiration rates, June 1987 to present.
Source: California Department of Water Resources (CDWR) 2013

3.4.1.1.3 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 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 unregulated, rain-driven tributaries flow directly into Don Pedro Reservoir, but these streams provide only a small amount of the annual flow to the reservoir. The average annual flow of the Tuolumne River at Don Pedro is approximately 1.7 million AF. Flood flows in the 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 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 DLA.

Downstream of the Project, water flows from the powerhouse or outlet works tunnel into the Tuolumne River, then into the impoundment formed by La Grange Dam, a non-project diversion dam owned by the Districts. Downstream of the La Grange Dam, the Tuolumne River becomes a low-gradient meandering stream, with an average gradient of about two ft per mile, in contrast to the upper Tuolumne where gradients can exceed well over 100 ft per 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, though the groundwater contribution has not been well quantified. The lower Tuolumne River is considered to be generally a gaining stream.

Hydrology Upstream of Don Pedro Reservoir

There are a number of streamflow gages on the upper Tuolumne River, either presently maintained or historical, that encompass much of 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. 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 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 Powerplant
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

Gage Number	Gage Name	Period of Record[2]	Notes
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 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 USGS are presented 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.

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 Powerplant that are 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

Month	Mean Monthly Flow (cfs)	Lowest Mean Monthly Flow (cfs)	Highest Mean Monthly Flow (cfs)
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 from 1923 through 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

Month	Mean Monthly Flow (cfs)	Lowest Mean Monthly Flow (cfs)	Highest Mean Monthly Flow (cfs)
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 from 1923 through 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 CCSF's upstream reservoir operations. Outflows from Don Pedro reflect real-time operations by the Districts to manage flows in accordance with storage requirements, ACOE flood control guidelines, and downstream demand for water, including instream flow requirements contained in the current FERC license. Table 3.4-8 provides Don Pedro outflows since the first full calendar year following the 1996 FERC order incorporating terms of the 1995 settlement agreement.

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

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			
USGS 11289650 - Tuolumne River Below La Grange 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.

Hydrology of the Lower Tuolumne River

Flows in the lower Tuolumne River above La Grange Dam are reported at three locations (Table 3.4-8) whose 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. The 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).

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

Month	Below La Grange 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 further 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 Project operations because the Flood Control Manual calls for keeping Tuolumne River flows below 9,000 cfs at the 9th Street Bridge to minimize significant property damage. This restriction has the greatest potential to affect Project operation during the wet winter and spring snowmelt months when diversions for irrigation or M&I use may be relatively low and, consequently, maintenance of flood control space in Don Pedro Reservoir is vital.

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

Month	Mean Monthly Flow (cfs)	Lowest Mean Monthly Flow (cfs)	Highest Mean Monthly Flow (cfs)
Aug	501	68	2415
Sep	680	73	4041
Oct	848	78	4760
Nov	647	93	2089
Dec	1129	110	5431

Source: USGS 11290000.

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 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 of 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), unimpaired flows for the Tuolumne River can vary considerably from day to day and occasionally show negative flows. These flows over time, however, are a reasonable representation of the total amount of natural runoff in the Tuolumne River. Table 3.4-11 presents a summary of average monthly unimpaired flow for 1975 to 2012.

Table 3.4-11. Tuolumne River at La Grange 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 2013a.

Flood Hydrology

The ACOE participated financially in the construction of the Don Pedro Project in order 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 the following 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 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.

Since completion of the new Don Pedro Dam in 1971, the flood of record occurred in January 1997 (the "1997 New Year's Flood"). The peak inflow was 120,935 cfs and peak outflow was 59,462 cfs, as measured at the La Grange gage. This is the only spill event utilizing the gated spillway that has occurred since Project completion.

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

Drought Hydrology

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. 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, and 250,000 AF of M&I water for CCSF's Bay Area customers. Unimpaired flow since 1975 at Don Pedro Dam has been less than 1.4 million AF over 40 percent of the years.

Successive dry years are challenging for water managers. Drought planning is based on supplying adequate amounts of water to meet demands through successive dry years. Since 1971, several drought periods have occurred, WYs 1976 through 1977; 1987 through 1992; 2001 through 2004; and the current 2012/2013 period. During the 1976/1977 drought, the combined two-year unimpaired flow was 1 million AF or 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 through 1992. The unimpaired flow over these six years averaged was 0.9 million AF, or just 48 percent of the mean. In the entire WY 1987 to 1992 period, not a single year exceeded 70 percent of the long-term mean annual flow. The successive four year low flow period from 2001 through 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. Furthermore, 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 groundwater storage provided by greater irrigation occurring during wet years. Recent studies have indicated that groundwater storage has been reduced and may no longer be in a state of equilibrium as had existed in the 1990s (TID 2008).

3.4.1.1.4 Development of Hydrology for the Tuolumne River Operations Model

The Districts have developed a detailed river-specific computer model 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", or no-action alternative, for the Project. The model may also be used to simulate other potential operations of the Project and can be used to compare the effects of alternative operations with the base case.

The hydrology associated with the model's base case contains simulated inflows to Don Pedro Reservoir for the WY 1971 to 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 above Don Pedro. 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. This component of Don Pedro Reservoir inflow may change among operation simulations due to changed flow requirements for the CCSF system demands, or due to user-controlled parameters.

The final model unimpaired hydrology 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 over the monthly time steps to be maintained. Gaged data from both the Tuolumne River and nearby drainages were included in the gage proration portion of the analysis. In order 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-foot "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 foot 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) model 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 beginning 100 to 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 in order 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-foot 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 and were previously described to relicensing participants in a March 27, 2013 Workshop and again in the Districts' April 9, 2013 submittal to FERC entitled *Districts' Response to Relicensing Participants Comments on the Initial Study Report (Attachment 2).*

3.4.1.2 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 fall within three Basin Plan units (HUs): (1) HU 536, which includes the Tuolumne River upstream of the 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 CVRWQCB 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. Municipal and Domestic Supply is listed as a potential use; however, in actuality Don Pedro Reservoir is currently 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 upon 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	Don Pedro Reservoir	Don Pedro Dam to San Joaquin River
			HU 536	HU 536.32	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

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	Don Pedro Reservoir	Don Pedro Dam to San Joaquin River
			HU 536	HU 536.32	HU 535
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 repressuration.	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 Freshwater Habitat (WARM)	Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.	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	Don Pedro Reservoir	Don Pedro Dam to San Joaquin River
			HU 536	HU 536.32	HU 535
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 COLD water bodies by the SWRCB for the application of WQOs.
3 Striped bass, sturgeon, and shad.
4 Salmon and steelhead.
Source: CVRWQCB 1998 and amendments.

3.4.1.2.1 Irrigated Agriculture

Water for irrigated agriculture is a designated beneficial use of Tuolumne River waters. TID and MID combine to serve over 200,000 ac of highly productive farmland north and south of the Tuolumne River through diversions at the non-project La Grange Dam. For annual crops (grains, pasture, vegetables), initial decisions and financial commitments to the number of acres to plant must be made by late January or early February—at a time when total water year precipitation levels and runoff are largely unknown. Many of these annual crops are grown to support the large regional dairy industry. Not only does this provide a source of feed for cows, but also is the means by which to dispose of nutrients created by the herds. Other major irrigated crops in the Districts service areas are nut and fruit orchards, which are permanent crops requiring significant initial investment. A reliable year-over-year water supply is necessary to sustain the yield and health of these permanent crops.

3.4.1.2.2 Municipal and Industrial Water Supply

The Project serves two distinct purposes related to M&I water supply. MID serves treated Project water to the City of Modesto's 200,000 people. The CCSF uses the water bank, created through CCSF's financial participation in the construction of the Project, to ensure the reliability of water supply to its 2.6 million customers in the Bay Area. CCSF's Hetch Hetchy water system provides 85 percent of the water supply to its Bay Area customers. The demand for M&I water is not substantially affected during successive dry years. This combined M&I demand for Tuolumne River water exceeds 300,000 AF per year.

3.4.1.2.3 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 and migration flows.

3.4.1.3 Water Quality

This section includes the following subsections: (1) water quality objectives (WQOs) for the Don Pedro Project; (2) general water quality, including CWA Section 303(d) constituents, (3) water temperature regime of the Don Pedro Reservoir, and 4) water temperature regime of the Project-affected reach between Don Pedro and La Grange dams.

3.4.1.3.1 Water Quality Objectives

The CVRWQCB has adopted WQOs to protect the beneficial uses listed above in Table 3.4-12. WQOs associated with the designated beneficial uses are provided in Table 3.4-13. The objectives are primarily narrative, incorporating California's numeric Title 22 drinking water standards by reference. A few, such as dissolved oxygen (DO) and pH, are numeric.

Table 3.4-13. Water quality objectives to support beneficial uses in the vicinity of the Don Pedro Hydroelectric 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 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).

Water Quality Objective	Description
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.
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 Project. The radioactivity and suspended material objectives do not apply to the Project; 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 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 ammendments.

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. These objectives can be difficult to apply to the Project because no data exist to characterize the temperature regime of “natural receiving waters” or ambient turbidity conditions. With recent advancements in temperature computer modeling, natural receiving water temperatures can be estimated with reasonable certainty.

Application of the Basin Plan’s temperature and DO objectives 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 the temperature structure of even complex reservoirs.

3.4.1.3.2 California List of Impaired Waters

Section 303(d) of the 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 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 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 Project Boundary and upstream and downstream of the Project.

Waterbody Segment	Pollutant/Stressor	Potential Sources	Expected TMDL Completion Date
Upstream of the Project			
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)	Escherichia coli (E. coli)	unknown	2021
Project Boundary			
Don Pedro Reservoir	Mercury	Resource Extraction	2020

Waterbody Segment	Pollutant/Stressor	Potential Sources	Expected TMDL Completion Date
Downstream of the Project			
Lower Tuolumne River (Don Pedro Reservoir to San Joaquin River)	Chlorpyrifos	Agriculture	2021
	Diazinon	Agriculture	2010
	Group A Pesticides[1]	Agriculture	2011
	Mercury	Resource Extraction	2021
	Temperature	unknown	2021
	Unknown Toxicity	unknown	2021
Turlock Lake	Mercury	unknown	2021
Modesto Reservoir	Mercury	unknown	2012
Dry Creek (tributary to Tuolumne River at Modesto)	Chlorpyrifos	Agriculture	2021
	Diazinon	Agriculture	2021
	Escherichia coli (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

3.4.1.3.3 Water Quality Information and Studies

Existing water quality information for waters in the vicinity of the 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,
- U.S. Geological Survey Water Resources (USGS) 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 with Don Pedro Reservoir and in the lower Tuolumne River, and
- Various CCSF reports.

When developing the PAD, the Districts found that water samples collected within the 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. Don Pedro Reservoir’s minor tributaries (e.g., Woods, Sullivan, and Moccasin creeks) entering the reservoir and the recreation infrastructure at Don Pedro Reservoir (e.g., campsites and fuel stations) were identified as potential sources of water quality degradation.

During the summer of 2012, surface water samples were collected at five locations upstream, within, and downstream of the Project and analyzed for 55 physical and chemical characteristics (TID/MID 2013c). 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 confirmed that water quality is good in the Project Boundary, upstream and downstream. Most constituents were reported at non-detect to just above reporting limit concentrations. The water is generally clear (i.e., average turbidity of <49 Nephelometric Turbidity Unit (NTU)), DO is near saturation at stream and epilimnion sites, alkalinity is low (<16 milligrams per litter (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. Nutrients, hardness (i.e., 6 to 15 mg/L), and turbidity (i.e., 0 to 8 NTU[3]) remain constant and/or decrease as water flows downstream through the Project, indicating that water quality is essentially maintained. With the exception of nutrients, there was no pattern of increasing or decreasing constituent concentrations from upstream to downstream of the Project (TID/MID 2013c).

Consistency with Basin Plan Water Quality Objectives

Basin Plan WQOs are presented above, in Table 3.4-14. The Districts' Water Quality study evaluated water quality data relative to 15 applicable Basin Plan WQOs[4,5] (TID/MID 2013c). As prescribed by the FERC-approved study plan, when numeric WQOs were not provided in the Basin Plan, data were compared to other relevant guidelines and benchmarks, including the EPA's (EPA 2000) California Toxics Rule (CTR) aquatic-life protective criteria (TID/MID 2013c). Numeric WQOs and the benchmarks used for evaluating the protection of designated beneficial uses of Project waters are provided in Table 3.4-15.

[3] In 2012, the sample collected between Don Pedro Reservoir's upper and middle bay was 282 NTU. All other samples exhibited turbidity between 8 NTU (most upstream sample) and 0 NTU (near dam and downstream samples).
[4] The radioactivity WQO does not apply to the Project.
[5] Temperature was evaluated separately and is discussed below, in Section 3.4.5.

Table 3.4-15. Benchmark values used for evaluating the protection of designated beneficial uses of 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]
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]

Basin Plan Water Quality Objective (Potentially Affected Beneficial Uses)	Symbol or Abbreviation	Benchmark Values	Reference	Notes
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]
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]

Basin Plan Water Quality Objective (Potentially Affected Beneficial Uses)	Symbol or Abbreviation	Benchmark Values	Reference	Notes
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 $CaCO_3$
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 $CaCO_3$

Basin Plan Water Quality Objective (Potentially Affected Beneficial Uses)	Symbol or Abbreviation	Benchmark Values	Reference	Notes
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 $CaCO_3$
		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

Basin Plan Water Quality Objective (Potentially Affected Beneficial Uses)	Symbol or Abbreviation	Benchmark Values	Reference	Notes
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 and (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 which 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[6]) and 0.11 mg/L, while 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 aware of no 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 contaminate 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 applied to untreated water in this study. Samples collected in August 2012 had concentrations less than the primary MCLs for all analytes; water quality was found to be consistent with drinking water standards (TID/MID 2013c). Analytes with secondary MCLs for tastes and odors are addressed below under “Taste & Odor.” Aquatic toxicity is discussed below under “Toxicity.

Color

The Basin Plan includes a narrative WQO regarding color.

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

pH

The Basin Plan requires that pH shall not be depressed below 6.5 nor raised above 8.5.

During August 2012 sampling, three locations had a pH value outside of 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). As expected for a low nutrient, snow-melt derived reservoir, these values are within the sonde’s measurement error of ± 0.1 mg/L and are considered consistent with the objective.

[6] If 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.

Pesticides

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

Downstream of the Project, 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 regarding 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 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, since significant pesticide use does not occur in association with the Project, these non-detects are considered applicable—chlordane and toxaphene are not present in 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 Project 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 Project. Additionally, the Districts are aware of no suspended sediment levels or discharges of such that cause a nuisance or adversely affect any designated beneficial uses of Project or other 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 did not include a provision for evaluating Settleable Material. The Districts are aware of no Settleable Material present in Project water or Settleable Material that causes a nuisance or adversely affects any designated beneficial uses of Project or other 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 Project or other 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. 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 Project or other 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 states that study water quality data would be compared to the aquatic life protective benchmarks from the 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 2013c). 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, as compared to a CTR guideline of 1.8 µg/L.

The Districts are aware of no Project O&M activity that may affect levels of copper. As reported in the PAD, algaecides are not used to manage algae in Project waters.

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 under the CWA for certain water constituents. The pollutant stressors identified in the 303(d) list are primarily related to agricultural use, but the list also includes mercury, a legacy contaminant of the gold mining era (SWRCB 2010). Mercury can affect the nervous system of higher trophic organisms and is bioaccumulated and transferred to higher trophic organisms through the food-web.

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 were 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 Project Boundary for mercury. In addition, the samples were below the CTR benchmark of 50 ng/L.

Samples were also analyzed for methylmercury (total) and methylmercury (dissolved). 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), while 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 or La Grange dams and 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 this 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 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. 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 Project O&M activity that may affect mercury methylation and do not propose any activities 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 2013c). In August 2012, turbidity was 8.6 NTU upstream of the Project (Tuolumne River above Don Pedro) and 0 NTU downstream of the Project (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 metolimnion,[7] a location where plankton reportedly accumulates. Turbidity was not recorded downstream of La Grange Dam.

There is no evidence to suggest that turbidity levels cause a nuisance or any adverse effect to beneficial uses in the study area or immediately downstream of the 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 twelve recreation sites sampled had fecal coliform counts below the WQO for the time surrounding and including Independence Day. The total coliform and *E. coli* benchmarks used to evaluate the bacteria counts are shown in Table 3.4-15. Likewise, all total coliform counts and *E. coli* levels were below their respective benchmarks. *E. coli* counts are thought to be better indicators of human impacts (EPA 2003).

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 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 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 . Total Petroleum Hydrocarbons were not detected at any of the sites.

Dissolved Oxygen

The general DO WQO of 7.0 mg/L applies to the Tuolumne River and its tributaries (CVRWQCB 1998).

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

Synoptic measurements of DO in August 2012 were all above Basin Plan numerical limits except in the mid-reservoir hypolimnion of Don Pedro Reservoir (3.2 mg/L), and the near-dam hypolimnion of Don Pedro Reservoir (4.8 mg/L). These results were expected, because large, deep reservoirs/lakes generally form strong thermoclines[8] with oxygen poor hypolimnions in the late summer/fall period. DO values were above the Basin Plan Objective at all surface sites (TID/MID 2013c).

In addition to the Water Quality study data collection, since June 2011, the Districts have collected DO profiles in Don Pedro Reservoir. Tables 3.4-16 and 3.4-17 provide a summary of data collected from two of the eight locations and is 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 can be gleaned from the figures, located below the Tables 3.4-17 and 3.4-18.

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
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

[8] The thermocline is the location where the rate of decrease of temperature with increase of depth is the largest.

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 would be expected in the deeper natural lakes and man-made reservoirs of inland northern California. The profile is a positive heterograde curve indicating a metalimnetic[9] oxygen maxima. This occurs whenever a reservoir is stratified but most strongly in the summer. Increasing temperatures in the epilimnion result in decreased solubility while typical oxygen consumption in the hypolimnion also results in a decrease in DO with depth. These metalimnetic oxygen maxima are almost always caused by algal 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 describe 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.

[9] Near or around the metalimnion.

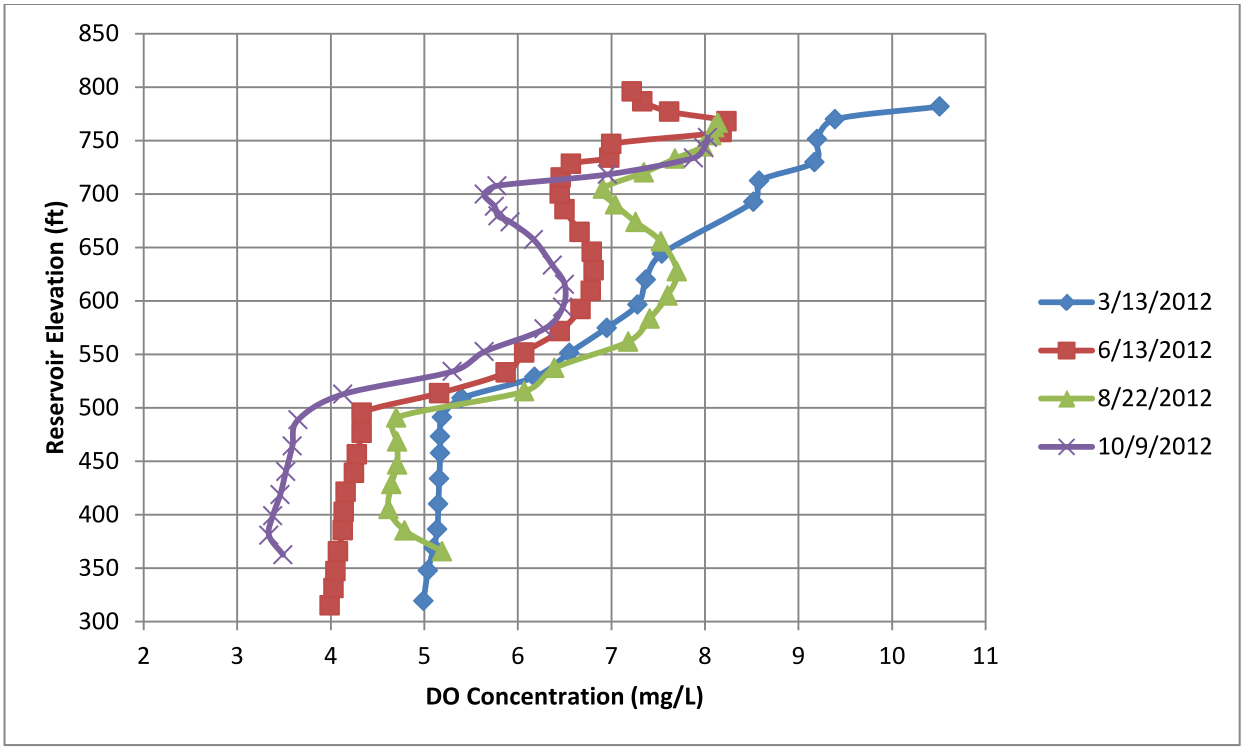


Figure 3.4-2. Dissolved oxygen profiles collected in Don Pedro Reservoir near the dam during 2012.

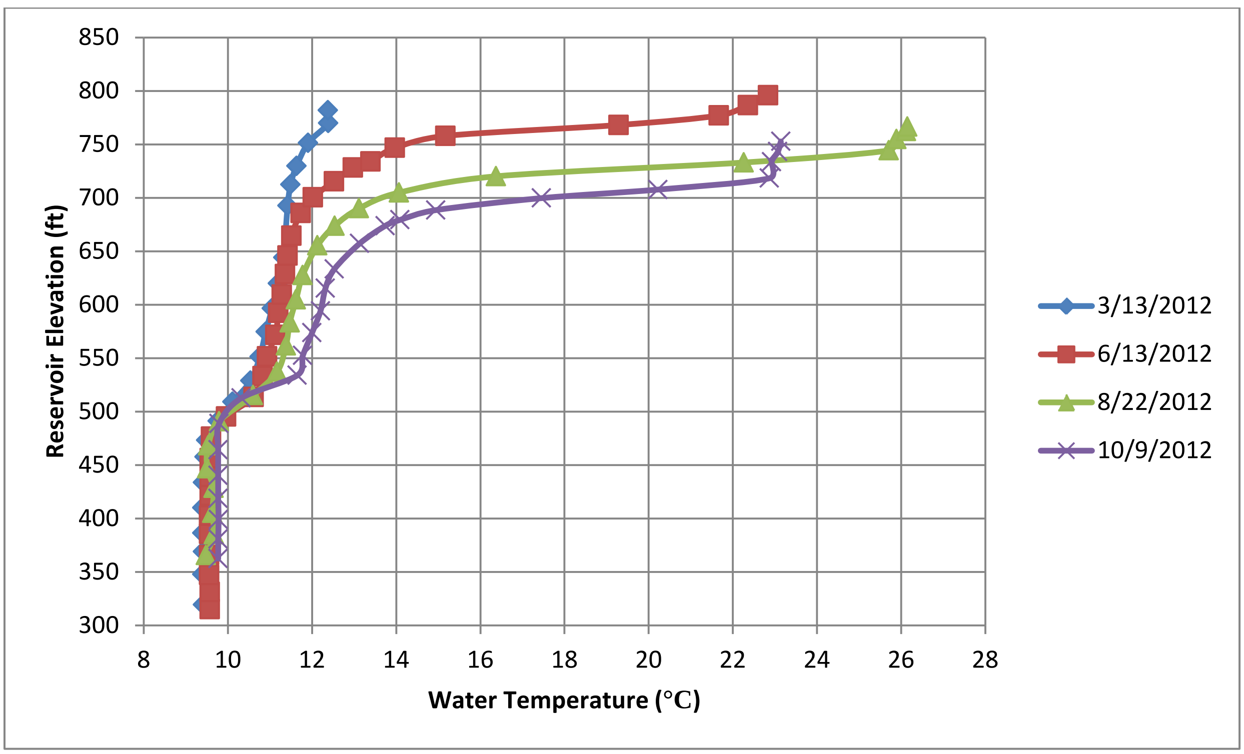


Figure 3.4-3. Water temperature profiles collected in Don Pedro Reservoir near the dam during 2012.

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 where the average of the day's 24 hourly DO measurements was below 7 mg/L.

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
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

3.4.1.4 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

Site Location[1]	Approximate River Mile	Latitude	Longitude	Period of Record
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[10] lakes – temperatures do not drop below approximately 10ºC, the reservoir circulates freely in winter, and it stratifies in summer. Ice does not form on the reservoir, and the reservoir mixes once in winter.

With respect to temperature patterns, 2011 was a typical year (Figure 3.4-5). The 2011 vertical temperature profiles show that in the early portion of the year, January through March, the reservoir is not stratified and equilibrium temperatures are around 10^{o} C. In April the data indicate significant warming at the surface with temperatures around 18^{o} C observed, 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 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 are usually just below 25^{o} C. When the last profiles were measured in 2011 on October 13 the reservoir remained stratified. Surface temperatures continued to drop and were around 20^{o} C.

10 A lake or reservoir that mixes one time, each year.

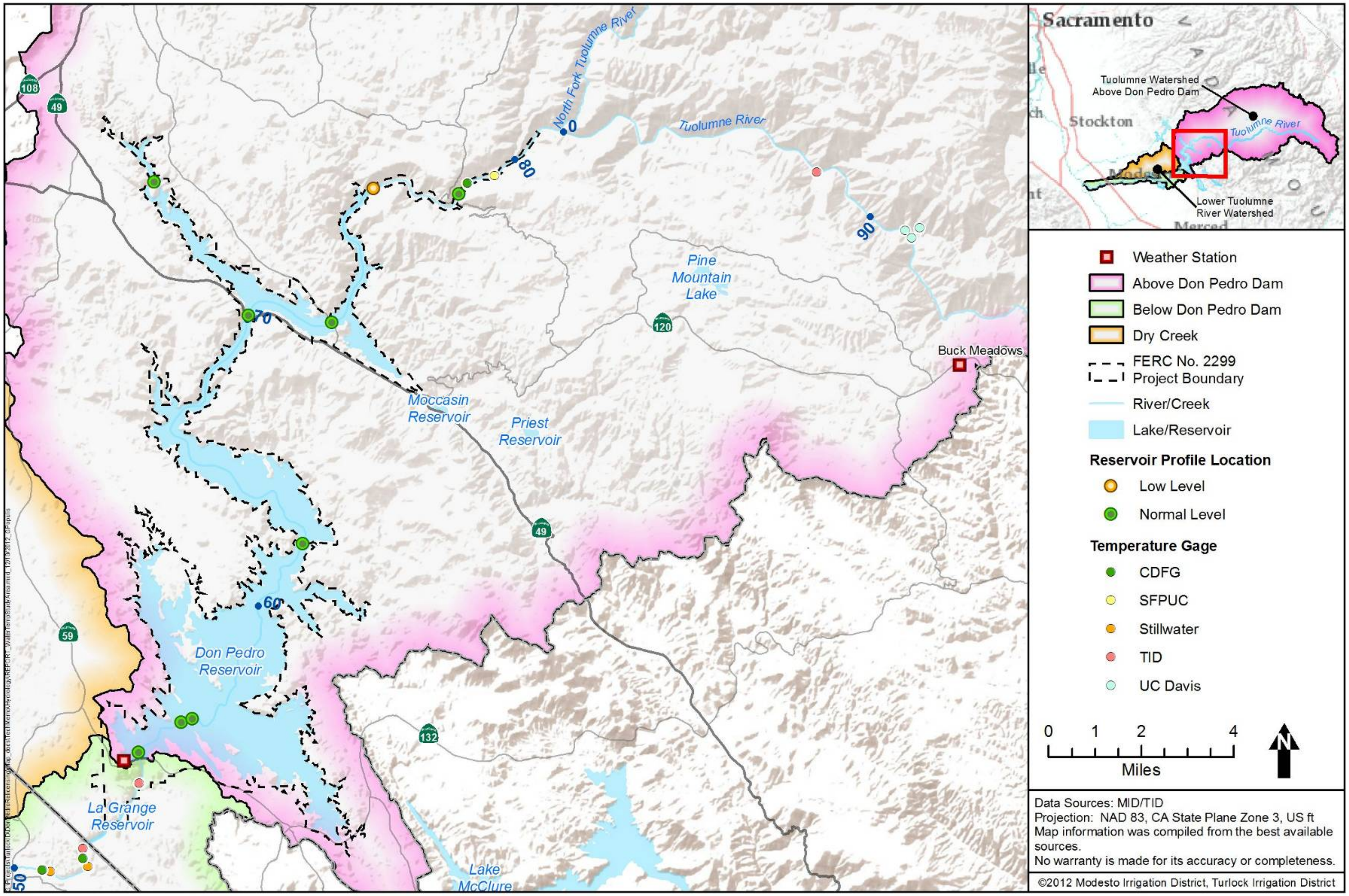


Figure 3.4-4. Don Pedro Reservoir temperature profile locations.

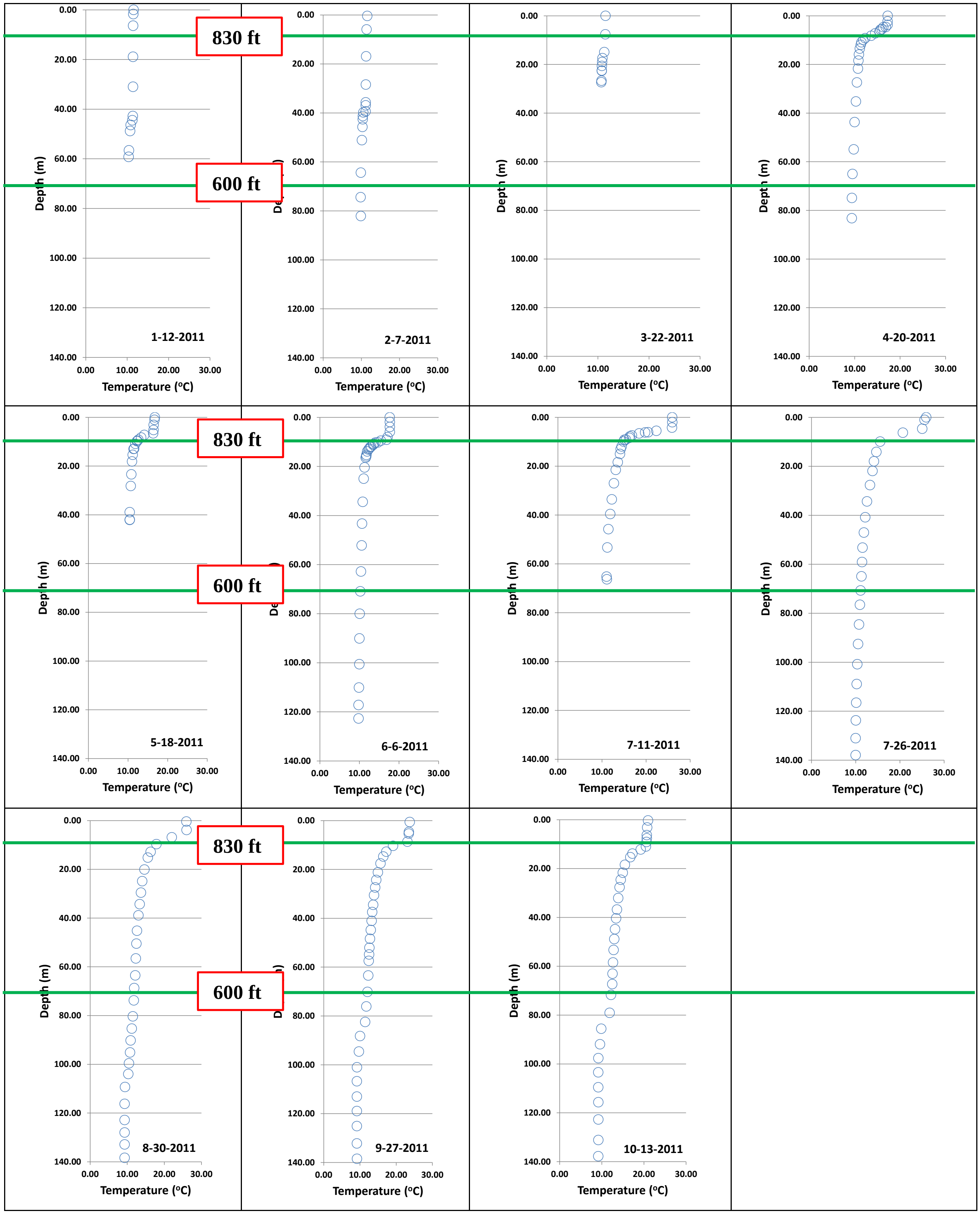


Figure 3.4-5. Water temperature profiles recorded in Don Pedro Reservoir in 2011.

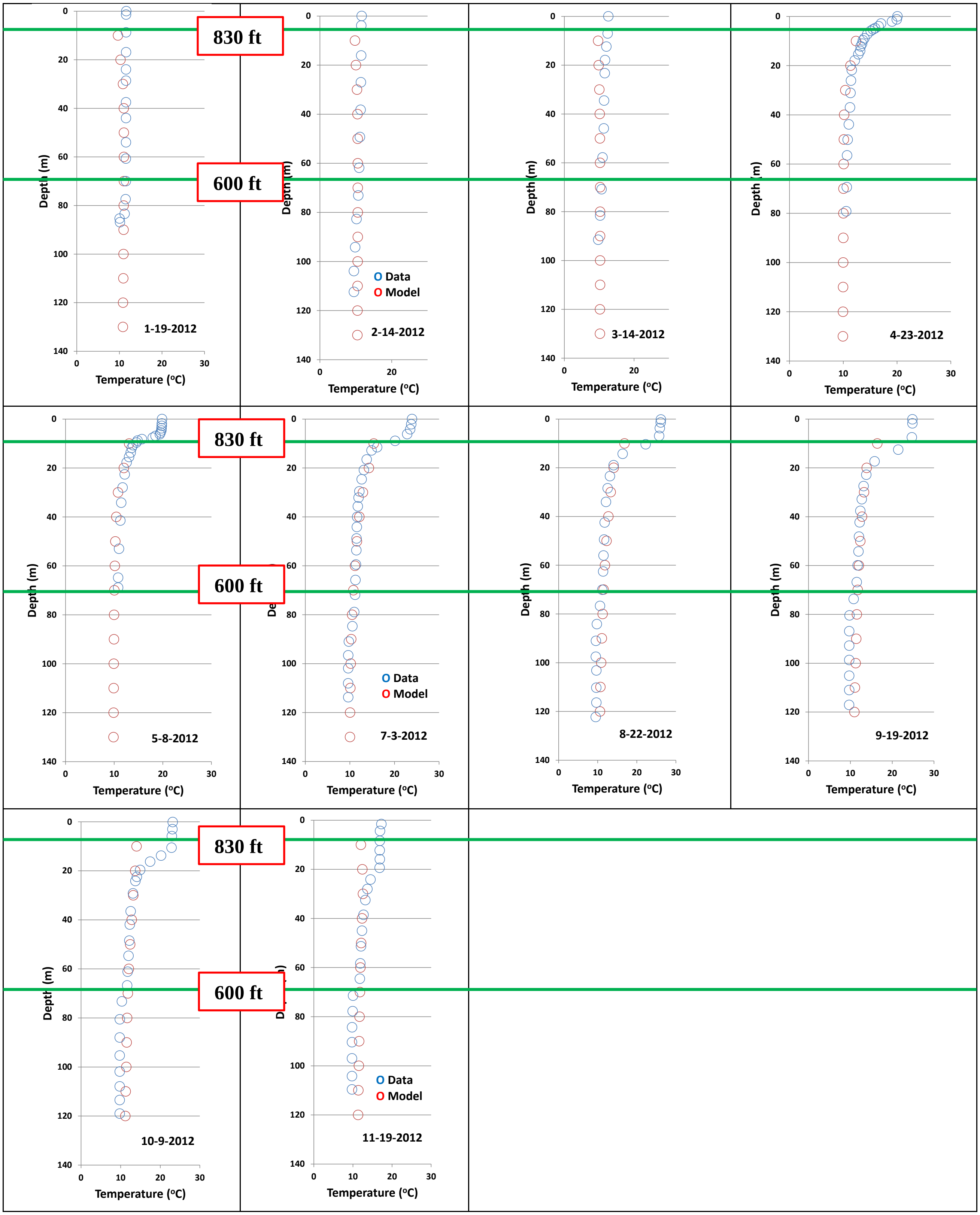


Figure 3.4-6. Water temperature profiles recorded in Don Pedro Reservoir in 2012.

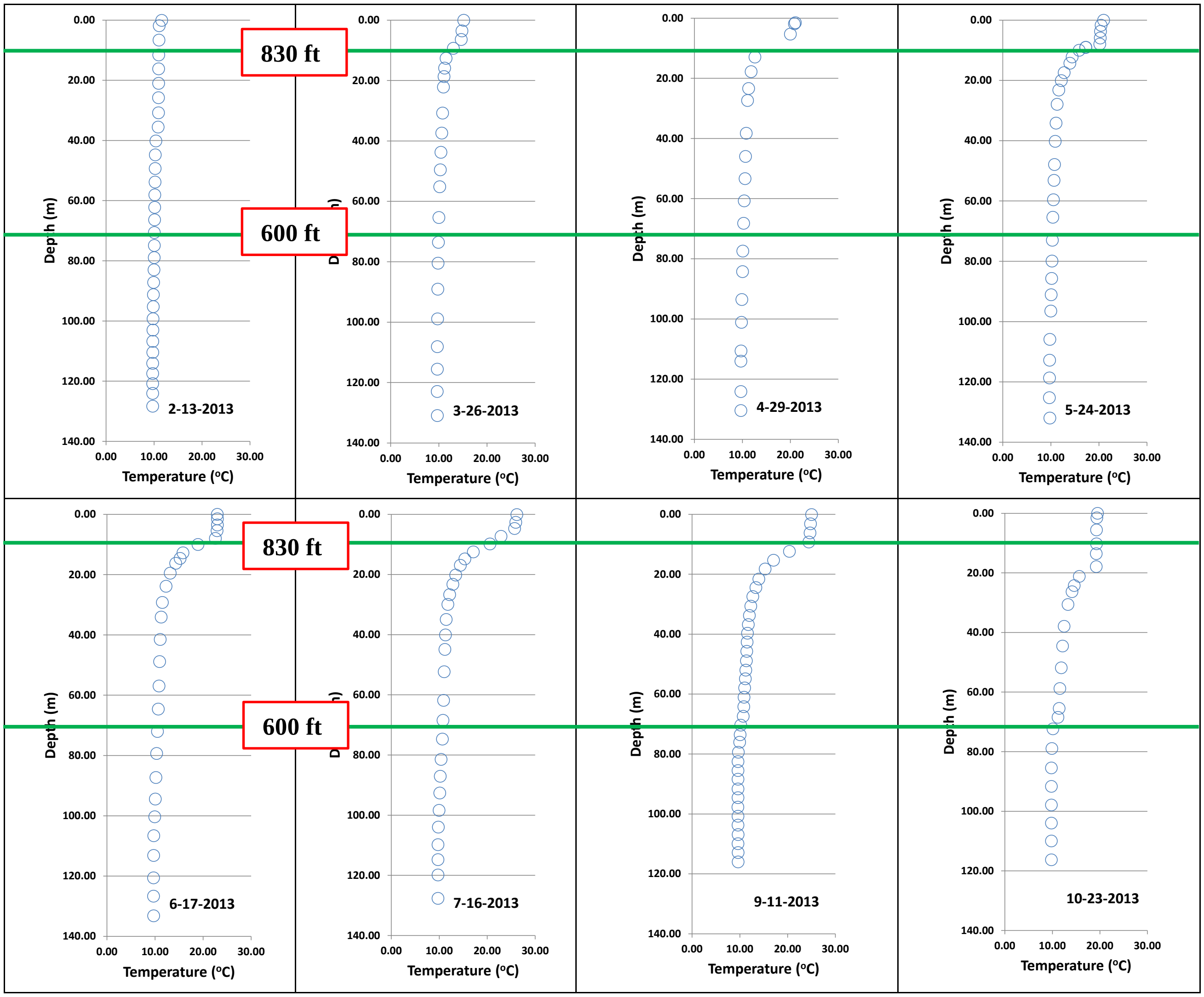


Figure 3.4-7. Water temperature profiles recorded in Don Pedro Reservoir in 2013

3.4.1.5 Water Temperature Between Don Pedro Dam and La Grange Dam

The Tuolumne River between Don Pedro Dam and the La Grange impoundment is directly affected by the discharges from the Project. The La Grange pool does not stratify because of the relatively small size of the pool compared to the amount of flow entering the impoundment.

Releases from Don Pedro Dam reflect hypolimnion temperatures and generally do not exceed 13 ºC (55.4ºF) and are often much cooler (Table 3.4-20). One year of temperature measurements have been collected within the La Grange impoundment. Within the La Grange impoundment temperatures warm slightly, about 1ºC or less.

Table 3.4-20. Don Pedro hypolimnion, Project outflow, and La Grange impoundment 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 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 water quality objective 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 Don Pedro Project are dominated by the cold water released from the Project.

3.4.2 Resource Effects

3.4.2.1 Effects on Water Quantity and Use

The Districts developed a water balance and operations model to simulate operations of the Don Pedro Project (Exhibit B, Section 2.6). The Operations Model (W&AR-02) provides a tool for examining water quantity, allocation, and distribution under various potential operational scenarios that may inform development of license requirements. The model can be used to simulate current and potential future operations of the Project for a period of analysis that covers a range of historical hydrologic conditions. It simulates flood control storage; water supply management; reservoir levels for recreation; reservoir releases; and hydropower generation. Under base case operations, there is no Project effect to existing water quantity or use.

The hydrologic period used in the Operations Model is 1971 through 2012. This period contains a wide range of hydrology, including numerous wet and dry years. The highest recorded flow on the Tuolumne River occurred in January 1997 and the wettest two consecutive years occurred in 1982-1983 with the combined unimpaired flow exceeding 8.4 million AF, or over 200 percent of normal. The period also contains two drought periods, 1976-1977 when the total unimpaired flow was just over 1 million AF, or 26 percent of normal, and the longest drought period on record, 1987 through 1992, when the total six-year unimpaired flow was just 5.5 million AF, or 46 percent of normal.

3.4.2.2 Effects on Water Quality

Under existing conditions, general water quality in Don Pedro Reservoir and downstream of Project facilities meets Basin Plan WQOs and designated beneficial uses. The Districts do not introduce CWA § 303(d) listed chemicals, including pesticides and mercury, into the lower Tuolumne River. Under the base case, the Project does not directly affect any designated use.

3.4.2.3 Effects on Water Temperature

As described above, under base case conditions, water temperatures in Don Pedro Reservoir and in surface water in the directly affected reach downstream of the Project meet the Basin Plan water temperature objective.

In order to perform a site-specific quantitative assessment of the thermal regime of the Don Pedro Reservoir and the effects of current Project operations, as well as potential alternative Project operations, the Districts' developed a FERC-approved Reservoir Temperature Model (W&AR-03). The model is a tool that facilitates examining water temperatures within and downstream of the Project under various potential operational scenarios over a range of hydrologic and meteorological conditions. Additionally, the model can be used to determine sensitivity of water temperatures to inflow, outflow, drawdown, and meteorological conditions.

The Reservoir Temperature Model works in conjunction with the Tuolumne River Operations Model (W&AR-02). The Operations Model is used to simulate alternative operational scenarios for the Project, and then the reservoir model is used to simulate the resulting reservoir temperature regime due to those operations.

The Danish Hydraulic Institute's 3-D modeling platform, MIKE3-FM, was used to develop the Don Pedro Reservoir Temperature model. The MIKE3 model of the reservoir extends from about elevation 300 ft to about elevation 850 ft, and from the tailwater of Don Pedro powerhouse (RM 54.8) to about 20 ft above the Don Pedro Reservoir normal maximum reservoir elevation of 830 ft. Data input and viewing can be performed using Geographic Information System (GIS) software. The reservoir uses a daily time step, consistent with the Operations Model.

The Districts calibrated and validated the MIKE3 model using the comprehensive data sets collected in 2011 and 2012 from eight in-reservoir locations and river locations both upstream and downstream of the Project (Table 3.4-18). The calibrated and validated model shows good agreement with the measured data. Additional exercises performed demonstrated that the model can be operated under numerous scenarios, including reservoir drawdown to the elevation of and below old Don Pedro Dam.

3.4.3 Proposed Environmental Measures

The Districts are not proposing any new PM&E measures in the DLA as some studies are still underway.

3.4.4 Unavoidable Adverse Impacts

An unavoidable effect of the Project is the annual development of a stratified temperature structure in the reservoir. However, this is not considered an adverse effect, as it provides for the maintenance of both warm and cold water fisheries in the reservoir and for the continual release of cold waters to the lower Tuolumne River which would otherwise likely experience higher temperatures, at least during certain annual periods, under natural conditions.

3.5 Fish and Aquatic Resources

3.5.1 Affected Environment

3.5.1.1 Historic Distribution of Fishes in the in the San Joaquin Valley and Tuolumne River

The Tuolumne River is located within a region referred to as the Central Valley Zoogeographic Subprovince 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.

The San Joaquin River and its tributaries below an elevation of about 80 ft[11] 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,

[11] All elevations are NGVD 29.

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 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 (*Lampetra tridentata).* 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 andGame (CDFG) 1946; Fry 1961, as cited in Yoshiyama et al. 1996). In other years, the 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 (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 three 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 economies of the native inhabitants along the Tuolumne River in the Yosemite region (Snyder 1993 unpublished memorandum, as cited in Yoshiyama et al. 1996).

Clavey Falls, at the confluence of the Tuolumne and Clavey rivers, may have also obstructed upstream migration of salmon at certain flows. Spring-run Chinook most likely did not pass over Preston Falls, located four 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 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 foot waterfall located about one mile above the mouth, likewise limited access. Yoshiyama et al. (1996) reported that steelhead may have ascended several miles into Cherry Creek, a tributary to the mainstem located about one mile below Early Intake Dam.

Anadromous fish abundance in the Tuolumne River has been reduced by habitat degradation and extensive instream and floodplain mining beginning in the mid-1800s. 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 present-day La Grange Dam, was a barrier to salmon migration. 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).

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, which were introduced for recreational fisheries in the late 1800s and early 1900s by CDFW. Introduced predators were, and continue to be, most abundant in large, slow-moving areas prevalent in the middle section of the 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 Bay development activities, state and federal Delta water exports, water quality issues, hatcheries, harvest, and poaching, all affected historical patterns of anadromous fish abundance in the Tuolumne River.

3.5.1.2 Fish Populations in Don Pedro Reservoir

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 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 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 in the trout fishery. The DPRA has been stocking black bass in the reservoir on an annual basis since the early 1980s (TID/MID 2013k), 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).

In 2012, the Districts conducted a study to provide information concerning the distribution and occurrence of fish in Don Pedro Reservoir (TID/MID 2013k). The objectives of the study were to document fish species composition, relative abundance, age and size composition, and characterize the influence of Project 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.

3.5.1.2.1 Fish Species Composition of Don Pedro Reservoir

Fourteen fish species were captured during the 2012 Reservoir Fish Population Study (Table 3.5-1) (TID/MID 2013k). 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 catch 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*). During the 2012 study, four fish species were collected that had not been previously identified in the reservoir: common carp, green sunfish, Sacramento sucker, and golden shiner (*Notemigonus crysoleucas*) (TID/MID 2013k).

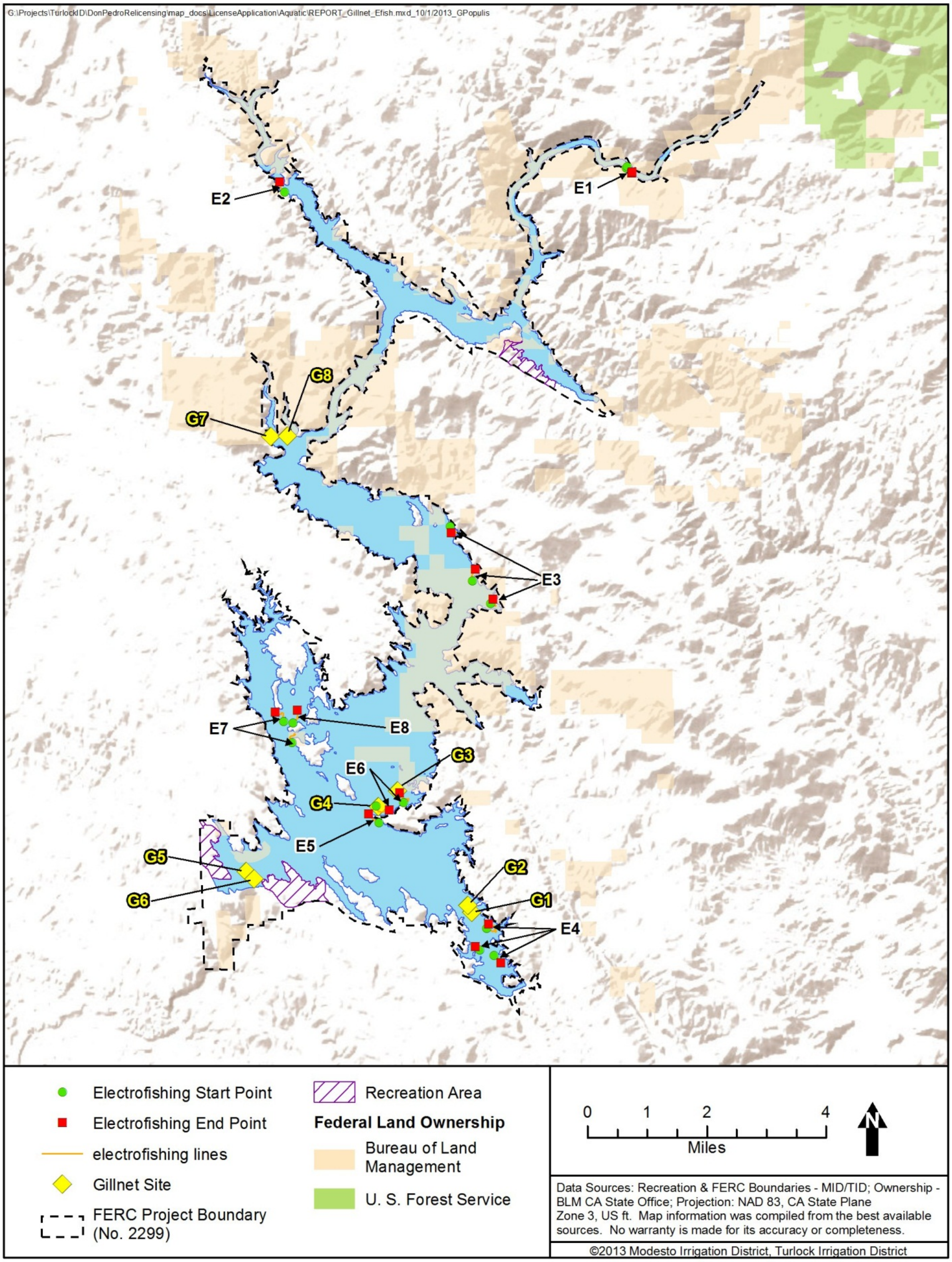


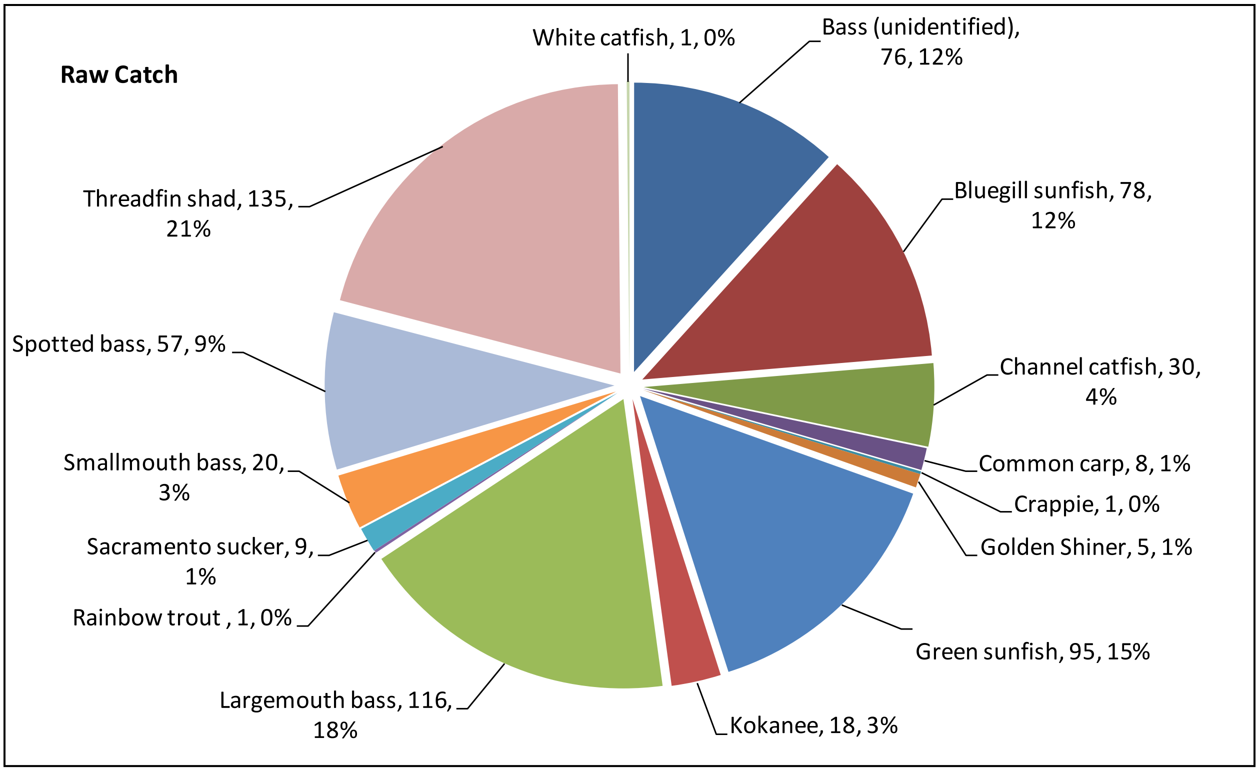
Figure 3.5-1. Location of fish population survey sites sampled using boat electrofishing and gill nets during the Don Pedro Reservoir fish population survey, October 2012.

Species that were well represented generally were present in multiple size classes. Largemouth bass ranged in length from 45 to 465 millimeter (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 percent 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. Summary of relative abundance, length, and weight of all fish species collected at Don Pedro Reservoir in 2012.

Species		Composition		Length (mm)			Weight (g)			Mean (Kn)[1]
	Native Species (N)	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*)	--	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.



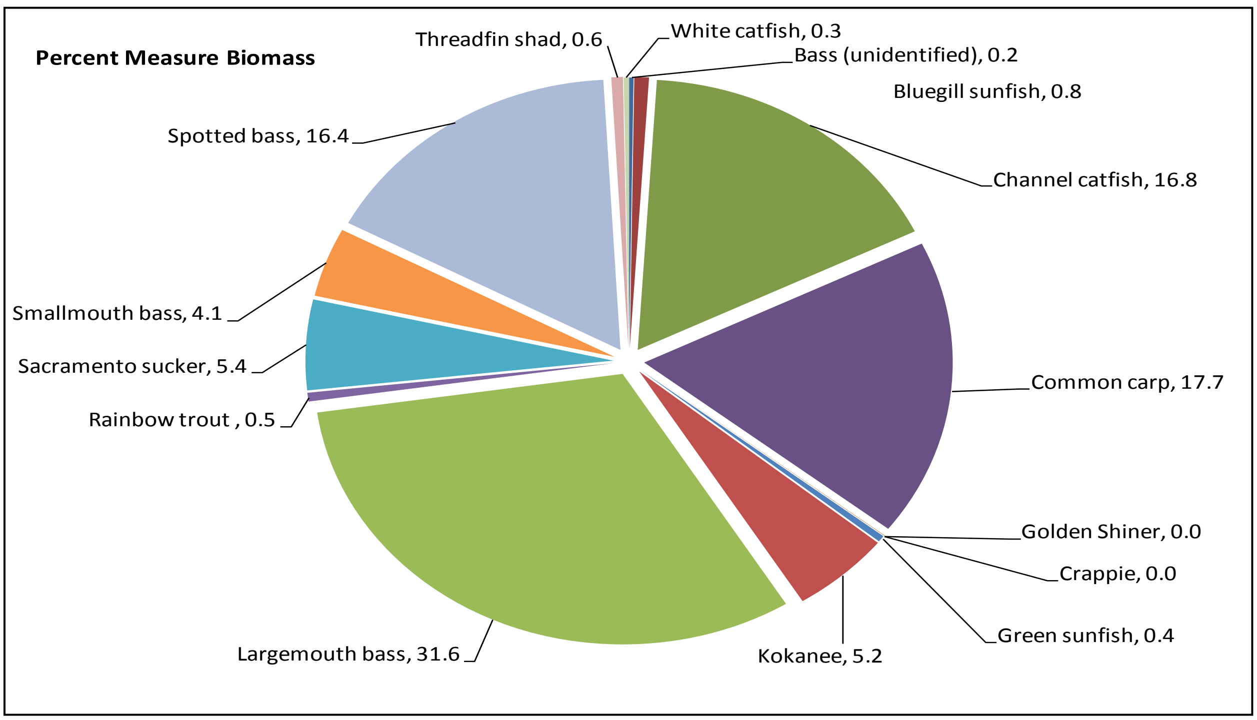


Figure 3.5-2. **Relative numbers of fish (top) and percent measured biomass (bottom) by species, combined from gillnet and boat electrofishing activities during the Don Pedro Reservoir fish population survey conducted in October 2012.**

Scales were collected for age analysis from black bass and salmonids in the reservoir (TID/MID 2013k). Insufficient numbers of salmonids (rainbow trout and kokanee) were collected for meaningful scale aging, so only black bass scales were read. 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.

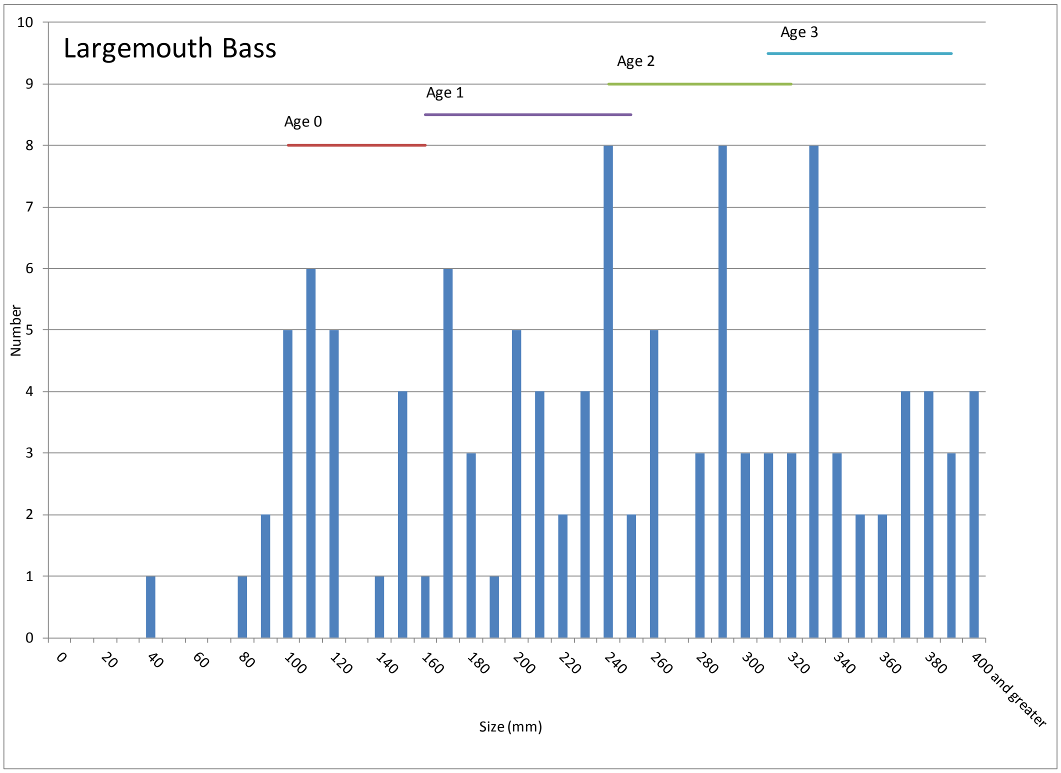


Figure 3.5-3. Length-frequency distribution of largemouth bass sampled during the Don Pedro Reservoir fish population survey, October 2012.

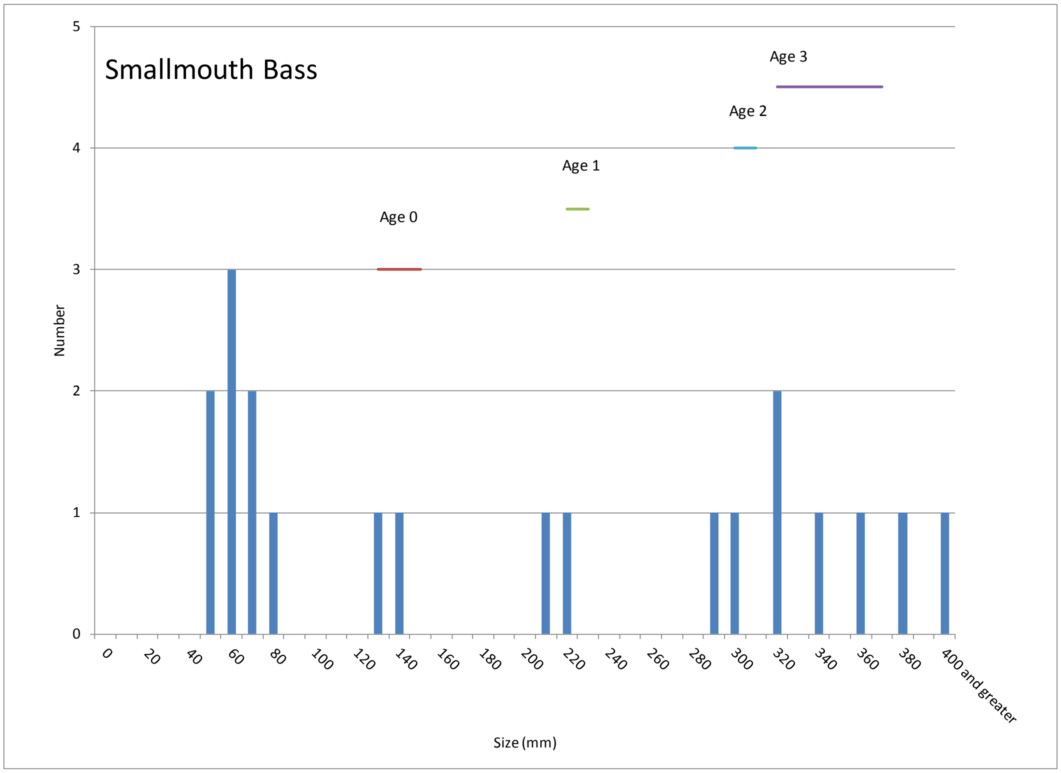


Figure 3.5-4. Length-frequency distribution of smallmouth bass sampled during the Don Pedro Reservoir fish population survey, October 2012.

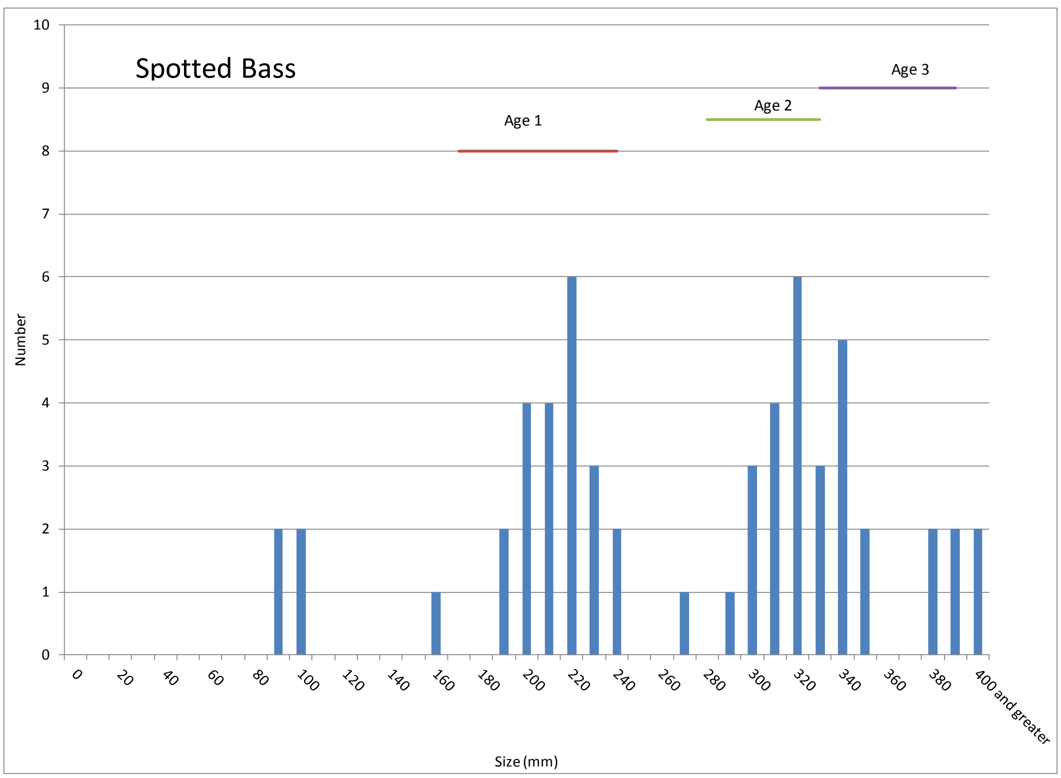


Figure 3.5-5. Length-frequency distribution of spotted bass sampled during the Don Pedro Reservoir fish population survey, October 2012.

3.5.1.2.2 Bass Nesting

An 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 maintained bass nest survival at or above the 20 percent criterion identified by CDFW (Lee 1999; TID/MID 2013k). 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.

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 2013k). 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.

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 2010) 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 2013k).

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

Month	No. of Months Analyzed	No. Months ≥20% Survival	Percent Total Months
May	27	27	100
June	27	27	100

3.5.1.2.3 Potential Spawning Tributaries

Streams that typically contain surface flows during spring and, in some cases, fall spawning periods are shown in Table 3.5-4 (TID/MID 2013k). Perennial tributary streams within the 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 Project operations, slopes at the locations where tributaries enter the reservoir are well below the 10 percent criterion defining a fish impediment (TID/MID 2013k). The results of the analysis indicated that fish passage impediments were identified only in Deer Creek, which is not considered a salmonid spawning stream (TID/MID 2013k). Cold-water fisheries in the reservoir are primarily supported by stocking; nonetheless, Project operations during the potential spring and fall fish migration periods accommodate access to possible cold-water spawning tributaries (TID/MID 2013k).

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

3.5.1.2.4 Angler Use

Creel surveys were conducted by the Districts for nine months in 2012 (TID/MID 2013k). 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%), and 78.4 percent of bass caught were released. Species composition and size statistics of fish caught by anglers interviewed during 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

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]
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.

3.5.1.2.5 Overview of Don Pedro Reservoir Fisheries

The results of the 2012 Don Pedro Reservoir fish population survey substantiate existing information that indicates current Project operations and resultant habitat conditions, along with ongoing management programs, support quality warm-water and cold-water fisheries (TID/MID 2013k). All three black bass species were prominent in the gill net and electrofishing surveys and in the angler surveys. 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 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 2013k; see Potential Spawning Tributaries section above).

3.5.1.2.6 Don Pedro Reservoir Fish Mercury Concentrations

The Don Pedro Reservoir Fish Mercury Study examined nine sites within Don Pedro Reservoir and upstream and downstream of the reservoir between fall 2008 and spring 2009 (Stillwater Sciences 2009). The highest fish tissue mercury concentrations (0.29–0.99 mg/kg) were observed in largemouth bass sampled from the shallow Moccasin Creek and Woods Creek arms of Don Pedro Reservoir. Concentrations in excess of the EPA (2000) fish tissue residue criterion (0.3 mg/kg) were found at all sites within Don Pedro Reservoir, as well as downstream of La Grange Dam in the lower Tuolumne River. Understanding that mercury tissue levels vary with fish size, adjustments of largemouth bass data to a common length standard of 350 mm (13 in) resulted in levels slightly higher than those found in other regional reservoirs. However, length adjusted catfish mercury levels (0.11 mg/kg for a standard length of 425 mm [16 in]) and unadjusted rainbow trout tissue levels (0.05 mg/kg) were below the ranges for regional riverine samples.

3.5.1.3 Fish Populations between Don Pedro Reservoir and La Grange 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 Dam (TID/MID 2013h). 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 2009). No known angler harvest or stocking data exist for this reach.

The study reach between La Grange 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 the reach. Fish sampling sites were selected throughout the study area to represent the range 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.

Two types of habitat were identified in the study reach: riverine and lacustrine. Riverine sites were characterized by observable currents, large substrate particles, and a lack of rooted 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 and La Grange dams contains two fish species, rainbow trout and prickly sculpin (*Cottus asper*), and that both species are distributed across the reach (TID/MID 2013h). 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 occurring in this reach). Rainbow trout were present in both lacustrine and riverine reaches, documenting that they use the range of habitat available in the reach. Overall, average condition (i.e., Kn=0.99) and appearance of the rainbow trout collected in 2012 indicated that fish were healthy.

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 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						

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 2013h). Sculpin were most abundant in riverine habitats (i.e., upstream sampling sites). Overall, sculpin condition and health appeared to be average (i.e., Kn=0.99).

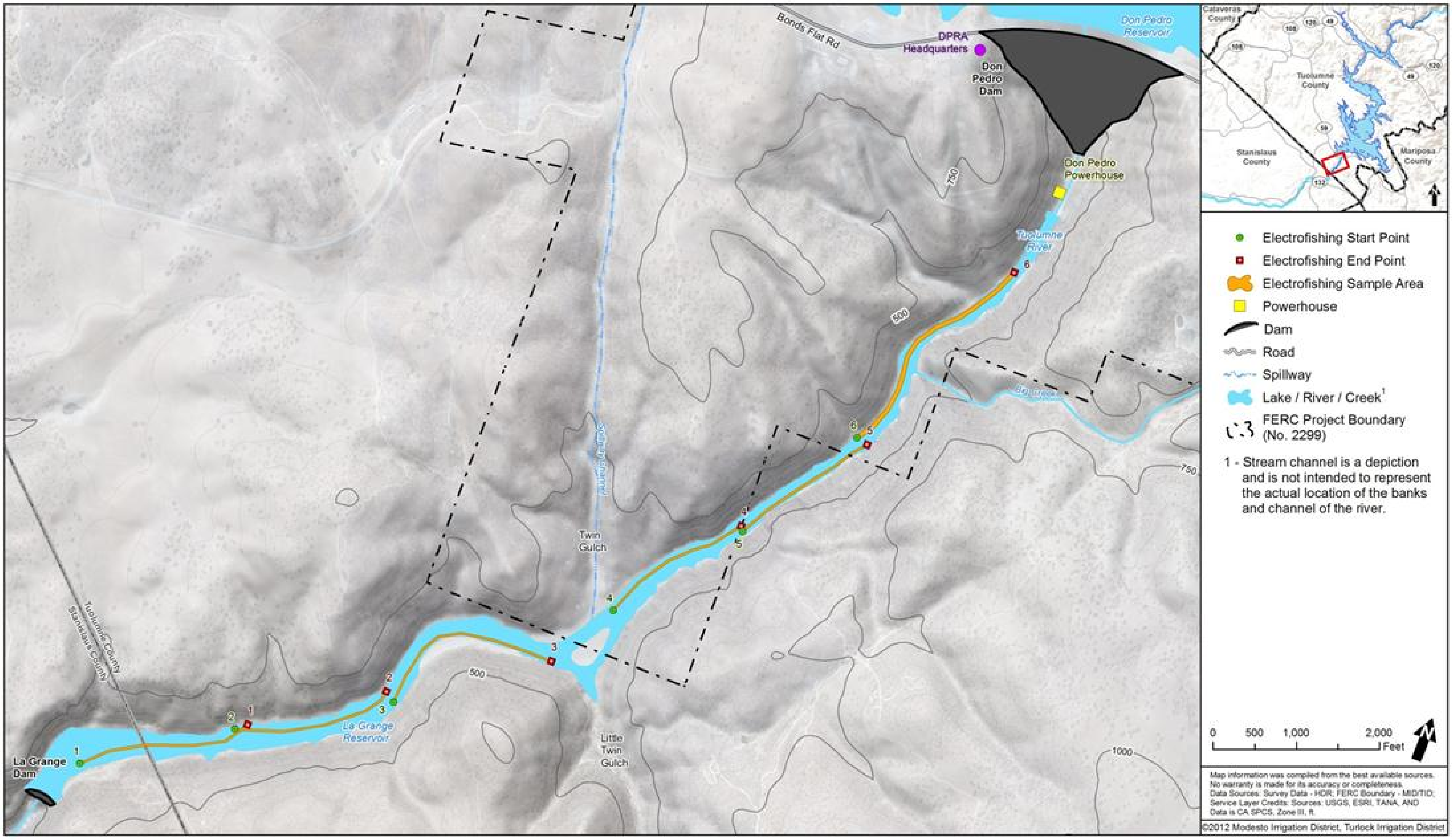


Figure 3.5-6. Study reaches and fish sampling areas in the reach between Don Pedro Dam and La Grange Dam in 2012.

3.5.1.4 Fish Populations in the Lower Tuolumne River

The lower Tuolumne River extends approximately 52 miles from La Grange 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 to 52) is gravel-bedded with moderate slope (0.10–0.15%), whereas the lower zone (RM 0 to 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 to 10.5): Lower sand-bedded reach,
- Reach 2 (RM 10.5 to 19.3): Urban sand-bedded reach,
- Reach 3 (RM 19.3 to 24.0): Upper sand-bedded reach,
- Reach 4 (RM 24.0 to 34.2): In-channel gravel mining reach,
- Reach 5 (RM 34.2 to 40.3): Gravel mining reach,
- Reach 6 (RM 40.3 to 45.5): Dredger tailing reach, and
- Reach 7 (RM 45.5 to 52.1): Dominant salmon spawning reach.

The lower Tuolumne River contains fish communities similar to those found throughout the San Joaquin 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 harvest (TID/MID 2013b). 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, Report 2011-8; TID/MID 2013b).

3.5.1.4.1 Physical Habitat Conditions

Prior to widespread European settlement, channel form in the gravel-bedded reach of the lower Tuolumne River consisted of a combination of single-thread and split channels that migrated and avulsed (McBain and Trush 2000). Anthropogenic changes that have occurred in the lower Tuolumne River corridor since the mid-1800s include gold mining, aggregate mining, grazing, agriculture, and more recently urban encroachment (greater detail regarding anthropogenic impacts to the lower Tuolumne River is provided in Section 4.0, Cumulative Effects).

As noted previously, bed material was excavated for gold and aggregate mining to depths well below the thalweg, 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, aggregate mining continues today.

Historically, aggregate mines excavated sand and gravel 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 32 percent of the channel length in the gravel-bedded reach, and are characterized by much lower velocities and greater depths than the un-mined sections of river. 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. The January 1997 flood caused extensive damage to dikes separating deep gravel mining pits from the river, breaching or overtopping nearly every dike along the six -mile-long reach (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.

In 2012, the Districts conducted a spawning gravel survey (TID/MID 2013a) and an *O. mykiss* habitat survey on the lower Tuolumne River (TID/MID 2013g). The reach evaluated for the spawning gravel study included the Tuolumne River from just downstream of La Grange Dam at RM 52.1 to RM 23, which accounts for the extent of riffle habitats documented in historical surveys (TID/MID 1992a). The habitat survey was conducted in the *O. mykiss* spawning and rearing reach, which extends from La Grange Dam to Roberts Ferry Bridge (approximately RM 52 to 39), and for the purpose of evaluating LWD from RM 52 downstream to RM 24.

The spawning gravel survey on the lower river (TID/MID 2013a) 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 Project's contribution to cumulative effects to 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.

The *O. mykiss* habitat survey (TID/MID 2013g) consisted of an inventory of instream habitat types and physical habitat characteristics and an appraisal of the distribution, abundance, and function of LWD in the lower Tuolumne River. The relative abundance of habitat types in the lower Tuolumne River during the survey was as follows: 14 percent riffle, 61 percent flat water, and 25 percent pool (TID/MID 2013g). Sediment model simulations indicate that without gravel augmentation, the channel bed from RM 52 to 39.7 would be slowly degrading and coarsening in response to a reduction in coarse sediment supply due to sediment retention in Don Pedro Reservoir. Gravel augmentation, however, has helped to increase coarse sediment storage in this area (TID/MID 2013a). 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 WY 2006 and WY 2011 resulted in substantial pool scour, with coarse sediment being re-deposited in pool tails and riffles and fine bed material mobilized to channel margins (TID/MID 2013a). 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 2013a).

The lower Tuolumne River has limited LWD (TID/MID 2013g). There was a total of 118 LWD pieces in the 16,905 linear ft of habitat surveyed in 2012, which when extrapolated to the RM 39 to 52 reach, is an estimated 453 pieces (TID/MID 2013g). 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 2013g). 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 river during high flows if it were not trapped in the reservoir (TID/MID 2013g). 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.

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

Overall, the 52 ac average of native riparian vegetation per RM is slowly changing, with a 419 ac increase in the net extent of native vegetation between 1996 and 2012 brought about primarily through active restoration projects. Areas with the greatest extent of native riparian vegetation per RM were mapped along the 12 miles downstream of La Grange 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 along the lower river corridor. 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. 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 DLA, Botanical Resources, for greater detail on riparian vegetation).

3.5.1.4.2 Fish Species Composition of the Lower Tuolumne River

Fish species composition in the lower Tuolumne River is shown in Table 3.5-8 (Ford and Brown 2001; TID/MID 2010, Reports 2009-3, 2009-4, and 2009-5) with a notation 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 to 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 the 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 2007).

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 3.5-8. 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[12]	*Lampetra tridentata*	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

[12] WUA versus flow analyses, using existing HSC, for Pacific lamprey are being conducted by the Districts; results will be presented in the FLA.

Family/Common Name	Scientific Name	Native (N) Or Introduced (I)	Resident (R) Or Migratory (M)
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 2010, Reports 2009-3, 2009-4, and 2009-5.

Fall-Run Chinook Salmon

Districts' Studies

The Districts conducted studies (described below) in 2012 to better understand Chinook salmon populations in the lower Tuolumne River and assess potential cumulative effects to the species resulting from activities inside and outside the basin.

The Districts conducted a Salmonid Population Information Integration and Synthesis Study in 2012 (TID/MID 2013b) to collect and summarize existing information to characterize Chinook salmon 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 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[13],

[13] 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.

San Francisco Bay Estuary[14], 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.

In 2012, the Districts conducted a study to understand the effects of predation on rearing and out-migrating juvenile Chinook salmon in the lower river (TID/MID 2013c). The study, which built upon previous 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 Dam (RM 52.2) to the confluence with the San Joaquin River (RM 0).

In 2012–2013, the Districts also conducted salmonid redd mapping (TID/MID 2013d) to document the spatial distribution of Chinook salmon redds and any evidence of redd superimposition in the Tuolumne River. The study involved identifying locations of redds, documenting redd superimposition, and comparing redd counts and densities at recent gravel augmentation sites to nearby control sites. The study area included the reach from La Grange Dam (RM 52.2) to Santa Fe Avenue Bridge (RM 22), which encompasses the area of Chinook salmon spawning in riffles as documented in recent annual spawning surveys conducted by CDFW.

The Districts have developed a Chinook Salmon Population Model (TID/MID 2013o) to investigate the relative influences of various factors on the life-stage-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. 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. A more detailed summary of the model is provided later in this section, following the discussion of fall-run Chinook life history.

A number of 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 1-D 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 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.

[14]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.

The July 16, 2009 FERC Order (128 FERC 61,035) also required the Districts to conduct a 2-D pulse flow study. The purpose of the 2-D Pulse Flow Study (Stillwater Sciences 2012a) was to assess habitat suitability and habitat segmentation 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 to assess the habitat suitability at sites including adjacent overbank inundation areas during in-channel flows of 1,000–1,500 cfs and flows up to 5,000 cfs.

The results of the following ongoing studies will also inform the assessment of potential cumulative effects on fall-run Chinook salmon:

- Chinook Salmon Otolith Study (W&AR-11), (TID/MID 2013f) (scheduled for completion in summer 2014), and
- Temperature Criteria Assessment (W&AR-14), (TID/MID 2013i) (scheduled for completion in 2014), including:
    - literature review of available temperature tolerances of Chinook salmon,
    - desktop study on the influence of temperature on growth of Chinook salmon in the Tuolumne River, and
    - desktop study on the influence of temperature on timing of initial spawning of Chinook salmon in the Tuolumne River.
- The Districts will complete additional analysis in 2013–2014 to supplement the PHABSIM instream flow study (Stillwater Sciences 2012a, 2013). The results will be filed with FERC:
    - An evaluation of effective weighted usable area (EWUA) by salmonid life stage, which will incorporate results of the final lower Tuolumne River water temperature model (TID/MID 2013j).. An evaluation of smallmouth, largemouth, and striped bass habitat, based on existing habitat suitability criteria; the results pertain to the assessment of predation on juvenile fall-run Chinook salmon (to be filed with the WAR-07 Predation Study Report in March 2015).
- Lower Tuolumne Floodplain Hydraulic Assessment (Scheduled for completion in 2014).[15]
    - A hydraulic analysis of the amount of floodplain inundated between RM 52.5 and 21.5 of the lower river at flows between 1,100 and 3,100 cfs, 3,100 and 5,300 cfs, and 5,300 and 8,400 cfs to supplement the USFWS (2008) assessment of floodplain inundation: *Flow-overbank inundation relationship for potential fall-run Chinook salmon and steelhead/rainbow trout juvenile outmigration habitat in the Tuolumne River*.
    - An evaluation of the floodplain inundation frequency and period at a range of flows that reflect alternative future Project operating conditions that can be compared to baseline conditions.

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

Fall-Run Chinook Life History

Chinook Spawning

Chinook salmon spawning primarily occurs 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 2013b). Egg incubation and fry emergence occur from October through January.

During the period of pre-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, spawner estimates (1971–2009) have ranged from 40,300 in 1985 to 77 in 1991 (TID/MID 2010, 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 2010, 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 2010, 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 estimates averaged 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 2007, 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 have been undertaken to improve the quality of spawning gravel in the lower Tuolumne River (see Fish Habitat Restoration Projects, below).

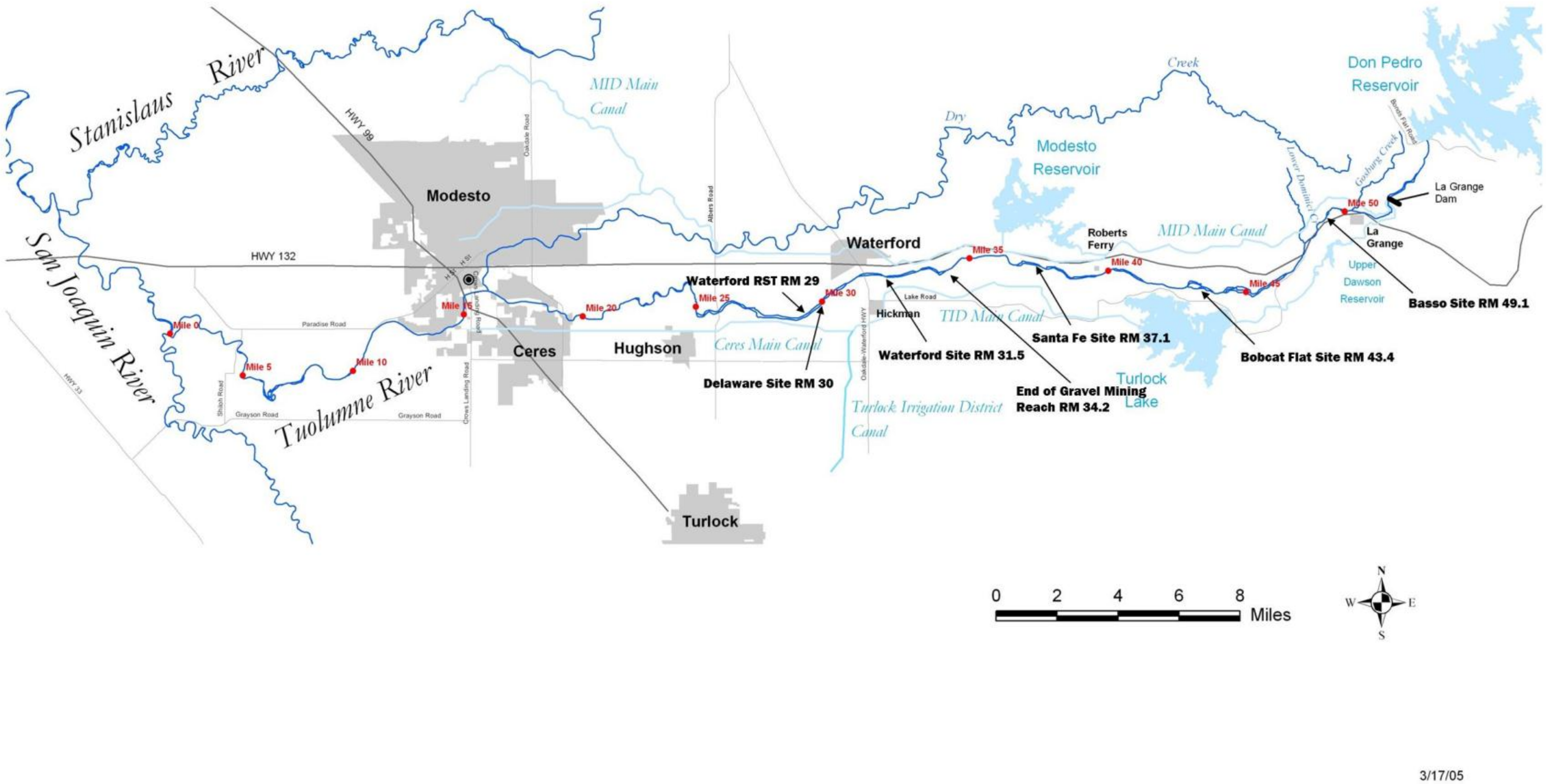


Figure 3.5-7. Vicinity map and study site locations for the Lower Tuolumne River Instream Flow Study.

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 2013d). 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 3.5-9) (TID/MID 2013d). 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 2013d).

In general, Chinook salmon spawning activity (by absolute number of redds and densities) increased as RM increased, with the highest abundance (48.2%) of observed redds occurring in Reach 1 (RM 52.0 to RM 47.4) (TID/MID 2013d). Reaches 2 and 3 accounted for 21.3 and 23.4 percent of redds, respectively, with Reach 4 accounting for 7.0 percent of Chinook spawning activity. Spawning activity at recent gravel augmentation sites accounted for 21.6 percent (141 of 653) of the new Chinook salmon redds observed during 2012–2013, the majority of these observed at the CDFW augmentation sites near La Grange (RM 50.6 to 51). Spawning habitat use was concentrated at upstream locations (Table 3.5-9), and most superimposition of Chinook salmon redds occurred upstream of RM 44.

Results from the current PHABSIM study (Stillwater Sciences 2013) corroborate results of previous studies, i.e., Chinook salmon spawning habitat (as estimated by weighted usable area (WUA)) is maximized at flows between 175 and 400 cfs (Table 3.5-10).

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, although as much as 90 percent of the Central Valley harvest consists of hatchery salmonids, and in recent years hatchery Chinook have accounted for a large proportion of the annual escapement to the Tuolumne River, Chinook size at return in the Tuolumne River does not appear to be declining in response to hatchery introgression (TID/MID 2013b).

Table 3.5-9. New Chinook salmon redds identified by reach and date during the 2012–2013 survey period.

Week[1]	Survey Dates	Reach (RM)				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	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%

Week[1]	Survey Dates	Reach (RM)				Grand Total	Percent
		1 (52.0–47.4)	2 (47.4–42.0)	3 (42.0–31.6)	4 (31.6–22.0)		
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.

Table 3.5-10. Lower Tuolumne River Instream Flow Study result comparisons of maximum WUA results between 1981, 1995, and 2013.

Species/Life stage	TID/MID 2013b 2013 (cfs)	TID/MID 2013b (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.

Chinook In-River Rearing and Outmigration

Chinook salmon rearing in the Tuolumne River primarily occurs from January to May (TID/MID 2013b). 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 2012a). Based on seine and rotary screw trap monitoring, juvenile Chinook salmon out-migrate 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 2013b).

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 2013b). 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, including creation of in-channel mining pits and reduced flood frequency, have created suitable habitat for non-native predators.

Previous predation studies in the lower Tuolumne River identified 12 fish species[16] 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).

Based on data collected in 2012, estimated predation rates on juvenile Chinook salmon (i.e., Chinook/predator/day) in the lower Tuolumne River were 0.10 for largemouth bass, 0.11 for smallmouth bass, 1.1 for striped bass, and 0.0 for Sacramento pikeminnow (TID/MID 2013c). Previous research also indicates that predation on juvenile Chinook salmon by Sacramento pikeminnow may be quite low in the Tuolumne River. Of the 68 Sacramento pikeminnow examined in 1992 (TID/MID 1992a), none had consumed juvenile Chinook salmon.

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 2013c). Based on the study results, a significant percentage of juvenile Chinook salmon losses in the lower Tuolumne River between Waterford and Grayson during 2012 may be attributable to predation by non-native piscivores (Table 3.5-11) (TID/MID 2013c).[17]

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 2013c). 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%).

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[16] The 12 fish species[16] 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, and riffle sculpin. *O. mykiss* also have the potential to prey on Chinook fry and juveniles.

[17] The Districts plan to conduct a new Predation Study in 2014, per FERC's May 21, 2013 study determination. The study will 1) use the mark-and-recapture method for estimating numbers of predator fish in the lower Tuolumne River, 2) sample for predator stomach contents and predator abundance at the same times and in the same locations, and 3) include acoustic tagging of Chinook salmon and predator fish combined with use of hydrophone arrays deployed at various SRPs.

An earlier study on the Tuolumne River (McBain and Trush and Stillwater Sciences 2006) hypothesized that at flows exceeding 2,500 cfs, higher velocities would increase Chinook salmon migration rates through SRPs. However, the results of the 2012 Predation Study (TID/MID 2013c) 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.

Table 3.5-11. Potential impact of predation in the lower Tuolumne River between RM 30.3 and RM 5.1 under a low predation rate (gastric evacuation time set at 20 hours) by length of migratory period of juvenile Chinook salmon.

Species	$\hat{N}$	Predation Rate (predator/day)	60-Day Migratory Period	90-Day Migratory Period	120-Day Migratory Period	Percent of Impact
Largemouth bass	2,701	0.1	16,206	24,309	32,412	31.5
Sacramento pikeminnow	81	0	0	0	0	0.0
Smallmouth bass	3,404	0.11	22,466	33,700	44,933	43.7
Striped bass	193	1.1	12,738	19,107	25,476	24.8
		Total	**51,410**	**77,116**	**102,821**	

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 3.5-10). 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. The largest increases in inundation area identified by the USFWS (2008) and Stillwater Sciences (2012a) occurred within a similar flow range.

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) show that flows above bankfull discharge at the locations studied were associated with increases in overbank habitat area suitable for juvenile life stages of Tuolumne River salmonids. Suitable habitat areas for juvenile salmonid life stages increased most rapidly between bankfull discharges of 1,000 and 3,000 cfs, corresponding to floodplain inundation. The increase in suitable habitat areas was less rapid at nearly all sites from 3,000 to 5,000 cfs. Extensive floodplain habitat does not occur at downstream locations due to higher flow thresholds required for floodplain inundation.

The highest frequency of stranding and entrapment of juvenile Chinook salmon in historical surveys occurred at sites similar to those used in the Pulse Flow Study (RM 48.8 to RM 45.9) at flows between 1,100–3,100 cfs (TID/MID 2001); the potential benefits of overbank rearing habitat have not been evaluated relative to the risk of stranding and entrapment of juvenile salmonids as high-flows recede from overbank areas.

Based on the results of the Pulse Flow Study, potential predation risk to juvenile salmonids may be reduced when overbank areas are inundated (Stillwater Sciences 2012a). The increases in habitat area may effectively reduce the encounter frequency of predators and prey, provide additional hiding cover in flooded vegetation, and preclude many of the larger piscivores from accessing the shallow, inundated habitat. However, several reaches with pool habitats inhabited by predator species lack adjacent floodplain habitats (McBain & Trush 2000), and the probability of encounter between predators and juvenile salmonids remains high in larger pools even under pulse flow conditions. The 2014 Predation Study will further investigate the predation risk in the larger pools.

Results of rotary screw trap monitoring and Delta out-migrant tracking and survival studies generally support the utility of increased spring pulse flows during April–May as a means of improving out-migrant 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, 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.

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 numbers of Chinook salmon recruited to the ocean fishery (TID/MID 2013b). For Chinook salmon out-migrants 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 Head of Old River Barrier.[18] 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

[18] 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 2013b).

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 2013b).

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 2013b). 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 (California Cooperative Oceanic Fisheries Investigations (CalCOFI) 2006, 2007; NMFS 2009b). The timing of large hatchery releases in the Central Valley may result in competition with wild fish during the first few months following ocean entry. Early growth conditions in the ocean 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 Dam and occurs from September through December, with peak activity occurring in October and November (TID/MID 2013b);cumulative adult fall-run Chinook salmon counts at the Tuolumne River weir (RM 24.5, downstream of the majority of Chinook spawning) from 2009–2013 are shown in Figure 3.5-8. 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 2013b).

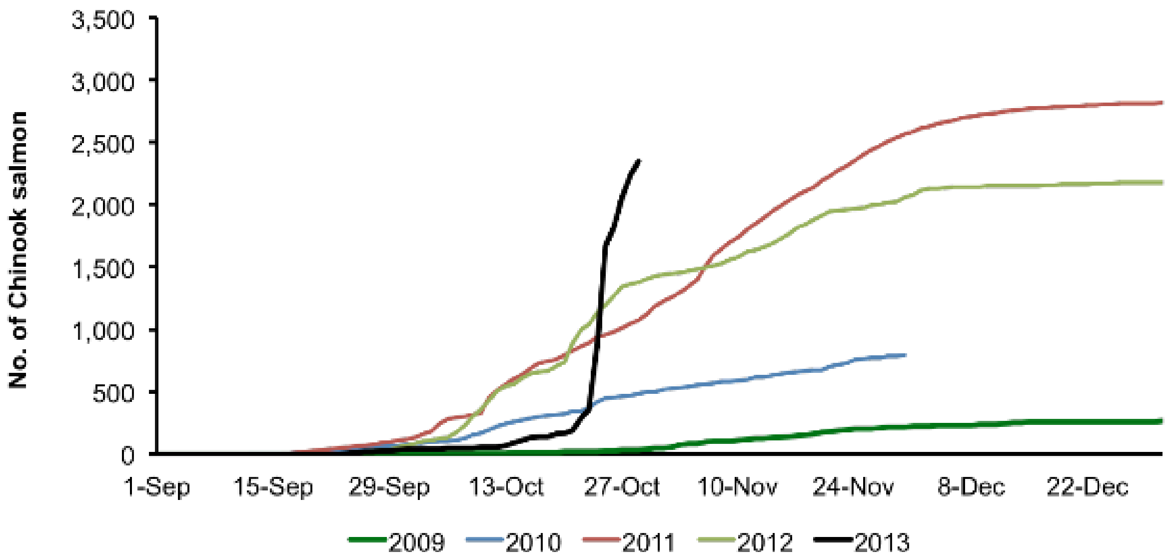

Figure 3.5-8. Cumulative adult fall-run Chinook salmon counts at the Tuolumne River weir (RM 24.5) 2009–2013.

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 2013b). 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 year-to-year variations in ocean survival and harvest may affect Tuolumne River escapement and subsequent population levels (TID/MID 2013b). Commercial harvest in the San Joaquin River basin is prohibited, and the Valley District[19], which includes rivers in San Joaquin, Stanislaus, and Tuolumne counties, is currently closed to the take of salmon. However, there are no available estimates of salmon lost to poaching in the San Joaquin and Tuolumne rivers (TID/MID 2013b).

Hatchery origin fish represent a large proportion of the Central Valley fall-run Chinook salmon harvest (TID/MID 2013b). 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). 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 (MID 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

[19] 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 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.

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).

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 2013b). Lindley et al. (2007) suggest that hatchery introductions have altered the genetic structure of salmonid populations in the Central Valley.

Chinook Salmon Population Model

In order to synthesize existing information on in-river life stages of fall-run Chinook salmon and to create a tool for evaluation of potential operational alternatives, a Tuolumne River Chinook salmon population model was developed. The Chinook Salmon Population Study (TID/MID 2013o) provides a quantitative population model to investigate the relative influences of various factors on life-stage-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 among potential alternative management scenarios. 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 the base-case simulation: (TID/MID 2013o). These findings represent a simulation only, and as such do not constitute conclusions based directly on empirical data (the status of the Chinook population based on empirical data is summarized in the preceding life-stage-related subsections). The primary purpose of the base-case simulation is to serve as a basis of comparison, against which alternative operating scenarios can be assessed for their *relative* effects to the Chinook population.

- Although absolute smolt production is expected to rise with increasing escapement, decreases in modeled Chinook salmon smolt productivity per spawner are consistent with redd superimposition effects.
- Consistent with increases in juvenile rearing density and smolt production found in monitoring data for years following higher escapement, model simulations indicate that Chinook salmon fry and juvenile rearing habitat is not limiting smolt productivity under current conditions.
- The modeled smolt survival relationship, based on historical smolt survival tests as well as more recent rotary screw trap monitoring, shows increased smolt productivity with increased La Grange gage discharge as measured by the summation of flows for the period from February to May. Consistent with variations in smolt size and timing of emigration in recent rotary screw trap data, model results show changes in smolt emigration timing due to water temperature effects on development rates. However, because monitoring data as well as model results indicate the majority of annual smolt emigration occurs early in the spring at lower water temperatures, model sensitivity testing results indicate that water temperature is not limiting smolt productivity under current conditions.

Steelhead/Rainbow Trout (Oncorhynchus mykiss)

Districts' Studies

On April 3, 2008, the Commission issued an order regarding the Districts Ten-Year Summary Report of fisheries monitoring at the Project pursuant to Article 58 of the Project license as amended (76 FERC ¶ 61,117). The April 2008 Order directed the Districts to implement their proposed *O. mykiss* monitoring plan, originally filed with the Commission on March 20, 2007, and revised in a submittal of July 16, 2007. The April 3, 2008 Order included a range of studies on *O. mykiss* in the Tuolumne River to provide information on population size, habitat use, river-wide distribution, and rates of anadromy (Table 3.5-12).

Table 3.5-12. ***Oncorhynchus mykiss*** **studies completed pursuant to the April 3, 2008 FERC Order.**

Study	Report	Submittal date
O. mykiss Population Estimates	2008 July *Oncorhynchus mykiss* Population Estimate Report	March 26, 2009
	March and July 2009 Population Size Estimates of *Oncorhynchus mykiss* in the Lower Tuolumne River	January 15, 2010
	March and August 2010 *Oncorhynchus mykiss* Population Estimate Report	March 31, 2011
	September 2011 *Oncorhynchus mykiss* Population Estimate Report	March 30, 2012
O. mykiss Anadromy	Not Implemented	n/a
O. mykiss Tracking	Tuolumne River *O. mykiss* Acoustic Tracking Study 2010 Technical Report	March 31, 2011
	Tuolumne River *O. mykiss* Acoustic Tracking Study 2011 Technical Report	March 30, 2012
O. mykiss Monitoring Summary	Tuolumne River *Oncorhynchus mykiss* Monitoring Report	January 15, 2010
	Tuolumne River 2010 *Oncorhynchus mykiss* Monitoring Summary Report	January 15, 2011
	Tuolumne River 2011 *Oncorhynchus mykiss* Monitoring Summary Report	January 13, 2012

In 2012, the Districts used the information from the *O. mykiss* studies listed above and conducted additional studies (described below) to better understand potential effects to *O. mykiss* resulting from activities within and outside the Tuolumne River basin.

The Districts conducted a Salmonid Population Information Integration and Synthesis Study in 2012 (TID/MID 2013b) to collect and summarize existing information to characterize *O. mykiss* populations in the Tuolumne River and develop hypotheses to understand factors potentially affecting those populations. The study area is described earlier in the fall-run Chinook salmon section.

The Districts also conducted an instream flow study, including a 1-D PHABSIM study and 2-D pulse flow study per the July 16, 2009 FERC Order (128 FERC 61,035). One purpose of the PHABSIM study (Stillwater Sciences 2013) was "to determine instream flows necessary to maximize *O. mykiss* production and survival throughout their various life stages." PHABSIM study site locations in the lower Tuolumne River are shown in Figure 3.5-7. The Pulse Flow Study (Stillwater Sciences 2012a) included a habitat suitability and habitat segmentation assessment for lower Tuolumne River fish species, including *O. mykiss*, at conditions above bankfull discharge (study described above in the Fall-Run Chinook Salmon section).

As noted above (see Physical Habitat Conditions, above), the Districts conducted an *O. mykiss* habitat survey in 2012 in the spawning reach between La Grange Dam and Roberts Ferry Bridge (approximately from RM 52 to 39) (TID/MID 2013g). In 2012, the Districts conducted the *Oncorhynchus mykiss* Scale Collection and Age Determination Study (TID/MID 2013n) 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 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).

The results of the following ongoing studies will also inform the assessment of potential cumulative effects to *O. mykiss*::

- Temperature Criteria Assessment, (TID/MID 2013i):
  - literature review of available information on temperature tolerances of *O. mykiss*,
  - empirical study of local adaptation of temperature tolerance of *O. mykiss* juveniles in the lower Tuolumne River, and
  - analysis of existing empirical information on the spatial distribution of juvenile *O. mykiss* in response to temperature.
- PHABSIM effective habitat analysis:
  - An evaluation of EWUA of affected *O. mykiss* life stages, which requires use of the final lower Tuolumne River water temperature model (TID/MID 2013j), will be conducted. The eWUA analysis relates to summer water temperature suitability for *O. mykiss* and will integrate both micro- and macro-habitat considerations. The results from the water temperature model over a range of flows will be combined with the summer WUA results so that macrohabitats with unsuitable water temperatures are excluded from the total WUA estimate.

Steelhead/Rainbow Trout Life Stages

Steelhead/Rainbow Trout Spawning

Central Valley steelhead and rainbow trout generally spawn from December through April, with peak activity occurring in February and March (TID/MID 2013b). 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 2013e), there is no empirical evidence of a self-sustaining "run" or population of steelhead currently in the Tuolumne River (TID/MID 2013b). Of the 147 individual fish examined by Zimmerman et al. (2008), otolith chemistry results indicated that only one 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 were spawned at the same time (i.e., did not originate from the same parent), and any indication of parental origin is unknown due to historical planting operations and straying of steelhead; most steelhead as well as 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 in Central Valley rivers, including the Tuolumne River, are not genetically distinct from one another. Nielsen et al. (2005) also found that Tuolumne River *O. mykiss* residing upstream of Don Pedro Reservoir exhibited genetic separation from those found downstream of La Grange Dam in the lower Tuolumne River.

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 2013b). 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 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 had higher rates of smolting because they were able to grow to larger total sizes but had 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 to undergo smoltification and migrate to the ocean to gain sufficient lipid stores to mature (TID/MID 2013e). Recognizing that decreased survival associated with Delta emigration and ocean rearing may not be offset by increased size (fecundity) of anadromous as compared to resident *O. mykiss*, it is apparent that increased summer flows since 1996 have resulted in large increases in resident fish, but no evidence of a steelhead run (TID/MID 2013e).

The low numbers of possible anadromous *O. mykiss* adults entering the Tuolumne River (Zimmerman et al. 2008) and potential for straying support this interpretation, suggesting that increased cold water releases during summer reduce, but do not necessarily eliminate, the possibility of smoltification within the overall sympatric *O. mykiss* population (TID/MID 2013e).

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 2013d). Biweekly redd surveys were again conducted between December 10 and April 19, 2013. Thirty-eight *O. mykiss* redds were observed from October 1, 2012 through April 19, 2013 (TID/MID 2013d). 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 3.5-13). 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 during the 2012–2013 study period. There was no evidence of *O. mykiss* redd superimposition during the 2012–2013 study period (TID/MID 2013d).

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 2013d). 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).

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*, spawning could be limited by gravel size. However, the *O. mykiss* Population Study 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 2013e). Results from the current PHABSIM study (Stillwater Sciences 2013) show that spawning habitat is maximized at flows greater than 225 cfs (Table 3.5-10), with variation in the 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 with gravel, depth, and velocity parameters analyzed in the Spawning Gravel in the Lower Tuolumne River Study (TID/MID 2013a).

Table 3.5-13. 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%
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%

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 2009 (Ford and Kirihara 2010) are shown in Table 3.5-14. However, as noted above, there is little evidence of a self-reproducing anadromous run of Central Valley 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 2013b).

Table 3.5-14. 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 at riffle habitat types, along with transitional run head and pool head habitat types.

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 2013g). 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 2013g). 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 regulated flow regime than they would under more widely varying flows (TID/MID 2013g).

There is apparent density-dependent exclusion of age 0+ juvenile *O. mykiss* from riffle/pool transitions by age 1+ and older fish (TID/MID 2013b). 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 2013g).

The downstream extent of suitable water temperatures may limit habitat for age 0+ fish. Results from 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 3.5-10). Prior PHABSIM modeling combined with water temperature suitability (Stillwater Sciences 2003) suggests that flows which maximize habitat for larger fish are generally higher, and may therefore limit juvenile habitat (TID/MID 2013b). Although *O. mykiss* abundance has increased since implementation of increased summer flows, stable flows and temperatures in summer, as noted, appear to select for a resident life history. Zimmerman et al. (2008) showed that very few steelhead occur in the Tuolumne River, and smolt-sized O. mykiss are rarely captured in RST's rotary screw traps in the lower river (Ford and Kirihara 2010).

Suitable water temperatures for smolt emigration in the range of 18–21°C (65–70°F) 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.

As noted above, results of the Pulse Flow Study (Stillwater Sciences 2012a) show that flows above bankfull discharge at the locations studied along the Tuolumne River were associated with increases in overbank habitat area suitable for life stages of salmonids. Although little information exists suggesting juvenile *O. mykiss* use floodplain habitats in the Central Valley (TID/MID 2013b), suitable habitat areas for juvenile *O. mykiss* life stages increased most rapidly between bankfull discharges of 1,000 and 3,000 cfs, corresponding to floodplain inundation.

Steelhead Ocean Rearing

Little is known about how Central Valley steelhead respond to changes in productivity patterns along the California coast (TID/MID 2013b). 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 freshwater.

Steelhead Upstream Migration

Adult Central Valley steelhead upstream spawning migration generally occurs from July through March, with peak activity occurring from December through February (TID/MID 2013b). Although there is no evidence of a steelhead run 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 2013b). 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.

Steelhead /Rainbow Trout Age Determination

The results of the 2012 *Oncorhynchus mykiss* Scale Collection and Age Determination Study (TID/MID 2013n) 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 3.5-15).

Table 3.5-15. Combined Zimmerman et al. (2009) and TID/MID 2013n 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+	52	365–523

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

The *O. mykiss* Population Study the best available information and synthesizes available information and provides a quantitative population model to investigate the relative influences of various factors on the life-stage-specific production of *O. mykiss* 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 (TID/MID 2013e). Model sensitivity testing suggests that *O. mykiss* production under existing conditions is influenced by a number of environmental factors. The following general conclusions were made based on the base-case simulation:

- The large amounts of suitable gravel for *O. mykiss* spawning (TID/MID 2013a) coupled with low sensitivity of the model to spawning related parameters suggests that under current conditions, juvenile *O. mykiss* productivity is unlikely to be limited by the availability of suitable gravel.

- Consistent with increased habitat use associated with increased summer baseflows since 1996 (documented in annual snorkel surveys), model sensitivity to juvenile rearing density for a combination of drier water year types and higher population sizes suggests a potential rearing habitat limitation for juveniles during summer. However, adult *O. mykiss* rearing habitat does not appear to be limiting at any time.
- For both juveniles and adults, model sensitivity to the water temperature threshold for a combination of drier water year types and higher population sizes during drier water year types suggests that a greater downstream extent of cool water habitat during summer corresponds to lower levels of water temperature related mortality.

3.5.1.4.3 Fish Habitat Restoration Projects

As directed under the 1995 Settlement Agreement, the Tuolumne River Technical Advisory Committee (TRTAC) developed 10 top priority habitat restoration projects aimed at improving geomorphic and biological components 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 (Completed in 2003),
  - Gravel Mining Reach Phase II (Not completed),
  - Gravel Mining Reach Phase III (Not completed), and
  - Gravel Mining Reach Phase IV (Not completed).
- Predator Isolation Projects:
  - SRP 9 (RM 25.7 to 25.9) (Completed in 2001), and
  - SRP 10 (RM 25.5) (Not completed).
- Sediment Management Projects (RM 47.5 to RM 51.8):
  - Riffle Cleaning (Fine sediment) (Not completed),
  - Gasburg Creek basin (Fine sediment) (Completed prior to 2008),
  - Gravel Augmentation (Coarse sediment) (Not completed), and
  - RM 43 (Coarse sediment) (Completed in 2005).

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 (2011).

CDFW placed about 27,000 yd^3 of gravel in the river near 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. The TRT, in partnership with the NRCS, the 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"). Restoration at the Big Bend project site 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 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.

3.5.1.5 Special-Status Fish Species

For the purpose of this DLA, a special-status species is discussed if there is a reasonable possibility that it might occur within the Project Boundary, or in the lower Tuolumne River downstream of the Project, and meets one or more of the following criteria:

- Found on NMFS's List of Species of Concern (NMFS 2009a), and listed as a Species of Concern (NMFS-S).
- Found on public land administered by the USDOI, BLM and formally listed by the BLM as Sensitive Species (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 California Endangered Species Act (CESA) as endangered, threatened, or proposed for listing.
- Found on the CDFW Commission's list of State and Federally Listed Endangered and Threatened Animals of California (CDFW 2013).

The Central Valley Fall- and Late-Fall-Run Chinook Salmon Evolutionarily Significant Unit (ESU) (NMFS-S, State species of special concern (SSC)) and Central Valley *O. mykiss* are discussed earlier in this section of the . The following special-status fish species are briefly addressed in the following subsections.

- Hardhead (*Mylopharodon conocephalus*) (CA SSC watch list),
- Sacramento Splittail (*Pogonichthys macrolepidotus*) (CA Threatened),
- Sacramento-San Joaquin Roach (*Lavinius symmetricus symmetricus*) (CA SSC watch list), and
- Red Hills Roach (*Hesperoleucus symmetricus*) (CA Endangered).

3.5.1.5.1 Hardhead (SSC)

The hardhead is a large cyprinid (minnow) (up to 580 cm long) that generally occurs in large undisturbed, low- to mid-elevation, cool to warm water rivers and streams (Moyle 2002). Hardhead mature following their second year. Spring spawning migrations into smaller tributary streams are common. The spawning season may extend into August in the foothill streams of the Sacramento River and San Joaquin River basins. Spawning behavior has not been well documented, but hardhead appear to spawn in gravel riffles (Moyle 2002). Little is known about life stage-specific temperature requirements of hardhead; however, 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 downstream habitats, and predation by smallmouth bass have resulted in population declines and isolation of populations (Moyle 2002). Hardhead also have 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 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 Project.

3.5.1.5.2 Sacramento Splittail (SSC)

Splittail 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 freshwater (Moyle 2002). Historically, 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). The 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). 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. Successful spawning has been recorded in the lower Tuolumne River in the 1980s, with both adults and juveniles observed near Modesto, near RM 8. As a supplement to the Districts' PHABSIM study (Stillwater Sciences 2013), WUA versus flow analyses for Sacramento splittail, using existing HSC, are being conducted (results to be presented in the FLA).

3.5.1.5.3 Sacramento-San Joaquin Roach (SSC)

The Sacramento-San Joaquin roach, a cyprinid, is part of the California roach complex, which is composed of various subspecies. 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). Assuming that the Sacramento-San Joaquin roach is indeed a single taxon (which is 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). Roach are tolerant of relatively high temperatures (30–35°C) and low oxygen levels (1–2 ppm) (Taylor et al. 1982). However, they are habitat generalists, also being found in cold, well aerated clear “trout streams” (Taylor et al. 1982), in human-modified habitats (Moyle 2002), and in the main channels of rivers. Adult Sacramento-San Joaquin roach have been observed and documented in the general vicinity of the Project, i.e., in Hatch and Second creeks, and Rough and Ready Creek, but not in the Tuolumne River mainstem.

3.5.1.5.4 Red Hills Roach (SSC, BLM-S)

The Red Hills roach, also a cyprinid and part of the California roach complex, is a recently discovered population of California roach (Brown et al. 1992, as cited in Jones et al. 2002), with abundant populations found in several pools of permanent water located along the intermittent streams that drain into Six Bit Gulch and Poor Man’s Gulch (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 the permanent pools are spring-fed (USDOI BLM 2009). During the dry part of the year, the fish are confined to these permanent 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, which makes it noticeably different from individuals of other roach populations, notably a chisel lip. 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).

3.5.1.5.5 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 2013l).

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 2013l). 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.

3.5.1.6 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 3.5-16). Long-term comparisons of historical data collected prior to WY 2000 are confounded by differences in invertebrate emergence timing and sampling methodology. Table 3.5-17 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 since the 1995 FSA have resulted in beneficial shifts in food supply for fishes. Although overall invertebrate abundances in Riffle 4A samples declined slightly in the post-FSA period (1996–present), community composition shifted away from pollution-tolerant organisms and towards those with higher food value for juvenile salmonids and other fish (TID/MID 2010, Report 2009-7).

Table 3.5-16. 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 3.5-17. 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.

3.5.1.7 Aquatic Invasive Species

Aquatic invasive species of concern in Don Pedro Reservoir and the lower Tuolumne River include two species of mussel, quagga mussel (*Dreissena rostriformis bugensis*) and zebra mussel (*D. polymorpha*), and the New Zealand mudsnail (*Potamopyrgus antipodarum*). Of these species, 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 found in four western states in 2007 and quickly expanded their geographic range to include parts of the western United States. 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. The zebra mussel was found in California for the first time in January 2008, at the San Justo Reservoir in San Benito County. These mussels could threaten water delivery and irrigation systems by clogging intake pipes and other conveyance structures.

Quagga and zebra mussels are 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 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 their ability to tolerate a range of temperatures, calcium concentrations, pH, DO, and salinity (Cohen 2008). Based on its ambient conditions, Don Pedro Reservoir is not considered to be particularly vulnerable to colonization. The Tuolumne River at Modesto is considered vulnerable, but was assigned a low priority designation.

The DPRA has attended workshops to learn about methods for preventing the spread of nonnative mussel species. DPRA has met with water recreation managers to discuss the issue and has conducted public education, vessel inspections, and monitoring aimed at preventing the introduction of these mussel species into Don Pedro Reservoir. Since June 2008, MID has been monitoring for zebra and quagga mussels at its treatment system using submerged vertical plates, which are inspected every two weeks for mussel attachment. MID has not detected any mussels since monitoring began.

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 education materials at boat launches and at the DPRA Visitor Center which educate recreational users on ways to reduce the spread of invasive species. .

3.5.2 Resource Effects

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

- Effects of Project O&M 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.
- Potential effects of Project related changes in the recruitment and movement of LWD on aquatic resources and their habitat.
- Potential effects of Project operations on stranding or displacement of fish.
- Potential effects of entrainment at the Project dam and intake on fish populations.

3.5.2.1 Project Effects on Fish Populations in Don Pedro Reservoir

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.

The Project affects reservoir water temperatures, which in turn can affect the cold-water fishery, 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 2013k) are consistent with all available evidence that suggests Don Pedro Reservoir supports a quality cold-water fishery, indicating that the Project has no adverse effect on cold-water fish species in the reservoir. The Districts are aware of no data or other evidence that indicate Project operations and maintenance have an adverse effect on the Reservoir's cold-water fishery.

FERC's SD2 identifies as a Project related issue the potential effects of Project operations to stranding or displacement of fish. Project related changes in reservoir surface elevation that result from water releases have the potential to affect reservoir fish by influencing shoreline and tributary habitats.

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, as explained in Section 3.5.1.2, there is no evidence that Project operations have a significant adverse effect on bass nesting in Don Pedro Reservoir. The bass nest survival evaluation showed that reservoir elevation changes occurring during the past 27 years maintained bass nest survival at or above the acceptable level identified by CDFW (Lee 1999; TID/MID 2013k).

Fish could also be affected if tributary access is limited during spawning seasons as the result of Project related fluctuations in reservoir water surface elevation. 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 2013k). Fish passage impediments were only identified in Deer Creek, which is not considered a salmonid spawning stream (TID/MID 2013k). Moreover, the Project is operated to accommodate access to possible cold-water spawning tributaries during the spring and fall fish migration periods (TID/MID 2013k).

FERC's SD2 also identifies as an issue potential effects of entrainment at the Project dam and intake to fish populations. The deep-water intake at Don Pedro Reservoir is located at a depth of 350 ft or more throughout the year (TID/MID 2013k), and as a result it is very unlikely that warm-water fish species are entrained at the Project. Stocked cold-water species occupy cooler, deeper water during some periods of the year. However, given the depth of the 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 combined. 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 to cold-water species, including salmonids.

The findings of the Don Pedro Reservoir Fish Population Survey Study (TID/MID 2013k) are consistent with all available evidence, which demonstrates that current habitat conditions in Don Pedro Reservoir support quality cold-water and warm-water fisheries. The Districts are aware of no evidence that indicates Project operations and maintenance activities have an adverse effect on the reservoir's fisheries. Because the Proposed Action will not change the operation or maintenance activities of the Project, no adverse effects to reservoir fisheries are anticipated over the term of the new FERC license.

Potential effects of sediment and LWD retention in Don Pedro Reservoir would manifest themselves in the lower Tuolumne River. As a result, the potential effects of sediment and LWD retention to aquatic resources are addressed in Section 4.0 Cumulative Effects.

3.5.2.2 Effects of Project Operation and Maintenance on Fish Populations in the Reach between Don Pedro Dam and La Grange Dam

Results of the Fish Assemblage and Population Between Don Pedro Dam and La Grange Dam Study conducted in 2012 (TID/MID 2013h) 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 occurring 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, Project related stage-flow fluctuations in the reach allow for the persistence of the two species. Although physical habitat conditions, structural complexity in particular, are not optimal, the Project does not preclude rainbow trout and sculpin from living and reproducing in the reach between the two dams and, therefore, would not be expected to have an adverse effect on these species over the term of the new license.

3.5.2.3 Effects of Project Operation and Maintenance on Fish and Aquatic Resources in the lower Tuolumne River

Effects of Project operations and maintenance on fish and BMI populations in the lower Tuolumne River are addressed in Section 4.0, Cumulative Effects.

3.5.3 Proposed Environmental Measures

The Districts are currently proposing no environmental measures in the DLA related to fish and aquatic resources as some studies are still underway.

3.5.4 Unavoidable Adverse Impacts

Unavoidable adverse impacts, to the extent they occur, will be addressed in the FLA, after additional information is available from ongoing studies.

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

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 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. Project O&M activities, including local vegetation management and noxious weed control efforts, are restricted to Project facilities and the Districts' three recreation areas.

The Don Pedro Project PAD compiled and presented existing information regarding botanical resources in the 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 affected environment and Project effects to (1) vegetation types within the Project Boundary; (2) special-status plants; (3) wetland and littoral habitats; and (4) noxious weeds.

3.6.1 Affected 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 Project falls within sections of 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
South Sierra	Canyon Live Oak	0.2
	Interior Live Oak	10.8
	Annual Grasses and Forbs	3.8

CalVeg Zone	CalVeg Alliances	Total Acres in Project
Central Valley	Douglas Fir- Pine	5.2
	Gray Pine	447.5
	Interior 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, 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 to5,200 feet.

3.6.1.2 Special-Status Plants

In 2012, botanical surveys were conducted targeting special-status plants within the Project Boundary. Prior to surveys, the California Native Plant Society (CNPS) database (CNPS 2012) was reviewed for special-status plant species occurring within the nine USGS quadrangle maps around the Project Boundary. Additionally, and 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 USDOI, 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 Project effects, including all 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 85 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): 57 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.

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	**57**	**28**

1 Special-status:
2 Occurrence is primarily on public lands but crosses into TID/MID lands.
BLM-S = Bureau of Land Management Sensitive Plants.
CNPS 1B = California Native Plant Society listed as endangered in California and elsewhere.

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).

3.6.1.2.1 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 (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*),[20] Congdon's lomatium, Red Hills soaproot, tripod buckwheat, shaggy-haired lupine and Mariposa cryptantha.

3.6.1.2.2 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 area of 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 were associated with Red Hills soaproot: noxious weeds and grazing. No disturbances associated with Project O&M were observed. Other special-status plants 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.

3.6.1.2.3 Mariposa Clarkia

Twenty-five occurrences of Mariposa clarkia were documented within the study area; two 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. At the time of survey, the majority of plants were in bloom. Four potential disturbances were associated with Mariposa clarkia: recreation, noxious weeds, grazing, and road and transmission line maintenance. No disturbances associated with Project O&M were observed in these areas. Additionally, one occurrence was in an area associated with a burn pile from Project debris removal activities, and parts of some occurrences extended below the reservoir normal maximum surface elevation.

3.6.1.2.4 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 (combined area of approximately 1.24 ac).

[20] Layne's ragwort is an ESA-listed species. 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.

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.

3.6.1.2.5 Tripod Buckwheat

Four occurrences of tripod buckwheat were documented within the study area; all on public land administered by the BLM at Sixbit Gulch. A total of approximately 277 individuals (combined area of approximately 0.07 ac) were observed, nearly all in bloom. A review of existing information showed 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. Other special-status plants growing in association with tripod buckwheat including Layne's ragwort, Red Hills onion, Congdon's lomatium, shaggy-haired lupine and Red Hills soaproot.

3.6.1.2.6 Congdon's Lomatium

Seven occurrences of Congdon's lomatium were documented within the study area, all on public land administered by the BLM; five occurrences 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 were observed: recreational use and noxious weeds. In addition, part of one occurrence extended below the reservoir normal maximum surface elevation. Other 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.

3.6.1.2.7 Shaggy-haired Lupine

Seven occurrences of shaggy-haired lupine were documented within the study area; four on public land administered by the BLM: two at Poor Man's Gulch and five at Railroad Canyon. Individual occurrences ranged from one to 2,000 plants (combined area of approximately 0.25 ac). At the time of survey, over 90 percent of the individuals were in fruit and the rest in flower. All but one occurrence was at the margin (just above or partially below) the reservoir normal maximum surface elevation. Other special-status plants were growing in association with shaggy-haired lupine including Layne's ragwort, Red Hills onion, Red Hills soaproot, tripod buckwheat, and Congdon's lomatium.

3.6.1.2.8 Red Hills Ragwort

Two occurrences of Red Hills ragwort were documented within the study area; one on public land administered by the BLM. Red Hills ragwort was also found at Recreation Bay and Sixbit Gulch. The total number of individuals observed was approximately 268 (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 associated with Red Hills ragwort: recreation, weeds and grazing. In addition, part of one occurrence extended below the reservoir normal maximum surface elevation. Other special-status plants were found growing in association with Red Hills ragwort, including 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. The bulk 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. Existing 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 and assessed the condition of each wetland 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. In doing so, CRAM 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. CRAM scores range from 97 to 59, with a maximum score possible of 100; a score of 100 indicates that every wetland service is provided by the wetland. Scores identified how many services were observed, and a narrative description provided 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. 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 in the wetlands (except as open water represented by Don Pedro Reservoir itself). In general, most wetlands were dominated by bedrock or cobble and boulder substrates; while these substrates do not support hydric soils, they do allow the development of hydrophytic vegetation. In addition, other indicators of ground saturation during some part of the growing season (e.g., 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 Project facilities, access roads, recreational use, or Project 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.

3.6.1.3.1 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, paved where it crosses the channel, and 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.

3.6.1.3.2 Poor Man's Gulch

Poor Man's Gulch is a small drainage located within the Red Hills ACEC that supports one wetland type: (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*) occurs 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.

3.6.1.3.3 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, with floodplains within a valley that becomes narrower and steeper travelling 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, although 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. However, 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.

3.6.1.3.4 Hatch Creek

Hatch Creek supports one NWI mapped wetland type: 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 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 is present at a short stretch of dirt terrace on the north bank, possibly from compounded effects of grazing and debris jam in the channel.

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, but channel and vegetation complexity are limited by the bedrock substrate and possibly by cattle grazing on private lands.

3.6.1.3.5 Big Creek

The emergent wetland system at Big Creek is contained within the Project Boundary, 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*), indicating 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, and recent cattle activity 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. The score 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.

3.6.1.3.6 Kanaka Creek

Kanaka Creek supports one NWI-classified wetland: 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. The score indicates that the wetland experiences few stressors from upland or hydrologic sources and provides most wetland services; however, two non-native plant species, fig and Himalayan blackberry, are common throughout.

3.6.1.3.7 Deer Creek

Deer Creek supports one type of NWI-classified wetland: 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 from 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.

3.6.1.3.8 Drainage #7

Drainage #7 is located within the Red Hills ACEC and supports one type of NWI-classified 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. 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; 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. Limited shrubs, such as 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.

3.6.1.3.9 Drainage #8

Drainage #8 is located within the Red Hills ACEC and supports one type of NWI-classified 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 of 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.

The upper portion of Drainage #8 has a steep gradient with exclusively bedrock and boulder bed and banks. 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 waterfall area supports little vegetation; 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 AA 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 Project 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 was ubiquitous throughout the study area, occurring in all habitat types (including the gabbro soils of the Red Hills ACEC) and at times dominant in annual grasslands and disturbed areas 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. 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. Of the total noxious weed occurrences, eight species were observed in 85 occurrences on public land administered by the BLM.

3.6.1.4.1 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.

3.6.1.4.2 Tree-of-heaven

Seven occurrences of tree-of-heaven (*Ailanthus altissima*) were found at three locations: one 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.

3.6.1.4.3 Giant Reed

Giant reed (*Arundo donax*) was found at one location 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.

3.6.1.4.4 Italian Thistle

Italian thistle is prevalent throughout the Project, particularly in 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.

3.6.1.4.5 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 locations, 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.

3.6.1.4.6 Yellow Starthistle

Yellow starthistle was found at a total of 38 occurrences: four 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 Rd. area, two in the area of Jacksonville Rd., 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.

3.6.1.4.7 Bermudagrass

Bermudagrass was found growing in a thin, discontinuous band below the normal maximum water surface elevation mark Don Pedro Reservoir. The Districts also documented an additional 76 occurrences at other locations 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 Rd., one at Moccasin Point Recreation area, four in the Moccasin Transmission Line area, one each at Poor Man's Creek, Sixbit Gulch and Don Pedro Bar), while the rest (57) 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 (due to the rhizomal nature of this species, individuals are difficult to differentiate) on around 20 ac.

3.6.1.4.8 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.

3.6.1.4.9 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 Rd., 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.

3.6.1.4.10 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.

3.6.1.4.11 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.

3.6.1.4.12 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

FERC's SD2 identifies the following issues associated with botanical resources:

- Potential effects of Project operation, including water level fluctuations, ground-disturbing activities, and maintenance to special-status plant species and botanical resources.
- Potential effects of Project operation, including recreation, water level fluctuations, ground-disturbing activities, and maintenance to the presence and spread of noxious weeds, including yellow starthistle.
- Effects of Project operation, including water level fluctuations, ground-disturbing activities, and maintenance activities to wetland, riparian, cottonwood and willow, and littoral vegetation communities.
- Effects of maintenance and use of Project recreation facilities by recreationists to special-status wildlife species, special-status plant species and botanical resources, and shoreline vegetation.
- Effects of vegetation clearing for Project maintenance to botanical resources, and the presence and spread of noxious weeds.

Each of these potential effects is analyzed below.

3.6.2.1 Special-Status Plants

Of more than 700 plant species identified during botanical surveys, a total of 57 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 co-located with noxious weed occurrences, many in areas also with evidence of private grazing, but also geographically removed from any Project O&M activity. 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 abundance of special-status plants, and may have compounded impacts where they occur in tandem.

Three instances of Project O&M 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 Project O&M, 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; in each, this represent 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 Project operations. Wetland conditions in these drainages begin at above the normal maximum surface elevation of Don Pedro Reservoir, continuing upstream (often well beyond the Project Boundary) where conditions allow. Wetland conditions below the Reservoir normal maximum surface elevation were not observed during study efforts, and no water backs up into these wetlands as a result of Project operations. As a result, Project operations and Don Pedro Reservoir fluctuations do not affect these 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 Project facilities and contained within the Project Boundary, these anthropogenic uses appear to be the primary drivers of habitat quality.

No Project facilities, access roads, recreational use, or Project 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 these species 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 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. Vehicles may carry noxious weed seeds or reproductive plant parts (e.g., some weeds may re-sprout from broken root bits) long distances, and roadsides often provide disturbed habitat for weed colonization (CDFA 2012). One weed, distaff thistle (CDFA B-listed), was located at two locations along roads: one location on Jacksonville Road and one 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 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.

Noxious weeds were common within developed recreation areas: nearly 150 occurrences were mapped. 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, the majority 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 weed found in grazed areas was medusahead grass, along with many occurrences of 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 below the normal maximum water surface elevation of Don Pedro Reservoir, including four occurrences of distaff thistle. Project 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 Project O&M 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 Project 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, Project O&M among them.

3.6.3 Proposed Environmental Measures

The Districts propose to develop and implement a Vegetation 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 will include best management practices to limit the spread of existing noxious weed occurrences or the establishment of new occurrences related to Project operations. The implementation of the Vegetation Management Plan is expected to limit the degree and extent of Project effects to 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 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 Project effects on wildlife resources. Information on species listed under the ESA and CESA is presented separately, in Section 3.8.

The Don Pedro Project PAD provided existing information on wildlife resources, including special-status species that are known to occur or have the potential to occur in the 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 Reptiles Study (TR-06),
- Bald Eagle Study (TR-10), and
- Special-Status Wildlife-Bats Study (TR-09).

3.7.1 Affected Environment

3.7.1.1 Wildlife Habitats and Setting

The Project is situated in the foothills of the west slope of California's Sierra Nevada. The Project Boundary encompasses over 5,538 ac 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 Project activity. Project O&M activities, including local vegetation management efforts, are restricted to Project 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 at the Project; 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 based 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[21] from within quadrangles occupied by the Project (CDFW 2013a):

- Western pond turtle (WPT) (*Actinemys* [*Emys*] [formerly *Clemmys*] *marmorata*),
- Foothill yellow-legged frog (FYLF) (*Rana boylii*),
- Bald eagle (*Haliaeetus leucocephalus*),
- Coast horned lizard (*Phrynosoma blainvillii*), and
- Sierra Nevada yellow-legged frog (*Rana sierrae*).

[21] 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.

Sierra Nevada yellow-legged frog is not considered further here, as it is restricted to elevations well above those present in the Project Boundary, generally above 6000 ft mean sea level (msl) (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 Project vicinity. The record is more than four miles from the Project and there is limited potential for the Project to affect this species; therefore, this species is not considered further here.

In its SD2, FERC indicated its environmental review will evaluate the effects of the 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, but that has been observed in the Project vicinity:

- Golden eagle (*Aquila chrysaetos canadensis*)

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 are known from further outside the study area (e.g., reservoirs in Mariposa County).

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 2012 studies, 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 (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 their locations were diversified to represent each geographic area of the reservoir. Non-reservoir basking survey sites were selected for the presence of suitable WPT habitat, including open water over one meter deep as well as with aquatic and terrestrial refugia. Potential WPT nesting habitat within 100 m of the Project reservoirs and other water bodies associated with the 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 deceased) 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 has 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 few areas with 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 mi upstream of the Project in Moccasin Creek and Mountain Pass Creek. Additionally, FYLF were observed in Hatch Creek, upstream of the Project, in 1970 (TID/MID 2011).

As part of 2012 studies, desktop FYLF habitat assessments were conducted at twenty locations (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 at three FYLF VES sites (Six-Bit Gulch, Poor Man’s Gulch, and Woods Creek). Additionally, bullfrog and crayfish were found throughout the Project 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. A variety of introduced predatory fish are present and American bullfrog larval and post-metamorphic life stages were observed at many locations within the study area. As a result, Don Pedro Reservoir does not provide 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. No surveyed tributaries to Don Pedro Reservoir were found to support FYLF or suitable habitat for FYLF within the study area.

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 Project facilities, including those accessible portions of the Tuolumne River that are within the Project Boundary (TID/MID 2013b). The study area for osprey and Swainson's hawk included the bald eagle study area as well as other relicensing study areas.

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 between 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 (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 were occupied in 2013, Woods Creek Arm Nest No. 1 and Mine Island Nest. Both of these nests were also occupied in 2012. Nestlings were present at both of these nests. The single nestling at Woods Creek Arm nest likely fledged prior to second survey visit. Two nestlings at Mine Island nest had 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 Wards 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	Wood 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	4176010	726313	flying around fish cleaning station	--

Date	No. of Bald Eagles	Location	UTM-N	UTM-E	Activity/Observation[1]	Perch Type
		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	--
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 Wards 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 Wards 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.

Species	No.	Age[1]	UTM-N	UTM-E	Observation Notes
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 are 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 occur in the Project Boundary or are known to occur in the Project vicinity, but one golden eagle was incidentally observed on and above a high ridgetop near the Project 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 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).

Nesting Swainson’s hawks are not heavily impacted by regular and consistent human activity; nests are not uncommon near roads and active agricultural lands (Woodbridge 1998). Hawks can be sensitive to new activity in areas that were previously inactive, causing nest abandonment (Woodbridge 1998).

Suitable habitat within the Project Boundary for Swainson’s hawk includes approximately 2,300 ac of annual grasslands, as well as adjacent habitats. No Swainson’s hawk were observed during 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 (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	--

Date	No.	Location	UTM-N	UTM-E	Activity/Observation[1]	Perch Type
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 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 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.

3.7.1.8.1 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).

3.7.1.8.2 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. However, 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).

3.7.1.8.3 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).

3.7.1.8.4 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).

3.7.1.8.5 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).

3.7.1.8.6 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).

3.7.1.8.7 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 an objective of sampling a broad range of habitat types and localities within the Project Boundary. During the initial reconnaissance for focused survey and Ladenburg Thalmann Asset Management (LTAM) sites, Project 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 identified:

- 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 of the five survey 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 of the five survey 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 Project facilities or recreation sites. Based on observed use patterns, maternity roosts and winter hibernacula are likely within the study area or Project vicinity, but none occur at Project facilities or areas affected by Project O&M. Two Project 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 Project campgrounds, and are likely subject to indirect disturbance related to recreational use. Evidence of roosting at campground facilities persisted throughout the 2012 bat study, suggesting that, generally, 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 Oak campground, used by pallid bats as a night roost, was found to have substantial evidence of human activity (burn marks on the interior walls of the structure, along with broken glass on the floor) within the structure. 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 disturbance or use could lead to a reduction of use by bats or abandonment of this night roost.

3.7.2 Resource Effects

FERC's SD2 identifies the following special-status wildlife related issues associated with the Project:

- Effects of project operation, including water level fluctuations, ground-disturbing activities, and maintenance on special-status wildlife species and habitat,
- Effects of maintenance and use of project recreation facilities by recreationists on special-status wildlife species, and
- Effects of vegetation clearing for project maintenance on wildlife.

Each of these potential effects is analyzed below.

3.7.2.1 Terrestrial Wildlife Habitats

The bulk of the Project Boundary is undeveloped land that is well-removed from any Project O&M activity and unaffected by the Project. Near Project facilities and developed recreation areas, Project 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 habitats, and are limited in scope and duration. As a result, the effects of Project O&M on wildlife habitats is minor.

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 does support 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 American bullfrog occurrences. 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 O&M could affect potential WPT nesting habitat below the normal maximum water surface elevation in Don Pedro Reservoir. Young WPT in nests within the fluctuation zone (eggs are laid in summer and hatchling turtles remain in the nest for approximately one year) 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 some 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, WPT typically select sites with at least some vegetation (low grasses and forbs), and therefore may not be impacted by those areas subject to the most 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.

The Districts have granted four grazing permits on a total of 559 ac within the Project Boundary. The Districts' permits require that no grazing is to occur below the normal maximum water surface elevation for Don Pedro Reservoir. As a result, permitted grazing has little potential to affect WPT basking or other habitat uses. However, WPT nesting, which can occur in upland areas above the normal maximum water surface elevation, may be reduced or precluded by animal use within grazing permit areas. Of the 1648 ac of potential WPT nesting habitat identified within the Project Boundary during 2012 study efforts, approximately 184 ac are within the Districts' grazing permit areas, which is approximately 11 percent of the total potential nesting habitat.

No FYLF were detected during study efforts, and FYLF are not reported from 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 several 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, Project 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 2012 and 2013 bald eagle surveys on Don Pedro Reservoir suggest that the Project is compatible with successful bald eagle foraging and nesting. While 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, 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…in most cases, ongoing existing uses may proceed…with little risk of disturbing bald eagles"[22]. Recreational use of Don Pedro Reservoir has been ongoing since 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 Project O&M does not occur, since no Project facilities or maintenance activities are located within 1.5 mi of a bald eagle nest.

Project O&M includes periodic ground squirrel management in developed recreation areas. Two methods are used: (1) burrow blasting, which injects oxygen and propane into ground squirrel burrows for subsequent ignition, most recently in the 2012–2013 season, and (2) targeted use of pelleted rodent poison, most recently during the 2009–2010 season. Because fish forage is plentiful adjacent to bald eagle nest sites and pelleted rodent bait is infrequently used, ground squirrel management is unlikely to affect bald eagles.

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 Project is not likely to have a substantial impact on osprey.

Project 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 Project 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 Project 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 Project facilities and developed recreation areas by special-status bats is common, the use of Project facilities and disturbance associated with Project 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 Project O&M (bat use patterns suggest they are present in the larger Project vicinity). Thirty-two night roosts were identified, many within or adjacent to 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.

[22] USFWS 2007

One night roost was observed to have substantial evidence of human activity: a small cinderblock structure near the A2 restroom in the Blue Oak 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, broken glass on the floor, and other indicators of frequent disturbance. 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 could lead to a reduction of use by bats or abandonment.

3.7.3 Proposed Environmental Measures

The Districts propose to develop and implement a Bald Eagle Management Plan to include the following components:

- protection of existing nests and access restrictions to prevent disturbance during bald eagle mating and rearing, and
- awareness training for employees for avoidance around known nests.

The Districts also propose to consult with agencies regarding measures to manage the pallid bat roost in the cinderblock structure near the A2 restroom in the Blue Oak campground.

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 discusses plant and wildlife species that may occur in the vicinity of the Project and are listed or candidates for listing as threatened or endangered under the ESA, the CESA, or both, as well as designated and proposed critical habitat for these species. This section also references certain species listed as Rare or Fully Protected under California law. Species not listed under the ESA, CESA, or California State Law, but that are afforded other special designation (e.g., by a federal or state agency) are referred to as “special-status species” and are addressed in Sections 3.4, 3.5, and 3.7.

Threatened and Endangered species investigations began by determining the species with potential to occur in the 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 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 of the Project (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*),
  - Red Hills vervain (*Verbena californica*),
  - Valley elderberry longhorn beetle (VELB) (*Desmocerus californicus dimorphus*),
  - Vernal pool fairy shrimp (*Branchinecta lynchi*),
  - California tiger salamander (CTS), Central Valley DPS (*Ambystoma californiense*),
  - California red-legged frog (CRLF) (*Rana draytonii*), and
  - Steelhead, California Central Valley DPS (*Oncorhynchus mykiss irideus*).

Central Valley steelhead are discussed in Section 3.5. The remaining species, and the potential for the Project to affect them, are addressed below.

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 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.

Based on review of the habitat requirements and known distributions, 12 species (nine plants, two birds, and one amphibian) were identified that are protected under the CESA or listed as rare or fully protected under California law and potentially occurring in the vicinity of the Project. These species are:

- 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*).
- CESA Threatened:
  - Red Hills 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*).

Bald eagle and golden eagle are discussed in Section 3.7. The remaining species, and the potential for the Project to affect them, are addressed below.

3.8.1 Species Removed from Consideration

FERC's SD2 specified certain ESA-listed wildlife species that will be addressed in FERC's environmental analysis of the Project. In addition to a subset of the species listed above, these include:

- 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*).

These four species are all listed as Endangered under the ESA; riparian brush rabbit is also listed as Endangered under the CESA. None of these species or their critical habitats (when designated) are reported within five miles of the Project Boundary, nor within Tuolumne county as a whole (CDFW 2013). For example, the closest designated critical habitat for Conservancy fairy shrimp is over 10 miles from the Project Boundary. Additionally, habitat distributions within the Project Boundary are not suggestive of potential for the occurrence of any of these species. Extensive field studies within the Project Boundary located no vernal pool habitats, which are required by Conservancy fairy shrimp (typically large or "playa" pools) (Eng et. al 1990). Riparian brush rabbit, riparian wood rat, and least Bell's vireo each require riparian shrub habitats; field studies documented these habitats to be uncommon within the Project Boundary, and not affected by Project O&M (see Section 3.6). As a result, these species are removed from further consideration.

3.8.2 ESA and CESA-listed Plants

Based on species list inquiries and species habitat requirements, a total of ten ESA or CESA-listed plants have the potential to occur in the Project vicinity (these are listed above). Of these, two species are known to occur: Layne's ragwort and California vervain, both ESA-listed species and both known from five occurrences (a distinct geographic grouping of plants) within one mile of the Project Boundary (CDFW 2013). California vervain is also listed under the CESA.

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. Field studies were performed in portions of the Project Boundary where there was potential for Project effects, including all 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 ESA or CESA-listed plant occurrence, up to 0.25 miles outside the Project Boundary. The study area included in surveys consisted of 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.

These surveys documented a total of 27 occurrences of two ESA or CESA-listed plant species: Layne's ragwort and California vervain. There were 25 occurrences of Layne's ragwort and two occurrences of California vervain, all of which were found on federal lands administered by the BLM within the Red Hills ACEC. No other ESA or CESA-listed plants occur within lands potentially affected by Project O&M or recreational use.

3.8.2.1 Layne's Ragwort

3.8.2.1.1 <u>Regulatory Status</u>

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 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).

3.8.2.1.2 Life History and 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 in elevation (Baldwin 2012, CNPS 2012). Layne's ragwort has stems that grow singly or in a cluster of two to four. They are sparsely tomentose or plus or minus glabrous stems with basal and cauline petioled leaves. The leaves are thick and firm, narrowly elliptic to lanceolate or oblanceolate, tapering at the base, plus or minus entire or weakly and irregularly dentate. Distal cauline leaves are sessile and bract-like. The yellow inflorescences have both ray and disk flowers. Five to eight ray flowers and fifty to sixty disk flowers will make up an inflorescence (Baldwin 2012). The species is occasionally found along streams as well. CNPS reports rapid urbanization as the primary threat to Layne's ragwort. In addition, clearing, grazing, road construction, and fire suppression threaten the species (CNPS 2012).

3.8.2.1.3 Occurrence and Habitat within the Project Boundary

Botanical surveys recorded 25 occurrences of Layne's ragwort within or adjacent to the 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 manazanita (*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 of Jacksonville Road. There are multiple footpaths throughout the area, including one that runs within a few feet of two occurrences. All three occurrences have the potential to be affected by recreation activities (i.e., trampled) and noxious weeds. Additionally, distaff thistle (*Carthamus creticus*) was observed within 250 ft of a Layne's ragwort occurrence. Distaff thistle is a noxious weed which spreads quickly and can form dense stands and crowd out native plants (DiTomaso and Healy 2007).

3.8.2.2 California Vervain

3.8.2.2.1 Regulatory Status

On September 14, 1998, the USFWS listed California vervain as threatened under the federal ESA (Federal Register 63:49002). No Critical Habitat has been designated for this species. USFWS is currently developing a Recovery Plan for California vervain. In December 2007, a 5-year review of the species by 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).

3.8.2.2.2 Life History and Habitat Requirements

California vervain is a perennial herb that is only found along small or intermittent perennial streams (CDFG 2005), usually within serpentinite, cismontane woodlands in valley and foothill grasslands between 853 ft and 1312 ft in elevation. This verbena generally has one to three decumbent to erect, sometimes canescent, stems. Leaves can be sessile or plus or minus clasping, elliptic to oblanceolate, entire to irregularly and obtusely toothed, tapered to truncate at the base. Spikes of one to five per cluster make up an inflorescence. Flowers can vary from violet to purple (Baldwin 2012). 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). USFWS reports threats to California vervain to include recreational activities such as gold mining, mountain biking and hiking. In addition, hydrological fluctuations also affect the species (USFWS 2012c).

3.8.2.2.3 Occurrence and Habitat Within the Project Boundary

Botanical surveys recorded two occurrences of California vervain within the Project study area: 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. One occurrence, in Poor Man's Gulch, consisted of over 200 individuals occupying approximately 0.2 ac. The second 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*). Observed potential stressors around California vervain included cattle grazing and recreation near one occurrence, and noxious weed presence (barbed goatgrass) near both occurrences.

3.8.3 ESA and CESA-listed Invertebrates

3.8.3.1 Valley Elderberry Longhorn Beetle

3.8.3.1.1 Regulatory Status

On August 8, 1980, 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 range of VELB extends throughout California's Central Valley and associated foothills below about 3,000 ft in elevation (USFWS 1999).

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 USFWS recommendation that VELB be de-listed (USFWS 2012b). In October of 2012, the USFWS began the process of reviewing the delisting proposal (USFWS 2012c).

3.8.3.1.2 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., eggs, larvae, and adults). An exit hole created by larvae just prior to pupation is often the only evidence of the beetle's presence. The life cycle takes 1 or 2 years to complete, with most of that time spent as larva living within the stems of the plant. Eggs are laid on elderberry leaves or bark and hatch within two days; the emerged larvae live within the stems of the plants feeding on the pith for 1 to 2 years. Adults emerge from the stems through holes made by larva prior to pupation. Adults generally emerge from late March through June and are short-lived (USFWS 2009). VELB primarily occurs within the riparian corridor but can occur infrequently in non-riparian scrub habitats adjacent to the corridor, and less commonly occupies 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.

3.8.3.1.3 Occurrence and Habitat Within the 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. 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 Project O&M activities, including all Project facilities and recreation sites, dispersed recreation areas on Don Pedro Reservoirs, and 10 drainages within the Project Boundary that were also designated for wetland studies.

Surveys recorded a total of 73 elderberry plant occurrences within the Project Boundary. 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

Site Location	Riparian Yes|No	Stem Count[1]	Number of Exit Holes	Recent Yes|No	Land Ownership
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

3.8.3.2.1 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 Project, at approximately 2.6 distance from the edge of the 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).

3.8.3.2.2 Life History and Habitat Requirements

Vernal pool fairy shrimp occurs 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 occupies 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 the vernal pool fairy shrimp has been collected from large vernal pools, including one exceeding 25 ac in area (Eriksen and Belk 1999), it tends to occur primarily in smaller pools (Platenkamp1998), and is most frequently found in pools measuring less than 0.05 ac in area (Gallagher 1996, Helm 1998). The vernal pool fairy shrimp typically occurs at elevations from 30 to 4,000 ft (Eng et al. 1990), although two sites in the Los Padres National Forest have been found to contain the species 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 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). Vernal pools are mostly rain fed, resulting in low nutrient levels and dramatic daily fluctuations in pH, DO, and carbon dioxide (Keeley and Zedler 1998).

3.8.3.2.3 Occurrence and Habitat Within the Project Boundary

Vernal pool fairy shrimp occurs in California from Shasta county south to Tulare County and in Jackson County, Oregon. Most of the known occurrences are in the Central Valley and Coast Ranges of California, with disjunct populations in San Luis Obispo County, Santa Barbara County, and Riverside County, California (Eng et al. 1990, Erickson and Belk 1999). The CNDDB includes a record of one occurrence within the Sonora quad, which is adjacent to Project quads (CDFW 2013).

The Districts engaged in detailed terrestrial resource studies in 2012 that surveyed all Project facilities, developed and dispersed recreation areas, and lands potentially subject to Project O&M activities. No vernal pools, or vernal pool plants that might indicate their presence, were located.

3.8.4 ESA and CESA-listed Wildlife

3.8.4.1 California Tiger Salamander

3.8.4.1.1 Regulatory Status

On August 4, 2004, the Central California Distinct Population Segment of the CTS was listed as threatened under the ESA (69 FR 47212). The Santa Barbara and Sonoma County populations are both currently listed as endangered (65 FR 57242 and 68 FR 13498, respectively). Critical Habitat was designated for the Central Population DPS on August 23, 2005, (70 FR 79380), including an area approximately one mile southwest of the Project Boundary in Stanislaus County. There are five known historical CTS occurrences within five miles of the Don Pedro Project. The most recent occurrence was observed in 2007, approximately 0.4 miles from Don Pedro Reservoir (CDFW 2013).

3.8.4.1.2 Life History and Habitat Requirements

CTS live in vacant or mammal-occupied burrows (e.g., California ground squirrel, *Otospermophilus beecheyi*, and valley pocket gopher, *Thomomys bottae*), or occasionally other underground retreats, throughout most of the year; in grassland, savannah, or open woodland habitats (Trenham 2001). Populations in Sonoma County, California, are closely associated with the presence of pocket gopher burrows (USFWS 2003a). 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 2004a). Adults spend little time in breeding sites before returning to upland habitats. CTS populations generally do not persist where fish, American bullfrogs, 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 2 to 4 weeks. Larvae transform in about 4 months (Behler and King 1979) as water recedes in late spring or summer, but larvae may overwinter in permanent ponds (Alvarez 2004b). CTS may not breed at all in drought years when ponds fail to fill. The number of larvae that successfully metamorphose at a given site tends to be "boom or bust" (Loredo and Van Vuren 1996).

According to the Interim Guidance on Site Assessment and Field Surveys for Determining Presence or a Negative Finding of the CTS (USFWS 2003b), 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 habitat. 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.

3.8.4.1.3 Occurrence and Habitat within the Project Boundary

No CTS were observed during the site assessments performed as part of this study, nor were there any incidental sightings of CTS during performance of the other relicensing studies during 2012. There is one known historical CTS occurrence within one mile of the Don Pedro Reservoir study area, in Tuolumne County, near Big Creek south of Don Pedro Reservoir.

Site assessments and habitat characterizations were performed for CTS in the Project vicinity and 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. 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 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 Project vicinity as a whole. Small burrows were present at many sites, and Don Pedro Reservoir is the only significant barrier to CTS movement between breeding sites. As specified in the FERC-approved study plan, the study area for this effort consisted of all suitable aquatic habitats within the Project Boundary and lands within 1.24 miles of the Project Boundary, consistent with USFWS requirements.

Initial evaluation determined that a total of 247 sites within the study area were determined to hold standing or slow-moving water for 10 weeks during the CTS breeding season. These locations were further assessed using aerial photography and field assessment methods (TID/MID 2013). Many of the aerially assessed sites that held water for at least 10 weeks appeared to have suitable upland dispersal habitat, but while these sites were located within the study area, they were not on lands affected by Project O&M due to proximity to Project facilities or Don Pedro Reservoir, and were therefore not evaluated further in the field. Following aerial assessment, field surveys to verify habitat characterizations and collect additional information were performed at potential breeding sites within the Project Boundary and representative breeding locations on publicly accessible lands within 1.24 miles of the Project Boundary. Field surveys revealed that the majority of these sites were perennial streams with too high of a gradient or lacked upland habitat suitable for dispersal. Within the Project Boundary, 38 field-assessed sites were characterized as potentially suitable CTS breeding sites, 29 of which were considered more favorable to CTS breeding due to the presence of small burrows and upland habitat suitable for dispersal.

Table 3.8-2 summarizes the sites that are potentially affected by Project operation or maintenance activities, and describes elements important to CTS breeding habitat.

Table 3.8-2. Summary of sites potentially affected by Project O&M.

Site	Habitat Feature/Seasonality/Location	Meets 10 week criterion	Burrows Observed	Upland Dispersal Habitat Available	Bullfrog Present	Fish Present
F31	Stream in Moccasin Point Recreation Area	--	--	x	--	--
F45	Sewage Treatment Pond near Fleming Meadows Recreation Area	X	x	--	--	--
F46	Sewage Treatment Pond near Blue Oaks Recreation Area	X	--	--	--	--
F47	Swimming lagoon at Fleming Meadows Recreation Area	X	x	--	--	--
F49	Sewage Treatment Pond near Fleming Meadows Recreation Area	X	x	--	--	--
F50	Sewage Treatment Pond near Blue Oaks Recreation Area	X	x	--	--	--
F51	Sewage Treatment Pond near Moccasin Point Recreation Area	X	x	--	--	--
F52	Sewage Treatment Pond near Moccasin Point Recreation Area	X	x	--	--	--
F73	Stream in Moccasin Point Recreation Area	--	--	x	--	--
F77	Pool in spillway channel	X	x	--	--	--
F78	Pool in spillway channel		x	--	x	--
F80	Pool in spillway channel	X	x	x	--	--
F81	Pond at base of Gasburg Creek Dike, adjacent spillway channel.	?	x	x	--	--
F82	Pool in spillway channel	X	?	--	--	--
F83	Pool in spillway channel	X	?	--	--	--
F85	Pool in spillway channel	X	?	--	x	--
F86	Pool in spillway channel	X	?	--	--	--
F87	Pool in spillway channel	X	?	--	x	--
F88	Pool in spillway channel	X	?	--	x	--
F89	Pool in spillway channel	X	x	--	--	--

3.8.4.2 California Red-Legged Frog

3.8.4.2.1 Regulatory Status

On May 23, 1996, the USFWS listed CRLF as threatened under the ESA (61 FR 25813 25833) throughout its range. 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 Project Boundary. No occurrences of CRLF have been recorded within five miles of the Project Boundary since 1984, and USFWS' recovery plan for the species lists CRLF as extirpated from the Tuolumne River watershed (USFWS 2002b).

3.8.4.2.2 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). 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 correlation to CRLF occurrence is the absence or near-absence of introduced predators such as American bullfrog and predatory fish—particularly centrarchids (i.e., freshwater sunfishes and bass), which feed on the larvae at higher rates than native predatory species and favor survival of the invasive bullfrog in streams (Hayes and Jennings 1988, Kruse and Francis 1977, Werner and McPeek 1994, Adams et al. 2003, Gilliland 2010)—and mosquito fish. Hiding cover from predators may be provided by 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 attach 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 utilize 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 a mile and probably occurs only during wet periods (USFWS 2006b).

CRLF is 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).

3.8.4.2.3 Occurrence and Habitat within the Project Boundary

Site assessments and habitat characterizations were performed for CRLF in the Project vicinity, including of a review of historical data, identification of potential habitats using aerial photography and National Wetlands Inventory digital maps (USFWS 1987), and site evaluations. Ponds and streams within the Project vicinity 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 Project vicinity as a whole. As specified in the FERC-approved CRLF study plan, the study area for this effort consisted of all suitable aquatic habitats within the Project Boundary and lands within one mile of the Project Boundary, consistent with USFWS requirements.

Initial assessment using aerial photography and National Wetlands Inventory digital maps determined that a total of 212 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 on lands affected by Project O&M due to proximity to Project facilities or Don Pedro Reservoir, and were classified as marginal habitat due to the type of habitat (e.g., manmade agricultural ponds) and presence of bullfrogs.

Following aerial assessment, field surveys to verify habitat characterizations and collect additional information were performed at potential breeding sites within the Project Boundary and representative breeding locations on publicly accessible lands within one mile of the Project Boundary. Field surveys revealed that the majority of these sites provide marginal habitat due to the lack of emergent or overhanging vegetation or 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 study efforts.

Table 3.8-3 summarizes sites that are potentially affected by Project O&M activities, and describes elements important to CRLF breeding habitat.

Table 3.8-3. Summary of sites potentially affected by Project O&M.

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.

Site Number	Habitat Description	Area (acres)	Meets 20-Week Criterion	Notes
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.
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.

3.8.4.3 San Joaquin Kit Fox

3.8.4.3.1 Regulatory Status

On March 11, 1967, the USFWS listed San Joaquin kit fox as endangered under the ESA (32 FR 4001) throughout its range. 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; no change in listing was recommended. No Critical Habitat has been designated. No occurrences of San Joaquin kit fox have been recorded within five miles of the Project Boundary since 1973 (CDFW 2013).

3.8.4.3.2 Life History and Habitat Requirements

San Joaquin kit foxes mate in winter and have between four and seven young in February or March. San Joaquin kit foxes utilize multiple underground dens throughout the year, sometimes using pipes or culverts as den sites in addition to burrows. Their primary food items are usually the most abundant nocturnal rodent or lagomorph in the 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 activities (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 because of the proximity to bedrock (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 a high clay content, such as in the Altamont Pass area in Alameda County, where they modify burrows dug by other animals (Orloff et al. 1986).

3.8.4.3.3 Occurrence and Habitat within the Project Boundary

Historically reported to occur throughout the San Joaquin valley, the largest populations of San Joaquin kit fox are currently reported from Kern, San Luis Obispo, Fresno, San Benito, and Monterey counties (CSU Stanislaus 2013). However, the CNDDB includes a single record of San Joaquin kit fox within the general Project vicinity, approximately 2.1 mi southwest of the Project Boundary. The record is from 1972-1973, in an area that is currently an OHV recreation development (CDFW 2013).

3.8.5 Resource Effects

FERC’s SD2 identifies the following issues related to threatened and endangered species associated with the Project:

- 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 ESA.
- Effects of maintenance and use of Project recreation facilities by recreationists on species listed as threatened or endangered under the ESA.
- Effects of Project O&M on designated critical habitat under the ESA.
- Effects of vegetation clearing for Project maintenance on species listed as threatened or endangered under the ESA.

Each of these potential effects is analyzed below.

3.8.5.1 ESA- and CESA-listed Plants

Botanical surveys documented a total of 27 occurrences of two ESA or CESA-listed plant species: Layne’s ragwort and California vervain. There were 25 occurrences of Layne’s ragwort and two occurrences of California vervain, all of which were found on federal lands administered by the BLM within the Red Hills ACEC. No other ESA or CESA-listed plants occur within lands potentially affected by Project O&M or recreational use.

Recreation activities take place in the vicinity of two occurrences of Layne's ragwort and California vervain in Poor Man's Gulch. A well-defined equestrian trail runs near one Layne's ragwort occurrence and continues down the gulch; recreation in this area has the potential to directly disturb plants and habitat. Potential stress to Layne's ragwort at Kanaka Point included recreationists access the study area via a free day-use parking lot, and there is evidence of a walking trail near the Layne's ragwort found in the area. Recreation in these areas is managed by the BLM.

Cattle grazing was observed around and near occurrences of Layne's ragwort in Poor Man's Gulch and Sixbit Gulch. Cattle grazing may affect plant populations by trampling, shifting the native ecology or plant community, or by the grazing itself. Cattle grazing in these areas is not an activity authorized by the Districts, but private and public grazing of cattle is common in parts of the Project Boundary.

Three noxious weed species are present in the vicinity of a subset of ESA-listed plant occurrences: distaff thistle, barbed goatgrass, and Bermudagrass. Near the Layne's ragwort occurrences in Poor Man's Gulch, a large infestation of barbed goatgrass enters the study area from upstream of the Project and continues down the gulch. Barbed goatgrass is also near Layne's ragwort in Sixbit Gulch. Distaff thistle was found within 250 ft of Layne's ragwort on Kanaka Point; and Bermudagrass, a CDFA C-listed weed (CDFA 2012), was also observed in this area. Each of these species is widespread throughout the Central Valley, and the Districts do not conduct O&M activities in these areas that present a risk of introduction or distribution of noxious weed propagules.

The outer boundary of four occurrences of Layne's ragwort extend below the normal maximum water surface elevation of Don Pedro reservoir. These plants are not adversely affected by current Project operations, but could be impacted by substantial changes in the duration or timing of inundation. No changes in operations are proposed by the Districts.

Surveyors did not identify any other potential stressors to ESA-listed plants. No other Project O&M activities, including ground-disturbing activities and vegetation management, occur in the vicinity of any identified ESA-listed plant occurrences.

The potential for other ESA- or CESA-listed species to occur in the 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 Project study area, including:

- Vernal pools, which are the habitat for Hoover's spurge, succulent owl's clover, Colusa grass, Greene's tuctoria, and hairy Orcutt grass.
- Mima mounds, which Hartweg's golden sunburst has been found to grow on almost exclusively.

- The clay or silty soils in seasonally flooded plains and swales, which is habitat for Delta button-celery.

A total of two ESA-listed plant species, one also CESA-listed, are known to occur in or near lands potentially subject to Project O&M or recreational activities. Potential stressors and disturbances to these occurrences (terrestrial recreation, cattle grazing, and noxious weeds), are not directly associated with the Project. As a result, the Project may affect, but is not likely to adversely affect, Layne's ragwort and California vervain. There will be no effect on any other ESA or CESA-listed plant species.

3.8.5.2 ESA and CESA-listed Invertebrates

VELB surveys documented a total of 73 elderberry occurrences on surveyed lands. Of the 73, 14 had VELB exit holes, and one occurrence showed signs of those exit holes being recent. No VELB were observed.

The bulk of elderberry occurrences were located on hillslopes or reservoir shorelines, in areas with little potential for recreational use and no Project O&M activities. However, some potential stressors were documented in proximity to the 73 elderberry occurrences. The most common potential stressors were proximity to roads and trails (nineteen occurrences). Additionally, some elderberry occurrences were located in or near areas periodically subject to vegetation management: fifteen in Moccasin Point Recreation Area, one in Blue Oaks Recreation Area, and two adjacent to Project sewage treatment facilities. Foot traffic was observed at a total of three occurrences, primarily from recreational use within developed recreation areas. Elderberry often favors partially disturbed "edge" habitats such as roadsides (USFWS 1984), and the elderberry plants observed were vigorous, with no signs of stress. Nevertheless, they could be affected if vegetation management activities directly disturb them.

Two occurrences of elderberry plants were located near the normal maximum water surface elevation of Don Pedro reservoir. These plants are not adversely affected by current operations, These plants could be affected by substantial changes in the duration or timing of inundation, but are not adversely affected by current operations. However, because operational modifications are not being proposed, these elderberry occurrences are not affected by Project O&M.

A total of 18 elderberry occurrences were located in areas with signs of grazing, which could affect the plants through trampling or direct browsing. Of these, four are within lands permitted for grazing by the Districts. However, these occurrences did not have any evidence of VELB exit holes.

VELB host plants and evidence of VELB were documented within the Project Boundary. Most elderberry shrubs located are on shorelines or hillsides that are not proximate to Project O&M and recreation and not affected by the Project. Elderberry in developed recreation areas and Project facilities were vigorous, with no signs of stress, but could potentially be affected by future O&M activities. As a result, the Project may affect, but is not likely to adversely affect VELB.

Vernal pool fairy shrimp are not reported to occur within the Project Boundary and the Districts' extensive terrestrial survey efforts did not document any vernal pools, or vernal pool plants that might indicate the presence of pools. The Project will have no effect on vernal pool fairy shrimp.

3.8.5.3 ESA and CESA-listed Wildlife

3.8.5.3.1 California Tiger Salamander

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. CTS site assessments documented the essential components of CTS breeding habitat (i.e., "the capability to hold water for a minimum of 10 weeks in all but the driest of years, suitable upland habitat, and evidence of small mammal burrows") at or near 38 sites within the assessment area, including 22 within the Project Boundary. No CTS were observed during site assessments or other resource studies.

Project O&M may affect potential CTS breeding habitat at 10 assessment locations in the Project spillway channel and one pond adjacent to the spillway channel. These sites are considered marginal habitat due to a lack of surrounding upland dispersal habitat. Additionally, American bullfrog were observed at three of the pools in the spillway channel and are likely present in each, limiting their suitability as potential habitat. Project O&M at the spillway channel are not subject to any Project activities under normal O&M procedures; the spillway has released water only once since Project construction, in 1997. As a result, Project O&M is unlikely to affect these marginal habitats.

Seven of the nine assessment sites located at Project developed recreation facilities met the 12-week criterion; one constructed swimming lagoon and 6 sewage treatment ponds. While these sites all hold water for at least 12 weeks during the CTS breeding season, they are considered marginal habitat due to their lack of suitable adjacent upland habitat.

Ground squirrel control occurs annually at Project recreation facilities, which could limit the ground squirrel burrows available for CTS use, but CTS occurrence at the sites near these control efforts is not anticipated due to the lack of suitable adjacent upland habitat. Additionally, despite ground squirrel control, burrows were observed at six of the seven sites located at Project recreational facilities, suggesting CTS habitat availability is not affected by ground squirrel control efforts.

CTS are not known to occur within the Project Boundary, but are reported from the Project vicinity. Potential CTS breeding habitat is present within the Project Boundary, but as generally marginal habitat. As a result, the Project may affect, but in not likely to adversely affect, CTS or its habitat.

3.8.5.3.2 California Red-Legged Frog

Potential CRLF breeding habitat (standing water for at least 20 weeks) was documented at or near 212 habitat sites within the study area. Many of the habitat sites within the Project

Boundary that met the 20 weeks criterion had limited or no emergent or overhanging vegetation present, and many of those locations with suitable vegetation were occupied by CRLF predators such as fish and bullfrogs, resulting in only 10 sites being categorized as potentially favorable to CRLF breeding. No CRLF were observed during site assessments or other resource studies.

Based on proximity to Project facilities, Project O&M may affect potential CRLF breeding habitat at 10 of the assessment locations in the spillway channel and one pond adjacent to the spillway channel. However, American bullfrog were observed at three of the pools in the spillway channel and are likely present in each, limiting their suitability as potential habitat. Because CRLF do not occur in the study area and the potential habitats observed are of generally poor quality, Project O&M is unlikely to affect CRLF in these areas. Additionally, potential habitats in the spillway channel are not subject to any Project activities under normal O&M procedures; the spillway has released water only once since Project construction, in 1997.

Seven of the nine study sites located at Project recreational facilities met the 20-week criterion and represent potential habitat; one constructed swimming lagoon and six sewage treatment ponds. Each of these sites is lined with either concrete or gravel and has minimal surrounding vegetation. While these sites all hold water for at least 20 weeks during the CRLF breeding season, they are considered marginal habitat due to their lack of overhanging and emergent vegetation and are not likely to support CRLF.

CRLF are not known to occur within the Project Boundary or the Project vicinity; no occurrences are known within a five-mile radius of the Project and the species is reported to be extirpated from the Tuolumne River watershed. Because the species does not occur, the Project will have no effect on CRLF.

3.8.5.3.3 San Joaquin Kit Fox

San Joaquin kit fox are not reported to occur within the Project Boundary, and extensive terrestrial survey efforts did not document any large burrows or fox sightings, but nearby occurrence records indicate that their presence cannot be ruled out. However, the Districts do not engage in predator control activities, and no habitat conversions or substantial developments are proposed that would alter potential San Joaquin kit fox habitat within the Project Boundary. As a result, the Project may affect, but is not likely to adversely affect, San Joaquin kit fox.

3.8.6 Proposed Environmental Measures

The Districts propose developing a Vegetation Management Plan that will include measures to limit the degree and extent of Project effects to ESA and CESA-listed plants within the Project Boundary. In addition, the Districts proposed to follow USFWS Conservation Guidelines for the VELB for management of elderberry within the Project Boundary (USFWS 1999).

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 Affected Environment

3.9.1.1 Recreation in the Project Vicinity

The Don Pedro Project, located on the Tuolumne River in Tuolumne County, California, provides diverse and substantial recreation opportunities, including boating, fishing, swimming, water skiing, picnicking, hiking, and camping. Recreational opportunities are also available in the Project vicinity.

The Tuolumne River and its confluences upstream of the Project Boundary are referred to herein as the upper Tuolumne River subbasin. Federally managed lands along the upper Tuolumne River provide extensive opportunities for popular recreational activities, including camping, fishing, and high-gradient whitewater boating in an undisturbed natural setting. Downstream of La Grange Dam, a diversion dam owned by the Districts located about two miles below Don Pedro Dam, the Tuolumne River provides opportunities for fishing, swimming, and low gradient boating in a rural/urban setting with agriculture and gravel mining along much of the corridor's overbanks.

3.9.1.1.1 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 key differences 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 acting, 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 area within 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).

Opportunities and amenities for a variety of recreationalists are also currently available at recreation facilities in the Project Boundary, including house boating; picnic sites for large groups; developed nature areas; and natural or undeveloped areas.

3.9.1.1.2 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 NPS and other organizations depend on 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, follows the river corridor in this segment.

In 1984, Congress designated portions of the upper Tuolumne River as Wild & 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 including 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).

In all, 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. 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)

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).

Camping

Within the Stanislaus National Forest, there are 12 riverside campsites and three USFS campgrounds. Motor homes 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.
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 is popular 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 Rafting 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.

3.9.1.1.3 Recreation Opportunities Downstream of the 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 Project area takes place at Turlock Lake and Modesto Reservoir, followed by fishing and boating on the lower Tuolumne River. The primary recreation activities on the Tuolumne River downstream of the Project include fishing, swimming, boating, and camping.

There are eight publicly available access sites on 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 Tuolumne River corridor downstream of the Project. 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. And from Lake Road which separates the campground from the day use area, the campground, the river and sloughs, and miles of dredger tailing piles-the by product of a half century of gold mining can be viewed (California State Parks 2013).

Each of the 66 campsites at the campground on the lower Tuolumne River 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-serve 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 to the San Joaquin River, a 50-mile river reach, has a mild 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 to Turlock Lake SRA. Downstream from RM 32, gradients are less than two feet per mile.

Fishing

The Tuolumne River downstream of the Project provides fishing opportunities, with special regulations for trout and salmon fishing. From La Grange 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 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 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.
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 168 MW Don Pedro Project is located on the Tuolumne River in western Tuolumne County in the Central Valley region of California. 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 along the reservoir extends from the Don Pedro Dam at RM 54.8 to RM 80.8. The total shoreline length is approximately 160 miles, including islands.

Primary recreation activities at the Project 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 Project 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.

Project Recreation Facilities

The Project includes three developed recreation facilities: Moccasin Point Recreation Area, Blue Oaks Recreation Area, and Fleming Meadows Recreation Area (Figure 3.9-1).

Developed recreation facilities at the Project 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.

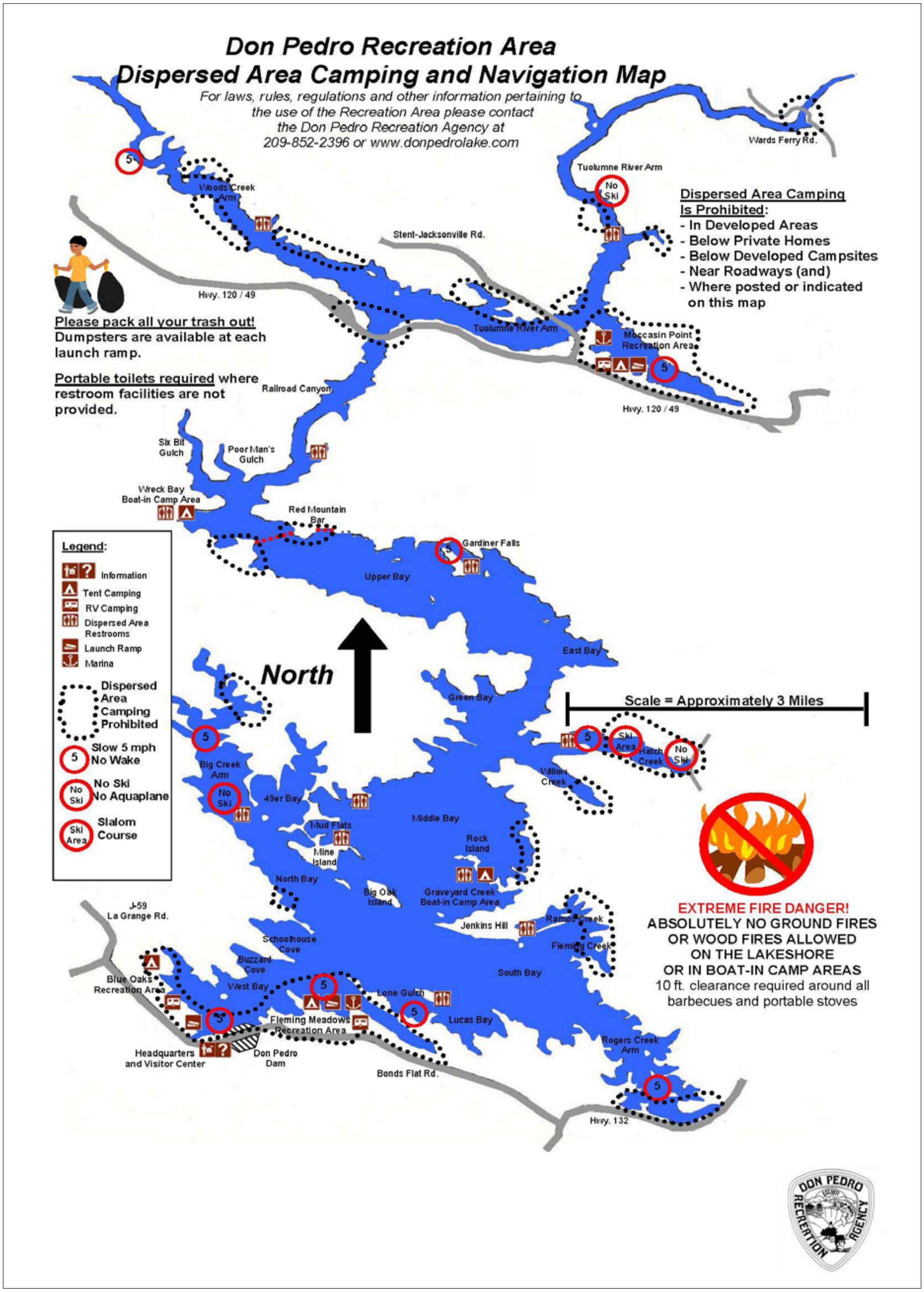

Figure 3.9-1. Existing Project recreation facilities.

Table 3.9-7 summarizes the amenities offered at the three developed Project recreation facilities. The three facilities are discussed in detail below.

Table 3.9-7. Summary of recreation facilities and other on-site amenities at Don Pedro Project developed recreation areas.

Amenities	Moccasin Point RA	Blue Oaks RA	Fleming Meadows RA
Project Recreation Facilities			
Camping Units - Total	68	195	263
With water and electric hookups	18	34	91
Picnic Areas –Total	2	1	2
Group Picnic Sites	1	1	1
Boat Launch Ramp	1	1	1
Fish Cleaning Stations	2	1	2
Comfort Stations - Total	6	9	12
With hot showers	1	4	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 176 campsites, 90 RV hookup sites, 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 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.

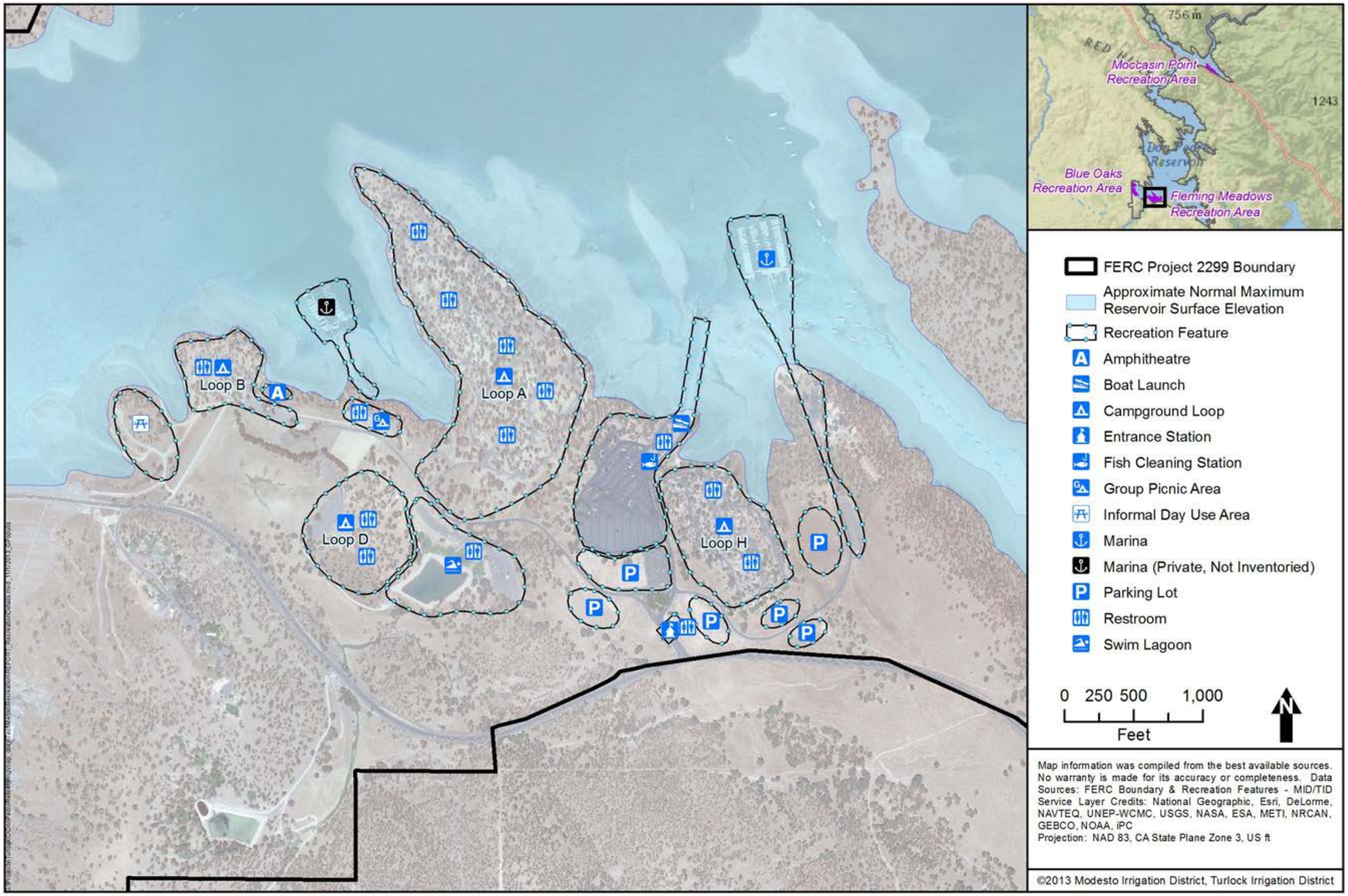

Figure 3.9-2. Fleming Meadows Recreation Area amenities.

Blue Oaks Recreation Area

The Blue Oaks Recreation Area, located just north of the emergency spillway section of the dam, is comprised of 161 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 station, houseboat repair yard, and a group picnic shelter. 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

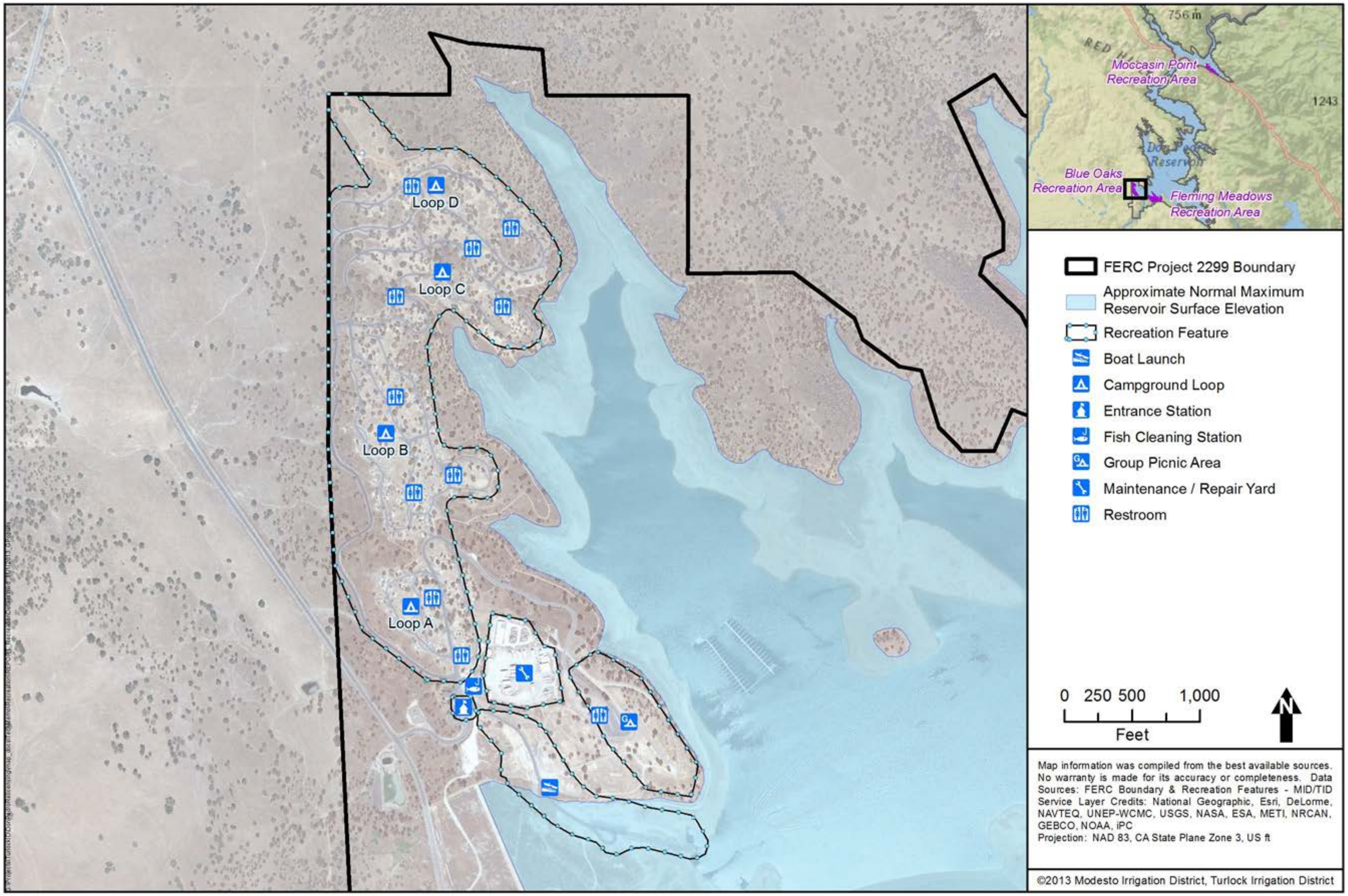

Figure 3.9-3. Blue Oaks Recreation Area amenities.

Moccasin Point Recreation Area

The Moccasin Point Recreation Area, located near the upper end of the Don Pedro Reservoir, is comprised of 78 campsites, 18 RV hookup sites, and one boat launching facility. Additional amenities include a full service marina and picnic area. There are also two 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.

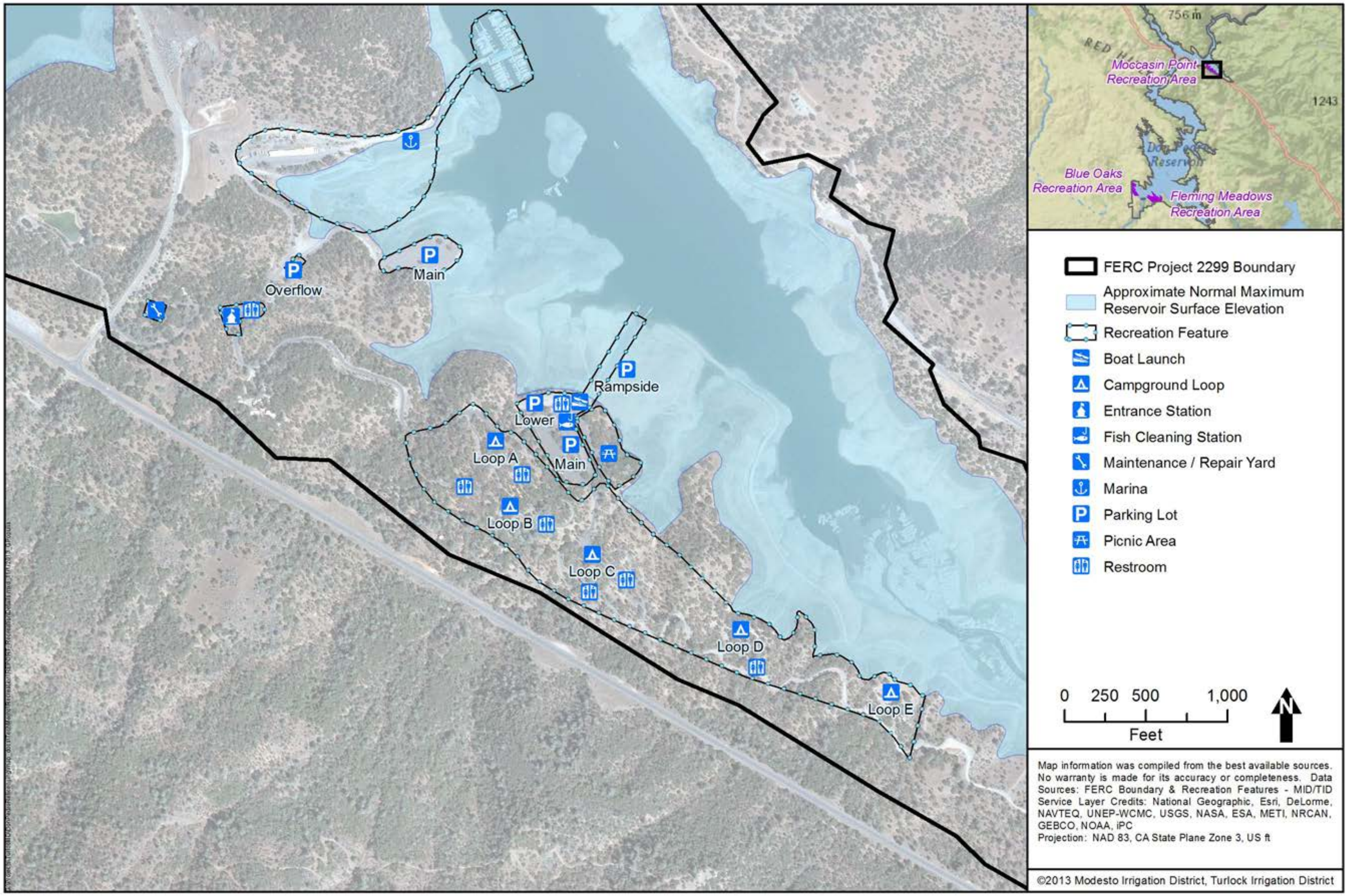

Figure 3.9-4. Moccasin Point Recreation Area amenities.

3.9.1.2.1 Recreational Activities at the Project

The most popular recreational activities at the Project include fishing; boating and water based activities; hiking, biking, and general trail use; picnicking; camping; and activities at dispersed recreation areas. These activities are discussed below.

Fishing

Don Pedro Reservoir supports year-round fishing and offers abundant populations of rainbow, brown, and brook trout; largemouth, smallmouth, spotted, and black bass; kokanee, silver, and resident Chinook salmon; black and white crappie; bluegill perch; channel, white, and black bullhead catfish; and green sunfish for anglers. 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. In 2010, 30 different organizations held 45 fishing tournaments at Don Pedro Reservoir. Table 3.9-8 summarizes the 2010 fishing tournament schedule for Don Pedro Reservoir. .

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

Date	Day of Week	Organization	Launch Location
3/27/10 3/28/10	Saturday Sunday	Sierra Bass Club	Blue Oaks
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 Project 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. 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 site, 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 location annually for the period 2003-2012 (USDA 2013). USFS estimates that two-thirds of these boaters were commercial rafting company customers and one-third were private boaters (USDA 2013). A whitewater boating take-out improvement feasibility study was conducted in 2012. The study is discussed further below.

House boating 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 559 camping units for recreational use with 143 offering water and electric hookups. Additionally, dispersed camping is allowed on most of the remaining Project 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.

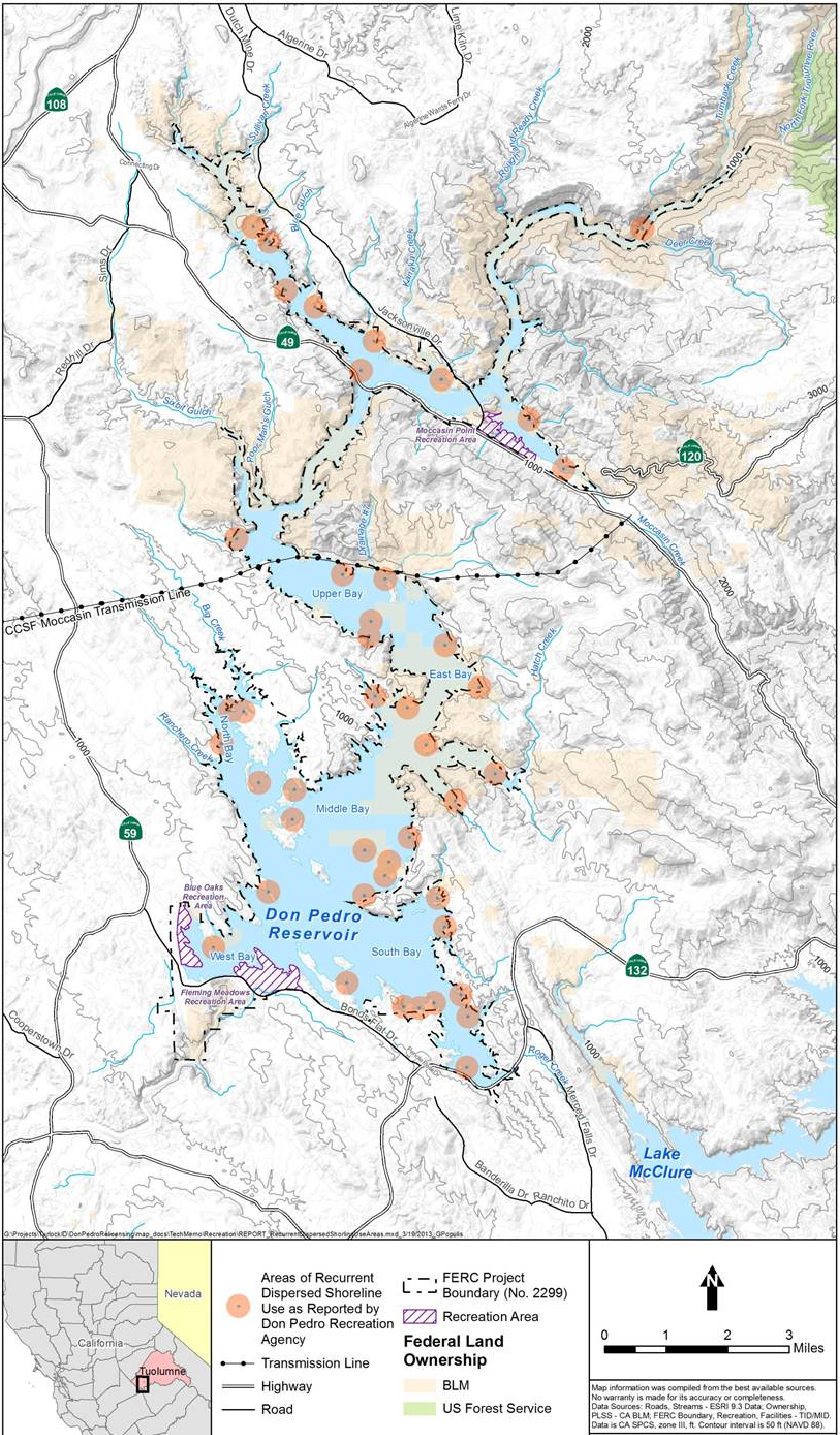

Figure 3.9-5. Dispersed recreation areas at the Don Pedro Project.

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 historical 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 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, 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 Special Designations

No portion of the Project has specifically been designated under the National Wildlife and Scenic Rivers System. No portion of the Project has been designated as wilderness area, recommended for such designation, or designated as a wilderness study area under the Federal Wilderness Act.

3.9.1.4 Recreation Studies Conducted as Part of Relicensing

The Districts conducted three recreational studies in 2012 and 2013 in support of Project 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 Project. The objectives of the study were to:

- assess the condition of existing developed recreation facilities at the Don Pedro Project, including dispersed use areas,
- estimate present capacity of recreation facilities at the Project to support present and future demand for public recreation (i.e., facility carrying capacity),
- describe the preferences, attitudes, and characteristics of the Project's recreation users,
- collect information about current Project 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 Project recreation resource areas; (3) estimate the current recreation use at Project 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 appear to 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 Recreational 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 Project 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% or 16 sites) showed “low” impact; five sites (22%) 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. As mentioned above, the Ward’s Ferry Bridge at RM 78.5 spans the Tuolumne River within the Project Boundary and acts as 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 boaters and boats exit the river at the end of their excursion. 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 engineering feasibility of developing an alternative site 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 was used to examine proposed alternative take-out locations and assess the technical feasibility of potential improvements. Six 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 boat take-out study at the Ward's Ferry location was to examine whether reasonable engineering options exist to improve on the efficiency and safety of removing boats and boaters from the river at the end of the whitewater trip at this location.

The 2012 study concluded that based on site assessment and preliminary engineering, take-out improvements at and just upstream of the Ward's Ferry Bridge appear to be technically feasible at both the river right option and river left option, with river right somewhat superior because it offers slightly more space without either sidehill cutting on the land side or large retaining walls on the river side of the site. Therefore, the lowest cost option identified in the 2012 study, which also involves lower construction risk, which met the study goal of improving the efficiency and safety of exiting the river and the site was the river right option.

The existing Moccasin Point Recreation Area take-out was also identified as a viable option. 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 Districts collect more information on the potential feasibility of developing boating take-outs at either Deer Creek or Deer Flats (Figure 3.9-6) The Districts conducted a site visit on September 13, 2013 to collect additional information about the Deer Creek and Deer Flats sites to form the basis of a preliminary feasibility assessment. A revised study report addressing these two additional sites will be provided in the Districts' USR.

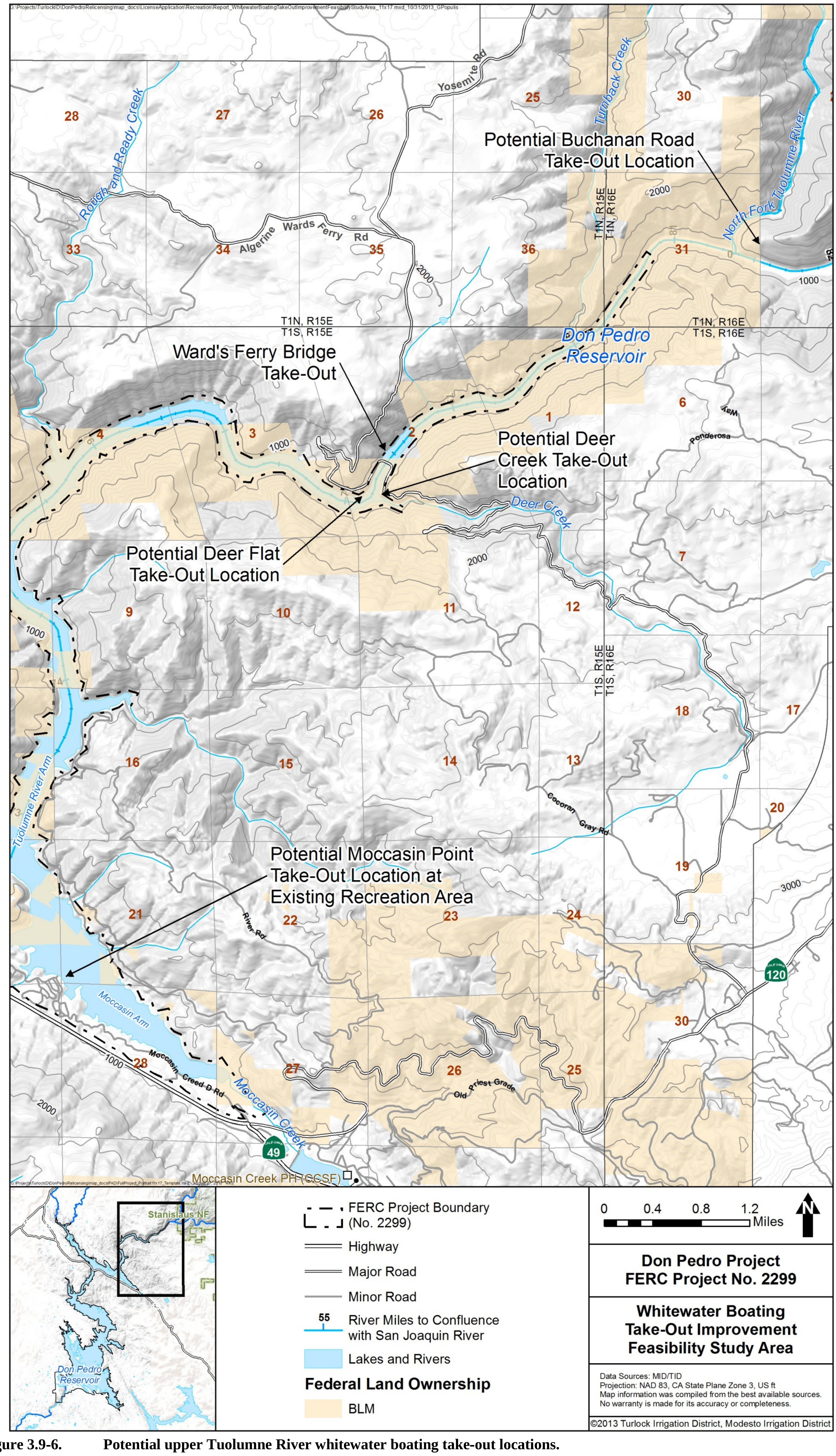

Figure 3.9-6. Potential upper Tuolumne River whitewater boating take-out locations.

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 Project's 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 Project's 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 Project 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 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.

A draft study report was filed with FERC on January 17, 2013 as part of the Districts' ISR. The 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, CA. 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 La Grange, consistent with other findings that the Tuolumne River is generally considered a "gaining" stream.

The 2012 study concluded that 100 cfs is boatable and lower flows would not provide enjoyable boating in inflatable kayaks or any other craft. La Grange gage data for the calendar years 1997[23] through 2012 reported flows were greater than or equal to 100 cfs 94 percent of the time. For the more popular boating season, flow exceeded 100 cfs over 80 percent of the time: May - 100%; June - 84%; July – 86%; August – 90%; September – 85%; and October – 98%. 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

[23] The year 1997 was the first full calendar year following the implementation of the 1996 FERC order adopting new, higher minimum flows for the Project.

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 5 to 8 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 additional volunteer boater study events at flows of approximately 200 cfs, 175 cfs, 150 cfs, and 125 cfs in August and September 2013. A revised study report presenting results of the 2012 and 2013 volunteer boater effort will be filed with the USR.

3.9.1.5 Land Use

The Don Pedro Project Boundary encompasses approximately 18,400 ac. The Districts own in fee title approximately 78 percent of the land within the Project Boundary, and the remaining 22 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 Project 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 Project lands, as well as motorized boat access over Project lands expect at designated boat launches. These rules and regulations are designed to protect and preserve the natural character and integrity of the 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 Project, much of the land is managed by the BLM. Downstream of the 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).

3.9.1.6 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 of the majority of the undeveloped Don Pedro Project shoreline is permitted for both day and overnight use. 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 recreational 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.

FERC's Revised SD2 identified the following recreation and land-use related issues associated with the Project:

- *Effects of water levels in project reservoirs on recreation.*

The Recreation Facility and Public Accessibility, and Public Use study 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 at Fleming Meadows, Blue Oaks, and Moccasin Point. 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 as envisioned under the Base Case does not have an adverse effect on visitor recreation at the Project.

- *Effects of current project operations on public access to project 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 and Public Accessibility, and Public Use study 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 meeting top recreational activities as 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 variety of small roads outside the Recreation Areas. Access is currently viewed as acceptable by the general public. Access to Project waters and recreational opportunities is expected to remain as is, as no change to Project operations is proposed.

- *Effects of project operations on quality and availability of flow-dependent recreation opportunities, including whitewater boating, angling, and wading.*

Project operations do not affect the flows available for whitewater boating, angling or wading in the reaches designated as Wild & Scenic upstream of the Project. Water level fluctuations of the reservoir, by definition, do not affect the Wild & Scenic reaches. The only use of the 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-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 along the river right side. 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. DPRA restricts motorboat use above Ward's Ferry Bridge to minimize this conflict.

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 Districts' draft report on its study of boating on the lower Tuolumne River will be part of the USR (TID/MID 2013c). The FLA will include information on the effects of Project operation to flow-dependent recreation opportunities on the lower Tuolumne River.

- *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. This study included a number of components including:

(1) Inventory and evaluate the developed project 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 project 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 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 project 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 project recreation facilities.

Table 3.9-10. Summary of inventory and evaluation of developed 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 Project 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 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. The marina parking facility experienced over 100 percent occupancy on holidays and weekends in 2012, and overall use is projected to exceed capacity by 2020 as marina users seek to park as close to the marina as possible. Use of the entrance overflow and main lot overflow parking lots are 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 project facilities and is consistent with recreation demands identified in the 2008 CORP (CORP 2008). Use levels through 2050 at the existing 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).

- *Effects of the project operations and maintenance on the condition and use of roads within the 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 Area	gravel	20	2-way in/out	Good

Site	Surface Material	Road Width (ft)	Circulation Type	Condition
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

The continued Project operation is 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).

- *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. 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 and river flows (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 in 2012. 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 2012 study concluded that based on site assessment and preliminary engineering, whitewater take-out improvements at Ward's Ferry Bridge appear to be technically feasible at the river right option and river left option. The Moccasin Point Recreation Area take-out was also identified as a viable option. 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 Districts collect more detailed information on the feasibility of potentially developing whitewater boating take-outs at Deer Creek and Deer Flats, two sites located approximately one-half mile downstream of the Ward's Ferry Bridge. The Districts conducted a site visit with relicensing participants on September 13, 2013 to collect additional information about Deer Creek and Deer Flats. A revised study report with this information included is under development (TID/MID 2013b).

3.9.3 Proposed Environmental Measures

The Districts intend that the DLA describes the base line conditions for, and the effects of, current Project operations under the premise that a thorough evaluation of the Project effects under the Base Case are necessary before resource protection and enhancement measures can be proposed. Therefore, the DLA does not contain any proposed measures for enhancing recreation at the Project. The Districts are evaluating alternatives and may include measures in the FLA.

3.9.4 Unavoidable Adverse Impacts

The Project's creation of a flatwater recreation resource may be considered by whitewater enthusiasts as an unavoidable adverse effect. However, the creation of this flatwater resource draws greater use than the upstream Wild & Scenic whitewater use and creates a different and more diverse suite of recreation opportunities.

3.10 Aesthetic Resources

3.10.1 Affected 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 Project is located in the Sierra foothills region, an area characterized by rolling hills, rural landscapes, native grasslands, and blue oak woodland.

The 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, 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 Project Boundary are owned by TID and MID, with the exception of 4,040 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 (RR-04, TID/MID 2013a) to document current visual conditions of the Project as viewed from BLM lands during various times of the year and identify any adverse visual resource effects due to continued operation of the Project. The objectives of the study were to identify, map, and describe BLM inventories associated with Project facilities and features on land administered by BLM and document the Existing Visual Condition (EVC) of all Project 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.

- 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,
- Don Pedro Spillway, and
- Blue Oaks Recreation Area.

Don Pedro Reservoir is 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.

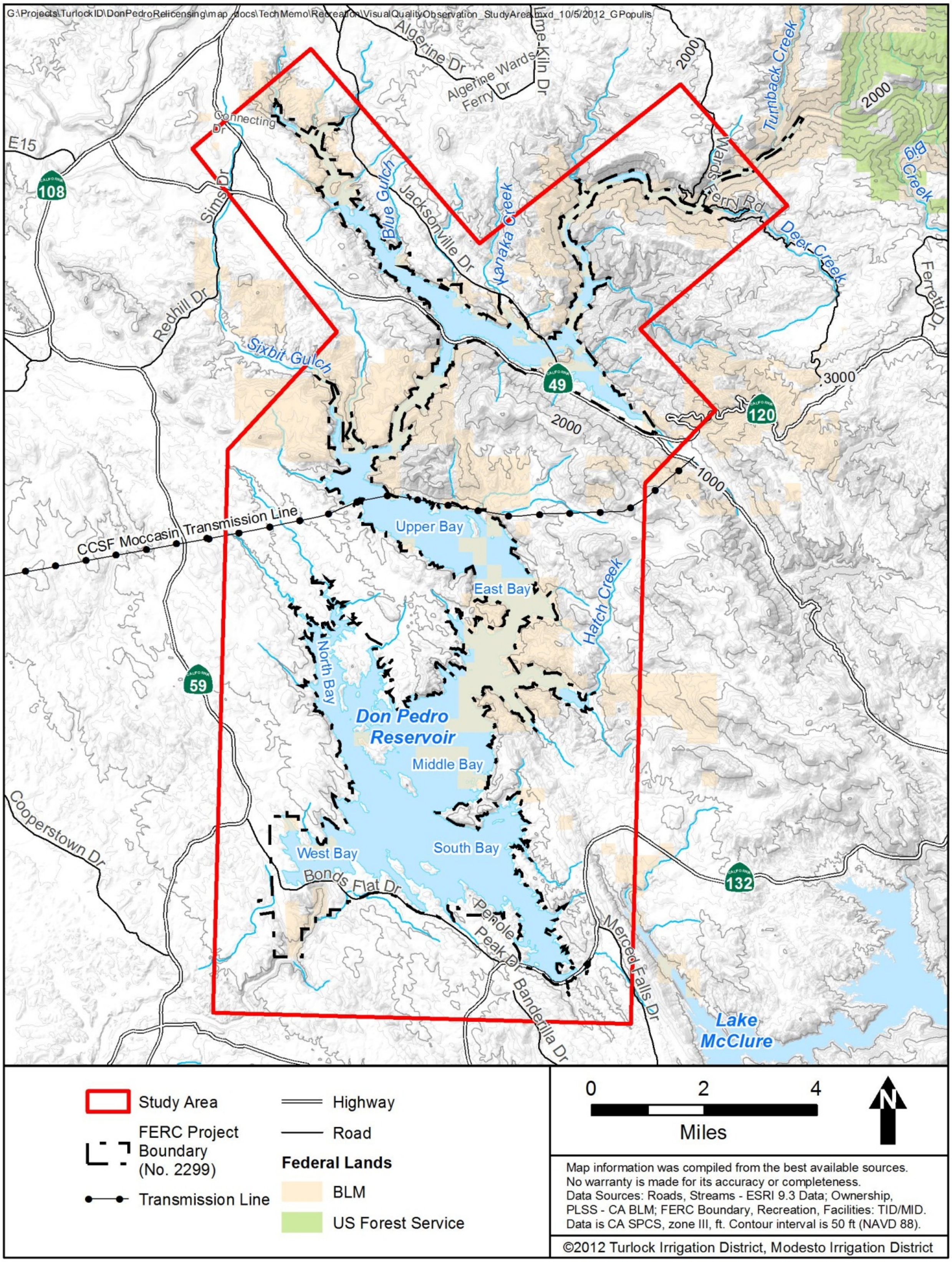

Figure 3.10-2. Visual Quality Study area.

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 takeout, 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 other 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 Project area, immediately adjacent to the Rogers Creek Arm of Don Pedro Reservoir. Although the reservoir can been 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 Project 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 the 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 Project 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 DPRA Headquarters and Visitor's Center or elsewhere in the Project area 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 Recreation Agency Headquarters and Visitor’s Center

The DPRA Headquarters and Visitor’s Center are located adjacent to the dam, and include a viewing platform that provides views of the Project’s facilities. The dam provides a strong visual contrast to the surrounding natural landscape (TID/MID 2013a). A communications tower, water storage tank, and a DPRA maintenance building and yard are also visible from the viewing platform. These also present a strong contrast to the surrounding landscape. The Blue Oaks Recreation Area is visible from the viewing platform but presents only a moderate contrast, even when recreation use is heavy (TID/MID 2013a).

3.10.1.9 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 Project 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).

3.10.1.10 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, DPRA Headquarters and Visitor's Center, 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).

3.10.1.11 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 3.11-11. 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

FERC's SD2 identifies the following potential Project effects on aesthetic resources:

- 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 Project powerhouse and switchyard or other Project facilities. Because the Proposed Action will not change the operation or maintenance activities of the Project, effects on aesthetic resources during the term of the new FERC license will be the same as those described above for existing conditions.

3.10.3 Proposed Environmental 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 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 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 Project or affected by Project operations, including an evaluation of TCP. These investigations substantially added to the existing, information provided in the Districts' PAD. The studies are still underway and scheduled to be completed by the end of February 2014. Theses studies will support the development of a Historic Properties Management Plan (HPMP), a draft of which will be provided in the FLA.

3.11.1 Affected 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 NRHP of 1996, as amended, requires FERC to evaluate potential effects on properties listed or eligible for listing in the NRHP prior to an undertaking. 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 Project. Potential effects that may be associated with this undertaking include any project-related effects associated with the day-to-day O&M of the Project and any new construction activity proposed under the new license. At this time, the Districts have not proposed any new construction activity.

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 the Commission 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 their non-federal representatives for purposes of consultation during relicensing 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, and SHPO, including obtaining SHPO's concurrence on the APE. By letter dated January 9, 2012, SHPO concurred with the Districts proposed APE. Consultation efforts further included six meetings between the Districts and their representatives, interested Tribes, BLM, and SHPO that focused on the collaborative development of study plans and preliminary study results. Representatives from five Tribes, BLM, the 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 to accomplish both 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 Project facilities and formal recreation use areas, (3) within informal recreation use areas identified by the DPRA[24], (4) within the Red Hills ACEC, and (5) along the reservoir edges, including reservoir reaches that contain intermittent and perennial streams. It is possible that studies implemented as part of the relicensing process may identify Project-related activities that have the potential to affect historic properties outside the original APE. It is also possible that during relicensing, Project improvements may be proposed that are outside the original APE. If such areas are identified, the APE will expand to address these other areas or activities.

[24] The FERC approved Historic Properties Study Plan specified that if informal recreation areas were found to extend beyond the 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.

3.11.1.3 Cultural History Overview

The 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.

3.11.1.3.1 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 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).

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 1970-1971, 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 La Grange and Old Don Pedro reservoirs 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.)[25] 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.

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[26]. Testing and/or data recovery, conducted by several entities, 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.

[25] 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).
[26] See Moratto 2002 for a summary of project history, and a bibliography of relevant resultant literature.

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.

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 was developed during the New Melones Reservoir project, located about 12 miles north and west of Don Pedro Reservoir (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). The general chronological sequences described in the following section reflect this new regional chronology.

Table 3.11-1. Archaeological chronology of the West-Central Sierra Nevada developed for the Sonora Region.

Period	Age Range (cal B.P.)[a]	Hydration Range (microns)[b]
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

[a] "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.

[b] Bodie Hills Obsidian; applicable only below 4,000 ft (below snow line). From Rosenthal (2008), based on Rosenthal and Meyer (2004).

3.11.1.3.2 General Prehistoric Chronological Sequence

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.

3.11.1.3.3 Ethnohistory

Ethnographically, the 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 were first contacted by the Spanish in the second part of the eighteenth century in the Sacramento-San Joaquin Valley by explorers (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 miners increased, large mining operations were shut down and Miwok participations 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 immediate vicinity of the Project area include the Chicken Ranch Rancheria of Jamestown, California and the Tuolumne Band of Me-Wuk Indians of Tuolumne, California.

3.11.1.3.4 General Historical Themes

Regional Mining History

Gold mining has captured the fancy and interest of historians and archaeologists for many years. Like every other county along California's Mother Lode, reaching from Mariposa in the south to Auburn in the north, intensive non-Native settlement in Tuolumne County began with its 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 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 important 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, 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 created disastrous problems 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 to rise, resulting in floods that destroyed crops, agricultural fields, and buildings. Fighting back, the farmers were successful in curtailing hydraulic mining 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. Hydraulic mining was effectively ended in California and Tuolumne County. The 1893 Caminetti Act permitted hydraulic mining if debris-impounding dams were constructed, but the construction and maintenance of the dams were 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, 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 did leave 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, water pumps and air power, along with investment of foreign capital, provided for the resurgence of the mining industry in Tuolumne County and the foothills. It was the second boom that more permanently changed the face of the countryside (Clark 1970:7).

Mines 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.

In addition to the Eagle-Shawmut Mine, the Orcutt, Harriman, Mammoth, Republican, Tarantula, Wheeler, and others on the Mother Lode vein near Jacksonville were inundated by the new Don Pedro Reservoir in the late 1960s. Only the concrete footings of the Clio Mine are above the water line and were recorded for this survey. 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 and were also recorded (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 became important producers of placer gold in the early 20th century. They are based on large-scale processing of low-grade placer-bearing gravel. 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 ca. 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, which supplied them with a steady supply of foodstuffs augmented by vegetable gardens and orchards. As the mining economy declined, however, 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. Additionally, county grasslands were used for stock grazing in the past as well as now. Hogs were one of the earlier animals to be raised in the county, since they took little care or consideration. Although most ranches and farms had a few hogs to keep the place clean and provide bacon and ham, few ranchers developed hog operations. Other animals, such as goats, llamas, sheep, chickens, and other poultry have been raised on county ranches and farms over the years, and dairy operations were spread over the county.

Livestock grazing was the primary agricultural industry in the vicinity of the APE, and in the 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 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, however, 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 probably portions of State Route 120. Within Tuolumne County, and the foothills in general, the pattern of roads leading to fords, then ferries, then successive bridge crossings, 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.

<u>Early Wagon Roads</u>

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, historic USGS topographic maps, and others. 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 (ca. 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 ca. 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 dam projects, for which most of the spurs and secondary railroads were built. The railroad was used during the 1920s construction of the Don Pedro Dam project, the Melones Dam project, and the O'Shaughnessy Dam project. 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[27]

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 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.

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. From small ditches built to serve only Columbia, TCWC's system was expanded, lengthened, and improved 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 was to shift from placer mining to hard-rock mining, then to agriculture and finally to domestic use, thus reflecting the changing economic pattern of not only Tuolumne County, but the entire foothill region. One important early ditch of the TCWC, the Algerine Ditch, ran close to the APE, near Sullivan and Curtis Creeks, however 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 in 1871-1872 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

[27] Much of the Tuolumne County Water Company history and La Grange Hydraulic Mining Company history is provided from Marvin and Francis 2012.

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, members of the Turlock and Ceres granges began actively 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: 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 met in June of 1887: W. L. Fulkerth, E. V. Cogswell, R. M. Williams, J. T. Dunn, and E. B. Clark. They quickly decided to establish the TID offices at 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 was hired as district engineer; he 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; when it was held, in October of 1887, only 12 of 188 votes cast opposed the sale. The first sale occurred in November, when

Robert McHenry purchased $50,000 in bonds. Not until 1890, however, were any contracts let for construction.

Concerned with the prospect of lawsuits against the Wright Act, the TID Board commenced a friendly suit before the State Supreme Court to test the legality of the act. The decision, handed down on May 31, 1888, upheld the Wright Act in all respects. TID then set about construction of the La Grange Dam, located about one-and-one-half miles above La Grange, near the site of the 1870s Wheaton Dam. Built as a joint undertaking of the Modesto and TIDs, under an agreement made in August of 1890, the division of water rights in proportion to the number of acres in the respective districts gave Turlock 68.46 percent of the total and Modesto 31.54 percent. The dam was completed by the Pacific Bridge Company in 1893, at a cost of $543,164. It backed up water in the narrow, inaccessible gorge of the Tuolumne River to form La Grange Reservoir, the highest overflow dam in the country and one of the largest in the world at the time of its completion. Most of the design was done by Luther Wagoner, engineer for MID, while E. H. Barton, TID engineer, supervised the construction.

The years following construction of the La Grange Dam were characterized by lawsuits, difficulties in selling bonds and making payroll, and the 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 Reservoir and the system on line, TID began to look for additional storage reservoirs.. In 1910, bonds were passed for construction of reservoirs downstream from the La Grange 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 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). However, TID's hydroelectric generation plan had not yet been carried out. In 1915, TID and MID agreed to build a water-storage dam at the Don Pedro site, and the following year TID Chief Engineer Roy V. Meikle revived the proposal to build a power plant at Hickman Drop; although this plan also would be 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 the history of MID has been closely entwined with that of TID since 1890, when they reached an agreement to construct the La Grange Dam. MID's history has also been written 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 1887, the organizers of MID circulated a petition calling for formation of the District, presenting it to the Board of Supervisors on April 25. Eleven days earlier, however, those opposed to the District had petitioned against the plan. Numerous challenges and court cases led by farmer Christopher Columbus Baker and harness-maker William Tregea over the ensuing years delayed the formation of the District. In November of 1889, however, Justice Minor ruled in favor of the District's organization, a decision immediately appealed by Tregea but upheld by the California Supreme Court in March of 1891 (Barnes 1987:31).

By early 1894, following completion of the La Grange Dam, MID had a means of diverting water from the Tuolumne River but no canals to carry it. Work on the main canal began in April 1890, with 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 completed. 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 brought on by the obstructionists' 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 Dam to the district boundary and into Dry Creek at 7 a.m. on April 3, 1903. It was not until 1904, however, that irrigation formally began, with Oramil McHenry, George Covell, and T. H. Kewin receiving 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 special rail coaches traveled throughout the nation in 1907-08, 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 27th largest producer of crops and livestock in the nation and was second only to Los Angeles County in the pace of growth. By the beginning of the 1920s, the transition of alfalfa to fruit, nut, and vine crops was well on its way.

With increased usage, the need for more water storage became apparent and the district decided to provide its own storage along its main canal below La Grange Dam. The choice was to enlarge 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 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 of expansion of the irrigating facilities and superseding the more temporary types of early construction with permanent and practically indestructible concrete. New headgates, weirs, and diversion points were constructed, and existing canal facilities were replaced and improved (Barnes 1987:55–56).

MID's most important long-range water management program after completion of the La Grange Dam was the concerted effort to line with concrete or divert into underground pipelines all of its main canal, laterals, and ditches. Evaporation and seepage accounted for a loss of 30 percent of the water, while weeds and tules clogged the canals and ground squirrels dug holes in their banks. 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. More work was done by the Works Progress Administration (WPA), and sections of canal were improved. 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, with 58 percent of the goal achieved. By 1960, 81 percent of the work had been completed, and the project was finished by 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, one of MID's largest projects was the construction, first, of the original Don Pedro Dam and Reservoir in 1923 and second, of the new and larger 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. In 1978 MID merged with the Waterford Irrigation District. In 1986, the New Hogan hydroelectric plant and the Coldwater Creek geothermal plant were completed. In 1994, the Modesto Regional Water Treatment Plant began wholesaling water to the City of Modesto, and in 1997 MID expanded electric service to Oakdale, Ripon, and Escalon.

<u>The New Don Pedro Project</u>

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. During this time, the Districts arranged with the CCSF to more fully develop the river's watershed, thus providing for the future requirements of the Districts. 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 Division of Water Resources discussed the feasibility of such a project. 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 project was reached by the three local agencies in November of 1943, and three months later the Corps of Engineers recommended the project 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 Department of Water Resources 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. Interestingly, 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 the Blue Oaks Campground, on lands now managed by the DPRA. Irrigation engineer, Charles Crawford, a 39-year employee of MID, was named as project 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, as planned, 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 employed and the project was 53 percent complete.

The last load of material was delivered May 28, 1970, with TID Chief Engineer Roy Meikle riding shotgun (Barnes 1987:140–143). The new dam began storing water in November 1970, and the portals of the old dam opened for the last time (Barnes 1987:146). Formal dedication ceremonies were held May 22, 1971, when San Francisco mayor Joseph Alioto spoke to an audience of 3,000 of the dam's vision, imagination, and beauty. Total costs of the project were $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), it was the railroad from Stockton to Milton, completed in May 1871 (originally part of the Stockton & Copperopolis Railroad), that 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. Clearly, 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, as they did not want to add this aspect to their management operations. The FPC disagreed and included a recreation requirement in the Project license for the City of San Francisco (with its adjacent Hetch Hetchy project that utilized Tuolumne River water) and the Districts (Paterson 1989:344). This resulted in the creation of the Don Pedro Recreation Area in 1970, which incorporates all lands and water available for recreation use that fall within the federally licensed Don Pedro Project (FERC Project Number 2299). Subsequently, three formal recreation areas were designated and built around the reservoir in the early 1970s and continue to be operated and maintained today much as they were in the 1970s: Fleming Meadows Recreation Area, Blue Oaks Recreation Area, and Moccasin Point Recreation Area.

Recreation activities at the Don Pedro Reservoir are myriad. They include individual and group activities, organized and spontaneous events for both reserved and at-the-gate participants. Motorized and non-motorized boating, houseboating, camping and RV camping, waterskiing and wakeboarding, jet-skiing, fishing (including scheduled bass tournaments), swimming, and hiking are all recreation opportunities available at Don Pedro Reservoir today.

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. Unfortunately fire and weather damage destroyed many of the earliest settlements, and others were later razed before reservoir inundation,[28] abandoned and forgotten (like Poverty Hill #1, Curtisville, and Blanket Creek), or otherwise decreased in importance (Stent, Campo Seco, Second Garrote, Arastraville). 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.

[28] 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.

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 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 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 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 during the Project.

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 area contains numerous prehistoric- and historic-era properties and that some areas within the Project 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.

3.11.1.4.1 <u>Summary of Record Search</u>

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 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 site type, 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 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 0.25mile study area, it appears that many of the historic features identified on the historic maps of the Project area have not been formally recorded as archaeological sites.

3.11.1.5 Results of the Historic Properties Study

To assist FERC in identifying historic properties that may be affected by the Project, as required under Section 106, a comprehensive and intensive field survey of the APE 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.

To date, though the field work has been completed, the Districts are still in the process of analyzing the field data. The Districts are currently working to complete the written documentation of resources identified as a result of the Historic Properties Study and to evaluate those resources that can be evaluated for the NRHP at the inventory level. The Districts are also still working to identify those resources that are being impacted by on-going Project-related effects. As such, the results presented below are preliminary and will be updated in the FLA. Included below are summaries of the archaeological resources and built environment resources that were identified as a result of the field survey of the APE.

3.11.1.5.1 Archaeological Resources

To date, the Districts have identified a total of 245 archaeological sites within the Don Pedro APE, of which at least 17 were previously documented during prior investigations and 228 were newly identified (Table 3.11-2). Of the 245 archaeological sites, 142 contain historic-era deposits and features (two of these represent the Woods Creek Mining Landscape and the Kanaka Creek Mining Landscape), 77 represent prehistoric or Native American use (one of these represents the Tuolumne River Prehistoric Archaeological District) and 26 represent both prehistoric and historic-era occupation. A district or landscape is a type of cultural resource defined as possessing "a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development," (NPS 1995:5). The two mining landscapes and single prehistoric district identified are each comprised of a continuity of archaeological sites. The Kanaka Creek Mining Landscape also includes one built environment resource, which is described under the built resources below.

The types of sites represented in the APE include prehistoric occupation sites, lithic quarry sites, small temporary task locations (lithic retooling, lithic reduction, subsistence procurement and processing, and hunting-related locals), districts/landscapes, and possibly other types of prehistoric or ethnographic occupation. Based on the artifact assemblages recorded during the study, the prehistoric and 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.). The historic sites observed represent the remains of a variety of historic-era land uses, to primarily include 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 1850s and as late as the 1960s.

In addition to the 245 archaeological sites identified, 124 isolated finds were located and documented within the APE. Of the 124 isolated finds, 85 are prehistoric in affiliation and 39 are historic-era isolates.

Table 3.11-2. Summary of archaeological sites identified within the APE.

Count	Temporary Site No.	Primary No./ Trinomial	Site Type	Description	Land Owner
1	HDR-DP-001	--	Prehistoric	A single milling station. Date unknown.	TID/MID
2	HDR-DP-002	--	Historic	A historic road segment. Dates between the late 19th century and the 1960s.	TID/MID
3	HDR-DP-004	--	Historic	Four historic dirt road segments. Dates to pre-1944.	TID/MID
4	HDR-DP-005	--	Historic	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
5	HDR-DP-006	P-55-1902/ CA-TUO-892	Multi-component	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). Prehistoric date unknown. Historic component dates between 1850 and 1960 and may represent either multiple periods of occupation or consistent occupation.	TID/MID
6	HDR-DP-007	--	Historic	Two features: a concrete pad; wooden beam; debris scatter. Dates to the early modern period (late 1960s or later).	TID/MID
7	HDR-DP-009	--	Multi-component	Two historic rock features; single prehistoric lithic flake. Date unknown.	TID/MID
8	HDR-DP-012	--	Historic	Two historic road segments; two metal items; two quartz crystals (natural). Dates to the 1890s.	TID/MID
9	HDR-DP-013	--	Prehistoric	One milling station; lithic scatter (50+ flakes). Date unknown.	TID/MID
10	HDR-DP-014	--	Prehistoric	Lithic scatter (40+ flakes, one handstone, one biface); one quarry feature. Date unknown.	TID/MID
11	HDR-DP-015	--	Prehistoric	Quarry/assay location with lithic scatter (100+ flakes). Date unknown.	TID/MID
12	HDR-DP-016	--	Historic	Nine mining features: four back dirt/tailings piles; three placer scar features; two ditches. Dates to post 1930.	TID/MID
13	HDR-DP-017	--	Historic	Two features: three to four bulldozer scrapes, and a backdirt pile. Date unknown.	TID/MID

Count	Temporary Site No.	Primary No./ Trinomial	Site Type	Description	Land Owner
14	HDR-DP-018	--	Prehistoric	Quarry; lithic scatter (500+ flakes, one battered cobble, one scraper, and one milling slab); one milling station. Date unknown.	TID/MID
15	HDR-DP-019	--	Multi-component	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 late 19th Century/early 20th Century.	TID/MID
16	HDR-DP-020	--	Historic	One feature comprised of about four tailings piles. Date unknown.	TID/MID
17	HDR-DP-021	--	Prehistoric	Quarry/assay location; Lithic scatter (200+ flakes, 20+ assayed cobbles, one spokeshave). Date unknown.	TID/MID
18	HDR-DP-022	--	Historic	Two concrete foundations. Dates to the late 1960s.	TID/MID
19	HDR-DP-023	--	Historic	Nine features: one feature of concrete footings, three bulldozer scrapers, two rock cairns, two prospect pits, a benchmark. Dates to the late 1960s.	TID/MID
20	HDR-DP-024	--	Prehistoric	Lithic scatter (65+ flakes, one core, one handstone, one abrader, one scraper, one chopper); three milling features with possible rock art; Looter's pile. Date unknown.	TID/MID
21	HDR-DP-025	--	Historic	A historic road segment. Dates from pre-1944 to the 1960s.	TID/MID
22	HDR-DP-026	--	Prehistoric	Two loci: lithic scatter and tools (450+ flakes, 20+ fire cracked rock, five handstones, three choppers, two Elko series projectile points, one modified flake, one scraper, one biface). Dates to Middle Archaic period.	TID/MID
23	HDR-DP-027	--	Prehistoric	Three features: two possible hunting blinds; one rock scatter. Date unknown.	TID/MID
24	HDR-DP-028	--	Prehistoric	Three milling stations; lithic scatter (25+ flakes). Date unknown.	TID/MID
25	HDR-DP-029	**P-55-1920/ CA-TUO-910/H, P-55-1921/ CA-TUO-911/H**	Multi-component	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 date is ca. 1870 to ca. 1900s.	TID/MID
26	HDR-DP-030	--	Historic	Two segments of a historic road; three features: a borrow scrape, iron pipe culvert, and earthen dam. Date unknown.	TID/MID

Count	Temporary Site No.	Primary No./ Trinomial	Site Type	Description	Land Owner
27	HDR-DP-031	**P-55-1923/ CA-TUO-913**	Multi-component	Five features: three modern depressions with backdirt piles, two historic bulldozer scrapes; lithic scatter (300+ flakes, two handstones). Prehistoric date is between 550 A.D. (1400 B.P.) and 1450 A.D. (500 B.P.) and historic date is between the 1930s and 1950s.	TID/MID
28	HDR-DP-032	--	Prehistoric	Lithic scatter (300+ flakes, two handstones, one milling slab). Date unknown.	TID/MID
29	HDR-DP-033	--	Prehistoric	Lithic scatter (10 flakes). Date unknown.	TID/MID
30	HDR-DP-034	--	Prehistoric	Lithic scatter (30+ flakes and one handstone). Date unknown.	TID/MID
31	HDR-DP-035	--	Historic	Two pits, a rock alignment, trash scatter. Date unknown.	TID/MID
32	HDR-DP-039	--	Multi-component	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. Prehistoric age unknown. Historic component dates to late 19th Century/early 20th Century.	TID/MID
33	HDR-DP-041	--	Prehistoric	Quarry/assay location; Lithic scatter (100+ flakes, one core). Date unknown.	TID/MID
34	HDR-DP-042	--	Multi-component	Five historic features: three pits and two rock foundations, limited historic trash scatter, lithic scatter (>10 flakes, four cores, one spokeshave, one gouge, two possible digging tools, one hammerstone). Prehistoric date unknown and historic date ca. 1890s to ca. 1900s.	TID/MID
35	HDR-DP-043	--	Prehistoric	Lithic scatter (12 flakes - two are utilized, one scraper, one core, one possible spokeshave). Date unknown.	TID/MID
36	HDR-DP-045	--	Multi-component	Lithic scatter (250+ flakes, two choppers, one modified flake, one utilized flake); transmission line tower foundations. Prehistoric date unknown and historic date 1921-1923.	TID/MID
37	HDR-DP-046	--	Prehistoric	One milling station feature (four cups); lithic scatter (three flakes). Date unknown.	TID/MID
38	HDR-DP-047	--	Prehistoric	One milling station feature (three cups); lithic scatter (two flakes). Date unknown.	TID/MID
39	HDR-DP-048	--	Historic	A rock cairn and prone post. Date unknown.	TID/MID
40	HDR-DP-049	--	Prehistoric	Lithic scatter (eight flakes, one core). Date unknown.	TID/MID

Count	Temporary Site No.	Primary No./ Trinomial	Site Type	Description	Land Owner
41	HDR-DP-050	--	Prehistoric	One quarry feature; lithic scatter (500+ flakes). Date unknown.	TID/MID
42	HDR-DP-051	--	Historic	Windmill remains. Date unknown.	TID/MID
43	HDR-DP-052	--	Historic	Windmill/well remains. Date unknown.	TID/MID
44	HDR-DP-053	--	Multi-component	Transmission tower foundation; Lithic scatter (one pestle, one retouched flake, and three flakes). Prehistoric date unknown and historic date 1921-1923.	TID/MID
45	HDR-DP-054	--	Prehistoric	One quarry feature; lithic scatter (27 flakes). Date unknown.	TID/MID
46	HDR-DP-055	--	Prehistoric	Lithic scatter (six flakes). Date unknown.	TID/MID
47	HDR-DP-056	--	Prehistoric	Lithic scatter (15 flakes). Date unknown.	TID/MID
48	HDR-DP-057	--	Prehistoric	One quarry feature; Lithic scatter (215+ flakes, one core). Date unknown.	TID/MID
49	HDR-DP-058	--	Prehistoric	Lithic scatter (50+ flakes). Date unknown.	TID/MID
50	HDR-DP-060	--	Prehistoric	Lithic scatter (six flakes). Date unknown.	TID/MID
51	HDR-DP-061	--	Prehistoric	Lithic scatter (two loci, 60+ flakes, one retouched flake, one scraper); midden; possible housepit. Date unknown.	TID/MID
52	HDR-DP-062	--	Prehistoric	Lithic scatter (four flakes - one is a possible scrapper, one broken CCS cobble). Date unknown.	TID/MID
53	HDR-DP-063	--	Prehistoric	One milling station feature (three cups); quarried outcrop; lithic scatter (12 pieces of debitage). Date unknown.	TID/MID
54	HDR-DP-064	--	Prehistoric	Lithic scatter (nine flakes). Date unknown.	TID/MID
55	HDR-DP-065	--	Prehistoric	Lithic scatter (100 flakes, one digging tool); a quarried CCS cobble with flake scars. Date unknown.	TID/MID
56	HDR-DP-066	--	Prehistoric	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 periods.	TID/MID
57	HDR-DP-067	--	Prehistoric	Lithic scatter (one flake, two assayed cobbles). Date unknown.	TID/MID

Count	Temporary Site No.	Primary No./ Trinomial	Site Type	Description	Land Owner
58	HDR-DP-068	--	Prehistoric	Lithic scatter (one portable mortar, three pieces of debitage). Date unknown.	TID/MID
59	HDR-DP-069	--	Prehistoric	Lithic scatter/assay location (four pieces of debitage). Date unknown.	TID/MID
60	HDR-DP-070	--	Multi-component	Historic component: three bulldozer scars, one bulldozer mound, one rock pile. Prehistoric component: lithic scatter (two flakes, two chunks of cryptocrystalline silicate with flake scars, one milling slab). Date unknown.	TID/MID
61	HDR-DP-071	--	Prehistoric	Lithic scatter (one modified flake, one chopper, and two flakes). Date unknown.	TID/MID
62	HDR-DP-072	--	Historic	Road segment. Dates to pre-1962.	TID/MID
63	HDR-DP-073	--	Prehistoric	Lithic scatter (one Elko Series projectile point, four cores, and seven flakes). Dates to Middle Archaic period.	TID/MID
64	HDR-DP-074	--	Prehistoric	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
65	HDR-DP-075	--	Prehistoric	Lithic scatter (two cores, one modified flake, and one biface). Date unknown.	TID/MID
66	HDR-DP-076	--	Prehistoric	Lithic scatter (100+ flakes, 50+ tools including choppers, hammerstones, edge modified cores, edge modified flakes, and cores); quarry (cobbles and outcrops across site). Date unknown.	TID/MID
67	HDR-DP-077	--	Prehistoric	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. Date unknown.	TID/MID
68	HDR-DP-078	--	Multi-component	Historic road segment; Lithic scatter (10+ flakes, one modified flake). Prehistoric date unknown. Historic date between 1944 and 1962.	TID/MID
69	HDR-DP-079	--	Historic	A segment of a utility pole line, with 15 pole remnants. Date unknown.	TID/MID
70	HDR-DP-081	--	Historic	Three features: a road/ditch, a placer scrape, an earthen dam. Date unknown.	TID/MID
71	HDR-DP-083	--	Historic	Nine 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
72	HDR-DP-084	--	Historic	Three tailings; two waste rock piles. Date unknown.	TID/MID

Count	Temporary Site No.	Primary No./ Trinomial	Site Type	Description	Land Owner
73	HDR-DP-085	--	Historic	Four placer mining scars; pipe segment. Date unknown.	TID/MID
74	HDR-DP-086	--	Historic	Four features: two pipes, a rock pile, a dug-out mining pit; waste rock/placer tailings; trash scatter. Date unknown.	TID/MID
75	HDR-DP-087	P-55-1913	Historic	Nine features: a dug-out house structure, a modern landmark shrine, two rock wall alignments, a structural foundation, two rock-lined holes, a dug-out spring, a structural depression, a spring box; trash scatter. Dates from the 1850s to the 1930s.	TID/MID
76	HDR-DP-090	--	Historic	Two metal pipes. Dates to the late 1960s.	TID/MID
77	HDR-DP-092	--	Multi-component	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. Prehistoric date unknown and historic dates to 1921-1923.	TID/MID
78	HDR-DP-093	--	Multi-component	One feature with prehistoric and historic petroglyphs (three panels). Prehistoric date unknown. Historic component dates to 1887.	TID/MID
79	HDR-DP-094	--	Historic	Don Pedro Road with two culverts, rock retaining wall; concrete pad; post; bulldozer scrape. Dates to the 1920s.	TID/MID
80	HDR-DP-095	--	Prehistoric	One milling feature (12 cups); one handstone. Date unknown.	TID/MID
81	HDR-DP-096	--	Historic	One feature: radio tower foundation. Dates to the 1950s/1960s.	TID/MID
82	HDR-DP-098	--	Multi-component	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. Prehistoric date unknown. Historic component dates between the 1920s and 1950s.	TID/MID
83	HDR-DP-099	--	Multi-component	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). Prehistoric date unknown and historic dates possibly as early as the 1890s with continued use through the present.	TID/MID
84	HDR-DP-100	--	Historic	Two tailings/waste rock piles; two tailings; two waste rock concentrations; a rock cairn. Dates to late 19th Century/early 20th Century.	TID/MID
85	HDR-DP-101	--	Historic	Two waste rock/tailings piles; one tailings; one depression; trash scatter; standing structure. Dates to late 19th Century/early 20th Century.	TID/MID
86	HDR-DP-102	--	Historic	Three waste rock/tailings concentrations; one tailings; one road segment; 1 one metal artifact; two fence posts. Dates to late 19th Century/early 20th Century.	TID/MID

Count	Temporary Site No.	Primary No./ Trinomial	Site Type	Description	Land Owner
87	HDR-DP-103	--	Historic	One segment of Hetch Hetchy Railroad; stacked rock feature; rock culvert; excavated area. Dates from 1916-1917 to 1949.	TID/MID
88	HDR-DP-104	--	Historic	Three tailings; three waste rock and tailings; one waste rock pile. Dates to late 19th Century/early 20th Century.	TID/MID
89	HDR-DP-105	--	Historic	Cut-off telephone pole; two beer cans. Date unknown.	TID/MID
90	HDR-DP-106	--	Prehistoric	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). Date unknown.	TID/MID
91	HDR-DP-107	--	Prehistoric	Lithic scatter (150+, one biface). Date unknown.	TID/MID
92	HDR-DP-108	--	Historic	Four features: one hearth, one cairn, two waste rock/tailings concentrations. Date unknown.	TID/MID
93	HDR-DP-109	--	Prehistoric	Two milling station features (three cups total); lithic scatter (100+ flakes, one biface). Date unknown.	TID/MID
94	HDR-DP-110	--	Prehistoric	Lithic scatter (14 flakes, one core/scraper). Date unknown.	TID/MID
95	HDR-DP-111	--	Historic	One historic road segment. Dates to pre-1944 through 1960s.	TID/MID
96	HDR-DP-112	--	Prehistoric	Lithic scatter (two flakes, two modified flakes, one biface, one uniface). Date unknown.	TID/MID
97	HDR-DP-113	--	Prehistoric	Nine housepits with possible midden deposits; five milling stations; lithic scatter (50+ flakes, one uniface, one scraper, 100+ fire cracked rock, one bowl mortar fragment). Date unknown.	TID/MID
98	HDR-DP-114	P-55-7353/ CA-TUO-4795H	Historic	Segment of the Don Pedro Spur of the Sierra Railway (one railroad spike, no features or other artifacts). Dates to ca. 1921-1923.	TID/MID
99	HDR-DP-115	--	Prehistoric	Quarry feature; lithic scatter (200+ flakes, 30-60 cores). Date unknown.	TID/MID
100	HDR-DP-116	--	Prehistoric	Five milling station features; lithic scatter (10+ flakes, one scraper). Date unknown.	TID/MID
101	HDR-DP-117	--	Historic	One historic road segment. Date unknown.	TID/MID
102	HDR-DP-118	--	Prehistoric	One milling station feature; lithic scatter (2 loci, 190+ flakes, 1 biface). Date unknown.	TID/MID

Count	Temporary Site No.	Primary No./ Trinomial	Site Type	Description	Land Owner
103	HDR-DP-119	P-55-136/ CA-TUO-336/H	Multi-component	Prehistoric component: thousands of flakes, thousands of fire cracked rocks, several milling stations, midden deposits, numerous lithic tools, possible hearth features, possible remnant housepits, and other sensitive materials. 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 Periods. Historic component dates to late 19th Century/early 20th Century.	TID/MID, BLM
104	HDR-DP-120	--	Historic	Three historic road segments. Date unknown.	TID/MID
105	HDR-DP-122	--	Historic	Four features: one earthen dam with rock retaining wall, one prospect pit, one rock alignment, two prospect trenches; trash scatter. Dates to late 19th Century/early 20th Century.	TID/MID
106	HDR-DP-124	--	Historic	Three prospect pit features; two prospect trench features; one water control feature; waste rock. Date unknown.	TID/MID
107	HDR-DP-125	--	Historic	One historic road segment. Dates to the 1870s.	TID/MID
108	HDR-DP-126	--	Historic	Three prospect trench features; waste rock. Date unknown.	TID/MID
109	HDR-DP-127	--	Prehistoric	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. Date unknown.	TID/MID
110	HDR-DP-128	--	Prehistoric	Two bedrock milling station features (nine cups total); lithic scatter (two flakes, one handstone). Date unknown.	TID/MID
111	HDR-DP-129	--	Historic	Two segments of Morgan's Bar Road. Dates to the late 19^{th} Century.	TID/MID
112	HDR-DP-130	--	Multi-component	One bedrock milling station feature; three prospect trenches; sparse trash scatter (glass, metal, ceramics); lithic scatter (six flakes, one handstone); one historic road segment. Prehistoric date unknown. Historic component dates to the 1890s.	TID/MID
113	HDR-DP-131	--	Prehistoric	10+ possible atlatl weights, some are cached. Date unknown.	TID/MID
114	HDR-DP-133	--	Historic	Nine tailings. Date unknown.	TID/MID
115	HDR-DP-134	--	Multi-component	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). Date unknown.	TID/MID

Count	Temporary Site No.	Primary No./ Trinomial	Site Type	Description	Land Owner
116	HDR-DP-135	--	Prehistoric	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
117	HDR-DP-136	--	Historic	One historic road segment. Date unknown.	TID/MID
118	HDR-DP-137	--	Prehistoric	Lithic scatter (five flakes). Date unknown.	TID/MID
119	HDR-DP-138	--	Historic	Two historic road segments. Date unknown.	TID/MID
120	HDR-DP-139	--	Multi-component	Lithic scatter (10+ flakes, one core, one biface, one handstone); historic trash scatter (bottle glass, ceramics, and a nail). Prehistoric date unknown. Historic component dates to late 19th Century/early 20th Century.	TID/MID
121	HDR-DP-140	P-55-1331/ CA-TUO-306	Prehistoric	Eight bedrock milling stations. Date unknown.	TID/MID
122	HDR-DP-141	--	Prehistoric	Lithic scatter (eight flakes). Date unknown.	TID/MID
123	HDR-DP-142	P-55-1384/ CA-TUO-361	Multi-component	One historic fence segment; two milling stations (five cups) and three pestles. Date unknown.	TID/MID
124	HDR-DP-143	--	Historic	One historic road segment. Date unknown.	TID/MID
125	HDR-DP-144	--	Historic	A historic pipe with 13 access point features. Date unknown.	TID/MID
126	HDR-DP-145	--	Prehistoric	Lithic scatter (70+ flakes, two bifaces, one flake tool, and one Elko Corner-notched point). Dates to Middle Archaic period.	TID/MID
127	HDR-DP-146	--	Historic	One historic road segment. Date unknown.	TID/MID
128	HDR-DP-147	--	Prehistoric	Lithic scatter (four flakes). Date unknown.	TID/MID
129	HDR-DP-148	--	Historic	Three can dumps. Dates to 1920s-1930s.	TID/MID
130	HDR-DP-149	--	Historic	Two water control features; three prospect pits. Date unknown.	TID/MID
131	HDR-DP-150	--	Historic	Two segments of a historic road. Date unknown.	TID/MID

Count	Temporary Site No.	Primary No./ Trinomial	Site Type	Description	Land Owner
132	HDR-DP-151	--	Prehistoric	Three milling station features; lithic scatter (100+ flakes, two handstones, one biface, two cores, two cached pestles, two cobble tools, one flake tool). Date unknown.	TID/MID
133	HDR-DP-152	--	Historic	Five wooden fence posts. Date unknown.	TID/MID
134	HDR-DP-153	--	Historic	Two segments of an historic road; three railroad ties and a metal can. Date unknown.	TID/MID
135	HDR-DP-154	--	Historic	Three segments of a historic road. Date unknown.	TID/MID
136	HDR-DP-155	--	Prehistoric	Lithic scatter (four flakes, four handstones). Date unknown.	TID/MID
137	HDR-DP-156	--	Historic	One historic road segment. Date unknown.	TID/MID
138	HDR-DP-157	P-55-3913 or P-55-3193	Historic	One feature: an iron wheel encased in concrete; a large encased metal pipe, metal debris. Dates to the 1920s-1930s.	TID/MID
139	HDR-DP-158	--	Prehistoric	Three groundstone artifacts and one flake tool. Date unknown.	TID/MID
140	HDR-DP-159	--	Historic	One historic road alignment. Date unknown.	TID/MID
141	HDR-DP-160	--	Historic	Two historic road segments. Date unknown.	TID/MID
142	HDR-DP-161	--	Historic	Two segments of an historic road. Date unknown.	TID/MID
143	HDR-DP-162	P-55-1927/ CA-TUO-917	Multi-component	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 period. Historic component dates to 1860s-1950s.	TID/MID
144	HDR-DP-163	--	Historic	One historic prospect trench; two tailings piles. Date unknown.	TID/MID
145	HDR-DP-164	P-55-1925/ CA-TUO-915	Prehistoric	Lithic scatter (two flakes, one core). Previously identified milling station with 14+ mortars was not observed and likely inundated during current recordation. Date unknown.	TID/MID
146	HDR-DP-165	--	Historic	One historic road segment. Dates to pre-1870 through at least 1907.	TID/MID

Count	Temporary Site No.	Primary No./ Trinomial	Site Type	Description	Land Owner
147	HDR-DP-166	--	Historic	One historic road segment. Date unknown.	TID/MID
148	HDR-DP-168	--	Historic	One historic road segment. Date unknown.	TID/MID
149	HDR-DP-170	--	Historic	One historic rock wall. Date unknown.	TID/MID
150	HDR-DP-171	--	Historic	A collapsed mine entrance; an adit; two concrete structures; trash scatter. Date unknown.	TID/MID
151	HDR-DP-172	--	Historic	One historic road segment. Date unknown.	TID/MID
152	HDR-DP-173	--	Historic	Two features: one prospect pit, one prospect trench. Date unknown.	TID/MID
153	HDR-DP-174	--	Historic	One segment of a historic ditch. Date unknown.	TID/MID
154	HDR-DP-175	--	Historic	One historic road segment. Dates from pre-1907 through the 1940s.	TID/MID
155	HDR-DP-176	--	Historic	One pit with dirt pile. Date unknown.	TID/MID
156	HDR-DP-177	--	Historic	One historic road segment. Dates to pre-1907.	TID/MID
157	HDR-DP-178	--	Historic	Four utility pole posts. Date unknown.	TID/MID
158	HDR-DP-179	--	Historic	One concrete foundation; one quartz tailing pile. Date unknown.	TID/MID
159	HDR-DP-180	--	Historic	One historic road segment; six prospect trenches. Date unknown.	TID/MID
160	HDR-DP-181	--	Historic	One segment of a historic road. Dates to pre-1907 to post-1945.	TID/MID
161	HDR-DP-182	--	Historic	Three historic road segments; dumped car. Dates to ca. 1920s – 1930s.	TID/MID
162	HDR-DP-183	--	Historic	Historic mining complex with eight features. Date unknown.	TID/MID
163	HDR-DP-184	--	Historic	One historic road segment. Date unknown.	TID/MID
164	HDR-DP-185	--	Historic	Two stacked erosion control features; one railroad tie. Date unknown.	TID/MID

Count	Temporary Site No.	Primary No./ Trinomial	Site Type	Description	Land Owner
165	HDR-DP-186	--	Prehistoric	Lithic scatter (three handstones, two pestles, one millings slab, one flake). Date unknown.	TID/MID
166	HDR-DP-187	--	Historic	One mining trench; one tailings pile. Date unknown.	TID/MID
167	HDR-DP-188	--	Historic	Two features: one trench, one tailings pile. Date unknown.	TID/MID
168	HDR-DP-189	--	Multi-component	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 date unknown and historic dates to 1902.	TID/MID
169	HDR-DP-190	--	Historic	One prospect trench. Date unknown.	TID/MID
170	HDR-DP-192	P-55-1363/ CA-TUO-340	Prehistoric	One rock shelter, midden, two bedrock milling stations; Lithic scatter (30+ flakes, 60+ cobble tools, 40+ groundstone tools). Date unknown.	TID/MID
171	HDR-DP-193	--	Historic	Concrete foundations, waste rock pile, possible entrance point into the underground Hetch Hetchy Aqueduct. Dates to the 1920s.	TID/MID
172	HDR-DP-195	--	Prehistoric	One milling station feature (one mortar cup) and one handstone. Date unknown.	TID/MID
173	HDR-DP-196	--	Prehistoric	Tuolumne River Prehistoric Archaeological District. Dates primarily from the Middle Archaic period to contact period.	TID/MID, BLM
174	HDR-DP-250	--	Multi-component	Placer mining complex; prehistoric milling station. Historic component dates to late 19th Century/early 20th Century. Prehistoric date unknown.	TID/MID, BLM
175	FW-DP-02	--	Historic	Utility line. Dates to the early 20th Century.	TID/MID
176	FW-DP-03	--	Prehistoric	Lithic Scatter. Date unknown.	TID/MID, BLM
177	FW-DP-04	--	Prehistoric	Lithic Scatter. Date unknown.	TID/MID, BLM
178	FW-DP-05	--	Prehistoric	Lithic Scatter. Date unknown.	TID/MID, BLM
179	FW-DP-06	--	Prehistoric	Lithic Scatter. Date unknown.	TID/MID, BLM
180	FW-DP-10	--	Historic	Ditch near Taco House site. Dates to late 19th Century/early 20th Century.	TID/MID, BLM
181	FW-DP-11/12	--	Historic	Ditch, Raggio parcel. Date unknown.	TID/MID, BLM

Count	Temporary Site No.	Primary No./ Trinomial	Site Type	Description	Land Owner
182	FW-DP-13	--	Historic	Road to Ferretti property. Dates to ca. 1870s to 1940.	TID/MID, BLM
183	FW-DP-16	--	Historic	Road - Old Sonora to Big Oak Flat Road. Dates to ca. 1850s to 1930s.	TID/MID, BLM, Private
184	FW-DP-17	P-55-6021	Multi-component	Prehistoric midden and lithic scatter with lithic flakes and tools, shell and glass beads, and other sensitive materials. Historic component consists of concrete foundation remnants for a former restaurant – the Taco House. Historic component dates between ca. 1930s and 1970. The prehistoric component dates as late as the contact period.	TID/MID, BLM
185	FW-DP-18	--	Multi-component	Habitation site with sensitive materials and a historic artifact scatter. Date of prehistoric component is unknown. Historic component dates to ca. 1850s – 1880.	TID/MID
186	FW-DP-20	--	Historic	Ditch. Dates between the 1850s and 1890s.	TID/MID, BLM
187	FW-DP-21	--	Historic	Temporary camp with prospect. Date unknown.	TID/MID, BLM
188	FW-DP-22	--	Historic	Mining - Dredge Area. Dates between the 1920s and 1942.	TID/MID, BLM
189	FW-DP-24	--	Historic	Jacksonville to Big Oak Flat Road. Dates to the 1880s – 1900s.	TID/MID, BLM
190	FW-DP-25	--	Historic	Utility line. Dates to the early 20th Century.	TID/MID, BLM
191	FW-DP-26	--	Historic	Ditch West of Steven's Bar. Date unknown.	TID/MID
192	FW-DP-30/31	--	Historic	Mining - Hard rock mining complex. Dates between the 1850s and 1940s.	TID/MID, BLM
193	FW-DP-32	--	Historic	Bulldozed structure. Date unknown.	TID/MID, BLM
194	FW-DP-33	--	Historic	Ditch near Jacksonville. Dates between the 1850s and 1900.	TID/MID, BLM
195	FW-DP-34/35/36/63	--	Historic	Jacksonville area roads. Dates to late 19th Century/early 20th Century.	TID/MID, BLM
196	FW-DP-37/38	--	Historic	Don Pedro and Indian Bar Road. Dates between the 1860s to the 1900s.	TID/MID, BLM
197	FW-DP-39	--	Historic	Road. Date unknown.	TID/MID
198	FW-DP-40	--	Historic	Ranch Road. Date unknown.	TID/MID, BLM

Count	Temporary Site No.	Primary No./ Trinomial	Site Type	Description	Land Owner
199	FW-DP-41	--	Historic	Hatch Creek Road. Dates to the latter half of the 19th Century.	TID/MID, BLM
200	FW-DP-42	--	Historic	Ditch, Brown Adit area. Dates to ca. 1850s.	TID/MID, BLM
201	FW-DP-43	--	Prehistoric	Habitation site. Dates to the Middle Archaic period.	TID/MID
202	FW-DP-44	--	Historic	Hetch Hetchy Power line. Date unknown.	TID/MID, BLM
203	FW-DP-45	--	Historic	Marsh Flat Road. Dates from the 1870s to the present.	TID/MID, BLM, Private
204	FW-DP-46	P-55-3227/ CA-TUO-2253H	Historic	Brown Adit site. Dates between 1926 and 1928.	TID/MID, BLM
205	FW-DP-47/48/51/52	--	Historic	Tuolumne Canyon Road. Date unknown.	TID/MID, BLM
206	FW-DP-50	--	Historic	Clio Mine. Dates to ca. 1850s to 1942.	TID/MID, BLM, Private
207	FW-DP-53	--	Historic	Kanaka Creek mining landscape. Dates between the 1850s and 1930s.	TID/MID, BLM, Private
208	FW-DP-54	--	Historic	Ditch above Kanaka Creek Cabin. Date unknown.	TID/MID, Private
209	FW-DP-55	--	Historic	Hard Rock mining site. Date unknown.	TID/MID, BLM
210	FW-DP-56	--	Historic	Ditch West of Stevens Bar. Date unknown.	TID/MID, BLM
211	FW-DP-58	--	Historic	Ditch with reservoir in Kanaka Creek Landscape. Date unknown.	TID/MID, BLM
212	FW-DP-59	--	Historic	Kanaka Creek Road. Date unknown.	TID/MID, BLM
213	FW-DP-61	--	Historic	Ditch. Date unknown.	TID/MID, BLM
214	FW-DP-64	--	Historic	Ditch. Dates between the 1850s and 1860s.	TID/MID, BLM
215	FW-DP-65	--	Historic	Woods Creek placer mining complex with habitation area. Dates to the latter half of the 19th Century.	TID/MID, BLM
216	FW-DP-66	--	Historic	Ditch. Date unknown.	TID/MID, BLM

Count	Temporary Site No.	Primary No./ Trinomial	Site Type	Description	Land Owner
217	FW-DP-68	--	Prehistoric	Milling station. Date unknown.	TID/MID, BLM
218	FW-DP-69	--	Historic	Placering area. Dates from 1848 to the 1850s.	TID/MID, BLM
219	FW-DP-70/71	--	Historic	Woods Creek Mining Landscape. Dates from 1848 to the 1880s.	TID/MID, BLM, Private
220	FW-DP-72	--	Prehistoric	Two milling stations. Date unknown.	TID/MID
221	FW-DP-73	P-55-3877/ CA-TUO-2893H	Historic	Ward's Ferry Road. Dates from 1850 to the 1980s.	TID/MID, BLM
222	FW-DP-74	--	Historic	Ward's Ferry Bridge Abutments. Dates to 1875.	TID/MID
223	FW-DP-75	--	Historic	Old River Road. Date unknown.	TID/MID, BLM
224	FW-DP-76	--	Historic	McCormick River Mine. Dates from 1914 to ca. 1940s.	TID/MID, BLM, Private
225	FW-DP-77	--	Historic	Road (recorded from boat - too steep). Date unknown.	TID/MID, Private
226	FW-DP-78	P-55-1351/ CA-TUO-326	Prehistoric	Habitation site previously excavated. Contact period site dating as late as ca. 1850s-1900s.	TID/MID, BLM
227	FW-DP-79	--	Historic	Utility line. Dates to the early 20th Century.	TID/MID
228	FW-DP-80	--	Historic	Road by Kanaka Creek cabin. Date unknown.	TID/MID, Private
229	FW-DP-81	P-55-1909/ CA-TUO-899 P-55-1908/ CA-TUO-898	Prehistoric	Occupation site with milling stations. Date unknown.	TID/MID, BLM
230	FW-DP-82	--	Historic	Road. Date unknown.	TID/MID, BLM
231	FW-DP-83	--	Historic	Ditch. Dates between the 1850s and the 1940s.	TID/MID, BLM
232	FW-DP-84	--	Historic	Road. Date unknown.	TID/MID, BLM

Count	Temporary Site No.	Primary No./ Trinomial	Site Type	Description	Land Owner
233	FW-DP-85	--	Multi-component	Historic mining complex with a prehistoric lithic scatter. Date of the prehistoric component is unknown. Historic component dates between the 1850s and the 1940s.	TID/MID, BLM
234	FW-DP-86	--	Prehistoric	Lithic scatter. Date unknown.	TID/MID, BLM
235	FW-DP-87	--	Historic	Ditch with rock-work. Date unknown.	TID/MID
236	FW-DP-88	--	Historic	Ditch. Date unknown.	TID/MID
237	FW-DP-89	--	Historic	Road. Date unknown.	TID/MID, Private
238	FW-DP-91	--	Historic	Ditch. Date unknown.	TID/MID
239	FW-DP-92	--	Historic	Raggio Parcel across from Taco House. Dates between the 1850s and 1900s.	TID/MID, BLM
240	FW-DP-93	--	Historic	Earlier alignment of Grizzly Road. Dates from ca. 1940s to the 1960s.	TID/MID, Private
241	FW-DP-94	--	Historic	Woods Creek placer mining complex. Dates from ca. 1850s to the present.	TID/MID, BLM, Private
242	FW-DP-95	--	Historic	Woods Creek placer mining complex with habitation areas. Dates from the 1850s to the 1880s.	TID/MID, Private
243	FW-DP-96	--	Historic	Woods Creek placer mining complex. Dates from the 1850s to the 1880s.	TID/MID, BLM
244	FW-DP-97	--	Historic	Woods Creek placer mining complex. Dates from the 1850s to the 1880s.	TID/MID, BLM
245	FW-DP-98	--	Historic	Woods Creek placer mining complex with habitation area. Dates from the 1850s to the 1880s.	TID/MID, BLM

3.11.1.5.2 Built Environment Resources

Forty-one built environment resources were identified within the APE, including two proposed historic districts. As described above, a district is defined as possessing “a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development,” (NPS 1995:5). Also, as is stated above, the Districts have not yet completed NRHP evaluations of any of these built environment resources, thus only a brief summary of these resources is provided here. The 41 built environment resources identified within the APE have been grouped into nine categories: [29]

(1) Don Pedro Project dam system resources (15),

(2) Don Pedro Project dam construction-related resources (1),

(3) Don Pedro Project operations support resources (10),

(4) Don Pedro Project recreation-related resources (4),

(5) Don Pedro Project Historic District (1),

(6) DPRA Historic District (1),

(7) TID and MID Transmission Lines (2),

(8) California Department of Transportation highway bridges (3), and

(9) other Non-Project resources (4).

Each of these resource groups are discussed below, starting with the Don Pedro Project dam system resources.

Don Pedro Project Dam System Resources

The Don Pedro Project dam system has 15 individual features that include the dam system, spillways, dikes, powerhouse, switchyard, substations, and reservoir. They are listed in Table 3.11-3below.

Table 3.11-3. Don Pedro Project dam system resources.

Building/Structure Field Designation	Date	Architectural Style	Designer
Don Pedro Dam FR-1	1970	None	Bechtel
Dam Spillways (2) HDR-1a Gated and HDR-1b Un-gated;	1969	None	Bechtel
Dikes (4) HDR-2a Dike A, HDR-2b Dike B, HDR-2c Dike C and HDR-2d Gasburg Creek Dike	1968 to 1970	None	Bechtel
FR-2 Powerhouse	1968 to 1971	None	Bechtel
FR-3a Switchyard	1970 to 1971	None	Bechtel

[29] The following resource groups are comprised of non-Project built environment resources (i.e., are not Project facilities) identified within the APE: TID and MID Transmission Lines, California Department of Transportation highway bridges, and Other Non-Project resources.

Building/Structure Field Designation	Date	Architectural Style	Designer
FR-4 Power Tunnel	1970	None	Bechtel
FR-5 Outlet Works/Diversion Tunnel	1968	None	Bechtel
HDR-3 Unit 1 Substation	1970	None	Bechtel
HDR-4 Unit 2 Substation	Circa 1972	None	Bechtel
HDR-5 Cable Hoist Building/Inclined Gate Track	1970	None	Bechtel
FR-6 Reservoir	1970	None	Bechtel

Don Pedro Project Dam Construction-Related Resources

Extant Don Pedro Project dam construction-related facilities are limited to one remaining built environment feature, a powder house, listed in Table 3.11-4. This resource is associated with the former Atkinson construction camp, now the Blue Oaks Recreation Area campground. Following completion of the new Don Pedro Dam in 1971, the construction camp buildings were demolished, leaving behind building foundation archaeological features and this one standing feature.

Table 3.11-4. Don Pedro Project dam construction-related resources.

Building/Structure Field Designation	Date	Architectural Style	Designer
HDR-6 Guy F. Atkinson Company construction camp powder house (Blue Oaks Campground)	1967-1968	Utilitarian	Bechtel

Don Pedro Project Operations Support Resources

The Don Pedro Project operations support infrastructure resource group involves 10 features presented in Table 3.11-5. The dam storage yard warehouse is a singular feature associated with a maintenance yard. The Riley Ridge Microwave Building and Towers has three features: the 1970s building and tower, and a more modern, larger tower. This group also includes five identical employee houses and a water tank at Riley Ridge.

Table 3.11-5. Don Pedro Project operations support resources.

Building/Structure Field Designation	Date	Architectural Style	Designer
HDR-8 Dam Storage Yard Warehouse	1970–1971	Utilitarian	Bechtel
HDR-9 Riley Ridge Microwave Building and Towers (1 building and 2 towers)	1970–1971	Contemporary	James W.B. Shade-Turlock (?)
HDR-10 Riley Ridge Employee Housing House 1 (5 houses in total)	1971–1972	Contemporary	James W.B. Shade-Turlock
HDR-11 Water Tank Riley Ridge	1971	Utilitarian	Clair A. Hill & Associates

Don Pedro Project Recreation-Related Resources

There are a total of four Don Pedro Project recreation-related resources. These resources are all operated or provided oversight by DPRA. DPRA is an agency that is operationally a department within TID and sponsored by the Districts and CCSF. Table 3.11-6 lists the four resources in this group. They include the DPRA headquarters and visitor center, and each of the three recreation areas: Blue Oaks, Fleming Meadows, and Moccasin Point. The buildings and features located at the Blue Oaks, Fleming Meadows, and Moccasin Point recreation areas are a combination of representative buildings (ones that are repetitive, standardized examples) and unique examples. The DPRA has standardized plans for the recreation areas which resulted in repetitive building forms. As such, only representative samples of repetitive buildings and structures such as comfort stations, entrance stations, fish cleaning stations, and boat ramps have been fully documented and used to describe the rest of these repetitive buildings/structures that are present. All buildings/structures within each recreation area have been included as features within their respective recreation area. Unique features encountered during the survey such as the Fleming Meadows Swimming Lagoon complex, and the Fleming Meadows Trading Post and Marina were fully documented.

Table 3.11-6. Don Pedro Project recreation-related resources.

Building/Structure Field Designation	Date	Architectural Style	Designer
HDR-12 Headquarters and Visitor Center	1972	Pole	Caywood, Nopp, Takata, Hansen, and Ward of Sacramento
HDR 13 Moccasin Point Recreation Area	1972	Pole	Clair A. Hill & Associates/Caywood, Nopp, Takata, Hansen, and Ward of Sacramento
HDR-14 Blue Oaks Recreation Area	1972	Pole	Clair A. Hill & Associates/Caywood, Nopp, Takata, Hansen, and Ward of Sacramento
HDR 15 Fleming Meadows Recreation Area	1972	Pole	Clair A. Hill & Associates/Caywood, Nopp, Takata, Hansen, and Ward of Sacramento

Don Pedro Project Historic District

This district is made up of those built environment elements that are associated with the construction, operation, and infrastructure of the Don Pedro Project as a hydroelectric generation and water storage project. Elements of this district include the resources found in the following resource groups (N=26): Don Pedro Project dam system resources, Don Pedro Project dam construction-related resources, and Don Pedro Project operations support resources. These resources were built between 1967 and 1972 and almost all of them are still in use today and function as they were originally intended.

Don Pedro Recreation Agency Historic District

This district is made up of those built environment elements that are associated with recreation activities at the Project. Elements of this district include all four of the Don Pedro Project recreation-related resources documented in the APE, which were all built in 1971-1972 for the sole purpose of formal Project-related recreational activities. This built environment district is associated with the Bay Region Tradition architectural style and the 1960s/1970s wave of new recreation facilities built in California around a number of large reservoirs created for water storage and hydroelectric power generation, such as that created for Lake Shasta near Redding, California.

TID and MID Transmission Lines

This resource group includes two transmission lines that extent from the switchyard near the powerhouse (see Table 3.11-7, below). These lines are not part of the facilities licensed by FERC as the Don Pedro Project. One line is owned by TID, while the other is owned by MID.

Table 3.11-7. TID and MID transmission lines.

Building/Structure Field Designation	Date	Architectural Style	Designer
FR-3b TID (east)/ FR-3c MID (west) transmission lines	1970 to 1971	None	Bechtel

California Department of Transportation Highway Bridges

This group has three resources listed in Table 3.11.8 below. The higher elevation reservoir water levels produced by the new Don Pedro Project built in the late 1960s/early 1970s required construction of three new highway bridges that fall within the APE. These included the James E. Roberts Memorial Bridge, Jacksonville Road Bridge, and Ward's Ferry Road Bridge.

Table 3.11-8. California Department of Transportation highway bridges.

Building/Structure Field Designation	Date	Architectural Style	Designer
HDR-7 James E Roberts Highway 120/49 Bridge 320018	1971	Steel girder	James E. Roberts Caltrans
FR-7 Moccasin Point-Jacksonville Road Bridge 32C0057	1970	Steel girder	Bechtel
FR-8 Ward's Ferry Road Bridge 32C0012	1972	Steel girder	Bechtel

Other Non-Project Resources

There are four non-Project built environment resources. They include (1) FW-DP-57, a cabin with an associated trash deposit on Kanaka Creek; (2) FW-DP-08, the La Grange Ditch by the Don Pedro Dam; (3) the Hetch Hetchy Aqueduct Red Mountain Bar siphon which has been previously recorded as CA-TUO-2928H by CSU Stanislaus personnel; and (4) a rubble stone building associated with a 1890s hardrock gold mining operation located on the Moccasin Creek arm of the Don Pedro Reservoir. This last resource was recorded as a feature of an archaeological site also described above in the section summarizing the archaeological resources identified within the APE.

3.11.1.6 Results of the Native American Traditional Cultural Properties Study

Beginning in 2011 and continuing through 2013, the Districts' consultant has been implementing the Native American TCP Study approved by FERC in order to identify TCPs within the APE. 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" [National Register Bulletin 38 (Parker and King 1998:1)]. 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 Project location and may be able to offer intellectual knowledge of places important to local Native American groups. To date, the Districts' consultant for this study has conducted close to 20 interviews with Tribal representatives 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 Project. Two field visits with Tribal representatives and Tribal elders to archaeological sites and other locations of importance to Tribal participants have also been conducted.

To date, no cultural resources eligible for the NRHP and meeting the definition for TCPs or locations of traditional or religious importance have been identified within the Don Pedro Project APE. However, the TCP study has not yet been completed and the Districts' consultant for the study is still working to complete the TCP identification efforts and subsequent NRHP evaluations, if needed, according to the procedures laid out in the FERC approved TCP study plan.

3.11.2 Resource Effects

Studies to determine the NRHP eligibility of cultural resources in the APE are ongoing, thus no historic properties have yet been identified. The continued O&M of the Project may potentially affect historic properties, if any are identified. 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 Project activity in combination with other non-Project activities). Certain Project O&M activities also may affect historic properties outside the Project Boundary.

Adverse effects are activities that may alter those characteristics of a 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 project that removes the windows or doors of a 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 Project facilities and roads, maintenance to historic buildings or other structures, vegetation management activities, recreational site use, issuance of grazing leases, and erosion caused by wave action and fluctuating water levels of the reservoir. In addition, certain kinds of Project-related activities may not have a direct impact on historic properties, but may create the conditions by which damage occurs. For example, a Project road may not directly impact historic properties, but may enable public access to areas that do contain these resources.

By contrast, there are 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 Project O&M activities. For example, the continued use of a paved Project 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 Project reservoir and no where near any other Project facility or within the vicinity of Project O&M activities. Subsequently, Project O&M activities may not adversely affect these historic properties.

The following sections describe in more detail some of the activities in the APE that may affect historic properties. At this time, the Districts have not yet determined which on-going Project-related effects are impacting historic properties within the APE. These details will be provided in the FLA.

3.11.2.1 Routine Operation and Maintenance of Buildings and Structures

The Project's hydroelectric operating system includes dams, powerhouses, penstocks, etc., 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 projects 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.

3.11.2.2 Reservoir Fluctuation

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.

3.11.2.3 Vegetation Management

Routine management of vegetation within the Project area is necessary to maintain safe distance between Project transmission line conductors and poles and the adjacent vegetation, or with other facilities within the APE. Additionally, hazard trees adjacent to or within the boundaries of historic properties may need to be trimmed or cut down to comply with California Public Resources Code 4293. However, timber felling, skidding of downed trees, and use of harvesting equipment all have the potential to affect historic properties.

3.11.2.4 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.

3.11.2.5 Road Maintenance, Construction and Use

Numerous road maintenance and construction activities have the potential to affect historic properties. Dirt access roads within the Project 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.

3.11.2.6 Recreation

Recreational activities common in the Project area 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.

3.11.2.7 Emergency Repairs

Emergency repairs to Project 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.

3.11.2.8 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. The more accessible historic properties are to public traffic, the more likely they are to be affected by vandalism. Archaeological sites that have been impacted by looting in the past are prone to additional looting. Such vandalism is often related to a site's proximity to recreation areas rather than the operation of the Project.

3.11.3 Proposed Environmental Measures

The Districts plan to develop a HPMP in consultation with the Tribes, BLM, and SHPO to manage potential effects on historic properties throughout the term of any new license. 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; routine monitoring of known cultural resources, and periodic review and revision of the HPMP.

3.11.4 Unavoidable Adverse Impacts

To determine whether Project-related O&M is resulting in, or has the potential to result in unavoidable adverse effects on historic properties, the Districts will develop a plan for NRHP evaluations to be included in the HPMP, in consultation with Tribes, BLM, and SHPO. Further, the HPMP will provide for a schedule and plan for managing adverse effects to historic properties caused by Project-related O&M, should any affected historic properties be identified.

3.12 Socioeconomic Resources

The Don Pedro Project is essential to the central San Joaquin Valley. The Project's primary purpose is to provide irrigation water to more than 200,000 ac of highly productive farmland, drinking water to residential and business customers, storage for flood management, recreation, and protection of anadromous fisheries,[30] and the Project provides low cost, non-polluting electrical power. In addition, the Project provides important benefits to the Bay Area by allowing operational flexibility in CCSF water supply system. As a part of the relicensing process, the Districts conducted a thorough analysis of the socioeconomic effects of the Project (TID/MID 2013a). The primary goals of the Socioeconomics Study were to quantify the baseline economic values and socioeconomic effects of current Don Pedro Project operations. As the Don Pedro Project is primarily a water supply project serving regional agriculture, municipal, and industrial water users, any changes in Project 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 2013a) to be filed with the Districts' USR in December 2013.

3.12.1 Affected Environment

The Don Pedro Project has many positive direct and indirect economic effects on the entire regional economy within Stanislaus, Merced, and Tuolumne counties. With low cost, 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 Project also provides reasonable M&I water supplies that are essential to meet population and business growth in the area. Surface water from the Project in both types of use helps reduce the use of groundwater supplies which frequently have been over drafted historically.

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 Project. The 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.

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 21,300 total jobs and $820.2 million in total annual labor income.

Table 3.12-1. Regional economic benefits – summary ($millions per year).[1,2]

Activity	Output		Labor Income		Employment	
	Direct	Total	Direct	Total	Direct	Total
Directly Supported Activities						
Crop Production	$567.0	$918.3	$179.1	$294.5	4,526	7,655
Recreation Spending	$6.2	$9.7	$1.9	$2.9	80	108
Hydropower	$24.7	$31.2	$7.5	$9.5	28	81
Subtotal	*$597.9*	*$959.2*	*$188.5*	*$306.9*	*4,634*	*7,845*
Forward Linkages						
Dairy Production	$929.8	$1,183.8	$43.5	$116.9	4,004	6,047

[30] Flood control and fishery-related benefits are not included as part of this economic evaluation.

Activity	Output		Labor Income		Employment	
	Direct	Total	Direct	Total	Direct	Total
Crop Processing	$405.6	$599.9	$52.3	$104.4	721	1,867
Dairy Processing	$1,408.6	$2,064.5	$131.8	$292.0	1,923	5,500
Subtotal	*$2,744.1*	*$3,848.1*	*$227.6*	*$513.3*	*6,648*	*13,414*
Total Economic Benefits						
Total	**$3,341.9**	**$4,807.3**	**$416.0**	**$820.2**	**11,282**	**21,259**

[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).
Source: TID/MID 2013a (based on IMPLAN modeling).

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 dairy farms 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 almost $1.5 billion of annual output to the local economy, including $567 million in crop production and $930 million in dairy farm output. Overall, considering all crop and dairy production, the two counties are ranked fifth and sixth within the state in terms of gross value of agricultural production. In addition to supporting about 8,530 on-farm (direct) jobs, crop and dairy farms in the Districts' service areas support an additional 5,170 off-farm jobs in a broad spectrum of industries throughout the area. 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 irrigation water 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 through the Project has been critical to the success of agriculture. And with the development of agriculture has gone the concurrent development of a plethora of industries which both support and are supported by agriculture. Consequently, the $1.5 billion in annual gross agricultural production within the Districts' service areas supports an additional $3.219 billion in annual output, taking into account both the industries which support and which are supported by production agriculture.

The $567 million of annual farmgate crop production in the Districts' service areas generates approximately $81.3 million annually in farm profit.[31] Farmgate value is calculated as the product of quantity of crop produced and price, summarized over all crops. Farm profits are calculated by subtracting from farmgate value all associated costs. Profits are the main determinant in whether land is retained in production or is converted to non-agricultural purposes. Relative to the estimated average total annual use of surface water and ground water for the two Districts, farm profit averages more than $106 per AF. The reliability and cost of water from the Project are both important factors in this profitability.

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).[32] 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, e.g., consistent annual deliveries of high quality surface water and sufficient groundwater supplies through recharge by 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. With those supplies, the two counties are regularly among the largest 10 most productive agricultural counties in California.

3.12.1.2 Municipal and Industrial Use

In addition to agriculture, the 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 Project water as a substitute for ground water supplies. And the CCSF, with 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.

Project water is also integral to conjunctive use programs in the region. Until 1995, all M&I water supplies were taken from groundwater pumping. Concerns over both overdraft and water quality led to the development of an agreement between MID, whereby the City of Modesto purchases surface water supplies from MID. M&I water demands are likely to increase with further population growth and economic development in the region.

The value of M&I water supplies is less easily estimated than that for agriculture. As noted, 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

[31] These figures relate to crop production only and do not include dairy farms.

[32] 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.

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[33]) 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 Project 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.

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 108 jobs, respectively.

Table 3.12-2. Regional economic benefits – recreation visitation at DPRA ($millions).[1,2]

Metric	Direct	Indirect	Induced	Total
Output	$6.2	$1.8	$1.7	$9.7
Labor Income	$1.9	$0.5	$0.5	$2.9
Employment	80	14	14	108

[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 2013a (based on IMPLAN modeling).

3.12.1.4 Hydropower Generation

Another of the many important benefits which the Project provides is hydroelectric generation. The facility provides an average of 622,440 MWh of clean, low cost energy per year (1997-2012). 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. The hydroelectric facility is particularly important in helping to meet peak power needs, especially during high-demand summer days.

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.

[33] Includes both fixed (capital) and variable (operating) costs associated with groundwater pumping.

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 2013b, FERC 2013.

3.12.1.5 Land Values

Land values, particularly agricultural land values, are affected by the availability of affordable water and electricity from the Project. Irrigators who have access to low cost and reliable water supplies, other factors equal, will be more profitable than those who do not have such access. 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; and because net income is higher, other factors equal, with lower than with higher 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

Region/Land Use	Land Value ($/acre)		
	Low	High	Average
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

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, and
- Water supply effects on SFPUC 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.

The environmental resources of the Don Pedro Project include large agricultural resources, M&I uses, recreational uses, hydropower production, and land value. There are currently no proposed measures to change Don Pedro Project operations. The socioeconomic effects on the CCSF are not analyzed as a part of this Exhibit.[34]

3.12.3 Proposed Measures

No environmental measures are proposed in the DLA that specifically address socioeconomic resources as several studies are still underway.

3.12.4 Unavoidable Adverse Impacts

The Don Pedro Project has no known unavoidable adverse effects on socioeconomic resources.

[34] CCSF indicated that it would prepare a socioeconomic study of the effects of any 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. If available, results of this study will be referenced in the FLA.

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 to 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 positive 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 to the Tuolumne and San Joaquin rivers may include hydropower operations, water storage and diversions for irrigation and municipal and industrial (M&I) water supply, historical and ongoing gravel and gold mining activities, 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 continued operation and maintenance of the Don Pedro Project to be (1) water resources, (2) aquatic resources including anadromous fish and their habitat, (3) geomorphology 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 downstream scope extended to the confluence of the Tuolumne and San Joaquin rivers. The temporal scope included past and present actions and reasonably foreseeable actions that could occur over the next 30 to 50 years.

There are eight dams and reservoirs on the Tuolumne River and its tributaries, with a combined storage capacity of about 2,777,000 AF. Six of these dams are located upstream of the Don Pedro Project (TID/MID 2011a, page 5-60, Vol. II). One main stem dam, La Grange Diversion Dam, is located approximately two miles downstream of the Don Pedro Project. The lower Tuolumne River below the La Grange Dam is directly affected by the operations of La Grange Dam, the Districts' non-project diversion dam[1] used to divert water into the Districts two irrigation canals. Therefore, all flow-related effects of the Don Pedro Project downstream of the La Grange Diversion Dam are, by definition, cumulative effects. This includes flows released for flood flow management purposes because the effects of higher flows on resources are influenced by prior channel modification, floodplain development and encroachment, and flow management targets established by the Corps of Engineers to protect the Modesto area and locations farther downstream on the San Joaquin River. Resources cumulatively affected, and the actions

[1] 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."

resulting in these cumulative effects, are addressed in this Section 4.1 - 4.5 of the license application.

4.1 Actions In and Outside of the Tuolumne River Basin

4.1.1 Summary of 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 which contribute to the cumulative effects. 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 the cumulative effects to the four resource areas identified in FERC's Scoping Document. A map of the San Joaquin River basin and Delta is provided in Figure 4.1-1.

The information available on each of these potential contributors to cumulative effects to the four resource areas identified by FERC varies greatly, ranging from very little (e.g., early to mid 1900s commercial and sport harvest) to large volumes of study (recent Delta juvenile and smolt survival studies). In this section, specific operations and maintenance activities of the Don Pedro Project are identified that may contribute to cumulative effects, then other activities affecting the Tuolumne River are described, and finally out-of-basin actions are described.

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
La Grange Dam	1893
Irrigation diversion begins	1901
Modesto Reservoir Dam	1911
Turlock Lake Dam	1914
Eleanor Dam	1918
Old Don Pedro Dam	1923
O'Shaughnessy Dam (Hetch Hetchy) (206,000 AF)	1923
Priest Dam	1923
Early Intake	1924
Hetch Hetchy Aqueduct completed; exports to San Francisco begin	1934
O'Shaughnessy Dam raised (360,000 AF)	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	
Old Melones Dam	1926
Friant Dam, completed in 1942	1942

Action	Date
Madera Canal completed in 1945	1945
Friant-Kern Canal completed in 1951	1951
Jones Pumping Plant	1951
Delta-Mendota Canal	1951
Delta Cross-Channel	1951
Hidden and Buchanan Projects	1962
Los Banos Detention Dam	1965
Little Panoche Detention Dam	1966
B.F. Sisk Dam	1967
O'Neill Pumping Plant	1967
William R. Giannelli Pumping-Generating Plant	1967
San Luis Drain	Halted in 1975
New Melones Dam	1983
San Felipe Division	1964 - 1987
State Water Project	
Harvey O. Banks Pumping Plant	1968
Edmonston Pumping Plant	1971
Pyramid Dam	1973
Castaic Dam	1973
Warne Powerplant	1982
Alamo Powerplant	1986
Coastal Branch Aqueduct	1997
Upper San Joaquin River	
Mendota Dam	1871
Sack Dam (seasonal 1870s-1945)	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
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 (also in CVP section)	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

Action	Date
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
Large-scale agriculture and livestock grazing begins in region	Mid 1800s

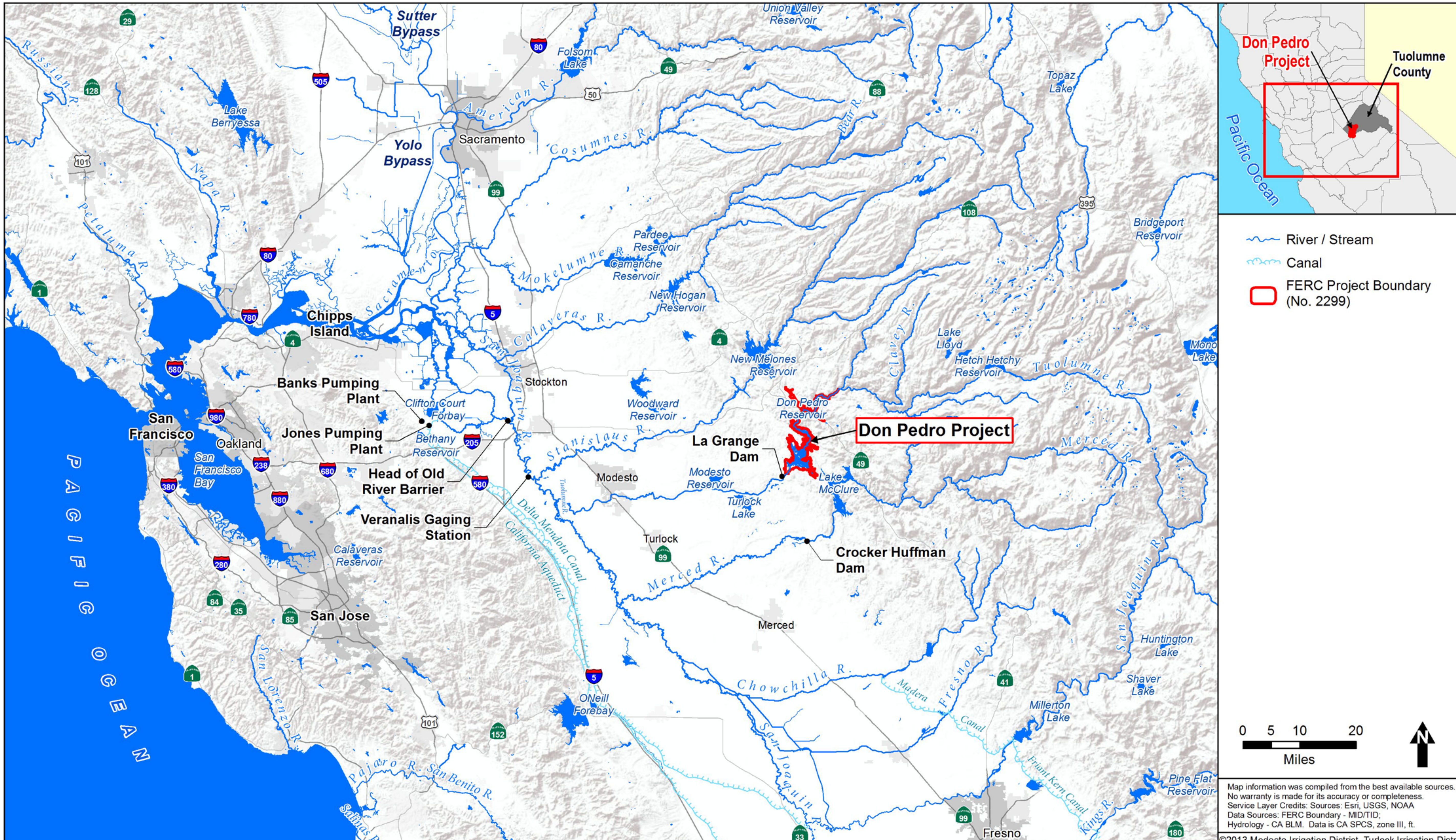

Figure 4.1-1. Map of the San Joaquin River basin and Delta.

4.1.2 Don Pedro Hydroelectric Project: Cumulative Effects of the Proposed Action

4.1.2.1 Project Dam and Reservoir

Don Pedro Dam is a 1,900-foot-long and 580-foot-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. Under normal operations of the hydroelectric units, the powerhouse tailwater elevation varies from about 300 ft to about 305 ft. The tailwater elevation at the outlet works tunnel is approximately 300 ft. In a typical year, the Don Pedro Reservoir water level peaks in late June/early July after the end of the snowmelt season, and reservoir water surface elevation is steadily drawn down over the summer and fall to serve water supply and lower Tuolumne River fish protection needs. Rainfall and snowmelt runoff resume from December to as late as June/early July during wet years.

The proposed action being considered by FERC in this licensing proceeding is whether, and under what conditions, to authorize the Districts to continue generating hydroelectric power at the Don Pedro Project. Operation of the hydroelectric facilities at the Don Pedro Dam is an important, but secondary, function of the Project. The primary purposes of the Project are to provide water storage to meet the needs of irrigation and M&I water users, and providing for flood management in accordance with the ACOE flood control manual. Don Pedro Reservoir contributes to cumulative effects to resources in the lower Tuolumne River by impeding the downriver transportation of bedload and LWD derived from the Tuolumne River watershed. Gravel and LDW recruitment from the portions of the watershed above CCSF's Hetch Hetchy dams are also impeded. The CCSF dams impede bedload and LWD transport from approximately 680 mi^2.of the 1300 mi^2, or 52 percent, of the Tuolumne River watershed above Don Pedro Reservoir. Therefore, primary contributors to potential effects to the lower Tuolumne River related to gravel recruitment and LWD from upstream sources are the Don Pedro and Hetch Hetchy system dams.

4.1.2.2 Timing and Magnitude of Flow Releases

Water is released from the 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 meet the license requirements for flows to 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; delivery of water to meet irrigation, municipal, and industrial needs; providing recreation opportunities; and providing scheduled releases for the protection of anadromous and resident fish in the lower Tuolumne River. 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 to meet downstream needs.

Flows released at Don Pedro to meet the Districts' irrigation and M&I water demands are all diverted from the Tuolumne River at La Grange Dam to the TID and MID canal systems. The Districts possess senior water rights in the Tuolumne River. These flows are diverted out of the

Tuolumne River at La Grange Dam. Diversions for irrigation purposes can occur year round, but generally from late February to early November. Therefore, Don Pedro operations contributes to cumulative effects in the lower Tuolumne River by storing water which is then scheduled for release; however, under base line conditions, the direct effects to resources in the lower Tuolumne River are due to the diversion of water from the river at La Grange Dam, and not the operations of Don Pedro Project. From 1971 to 2012, the average annual water diversion at La Grange Dam to the Districts canals has been approximately 900,000 AF.

Flows released at Don Pedro 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 aquatic resources protection purposes. The ACOE guidelines call for making 340,000 AF of storage available for management of high flow conditions. Flow releases for high flow management purposes from March to July are affected by diversions at La Grange Diversion Dam for water supply purposes. High flows on the Tuolumne River are affected by the operation of the upstream Hetch Hetchy system. The resulting water elevations and water velocities in the lower Tuolumne River during high flows are affected by past and present in-channel and overbank mining, levee development, agricultural development on the floodplain, and urban development, particularly in Modesto. Flow releases for high-flow management purposes may occur from November to July. Water levels in Don Pedro Reservoir have exceeded the normal maximum water level of 830 ft only once since Project construction, in early January 1997.

In addition to flood storage reservation within the reservoir, downstream flow restrictions also affect 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 area of the Tuolumne River basin 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 to be intercepted by Don Pedro Reservoir, pre-flood releases may be made to reduce the risk of having to release greater flows at a later time.

Between La Grange 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 northeast of the Project. It is a flashy watershed, and once its soil is saturated any rainfall results in rapid runoff. Significant flows, on the order of 6,000 cfs or higher, can occur when significant rainfall occurs between Modesto and the upper end of the Dry Creek watershed. Because these flows from Dry Creek come in above the USGS’s Tuolumne River 9th Street river gage, they must be taken into account when making releases from Don Pedro Reservoir to the lower river to avoid exceeding 9,000 cfs.

CCSF participated financially in the construction of the current Don Pedro Dam. In return for this financial participation, the CCSF obtained up to 570,000 AF of water banking privileges in Don Pedro Reservoir, which allows the CCSF to improve its overall water supply management system for its Bay Area water users. CCSF pre-releases water from its upstream facilities into the water bank in the 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' water rights. Once the water enters Don Pedro Reservoir, the water belongs to the Districts, and the Districts have unrestricted entitlement to its use.

Prior to its construction, it was recognized that the new Don Pedro Project was necessary for the protection of Tuolumne fall-run Chinook salmon because the original Don Pedro reservoir built in the early 1920's, which had no downstream release requirements, would spill less and less water as CCSF increased its exports to the Bay Area. The FPC, predecessor agency of FERC, recognized that fisheries releases to the lower Tuolumne River, when combined with rising CCSF diversions, could ultimately undermine the economic feasibility of the new Don Pedro Project. To balance those factors, FPC's 1964 decision set normal-year releases for fish of 123,210 AF for the first 20 years, and 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. The current version of these classifications is described in Section 3.4, Water Quantity and Quality, of this DLA.

The settlement agreement and license order also specified certain pulse flows for the benefit of upstream migrating adult salmon and downstream migrating juveniles, the amount of which also 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.

4.1.2.3 Hydroelectric Power Production

Electric power is generated at the Don Pedro 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 requirements, to release flows with a preference for on-peak rather than off-peak hours. Hydroelectric generation at the Don Pedro Project does not impact any of the potentially cumulatively affected resources identified by FERC, except socioeconomics, because the flows released are not done so for purposes of power production and, absent power production at the Don Pedro Dam, these flows would be released on essentially the same schedule. The socioeconomic effect of power generation is a positive one due to it being a low cost source of energy and not a source of greenhouse gases.

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.

4.1.2.4 Other Project-Related Actions

4.1.2.4.1 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 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 Project lands, as well as motorized boat access over Project lands except at designated boat launches. These and other rules ensure that over 90 percent of the reservoir shoreline remains in its natural condition. These actions are not likely to have an effect on any cumulatively affected resources identified by FERC.

4.1.2.4.2 Herbicide and Pesticide Applications near Don Pedro Reservoir

The DPRA applies herbicides and pesticides to certain land areas at the Project. To control ground squirrels, a pesticide is applied in early spring or late fall as needed in the areas of developed recreation facilities. Pre- and post-emergent herbicides are used to treat invasive plants at campsite pads and road edges. Other areas treated with herbicides and pesticides include areas 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. These actions are not likely to contribute to have an effect on any cumulatively affected resources identified by FERC.

4.1.3 Non-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 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. Dates for completion of construction of select impoundments are also provided in Table 4.1-3. A brief discussion of past development activities and uses of Tuolumne River water is provided in Section 3.5.1 of the Districts' PAD.

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)

Owner	FERC Project No.	Stream	Dam or Diversion Dam	Reservoir or Impoundment Name (date completed)	Capacity (AF)
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	2,033,000
TID MID	None	Tuolumne River	La Grange Dam	La Grange Dam Reservoir	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	Unknown

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 the District's Turlock Lake

Owner	FERC Project No.	Powerhouse	Location / Description
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

4.1.3.1 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). The primary purposes of these projects is to provide water storage for purposes of water supply and hydropower generation. CCSF stores and diverts water from the upper Tuolumne River for use outside of the Tuolumne River basin. CCSF provides potable water to approximately 2.6 million Bay Area residents and serves much of the Bay Area's commercial, manufacturing, and industrial enterprises. The Hetch Hetchy system includes the San Joaquin Pipeline (SJPL) which transports about 85 percent of the CCSF's total water supply needs. 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 of the upper Tuolumne River to the San Francisco Bay Area is about 465 cfs. The average annual use is about 230,000 AF, or about 12 percent of the average annual runoff.[2]

CCSF's Hetch Hetchy operations may contribute to cumulative impacts to the four resource areas identified by FERC in its Scoping Document. Through the out-of-basin transfer of significant volumes of water, CCSF operations contribute to the cumulative effects to water resources of the Tuolumne and San Joaquin rivers, and the Bay-Delta. CCSF operations also affect the timing and volume of releases to the main stem Tuolumne River, and therefore contributes to cumulative effects to aquatic resources and essential fish habitat. By trapping bedload and LWD from over 650 mi^2 of the upper Tuolumne River watershed, the Hetch Hetchy facilities contribute to cumulative effects on the Tuolumne River's geomorphological processes, which also contributes to impacts on aquatic resources in the Tuolumne River. The Hetch Hetchy water supply system and hydropower generation contribute significantly to the socioeconomic welfare of CCSF's 2.6 million customers in the San Francisco Bay Area.

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. Water flow to the hatchery is estimated to be about 15 million gallons per day (23 cfs) or about 11,000 AF per year. Water from the hatchery is discharged into Moccasin Creek. Water from Moccasin Reservoir also feeds the CCSF's Foothill Tunnel.

[2] For the period 1987 - 2012.

4.1.3.2 Dam and Reservoir Operations Downstream of the Don Pedro Project

Water flows from the Don Pedro powerhouse or outlet works discharge into the Tuolumne River and about one mile downstream enter the La Grange impoundment. At La Grange 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 Tuolumne 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 other sluice gates associated with the La Grange facilities.

La Grange Dam is located near the border of Stanislaus and Tuolumne counties at RM 52.2. Originally constructed between 1891 and 1893, the primary purpose of the dam is to raise the level of the Tuolumne River to permit the diversion of water from the Tuolumne River to the Districts' canal systems by means of gravity. TID and MID combined forces to build the dam to divert streamflows the Districts had rights to in the Tuolumne River. The La Grange Dam has been serving this basic purpose and function for approximately 120 years. The La Grange Dam replaced the Wheaton Dam built by other parties in the early 1870s. La Grange Dam was constructed at the downstream end of a narrow, steep-sided canyon. The canyon walls contain the present day La Grange Reservoir. La Grange is operated as a run-of-river facility with little fluctuation of its pool. When not in spill mode (above elevation 296.5 ft, which occurs about 30 percent of the time), the pool operates between elevation 296 ft and 294 ft about 90 percent of the time. The amount of storage in this two-foot operating band is less than 100 AF of water. 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 the La Grange Dam.

The operation of La Grange Dam directly effects the flows in the lower Tuolumne River and has since 1893. Therefore, La Grange operations directly effects water resources, aquatic resources and EFH, geomorphological resources, and socioeconomics. The direct effects resulting from La Grange operations occur whenever all flows, except FERC-required minimum flows, are diverted to meet the needs of the Districts' water users. During flood management periods that coincide with water diversions, La Grange operations contribute to cumulative effects in the lower Tuolumne River. During solely flood management periods, La Grange does not contribute to either direct or cumulative effects on water or aquatic resources of the lower Tuolumne River. La Grange Dam historically may have contributed to direct effects on gravel recruitment to the lower Tuolumne River, and currently may contribute to cumulative effects to gravel recruitment. La Grange Dam through its diversions contributes direct and cumulative effects to socioeconomics.

4.1.3.3 Riparian Diversions Downstream of Don Pedro Project

There are 26 points of unscreened riparian water diversion along the lower Tuolumne River between La Grange Dam and the San Joaquin River, and four unscreened riparian diversions along Dry Creek (Figure 4.1-2). There are numerous riparian 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.

4.1.3.4 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 2013a, Attachment A).

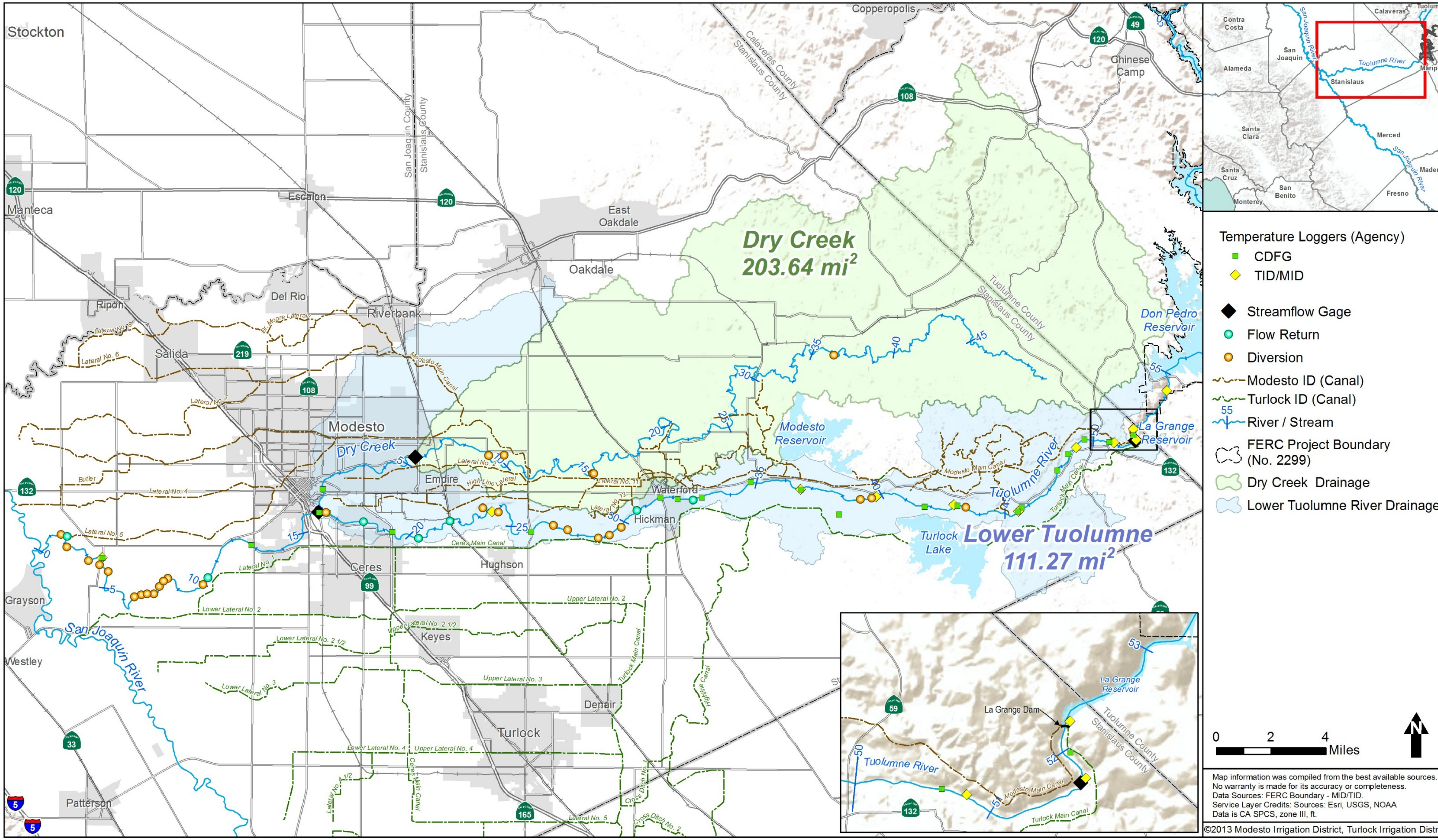

Figure 4.1-2. Locations of riparian diversions along the lower Tuolumne River and Dry Creek.

4.1.3.5 Resource Extraction, Land Development, and Land Use Practices Along the Tuolumne River

4.1.3.5.1 In-Channel and Floodplain Mining

Mining-related impacts to the mainstem of the Tuolumne River corridor began with the California Gold Rush in 1848. A historical timeline of mining activities in the San Joaquin River's tributaries, including the Tuolumne, (McBain and Trush 2000) 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). Decades of dredge mining in the main channel of the Tuolumne River resulted in the excavation of channel and floodplain sediments and 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 Project are gold and gravel. The Columbia and Springfield placer mining operations northwest of the Project produced approximately $55,000,000 in gold prior to 1899 (TID/MID 2011a. 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 Project had a long history of production prior to 1941, and two plants are currently processing stone from these deposits (TID/MID 2011a). 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 Project vicinity (TID/MID 2011a). Most of the chromite came from the McCormick Mine, located northwest of the Project. 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 Project (TID/MID 2011a).

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 2011a). 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 mining residual dredger tailings upstream of RM 45 were removed from the floodplain downstream of La Grange 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.

The past in-channel mining has resulted in the replacement of the river channel with a series of large ponds/pools, referred to as Special-Run Pools (SRPs). There are nine active SRPs along the river, extending from RM 51 (SRP 1) to RM 25.25 (SRP 10), and including SRPs at RM 45, 44, 41, 30/31, 28/29, 27, and 26 . These SRPs are primarily located in the gravel-bedded reach of the lower Tuolumne River, which coincides with the preferred spawning habitat for Chinook salmon and O.mykiss. The SRPs also form preferred habitat for non-native species that prey on fry juvenile salmonids. Therefore, past in-channel aggregate mining has contributed significantly to cumulative effects on geomorphology and aquatic resources of the lower Tuolumne River. The same is true of floodplain mining, i.e., by modifying the natural floodplain of the river and removing local sources of gravel recruitment.

4.1.3.5.2 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 2013b). 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 and row crops (RM 24.0 - 40) and livestock grazing (RM 40 - 51) (McBain & Trush 2000).

Timber operations were in existence throughout the Sierra Nevada range 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 and 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.

4.1.3.5.3 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 through the lower San Joaquin River and Delta. 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 2013b).

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. The Sonora WWTP accounts for about 11 percent of the phosphorus input (TID/MID 2011a). Urban runoff to the lower Tuolumne River from the Modesto area has been shown to contain pesticides (Dubrovsky et al. 1998). A total of fifteen pesticides were detected, and chlorpyrifos, diazinon, DCPA, metolachlor, and simazine were detected in almost every sample (Dubrovsky et al. 1998).

The Central Valley Regional Water Quality Control Board (CVRWQCB) has issued various Cleanup and Abatement Orders for the Tuolumne River and its tributaries (TID/MID 2011a). 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.

4.1.3.6 Fish Hatchery Practices

The following paragraphs relate to fish hatchery practices as they pertain specifically to the Tuolumne River and Don Pedro Reservoir. For a more in-depth discussion of hatchery practices in the State of California, see Section 4.1.4.7, Hatchery Practices, of this DLA.

Fall-run Chinook salmon are raised at five major Central Valley hatcheries, which release more than 32 million smolts each year. Due to concerns over population size and hatchery influence, the Central Valley fall/late fall-run Chinook salmon is a Species of Concern under the federal Endangered Species Act. Hatchery origin fish contribute disproportionately to the salmon runs of the Central Valley (Barnett-Johnson et al. 2007, Johnson et al. 2011), and adipose-fin clipped fish from hatcheries have been found at high levels in Tuolumne River carcass surveys in some years (e.g., TID/MID 2005; TID/MID 2012, Report 2011-8). Recent studies have provided local evidence of high rates of straying into the Tuolumne River resulting from off-site hatchery releases by the Merced River Fish Facility and Mokelumne River Hatchery (Mesick 2001; ICF Jones & Stokes 2010).

CDFW manages the Don Pedro Reservoir fishery as a put-and-grow resource with substantial stocking and appropriate fishing regulations. As part of its Inland Salmon Program, CDFW generally plants rainbow trout (*O. mykiss*), kokanee (*O. nerka*), and land-locked Chinook salmon in Don Pedro Reservoir annually. Don Pedro Reservoir is also managed by CDFW as a year-round fishery for black bass. No known fish stocking has occurred in the reach of the Tuolumne River between Don Pedro Dam and La Grange Dam (TID/MID 2013d).

4.1.3.7 Freshwater Salmonid Harvest

The 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 2013c). 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.

4.1.3.8 Non-Native Fish Species

Of the 22 non-native fish species documented in the lower Tuolumne River, 18 were introduced by state or federal agencies (CDEW, NMFS, USFWS, and the State Board of Human Health) between 1874 and 1954, and one was introduced with permission from CDFW in1967 (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. Largemouth and smallmouth bass were first released in California by CDFW between 1874 and 1891 (Dill and Cordone 1997; TID/MID

1992). 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, black and white crappie, warmouth, bigscale logperch, western mosquitofish, and inland silversides.

4.1.3.9 Tuolumne River Fisheries Management and Recovery Activities

4.1.3.9.1 Native Salmonid Management and Recovery Programs

The Ecosystem Restoration Program[3] 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.

The draft Central Valley Salmon and Steelhead Recovery Plan (NMFS 2009a) 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 this DLA 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-

[3] (http://www.dfg.ca.gov/ERP)

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.

4.1.3.9.2 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 (Completed in 2003),
  - Gravel Mining Reach Phase II (Not completed),
  - Gravel Mining Reach Phase III (Not completed), and
  - Gravel Mining Reach Phase IV (Not completed).
- Predator Isolation Projects:
  - Special Run-Pool (SRP) 9 (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):
  - Riffle Cleaning (Fine sediment) (Not completed),
  - Gasburg Creek basin (Fine sediment) (Completed prior to 2008),
  - Gravel Augmentation (Coarse sediment) (Not completed), and
  - River Mile 43 (Coarse sediment) (Completed in 2005).

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.

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 2013c). 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).

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 from 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 of planted vegetation 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 concerning tributary restoration projects and for 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[4] is designed to improve the ecological health of the Bay-Delta watershed through restoring and protecting habitats and ecosystem functions.

4.1.4 Non-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

[4] (http://www.dfg.ca.gov/ERP)

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 present day Delta encompasses about 60,000 acres of open water surface (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.

4.1.4.1 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.

4.1.4.2 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. USBOR 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 is described in the following subsections. The effects associated with operation of these projects, in concert with operation of other facilities, are addressed in Section 4.1.4.2.

4.1.4.2.1 Central Valley Project

The CVP 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). USBOR 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. USBOR 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 (USBOR 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[5]

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 USBOR.

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 salt water 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 river 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.

[5] Source: http://www.usbr.gov/projects/Project.jsp?proj_Name=Central+Valley+Project

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 USBOR, 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 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[5]

The New Melones Dam and Power Plant are located on the Stanislaus River, about 60 miles upstream from 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 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 USBOR in 1979 for integrated operation as part of the CVP. The Oakdale and South San Joaquin Irrigation Districts own and operate the downstream Goodwin Diversion Dam, which diverts water from the Stanislaus River into the districts' canals.

The New Melones Dam, originally designed for flood control, has provided significant flood control benefits by averting the costs of flood-related damage. 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 municipal and industrial water 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 USBOR 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 always been met during drought years, and the USBOR 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.

The East Side Division and the construction of the New Melones Dam and Power Plant is one of the more controversial chapters in the history of the CVP. Developing the division brought the need for water and flood control into direct conflict with concerns over damage to cultural resources and the environment. The battle over construction of New Melones Dam was a signal that the end of the era of large dam construction had come. The controversy focused on the loss of a popular stretch of recreational white water, inundation of archeological sites, and flooding of the West`s deepest limestone canyon. Controversy over the project lasted over a decade before the decision was made to proceed and provide irrigation water, flood control, and power generation.

San Luis Unit[5]

Authorized in 1960, the San Luis Unit was constructed by the USBOR and the State of California. It is now jointly operated by the USBOR 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. Giannelli Pumping-Generating Plant, located at San Luis Dam, was completed in 1967. The San Luis Canal, the largest earth-moving project in USBOR 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 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 detention 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 supplemental irrigation supply to approximately 600,000 acres in western Fresno, Kings, and Merced counties.

San Felipe Division[5]

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 Santa Clara Tunnel and Conduit, Pacheco Tunnel and Conduit, 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.

4.1.4.2.2 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 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 Giannelli 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 Giannelli 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.[6]

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

[6] Source: http://www.water.ca.gov/swp/swptoday.cfm

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. The Edmonston Plant pumps water nearly 2,000 feet up and over the Tehachapi Mountains through approximately 10 miles of tunnels.

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.

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 acre-foot 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 municipal and industrial water users (USBOR and CDWR 2005). Of the contracted water supply, approximately 75 percent goes to municipal and industrial users and 25 percent to agricultural users.

4.1.4.3 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 the flow and water quality in the mainstem San Joaquin River. The west side 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.

4.1.4.3.1 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 nineteenth century 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 gave up their historic rights to the San Joaquin River's water in exchange for Delta 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 rivers 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 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, and full restoration flows are scheduled to begin no later than January 1, 2014. In 2013, interim flows between 350 and 400 cfs have been released from Friant Dam to maintain the flow target at Gravelly Ford.[7] Up to 1,060 cfs was released from Friant Dam in 2013 as part of spring pulse flows.

4.1.4.3.2 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 waters 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).

[7] Source: http://restoresjr.net/activities/if/index.html

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).

4.1.4.3.3 Stanislaus River

There are over 30 dams in the Stanislaus River watershed, with a combined storage capacity of approximately 2.7 million AF, more than 220 percent of the 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-foot-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-foot-high timber crib overflow spillway dam) and the Stanislaus Forebay (60-foot-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-foot-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 feet tall) and Reservoir (64,325 AF) and Beardsley Dam (280 feet tall) and Reservoir (97,802 AF) on the Middle Fork Stanislaus River upstream of Melones Dam, and the Tulloch Dam (205 feet tall) and Reservoir (66,968 AF) (capacity 67,000 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 feet 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 feet tall) 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 USBOR for flood control, to provide water for CVP contractors in the watershed, and to maintain water quality in the Stanislaus River and Delta.

4.1.4.4 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 been during the summer and fall upstream of Turner Cut. In January 1998, the State Water Resources Control Board (SWRCB) adopted the Clean Water Act (CWA) Section 303(d) list that identified this DO impairment, and the CVRWQCB initiated development of a total maximum daily load (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 (25%) of the cost is provided by the San Joaquin Tributaries Authority and San Joaquin River Group Authority, a joint power 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.

4.1.4.5 Delta Water Management and Diversions

The Delta's boundaries are defined in the 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 with 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, account for the next largest volume 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 uses (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 over 2,200 water 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).

4.1.4.5.1 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 scenarios of future conditions 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 established 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.

4.1.4.6 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 as 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.

4.1.4.7 Land Use

4.1.4.7.1 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.

4.1.4.7.2 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 (CDPR) 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).

4.1.4.7.3 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).

4.1.4.7.4 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.

4.1.4.7.5 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,[8] 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 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, State Bill (SB) 375 is the State's first attempt to control greenhouse gas emissions by reducing urban spawl. SB 375 links land use and transportation planning and encourages more compact, higher-density development through various incentives, including transportation funding and

[8] http://quickfacts.census.gov/qfd/states/06000.html

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).

4.1.4.8 Fish Hatchery Practices

CDFW is the principal agency responsible for managing and conserving fisheries and aquatic resources in California. As part of its responsibility, CDFW operates a statewide system of fish hatcheries that rear and subsequently release millions of trout, salmon, and steelhead of various age and size classes into state waters. These 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.

Anadromous fish hatcheries have been present in California since the first one was established by the United States Fish and Fisheries Commission on the McCloud River in 1872 (JHRC 2001). In the early 1900s, CDFW assumed responsibility for stocking hatchery trout into state lakes and rivers. Since 1945, CDFW has reared inland and anadromous fish species at 21 hatcheries throughout California. CDFW currently stocks trout in high mountain lakes, low elevation reservoirs, and various streams and creeks. Salmon have been stocked primarily in rivers and direct tributaries to the Pacific Ocean, with the exception of kokanee, coho, and Chinook salmon, which have been planted in reservoirs for sport fishing. Currently, California operates both trout (14) and salmon and steelhead (10) hatcheries throughout the state (ICF Jones & Stokes 2010). In addition to anadromous fish releases in the San Joaquin River basin, discussed below, fish are released from CDFW facilities in the Sacramento River basin, including fall-run Chinook salmon produced at the Nimbus Hatchery.

In the 1970s CDFW began stocking Chinook salmon in some California lakes and reservoirs (JHRC 2001). Initially, out-of-state sources of eggs were used, but subsequently, because none of these sources could provide disease-free eggs, eggs that were in excess of CDFW hatcheries' needs were used (JHRC 2001). Salmon, often from out-of-basin stocks, may have escaped downstream from the lakes and reservoirs in which they were planted and later returned as adults to that stream, possibly interbreeding with wild adult salmon from that stream (JHRC 2001). Until the early 1980s, California's hatcheries occasionally used broodstock from other basins or moved fry to other basins (JHRC 2001). This practice could have affected the genetics of fish naturally occurring in the receiving basins or resulted in the transfer of diseases from the hatchery to the wild population (JHRC 2001).

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 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 improves their survival and contribution to fisheries and reduces the potential for competition of hatchery smolts with naturally produced fish (JHRC 2001). However, off-site releases may also increase the straying rate of returning adult salmon. Dettman and Kelley (1987) (as cited in JHRC 2001) estimated that 46 percent of Feather River Hatchery fish released in the Delta returned to rivers other than the Feather River. Releases that substantially increase the rate of straying fish, and likely increase interbreeding between natural and hatchery populations of different watersheds, are inconsistent with the CDFW and NMFS goal of maintaining the genetic integrity of wild salmon stocks (JHRC 2001).

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. Average annual production (from 2004-2008) was 972,344 fish, with most fish stocked as smolts. Most Merced River Hatchery fish are released from the hatchery from April through June, at 70 to 90 fish per pound. 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 Fish Hatchery was built in 1963 by the East Bay Municipal District (and is operated by CDFW) to offset impacts to fisheries due to construction of Camanche Dam (ICF Jones & Stokes 2010). The hatchery is located on the south bank of the Mokelumne River immediately downstream of Camanche Dam and raises fall-run Chinook salmon and steelhead with water from Camanche Reservoir. In addition to mitigation responsibilities, the Mokelumne River Hatchery has an enhancement program supported by commercial salmon trollers. The Mokelumne River Hatchery receives its steelhead broodstock from the Feather River Hatchery or from adults returning to the hatchery, and has received broodstock fish from the American River, and Battle Creek (CDFW 2012). The Chinook salmon broodstock is of Central Valley origin. Average annual fish production at the Mokelumne River Hatchery from 2004 through 2008 was 5,351,901 fish. 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.

4.1.4.9 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.

4.1.4.10 Non-Native Species

Non-native species enter a region in a variety of ways, most prominently through historical stocking by state resource management agencies, illegal introductions by anglers, ballast water discharged from ships, and boating activities. Introduction of non-native species has resulted in large changes in the fish community structure of the Central Valley (Moyle 2002). Non-native fish introductions in California date back to European settlement, and current fish communities in the lower reaches of the San Joaquin River tributaries and Delta are dominated by non-native taxa. Over 200 nonnative species have been introduced in the Delta and become naturalized (Cohen and Carlton 1995), including many fish that prey on juvenile salmonids (e.g., smallmouth bass, largemouth bass, and striped bass).

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).

4.1.4.11 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.

4.1.4.11.1 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 2009, NMFS issued a Public Draft Recovery Plan (NMFS 2009a) for several ESA listed anadromous salmonids in the Sacramento River and Central Valley: 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 scheduled 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., time scales 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.

4.1.4.11.2 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.

Implementation of the 2009 San Joaquin River Restoration Settlement Act and SJRRP will have significant effects on stream flows in the basin.[9] 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.

Annual restoration flows in the San Joaquin River vary from 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 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.

The first interim water releases from Friant Dam in support of the SJRRP began on October 1, 2009. In 2013, interim flows between 350 and 400 cfs have been released from Friant Dam to maintain the flow target at Gravelly Ford.10 Up to 1,060 cfs was released from Friant Dam in 2013 as part of spring pulse flows.

4.1.4.11.3 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.[11] 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 Clean Water Act, 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 municipal and industrial, 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 USBOR, 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.

[9] Source: www.restoresjr.net
[10] Source: http://restoresjr.net/activities/if/index.html
[11] Source: http://www.swrcb.ca.gov/about_us/water_boards_structure/history_water_policy.shtml

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 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 municipal and industrial 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 and do not occur or if actions do not produce the expected results.

4.1.4.11.4 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 TMDLs that may directly or indirectly affect flows and water quality in the San Joaquin River is shown below (SWRCB 2010):

- Completed:
  - San Joaquin River diazinon and chlorpyrifos,
  - San Joaquin River salt/boron at Vernalis, and
  - San Joaquin River dissolved oxygen at Stockton.
- To be completed:
  - San Joaquin River salt/boron upstream of Vernalis,
  - San Joaquin River unknown toxicity, and
  - San Joaquin River temperature.

4.1.4.11.5 Bay-Delta Conservation Plan

The Bay-Delta Conservation Plan (BDCP) is expected 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 will include 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 is being developed to address ecological needs of at-risk Delta species, primarily fish, while improving and securing a reliable water supply. The BDCP will be structured to improve the health of the system as a whole by implementing a comprehensive restoration program for the Delta. The plan includes a suite 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 attempts to balance species conservation with a variety of other important uses in the Delta. A joint EIS/EIR, to be prepared by state and federal agencies, will include an analysis of the environmental impacts of improved water conveyance infrastructure and habitat conservation measures. Implementation of the BDCP will likely require changes to the Bay-Delta Plan (see preceding section).

Implementation of the BDCP will occur over a 50-year timeframe and be conducted by a number of agencies and organizations with specific roles and responsibilities as prescribed by the BDCP. A major part of implementation will be monitoring conservation measures to evaluate their effectiveness and revising actions through adaptive management.

4.1.4.11.6 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 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.

4.1.4.11.7 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." On September 20, 2011, the U. S. District Court invalidated the Biological and Conference Opinion and remanded it to NMFS for further consideration in accordance with the court's decision and the requirements of law. The decision has been appealed by defendant interveners in the case.

4.1.4.11.8 The Central Valley Project Improvement Act

As noted previously, the Ecosystem Restoration Program[12] 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) balances the priorities of fish and wildlife protection, restoration, and mitigation with 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 water flows, replenishment of spawning gravels, restoration of riparian habitats, screening of water diversions, and habitat restoration.

4.1.4.11.9 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.

4.1.4.11.10 CCSF Water System Improvement Program

On October 30, 2008, the SFPUC adopted a systemwide 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

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[12] http://www.dfg.ca.gov/ERP

objectives that address system performance in the areas of water quality, seismic reliability, delivery reliability, and water supply.

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 of the 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 the wholesale customers (including 9 mgd for the cities of San Jose and Santa Clara) and 81 mgd for the 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 water 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.

4.2 Geomorphology

Geomorphology in the lower Tuolumne River is cumulatively affected by a variety of anthropogenic actions within the Tuolumne River watershed (see Section 4.1 of this DLA for an account 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 contributes to these cumulative effects, but the Project's effects diminish relative to other impacts, mainly those associated with aggregate mining, with increasing distance downstream. As a result, with greater distance downstream of the Project, it becomes increasingly difficult to isolate effects of the Project on geomorphologic conditions in the river channel.

FERC's SD2 identifies the following potential Project effects related to geomorphology in the Tuolumne River:

- Potential effects of any Project-related changes in streamflow and sediment delivery on 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 Lower 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 lower 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). 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 feet wide and 35 feet 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 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 separating 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 2011a).

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 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' 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 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 dam has been progressively 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 USACOE 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). These changes in hydrology have had impacts on sediment supply and transport and, as a result, channel morphology.

Flow regulation associated with upstream dams also affects riparian vegetation by modifying the hydrologic and fluvial processes that influence survival and mortality of riparian plants TID/MID 2013b) As noted above, each increment of flow regulation (La Grange Dam, Hetch Hetchy 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 flood scour allowed riparian vegetation to initiate 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 and 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 more recent bathymetric surveys conducted in 2011 is discussed below in Section 4.2.3. Small tributaries downstream of La Grange Dam do not supply significant quantities of coarse sediment (McBain and Trush 2004).

Fine (predominantly <2 mm) bed material (FBM) is supplied to the lower Tuolumne River primarily by the three largest tributaries downstream of La Grange 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 event.

The January 1997 flood eroded approximately 500,000 yd^3 of sediment from the spillway at New Don Pedro Dam, depositing sediment behind La Grange 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 Dam (RM 52.1) downstream to Roberts Ferry Bridge (RM 39.6) (Stillwater Sciences 2002). The survey estimated fine sediment storage in pools and other discrete deposits and estimated the relative contribution of fine sediment from tributaries. Results from the survey 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 LaGrange 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 vicinity 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 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). 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 influencing channel sediment dynamics.

4.2.2 2012 Spawning Gravel Study in the Lower Tuolumne River

To assess the contribution of the Project's continued operation to cumulative effects on the supply, transport, and storage of coarse and fine sediment downstream of La Grange Dam, the Districts conducted a study in 2012 of spawning gravel in the lower Tuolumne River (TID/MID 2013f). 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 for the purpose of determining any cumulative effects of the Project on Projected-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 2013f) 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 Old Don Pedro Dam, which represents less than 1 percent of the original storage capacity of Don Pedro Reservoir in 1971 (HDR 2012; TID/MID 2013f). 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 1923 - 1946 period reported by Brown and Thorp (1947) and are comparable to sediment yields estimated for other reservoirs on the western slope of the Sierra Nevada range.

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 and 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 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.
- Field surveys indicate that sediment storage features (e.g., lateral bars and riffles) are depleted of coarse sediment, and riffles throughout the gravel-bedded zone have progressively diminished in size.
- 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 2013f) indicates that without gravel augmentation, the channel in the first 12.4 miles downstream of La Grange 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 2013f). Gravel augmentation has helped increase coarse sediment storage in the reach, and 94 percent of the coarse sediment added through augmentation has been retained.

Differencing of channel topography surveyed in 2005 and 2012 show little change in storage has occurred 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 2013f). 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 has 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 that is not mobilized during infrequent high-flow events.

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 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 continue to be an important source of fine sediment to the lower Tuolumne River channel (TID/MID 2013f).

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 2013f). 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 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, accuracy and precision of riffle delineation [see Section 5.4.1 of TID/MID 2013f]). 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.

4.3 Water Resources

FERC's SD2 identifies the continued operation and maintenance of the Don Pedro Project as potentially contributing to cumulative effects to water resources. 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 will be 30 to 50 years into the future. FERC also indicated that only future resource effects resulting from reasonably foreseeable future actions are to be considered. The consideration of past actions that resulted in, or continue to result in, cumulative effects to water resources shall be limited to the amount of available information available on the past action and the relevance to the resource.

Cumulative effects to water resources can be subdivided into effects to water quantity and water quality. Within the geographic scope identified by FERC, major factors contributing to cumulative effects to water quantity and/or water quality, in addition to the Don Pedro Project, include the following:

- CCSF's development of the Hetch Hetchy water system (1923–present) on the upper Tuolumne River for water supply and hydropower purposes, including construction of the San Joaquin Pipeline with a capacity to deliver up to 484 cfs, or 313 mgd, to its Bay Area water customers;
- Construction and operation of the Districts' original Don Pedro Project (1923-1971) with a total storage of roughly 300,000 AF of water storage for irrigation purposes;
- Construction and operation of the Districts' La Grange diversion dam (1893-present) located about two (2) miles downstream of the Don Pedro Dam for the purpose of raising the water level of the Tuolumne River to enable diversion of Tuolumne River water to TID and MID irrigation and M&I customers;
- 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 floodplain of the Tuolumne River for purposes of 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/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 the Delta (1880-present);
- Construction and operation of major storage reservoirs in San Joaquin, Merced, Stanislaus, Calaveras, Mokelumne, and Sacramento river basins (1920s-present);
- Construction and operation of major water diversion, pumping and canal delivery systems in the San Joaquin and Delta water systems (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 river corridors and within the Bay-Delta estuary area;
- Increased use of pesticides and herbicides to support agriculture;
- Development and expansion of wastewater systems to support urban development; and
- Climate change.

The major factors identified above are in addition to a host of other minor factors (e.g., levees for flood control, water withdrawals and wastewater discharges for industrial use) that are also contributors to cumulative effects to water resources. Due to the number, magnitude, and changing nature of these various factors, there is considerable room for error when evaluating the degree to which any single factor affects water resources within the geographic scope identified in the SD2. The complexity of co-occurring past, current, and potential future actions in the San Joaquin River basin and/or the San Joaquin – Sacramento Bay Delta Estuary makes it very difficult, perhaps impossible, to quantitatively isolate the specific effects to water resources of individual actions, including the actions of the Project. Qualitative assessments are presented below.

4.3.1 Water Quantity

Major factors contributing to cumulative effects to 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 the La Grange diversion dam to the Districts' irrigation systems for agriculture and M&I purposes, irrigation return flows in Dry Creek and along the lower Tuolumne River, and riparian pumping withdrawals along the lower Tuolumne River.

CCSF's diversion of 250,000 AF of water out of 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 drainage above Don Pedro Reservoir. CCSF regulation can affect Tuolumne River flows during all low, normal and moderately high flow conditions. CCSF's historic average diversion is about 12 percent of the total average unimpaired flow of the Tuolumne River at LaGrange. Also during drought years, if CCSF uses credits available to it in the water bank, the only inflow to the Don Pedro Reservoir may be that from the unregulated portion of the Tuolumne River and any minimum releases from 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 fall to less than 100 cfs, but outflows very seldom fall to less than 200 cfs. The primary affect of Don Pedro is to store water during higher flows for later release during the irrigation season, with the highest releases 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, while outflows exceed 4,000 cfs about 14 percent of the time. Operation of Don Pedro results in primarily seasonal differences between inflows and outflows due to monthly and annual storage carry-over 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 magnitude and frequencies of reservoir inflows and outflows.

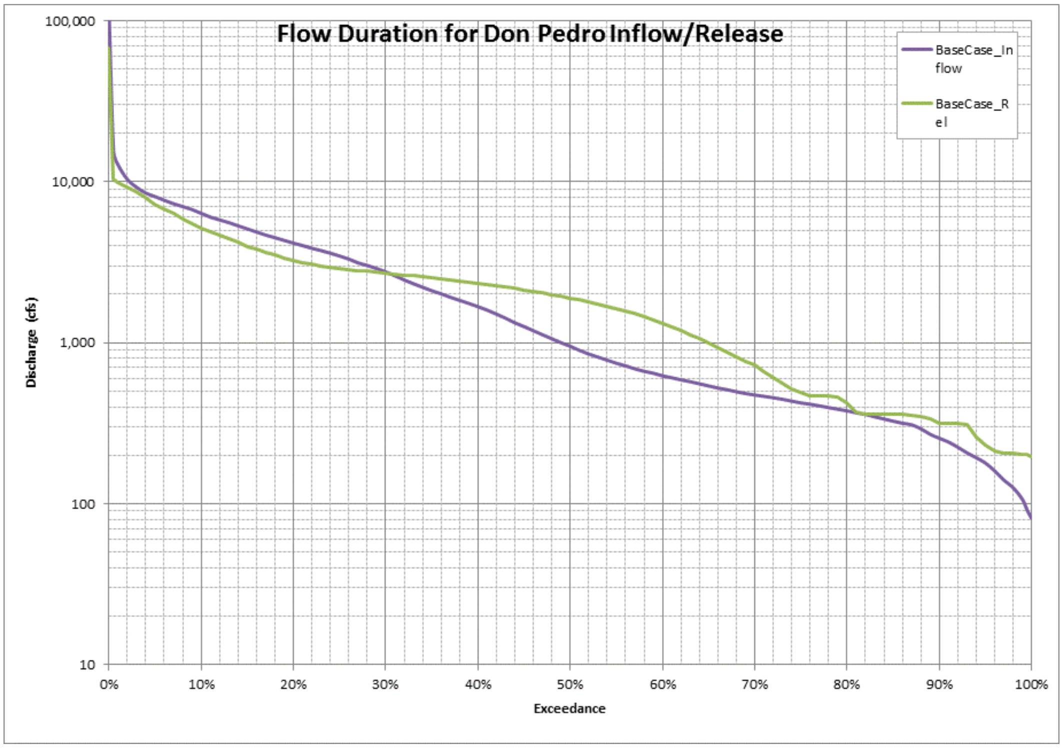

Figure 4.3-1. Don Pedro Reservoir annual inflow and outflow, 1971—2012

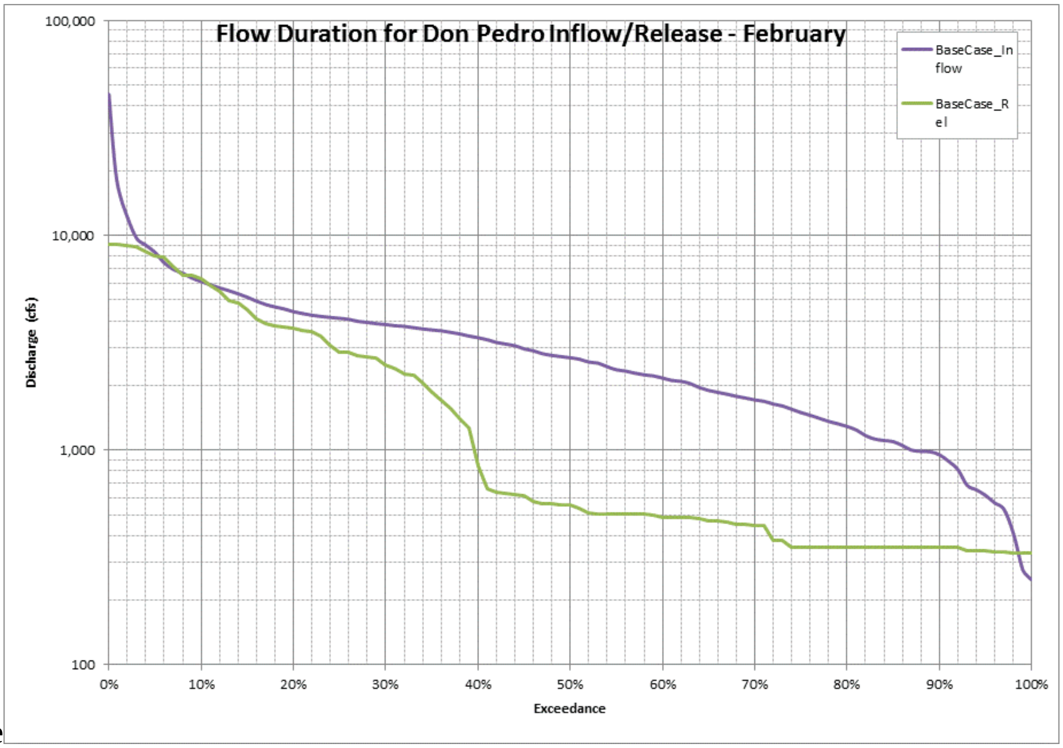

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Figure 4.3-2. Don Pedro Reservoir February inflow and outflow, 1971—2012.

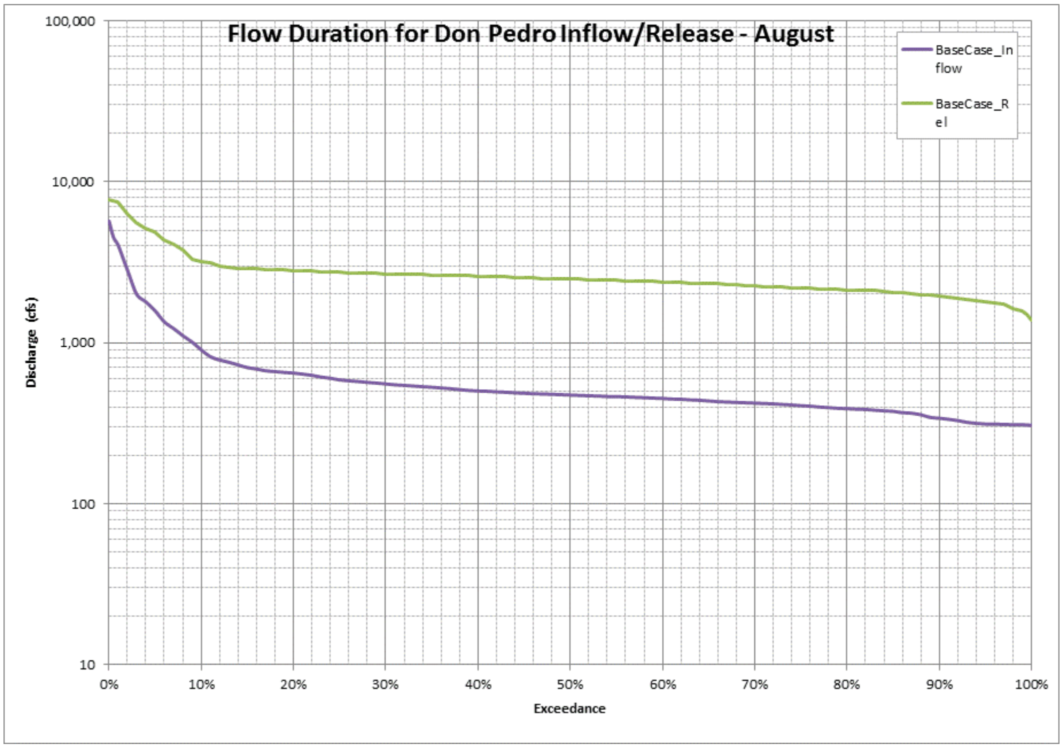

Figure 4.3-3. Don Pedro Reservoir August inflow and outflow, 1971—2012

It is the operation of the Districts' 120 year-old La Grange Dam that has the most pronounced effects on water quantity of the Tuolumne River at the confluence with the San Joaquin River, and along the lower Tuolumne River. This can be shown by the differences in flows released at Don Pedro and the flows 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 through 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 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, while 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 rights of the Districts. The Act requires that CCSF release 2,350 cfs or 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 Districts' water right held to receive 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 the 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 canals. (Figure 4.3-5). Diversions by the Districts' full water right entitlement at La Grange would, absent Don Pedro Dam, leave the lower Tuolumne River without water a substantial portion of the year.

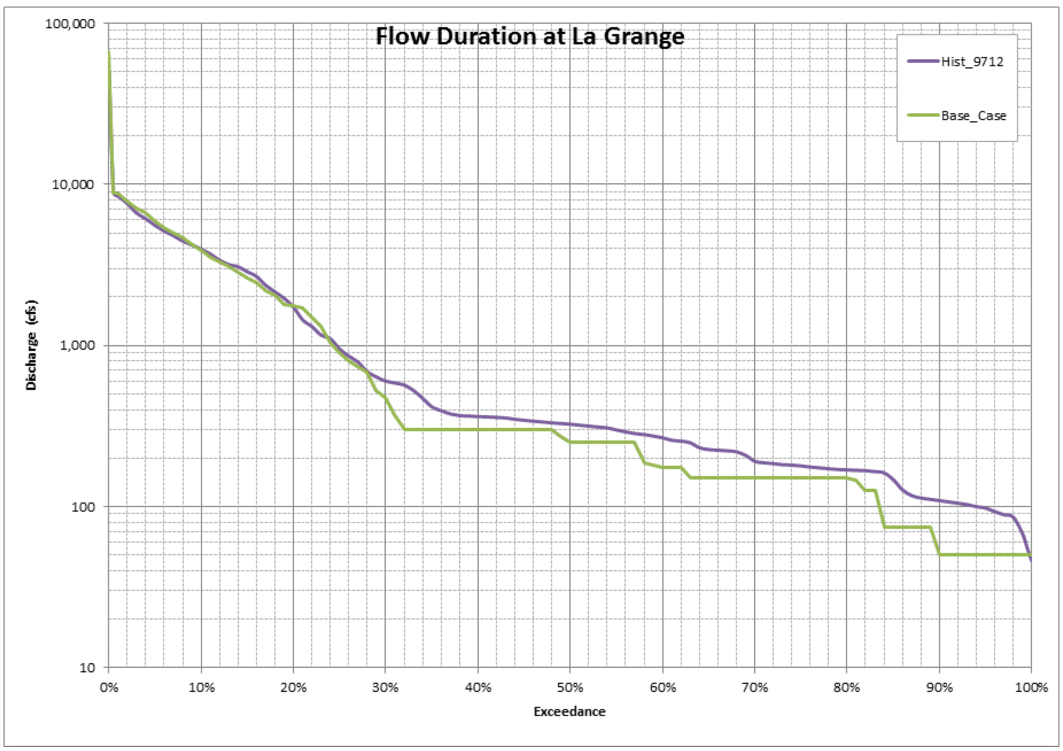

Figure 4.3-4. Historical (1997—2012) and modeled Base Case (1971—2012) flows at the USGS La Grange gage.

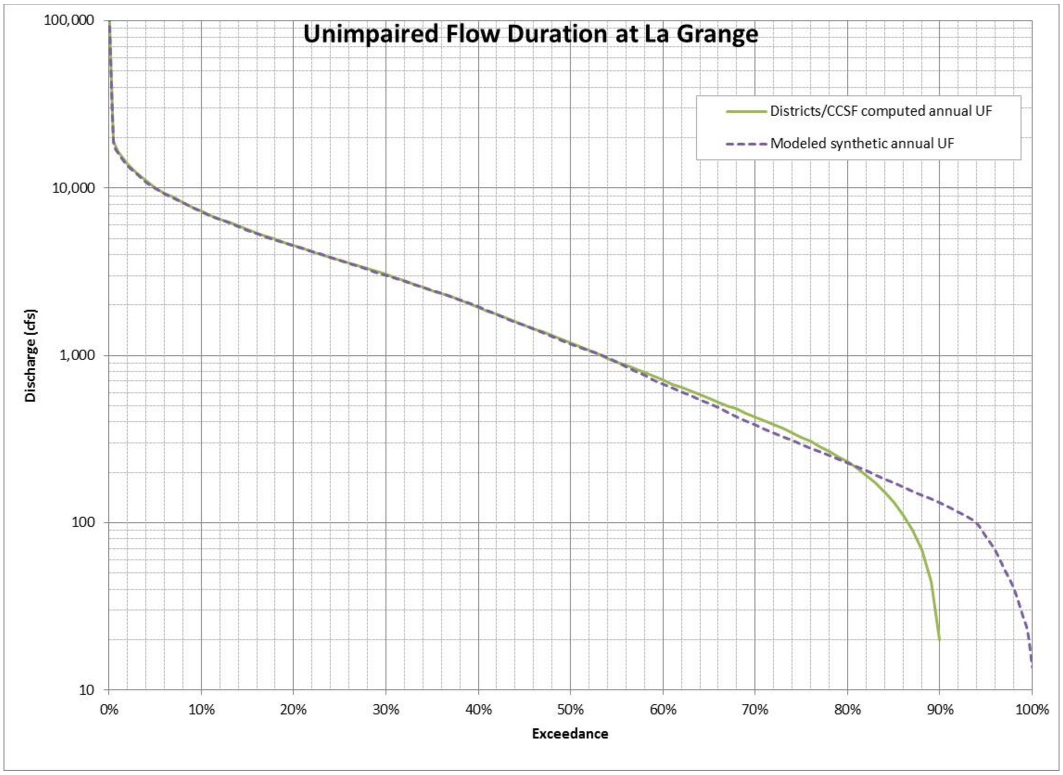

Figure 4.3-5. Estimates of unimpaired flow at USGS La Grange gage, 1971—2012.

The Don Pedro Project is required under its FERC license to provide flows to the lower Tuolumne River, measured by 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 this flow has 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 Project currently contributes a significant positive cumulative effect to 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 for the benefit of flood control and irrigation/M&I use 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 also influenced by occasional operational spills from the Districts irrigation system, farm runoff, groundwater accretions, and riparian pumping. Actions adding to flow in the lower Tuolumne contribute to an increased flow quantity and riparian diversions contribute to reducing flow quantity in the river. Quantitative values for these factors are generally unavailable, although direct accretion measurements taken by the Districts as part of relicensing study show that the lower Tuolumne River is a generally accreting river; however, riparian diversions acting together can contribute to significant loss of flow. There are a total of

26 known riparian diversions with an estimated total combined withdrawal capacity of 76.6 cfs (CDWR 2013).

Factors contributing to cumulative effects to water quantity in the San Joaquin River and the Bay-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, Mokelumne, and Calaveras rivers, as well as the Tuolumne River, all contribute to cumulative effects to the water quantity of the San Joaquin River and Bay-Delta system. The total drainage area of the San Joaquin at Vernalis is 13,500 mi^2 at its entrance to the Delta and is 31,800 mi^2 in total. The Tuolumne River has a drainage area of approximately 1,900 mi^2, or 14 percent of the watershed at Vernalis and 6 percent of the total drainage area. The Sacramento River also enters the Delta, and together the Sacramento-San Joaquin rivers drain almost 60,000 mi^2 of California into the Bay-Delta system. In addition to water development projects associated with the State Water Project and the CVP, numerous riparian diversions also occur along the San Joaquin River and its tributaries and throughout the San Joaquin – Sacramento Delta Estuary. Except for the State and Federal pumping plants, the total quantity of water historically diverted and pumped by these diversions is not well known.

4.3.2 Water Quality

Many of the factors listed above in section 4.3 and 4.3.1 also contribute to the cumulative effects to the water quality of the Tuolumne and San Joaquin rivers. Water quality studies performed as part of relicensing indicate that the waters of the Don Pedro Reservoir and the Tuolumne River below La Grange diversion dam meet the state's water quality standards. The lower Tuolumne River accumulates pollution loadings from pesticides and wastewater discharge as it travels downstream (see Exhibit E-3.4 for additional information). Of significant concern to regulatory agencies, the lower Tuolumne River has been identified as impaired for temperature. In addition to the natural climate characteristics of the Central Valley, factors contributing to the cumulative effects to thermal conditions in the lower Tuolumne River include water storage in Don Pedro Reservoir, water diversions at La Grange Dam, in-channel and overbank modifications including removal of riparian vegetation, accretions from irrigation operations and groundwater, riparian diversion, and wastewater discharges.

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. As a result, while reservoir inflow temperatures vary considerably due to local meteorological and geophysical conditions, outflow temperatures vary only slightly. Figure 4.3-6 displays actual mean daily reservoir inflow and outflow temperatures recorded over the period of October 2011 through December 2012. The figure demonstrates the direct effect of the Don Pedro Reservoir on Tuolumne River temperatures. Outflow temperatures are generally slightly higher than inflow temperatures from mid-

November to about mid-March when outflow temperatures are relatively steady at 10 to 11°C (50°F) and inflow temperatures tend to vary from about 3 to 8°C. Outflow temperatures are cooler than inflow temperatures from June through early October when outflow temperatures are relatively steady at 11 to 12°C and inflow temperatures can be significantly higher. From early June to at least late September, inflow temperatures reach 20°C and can exceed 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.

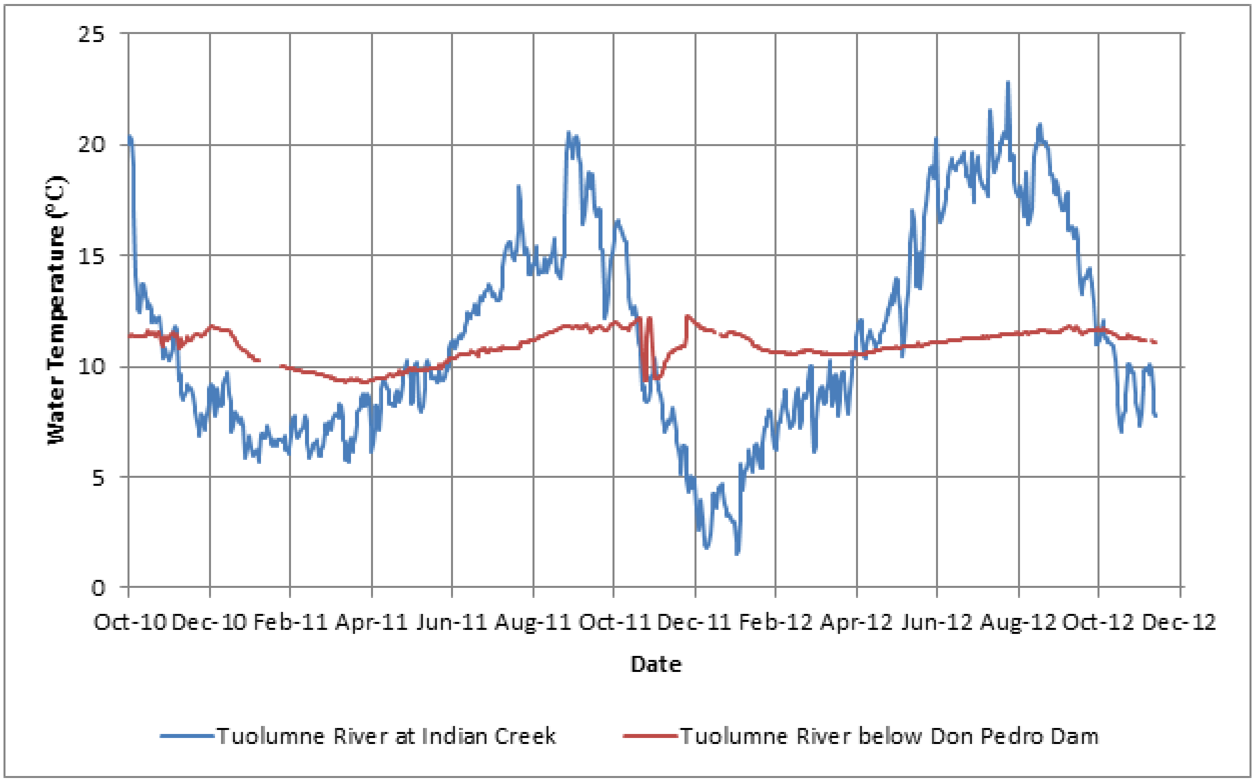

Figure 4.3-6. **Don Pedro Reservoir inflow and outflow temperature.**

These temperature patterns show very little change through the La Grange pool and just below La Grange diversion dam. La Grange pool is shallow and short and is more riverine than lacustrine from a temperature perspective. La Grange pool does not stratify because it is shallow 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 on river temperature in the lower Tuolumne River would be consistent with its overall direct effects on water temperature; that is, Don Pedro 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 April to mid-May and mid-October to mid-November time frames, and tend to provide a slight initial warming during the mid-November to mid-March time frame.

The diversion of flows at La Grange diversion dam has a more direct effect on river temperatures in the lower Tuolumne River by reducing the release from Don Pedro which reduces travel time and increases exposure to local meteorological conditions. Diversions from the river are relatively small during the November through February time frame, so the effects of La Grange operations on lower Tuolumne River temperatures are also very limited. Since reservoir inflow and outflow temperatures are essentially the same during the April to mid-May time frame, La Grange diversions are unlikely to affect river water temperatures significantly. In addition mean ambient air temperatures during April are about 15 to 16° C, so warming is generally limited, however daylight hours are beginning to increase and sunlight is more direct, so water temperatures are beginning to warm.

One of the parameters for indicating temperature effects on water resources is a rolling seven-day average of the daily maximum temperatures (7DADM). Table 4.3-1 provides 7DADM temperatures for specific river mile locations on the lower Tuolumne River based on actual temperatures recorded at various locations along the river. This table confirms that diversions at La Grange Dam have little effect on river temperatures during the April to mid-May time frame. The mean of the maxima in April is 11°C at the USGS gage at La Grange and only warms to 15° C at RM 23.6.

Table 4.3-1. Monthly average 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 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 5/2010 - 2/2013			RM 51.8			RM 45.5			RM 39.5			RM 23.6			RM 16.2			RM 3.5		
				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

However, as ambient air temperatures increase in the lower Tuolumne River valley and direct sunlight increases, water temperatures become highly influenced by local meteorological conditions. This is demonstrated in Figures 4.3-7, 4.3-8, and 4.3-9. Using the Districts' HEC-RAS river hydraulic and temperature model developed during the relicensing process in accordance with the FERC–approved study plan W&AR-16, the figures show for three locations along the lower Tuolumne River, RM 39.5, 30, and 16.5, the relationship between ambient air temperatures and flow.

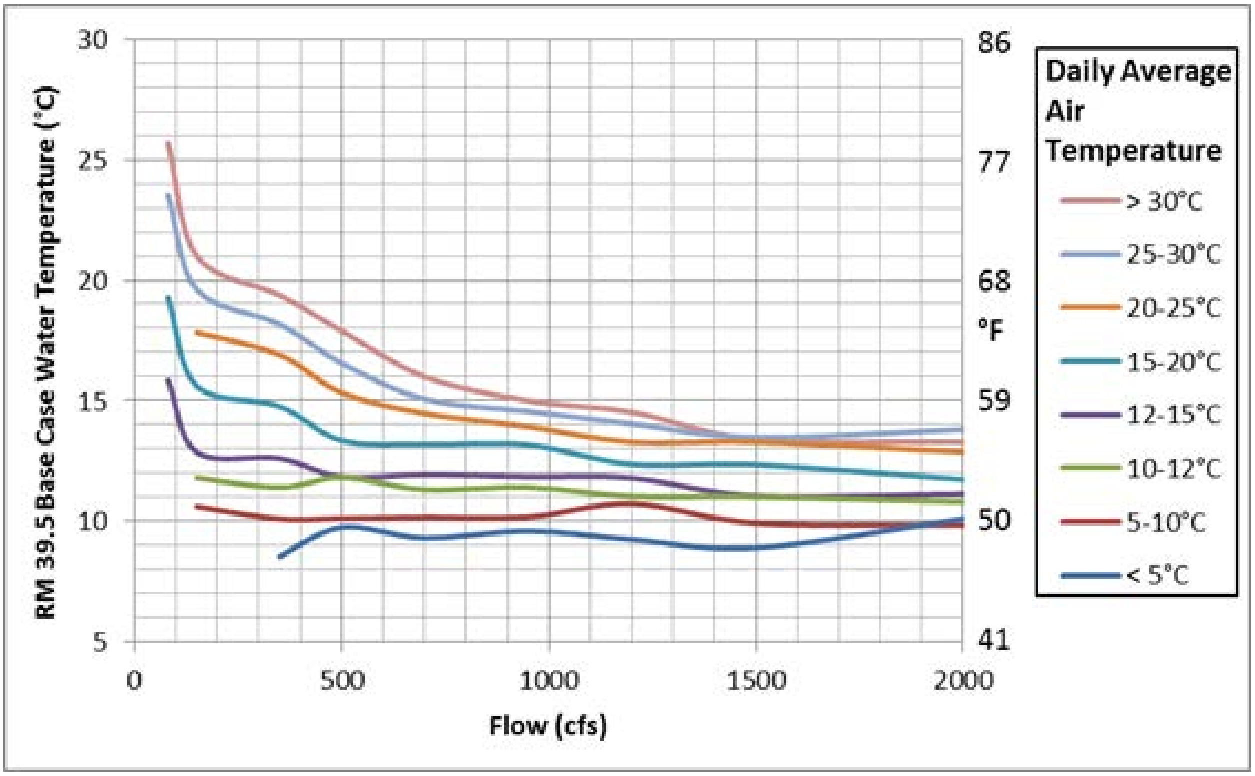

Figure 4.3-7. Relationship between mean daily ambient air temperature, water temperature and flow in the lower Tuolumne River – River Mile 39.5.

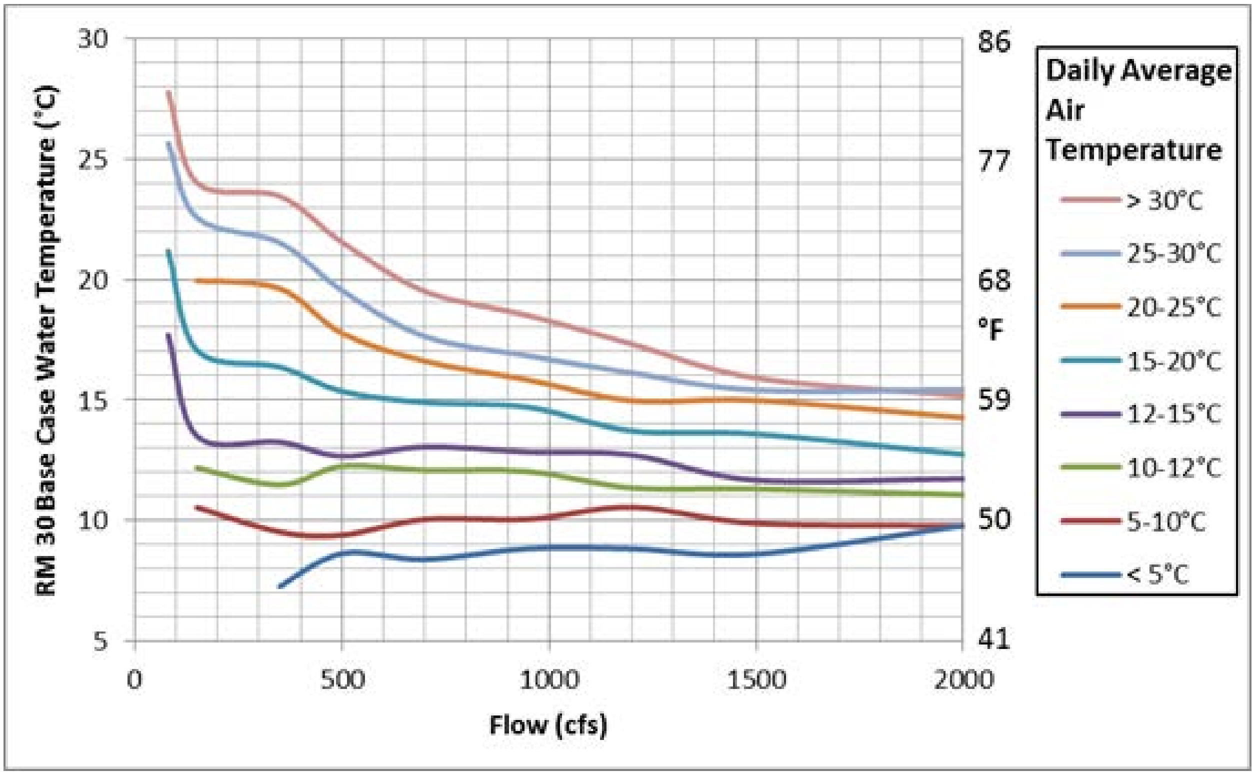

Figure 4.3-8. Relationship between mean daily ambient air temperature, water temperature and flow in the lower Tuolumne River – River Mile 30.0

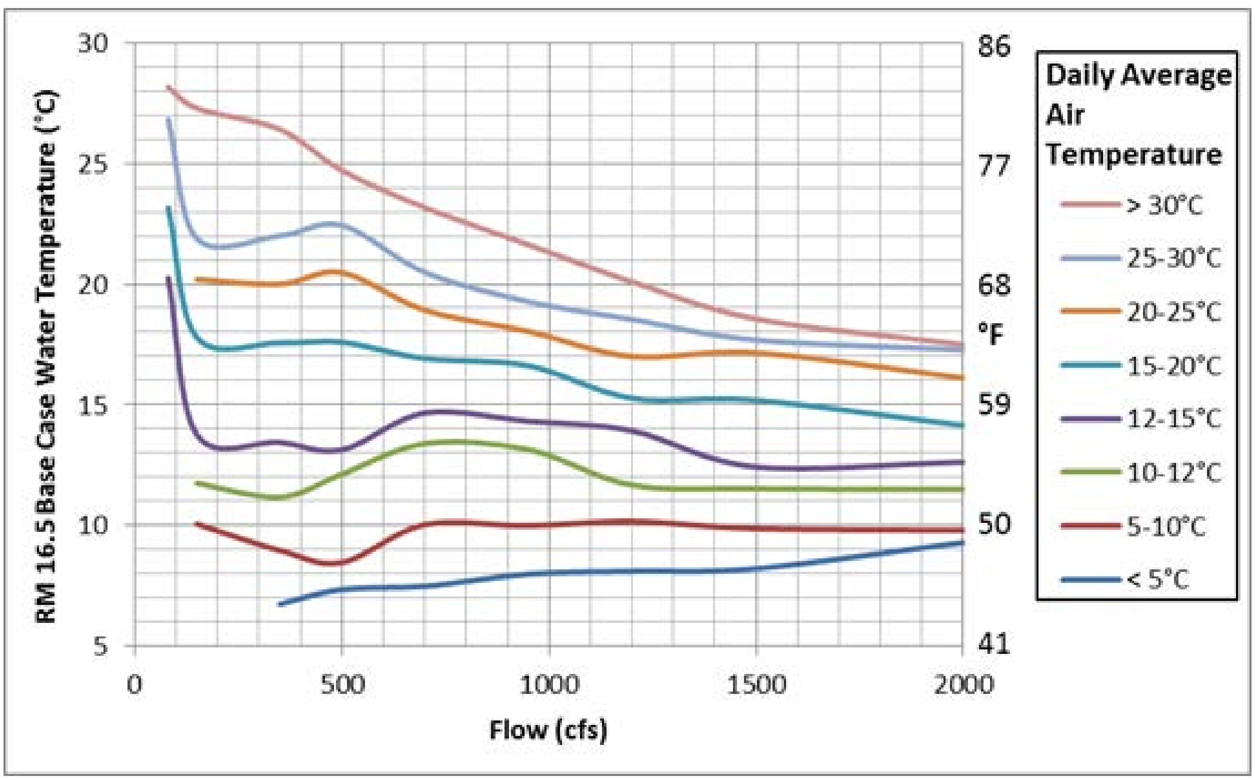

Figure 4.3-9. Relationship between mean daily ambient air temperature, water temperature and flow in the lower Tuolumne River – River Mile 16.5.

The plots show that when mean daily ambient air temperatures are between 15 and 20°C (April/May), a flow of 100 cfs will result in a mean daily water temperature at RM 39.5 of 18°C[13] and a flow of 200 cfs will result in a temperature of 15°C; however to reduce the temperature 1°C more would require a flow of about 420 cfs. The influence of ambient temperature conditions is more extreme as air temperatures increase. When mean daily air temperatures are between 25 and 30°C (July/August), a flow of 100 cfs will result in a water temperature of 22°C at RM 39.5, a flow of 150 cfs will reduce the temperature to 19.5°C, however, an additional 400 cfs, or a 550 cfs flow, would be needed to reduce the temperature to 16°C. The first three degree reduction in water temperature only takes 50 cfs, but the next three degrees takes 400 cfs. As one moves downstream, the influence of ambient climate conditions becomes greater. At RM 30, nine miles downstream, when ambient air temperature is between 25 and 30°C and flow is 100 cfs, the resulting river temperature would be 24.5°C. Increasing the flow to 150 cfs reduces the temperature to about 22.5°C, and doubling the flow to 300 cfs only reduces the temperature by another 0.5° C. It would require a continuous flow of 650 cfs to reduce the temperature to 18C and a continuous flow of 1,250 cfs to reduce the water temperature to 16°C. At RM 16.5, a flow increase from 100 cfs to 150 cfs reduces mean water temperatures from 26°C to 21.5°C, yet it takes a continuous flow of nearly 800 cfs to reduce the water temperature to 20°C.

Accretion flows due to groundwater are normally expected to be about 12 to 14°C, so would be expected to slightly warm streamflows during cold months and cool them during warm months. Temperature data from thermologgers located below RM 10 do indicate some cooling of summer water temperatures (Table 4.3-1), and this river reach appears to receive accretions from groundwater based on the Districts' accretion flow measurements. Operational spills from irrigation canals may affect water temperatures when they are significant in volume but this seldom occurs. Withdrawals by riparian water users will tend to increase water temperatures during the peak of the irrigation season.

Cumulative effects to water temperature and water quality expand significantly below the confluence of the Tuolumne and San Joaquin rivers. As described generally above, there are numerous factors which affect water quality and water temperature in the San Joaquin River and the Bay-Delta, prominent among these are river diversions at Friant Dam on the San Joaquin River, at Crocker-Huffman Dam on the Merced River, and at New Melones and other dams on the Stanislaus River. Intense agricultural development along the San Joaquin and its tributaries has resulted in additional river water withdrawals and introduction of pesticides and herbicides.

The flow of subsurface drainage water from intensively farmed irrigated agriculture land on the Westside of the San Joaquin Valley into the San Joaquin River has created a well-known water salinity and specific ion (selenium and boron) quality problem for the river. The flow of water from the Tuolumne River (and the Merced and Stanislaus Rivers) dilutes and improves the overall salinity level of the San Joaquin River as it moves downstream toward the Delta and Bay.

Urbanization along the San Joaquin and the Delta and Bay Areas has introduced a number of water quality concerns, including from urban runoff and municipal and industrial wastewater

[13] All starting temperatures are 10°C

discharges. The development of the Stockton Ship Channel resulted in a zone of near-zero dissolved oxygen 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. In general, the factors affecting water quality in the San Joaquin and the Delta-Bay ecosystems are likely proportional to the 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;[14] the Project serves approximately 210,000 acres, or about 4 percent of the total. There are 20 major dams tributary to the Bay-Delta that store over 20 million AF of water for irrigation, M&I, and flood control purposes;[15] the Don Pedro Project total usable storage for those purposes is 1.7 million AF, or about 8 percent of the total.

With respect to pollution loadings and dissolved oxygen concerns in the San Joaquin River, the Don Pedro Project contributes no adverse effects to these constituents of water quality. Due to the overwhelming factor of summer climate conditions in the San Joaquin basin, the Don Pedro Project's has little to no influence on water temperatures in the San Joaquin River and Bay-Delta system.

4.4 Fish and Aquatic Resources

As described previously in this section of Exhibit E, 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 Don Pedro Project contributes to the cumulative effects on water resources of the lower river. 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 Project are attenuated with increasing distance downstream in the Tuolumne River and into the San Joaquin River basin and the Delta. As anadromous Chinook salmon and steelhead or resident rainbow trout move farther downstream from the 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 on the life cycles of these fish.

FERC's SD2 identifies the following potential direct Project effects on fish and aquatic resources in the Tuolumne River:

- Effects of Project operation and maintenance on fish and aquatic resources in the Project-affected downstream reach including fall-run Chinook salmon (*Oncorhynchus tshawytscha*).

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[14] (http://www.idrinkwine.net/the-sjv/)
[15] (http://cdec.water.ca.gov/cdecapp/resapp/getResGraphsMain.action)

- Effects of retention of sediment in the Project reservoir on downstream fish spawning habitat and benthic macroinvertebrate populations.
- 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.

FERC's SD2 also states that the Project may contribute to cumulative effects on water resources, aquatic resources and essential fish habitat (EFH); geomorphology, and socioeconomics. 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 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 will be 30 to 50 years into the future and any consideration of such future effects should focus on reasonably foreseeable future actions.

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, current, 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 Project. To the extent that the degree of influence of any individual action on a resource is indeterminant, then the effect of modifying that action is also likely to be indeterminant.

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 the previous three sections. 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, (7) freshwater harvest, and (8) a synthesis of effects occurring within the geographic scope for cumulative effects, which includes an account of how climate change may contribute to cumulative effects in the future. The geographic scope of the assessment, as noted above, includes the Tuolumne River from Hetch Hetchy Dam to its confluence with the San Joaquin River and the San Joaquin River downstream through the Delta. Within this area, designated EFH for fall-run Chinook salmon includes the lower Tuolumne River, the lower San Joaquin River, and the Delta. As a result, all habitat effects discussed below are relevant in the context of EFH.

The Don Pedro Project contributes to cumulative effects on 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 4.1.3) the CCSF operations of the Hetch Hetchy system, water diversions at La Grange Dam, withdrawals of water 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 other reservoir and diversion facilities in the San Joaquin River and its tributaries, along with an array of other actions (see Section 4.1.4), also contribute to cumulative effects on aquatic organisms within the system.

4.4.1.1 Hydrologic and Physical Habitat Alteration

4.4.1.1.1 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 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, 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 flow regime. Historically, Wheaton Dam and the present day La Grange Dam lacked the storage capacity needed to affect high flow conveyance to the lower Tuolumne River during winter and spring (McBain and Trush 2000). CCSF's Hetch Hetchy Project, the Districts' 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 Dam.

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.

These changes in hydrology have had both immediate impacts on habitat conditions for salmonids and other native aquatic organisms as well as introduced piscivore species (e.g., depth, velocity, water temperature) and longer-term impacts on aquatic habitat characteristics due to changes in flow magnitude and timing, flood frequency, sediment supply, transport, and channel morphology.

Physical Habitat and Riparian Alteration

Gravel and gold mining, as well as other land uses, adversely affected aquatic habitat prior to dam construction on the Tuolumne River (TID/MID 2005) (see Section 4.1.1 for a summary of the chronology of current and historic actions within the defined geographic scope for cumulative effects). The presence of dams, aggregate extraction, agricultural and urban encroachment, and other land uses have resulted in sediment imbalances in the lower Tuolumne River channel (McBain & Trush 2000). Don Pedro Dam and La Grange Dam, combined with other dams upstream of the Project, trap all coarse sediment and LWD that would otherwise pass downstream, and excavation of bed material for gold and aggregate to depths below the river thalweg has significantly available reduced spawning habitats, eliminated active floodplains and terraces and created large in- and off-channel pits that provide suitable habitat for non-native predator species. The channel downstream of La Grange Dam is characterized by downcutting, widening, armoring, and depletion of sediment storage features (e.g., lateral bars and riffles) due to the cumulative effect of sediment trapping by upstream reservoirs, mining, and other land uses (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 degradation (as compared to aggradation) 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 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.

The large in-channel pits where sand and gravel aggregate were extracted created the so-called SRPs. Historical deposits of dredger tailings (RM 38.0–50.5) confined the active river channel, preventing sediment recruitment that would otherwise have resulted from the normal process of channel migration (McBain and 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 the 6-mile-long reach (TID/MID 2011a).

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 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). 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 increasing habitat complexity.

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. Livestock selectively graze younger riparian plants, which limits 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 and 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 and Trush 2000, Grant et al. 2003).

Mining has 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 change in riparian species composition and 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 Dam, Hetch Hetchy 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 flood scour allowed riparian vegetation to initiate along the low water channel, where historically vegetation would have been absent; however the legacy of impacts has altered the structure of the floodplain and potential for establishment in many areas.

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 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), brought about primarily through 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 and 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 Dam, was a barrier to salmon migration. 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).

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 2013c).

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 2013h). 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 2013c) 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 noted for juvenile Chinook stranding potential (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, FERC-required spawning flow requirements have served to reduce the risk of redd dewatering (TID/MID 2013c). 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 2013c).

Because current 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 2013c). 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 upon 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 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 2013c), so it is unclear to what degree LWD retention by upstream dams has contributed to adverse habitat effects in the lower river.

Measures have been undertaken to improve conditions for migratory salmonids in the Tuolumne River relative to what they would otherwise be. Since implementation of increased summer flows under the 1996 FERC Order, *O. mykiss* abundance has increased, although stable flows in summer appear to select for a largely resident life history (TID/MID 2013c).

SRPs, created by in-channel mining, can be up to 400 feet wide and 35 feet deep and occupy approximately 32 percent of the length of the channel in the gravel-bedded reach (RM 52–24). These habitat features harbor non-native fish that may prey upon juvenile salmonids, such as largemouth and smallmouth bass, which were introduced (see Introduced Fish Species, below) in the late 1800s and early 1900s. 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), making it 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 some extent a result of past sand and gravel mining coupled with the introduction of non-native piscivorous fish species (Orr 1997).

4.4.1.1.2 San Joaquin River and Delta

Hydrologic Alteration

The larger dams on the San Joaquin River and its tributaries generally capture peak flows and alter downstream flow regimes, sometimes increasing flows, such as downstream of Crocker-Huffman Diversion Dam in the Merced River, but typically decreasing flows (Cain et al. 2003). The dams also capture sediment that would otherwise move downstream and, together with channel and riverbank alterations, have altered geomorphic processes. Construction of in-channel diversions each year by the Cowell Agreement diverters also affects channel morphology and river substrate composition, which in turn adversely affects habitat for aquatic biota, including anadromous salmonids. The dry reach of the San Joaquin River below the Gravelly Ford Canal has caused the degradation of large stretches of riverside habitat and wetlands, and has nearly eliminated the historic Chinook salmon run of about 15,000 fish each year (Cain et al. 2003). 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).

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 2013c). 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 almost no upstream migrant steelhead 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 2013c). Flow alterations may also affect straying of salmonids from other rivers into the Tuolumne River (TID/MID 2013c).

The extent of historical flooding in Central Valley rivers was vast (Kelley 1989), and the timing of juvenile Chinook salmon outmigration would have allowed them 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 2013c).

Physical Habitat Alteration

Few locations in the eastern and central Delta provide suitable habitat for rearing salmonids (TID/MID 2013c). 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 2013c). 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 (USBOR 2008), suggesting that loss of historical floodplain habitat access in the Delta may have effects upon steelhead rearing and 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 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.

Effects on Fish Resources

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 2013c) (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

Land use and dams have contributed to effects on water quality in the Tuolumne River basin (McBain & Trush 2000, 2004), the Lower San Joaquin River, and the Delta.

4.4.1.2.1 Water Temperature

As discussed in Section 4.3.2, reservoir inflow temperatures vary considerably primarily due to local meteorological and geophysical conditions.

Temperature and other potential water quality impacts on aquatic resources, primarily DO, in the lower Tuolumne River have generally been limited to late spring through early fall. Temperature modeling was also conducted to evaluate the reach of the Tuolumne River from La Grange Dam to the confluence with the San Joaquin River. Water temperatures in this reach are typically affected more by meteorological conditions than they are by changes in flows, with anthropogenic flow reductions considered to have an effect on water temperatures in this reach only during June (TID/MID 2013x).

Water quality and 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 2013c). No evidence of Chinook salmon pre-spawning mortality has been identified in the lower Tuolumne River (TID/MID 2013c). No instances of water temperature related mortality for any fish species have been observed in the lower Tuolumne River (TID/MID 2013c).

Because the majority of adult steelhead migration occurs from November through March, when water temperatures are low, temperature-related effects on steelhead arrival timing and pre-spawn mortality are unlikely (TID/MID 2013c).

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 2013c), and Myrick and Cech (2001) suggested that only the earliest spawners arriving in the 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 suitable water temperature conditions for Chinook salmon egg incubation. 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.

Rotary screw trap (RST) information indicates 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 provisions resulting from the 1996 FERC Order help maintain appropriate water temperatures during rearing and outmigration phases.

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 2013c). However, available information indicates that juvenile *O. mykiss* rearing habitat may potentially 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 2013c). Increased densities and downstream distribution of juvenile *O. mykiss* have been documented since implementation of increased summer base flows under the 1996 FERC Order, and during years with extended flood control releases (TID/MID 2013c).

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 occurring late in the spring (TID/MID 2013c). Increased summer base flows and stable summer temperatures in the Tuolumne River since 1996 appear to select for a largely resident *O. mykiss* life history (TID/MID 2013c).

Water temperature and quality 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 2013c). 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 historical Delta smolt survival studies from 1983–1992 (TID/MID 2013c). 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 2013c).

4.4.1.2.2 Dissolved Oxygen

Beginning in the 1960s, CDFW documented potentially adverse effects of low DO levels on adult salmon in the lower San Joaquin River. 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 of the months with low DO. 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 migratory 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 biological oxygen demand (BOD) exceeds the capacity of the Aeration Facility to help meet the DO objective in some portions of the DWSC. Comparing 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 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 time pulse flow releases from the San Joaquin River tributaries (Brunell et al. 2010). However, the response of the DO in the DWSC is complex and difficult to predict solely by flow management; other factors, such as BOD or temperature, also influence DO.

4.4.1.2.3 Nutrients and Contaminants

Shoreline protection measures at Don Pedro Reservoir, including prohibition of shoreline disturbances and off-road vehicle use on Project lands, may benefit 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 in the lower Tuolumne River.

The CDPR 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). 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. 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*), dichlorodiphenyldichloroethylene (DDE), mercury, temperature, selenium, electrical conductivity, and several pesticides, both upstream and downstream of the Merced River confluence.

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 2013c). 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 2013c).

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 (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 2013c).

4.4.1.3 Connectivity and Entrainment

4.4.1.3.1 Upstream Migration Barriers

Dams throughout the San Joaquin River and it 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 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). Currently, La Grange Dam is a complete barrier to upstream migration of fall-run Chinook, Central Valley steelhead, and other migratory fish species in the Tuolumne River. The uppermost extent of anadromy in the San Joaquin River basin is at the base of the Crocker-Huffman Diversion Dam on the Merced River (Cain et al. 2003).

4.4.1.3.2 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 2013c). Therefore, significant mortality due to entrainment of juvenile Chinook in the lower Tuolumne River is considered unlikely (TID/MID 2013c). 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. Water exports at the SWP and CVP facilities also affect food supplies for juvenile Chinook salmon that are rearing in the Delta, and the presence of these facilities creates lentic habitats that support the persistence of non-native fish species.

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 2013c), and salvage losses of Chinook salmon entrained into the SWP and CVP increase with increasing export flows (TID/MID 2013c

4.4.1.4 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).

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 a large percentage of annual escapement could consist of hatchery-reared fish.

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). Two facilities, the Merced and Mokelumne hatcheries, because of their proximity to the Tuolumne River may be more likely than other stocks to stray into the lower Tuolumne River, and thereby contribute to cumulative effects on aquatic resources, primarily anadromous salmonids and their EFH.

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[16]. Natural and hatchery contributions to historical escapements are not available prior to the CFM years (Newman and Hankin 2004).

Hatchery origin fish represent a large proportion of the Central Valley fall-run Chinook salmon harvest (TID/MID 2013c). 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). 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 2013c).

There is no evidence that the introduction of hatchery fish has altered the run timing of Chinook salmon in the Tuolumne River. However, 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 2013c). 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 (e.g., TID/MID

[16] 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.

2011b), suggesting that any hatchery influences on Tuolumne River spawner fecundity and spawning success are minor (TID/MID 2013c).

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 2013c). 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 2013c).

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.

4.4.1.5 Introduced Species and Predation

Predation on native salmonids in the lower Tuolumne River is influenced by channel modifications that have created habitats that support non-native piscivores. Reductions in flood frequency resulting from the construction of large upriver reservoirs have increased predator habitat suitability within in-channel pits and SRPs created by mining (Orr 1997; McBain & Trush 2000; Ford and Brown 2001). 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 for the SRP 9 predator isolation 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 2013c). Apparent variations in the relationship between springtime 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 2013c). 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 2013g).

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.

No data exist to document the degree of piscine or avian predation of juvenile *O. mykiss* in the lower Tuolumne River. However, predation risk is likely low because *O. mykiss* distribution during summer is generally restricted to cool water locations upstream of Roberts Ferry Bridge (RM 39.5), and 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 2013c).

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 2013c). 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 2013c).

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 2013c).

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.

4.4.1.6 Benthic Invertebrates and Fish Food Availability

Although analysis of historical drift samples and stomach contents of rearing juvenile Chinook salmon indicates adequate food resources for juvenile rearing (TID/MID 2013c), analysis of long-term Hess sampling data gathered from 1988-2009 at Riffle 4A (RM 48.8) in the lower Tuolumne River indicate 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 introductions (TID/MID 2013c).

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 2013c) 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 2013c).

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.

4.4.1.7 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 2013c). 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 2013c). Illegal harvest of resident *O. mykiss* could occur year-round, but there is no estimate of its extent in the Tuolumne River.

4.4.1.8 Synthesis of Effects Occurring within the Geographic Scope for Aquatic Resources Cumulative Effects

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 (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 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 2009b).

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 2013c). 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 2013c). 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 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 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

A discussion of cumulative impacts on socioeconomic issues will be included in the FLA.

5.0 DEVELOPMENTAL ANALYSIS

The Developmental Analysis section of the FLA will contain the economic analysis of Project operations and maintenance under the current license and under the Districts' proposed future plan of operations, including any new resource protection, mitigation and enhancement (PM&E) measures. This section will also contain the economic analysis of PM&E measures that may be proposed by relicensing participants. Lastly, the developmental analysis will provide the estimate of the value of developmental resources associated with the Project under the current license and under the Districts' proposal for future operations.

The DLA has identified certain resource PM&E measures, over and above current PM&E measures, that the Districts are proposing to undertake during the term of the new FERC license. These are:

- implementation of a Historic Properties Management Plan (HPMP) to resolve concerns with and protect cultural resources,
- implementation of a Bald Eagle Management Plan; and
- implementation of a Vegetation Management Plan to protect sensitive species and manage invasive plant species.

These plans are under development and draft plans will be included in the FLA. The annual and any capital costs associated with these plans will be provided in the FLA. Potential additional environmental PM&E measures are continuing to undergo evaluation using the suite of site-specific and river-specific models created during the relicensing process to inform the development of any future license requirements. The FLA may contain additional measures proposed by the Districts that are shown to balance resource protection and the economic welfare of affected water and power customers.

In 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 have developed a suite of five (5) core project- and river-specific computer models to evaluate alternative operational scenarios. These models are:

- Tuolumne River Operations Model,
- Don Pedro Reservoir Temperature Model,
- Lower Tuolumne River Temperature Model,
- Tuolumne River Fall-run Chinook Population Model, and
- Tuolumne River *O.mykiss* Population Model.

The development of each of these models included the conduct of Consultation Workshops with relicensing participants to share information, encourage dialogue, and obtain interim review and comment on model architecture, parameters, and methodologies during the model development process. In total, 16 Workshops were held with relicensing participants over the two year period of model development. This programmatic consultation has been documented in a series of Workshop Meeting Notes, all of which have been previously filed with FERC. This documentation is also included as part of this DLA.

Three additional models have been developed that are also intended to aid informed decision-making. The Districts have 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 more recent years. This model may be used to assess the effects of alternative scenarios to gravel availability. The Districts have also developed an Instream Flow Model for the lower Tuolumne River to assess flow and habitat relationships for fall-run Chinook and *O.mykiss*, and a socioeconomic model for the purpose of estimating the effects to the economic welfare of local and regional affected populations resulting from any potential water supply changes. The City and County of San Francisco (CCSF) has developed a model for purposes of evaluating socioeconomic effects in its Bay Area service area from potential water supply changes resulting from flow alternatives.

All of the Districts' models referenced above are described in detail in separate reports. Together, these models provide an in-depth, site-specific analysis of the Tuolumne River, the Don Pedro Project, and affected resources and populations. In addition, the Operations Model includes the water supply operations of the CCSF's Hetch Hetchy Water System (see Exhibit B of this application).

The models work together to enable users to understand the interrelationships among Don Pedro operations, river flows, reservoir and river temperatures, salmonid habitat and in-river life stages, and the effects of alternative operations on each of these resources. Each model has gone through calibration and validation processes, and the "base case" conditions have been established. The "base case" under FERC's procedures and protocols represents the scenario of future operations under the current conditions. Specifically for 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 not yet fully implemented. The base case is considered the "no action" alternative under FERC's assessment of the effects of alternative operational scenarios. Each of the five core models utilizes the same agreed-upon hydrology covering the 1971 through 2012 period.

The models are designed to operate in tandem, with the output of one providing input to the next. The Operations Model represents the Districts' physical operation of the Don Pedro Project in accordance with the current FERC license requirements for protection of aquatic resources, relevant provisions of the Raker Act and Fourth Agreement between the Districts and CCSF, the ACOE's Flood Control Manual, meeting the water supply needs of the Districts' customers, and Hetch Hetchy Water System operations. The base case can be modified in any number of ways to evaluate alternative operating scenarios. Each alternative scenario results in a new model output that provides any resulting changes to reservoir inflows, reservoir releases, reservoir water levels, and water supply to the Districts' customers. The Operations Model output becomes the input to the Don Pedro Reservoir Temperature Model, a detailed three-dimensional (3-D) depiction of the reservoir used to predict any change in reservoir thermal regime and outflow temperatures resulting from changed operations. The reservoir temperature model and Operations Model feed the lower Tuolumne River temperature model, which in turn provides flow and temperature input to the in-river fall-run Chinook and/or *O.mykiss* models. Changes in water supply to the District or CCSF can then be used as inputs into the respective socioeconomic models to estimate consequences to local and regional economic welfare.

All of the models have now been completed in accordance with the FERC-approved study plans and are available for use. The Districts have provided user manuals and/or training in the use of the Operations Model and temperature models, and have offered such training for use of the two salmonid models. The Districts are using the models to evaluate a range of alternative operational scenarios. The FLA will evaluate alternative proposals for future Project operations.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Comparison of Alternatives

A comparison of alternatives, conclusions and recommendations will be included in the FLA.

6.2 Consistency with Comprehensive Plans

Applicable comprehensive plans were discussed in the PAD. An updated list and review of consistency will be included in the FLA.

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Section 2.0: Proposed Action and Alternatives

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Section 5.0: Developmental Analysis

No References Listed

Section 6.0: Conclusions and Recommendations

No References Listed