LA GRANGE HYDROELECTRIC PROJECT
FERC NO. 14581

FINAL LICENSE APPLICATION

EXHIBIT E – ENVIRONMENTAL REPORT

WATER & POWER
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Modesto Irrigation District
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List of Acronyms and Abbreviations

°C ....Degrees Celsius

°F...............................Degrees Fahrenheit

ACOE.........................U.S. Army Corps of Engineers

ac-ft ....acre-feet

AFLA ....Amendment to the Final License Application

AFRP..........................Anadromous Fish Restoration Program

APE ....area of potential effect

BLM...........................Bureau of Land Management

CCSF..........................City and County of San Francisco

CCV ....California Central Valley

CCVHJV ....California Central Valley Habitat Joint Venture

CDEC.........................California Data Exchange Center

CDFA.........................California Department of Food and Agriculture

CDFG.........................California Department of Fish and Game, now CDFW

CDFW........................California Department of Fish and Wildlife

CDPR ....California Department of Parks and Recreation

CDWR........................California Department of Water Resources

CESA ....California Endangered Species Act

CFR............................Code of Federal Regulations

cfs...............................cubic feet per second

CHTR……………….Collection, Handling, Transport and Release

CI................................confidence interval

cm...............................centimeter

CNDDB......................California Natural Diversity Database

CNPS..........................California Native Plant Society

CVRWQCB ....Central Valley Regional Water Quality Control Board

CWA ....Clean Water Act

Districts......................Turlock Irrigation District and Modesto Irrigation District

DLA ....Draft License Application

DO..............................dissolved oxygen

DPRA.........................Don Pedro Recreation Agency

DPS ....Distinct Population Segment
EFH ....Essential Fish Habitat
EIR ....Environmental Impact Report
EIS..............................Environmental Impact Statement
EPA ....Environmental Protection Agency
ESA ....Endangered Species Act
ESU ....Evolutionarily Significant Unit
ETo.............................evapotranspiration
FERC..........................Federal Energy Regulatory Commission
FFS ....Foothills Fault System
FLA ....Final License Application
FPA ....Federal Power Act
Framework ....Upper Tuolumne River Reintroduction/Fish Passage Assessment Framework process
ft ....foot/feet
g..................................gram
GIS ....Geographic Information System
HPMP.........................Historic Properties Management Plan
in ....inch
ILP..............................Integrated Licensing Process
ISR ....Initial Study Report
LGDD ....La Grange Diversion Dam
LWD ....large woody debris
M&I............................municipal and industrial
mg/L ....milligram/liter
mi^2 ....square mile
MID............................Modesto Irrigation District
ml ....milliliter
mm ....millimeter
MW ....megawatt
MWAT ....Maximum Weekly Average Temperature
MWh ....megawatt-hours
n..................................number

NGO ....non-governmental organization
NEPA ....National Environmental Policy Act
NMFS..........................National Marine Fisheries Service
NRHP..........................National Register of Historic Places
NTU ....nephelometric turbidity unit
NWI.............................National Wetland Inventory
NWIS ....National Water Information System
O&M...........................operation and maintenance
PAD.............................Pre-Application Document
PM&E ....protection, mitigation, and enhancement
POAOR ....Public Opinions and Attitudes in Outdoor Recreation
Project ....La Grange Hydroelectric Project
PRV.............................pressure relief valve
PSP..............................Proposed Study Plan
RM ....river mile
RSP ....Revised Study Plan
SB................................Senate Bill
SCORP ....State Comprehensive Outdoor Recreation Plan
SD1 ....Scoping Document 1
SD2 ....Scoping Document 2
SFPUC ....San Francisco Public Utilities Commission
SHPO ....State Historic Preservation Officer
SSJNWA ....Sierra-San Joaquin Noxious Weeds Alliance
SPD ....Study Plan Determination
SWRCB.......................State Water Resources Control Board
TID..............................Turlock Irrigation District
TLP ....Traditional Licensing Process
TM...............................technical memorandum
UOWTI ....Upper Optimum Water Temperature Index
USDA..........................United States Department of Agriculture
USFS ....United States Forest Service
USFWS ....United States Fish and Wildlife Service
USGS ....United States Geological Survey

USR............................Updated Study Report

UTWTI.......................Upper Tolerable Water Temperature Index

WRCC........................Western Regional Climate Center

WSNMB ....Western Sierra Nevada Metamorphic Belt

WTI ....water temperature index

WY ....water year

EXHIBIT E – ENVIRONMENTAL REPORT

EXCERPT FROM CODE OF FEDERAL REGULATIONS (CFR) DESCRIBING CONTENTS OF THE EXHIBIT (18 CFR §4.61)

(d) Exhibit E is an Environmental Report.
(2) For minor projects and major projects at existing dams 5 MW or less. An application for license for either a minor water power project with a total proposed installed generating capacity of 1.5 MW or less or a major project—existing dam with a proposed total installed capacity of 5 MW or less must contain an Exhibit E under this subparagraph. See §4.38 for consultation requirements. The Environmental Report must contain the following information:
(i) A description, including any maps or photographs which the applicant considers appropriate, of the environmental setting of the project, including vegetative cover, fish and wildlife resources, water quality and quantity, land and water uses, recreational uses, historical and archeological resources, and scenic and aesthetic resources. The report must include a discussion of endangered or threatened plant and animal species, any critical habitats, and any sites included in, or eligible for inclusion in, the National Register of Historic Places. The applicant may obtain assistance in the preparation of this information from state natural resources agencies, the state historic preservation officer, and from local offices of Federal natural resources agencies.
(ii) A description of the expected environmental impacts from proposed construction or development and the proposed operation of the power project, including any impacts from any proposed changes in the capacity and mode of operation of the project if it is already generating electric power, and an explanation of the specific measures proposed by the applicant, the agencies, and others to protect and enhance environmental resources and values and to mitigate adverse impacts of the project on such resources. The applicant must explain its reasons for not undertaking any measures proposed by any agency consulted.
(iii) A description of the steps taken by the applicant in consulting with Federal, state, and local agencies with expertise in environmental matters during the preparation of this exhibit prior to filing the application for license with the Commission. In this report, the applicant must:
(A) Indicate which agencies were consulted during the preparation of the environmental report and provide copies of letters or other documentation showing that the applicant consulted or attempted to consult with each of the relevant agencies (specifying each agency) before filing the application, including any terms or conditions of license that those agencies have determined are appropriate to prevent loss of, or damage to, natural resources; and
(B) List those agencies that were provided copies of the application as filed with the Commission, the date or dates provided, and copies of any letters that may be received from agencies commenting on the application.

PREFACE

Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) are filing this final application for license with the Federal Energy Regulatory Commission (Commission or FERC) for the existing La Grange Hydroelectric Project (Project) located on the Tuolumne River in the Central Valley of California. This Exhibit E, the Environmental Report of the Final License Application (FLA), is prepared in accordance with 18 CFR §4.61.

The following sections describe the La Grange Project facilities, including elements associated with hydropower generation (Project facilities) and non-Project features which are those operated by the Districts to achieve the primary purpose of the La Grange Project, which is diverting water for irrigation and municipal and industrial (M&I) uses. Hydroelectric generation is a secondary purpose of the La Grange Project. Water diversions at the La Grange Project are not dependent on the issuance of a FERC license and will occur with or without the licensing of the hydropower facilities.

1.0 INTRODUCTION

Exhibit E provides an environmental analysis by resource area. For each resource area, the existing environment is described. The Districts have developed the information on environmental resources contained in this license application in consultation with state and federal fish and wildlife agencies, local governments, Tribes, non-governmental organizations (NGO), and members of the public. Exhibit E is supported by data and analysis from a number of studies conducted by the Districts in support of the Project licensing process (Table 1.0-1), as well as resource studies submitted by the Districts as part of the upstream Don Pedro Hydroelectric Project (Federal Energy Regulatory Commission [FERC] No. 2299) (Don Pedro Project) relicensing process and referenced herein. The Districts have implemented a total of 13 individual studies as part of the Project licensing process and final study reports or technical memoranda for each of the studies listed are attached to this FLA. Numerous other studies of the resources of the Tuolumne River conducted by the Districts prior to the relicensing of the Don Pedro Project are also relevant to the La Grange licensing process.

The Districts jointly own the La Grange Diversion Dam (LGDD) located on the Tuolumne River in Stanislaus County, California (Figures 1.0-1 and 1.0-2). LGDD is 131 feet (ft) high and is located at river mile (RM) 52.2 at the exit of a narrow canyon, the walls of which contain the headpond[1] formed by the diversion dam. Under normal river flows, the headpond formed by the diversion dam extends for roughly 2 miles upstream. When not in spill mode, the water level upstream of the diversion dam is between elevation 294 feet and 296 feet approximately 90 percent of the time. Within this 2-foot range, the headpond storage is estimated to be less than 100 acre-feet (ac-ft) of water.

The drainage area of the Tuolumne River upstream of LGDD is approximately 1,550 square miles. Tuolumne River flows upstream of LGDD are regulated by four reservoirs: Hetch Hetchy, Lake Eleanor, Cherry Lake (also known as Lake Lloyd), and Don Pedro. The Don Pedro Project is owned jointly by the Districts, and the other three dams are owned by City and County of San Francisco (CCSF) and operated by the San Francisco Public Utilities Commission (SFPUC). Inflow to the La Grange headpond is the sum of releases from the Don Pedro Project, located 2.3 miles upstream, and very minor contributions from two small intermittent drainageways downstream of Don Pedro Dam.

LGDD was constructed from 1891 to 1893 displacing Wheaton Dam, which was built by other parties in the early 1870s. LGDD raised the level of the Tuolumne River to permit the diversion and delivery of water by gravity to irrigation systems owned by TID and MID. The Districts' irrigation systems currently provide water to over 200,000 acres of prime Central Valley farmland and drinking water to the City of Modesto. Built in 1924, the La Grange hydroelectric plant is located approximately 0.2 miles downstream of LGDD on the east (left) bank of the Tuolumne River and is owned and operated by TID. The powerhouse has a capacity of 4.7 megawatts (MW). The Project operates in run-of-river mode. The LGDD provides no flood control benefits, and there are no recreation facilities currently associated with the Project or the

[1] La Grange "pool" and La Grange "headpond" are used interchangeably. Both terms describe the same geographic area and Project facility.

La Grange headpond. A shoreline walking trail is proposed for installation and further detail about this proposed recreational facility is provided in Section 3.8 of this Exhibit E.

Table 1.0-1. Resource studies associated with the La Grange Hydroelectric Project licensing process.

No	Study	Final Report
1	Salmonid Habitat Mapping[1,2]	February 2016
2	Effects of the Project and Related Activities on the Losses of Marine-Derived Nutrients in the Tuolumne River Study[2]	February 2016
3	Topographic Survey[1,2]	February 2017
4	Upper Tuolumne River Basin Fish Migration Barriers Study[1,3]	February 2017
5	Hatchery and Stocking Practices Review[3]	February 2017
6	Recreation Access and Safety Assessment[2]	April 2017
7	Flow Records for Five Discharge Structures at the La Grange Project[1,2]	September 2017
8	La Grange Project Fish Barrier Assessment[1,2]	September 2017
9	Fish Presence and Stranding Assessment[1,2]	September 2017
10	Investigation of Fish Attraction to La Grange Powerhouse Draft Tubes[1,2]	September 2017
11	Fish Passage Facilities Alternatives Assessment[1,2]	September 2017
12	Upper Tuolumne River Basin Water Temperature Monitoring and Modeling Study[1,3]	September 2017
13	Cultural Resources Study[2]	September 2017

[1] Component of the Fish Passage Assessment.
[2] Approved by FERC in the Commission's February 2, 2015, Study Plan Determination.
[3] Study was conducted voluntarily by the Districts.

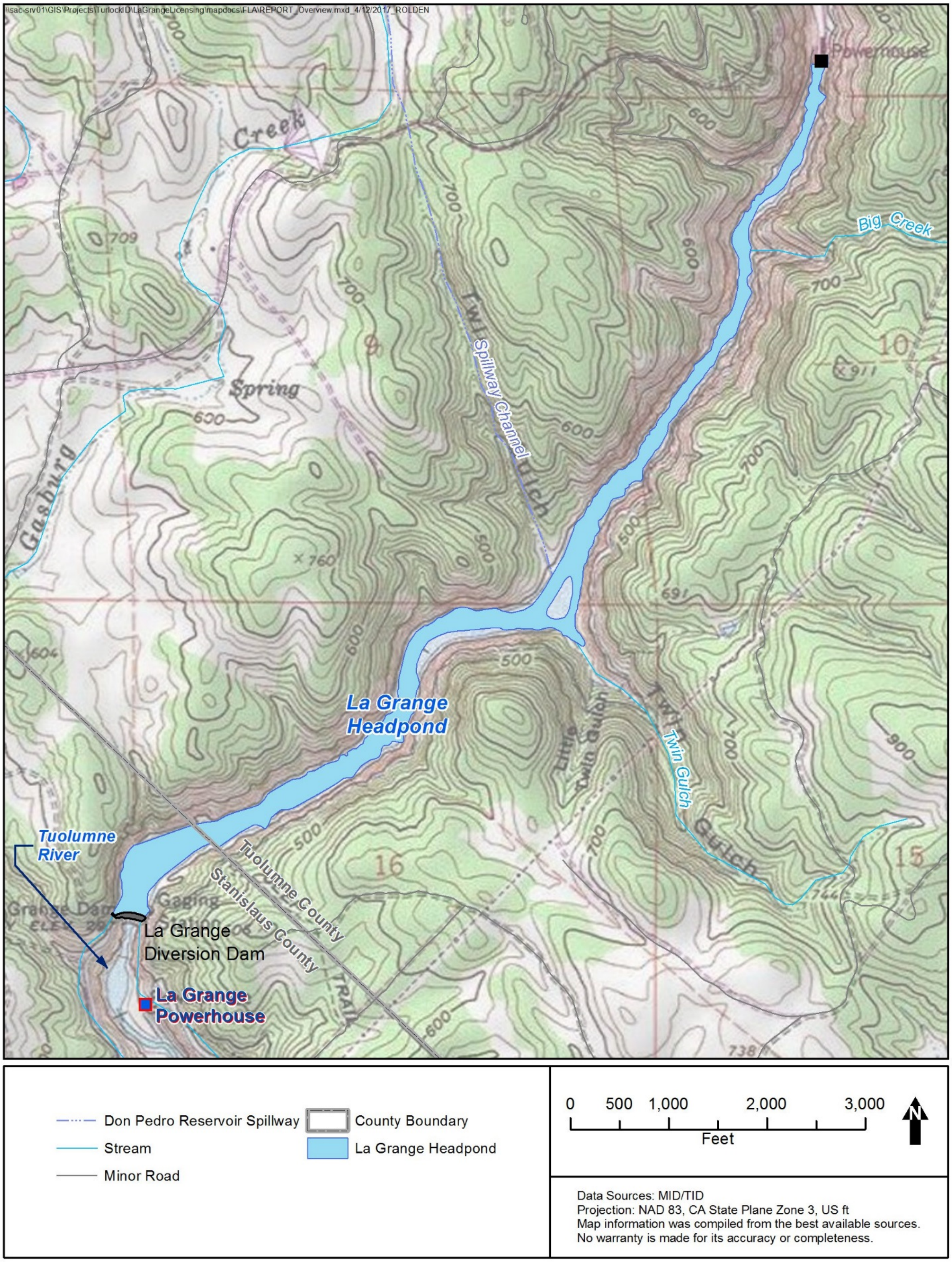

Figure 1.0-1. La Grange Hydroelectric Project site location map.

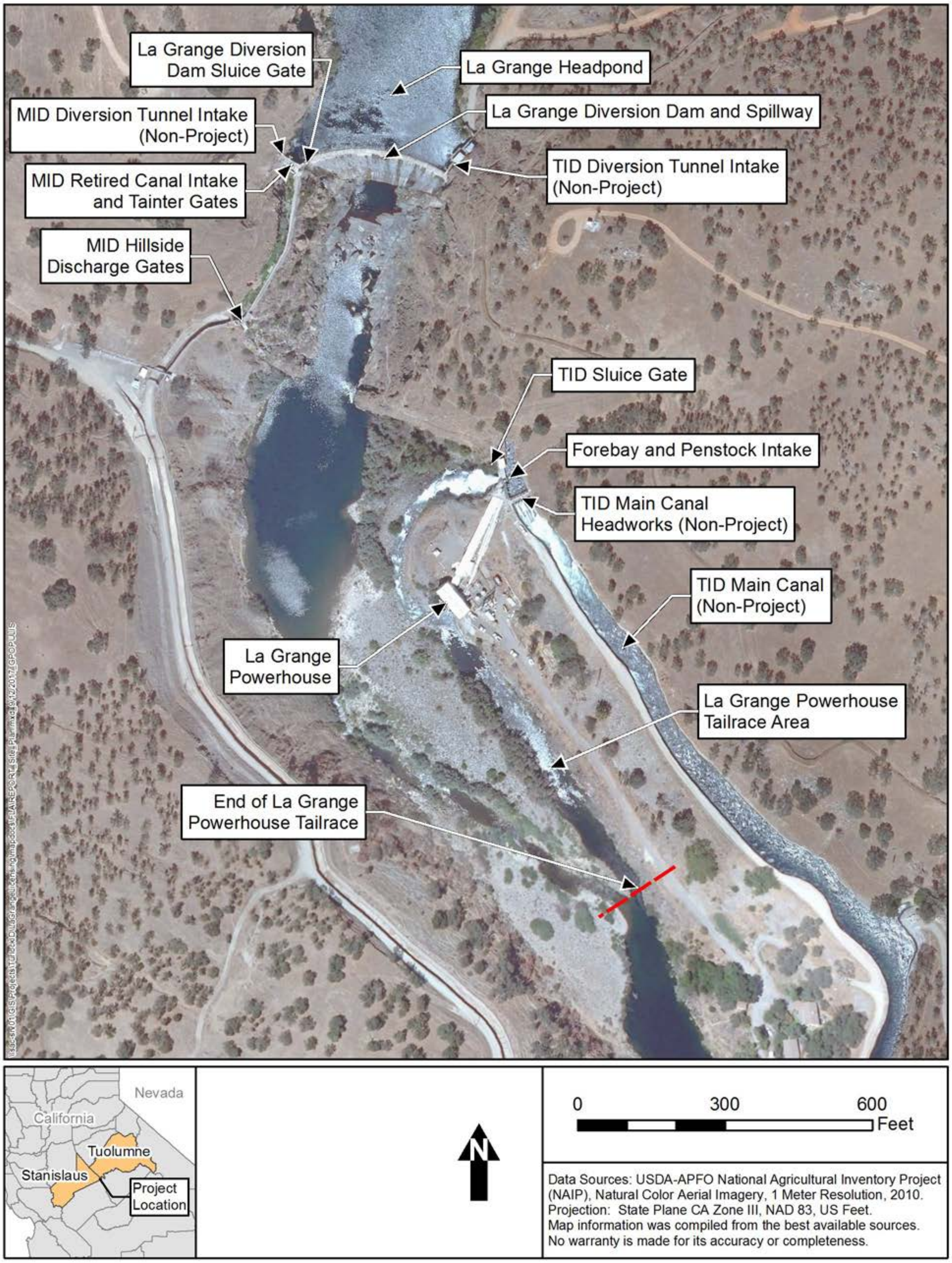

Figure 1.0-2. La Grange Hydroelectric Project site plan.

1.1 Purpose of Action and Need for Power

1.1.1 Purpose of Action

FERC is the federal agency authorized to issue licenses for the construction, operation, and maintenance of the nation's non-federal hydroelectric facilities. In accordance with the Federal Power Act (FPA), as amended, FERC is able to issue such licenses for a period not less than 30 years, but no more than 50 years. Under the FPA, FERC issues licenses that 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, irrigation, recreation, 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 define the specific Proposed Action it is considering and state the purpose and need for the Proposed Action.

In the case of the Project, the Proposed Action under review by FERC is the issuance of an original license to the Districts to authorize the generation of hydroelectric power by TID at the existing La Grange powerhouse.

1.1.2 Need for Power

Issuing an original license for the Project will authorize the generation of hydroelectric power for the term of the license, producing low-cost electricity from a non-polluting renewable resource.

The electricity generated by the Project is important to the State of California. In January 2016, the California Energy Commission issued the California Energy Demand 2016–2026, Revised Electricity Forecast. The updated forecast presents low, mid, and high forecasts for the state: average annual growth rates for electricity consumption for 2014–2026 are 0.54 percent, 0.97 percent, and 1.27 percent, respectively (Kavalec et al. 2016).

The electricity generated by the Project also helps the State of California to achieve targets set for the use of renewable energy sources. California State Senate Bill 350 (SB 350) revised the California State Renewables Portfolio Standard Program and required the State to obtain 50 percent of its energy from renewable energy resources by 2030. As a hydroelectric generation facility of less than 30 MW, the Project meets the qualifications for a renewable energy resource under SB 350.

1.2 Statutory and Regulatory Requirements

1.2.1 Federal Power Act

The issuance of an original license for the Project is subject to numerous requirements under the FPA and other applicable statutes. Potentially applicable statutes and regulatory requirements are summarized below in chronological order based on date of enactment of the applicable statute. Actions undertaken by the Districts or the agency with jurisdiction related to each requirement are described below, or an explanation is provided as to why the statute is not applicable to the Proposed Action.

1.2.1.1 Section 18 Fishway Prescription

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 may prescribe. The Districts 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 Integrated Licensing Process (ILP) for the Project. In its Scoping Document 2 (SD2), FERC identified the effects of the Project on upstream and downstream migration of anadromous fish as a potential resource issue.

1.2.1.2 Section 4I Conditions

According to the order finding the Project to be subject to FERC's jurisdiction, the Project occupies U.S. lands administered by the Bureau of Land Management (BLM). Section 4I of the FPA gives the Secretary of the land administering agency authority to prescribe conditions on licenses issued by FERC for hydropower projects located on "reservations" under the Secretary's supervision (16 U.S.C. §§ 796(2), 797I). The Districts have consulted with the BLM during 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 may include conditions based on recommendations of federal and state fish and wildlife agencies for the protection, mitigation, or enhancement (PM&E) of fish and wildlife resources affected by the Project, unless FERC determines such conditions are inconsistent with the purposes and requirements of the FPA or other applicable law. During the Project licensing proceeding, the Districts have consulted with NMFS, the USFWS, and the California Department of Fish and Wildlife (CDFW).

1.2.1.4 Section 30I 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 licensing of the Project.

1.2.2 Clean Water Act

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

Within 60 days following FERC's Notice of Acceptance and Ready for Environmental Analysis, an application will be filed requesting a Section 401 Water Quality Certificate from the SWRCB.

The Project's compliance with the CWA is described in Section 3.4 of this Exhibit E.

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 licensing the Project, and therefore must consult with the USFWS and NMFS to determine whether its actions would jeopardize the continued existence of any endangered or threatened species or adversely affect any designated critical habitat. Jeopardy exists when an action would "…appreciably reduce the likelihood of both the survival and recovery of a listed species…" (50 CFR § 402.02). Consultation involves a request to the USFWS and NMFS for an inventory of endangered and threatened species, and species proposed by USFWS or NMFS for listing as endangered or threatened that may be present in the vicinity of the Project. Pursuant to Section 7(a)(3) of the ESA, FERC then prepares a biological assessment to determine whether these listed species or their critical habitats are likely to be adversely affected by the federal action. At the end of the consultation process, the USFWS or NMFS (or both) issue a biological opinion that specifies whether or not the action will place an endangered or threatened species or its 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 on a threatened or endangered species associated with the taking of the species, mitigation measures, and terms and conditions for implementation of the mitigation measures.

On May 23, 2014, FERC initiated informal consultation with the USFWS and the NMFS under Section 7 of the ESA and the joint agency regulations thereunder at 50 CFR, Part 402, and designated the Districts as FERC's non-federal representatives for carrying out informal consultation. The Districts consulted with USFWS and NMFS in developing the study plans for the Project, requested review of study reports, and conducted numerous workshops relating to anadromous fish during the licensing process.

Rare, threatened, and endangered species at the Project are described in Section 3.7 of this Exhibit E.

1.2.4 Coastal Zone Management Act

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

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

1.2.5 National Historic Preservation Act

FERC licenses may permit activities that may "…cause changes in the character or use of historic properties, if any such historic properties exist…" (36 CFR § 800.16[d]). FERC must therefore comply with Section 106 of the National Historic Preservation Act of 1966, as amended, (54 U.S.C. 300101 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 licensing of the Project) (36 CFR § 800).

On May 23, 2014, FERC designated the Districts as its non-federal representatives for purposes of consultation during the licensing under Section 106 of the National Historic Preservation Act and associated regulations found at 36 CFR § 800.2I(4). As FERC's non-federal representatives, the Districts have consulted during the Project licensing with potentially affected Tribes, BLM, and the State Historic Preservation Officer (SHPO), including obtaining the SHPO's agreement that the area of potential effects (APE) was sufficient for the proposed undertaking, per 36 CFR § 800.4(a)(1). SHPO provided this agreement on the APE in a letter dated July 8, 2016. Consultation efforts included a kick-off meeting held on June 27, 2016 in which all agency and tribal participants were invited, including SHPO, BLM, and FERC. The Tuolumne Band of Me-Wuk Indians, FERC, and the Districts participated in this meeting. Further efforts included providing tribal monitors to participate in the field inventory of the APE. To assist FERC in identifying historic properties that may be affected by the Project, as required under Section 106, the Cultural Resources Study Report (TID/MID 2017b) was submitted to potentially affected Tribes and the BLM for review and will be submitted to SHPO for review and concurrence before it is filed with FERC. The effects of the Project on historic properties are described in Section 3.10 of this Exhibit E. The Districts have also prepared a draft Historic Properties Management Plan (HPMP) in consultation with Tribes, BLM, and SHPO to manage potential effects on historic properties throughout the term of an original license (filed as Privileged [TID/MID 2017d]).

1.2.6 Wild and Scenic Rivers Act

Congress formally designated portions of the upper Tuolumne River, upstream of the Don Pedro Project Boundary, as Wild and Scenic by PL98-425 on September 28, 1984. All sections of Wild and Scenic River within the Tuolumne River basin are far upstream of the Project and as a result will not be affected by the Proposed Action in this FLA. However, if anadromous fish restoration in the upper Tuolumne River were to proceed, there may be effects to resources and use of Wild and Scenic River reaches.

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

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

Anadromous fishery resources at the Project are described in Section 3.5 of this Exhibit E. In addition, the Districts have prepared a Biological Assessment for California Central Valley Steelhead (*O. mykiss*) and EFH Assessment for fall-run Chinook salmon (*O. tshawytscha*) (TID/MID 2017a) that is attached to this FLA.

1.3 Public Review and Consultation

1.3.1 Pre-Application Document

The Districts began the multi-year licensing process for the Project by filing a Pre-Application Document (PAD) with FERC on January 29, 2014. The Districts' PAD included descriptions of the Project facilities and operations. It also contained a summary of the extensive amount of information available on water resources; fish and aquatic resources; terrestrial and wildlife resources; rare, threatened, and endangered species; recreation and land use; cultural resources; and socioeconomic resources relevant to the Project. A preliminary assessment of the resource effects of Project operations was also provided in the PAD. The Districts distributed the PAD to federal and state resource agencies, NGOs, local governments, Tribes, and other licensing participants.

1.3.2 Discussion of Licensing Process with Interested Participants

On January 29, 2014, the Districts requested that FERC approve use of the Traditional Licensing Process (TLP) for licensing the Project, instead of the default ILP. The due date for comments on the TLP request was February 28, 2014. The Districts hosted a meeting with interested participants to discuss the possible use of the TLP instead of the ILP. Representatives from NMFS, USFWS, CDFW, SWRCB, California Sportfishing Protection Alliance, Tuolumne River Trust, CCSF, and Friends of the River attended the meeting.

Attendees at the meeting requested a 21-day extension to the February 28, 2014 deadline for comments on the Project TLP request. The Districts agreed to seek additional time and on February 25, 2014 filed with FERC a request for a three-week extension to the due date for comments. In letters dated February 26 and 27, 2014, CDFW and NMFS, respectively, filed letters supporting the use of the ILP. On February 28, 2014, FERC extended the deadline for comments to March 21, 2014.

On March 21, 2014, NMFS and the Conservation Groups[2] filed comment letters declining to adopt the TLP and supporting use of the ILP for licensing the Project. On March 24, 2014, the Districts stated they did not object to use of the ILP and, subject to FERC's final decision, would plan to proceed using the ILP. On April 17, 2014, FERC established March 24, 2014 as the pre-filing process start date for the ILP.

1.3.3 Scoping

Following the Districts' submittal of the PAD, FERC conducted scoping to identify issues and alternatives to be addressed during the licensing process. Commission staff conducted two public scoping meetings in Turlock and Modesto, California, on June 18, 2014. The purpose of scoping was to identify the significant environmental issues to be evaluated in FERC's environmental assessment.

FERC issued Scoping Document 1 (SD1) on May 23, 2014, to solicit comments on the scope of environmental studies in the licensing process, and to encourage participation in the licensing process. SD1 was noticed in the Federal Register on June 2, 2014 and included FERC's preliminary view of the scope of environmental issues associated with the Project. Based on verbal comments received during the two scoping meetings as well as written comments received through the scoping process, FERC issued SD2 on September 5, 2014.

[2] In its Study Plan Determination for the La Grange Hydroelectric Project dated February 2, 2015, FERC identified the following entities as comprising the Conservation Groups: American Rivers, American Whitewater, California Sportfishing Protection Alliance, California Trout, Central Sierra Environmental Resource Center, Friends of the River, Golden West Women Flyfishers, Trout Unlimited, and the Tuolumne River Trust.

1.3.4 Study Plan Development

USFWS, NMFS, SWRCB, the Conservation Groups and the Bay Area Water Supply and Conservation Agency each filed a comment letter by the deadline of July 22, 2014. USFWS, NMFS, SWRCB and the Conservation Groups submitted a total of 16 study requests. On September 5, 2014, the Districts filed their Proposed Study Plan (PSP) document with the Commission and distributed the PSP to licensing participants for review and comment. On October 6, 2014, the Districts held a PSP meeting at MID's office in Modesto, California. Based on discussions at the PSP meeting, the Districts prepared an Updated Study Plan document and provided this document to licensing participants for review on November 21, 2014. Also on November 21, the Districts provided notes from the PSP meeting to licensing participants. On December 4, 2014, NMFS, the Conservation Groups, and CDFW filed comments on the PSP and/or Updated Study Plan documents.

On January 5, 2015, in response to comments from licensing participants, the Districts filed a Revised Study Plan (RSP) containing three study plans, (1) Cultural Resources Study Plan, (2) Recreation Access and Safety Assessment Study Plan, and (3) Fish Passage Assessment Study Plan[3]. The Fish Passage Assessment contains three related elements that together comprise the entire study plan, (1) Fish Passage Facilities Assessment, (2) Upper Tuolumne River Basin Habitat Assessment, and (3) Habitat Assessment and Fish Stranding Observations below LGDD and Powerhouse. Comments on the RSP were received from CDFW on January 16, 2015, and from NMFS, the Conservation Groups, and the City of Modesto on January 20, 2015.

1.3.5 Study Plan Determination

On February 2, 2015, FERC issued the Study Plan Determination (SPD), approving or approving with modifications six studies (Table 1.3-1). Of those six studies, five had been proposed by the Districts in the RSP. The Districts note that although FERC's SPD identified the Fish Passage Barrier Assessment, Fish Passage Facilities Alternatives Assessment, and Fish Habitat and Stranding Assessment below LGDD as three separate studies, all three assessments are elements of the larger Fish Passage Assessment as described in the RSP. The sixth study approved by FERC, Effects of the Project and Related Activities on the Losses of Marine-Derived Nutrients in the Tuolumne River, was requested by NMFS in its July 22, 2014 comment letter. Of the eight studies requested by licensing participants, FERC approved only the NMFS study noted above.

In addition to the six studies noted in Table 1.3-1, the SPD required the Districts to develop a plan to monitor anadromous fish movement in the Project's powerhouse draft tubes and to determine the potential for injury or mortality from contact with the turbine runners. Per the SPD, the Districts developed a study plan in consultation with NMFS and other licensing participants. The Districts filed the Investigation of Fish Attraction to La Grange Powerhouse Draft Tubes study plan with FERC on June 11, 2015, and on August 12, 2015, FERC approved the study plan as filed.

[3] The Fish Passage Assessment Study Plan contained a number of individual, but related, study elements.

Table 1.3-1. Studies approved or approved with modifications in FERC's Study Plan Determination.

No.	Study	Approved by FERC in SPD without Modifications	Approved by FERC in SPD with Modifications
1	Recreation Access and Safety Assessment		X
2	Cultural Resources Study		X
3	Fish Passage Barrier Assessment		X[1]
4	Fish Passage Facilities Alternatives Assessment		X
5	Fish Habitat and Stranding Assessment below La Grange Dam		X
6	Effects of the Project and Related Activities on the Losses of Marine-Derived Nutrients in the Tuolumne River	X[2]	

1 Page A-1 of Appendix A of FERC's SPD states that FERC approved with modifications the Fish Passage Barrier Assessment. However, the Districts found no modifications to this study plan in the SPD. On page B-7 of the SPD states "no modifications to the study plan are recommended."
2 FERC directed the Districts to conduct the study plan as proposed by NMFS.

1.3.6 Resolution of Disputed Studies

On February 23, 2015, NMFS filed a timely request with FERC for dispute resolution with regard to two of its study requests rejected by FERC staff in the SPD. The two disputed studies were:

- Request 3 – Quantifying Existing Upper Tuolumne River Habitats for Anadromous Fish as They Pertain to Fish Passage Blockage at La Grange Dam.
- Request 4 – Effects of the Project and Related Activities on the Genetic Makeup of Steelhead/Rainbow Trout *Oncorhynchus mykiss* in the Tuolumne River.

On February 27, 2015, FERC issued a letter to NMFS stating that FERC had determined that Request 3 would not be considered by the Study Dispute Panel because it had already been afforded the Commission's formal dispute resolution process during the Don Pedro Project dispute resolution process. On May 1, 2015, FERC issued a Formal Study Dispute Determination, which stated that upon consideration of the findings and recommendations of the Study Dispute Panel, the Director of the Office of Energy Projects was not requiring the Project study plan to be modified to incorporate a genetics study.

1.3.7 Upper Tuolumne River Reintroduction/Fish Passage Assessment Framework

In 2015, as part of the Fish Passage Facilities Alternatives Assessment, significant data gaps relevant to informing the biological and engineering basis for the development of fish passage alternatives were identified and presented in the Fish Passage Alternatives Assessment: Technical Memorandum No. 1 (TID/MID 2015)[4]. The Fish Passage Facilities Alternatives

4 The Districts issued Technical Memorandum (TM) No. 1 to licensing participants on September 4, 2015 and reviewed data gaps identified in the TM at a Workshop on September 17, 2015. The Districts explained that these data gaps required

Assessment Study Report[5] (TID/MID 2017c) is attached to this FLA and provides a summary of study workshop consultation with licensing participants and site-specific considerations and potential biological and engineering criteria needed to inform the Assessment.

As a result of these data gaps related to examining the feasibility of fish passage at the La Grange and Don Pedro projects, the Districts in consultation with licensing participants, broadened the scope of the Fish Passage Facilities Alternatives Assessment to implement an Upper Tuolumne River Reintroduction/Fish Passage Assessment Framework process (Assessment Framework). The Assessment Framework was intended to provide an opportunity for obtaining and discussing information needed to inform the question of fish passage in a transparent and open forum conducive to discussing and confirming appropriate values for relevant biological and engineering parameters. It is broadly recognized that fish passage is just one component of the evaluation of benefits, risks and constraints required to evaluate the feasibility of anadromous fish restoration, which also must consider the feasibility of facilities to achieve expected performance metrics, the suitability of upstream habitat, and effects on existing uses, the availability of source populations, as well as a host of other questions.[6]

The collaborative Assessment Framework identified the various interconnected and interdependent factors that may need to be considered when determining whether undertaking the substantial and costly efforts involved in restoring fish to former habitats have merit. Simply constructing fish passage facilities does not address the more fundamental questions which relate to life cycle survival, source population stability, changes in habitat that may have occurred over time, and a host of other factors to consider. Identified Assessment Framework elements include ecological feasibility, biological constraints, and economic, regulatory, and other key considerations.

The assessment of fish passage at the La Grange and Don Pedro projects is under consideration for its potential to support the recovery of ESA-listed anadromous fish by their reintroduction to the Tuolumne River[7], and as such, it is appropriate to consider fish passage at LGDD in this broader context. Furthermore, the siting, configuration, design, construction, and operation of fish passage facilities at high head dams is a relatively recent experimental undertaking, which has proven to be complex and costly, with few examples, if any, of successful performance[8]. As such, a reintroduction action requiring fish passage should proceed with extreme caution

resource agency input in order to continue to make progress on the Fish Passage Assessment. Comments were requested to be provided by October 23, 2015, which was subsequently extended to October 30, 2015. Despite continuing requests, the Districts have still not received the requested input or comments on TM No. 1 from any participant in the licensing process. At subsequent Workshops in 2016, the Districts continued to highlight the need for comment and input from licensing participants in order to proceed with the next steps in the Fish Passage Facilities Alternatives Assessment. As of the filing of the FLA, the requested input on TM No. 1 to address data gaps has not been received.

[5] Please see Section 3.5 of this Exhibit E for further details regarding the Fish Passage Facilities Alternatives Assessment Study Report.

[6] For reference, see Anderson et al. (2014).

[7] Since all the available information regarding historical spring-run Chinook and steelhead distribution in the Tuolumne River is anecdotal, the Districts do not agree that these species have been shown to have consistently populated the river upstream of the Don Pedro Project, and as such, do not necessarily consider this potential action under consideration to be a "reintroduction".

[8] As in any project, success of the undertaking is measured by whether it met performance expectations, in the case of fish passage for example, required collection efficiency.

(Lusardi and Moyle 2017) and prior to implementation, a thorough investigation of the engineering, biological, regulatory, social and economic issues surrounding such a proposal is necessary to ensure that scientifically defensible information is used to support the evaluation of the possibility of achieving a prudent, safe, and effective fish passage facility design.

The Assessment Framework process introduced by the Districts is consistent with guidance provided in Anderson et al. (2014), *Planning Pacific Salmon and Steelhead Reintroductions Aimed at Long-Term Viability and Recovery*. This peer-reviewed journal article authored by the NMFS Northwest Fisheries Science Center in collaboration with state fish and wildlife agencies, stresses the need for implementing a broad evaluation process that describes benefits, risks, and constraints prior to implementing a fish introduction or reintroduction program.

The Assessment Framework process was implemented throughout 2016 and into 2017. Assessment Framework participants were comprised of interested licensing participants and participation was voluntary. Early Plenary Group workshops were conducted on January 27, 2016 and May 19, 2016 for all Assessment Framework participants. At these Plenary Group workshops, a process and schedule, a summary of the information data gaps, a list of information to be provided by studies being carried out by NMFS, a list of potential voluntary studies to be conducted by the Districts to address information gaps, and the formation of technical subcommittees were discussed to help guide 2016/2017 activities. Since then, ten additional engagements (meetings or conference calls) have taken place in 2016[9] and 2017[10]. Technical subcommittees were established to focus on specialized technical topics related to the Assessment Framework, including: (1) collaborative development of study plans for voluntary upper Tuolumne River studies that the Districts might consider undertaking, (2) discussions to define reintroduction goals and objectives to evaluate the prudency of undertaking a reintroduction program, and (3) discussions to identify appropriate water temperature criteria and targets species life stage periodicities to evaluate thermal suitability in the potential reintroduction reach.

At the May 18, 2017 Assessment Framework Plenary Group meeting, the final results of the Reintroduction Goals and Water Temperature technical subcommittees were presented to Plenary Group members for review and approval. The Reintroduction Goals technical subcommittee had a total of five, well-attended meetings toward developing a statement to define the reintroduction program goal for the Tuolumne River. A draft goal statement (absent additional corollary statements since no input was received toward their development) was discussed by Plenary Group members. The final Tuolumne River reintroduction program goal statement as approved by the Plenary Group was to *"Contribute to the recovery of ESA listed salmonids in the Central Valley by establishing viable populations in the Tuolumne River at fair and reasonable cost."*

[9] Dates of engagements in 2016: February 16, March 18, April 13, April 18, September 15, October 14, October 20, December 1.
[10] Dates of engagements in 2017: January 26, May 18.

The goal of the Water Temperature technical subcommittee was to develop general temperature indices or guidelines (and associated life stage periodicities) for assessing reintroduction with regards to thermal suitability. Over a series of conference calls and meetings, the subcommittee produced a literature review (using Water Temperature Considerations for the Yuba River Basin – Anadromous Salmonid Reintroduction Evaluations (Bratovich et al. 2012) as a starting point) to help inform the development of potentially suitable temperatures for reintroduction into the Tuolumne River. The Plenary Group reviewed and approved the draft water temperature indices (WTIs) and species life stage periodicities as presented in Table 1.3-2. Detailed information for each engagement in 2016 and 2017 related to the Assessment Framework process are included in the consultation record (attached to this FLA).

1.3.8 Initial Study Report

On February 2, 2016, the Districts filed the Initial Study Report (ISR) for the Project. The Districts held an ISR meeting on February 25, 2016, and on March 3, 2016, filed a meeting summary. Comments on the meeting summary and requests for new studies and study modifications were submitted to FERC by Monday, April 4. One new study request was submitted; NMFS requested a new study entitled Effects of Project Under Changing Climate (Climate Change Study). On May 2, 2016, the Districts filed with FERC a response to comments received from licensing participants and proposed modifications to the Fish Passage Facilities Alternatives Assessment and the La Grange Project Fish Barrier Assessment. On May 27, 2016, FERC filed a determination on requests for study modifications and new study. The May 27, 2016, determination approved the Districts' proposed modifications, but did not require the Districts perform the NMFS-proposed Climate Change Study.

Table 1.3-2. La Grange Reintroduction Assessment Framework – Upper Tuolumne River Temperature and Timing.

	UOWTI (MWAT)	UTWTI (MWAT)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Spring-run Chinook Salmon[1,2]														
Adult Upstream Migration	64	68												
Adult Holding	61	65												
Adult Spawning	56	58												
Embryo Incubation and Emergence	56	58												
Fry Rearing	65	68												
Juvenile Rearing and Downstream Movement	65	68												
Smolt Outmigration	63	68												
Steelhead[1,2]														
Adult Upstream Migration	64	68												
Holding	61	65												
Adult Spawning	54	57												
Embryo Incubation and Emergence	54	57												
Fry Rearing	68	72												
Juvenile Rearing and Downstream Movement	68	72												
Smolt Outmigration	55	57												

UOWTI = Upper Optimum Water Temperature Index.
UTWTI = Upper Tolerable Water Temperature Index.
MWAT = Maximum Weekly Average Temperature.
[1] Dark shaded areas represent known peak periods for the specified lifestage whereas light shaded areas represent presence.
[2] The absence of dark shaded areas for any lifestage indicates that the Technical Committee did not identify any particular peak period based on the available data.

1.3.9 Revisions to Pre-filing Schedule

SD1 contained a schedule of pre-filing activities, many of which extended well into 2017. However, SD1 also included a filing date for the FLA in June 2016, a year before the completion of the ILP schedule. On May 2, 2016, the Districts proposed a new pre-filing schedule in their response to comments on the ISR. FERC approved the new schedule and provided a new process plan and schedule on May 27, 2016, as part of the determination on requests for study modifications and new study. The FERC-approved schedule included an FLA filing date of September 25, 2017. On September 1, 2017, FERC approved the Districts' Request for Extension of Time, which extended the FLA filing date to October 11, 2017.

1.3.10 Updated Study Report

The Districts filed an Updated Study Report (USR) on February 1, 2017, held a USR meeting on February 16, and filed a meeting summary on March 3. Comments on the meeting summary and requests for new studies and study modifications were to be submitted to FERC by Monday, April 3. Comments on the USR were received from the Central Sierra Environmental Resource Center on February 27, 2017, from NMFS on April 3, 2017, and from CDFW on April 13, 2017. On May 2, 2017, the Districts filed with FERC a response to comments received from licensing participants. There were no requests for new studies or study modifications by any party.

1.3.11 Draft and Final License Applications

The Draft License Application (DLA) was filed with FERC on April 24, 2017, which was followed by a 90-day public comment period. The Districts received comments on the DLA from NMFS on May 12, 2017, from FERC on July 18, 2017, and from CDFW on August 18, 2017. The Districts have provided responses to all of the comments received as an attachment to this FLA.

2.0 PROPOSED ACTION AND ALTERNATIVES

This section describes the no-action alternative, the Districts' proposal for operating the Project under an original license, and other alternatives considered but eliminated from detailed study.

2.1 No-action Alternative

Under the no-action alternative FERC would not issue an original license for the Project, and in that case the TID powerhouse units would be removed from service. This alternative is used to establish baseline environmental conditions for comparison with other alternatives. In this case, the Districts would most likely replace the existing turbines with pressure relief valves (PRVs) in the powerhouse waterways and continue to operate the La Grange facilities as presently done, but without generation of electricity. Therefore, current Project operations related to passing river flows beyond what is needed for water supply purposes would remain the same as present day.

2.1.1 Existing Project Facilities

The Districts completed construction of the LGDD in 1893. TID's powerhouse containing the two hydroelectric units was built in 1924. The primary Project facilities are: (1) LGDD, (2) the La Grange headpond, (3) two penstock and intakes, (4) TID's sluiceway, (5) the La Grange powerhouse, (6) an excavated tailrace, and (7) a substation. Further details on these facilities are provided in Exhibit A of this FLA.

Lands surrounding the Project are a mixture of private land, land owned by the Districts, and federal land administered by BLM. A proposed Project Boundary is shown in Exhibit G of this FLA.

2.1.2 Current Project Operation

The Project operates in a run-of-river mode. The diversion dam is located at the exit of a narrow canyon and the impounded water provides little to no active storage. The LGDD acts as a diversion dam delivering flow through its tunnel intakes to the TID and MID canal systems. Combined, these canals provide water to over 200,000 acres of prime Central Valley farmland and the City of Modesto to supplement its primary M&I water supply coming from groundwater sources. The Project also provides domestic water to the Town of La Grange.

All flows released from the Don Pedro Project, located upstream of LGDD, are either diverted by TID and/or MID for water supply purposes, or are passed downstream at the La Grange facility. On the MID side of the river, gates can deliver water to the river approximately 400 feet downstream of LGDD. Normally, a flow of approximately 5 to 10 cubic feet per second (cfs) is discharged from these gates to the plunge pool in the river below LGDD. On the TID side of the river, water can be passed to the river through either two 5-foot-wide by 4-foot-high sluice gates located adjacent to the penstock intakes or through TID's powerhouse. The Portal No. 1 gate located in the dam can deliver water to the river immediately downstream of LGDD.

2.1.3 Existing Resource Measures

Current resource protection measures include the passing of water from the MID side of the river to the plunge pool located below the LGDD. This flow is approximately 5 to 10 cfs and is released from gates on the MID side of the river as described above. In addition, to maintain the safe passage of flows to the river in the event of a unit or station outage, TID's sluice gates are opened immediately upon a unit or powerhouse trip.

2.2 Districts' Proposal

2.2.1 Proposed New Project Facilities

At this time, two new facilities are proposed by the Districts, including a foot path trail and a fish exclusion barrier in the sluice gate channel. These proposed facilities are described in further detail in Section 2.2.3 below and in Sections 3.5 and 3.8 of this Exhibit E. No facilities are proposed to be removed from the Project.

2.2.2 Proposed Project Operations

The Project would continue to operate in a run-of-river mode. No changes to powerhouse operations are proposed. The Districts would continue to pass at least 5 to 10 cfs to the plunge pool below LGDD at all times.

2.2.3 Proposed Resource Protection Measures

This FLA contains a number of specific proposals for resource PM&E purposes. The resource measures proposed for future implementation under the Project license, if issued by FERC, consist of the following items:

- Formalization of existing Project operation and maintenance (O&M) activities to ensure a minimum flow of 5 to 10 cfs to the plunge pool below LGDD.
- Monitoring of dissolved oxygen in the Project tailrace area.
- Installation of a fish exclusion barrier near the TID sluice gate channel entrance to prevent fish from entering the channel.
- Construction and maintenance of a foot path trail along the river-right shoreline of the La Grange headpond to add a public recreation opportunity in the Project vicinity.
- HPMP development and implementation, as contained in the draft HPMP attached to this FLA (filed with FERC as Privileged).

Further details about each of the resource measures listed above are provided in Section 3.0 of this Exhibit E.

2.3 Alternatives Considered but Eliminated from Detailed Study

2.3.1 Decommissioning the Project's Generating Equipment

If the Commission denies an original license or the Districts decide not to accept a license, TID would cease generating power at the existing two-unit station. Without electrical generation, a license would not be required and LGDD would continue to operate LGDD facilities as needed to fulfill its primary purpose, which is the diversion of water for water supply purposes. Consistent with standards of good practice at any operating diversion dam, flows not diverted for water supply purposes would continue to be safely and effectively passed downstream.

3.0 ENVIRONMENTAL ANALYSIS

3.1 General Description of the Tuolumne River Basin

The upper Tuolumne River originates from tributary streams located on Mount Lyell and Mount Dana in the Sierra Nevada. These tributaries join at Tuolumne Meadows (elevation 8,600 feet), and from this point the upper Tuolumne River descends rapidly through a deep canyon in wilderness areas of Yosemite National Park to Hetch Hetchy Reservoir (at an elevation of about 3,800 feet). Six miles below O'Shaughnessy Dam, which impounds Hetch Hetchy Reservoir, the Tuolumne River leaves Yosemite National Park and enters the Stanislaus National Forest. Except for a short reach at Early Intake Reservoir, the river flows unimpeded through a deep canyon for approximately 40 miles, from O'Shaughnessy Dam to the upstream end of Don Pedro Reservoir with a normal maximum water level of 830 feet.

The mainstem Tuolumne River is joined by several tributaries–including (from upstream to downstream) Cherry Creek, the South Fork Tuolumne River, the Clavey River, and the North Fork of the Tuolumne River–before entering the Don Pedro Reservoir. There are two dams in the Cherry Creek basin: Cherry Dam, which impounds Cherry Lake, located on Cherry Creek about 12 miles above its confluence with the Tuolumne River and Eleanor Dam, which impounds Lake Eleanor, located about 3.5 miles upstream of its confluence with Cherry Creek (SFPUC 2008).

Downstream of Don Pedro Reservoir, the rolling hills of the eastern Central Valley gradually flatten to become a terraced floodplain. Two small, intermittent drainageways enter the La Grange headpond between Don Pedro Dam and LGDD. Below the LGDD, the Tuolumne River flows to its confluence with the San Joaquin River. Dry Creek, which joins the lower Tuolumne River at RM 16, is the only significant tributary (drainage area ≈ 204 mi^2) downstream of LGDD. Subbasins in the Tuolumne River watershed are shown in Figure 3.1-1.

The Tuolumne River watershed covers 1,960 square miles and encompasses a wide range of climates and hydrologic conditions. Annual precipitation within the watershed ranges from over 60 inches in the high mountains to 12 inches in the Central Valley (Western Regional Climate Center 2010). At its headwaters in the Sierra Nevada, the Tuolumne River experiences significant snow accumulation from December to April. Downstream in the foothills the climate is described as Mediterranean: winters are wet and cool, with most precipitation occurring as rain, and summers are hot and dry. Runoff from the upper basin occurs from April to July, when the winter snowpack melts (U.S. Army Corps of Engineers [ACOE] 1972). In the Sierra foothills and valley floor, runoff occurs from December to March, coinciding with the rainy season.

Lands within the Tuolumne River basin have a number of uses and land ownership patterns. Upstream of the Don Pedro Project, lands are primarily federally owned, with the National Park Service managing Yosemite National Park, the United States Forest Service (USFS) managing the Stanislaus National Forest, and the Bureau of Land Management managing public lands along the Don Pedro Reservoir. Developed land in this section of the subbasin is limited to small communities, such as Groveland and Smith Station, dispersed individual residences, and small tracts of non-irrigated farmland.

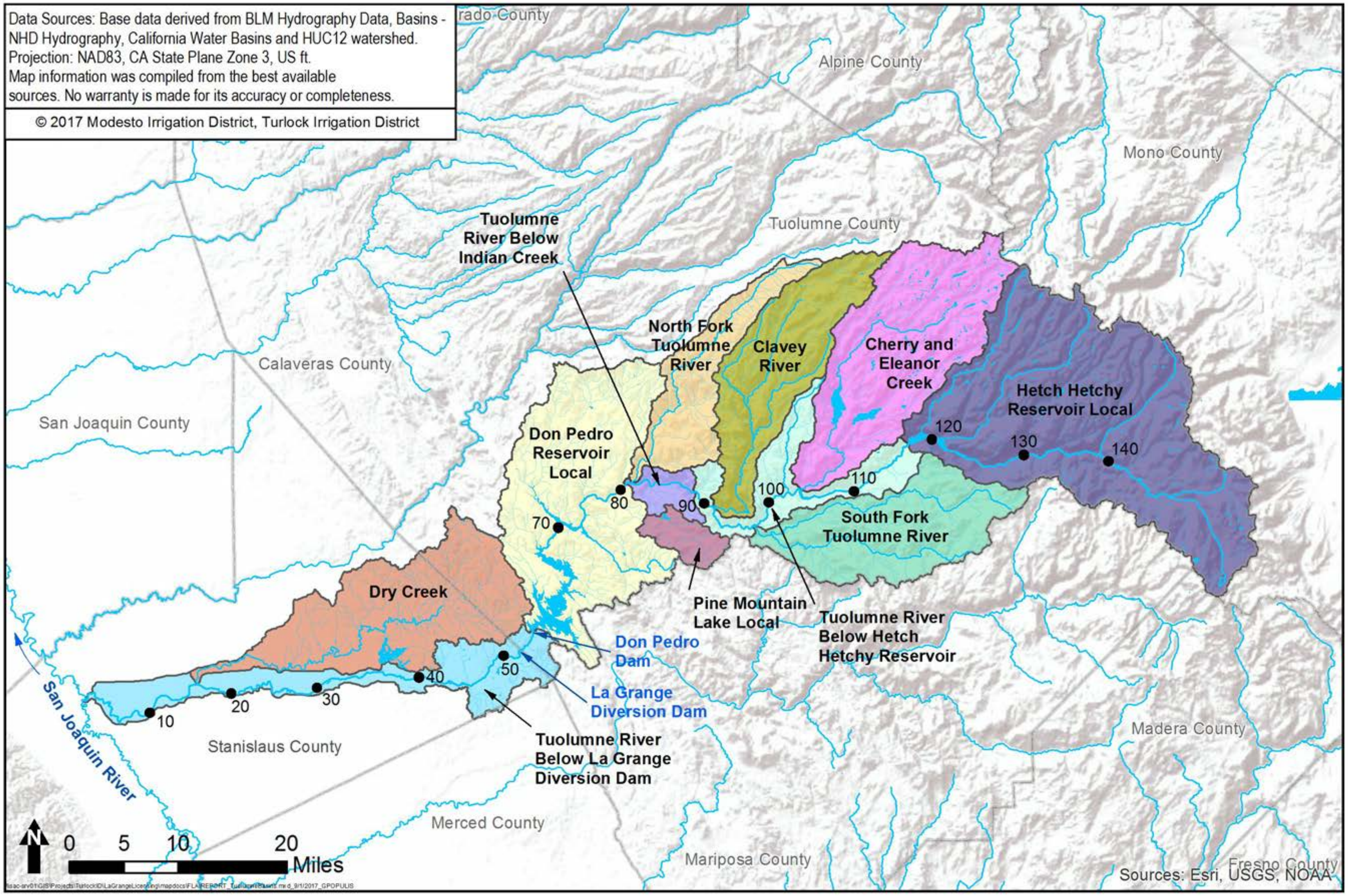

Figure 3.1-1. Subbasins of the Tuolumne River watershed.

Located at RM 118, O'Shaughnessy Dam impounds Hetch Hetchy Reservoir and diverts water to the Bay Area through the Canyon, Mountain, and Foothill tunnels, and San Joaquin Pipelines. Owned by CCSF, the 360,400-ac-ft Hetch Hetchy Reservoir is an integral component of CCSF's Hetch Hetchy Water and Power System, which provides approximately 85 percent of CCSF's Bay Area municipal and industrial water supply and generates on average 1,700,000 megawatt-hours (MWh) of electricity each year. CCSF also owns the Early Intake Diversion Dam, located at RM 105, which can be used to divert water supplied by CCSF's Cherry Creek facilities through the Mountain and Foothill tunnels to the San Joaquin Pipelines during emergency and extreme drought conditions.

Located at RM 54.4, the Districts' Don Pedro Dam impounds the Don Pedro Reservoir, the primary storage facility of the two irrigation districts, has a total storage capacity of just over 2 million acre-feet. Don Pedro Reservoir storage capacity contains for 340 TAF of seasonal storage for flood control purposes, and a 570 TAF "water bank" supporting CCSF's water supply system. The Districts divert water at LGDD to meet the irrigation and M&I water demands of their customers. Waters not diverted may be passed through TID's hydropower facilities located about ¼ mile below LGDD.

Land in the Central Valley along the lower Tuolumne River is primarily privately owned and used for agriculture, grazing, rural residential purposes, and denser residential purposes in the communities of Waterford, Empire, Ceres, and Modesto (Stanislaus County 2006). A small portion of land downstream of the La Grange Project is under state ownership, primarily at the Turlock Lake State Recreation Area, a small state park extending from the southern bank of the Tuolumne River to the north shore of Turlock Lake.

The region surrounding the La Grange Project has a diverse economic base. Detailed information on socioeconomic resources of the area is available in the Socioeconomics Study Report for the Don Pedro Hydroelectric Project (TID/MID 2014).

3.2 Analysis of Direct, Indirect, and Cumulative Effects

3.2.1 Direct Effects

The Districts have considered direct effects to resources as a result of the Proposed Action, and have provided information for each resource in Sections 3.3 through 3.11 of this Exhibit E. The direct effects of the Project are limited to the immediate area in the vicinity of the TID powerhouse potentially affected by its operation for hydropower purposes.

3.2.2 Indirect and Cumulative Effects

As described in FERC's SD2 (FERC 2014), the scope of FERC's environmental assessment for the Project licensing includes an analysis of the extent to which the Proposed Action would contribute to indirect and cumulative effects on resources. According to the Council on Environmental Quality's regulations for implementing NEPA (50 CFR §1508.7), cumulative effects on a resource are the result of the combined influence of past, present, and reasonably foreseeable future actions within a specified geographical range (FERC 2008), regardless of which agency (federal or non-federal) or entity undertakes such actions. Related specifically to the Tuolumne River basin, cumulative effects may 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 and present mining and resource extraction activities, land and water development activities, and the introduction and spread of non-native species in the watershed.

Based on FERC's scoping meetings, comments received during scoping, and information in the PAD, FERC identified the following resources as having the potential to be cumulatively affected by the continued O&M of the Project: water resources (water quality), aquatic resources, geomorphology, recreation, and socioeconomic resources. Cumulative effects are assessed in applicable resource sections of this Exhibit E.

3.2.2.1 Geographic Scope of Indirect and Cumulative Effects

In accordance with FERC's SD2, the geographic scope to be considered is defined by the physical limits of the proposed action's effect on the resources, and the contributing effects from other hydropower and non-hydropower activities within the Tuolumne River basin (FERC 2014).

According to FERC's SD2, the potential geographic scope of cumulative effects on resources should include:

- Water resources, aquatic resources, and socioeconomic resources extending upstream on the Tuolumne River to Hetch Hetchy and downstream to San Francisco Bay.
- Geomorphologic resources extending upstream on the Tuolumne River to Hetch Hetchy and downstream to the confluence of the Tuolumne and San Joaquin rivers.
- Recreation resources extending upstream to the upper extent of Don Pedro Reservoir and downstream to the confluence of the Tuolumne and San Joaquin rivers.

3.2.2.2 Temporal Scope of Indirect and Cumulative Effects

In accordance with FERC's SD2, the temporal scope of the cumulative effects analysis should include a discussion of past, present, and reasonably foreseeable future actions and their effects on each resource that could be cumulatively affected. The historical discussion is limited by the amount of available information on each resource. The temporal scope extends 30 to 50 years into the future in order to coincide with the potential term of an original license for the Project.

3.3 Geology and Soils

The La Grange Project is located in the Western Sierra Nevada Metamorphic Belt (WSNMB) 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 as cited in TID/MID 2011). 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 as cited in TID/MID 2011). 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 approximately 210 miles southeast of the Project, where characteristic rocks of the Sierra Nevada are abruptly truncated by this east-west fault system. The La Grange Project is located a few miles east of the surficial boundary with the Great Valley geomorphic province (Figure 3.3-1).

The area upstream of the La Grange Project along the Tuolumne River is underlain by a series of bedrock and surficial deposits. Above LGDD the river runs westerly in metavolcanic rock of the Jurassic age Gopher Ridge Formation. To the west of the Gopher Ridge Formation, through most of the area below LGDD, the river runs in slates of the Jurassic age Merced Falls Slate and volcanic rocks of the Peaslee Creek Volcanics. West of the Merced Falls Slate and Peaslee Creek Volcanics, the river is underlain by alluvium of Holocene Age and is locally flanked by historical dredger tailings. Most of the riverbed between La Grange Regional Park and the confluence with the San Joaquin River runs in alluvium of Holocene Age that overlies the Riverbank, Turlock Lake, and Modesto Formations of Pleistocene age. These units are in turn generally underlain by Cenozoic valley fill (TID/MID 2011).

Several unnamed faults related to the Bear Mountains Fault Zone cross the river in the La Grange Project vicinity, striking northeasterly (Figure 3.3-1). None of these faults is classified by the California Geological Survey as active within Holocene time (movement within the last 11,400 years). The river reach that extends upstream from LGDD to the toe of Don Pedro Dam is in the western lithotectonic belt of the Western Sierra Nevada (Figure 3.3-2). The Districts conducted a study of geology and faulting in the immediate vicinity of the LGDD. The study found that the faults and geologic structures within the LGDD vicinity are non-capable (inactive) and are not potential seismic sources for LGDD (TID/MID 2016; Appendix F-2 to Exhibit F of this FLA, filed only as CUI//CEII).

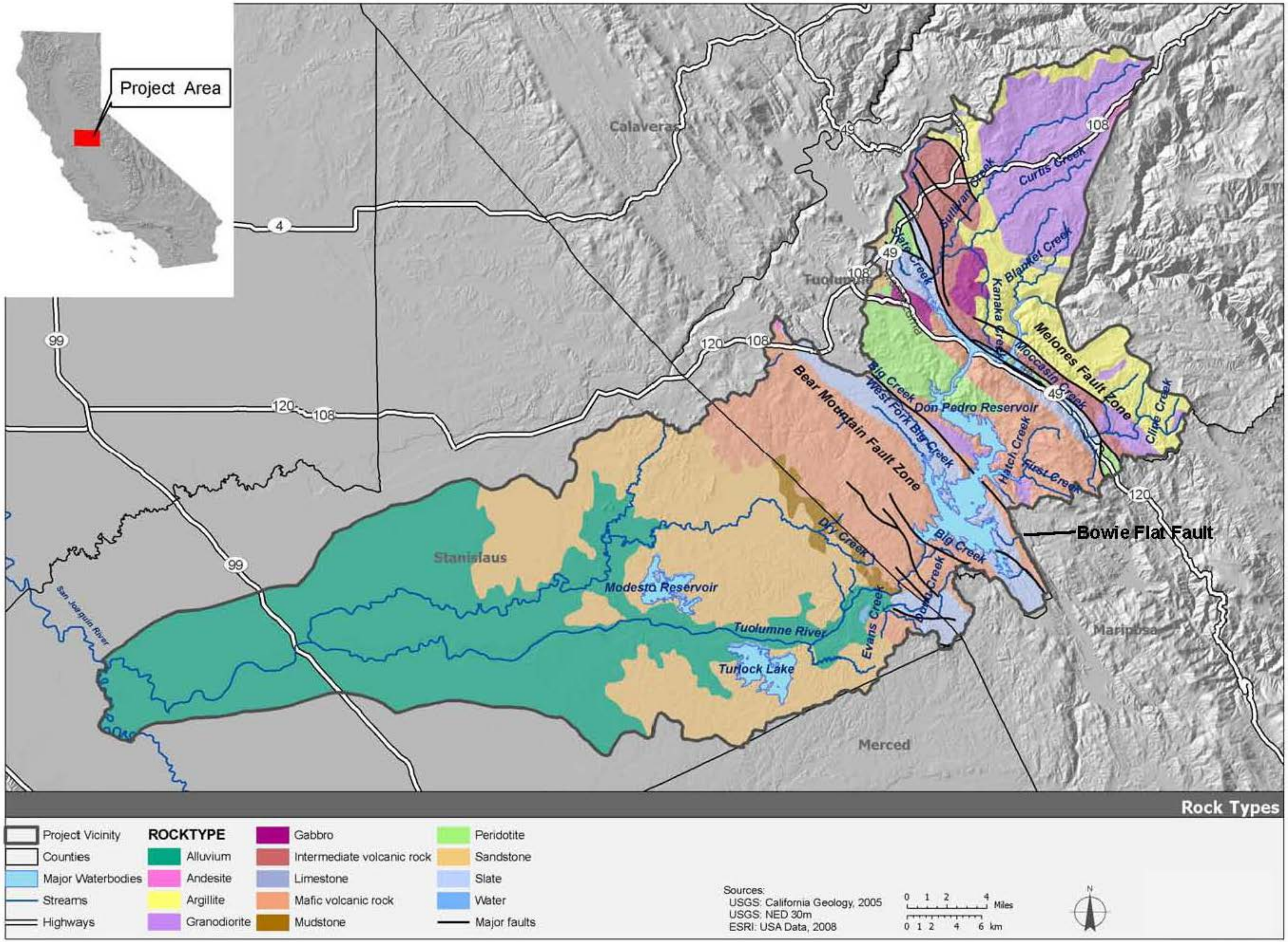

Figure 3.3-1. Geological map of the La Grange Project vicinity showing major rock types and fault zones.

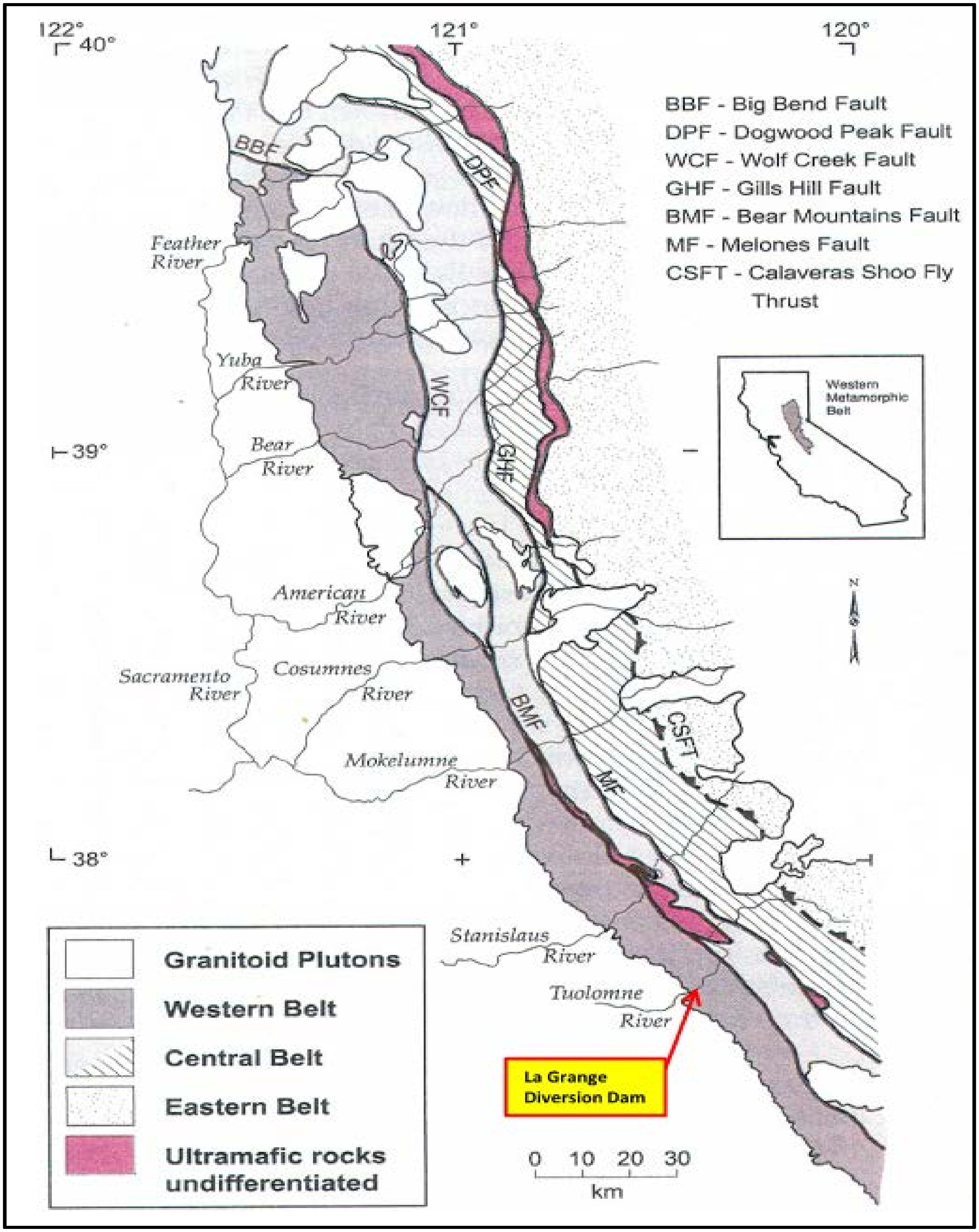

Figure 3.3-2. **Lithotectonic belts of the western Sierra Nevada Metamorphic Belt and the location of the LGDD (Mayfield and Day 2000).**

3.3.1 Soils

The Project is located within the foothills of the Sierra Nevada near the Bear Mountain Fault Zone. The soils in the vicinity are derived from a variety of parent materials including schist, serpentine (ultramafic rocks), metavolcanic, and metasedimentary rocks (TID/MID 2011). Many of the soils are shallow, and associations with “rock outcrop” cover virtually the entire Project vicinity. One soil association (i.e., Whiterock-rock outcrop-Auburn) dominates the area.

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 are shallow, formed on bedrock, and located at elevations of 160 to 2,500 feet on slopes that are 3 to 60 percent. The soils formed in material weathered from slate and partially metamorphosed sandstone (TID/MID 2011). 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 near 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 indicated by the large amount of “rock outcrop” in the association (TID/MID 2011).

3.3.2 Faulting

The three lithotectonic subunits of the WSNMB are separated by steeply dipping major faults collectively referred to as the Foothills Fault System (FFS) (Figure 3.3-2; Clark 1960; Clark and Huber 1975 as cited in TID/MID 2011). This fault system is an anastomosing (braided or interwoven) complex of north-northwest-striking fault-related structures with serpentinized or mineralized zones and sheared contacts between rocks (Clark 1960 as cited in TID/MID 2011). There is one major fault zone in the FFS that crosses the Tuolumne River near the Project vicinity (i.e., Bear Mountain Fault Zone) (Figure 3.3-1). The Bear Mountain Fault Zone is oriented northwest/southeast and is located to the northeast of the Project vicinity (Figure 3.3-1). It is believed that the Bear Mountain Fault Zone represents a splay of the Melones Fault zone and that the two merge at depth. The California Division of Mines and Geology open File Report 84-52 (1984) states that the Bear Mountain Fault zone did not warrant zoning as an active fault because it is poorly defined at the surface or lacks evidence of Holocene (recent) displacement (TID/MID 2011). The Districts have conducted a study of the geology and faulting in the vicinity of the LGDD for the purposes of evaluating dam safety, and this information is provided in Appendix F-2 to Exhibit F of this FLA, filed only as CUI//CEII.

3.3.3 Tectonic History and Seismicity

The structural features within the WSNMB record deformation related to at least three orogenic (mountain building) events during the Devonian, Permian-Triassic, and Jurassic (Dickinson 1981 as cited in TID/MID 2011). The dominant northwest-trending structural grain of this belt was imposed during the late Jurassic Nevadan orogeny (Schweickert 1981; Varga and Moores 1981; Schweickert et al. 1984; Day et al. 1985 as cited in TID/MID 2011). This deformation produced the FFS, the northwest-trending folds, a variably developed fabric in the rocks, and regional greenschist-facies metamorphism. Present studies show an upward movement of the Sierran block of 20 to 30 inches per century (Avendian 1978 as cited in TID/MID 2011). Most of the elevation of the Sierra Nevada range is due to late Cenozoic uplift and tilting associated with fault activity along the eastern margin (Wakabayashi and Sawyer 2001 as cited in TID/MID 2011). The range slopes gently westward from the crest and abruptly eastward from the crest.

The LGDD is located within the Sierra Nevada block east of the boundary that separates the Central Valley and Sierra Nevada provinces that make up the block. The block is continental crust composed of Paleozoic and Mesozoic age granitic plutons intruded into Paleozoic and Mesozoic metamorphic basement and oceanic crust and is the result of plate convergence and accretion of several terranes to the North American plate (Wong and Savage 1983). After the Nevadan orogeny (160 to 123 million years ago) accreted an island arc terrane (that presently underlies the site), major magmatic activity related to subduction farther west created the large Cretaceous plutons in the central Sierra Nevada (Bateman et al. 1963). Subsequent uplift of the block along its eastern margin created a gently dipping slope to the west. The sediment of the Great Valley Sequence was eroded from the central Sierra Nevada magmatic arc and deposited into the basin between the arc and subduction zone (Hamilton and Meyers 1967). In the middle Tertiary, transform faulting was initiated along the continental margin and continues to the present (Wong and Savage 1983). The main present-day tectonic deformation of the Sierra Nevada block occurs along the western boundary (Central Valley thrust fault system), eastern boundary (Sierra Nevada Frontal Fault System – California Shear Zone), and southern boundary (Garlock Fault) of the block and is related to the transform faulting (San Andreas fault system) along the continental margin (Wong and Savage 1983; Hill et al. 1991).

The internal portion of the block is characterized by a low level of deformation and seismicity (Wong and Savage 1983; Uhrhammer 1991; Hill et al. 1991). Uplift and gradual tilting to the west related to the general transform regime that started during the middle Tertiary is the main tectonic activity currently affecting the block interior. Minor faulting in response to the tilting occurred along the older zones of weakness in the block, including the FFS (segments of which have undergone movement in the late Quaternary [Jennings and Bryant 2010; USGS 2013]). The system is presently undergoing east-west extension (Wong and Savage 1983; Hill et al. 1991; Uhrhammer 1991). The seismicity in the area of the FFS is diffuse, characterized by low levels of both historical and instrumental seismicity earthquakes with magnitudes less than 5, and by little direct correlation of earthquakes to particular geologic structures (Hill et al. 1991; Uhrhammer 1991) (Figure 3.3-3).

The largest earthquake that has occurred on a segment of the FFS (Cleveland Hills Fault) is the August 1, 1975 Oroville earthquake (ML = 5.7; Mw =5.8), approximately 220 kilometers northwest of LGDD (Morrison et al. 1976). The earthquake involved predominantly normal displacement along a west dipping plane (east-west extension, west side down) that extended from the hypocenter at a depth of about 8 kilometers to the ground surface (Bufe et al. 1976; Lahr et al. 1976; Langston and Butler 1976).

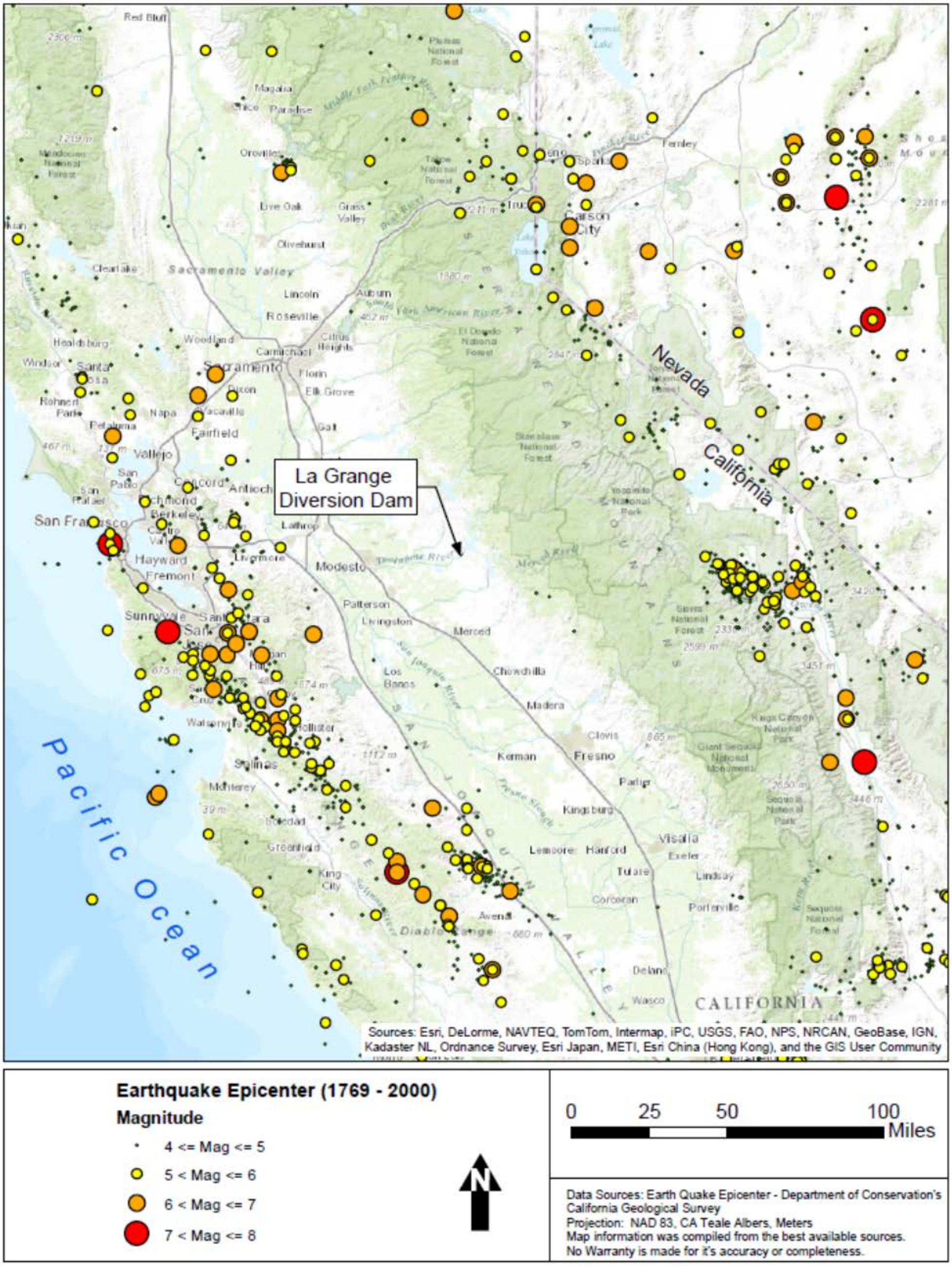

Figure 3.3-3. Historical seismicity.

3.3.4 Mining Resources

Past and present mines in the general vicinity of the La Grange Project are shown in Figure 3.3-4. The chief mineral commodity in the vicinity is gold. The immensely rich 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 the surrounding area have also been highly productive and exceptionally long-lived (TID/MID 2011).

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 processing the stone from these deposits (TID/MID 2011).

California leads the nation in aggregate production and virtually all of it 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. 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 as cited in TID/MID 2011). An estimated 540 million tons (338 million cubic yards) of Aggregate Resources are located in six different geographic areas of Stanislaus County (Higgins and Dupras 1993 as cited in TID/MID 2011).

3.3.5 Geomorphology

Downstream of LGDD, the Tuolumne River leaves a steep and confined bedrock valley and enters the eastern Central Valley near La Grange Regional Park, where hillslope gradients in the vicinity of the river corridor are typically less than five percent (TID/MID 2011). From the LGDD to the San Joaquin River, the Tuolumne River can be divided into two broad geomorphic reaches defined by channel slope and bed composition: a gravel-bedded reach that extends from LGDD (RM 52.1) to Geer Road Bridge (RM 24) and a sand-bedded reach that extends from Geer Road Bridge to the confluence with the San Joaquin River (McBain and Trush 2000 as cited in TID/MID 2011). The gravel-bedded and sand-bedded zones have been further subdivided into seven reaches based on present and historical land uses, the extent and influence of urbanization, valley confinement from natural and anthropogenic causes, channel substrate and slope, and salmonid use (McBain and Trush 2000 as cited in TID/MID 2011).

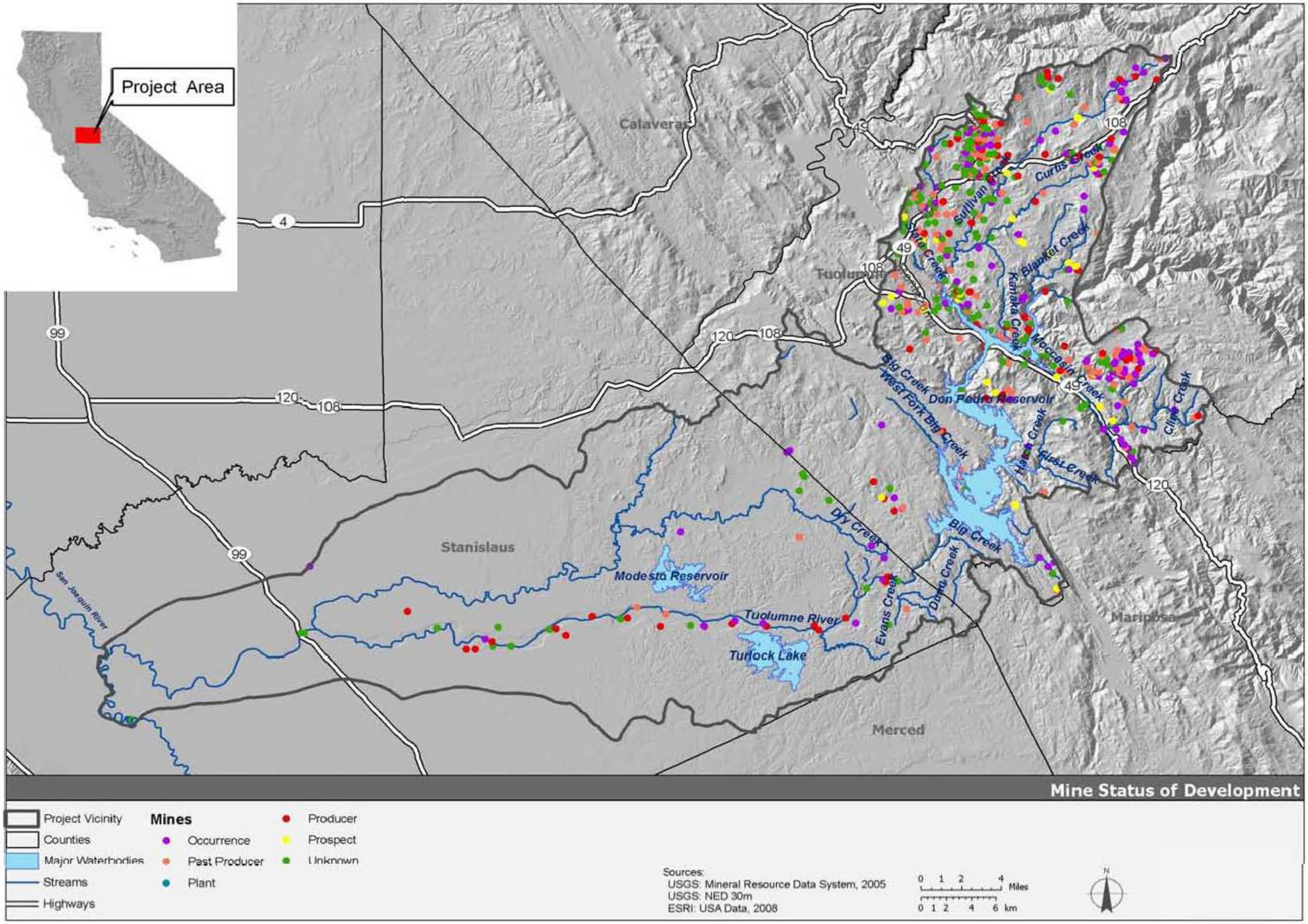

Figure 3.3-4. **Past and present mines in the Tuolumne River basin.**

Past surveys of the channel downstream of LGDD indicate channel downcutting, widening, armoring, and localized depletion of sediment storage features (e.g., lateral bars and riffles) (California Department of Water Resources [CDWR] 1994; McBain and Trush 2004 as cited in TID/MID 2011). Bedload impedance reaches, defined as locations where current hydraulic conditions are insufficient to transport coarse bed material (>4 millimeters [mm]) through the reach, were identified from LGDD to the confluence of the San Joaquin River (McBain and Trush 2000 as cited in TID/MID 2011). These reaches are primarily associated with former instream aggregate extraction and gold dredger pits (TID/MID 2011).

Detailed investigations of coarse sediment budget in the lower Tuolumne River were completed as part of the relicensing of the upstream Don Pedro Project (W&AR-04; TID/MID 2013). In summary, the coarse sediment budget for RM 52.2 to RM 45.5, encompassing the Dominant Salmon Spawning Reach immediately downstream of LGDD, indicates that approximately 4,549–6,707 yd^3 (5,913–8,720 tons) of coarse bed material was lost from storage between 2005 and 2012. If the estimated total storage change from differencing 2005 and 2012 DTM data is distributed over the total channel area, it equates to an average bed lowering of 13 mm (0.5-in). The estimated lowering in the reach during the 2005–2012 period is well less than half the average median grain size of the coarse channel bed (approximately 51 mm), and the total estimated volume lost from storage in the reach is comparable in magnitude to the quantity of coarse sediment added during any one of the augmentation projects that occurred since 2002 (approximately 7,000–14,000 tons) (TID/MID 2013).

Differencing of channel topography surveyed in 2005 and 2012 shows that little change in storage occurred during this period at the reach scale, but high-flow events in water year (WY) 2006 and WY 2011 locally scoured the bed and redistributed coarse and fine sediment deposits (TID/MID 2013).

3.3.6 Potential Geologic, Geomorphic, and Soil Resource Effects

FERC's SD2 identifies the following potential direct Project effects associated with geologic, geomorphic, and soil resources:

- Effects of Project operation on erosion and sedimentation in the Tuolumne River downstream of LGDD.
- Effects of Project O&M on shoreline erosion at La Grange headpond.
- Effects of Project O&M on upland erosion, including erosion caused by runoff from Project-related roads and trails.
- Effects of Project operation, including operation of spillways and dam outlet facilities, on erosion and sedimentation.
- Effects of Project structures on landslides and erosion rates.

There would be no direct or indirect effects on geology and soils around the La Grange headpond or in the lower Tuolumne River as the result of continued hydroelectric power generation at the Project. Continuation of existing hydropower operations at the Project would have no effect on stage or flows in the La Grange headpond or lower Tuolumne River, because flows in the headpond and lower river are a result of independent, non-interrelated primary purposes and uses of the La Grange Project (e.g., diversion of irrigation and M&I water supply; safe passing of undiverted water downstream). The La Grange facilities would continue to be a run-of-river operation.

The land surrounding the La Grange headpond is mostly undeveloped, and geographically removed from O&M activity. The land around the headpond is owned by TID, MID, or administered by BLM, and no development is permitted along the La Grange headpond shoreline. The La Grange headpond contained within a canyon-reach of the Tuolumne River with heavily armored or rock-outcrop shorelines. There is no evidence of large land-movement or slides after 100-years of operation. Nor has any substantial erosion been observed above the normal maximum water level along the headpond. Road use is limited to infrequent O&M related activities conducted by the Districts, and no significant erosion occurs along the one access road infrequently used by the Districts. In no case has erosion been observed to be affecting any non-geologic resources, including special-status species or cultural resource sites, along or above the normal maximum water surface elevation. The La Grange powerhouse discharges into a geologically stable channel downstream of the powerhouse, so no disturbance of sediment occurs as the result of changes in flow from the TID powerhouse into the tailrace.

3.3.7 Proposed Geologic, Geomorphic, and Soil Resource Measures

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

3.3.8 Cumulative Effects to Geologic, Geomorphic, and Soil Resources

FERC's SD2 identified 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 considered for cumulative effects to geomorphology includes the past, present, and reasonably foreseeable future actions. The temporal scope extends 30 to 50 years into the future in order to coincide with the potential term of an original license for the Project.

Future operation of the TID hydropower facilities as proposed by the Districts under the terms of a FERC license would not contribute to cumulative effects to geologic, geomorphic or soil resources either upstream or downstream of LGDD. Flows upstream of LGDD are a result of the cumulative operation of several storage reservoirs, the operation of which are independent of the operation of TID's small hydropower plant at LGDD. Electricity production at TID's small hydropower facility is not a factor in determining flow releases from upstream water resource projects. If the La Grange hydropower facilities did not exist, there would be no change in future conditions upstream or downstream of the LGDD. Therefore, operation of TID's powerhouse has no cumulative effects on geologic, geomorphic, or soil resources. Sediment storage in the LGDD headpond can result from spillway use at the upstream Don Pedro Reservoir due to flood flow releases. This occurred twice in the last 50 years, and was unrelated to operation of TID's hydropower plant.

Construction of the sluice gate channel barrier may potentially result in short-term effects to soil resources by causing localized erosion near the tailrace and in the sluice gate channel. Any such localized erosion would be contained within the sand bag cofferdams placed downstream of the barrier and temporary bypass channel construction.

The Proposed Action of continued hydroelectric power generation would not result in any cumulative effects on geomorphology over the geographic and temporal scopes defined for this resource in FERC's SD2. Diversions from the headpond and flows into the lower river are not dependent on the hydroelectric operations of TID's powerhouse. Therefore, the continuation of power generation would not have an effect on stage or flows in the La Grange headpond or lower Tuolumne River, and thus will not contribute to cumulative effects to geomorphology.

3.3.9 Unavoidable Adverse Impacts to Geologic, Geomorphic, and Soil Resources

No unavoidable adverse impacts to geologic, geomorphic, and soil resources are anticipated as a result of the Proposed Action.

3.4 Water Resources

3.4.1 Water Resource Studies

An extensive environmental resources study program was completed to support the ongoing relicensing of the Don Pedro Project (TID/MID 2014a). A number of these studies addressed water resources associated with the Don Pedro Project and associated flows into the La Grange headpond and the lower Tuolumne River. As a result, several studies conducted as part of the Don Pedro Project relicensing, listed below, provide information relevant to characterizing the potentially affected water resources of the Project (listed below).

- The Water Quality Assessment Study (TID/MID 2013) was conducted to characterize existing water quality conditions within Don Pedro Reservoir, at the Don Pedro Project discharge, and just downstream of LGDD. Data are evaluated to assess the consistency of existing water quality conditions with the CVRWQCB's Basin Plan Objectives (CVRWQCB 1998).
- Tuolumne River Operations/Water Balance Model Study (TID/MID 2017b) was developed to simulate operations and their effects on water supplies. The geographic scope of the model is from Hetch Hetchy Dam to the confluence of the Tuolumne River with the San Joaquin River.
- The Don Pedro Reservoir Temperature Model (TID/MID 2017c) simulates and characterizes the seasonal thermal dynamics of the Don Pedro Reservoir under current and alternative future conditions.
- Lower Tuolumne River Temperature Model (TID/MID 2017f) simulates water temperature in the lower Tuolumne River from below Don Pedro Dam (RM 54.6) to the confluence with

the San Joaquin River (RM 0) under existing conditions and under alternative Don Pedro Project operations scenarios. The Districts conducted a supplemental study entitled In-River Diurnal Temperature Variation Study, to investigate the diurnal temperature variability along specific reaches of the lower Tuolumne River.

In addition to the water resource investigations performed as part of licensing studies for the La Grange and Don Pedro projects, there are other sources of water quality information for the Tuolumne River basin:

- Environmental Protection Agency (EPA) Storage and Retrieval (STORET) data and reports,
- United States Geological Survey (USGS) Water Resources Data Reports and data collected for the National Water Quality Assessment Program,
- CVRWQCB reports prepared for the Surface Water Ambient Monitoring Program, and
- California Department of Water Resources (CDWR) data.

3.4.2 Water Quantity

3.4.2.1 Drainage Area

The Tuolumne River can be divided into three subbasins: the upper Tuolumne River, the Don Pedro Project area, and the lower Tuolumne River. The La Grange Project occupies the most upstream section of the lower Tuolumne River, below Don Pedro Dam. Table 3.4-1 provides the approximate drainage areas and lengths of reaches in these subbasins.

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

Subbasin	Length of Reach (miles)	Drainage Area (mi^2)	Total Upstream Drainage Area (mi^2)
Upper Tuolumne River	60	1,300	1,300
Don Pedro Project Area	28	230	1,530
Lower Tuolumne River	51	410	1,940
Total	**139**	**1,940**	**NA**

The upper Tuolumne River includes the Hetch Hetchy Reservoir watershed (459 mi^2) and the Cherry Lake/Lake Eleanor Reservoir (Cherry/Eleanor) watershed (193 mi^2). Hetch Hetchy Reservoir has a normal pool elevation of about 3,800 feet, Cherry Lake has a normal pool elevation of 4,700 feet, and Lake Eleanor has a normal pool elevation of 4,657 feet. Don Pedro Reservoir has a normal maximum water surface elevation of 830 feet, and the surface elevation of the La Grange headpond varies between about 294 feet and 296 feet (TID/MID 2014b).

3.4.2.2 Climate

The climate and hydrology of the Tuolumne River basin varies considerably over the river's length. Annual precipitation above 10,000 feet exceeds 60 inches per year, occurring mostly as snow, whereas less than 100 miles away in the Central Valley, the annual precipitation is less than 12 inches. In addition to the geographic variation in precipitation, the seasonal and annual variations are also extreme. In the lower reaches of the river, the average precipitation from May through September, inclusive, is less than 1 inch. Year-to-year variation is also dramatic. During the period of WY 1971–2012, the lowest estimated unimpaired flow at the La Grange gage was 0.38 million (WY 1977) compared to a high of 4.6 million ac-ft (WY 1983), i.e., an inter-annual range that varies by a factor of 12. Another characteristic of the basin's hydrology is that dry and wet years often come in consecutive, multi-year sequences. The third driest year in the WY 1971–2012 period was WY 1976 (672,000 ac-ft), the year before the driest year of WY 1977, and the third wettest year was WY 1982 (3.8 million ac-ft), the year before the wettest year of WY 1983.

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean (°F)	27°	28°	30°	34°	42°	49°	57°	56°	52°	44°	34°	29°
Avg. Precipitation (in)	9.0	7.3	6.7	3.9	2.5	1.1	0.7	0.7	1.2	2.6	6.1	7.8
Avg. Snowfall (in)	79.5	73.3	75.9	36.6	14.5	2.3	0	0.2	1.1	10.3	40.9	66.4

Source: Western Regional Climate Center 2006.

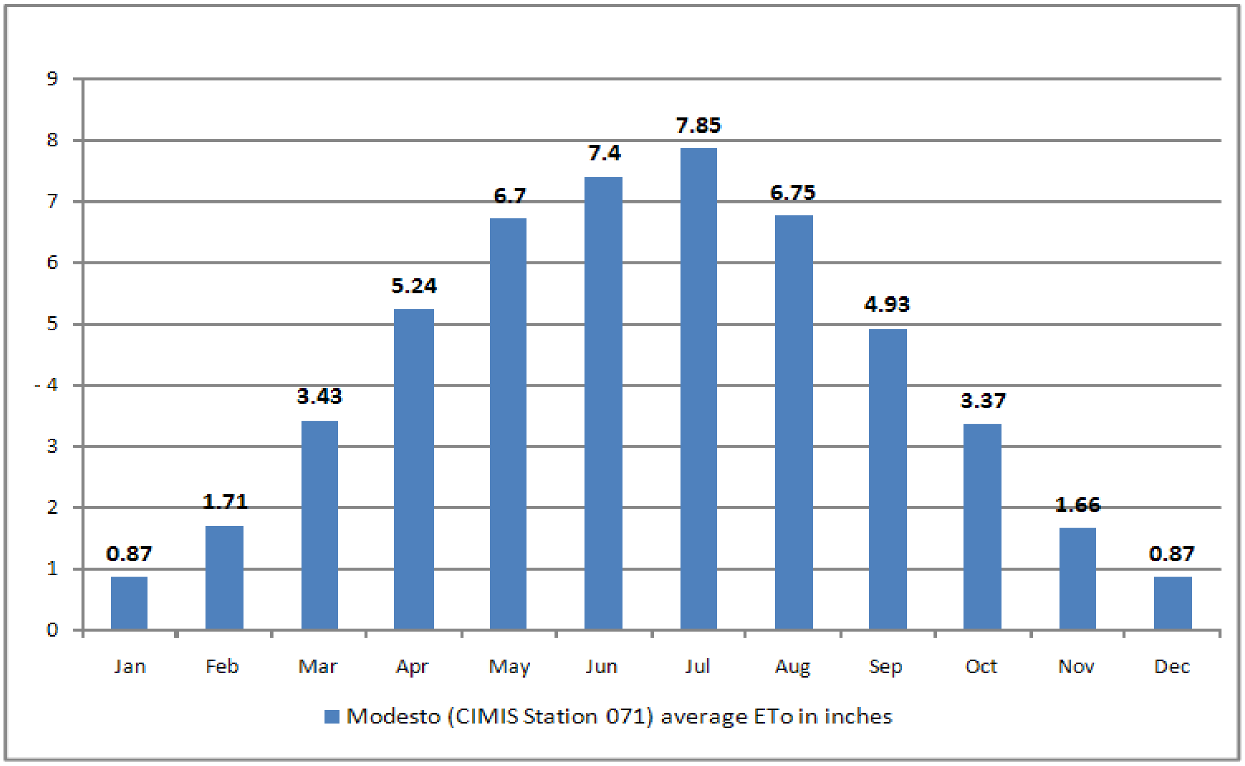

Figure 3.4-1. Modesto monthly average evapotranspiration rates (Eto in inches), June 1987 to 2013. Source: CDWR 2013.

3.4.2.3 General Description of Basin Hydrology

The hydrologic characteristics of the Tuolumne River and its tributaries vary significantly from headwater areas to the river's terminus at the San Joaquin River. Above about 5,000 feet, 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 water. 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. As noted previously, several reservoirs are located upstream of the Don Pedro Project, from 3,000 to 5,000 feet elevation. 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 and La Grange headpond would normally receive about 88 percent of their inflow from January through July. However, because of upstream regulation, the pattern of inflow does not reflect a typical snow-melt driven hydrograph. Some low-elevation unregulated, rain-driven tributaries flow directly into the reservoirs, but these streams provide only a small fraction of the annual flow. The average annual flow of the Tuolumne River at Don Pedro Reservoir is approximately 1.7 million ac-ft. Flood flows in the Don Pedro Project area can be the result of heavy rains, rain-on-snow (mainly in winter and early spring), and/or snowmelt-floods (mostly in spring through early summer). To protect downstream entities from flooding, the ACOE Flood Control Manual for the Don Pedro Project requires the maintenance of a flood envelope of 340,000 ac-ft from October 7 through April 27 and conditional flood space thereafter depending on the anticipated snowmelt runoff during April, May, and June (ACOE 1972).

Water flows from the Don Pedro powerhouse or outlet works tunnel into the Tuolumne River and then into the impoundment formed by LGDD, the La Grange headpond. Downstream of LGDD, the Tuolumne River becomes a meandering stream, with an average gradient of about 2 feet/mile, in contrast to the upper Tuolumne where gradients can exceed 100 feet/mile. In the lower Tuolumne River valley, around 75 percent of the annual runoff occurs during rainstorms between December and March (ACOE 1972). Some flow in this area is derived from groundwater, but the groundwater contribution has not been well quantified.

Hydrology Upstream of Don Pedro Reservoir

There are a number of streamflow gages on the upper Tuolumne River, either presently maintained or historical, which provide data that characterize hydrologic conditions upstream of the Don Pedro and La Grange reservoirs (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 Don Pedro Project Boundary. The sum of these four gages constitutes the flow from the majority of the Tuolumne River watershed. Approximately 875 mi^2 of the 1,300 mi^2 of the watershed upstream of Don Pedro Reservoir is accounted for by these four gages: Tuolumne River below Early Intake near Mather, Cherry Creek below Dion R. Holm Powerhouse, 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. The Don Pedro Hydroelectric Project Amendment to the Final License Application (AFLA) provides detailed hydrology data for the Tuolumne River upstream of the Don Pedro Reservoir (TID/MID 2017a).

Table 3.4-3. Flow and 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

Gage Number	Gage Name	Period of Record[2]	Notes
11276900	Tuolumne River Below Early Intake Near Mather CA	10/1/1966-present	Downstream of Hetch Hetchy and Kirkwood Powerhouse
11278400	Cherry Creek Below Dion R. Holm Powerhouse, 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 Hetch Hetchy Water and Power, but data after 2002 are not reported on USGS. Recent data available through California Data Exchange Center (CDEC)
11282000	Middle Tuolumne River At Oakland Recreation Camp CA	10/1/1916-9/30/2002; 1/28/2009-present	Gage re-installed in 2009 by CCSF Hetch Hetchy Water and Power, 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 ac-ft)
Relevant Streamflow Gages Downstream of Don Pedro Reservoir			
11289650	Tuolumne River Below LGDD 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.

Hydrology of the Lower Tuolumne River

Water releases from Don Pedro Reservoir that pass through the La Grange headpond and subsequently passed to the lower Tuolumne River are provided to benefit fish and aquatic resources in the lower Tuolumne River. Flows in the lower Tuolumne River below LGDD are reported at three USGS gages: 11289650, 11289000, and 11289500 (Table 3.4-4). Records for these locations are available from the USGS NWIS website for October 1, 1970 to the present time. Additionally, flows occurring at specific structures within the La Grange Project have been measured from 2005 through 2016 and are summarized in the Flow Records at Five Discharge Structures at the La Grange Project Technical Memorandum attached to this FLA (TID/MID 2017e).

Table 3.4-4. Flows downstream of La Grange Diversion Dam, water deliveries to TID and MID, and total Don Pedro Project outflows, 1997-2016.

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	2013	2014	2015	2016			
	USGS 11289650 – Tuolumne River Below La Grange Diversion Dam Near La Grange, CA (cfs)																						
Jan	13,070	2,114	1,247	324	325	177	184	223	187	4,456	353	171	165	232	4,096	342	175	159	166	152	1,416	13,070	152
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	172	157	165	161	1,631	8,116	161
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	168	158	172	168	1,651	5,407	158
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	412	356	361	632	1,874	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	294	159	171	382	1,591	7,847	159
Jun	269	4,433	284	340	54	97	234	127	3,809	4,657	127	95	149	2,555	5,027	134	97	94	105	110	1,140	5,027	94
Jul	290	2,845	287	421	89	88	243	108	1,913	834	114	93	107	813	2,132	107	102	95	98	105	544	2,845	88
Aug	287	1,019	259	603	110	86	236	106	773	584	110	99	102	316	2,498	104	108	95	95	98	384	2,498	86
Sep	285	1,423	294	473	112	68	250	110	328	412	89	97	106	308	1,197	102	102	92	90	87	301	1,423	68
Oct	465	628	424	412	189	202	297	209	464	449	141	174	385	491	491	255	276	136	141	In	328	628	136
Nov	380	316	338	347	184	191	231	186	369	379	174	161	255	399	366	176	164	168	162	WY	260	399	161
Dec	330	1,321	336	334	177	187	226	178	1,285	352	169	164	256	4,152	366	174	158	167	155	2017	552	4,625	155
	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	9	55	16	3	74	358	3
Feb	168	56	47	72	142	67	58	44	204	135	113	45	29	11	93	69	49	48	27	10	74	204	10
Mar	642	121	301	231	213	434	328	355	260	142	348	346	219	253	96	340	616	36	55	41	269	642	41
Apr	601	250	630	586	607	720	325	720	450	249	483	575	474	337	453	275	475	311	301	295	456	720	249
May	872	310	697	659	773	724	605	653	665	716	682	656	573	533	674	736	673	393	284	505	619	872	284
Jun	701	655	769	733	802	791	801	751	695	802	763	646	716	769	708	767	775	436	406	660	707	802	406
Jul	962	787	781	915	905	891	894	825	1,043	846	803	748	791	704	761	869	834	539	496	689	804	1,043	496
Aug	813	869	927	878	767	707	825	704	827	824	781	793	721	754	858	764	769	455	401	577	751	927	401
Sep	550	482	566	474	567	583	525	461	604	594	411	506	474	482	589	453	446	348	286	417	491	604	286
Oct	347	344	334	293	387	358	380	270	299	304	321	301	266	271	233	434	424	125	112	In	305	434	112
Nov	78	73	195	44	36	105	172	84	141	173	162	100	112	184	169	53	109	135	85	WY	116	195	36
Dec	26	86	72	75	72	58	13	43	126	8	9	18	2	0	0	3	26	0	0	2017	34	126	0

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	2013	2014	2015	2016			
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	93	17	0	1	154	581	0
Feb	599	326	313	0	8	6	323	302	339	529	257	101	151	180	190	202	265	0	0	0	205	599	0
Mar	1,457	454	623	603	595	1,023	637	1,035	872	644	1,113	1,132	601	601	581	477	963	86	44	153	685	1,457	44
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	792	659	833	759	944	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	1,074	760	595	848	1,141	1,710	595
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	1,467	1,077	1,016	1,364	1,458	1,725	1,016
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	1,637	1,335	1,130	1,545	1,770	2,081	1,130
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	1,312	1,050	825	1,375	1,550	1,796	825
Sep	812	977	952	1,063	825	736	714	617	991	936	631	571	793	1,097	1,069	953	566	532	506	786	806	1,097	506
Oct	505	613	566	527	445	358	742	577	259	379	305	129	180	430	533	139	390	274	283	In	402	742	129
Nov	30	0	59	24	4	22	1	1	3	8	35	2	27	279	95	0	1	0	1	WY	31	279	0
Dec	109	0	301	173	12	94	36	12	27	1	45	149	20	600	29	6	0	0	0	2017	85	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	276	230	182	155	1,652	13,630	155
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	486	205	191	171	1,909	8,885	171
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	1,748	279	270	361	2,605	5,983	270
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	1,680	1,326	1,494	1,686	3,274	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	2,039	1,313	1,050	1,735	3,351	9,902	1,050
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	2,337	1,606	1,527	2,135	3,305	7,134	1,527
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	2,571	1,971	1,724	2,340	3,119	5,448	1,724
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	2,189	1,598	1,320	2,049	2,635	5,074	1,320
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	1,115	971	882	Not reported	1,615	2,882	882
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	827	1,089	535	537	In	1,035	1,587	535
Nov	489	389	592	415	224	318	404	270	513	559	371	263	394	862	630	228	273	303	247	WY	408	862	224
Dec	466	1,407	709	582	261	339	275	233	1,437	361	223	330	277	4,752	394	183	184	167	155	2017	670	4,752	155

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 2016 period. Without 1997 values, the mean monthly flow at USGS gage 11289650 (Tuolumne River Below LGDD Near La Grange, Ca) in January is 803 cfs and February is 1,289, compared to 1,416 and 1,631 cfs, respectively.

3 Some values rounded by USGS – sum of individual gage monthly mean flows might not precisely equal combined gage monthly mean flows.

3.4.2.4 State Designated Beneficial Uses

Beneficial use designations for the Tuolumne River are established by the CVRWQCB through the issuance of the Water Quality Control Plan (Basin Plan) (CVRWQCB 1998). The La Grange Project lies within Basin Plan unit (HU) 535, which includes the Tuolumne River from Don Pedro Dam to the San Joaquin River. Table 3.4-5 lists the designated beneficial uses for HU 535. As provided in the Basin Plan, existing beneficial uses of the lower Tuolumne River from Don Pedro Dam to the San Joaquin River (HU 535) water include: (1) agricultural supply, (2) water contact recreation, (3) non-water contact recreation, (4) warm freshwater habitat, (5) cold freshwater habitat, (6) migration of aquatic organisms, (7) spawning, and (8) wildlife habitat. Municipal and domestic supply is a designated potential beneficial use.

Table 3.4-5. Designated beneficial uses of the lower Tuolumne River from the Basin Plan.

Designated Beneficial Use Description from Basin Plan, Section II		Use	Designated Beneficial Use Don Pedro Dam to San Joaquin River (HU 535)
Municipal and Domestic Supply (MUN)	Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.	Municipal And Domestic Supply	Potential
Agricultural Supply (AGR)	Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation (including leaching of salts), stock watering, or support of vegetation for range grazing.	Irrigation	Existing
		Stock Watering	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 re-pressurization.	Service Supply	--
		Power	--
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
		Canoeing and Rafting[1]	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
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

Designated Beneficial Use Description from Basin Plan, Section II		Use	Designated Beneficial Use Don Pedro Dam to San Joaquin River (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
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

1 Applies to streams and rivers only.
2 Resident does not include anadromous. Any hydrologic unit with both WARM and COLD beneficial use designations is considered a COLD water body by the State Water Resources Control Board for the application of water quality objectives.
3 Warm water fish species include striped bass, sturgeon, and shad.
4 Cold water fish species include salmon and steelhead.
Source: CVRWQCB 1998 and amendments (CVRWQCB Basin Plan revised April 2016).

3.4.3 Water Quality

3.4.3.1 Water Quality Objectives for the Lower Tuolumne River

The Lower Tuolumne River comprises the Tuolumne River subarea delineated by the Basin Plan (CVRWQCB 1998). The Tuolumne River subarea extends downstream from the Stanislaus-Tuolumne county line and upstream of the Shiloh Road Bridge. The CVRWQCB has adopted water quality objectives for the Tuolumne River subarea to protect beneficial uses (Table 3.4-6). The objectives are primarily narrative, incorporating California's numeric Title 22 drinking water standards by reference, although some (i.e., bacteria, dissolved oxygen [DO], pH, temperature, and turbidity), are numeric.

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

Table 3.4-6. Water quality objectives to support beneficial uses in the vicinity of the La Grange Project as designated by the CVRWQCB and listed in the Basin Plan.

Water Quality Objective	Description
Bacteria	In terms of fecal coliform, less than a geometric average of 200/100 milliliter (ml) on five samples collected in any 30-day period and less than 400/100 ml on ten percent of all samples taken in a 30-day period.
Biostimulatory Substances	Water shall not contain biostimulatory substances that promote aquatic growth in concentrations that cause nuisance or adversely affect beneficial uses.
Chemical Constituents	Waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses. Specific trace element levels are given for certain surface waters, none of which include the waters in the vicinity of the Don Pedro Project. Other limits for organic, inorganic and trace metals are provided for surface waters that are designated for domestic or municipal water supply. In addition, waters designated for municipal or domestic use must comply with portions of Title 22 of the California Code of Regulations. For protection of aquatic life, surface water in California must also comply with the California Toxics Rule (40 CFR Part 131).
Color	Water shall be free of discoloration that causes a nuisance or adversely affects beneficial uses.
Dissolved Oxygen (DO)	The DO concentrations shall not be reduced below the following minimum levels at any time. Waters designated WARM 5.0 milligrams/liter (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.

Water Quality Objective	Description
Temperature	The natural receiving water temperature of interstate waters shall not be altered unless it can be demonstrated to the satisfaction of the CVRWQCB 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 CVRWQCB.
Turbidity	In terms of changes in turbidity (nephelometric turbidity units [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.

Source: CVRWQCB 1998 and amendments (CVRWQCB Basin Plan revised April 2016).

3.4.3.2 California List of Impaired Waters

Section 303(d) of the federal CWA requires that every two years each state submit to the EPA a list of rivers, lakes, and reservoirs for which pollution control and/or requirements have failed to provide adequate water quality. The SWRCB and CVRWQCB work together to research and update the list for the State of California. Based on a review of this list, the surface water bodies identified by the SWRCB as CWA § 303(d) State Impaired in the vicinity of the La Grange Project are listed in Table 3.4-7 (SWRCB 2012). The § 303(d) list 2012 updates, approved by EPA in 2015, are unchanged from 2010. There are currently no approved TMDL plans for the Tuolumne River.

Table 3.4-7. 2012 CWA Section 303(d) list of water quality limited segments for the lower Tuolumne River.

Waterbody Segment	Pollutant/Stressor	Potential Sources
Lower Tuolumne River (Don Pedro Reservoir to San Joaquin River)	Chlorpyrifos	Agriculture
	Diazinon	Agriculture
	Group A Pesticides[1]	Agriculture
	Mercury	Resource Extraction
	Temperature	unknown
	Unknown Toxicity	unknown

[1] The Group A Pesticides consist of aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexanes (including lindane), endosulfan, and toxaphene (SWRCB 2012).

3.4.4 Potential Water Resource Effects

FERC's SD2 (page 19) identifies the following issues related to water resources:

- Effects of Project operation on the quantity and timing of streamflow in the Project-affected downstream reach, including water storage, peaking operations, and ramping rates.
- Effects of Project O&M on water quality, water temperature, and water quantity in the Project reservoir and the Project-affected downstream reach.

The Project operates in a run-of-river mode, receiving water released from the upstream Don Pedro Project, and either diverting it for water supply purposes or safely passing it downstream, without affecting the rate of flows by use of storage. Streamflows diverted for water supply purposes affect the quantity of water passing downstream as depicted in Table 3.4-4 above. Hydropower generation at TID's powerhouse safely passes a portion of the flows not diverted for water supply purposes. Absent hydropower generation, the same quantity of flow would be passed downstream by other means, most likely continuing to be passed at the powerhouse through PRVs installed to replace the existing turbines. Therefore hydropower generation does not affect the quantity and timing of downstream flows.

An unexpected unit outage at the TID powerhouse, though infrequent, can result in a disruption of flows downstream. To avoid any adverse effect from such an occurrence, TID operations staff in the TID Control Center monitor La Grange operations on a continuous basis. A station or unit trip results in the immediate opening of one or both of the TID sluice gates, rapidly delivering water to the TID tailrace.

Another potential adverse effect of the Proposed Action requiring evaluation is the dewatering of the tailrace channel during a powerhouse outage which requires flows to be diverted to the TID sluice gate channel. The amount of time it takes for TID sluice gate channel flows to manifest in the tailrace channel in order to offset the loss of powerhouse flows has a direct influence on water surface elevations in the tailrace channel. The powerhouse operation is monitored around-the-clock from the TID remote operations desk located at TID's central control. Although remote start-up is possible, for safety reasons, operators are generally dispatched to the Project to check conditions following a station trip and to start the unit(s). If a unit or station trip, remote operators immediately open the two sluice gates to make certain flows continue downstream without disruption. The disruption to downstream flow as measured at the nearby USGS La Grange gage was examined by the Districts at the request of NMFS and FERC as part of the Don Pedro Project relicensing. The results of this analysis showed that flow fluctuations were less than 2 inches 99.4 percent of the time. This study (attachment to TID/MID 2014a [Districts' Response to NMFS-4, Element 1 through 6]) is attached to this FLA. These data indicate that operations of the La Grange powerhouse and the sluice gates are well synchronized if the powerhouse trips offline resulting in a relatively stable flow in the tailrace channel. The Proposed Action would not have an adverse effect flow in the tailrace channel. Further discussion of this potential resource effect and the associated studies are provided in Section 3.5 of this Exhibit E.

Based on the studies conducted, no adverse effects on water resources in the La Grange headpond or the lower Tuolumne River would be expected as the result of continued hydroelectric power generation at the Project. Continuance of existing hydropower operations at the Project would have no effect on flows, temperature, water quality, or any other environmental conditions in the La Grange headpond or lower Tuolumne River.

3.4.5 Proposed Water Resource Measures

In order to ensure consistent and adequate flow to support aquatic resources in the mainstem Tuolumne River reach downstream of the Project, the Districts propose to formalize the current Project O&M activity that provides a minimum flow of approximately 5 to 10 cfs to the plunge pool downstream of LGDD at all times. The current hillside releases to the plunge pool sustain favorable water quality conditions for resident and migratory fish species, as evidenced by weir passages of Chinook salmon, Sacramento pikeminnow (*Ptychocheilus grandus*), sculpin (*Cottus spp.*), and sunfish (*Lepomis*) documented by the Districts in 2015-2017 (TID/MID 2017d; attached to this FLA).

The Districts have collected temperature, turbidity, and dissolved oxygen data in the tailrace channel as part of the Fish Barrier Assessment, all of which indicate satisfactory conditions for aquatic life (TID/MID 2017d; attached to this FLA). During the first year of the assessment (2015), there was a brief period from late September through October during which daily instantaneous measurements of dissolved oxygen below 8.0 mg/L were recorded at the tailrace channel weir location. The low instantaneous dissolved oxygen levels appeared to be a localized event as dissolved oxygen levels at the main channel weir remained above 8.0 mg/L during the same period of time. To further evaluate the potential cause of this spatially and temporally isolated event, the Districts propose to monitor dissolved oxygen from September 1 to November 30 each year for the first 2 years of a new operating license. Monitoring equipment will collect dissolved oxygen information at 15 minute intervals at three locations; the Project forebay, immediately below the powerhouse, and at the lower end of the tailrace channel. At the end of the monitoring period each year, these data will be compiled, analyzed, and submitted as an annual report to FERC. The annual cost for dissolved oxygen monitoring and reporting are estimated to be $7,500. If results indicate a specific cause for low dissolved oxygen exists, the Districts will develop and submit an action plan to FERC in year 3 of the license.

3.4.6 Cumulative Effects to Water Resources

FERC's SD2 defined the geographic scope of cumulative effects to water resources as extending from Hetch Hetchy Reservoir to San Francisco Bay. The temporal scope considered for cumulative effects to water resources includes the past, present, and reasonably foreseeable future actions. The temporal scope extends 30 to 50 years into the future in order to coincide with the potential term of an original license for the Project.

The Proposed Action of continued hydroelectric power generation would not result in any cumulative effects to water resources over the geographic and temporal scopes defined for this resource in FERC's SD2. Diversions from the headpond and flows into the lower river are independent of and would continue to occur absent the hydroelectric operations at the Project. Therefore, the continuance of power generation would not have an effect on stage or flows in the La Grange headpond or lower Tuolumne River, and thus will not contribute to cumulative effects to water resources in the past, present, or next 30 to 50 years.

3.4.7 Unavoidable Adverse Impacts to Water Resources

No unavoidable adverse impacts to water resources are anticipated as a result of the Proposed Action of continued hydroelectric power generation at the La Grange powerhouse.

3.5 Aquatic Resources

3.5.1 Fish Populations between Don Pedro Dam and LGDD

In 2012, as part of the relicensing of the Don Pedro Project, the Districts conducted a study to characterize the fish assemblage in the 2.3-mile-long reach of the Tuolumne River between the Don Pedro powerhouse (RM 54.6) and LGDD (RM 52.2) (TID/MID 2013a). Reconnaissance surveys were conducted to evaluate habitat, and fish were sampled at sites selected to represent the availability of near-shore habitats. Boat electrofishing was conducted at each sampling site, with the duration of sampling recorded to ensure there was consistent effort among sites. Prior to this study, a single sampling event occurred in 2008 (TID/MID 2009). No known angler harvest or stocking data exist for this reach.

Two fish species were found in the study area during the 2012 study: rainbow trout and prickly sculpin (*Cottus asper*), both of which were distributed across the reach (TID/MID 2013a, W&AR-13). Relative abundance, length, and weight of fish collected in 2012 are shown in Table 3.5-1.

Table 3.5-1. Summary of relative abundance, length, and weight of fish species collected at all sites between Don Pedro Powerhouse and LGDD 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 rainbow trout population in the reach exhibited four age classes, indicating that reproduction occurs in the reach (as noted above, there are no records of stocking having been conducted in this reach). Rainbow trout were present in both lacustrine and riverine reaches, documenting that they use the range of available habitat (TID/MID 2013a). Average condition (i.e., Kn = 0.99) and appearance of the rainbow trout collected in 2012 indicated that fish were healthy (TID/MID 2013a).

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

3.5.2 Fish and Aquatic Resources in the Lower Tuolumne River

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

- Reach 1 (RM 0–10.5): Lower sand-bedded reach,
- Reach 2 (RM 10.5–19.3): Urban sand-bedded reach,
- Reach 3 (RM 19.3–24.0): Upper sand-bedded reach,
- Reach 4 (RM 24.0–34.2): In-channel gravel mining reach,
- Reach 5 (RM 34.2–40.3): Gravel mining reach,
- Reach 6 (RM 40.3–45.5): Dredger tailings reach, and
- Reach 7 (RM 45.5–52.1): Dominant salmon spawning reach.

Fish species documented in the lower Tuolumne River are shown in Table 3.5-2, with a notation as to whether a species is native or non-native and resident or migratory. The distributions of native and non-native fishes are influenced by water temperature and velocity, which vary by location, season, and in response to flow. Most native resident fish species are riffle spawners and are generally more abundant in the gravel-bedded reach (RM 24-52). 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 in the lower 6 to 7 miles of the gravel-bedded reach, where water temperatures are warmer and Special Run Pools 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 1992; 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 in 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 released in California between 1891 and 1954. Largemouth and smallmouth bass were released in California by CDFW between 1874 and 1891 (Dill and Cordone 1997; TID/MID 1992).

Table 3.5-2. Fish species documented in the lower Tuolumne River.

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

Sources: TID/MID 2017a; Ford and Brown 2001; TID/MID 2010b, c, d, Reports 2009-3, 2009-4, and 2009-5.

3.5.2.1 Fall-run Chinook Salmon

The lower Tuolumne River supports Central Valley fall-run Chinook salmon. Adult fall-run Chinook salmon spawn from late October through December (with peak activity in November) (TID/MID 2013c). Spawning occurs in the gravel-bedded reach (RM 24-52) where water temperatures are suitably cool and spawning riffles are present (TID/MID 2013c). Egg incubation and fry emergence occur from November through January. Chinook salmon rearing in the Tuolumne River primarily occurs from January to April (TID/MID 2013c).

A Chinook salmon population estimate was conducted by the Districts from 2008 to 2011 (TID/MID 2012a). In 2011 the survey was conducted from RM 51.8 to 35.0, and juvenile population size was estimated to be 24,299 (TID/MID 2012a). These estimates were higher than the 2008 and 2010 estimates, but slightly lower than 2009 estimates (TID/MID 2012a). A number of additional surveys have been conducted to study the Chinook salmon population in the lower Tuolumne River as summarized in the Don Pedro AFLA (TID/MID 2017c). Since 1971, the CDFW has conducted annual salmon spawning surveys. The Districts have operated an adult salmon counting weir at RM 24.5 since 2009. In addition, the Districts have studied Chinook salmon in the lower Tuolumne River through annual seine surveys since 1986 and annual snorkel surveys since 1982. Many of the fry and juvenile Chinook salmon in the Tuolumne River are consumed by introduced predators between RM 5.1 (location of the Grayson rotary screw trap) and RM 30.3 (location of the Waterford rotary screw trap) (TID/MID 2013b).

3.5.2.2 Rainbow Trout/Steelhead (*O. mykiss*)

O. mykiss exhibits two life history forms: a resident form known as rainbow trout and an anadromous form known as steelhead. The causes for the expression of anadromous or resident life-histories in *O. mykiss* occupying the lower Tuolumne River is poorly understood (TID/MID 2017j). Although rare occurrences of anadromous *O. mykiss* have been documented in the Tuolumne River (Zimmerman et al. 2008), there is no empirical evidence of a self-sustaining "run" or population of steelhead in the lower river (TID/MID 2013c; CDFW 2017b).

California Central Valley (CCV) steelhead return from the ocean to enter fresh water beginning in August, and spawning occurs from December through April. After spawning, adults may survive and migrate back to the ocean. Steelhead progeny rear for one to three years in fresh water before they migrate to the ocean as smolts, where most of their growth occurs. Since 2009, a total of six *O. mykiss* greater than 16 inches have been detected at the Districts' adult counting weir located at RM 24.5[11].

[11] CDFW (2017a) annual fishing regulations considers steelhead as any *O. mykiss* larger than 16 inches found in any of California's anadromous waters. However, results from Zimmerman et al. (2008) demonstrate that size alone is not a reliable indicator of *O. mykiss* anadromy in the Tuolumne River with only 1 out of 38 Tuolumne River *O. mykiss* 16 inches or greater having an anadromous life history.

A population estimate of *O. mykiss* was conducted by the Districts in the lower Tuolumne River from 2008 to 2011 (TID/MID 2012b). In 2011, population estimates for juveniles and adults from RM 51.8 to 35.0 were 47,432 and 9,541, respectively (TID/MID 2012b). These estimates were higher than those from previous years (TID/MID 2012b).

3.5.3 NMFS Recovery Plan

In July 2014, NMFS published a Recovery Plan for the Evolutionary Significant Units (ESU) of Sacramento River Winter-run Chinook Salmon, Central Valley Spring-run Chinook Salmon and the Distinct Population Segment (DPS) of CCV Steelhead (NMFS 2014). The overarching goal of the recovery plan is the removal of these Chinook ESUs or steelhead DPS from the Federal List of Endangered and Threatened Wildlife (50 CFR 17.11). In order to achieve recovery, each of the four diversity groups (e.g., northern Sierra Nevada, southern Sierra Nevada, etc.) must be represented and population redundancy within the groups must be met (i.e., diversity group recovery). The Tuolumne River is a part of the southern Sierra Nevada diversity group which is comprised of streams tributary to the San Joaquin River from the east. Diversity group recovery for the southern Sierra Nevada for the CV spring-run Chinook salmon ESU and CCV steelhead DPS consist of two populations (of each species/run) at low risk of extinction (NMFS 2014).

The federal ESA listing status and presence is described below for each relevant species/run to the Tuolumne River.

3.5.3.1 Central Valley Spring-run Chinook Salmon

The Central Valley spring-run Chinook salmon ESU was originally listed as a threatened species in 1999 (64 FR 50394). After the development of the NMFS hatchery listing policy, the status of the ESU was re-evaluated, and a final determination was made that reaffirmed the threatened species status for the ESU (70 FR 37204) (NMFS 2016a). NMFS proposed critical habitat for Central Valley spring-run Chinook salmon on December 10, 2004 (69 FR 71880) and published a final rule designating critical habitat for the ESU on September 2, 2005 (70 FR 52488) (NMFS 2016a). According to Lindley et al. (2007), the majority of spring-run Chinook historically in the Central Valley were produced in the southern Sierra Nevada diversity group . However, all spring-run Chinook populations have been extirpated from the southern Sierra Nevada and the Basalt and Porous Lava diversity groups (NMFS 2009). Currently, the only recognized populations of spring-run Chinook occur in the Sacramento River basin (NMFS 2009). There is no CV spring-run Chinook salmon critical habitat in the Tuolumne River watershed. In accordance with the Recovery Plan, both the Tuolumne River (below La Grange Diversion Dam) and the upper Tuolumne River (above the La Grange Diversion Dam) are considered candidate areas for reintroduction (NMFS 2014).

3.5.3.2 California Central Valley Steelhead

NMFS listed the CCV steelhead as a threatened species on March 19, 1998 (63 FR 13347), and on September 8, 2000, pursuant to a July 10, 2000 rule issued by NMFS under Section 4(d) of the ESA (16 USC § 1533(d)), statutory take restrictions that apply to listed species began to apply, with certain limitations, to CCV steelhead (65 FR 42422) (NMFS 2016b). On January 5, 2006, NMFS reaffirmed the threatened status of CCV steelhead and decided to apply the joint U.S. Fish and Wildlife Service-National Marine Fisheries Service DPS policy (61 FR 4722). NMFS proposed critical habitat for CCV steelhead on February 5, 1999 (64 FR 5740) in compliance with Section 4(a)(3)(A) of the ESA. In the Tuolumne River, critical habitat for CCV steelhead extends from the confluence with the San Joaquin River upstream to LGDD. As noted above, existing information indicates there is not a self-sustaining "run" or population of steelhead in the lower river (TID/MID 2013c; CDFW 2017a). In accordance with the Recovery Plan, the Tuolumne River (below La Grange Diversion Dam) is considered a Core 2 population (i.e., meeting or having the potential to meet, the biological recovery standard for moderate risk of extinction). The upper Tuolumne River (above La Grange Diversion Dam) is considered a candidate area for reintroduction (NMFS 2014).

3.5.4 Fish Studies Conducted in the Lower Tuolumne River

The description of fish and aquatic resources in this FLA is based primarily on three sets of studies conducted by the Districts: (1) studies conducted prior to the relicensing of the Don Pedro Project, (2) studies conducted as part of the Don Pedro relicensing, and (3) studies conducted as part of the licensing proceedings associated with the Project.

3.5.4.1 Fish Studies Conducted Prior to 2010

The Districts, in cooperation with state and federal resource agencies and environmental groups, conducted over 200 resource investigations between 1971 and 2010. The first 20 years of study led to the development of a FERC-mediated settlement agreement (in 1995) with resource agencies and NGOs, whereby the Districts agreed to modify Don Pedro Project operations to increase flows released to the lower Tuolumne River for the benefit of fish, especially fall-run Chinook salmon. The record created by the continuous process of environmental investigation and resource monitoring has produced detailed baseline information.

Major studies conducted by the Districts since the 1995 Settlement Agreement but prior to 2010 fall into the following general categories: (1) salmon population models, (2) salmon spawning surveys, (3) seine, snorkel, and fyke net reports and various juvenile salmon studies, (4) screw-trap monitoring, (5) flow fluctuation assessments, (6) smolt monitoring and survival evaluations, (7) fish community assessments, (8) aquatic invertebrate reports, (9) Delta salmon salvage reports, (10) gravel, incubation, redd distribution studies, (11) water temperature and water quality assessments, (12) instream flow incremental methodology assessments, (13) flow and delta water export reports, (14) restoration and associated monitoring, and mapping, and (15) general monitoring. For a list of the studies conducted in the lower Tuolumne River prior to 2010 (i.e., Don Pedro Project relicensing), refer to Exhibit E of the Don Pedro Hydroelectric Project AFLA (TID/MID 2017c).

3.5.4.2 Fish Studies Conducted by the Districts as Part of the Don Pedro Hydroelectric Project Relicensing

As part of the Don Pedro Project relicensing process, over 40 additional resource studies were conducted of which 25 were focused on fish and aquatic resources (TID/MID 2017j). For a list of and more detailed information about these studies' goals and objectives, implementation, and conclusions, refer to the Don Pedro Hydroelectric Project AFLA (TID/MID 2017c).

3.5.4.3 Aquatic Resource Studies Conducted by the Districts as Part of the Project Licensing

As part of the La Grange Hydroelectric Project licensing process, the Districts completed ten aquatic resources studies (Table 3.5-3); seven that were required by FERC and three implemented voluntarily to provide baseline information to aid in the assessment of anadromous fish reintroduction to the upper Tuolumne River above the Don Pedro Reservoir.

Table 3.5-3. Aquatic resource studies completed in support of the La Grange licensing process.

No.	Study
1	La Grange Project Fish Barrier Assessment[1,2]
2	Topographic Survey[1,2]
3	Salmonid Habitat Mapping[1,2]
4	Fish Presence and Stranding Assessment[1,2]
5	Investigation of Fish Attraction to La Grange Powerhouse Draft Tubes[1,2]
6	Effects of the Project and Related Activities on the Losses of Marine-Derived Nutrients in the Tuolumne River Study[2]
7	Fish Passage Facilities Alternatives Assessment[1,2]
8	Upper Tuolumne River Basin Fish Migration Barriers Study[1,3]
9	Upper Tuolumne River Basin Water Temperature Monitoring and Modeling Study[1,3]
10	Hatchery and Stocking Practices Review[3]

1 Component of the Fish Passage Assessment as identified in the Revised Study Plan.
2 Approved by FERC in the Commission's February 2, 2015, Study Plan Determination.
3 Study was conducted voluntarily by the Districts.

The aquatic resource studies completed by the Districts evaluated fish migration and potential barriers; fish passage engineering feasibility; aquatic habitat within the general La Grange Project area; fish species presence; estimates of the historical losses of marine-derived nutrients to reaches above the Project due to the existence of the LGDD; hatchery stocking practices; thermal suitability; and the potential for stranding (of fish and redds) or direct injury due to hydroelectric operations of the La Grange Project. A summary of each study is presented below.

La Grange Project Fish Barrier Assessment

The La Grange Project Fish Barrier Assessment (TID/MID 2017h, attached to this FLA) was conducted to evaluate the extent to which the LGDD and the La Grange powerhouse act as barriers to the upstream migration and spawning of adult fall-run Chinook salmon and, if they occur in the lower Tuolumne River, steelhead. Specific objectives of the study are to:

- determine the number of fall-run Chinook salmon and steelhead migrating upstream to LGDD and the La Grange powerhouse during the 2015-2016 and 2016-2017 migration seasons;
- compare the number of fall-run Chinook salmon and steelhead migrating upstream to the LGDD and the La Grange powerhouse to total escapement during the 2015-2016 and 2016-2017 migration seasons;

- document carcass condition (egg retention) to evaluate pre-spawn mortality rates of fall-run Chinook salmon and steelhead migrating upstream to LGDD and the La Grange powerhouse, which do not move back downstream to spawn; and
- implement formal documentation of incidental fish observations in the vicinity of LGDD, La Grange powerhouse tailrace, and the TID sluice gate channel (see Fish Presence and Stranding Assessment, below).

Two fish-counting weirs were installed in the Tuolumne River on September 11, 2015. One weir segment was placed downstream of the large pool just below LGDD in the Tuolumne River main channel and the second segment was placed just below the La Grange powerhouse in the tailrace channel. Each weir consisted of rigid panels that directed fish through a passing chute that was continuously monitored by a video system (TID/MID 2017h). An additional fish counting weir (RM 24.5) operated since 2009 and located downstream of the fall-run Chinook salmon spawning reach was used to determine the total escapement of fall-run Chinook salmon and *O. mykiss* through direct counts.

After a brief testing period, weir operation and monitoring began on September 23, 2015 and continued through April 14, 2016. For the 2016-2017 monitoring season, both weirs were installed on September 20, 2016 and monitoring continued until January 2, 2017 when flood control releases from Don Pedro Reservoir required that they be removed. Sustained high flows through spring did not allow reinstallation of the counting weirs during the second study year (TID/MID 2017h).

Digital video footage was reviewed to identify passage events and to evaluate daily upstream and downstream weir counts and the total number of fish exhibiting persistent upstream migration behavior (upstream counts minus downstream counts). The total number of fish exhibiting persistent upstream migration behavior was divided by total escapement determined at the downstream weir (at RM 24.5) to estimate the extent to which the La Grange facilities are a barrier to upstream migration and spawning (TID/MID 2017h). Due to higher discharges and greater numbers of fall Chinook in 2016-2017, statistical inference methods were used to estimate the total numbers of individuals present in the vicinity of the La Grange facilities based on the number of uniquely identified fish by sex and the median number of passage events observed during the 2015-2016 season (TID/MID 2017h).

During the 2015-2016 sampling period, 3,264 salmon Chinook salmon passage events (1,617 upstream, 1,647 downstream) were detected at the tailrace and main channel weirs. The majority of passage events (89.7 percent) occurred during November and December. Individual fish were identified based on estimated fish length, sex, and general morphological characteristics. Based on this approach, 105 individual Chinook salmon accounted for the 2,329 passages at the tailrace channel weir, and 12 Chinook salmon accounted for the 935 passages at the main channel weir. Of these, 82 were males and 35 females, and 33 (28 percent) had a clipped adipose fin (i.e., could be definitively identified as hatchery-origin fish). Based on morphological characteristics, it is likely that some individuals were detected at both weirs although evaluating movement between these weirs was not an objective of the study. Additionally, 23.9 percent of Chinook passing the lower Tuolumne weir (RM 24.5) were ad-clipped. Given that 25 percent of Central Valley fall-run Chinook salmon hatchery production is marked annually (via CDFW's Constant

Fractional Marking Program), and that there is no hatchery in the Tuolumne River, this suggests that nearly all Chinook salmon entering the lower Tuolumne River and in the vicinity of the La Grange facilities during the study period were hatchery strays (TID/MID 2017h). A high rate of straying has been documented for fall-run Chinook salmon in the San Joaquin basin, and likely exists for Tuolumne River stock as well (FERC 1996).

Chinook salmon often made multiple, consecutive upstream and downstream passages. At the tailrace weir, the median time from initial passage through final passage was 101.5 hours (4.23 days), and ranged from 0.37 hours to 823.89 hours (34.33 days). At the main channel weir, the median time from initial passage event through final passage event was 153.65 hours (6.40 days), and ranged from 4.83 hours to 491.28 hours (20.47 days) (TID/MID 2017h).

Total escapement into the Tuolumne River was determined to be 421 adult fall-run Chinook salmon based on weir counts at RM 24.5 between September 28, 2015 and December 31, 2015 (Becker et al. 2016).

Based on 2015/2016 weir counts, 117 adult Chinook salmon were observed at the La Grange counting weirs between September 23, 2015 and April 15, 2016. The proportion of the Chinook salmon escapement that was observed to be in the vicinity of the La Grange facilities was 26.9 percent (117/435). Of the individual salmon observed during the 2015/2016 monitoring season, most (85.5 percent) spent less than 10 days near the La Grange facilities, with 21.4 percent (number [n]=25) spending less than 24 hours near the La Grange facilities (TID/MID 2017h).

A goal of this study was to determine the total number of fish exhibiting persistent upstream migration behavior (i.e., defined as fish that move upstream to the La Grange facilities and don't return to downstream spawning habitat) to estimate the extent to which the La Grange facilities are actually a barrier to upstream migration and spawning. During the 2015/2016 monitoring season, only a single salmon met the criterion of exhibiting persistent upstream migration, a female that was likely stranded and dewatered in the sluice gate channel during an event when the powerhouse tripped offline. During the 2015/2016 monitoring period, 435 salmon moved upstream of the lower weir site (located at RM 24.5). Based on passages at the two monitoring locations, less than one percent of the total fall-run escapement exhibited persistent upstream migration as defined by the study criteria (1/435) (TID/MID 2017h).

Despite a shorter sample season during the 2016/2017 monitoring period, a total of 11,239 fall-run Chinook salmon passage events (5,485 upstream, 5,754 downstream) were detected at the tailrace weir and 10,544 Chinook passage events (5,248 upstream, 5,296 downstream) at the main channel weir. It is important to note that the number of passage events are not equal to the numbers of individual fish since a single fish can produce multiple passage events. The first Chinook salmon passage event was October 8, 2016, and Chinook salmon were observed through January 1, 2017 (TID/MID 2017h).

In 2016-2017, 74.8 percent of passage events at the tailrace weir were assigned a sex. Of those passage events, the ratio of female to male passage events was 0.19, roughly similar to the 1 female for every 5 male passages that was observed in 2015-2016. The high number of passage events at the tailrace weir prevented the accurate identification of unique individuals based on video review. Because unique individuals could be identified and monitored in 2015-2016, it was possible to use the distribution of passage events per individual to help inform the number of individuals present at the tailrace weir in 2016-2017.

In 2015/2016, males had a significantly greater median number of passages than females (19 vs. 8 passage events, P=0.006) based on a Student's t-test. At the main channel weir, the median number of passages for females was 27 and 81 for males The number of passage events was also more variable for males relative to females (TID/MID 2017h). Because the percentage of sex-assigned passages was similar in 2015-2016 to 2016-2017 (69.7 percent and 74.8 percent, respectively), and the ratio of female to male passages of known sex was also similar (0.21 and 0.19, respectively), the total number of passages in 2016/2017 (11,239 and 10,544) were apportioned into males and females based on the proportion of each sex for the passage events where sex could be assigned. Applying the sex-specific median number of passages to the total number of passages provided an estimate of approximately **225** (128 – 360 95 percent confidence interval [CI]) females and **497** (363 – 944 95 percent CI) males for a total of **722** individual fall-run Chinook (491 – 1304 95 percent CI). Sex specific estimates for the main channel weir were **130** females (16–infinity 95 percent CI) and **83** males (57–3376 95 percent CI) for a total of approximately **213** individuals. The low number of individuals at the main channel weir in 2015/2016 resulted wider median confidence intervals that led to wider 95 percent confidence intervals of the estimates.

Total escapement into the Tuolumne River was determined to be 3,555 adult fall-run Chinook based on weir counts at RM 24.5 between September 19, 2016 and December 31, 2016. Sex was determined for nearly all passages and consisted of 59 percent (n=2,109) male and 39 percent (n=1,383) female, and 62 fish could not be identified by gender. Ad-clips were observed in 24 percent (n=848) of the Chinook salmon passages at the lower Tuolumne weir; similar to the ratio of ad-clipped fish the prior year. During the 2016/2017 monitoring period, three unspawned salmon carcasses (discussed below) were found upstream of the La Grange weirs. Based on passages at the two monitoring locations, less than one percent of the total fall-run escapement exhibited persistent upstream migration during the 2016/2017 monitoring period.

As noted above, direct counts of ad-clipped fish suggest that the great majority of Chinook salmon entering the lower Tuolumne River and in the vicinity of the La Grange facilities during the study period were hatchery strays (TID/MID 2017h). A review of California's anadromous fish hatchery programs found that off-site releases promote straying among populations (California HSRG 2012). As most salmon return at three years of age, the majority of adult salmon observed in the Tuolumne River during fall 2015 and 2016 were likely from brood years 2012 and 2013. During those brood years, 98 to 100 percent of juvenile Chinook salmon born at hatcheries on the Merced, Mokelumne, and Feather rivers were transported to off-site locations for release (Regional Mark Processing Center 2017).

Boggs et al. (2005) found that fallback percentages of adult Chinook salmon at fish ladders on the Snake River were nearly 3 to 13 times greater for Chinook salmon that had been transported as juveniles. Similar patterns were also seen with transported vs. non-transported steelhead, suggesting that transportation of migrating juveniles disrupts the sequential imprinting for efficient homing to spawning tributaries. Out-of basin strays would have no site fidelity to the Tuolumne River spawning reach, and the number of individual Chinook salmon identified near the La Grange facilities during the study period may have been influenced by the high percentage of hatchery origin Chinook salmon strays in the Tuolumne River. Also, Okland et al. (2001) found adult Atlantic salmon migrating in a free-flowing river commonly exhibited a "search" phase. This was characterized as movements both upstream and downstream at or close to the position of spawning. It is possible that a similar "search" pattern was observed in the Tuolumne River based on the observation of consecutive upstream and downstream passages by individual Chinook salmon at the tailrace and main channel weirs.

During the 2015/2016 sampling period, 270 *O. mykiss* passage events (140 upstream, 130 downstream) were detected at the tailrace weir and no *O. mykiss* were detected at the main channel weir. Estimated lengths of *O. mykiss* ranged from 10 centimeters (cm) to 60 cm. Adult-sized *O. mykiss* (>30 cm) accounted for 141 of these passage events (68 upstream, 73 downstream). Unlike Chinook salmon, it was not possible to identify individual *O. mykiss*, because there was much less variability in fish length, sex, and general morphological characteristics.

Adult *O. mykiss* were first observed on October 6, 2015, and last observed on March 29, 2016. The majority (83.5 percent) of adult *O. mykiss* detections occurred from November through January. Two adipose-clipped (i.e., hatchery-origin fish) *O. mykiss* observations occurred on February 19 and February 24. Based on estimated length (approximately 50 cm) and general morphological characteristics, these two observations were likely of a single fish (TID/MID 2017h).

A total of 919 *O. mykiss* passage events (437 upstream, 482 downstream) were detected at the tailrace weir during the 2016/17 monitoring period and estimated lengths ranged from 10 to 50 cm. Adult-sized *O. mykiss* (>30 cm) accounted for 125 of these passage events (46 upstream, 79 downstream). The first adult *O. mykiss* detection occurred on October 1, 2016 and the last detection occurred on December 31, 2016. Sixty-two percent (n=78) of the adult passage events occurred in December. Unlike Chinook salmon, it was not possible to identify the total number of individual *O. mykiss* as there was much less variability in fish length, sex, and general morphological characteristics. Eight passage events (4 upstream, 4 downstream) of adipose-clipped *O. mykiss* were observed between December 24 and December 31 at the tailrace weir. Based on estimated length (40-50 cm) and general morphological characteristics, these observations were likely of a single fish.

A total of 831 *O. mykiss* passage events (344 upstream, 487 downstream) were detected at the main channel weir. Estimated lengths of *O. mykiss* observed ranged from 10 cm to 30 cm. A single adult sized *O. mykiss* (30 cm) was detected moving upstream, and subsequently downstream, on December 14, 2016.

During the 2015/2016 and 2016/2017 monitoring period, three and one *O. mykiss* (>30 cm) passages recorded, respectively at the lower weir site (RM 24.5). Due to this low number of upstream migrating *O. mykiss* observed at the downstream weir, *O. mykiss* passages detected in the vicinity of the La Grange facilities during the study predominantly represent movement of "resident" *O. mykiss* rearing in and around the La Grange powerhouse tailrace. Although it was not possible to identify individual *O. mykiss* passing the La Grange weirs, 83.5 percent (n=90) and 62.4 percent (n=78) of the adult *O. mykiss* passage events occurred prior to the first *O. mykiss* detection at the lower weir site during the 2015/2016 and 2016/2017 monitoring period, respectively. Additionally, snorkel surveys (TID/MID 2010d, 2012b) have regularly identified adult *O. mykiss* (30-50 cm) in the upper reaches of the lower Tuolumne River (TID/MID 2017h). Furthermore, Zimmerman et al. (2008) evaluated 147 otoliths from the Tuolumne River and detected only a single fish expressing a steelhead migratory history and 9 additional individuals with maternal steelhead origin. Review of the data indicates that size alone is not an effective indicator of anadromy, as 38 of the fish sampled were 40 cm or greater, with only 2.6 percent (1 of 38 fish) expressing a steelhead migratory history. Therefore, 97 percent of the larger *O. mykiss* (≥40 cm) were resident fish.

Due to the number of "resident" *O. mykiss* passages, it was not possible to calculate the persistent upstream migration of steelhead (i.e., as defined in the RSP, number of individual *O. mykiss* remaining upstream of the weir divided by the total count of *O. mykiss* observed passing the weir at RM 24.5). Given that no *O. mykiss* remained above the main channel or tailrace weirs and no *O. mykiss* carcasses were recovered to evaluate pre-spawn mortality (note unlike Chinook salmon, *O. mykiss* spawn multiple times), it is expected that all fish moved downstream to spawn and the La Grange facilities did not impact potential *O. mykiss* production.

During the 2015/2016 sampling period, no Chinook or *O. mykiss* spawning activity was observed upstream of either weir (TID/MID 2017k). A single unspawned female was discovered in the sluice gate channel. During the 2016/2017 monitoring period, there was no Chinook or *O. mykiss* spawning activity upstream of the tailrace channel weir. Two active Chinook redds were identified just upstream of the main channel weir. Two unspawned female Chinook salmon carcasses were recovered above the tailrace weir on November 19, 2016. A single unspawned female Chinook carcass was also recovered in the main channel. Additional CDFW escapement surveys conducted in the Tuolumne River did not document any pre-spawn or partial-spawn Chinook mortalities during the 2015[12] or 2016 fall-run monitoring period (Gretchen Murphey, CDFW pers. Comm., January 2017).

These observations are consistent with the low levels of pre-spawn or partial-spawn mortality of Tuolumne River fall-run Chinook during CDFW surveys conducted in previous years (CDFW 2014). Of previous years evaluated, the maximum annual occurrence of pre-spawn or partial-spawn mortality documented was five individuals in 2013 (CDFW 2014). Results indicate that pre-spawn mortality below the La Grange facilities are low and did not appear to affect Chinook production during the study period.

[12] In comments filed on the La Grange Hydroelectric Project Draft License Application (CDFW 2017a), CDFW requested the following statement be added to the study results: "The report should also mention that CDFW only tagged 8 fish that year, which constitutes a very small sample size and as such, no definitive statements regarding pre-spawn mortality can be concluded based upon this data set."

Topographic Survey

The goal of the Topographic Survey (TID/MID 2017k, attached to this FLA) was to collect information to evaluate the effects of Project operation on stream flow and anadromous fish habitat in the Tuolumne River between LGDD and the La Grange USGS gage. Specific objectives of the survey were to:

- survey a longitudinal profile and transects along the channel thalweg in the La Grange powerhouse tailrace, TID sluice gate channel, and the Tuolumne River mainstem channel upstream of where it joins the tailrace channel and take survey measurements that characterize the large cobble and bedrock island that separates the La Grange powerhouse tailrace and the mainstem Tuolumne River below LGDD;
- take survey measurements at geomorphic hydraulic control features in the channels below the LGDD and La Grange powerhouse; and
- measure water depths at a flow of approximately 25 cfs in the mainstem river channel upstream of where it joins the tailrace channel and at approximately 75 to 100 cfs in the La Grange powerhouse tailrace channel and the TID sluice gate channel.

In June and July 2015, longitudinal and hydraulic control features were surveyed using a Real Time Kinematic Global Positioning System. Data were collected along the thalweg of the channel at approximately every 10 feet as well as at hydraulic control points. At each survey location, depths were recorded and flows were measured on the same day as the survey. The large cobble and bedrock island and the sluice gate channel were characterized using existing LiDAR data. During 2015 survey work, no water depths were recorded in the TID sluice gate channel because the sluice gate channel was dry during both survey days. Operators reopened the 18-inch pipe in the fall of 2015 to allow for a minimum channel maintenance flow of approximately 5 to 10 cfs in the sluice gate channel. In October 2016 a hydraulic study of the TID sluice gate channel was completed, and is included as an appendix to the final Topographic Survey Technical Memorandum (TID/MID 2017k).

Topographic measurements included longitudinal measurements of the mainstem Tuolumne River, the TID sluice gate channel, the La Grange powerhouse tailrace channel and the large cobble and bedrock island (Figures 3.5-1 through 3.5-4). The elevations on the island at the time of the survey ranged from 176.9 to 193.0 feet. The average elevation was 186.9 feet and the average distance between points was approximately 1.4 feet (TID/MID 2017k).

Two points of hydraulic control were identified in each of the mainstem channel and the La Grange powerhouse tailrace channel (Figure 3.5-5). Both channels had a larger pool at the upstream end with a smaller pool about halfway down the reach above the confluence of the channels (TID/MID 2017k).

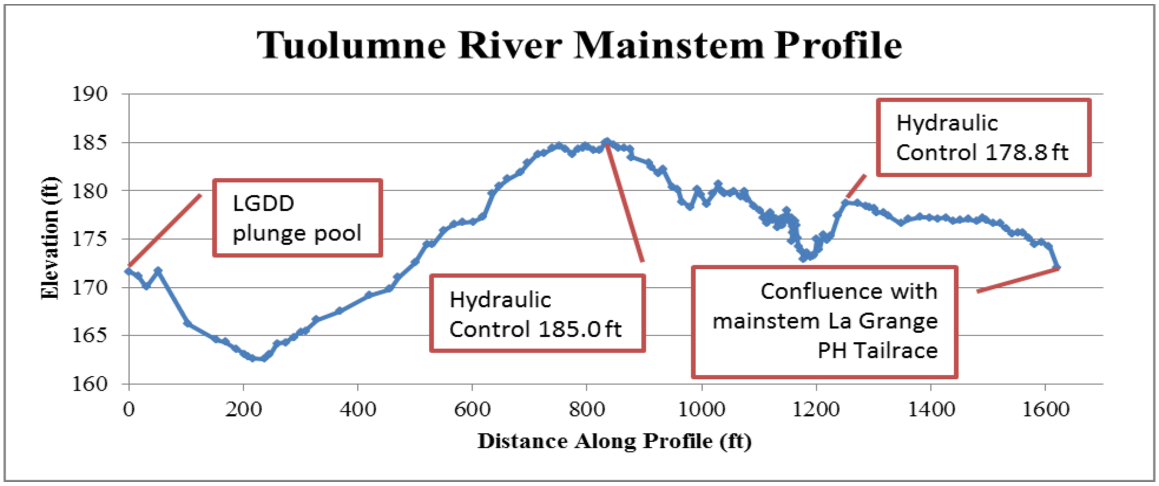

Figure 3.5-1. Longitudinal profile of the Tuolumne River mainstem channel.

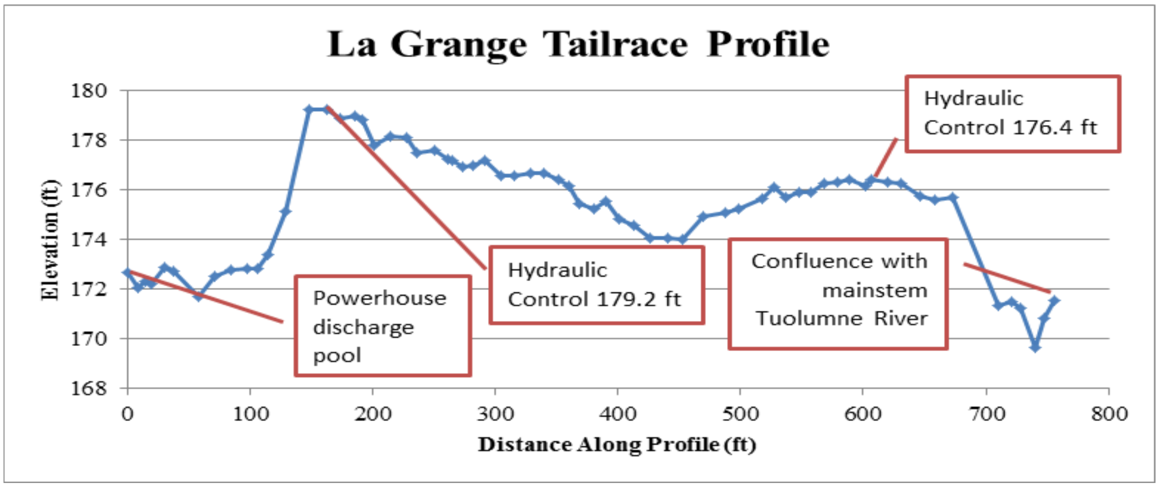

Figure 3.5-2. Longitudinal profile of the La Grange powerhouse tailrace channel.

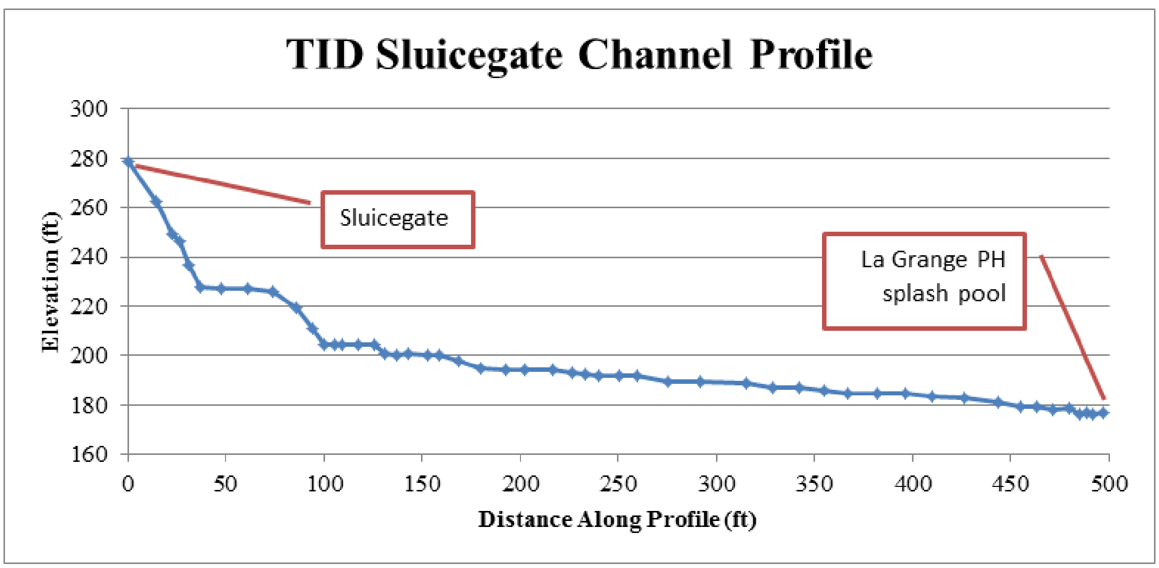

Figure 3.5-3. Longitudinal profile of the TID sluice gate channel.

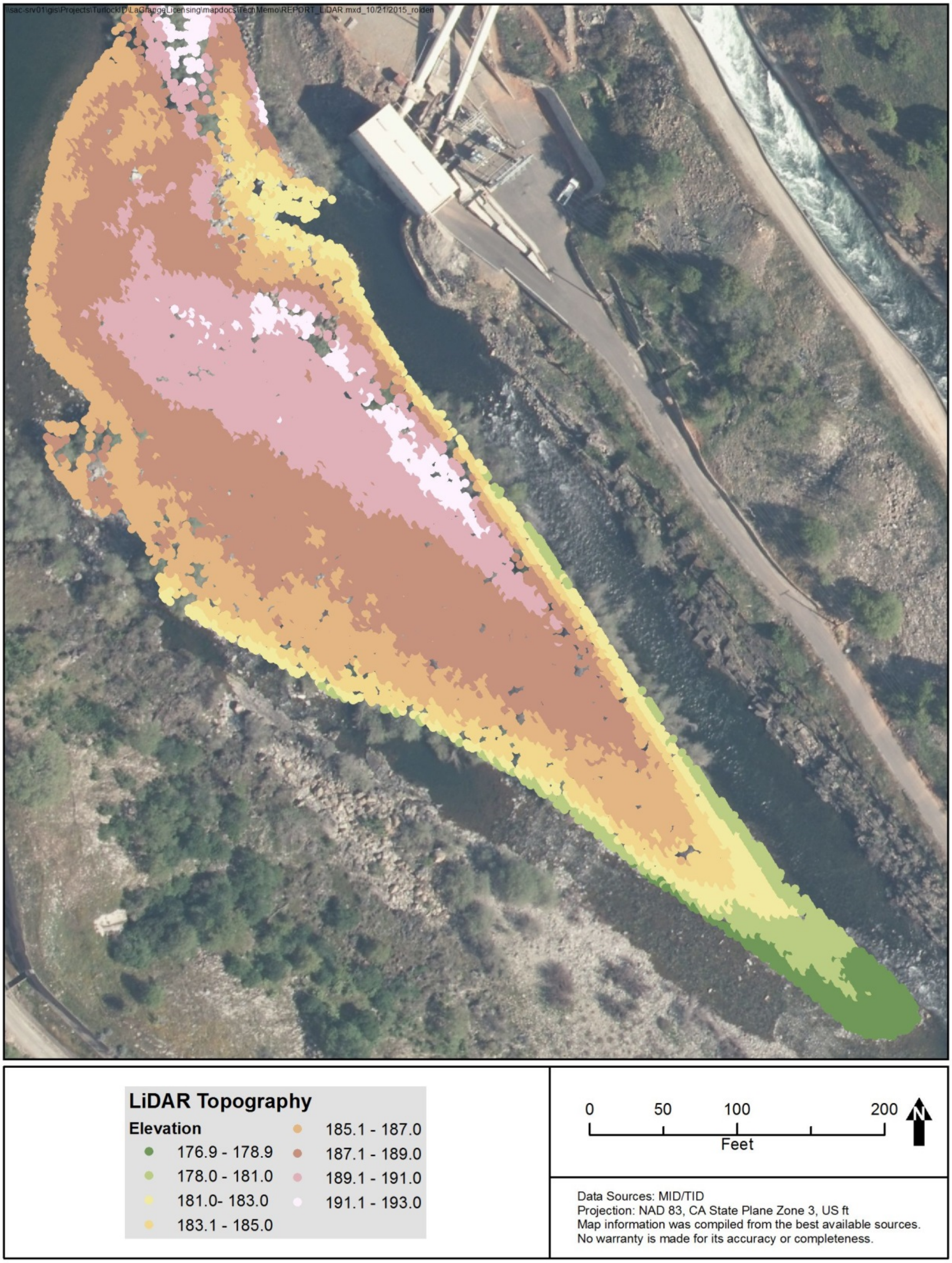

Figure 3.5-4. Mid-channel island LiDAR topography.

Figure 3.5-5. Channel thalwegs and hydraulic control locations with distances along profile identified.

Tuolumne River channel flow measurements were difficult to complete due to the low flow conditions and the lack of a suitable flow measurement location. However, the combined flow for both channels is captured by the USGS gage just downstream of the study area, thus mainstem channel flow measurements can be inferred by subtracting the flow measurement within the La Grange powerhouse tailrace channel (TID/MID 2017k).

Flow measurements for each of the channels were not measured on July 15, 2015 as they were similar to June 23, 2015 according to both the USGS gage immediately downstream of the study area and a visual assessment by survey staff. The RSP states that flows should be approximately 75 to 100 cfs in the La Grange tailrace channel and approximately 25 cfs in the main channel during data collection associated with the study. As shown below in Table 3.5-4, the flow measurement results are consistent with this requirement (TID/MID 2017k).

Table 3.5-4. Flow measurements below LGDD and powerhouse.

Date	Manual – La Grange Powerhouse Tailrace (cfs)	USGS 11289650 (cfs)	Inferred – Main Channel (cfs)
6-23-2015	81	~100	19
7-15-2015	NA	~90	NA

Depth measurements along the surveyed longitudinal profiles were recorded under discharges identified in the RSP. A summary of these data is provided below (Table 3.5-5). A range of depths is provided along with the average and median depths for each of the channel profiles. The median depth may be more representative of the most common depths by length as the deep pool depths are an order of magnitude larger than the most prolifically observed depths. The complete dataset of depth measurements is available upon request to the Districts (TID/MID 2017k).

As noted above, depths in the TID sluice gate channel were not available during the time of the 2015 survey as the sluice gate was closed and no water was in the channel. Additionally, existing LiDAR data of the sluice gate channel provided by the Districts was conducted when the TID sluice gate was closed (TID/MID 2017k).

Table 3.5-5. Summary of depth measurements collected in 2015 for each channel below LGDD.

Channel	Depth Range (ft)	Average Depth (ft)[1]	Median Depth (ft)
Tuolumne River Mainstem	0.3-23.1	6.2	2.9
La Grange Powerhouse Tailrace	0.7-9.1	3.4	2.2
TID Sluice Gate[2]	NA	NA	NA

1 Average and median depth calculated along the longitudinal profile measurements.
2 The TID sluice gate was closed during the survey.

In 2016, a hydraulic study of the TID sluice gate channel was completed, and the results are presented as an attachment to the Topographic Survey Technical Memorandum (TID/MID 2017k). If the La Grange powerhouse trips off line, the sluice gate(s) located adjacent to the penstock intakes (Figure 3.5-6) is immediately opened to maintain discharge in the tailrace channel. When powerhouse operation is restored, the sluice gate(s) closes. An 18-inch pipe delivers approximately 5 to 10 cfs from the forebay structure to the sluice gate channel continuously, maintaining flowing water to the sluice gate channel (TID/MID 2017k).

Figure 3.5-6. Aerial photo of sluice gate channel area, forebay, penstock intakes, powerhouse and upper end of tailrace channel.

The Districts performed field survey measurements of topography and water surface elevation in the channel below the sluice gate at the constant flow from the 18-inch pipe which was measured to be approximately 8 cfs and at a sluice gate flow of 80 cfs. This field survey information and water surface elevation data were used to develop a HEC-RAS (version 5.0.3) hydraulic model and plot cross-section and longitudinal depth profiles as well as to quantify the stage changes associated with flow changes during operation of the sluice gates to enable the evaluation of the potential for fish stranding (TID/MID 2017k).

Model set up, geometry development, and calibration were completed using the 2016 field survey information. Following calibration of the water surface for the surveyed 8 cfs and 80 cfs water surface profiles, the model was executed to simulate a gate closure event in which the inflow to the model was transitioned from a constant gate discharge of 100 cfs to a flow of 5 cfs, simulating a gate closure over a closure time of two minutes. The model was run at a 10-second time interval and ran 10 minutes past the end of the gate closure event to capture the attenuation of flow at the downstream end of the model (TID/MID 2017k).

Within the sluice gate channel, there is a shallow watered pool located below the gates at the upper send of the channel. The HEC-RAS unsteady flow model runs demonstrated that a change in water surface, during a gate closure event from 100 cfs gate discharge to 5 cfs, would result in an average water surface drop along the flow channel of 1.7 feet starting within 6 minutes of the beginning of gate closure. The drop is relatively uniform across the lower reach length, demonstrating flow connectivity between the upstream pool area and the downstream tailrace.

The modeled two-minute gate closure begins on the second minute of modeling and the modeled lag between gate closure and change in downstream hydrograph is approximately one minute (TID/MID 2017k).

Modeled HEC-RAS output was exported to a Geographic Information System (GIS) to provide a plan view of the modeled water surfaces and to examine the channel reach at various flow changes in the flow rates. Figure 3.5-7 provides a plan view of modeled 80, 50, 25, and 8 cfs (colored polygons). For the section of the channel leading up from the tailrace to station 3+25.6, the modeled 8 and 80 cfs water surfaces match well with surveyed extents. Above station 3+25.6, topographic analysis shows that the average channel slope is 36 percent, demonstrating an extremely steep section (TID/MID 2017k).

Examination of Figure 3.5-7 indicates zones of continuous water connectivity and absence of isolated pools during the changing flows upon gate closure. This matches field observations made during the La Grange study program after gate closure. Unsteady flow analysis of a two-minute gate closure event (in which the flow rate changes from 100 to 5 cfs) indicates the existence of a continuous flow channel as flow is reduced to the approximate minimum flow of 5 cfs (TID/MID 2017k).

Salmonid Habitat Mapping

The Salmonid Habitat Mapping study (TID/MID 2016c, attached to this FLA) examined potential effects of Project operations on anadromous fish habitat in the Tuolumne River in the vicinity of the LGDD and Project facilities. Specific objectives of the study were to:

- Map substrate and habitat in the main channel and tailrace, delineating the presence of pools, runs, high- and low-gradient riffles, step-pools, and chutes;
- Map patches of spawning-sized gravels in the tailrace and main channel that are greater than two m^2 (21.5 ft^2); and
- Conduct pebble counts in riffles, runs, and pool tailouts to document substrate particle size distribution in these habitats.

At the request of NMFS representatives during a May 5, 2015 telephone discussion of study implementation, data collection for this study element was expanded to provide complete gravel facies mapping of channel and bar features found within the study area and an expanded assessment of spawning gravel areas with an estimate of maximum potential spawning population sizes of Chinook salmon and *O. mykiss* (TID/MID 2016c).

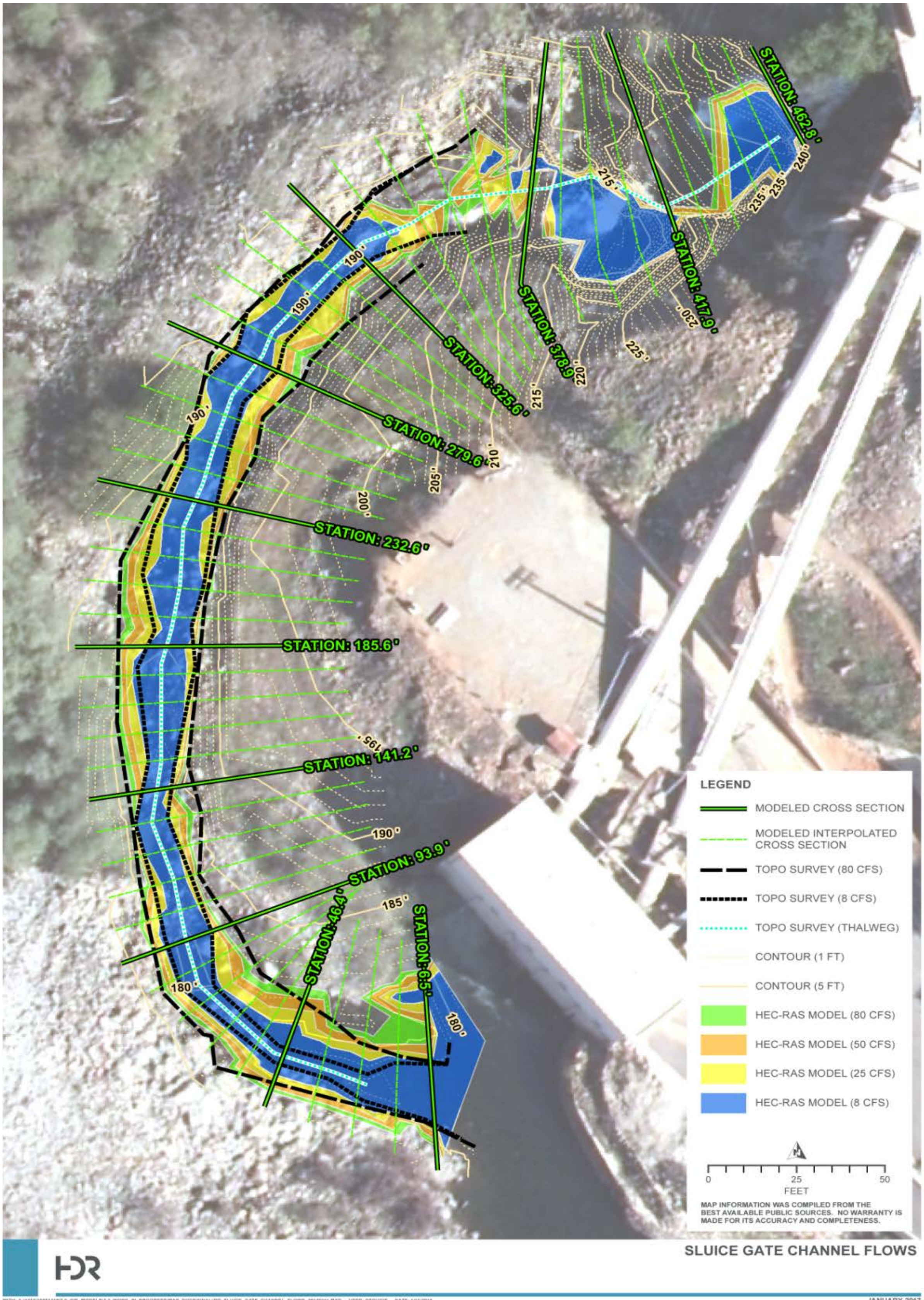

Figure 3.5-7. **Modeled water surfaces during flow changes from 80 to 8 cfs.**

Habitat mapping results indicate that the main channel in the study area is dominated by pool habitat, including a plunge pool immediately downstream of the LGDD, a large mid-channel pool adjacent to the MID hillside discharge, and two smaller pools in the lower portion of the channel (Table 3.5-6). There are a total of three small low-gradient riffles with no spawnable substrate in the lower portion of the main channel, along with one glide associated with the tailout of the large pool, and a bedrock outcrop separating the large pool from the plunge pool (TID/MID 2016c).

The tailrace channel includes two riffles, one of which include spawnable substrate, along with one run habitat in the lower portion of the channel (Table 3.5-6). The upper portion of the tailrace channel includes a single pool with turbulent flow from the La Grange powerhouse discharge along with a glide associated with the tailout of this pool. Estimated average width of habitats in the tailrace channel is approximately 50 feet. The TID sluice gate channel is a high-gradient step-pool that originates at the TID canal (a non-Project feature) and empties into the pool at the upstream portion of the tailrace channel. Estimated average width of the sluice gate channel is approximately 30 feet (TID/MID 2016c).

Table 3.5-6. Summary of mesohabitat mapping results.

Mesohabitat	Total Number	Total Length (ft)	Percent of Channel
Main Channel			
Riffle	3	523	30%
Glide	1	122	7%
Pool	4	1,022	58%
Outcrop, bedrock	1	106	6%
Total	**9**	**1,773**	**100%**
Tailrace Channel			
Riffle	2	400	57%
Glide	1	49	7%
Pool	1	152	22%
Run	1	98	14%
Total	**5**	**699**	**100%**
Sluice Gate Channel			
Step-pool	1	383	100%
Total	**1**	**383**	**100%**

Overall, the study area was mapped predominately as gravel-boulder-Cobble (41 percent), sand-bedrock-Cobble (30 percent), and boulder-gravel-Cobble (11 percent). The sluice gate and tailrace channels are predominately cobble-bedded with varying proportions of gravel- and boulder-size substrates, along with some bedrock outcrops in the sluice gate channel. Substrates in the sluice gate channel are the coarsest in the study area, being composed of cobbles, boulders, and bedrock with some coarse gravel. The La Grange powerhouse tailrace channel (facies units 4 through 7) is composed of cobble with varying proportions of gravel- and boulder-size substrates. The thalweg of the Tuolumne River main channel is also predominately composed of cobble-sized sediments, with varying proportions of gravel- and boulder-size substrates, and some bedrock outcrops. The medial and lateral floodplain areas, as mapped with facies units 8, 12, 19, and 23, are composed of a mixture of sediment facies types similar to that present in the tailrace and main river channel (TID/MID 2016c).

Only one of the two spawning gravel patches (facies unit 6, riffle habitat unit 16) mapped in the La Grange powerhouse tailrace channel was suitable for Chinook salmon spawning based on a pebble count D50 of 70 mm. Neither of the tailrace spawning gravel patches had suitable substrate for *O. mykiss* spawning, based on D_{50} values that exceeded the suitable range for *O. mykiss* (10–46 mm) (TID/MID 2016c).

For Chinook salmon, the total area of suitable spawning gravel within the tailrace channel was estimated to be 13,610 ft^2. Of that area, a total of 9,014 ft^2 was estimated to meet the spawning depth and velocity criteria at approximately 175 cfs (Table 3.5-7). There was no suitable spawning gravel found in the Tuolumne River main channel or TID sluice gate channel, and no suitable spawning substrate found for *O. mykiss* at any location within the study area (TID/MID 2016c).

Table 3.5-7. Estimated suitable spawning area and maximum Chinook salmon population size in the tailrace channel.

FERC (1996) Spawning Flow Requirement (cfs)	FERC (1996) Water Year type(s)	Suitable Spawning Area (ft^2)	Estimated Maximum Potential Chinook Spawning Population Size[3]	
			1988-1989 Redd Size Data[1]	2012 Redd Size Data[2]
150	Critical and below through Median Dry	8,540	328	396
175	Median Below Normal	9,014	346	418
180	Intermediate Dry-Below Normal	9,086	350	422
300	Intermediate Below Normal-Above Normal through Median Wet/Maximum	8,839	340	410

1 Based on average Tuolumne River Chinook salmon disturbed redd area of 52 ft^2 (4.8 m^2) (TID/MID 1992, Appendix 6).
2 Based on average Tuolumne River Chinook salmon disturbed redd area of 43.1 ft^2 (4.0 m^2) (TID/MID 2013d).
3 Population size is a theoretical maximum based solely on spawning area divided by redd size.

The suitable spawning habitat area for Chinook salmon was extrapolated to current spawning flow requirements (October 16 – December 31) of the Don Pedro Project (FERC 1996) to estimate the maximum potential Chinook salmon spawning population sizes (Table 3.5-7). Maximum population sizes for Chinook salmon would range from approximately 328–422, dependent on redd size estimates. These maximum potential spawning population size estimates are based on the average redd size estimates of 52 ft^2 (4.8 m^2) and do not take into account factors related to actual spawning site selection (i.e., non-uniform habitat selection at the site-scale) or superimposition of redds constructed by later arriving spawners upon previously constructed redds (TID/MID 2016c).

Fish Presence and Stranding Assessment

The Fish Presence and Stranding Assessment (TID/MID 2017e, attached to this FLA) is being conducted to formally document fish observations in the vicinity of the LGDD, La Grange powerhouse tailrace, and the TID sluice gate channel during the fall-run Chinook salmon and steelhead migration period for the 2015/2016 and 2016/2017 seasons. Specific objectives of the study are to:

- Record daily observations of fish in the immediate vicinities of the LGDD, La Grange powerhouse, and within the sluice gate channel;
- If the La Grange powerhouse trips offline (i.e., unexpectedly stops operating), conduct sluice gate channel surveys to record fish presence and, if necessary, conduct relocation activities; and
- Document redds that become dewatered, and the duration of any dewatering, due to changes in La Grange powerhouse operations.

Results from the daily observations indicated that fish species observed in the tailrace channel included fall-run Chinook salmon (*Oncorhynchus tshawytscha*), *Oncorhynchus mykiss* (*O. mykiss*), Sacramento pikeminnow (*Ptychocheilus grandis*), Sacramento sucker (*Catostomus occidentalis*), and striped bass (*Morone saxatilis*). Fish observed in the main channel surveys included bluegill (*Lepomis macrochirus*), fall-run Chinook salmon, hardhead (*Mylophardon conocephalus*), sculpin (*Cottidae spp.)*, Sacramento pikeminnow, Sacramento sucker, and threespine stickleback (*Gasterosteus aculeatus*). During the 2015/2016 monitoring period, the majority of fish observations were juvenile Sacramento pikeminnow and juvenile Sacramento sucker, which accounted for 95 percent of the observations. For the 2016/2017 monitoring period, the majority of fish observations were adult fall-run Chinook salmon, which accounted for 98 percent of observations. The majority of these observations were likely the same individual fish observed multiple times over consecutive days throughout the monitoring period (TID/MID 2017e).

A constant minimum channel maintenance flow of approximately 5 to 10 cfs is provided in the sluice gate channel at all times to significantly reduce the risk of stranding any fish that may enter the channel during a high flow event (due to the La Grange powerhouse tripping offline). This flow volume would allow fish to volitionally exit the channel at all times, thereby minimizing the need for handling and relocating fall-run Chinook salmon or *O. mykiss* (TID/MID 2017e).

The La Grange powerhouse tripped offline, and the TID sluice gate opened a total of 29 times; 18 times with a duration ranging from 0.25 to 505.5 hours (median 40.5 hours) during the 2015/2016 monitoring period and 11 times ranging from 1.0 to 29.75 hours (median 10.0 hours) during the 2016/2017 monitoring period. During each event, TID operators and a qualified biologist were on-site and surveyed the channel for stranded fish as the sluice gate was closed and flow was reduced to the minimum flow of approximately 5 to 10 cfs. Adult fall-run Chinook salmon were documented to enter the sluice gate channel during periods when the sluice gates were opened and at minimum flow conditions during both monitoring seasons (a total of 7 occasions). Given that a minimum flow of 5 to 10 cfs is maintained in the sluice gate channel, stranding of fish in this channel has been extremely rare. The occurrence of stranding in the sluice gate channel was limited to a single event during the study (TID/MID 2017e).

To evaluate the potential for dewatering of redds, water level data collected in the tailrace channel over the past two years has shown that operations of the La Grange powerhouse and the sluice gates are well synchronized if the powerhouse trips offline resulting in a relatively stable flow in the tailrace channel. Based on water level data recorded at 15-minute intervals, the maximum elevation change between readings was 0.57 foot during the 2015/2016 monitoring season (Figure 3.5-8). The single redd observed in the tailrace channel was not dewatered during the monitoring period. Due to flood control releases which began January 2, 2017, the tailrace channel levelogger was inaccessible for data download and assessment of potential redd dewatering. The estimated daily flow in the tailrace channel was 150 cfs between November 14, 2016 and January 1, 2017, and there was a single sluice gate event (November 23, 2016) during this period. There were no dewatered Chinook salmon redds identified during daily surveys in the tailrace channel through January 1, 2017. Flood control releases from Don Pedro Reservoir from January 2, 2017 to April 30, 2017 ranged from 1,770 cfs to 13,900 cfs. Given these consistent flows followed by the extended high flow event, it is highly unlikely that there was any redd dewatering during the 2016/2017 monitoring period (TID/MID 2017e).
Given that the sluice gates open immediately when the La Grange powerhouse trips offline, there is very little risk in dewatering the tailrace channel during these operational changes (TID/MID 2017e).

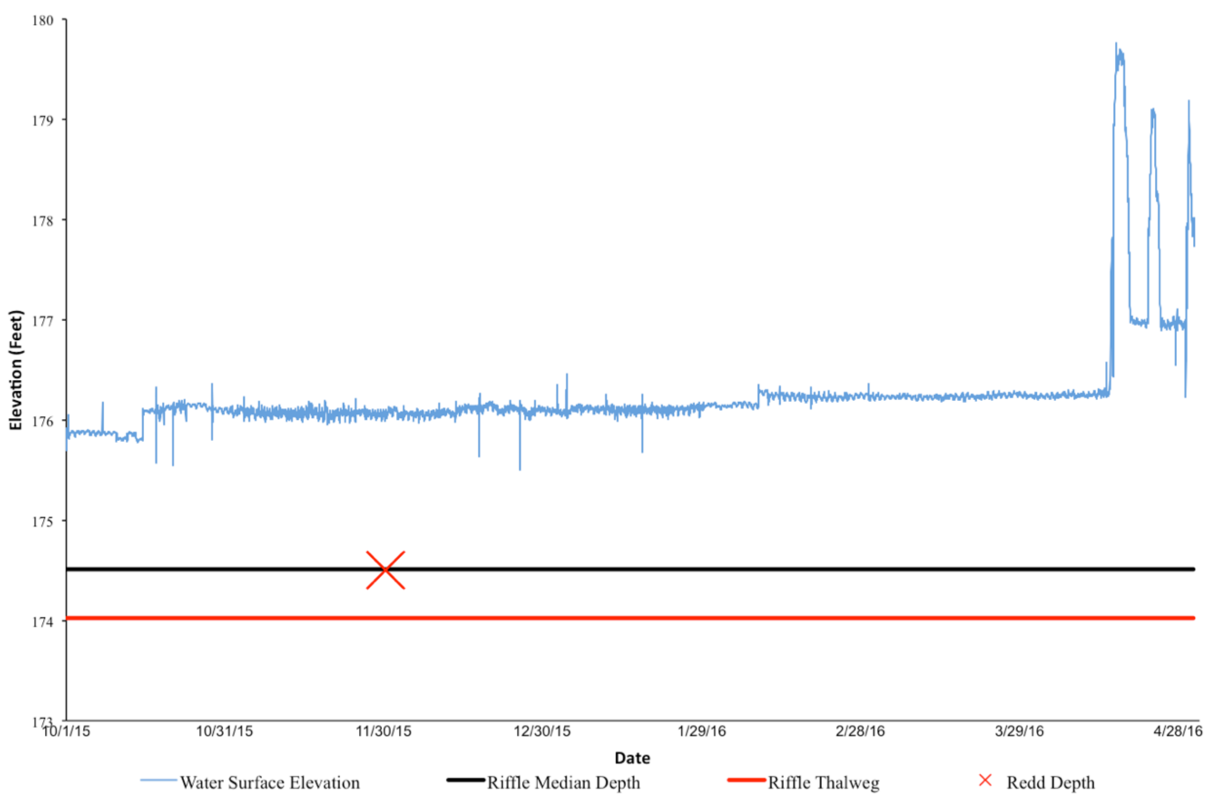

Figure 3.5-8. Tailrace channel water surface elevation levelogger data for the 2015/2016 monitoring season.

Investigation of Fish Attraction to La Grange Powerhouse Draft Tubes

The goal of the Investigation of Fish Attraction to La Grange Powerhouse Draft Tubes (TID/MID 2017g, attached to this FLA) was to evaluate the potential impact of certain La Grange powerhouse facilities on adult fall-run Chinook salmon and *O. mykiss*. Specific objectives of the study were to:

- Document adult resident *O. mykiss* and adult anadromous salmonid behavior in the vicinity of the La Grange powerhouse discharge during the fall 2015 (fall-run Chinook) to spring 2016 (*O. mykiss*) migration season;
- Identify anadromous fish reaching the La Grange powerhouse;
- Describe behavioral activities of fish in relation to La Grange powerhouse operations; and
- Determine if fish are moving into the draft tubes of operating units.

An imaging sonar unit (ARIS Explorer 1800) was deployed approximately 5 feet outside of the pit and 8 feet below the water surface, and was aimed with a positive 9.5 tilt angle to allow for imaging the bottom edges of the draft tube and the water volume below the Unit 1 draft tube (Figure 3.5-9). The unit was in operation on September 1, 2015 for the 2015/2016 migration season to determine if fish were attempting to access the La Grange powerhouse or enter the powerhouse draft tubes, and to assess their behavior in relation to powerhouse operations. The Unit 1 draft tube was the focus of the evaluation given water availability and that the projected generation schedule anticipated the operation of only this unit during the study period (TID/MID 2017g).

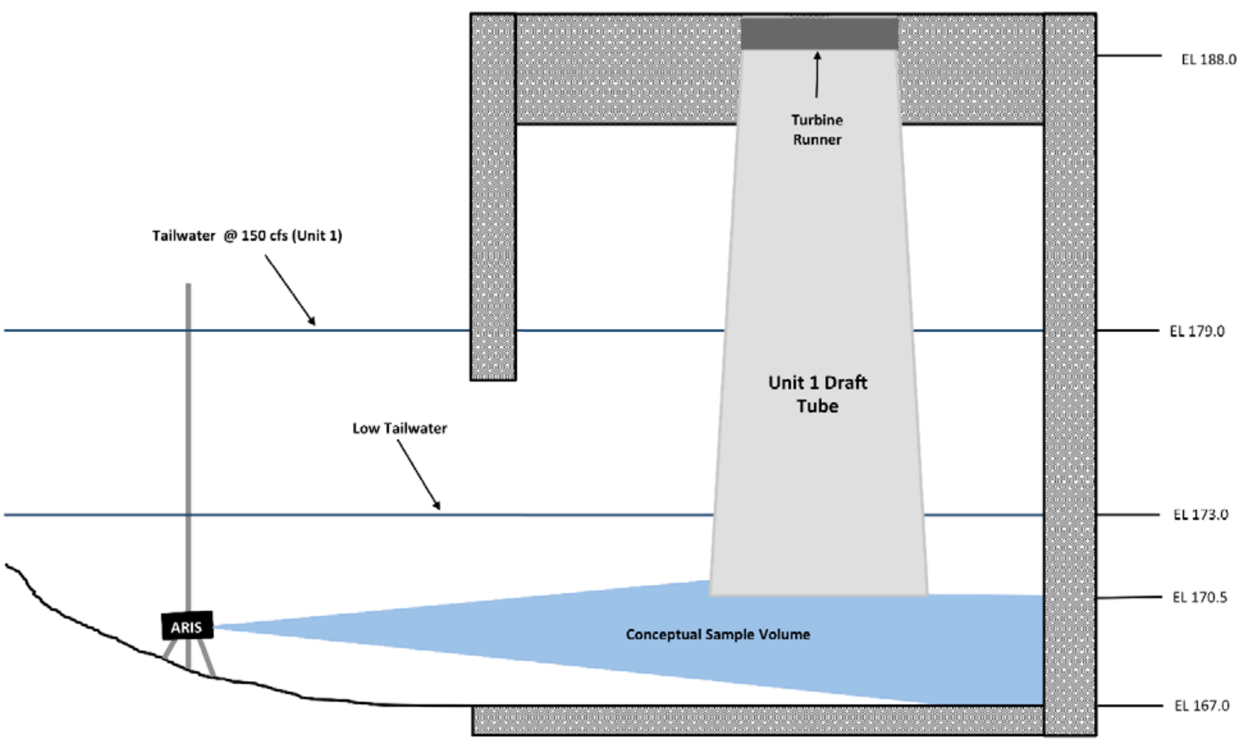

Figure 3.5-9. Conceptual depiction of an imaging sonar deployment used to assess fish presence and behavior in the vicinity of and directly below the La Grange Unit 1 draft tube. Note that drawing is not to scale.

Continuous data collection began on September 4, 2015 and continued through May 5, 2016. Image data were ported directly to external hard drives, and backed up and archived daily to additional hard drives to ensure no data were lost (TID/MID 2017g).

Subsets of the imagery data were processed and analyzed to encompass periods during the fall-run Chinook salmon migration/spawning period (October through mid-December) and during the period after the fall-run Chinook salmon season (mid-December through May). Consistent with the FERC approved study plan, sub-sampled time periods were chosen based on observations of fish passing the tailrace monitoring weir (the Districts deployed a counting weir just downstream of the La Grange powerhouse in accordance with the La Grange Fish Barrier Assessment [(TID/MID 2017h]) concurrent in time with the Draft Tube Study). Weir count data from the Fish Barrier Assessment were reviewed to optimize the timing of the sonar imaging analysis (i.e., to determine when peak counts of fish are in the vicinity of the powerhouse) and included the following: the consecutive five-week period from November 15 through December 19, 2015; and five three-day periods between December 20, 2015 and February 2016 (December 20 through 22, December 26 through 28, January 10 through 12, January 21 through 23, and February 24 through 26) (TID/MID 2017g).

Although imaging sonar is an accepted fisheries science data collection method and has been used for both fish passage investigations at hydropower dams (Johnson et al. 2013), an important limitation of imaging sonar is that fish cannot be identified to species when similar species are present at the same time. In the context of this study this limitation is relevant since it was not possible to separate observations of Chinook salmon from observations of *O. mykiss* and other adult-sized fish (e.g., striped bass and Sacramento pikeminnow) based on imaging sonar data alone as those species are all generally similar in body shape (as opposed to for example lamprey or sturgeon which have distinctly different body shapes and as a result can be identified using imagery sonar). As such, all adult-sized fish (including Chinook salmon and *O. mykiss)* observed in the ARIS system field of view during the sampling period were included in the analysis and overall fish observations are inclusive of both Chinook salmon and *O. mykiss* as well as other adult fish of other species that may have been present during the sampling periods. Another important note is that an individual fish cannot be identified and tracked from the imaging sonar. This is relevant to the study results since total observations identified does not necessarily equal numbers of fish present in the vicinity of the draft tube (i.e., one fish may be responsible for multiple observations) (TID/MID 2017g).

Study results indicated that the area in the vicinity of the draft tube pit was occupied frequently by adult fish. Weir counts from the Fish Barrier Assessment indicated that the majority of observations at the tailrace weir were of adult salmonids, although striped bass, Sacramento pikeminnow, common carp and goldfish were also observed (TID/MID 2017g).

Adult fish observations during these periods often exceeded 30 per day. Though fish presence in the vicinity of the La Grange powerhouse was evident, they were detected most frequently in the foreground of the field of view and not close to the draft tube. It appears that adult fish often occupy the area in front of the powerhouse but do not approach the draft tube. This result was evident during both Unit 1 On and Unit 1 Off conditions. Adult fish were not observed to occupy the area under the draft tube when Unit 1 was operational. Furthermore, fish were rarely observed occupying the area under the draft tube when Unit 1 was not operational (TID/MID 2017g).

The study results indicate that there is likely an extremely low risk of fish entering the draft tube and furthermore, swimming vertically up the draft tube and leaping into and being injured as a result of being in contact with the turbine runners in Unit 1 while it is in operation. Given that both units at LGDD are vertically oriented Francis units with conical, straight-drop draft tubes (not elbow draft tubes) and the low steel of the turbine runner is significantly above tailwater elevation during normal operation (Figure 3.5-9), it is likely that the study results apply to both units. These results were also corroborated in the field where crews were on site daily (Fish Presence and Stranding Assessment [TID/MID 2017f]) throughout the study period and reported no observations of injuries or mortalities of adult fish that would have indicated evidence of fish being struck by turbine blades (TID/MID 2017g).

Effects of the Project and Related Activities on the Losses of Marine-Derived Nutrients in the Tuolumne River

The goal of the Losses of Marine-Derived Nutrients study (TID/MID 2016b, attached to this FLA), as cited by NMFS, was to evaluate the potential effects of the Project and Project-related activities on the degree of reduction in or loss of nutrient replenishment in the upper and lower Tuolumne River. Specific objectives of this study, as requested by NMFS, are described below:

- Estimate a range of the historical mass of marine-derived nitrogen transported annually by Chinook salmon (all runs) to the Tuolumne River.
- Estimate the historical mass of marine-derived nitrogen that was transported annually by spring-run Chinook salmon to the upper Tuolumne River.
- Estimate the current annual mass of marine-derived nitrogen transported by fall-run Chinook salmon to the Tuolumne River.
- Estimate annual losses, from historical to current levels, of marine-derived nitrogen transported by fall-run Chinook salmon to the Tuolumne River.
- Estimate the annual loss, from historical to current levels, of marine-derived nitrogen to the upper Tuolumne River.

In order to meet the study objectives, estimated historical escapement of all runs of Chinook salmon (i.e., fall-run and spring-run) to the Tuolumne River was required. In its study request, NMFS (2014) acknowledged that this information is not available regarding the actual, pre-European settlement, historical escapement ranges for Chinook salmon in the Tuolumne River. NMFS (2014) provided references and quotes from some historical accounts for use in the development of this study. Empirical data of historical annual escapement estimates are not available; therefore, some anecdotal accounts must be used to approximate roughly historical quantities. To augment the information provided by NMFS (2014), a literature review was conducted to locate potential historical escapement estimates for spring-run Chinook salmon, as well as for fall-run Chinook salmon and total Chinook salmon escapement to different reaches of the Tuolumne River. Based on the information provided by NMFS (2014) and this literature review, neither of which identified actual counts, study authors used a combination of anecdotal accounts of historic escapement to the San Joaquin watershed and an allocation back to the Tuolumne River based upon the proportional distribution of reported historical habitat to provide a rough approximation of historical spring-run Chinook salmon, fall-run Chinook salmon and total Chinook salmon escapement ranges to the upper Tuolumne River watershed (TID/MID 2016b).

Additional literature sources and more recent escapement data were also reviewed to further refine NMFS (2014) recommendation on assumptions for the average mass and average nitrogen content per individual fish as well as the for peak and 10-year average escapement values. To better reflect the available information, parameter assumptions for average mass, average nitrogen, and peak and 10-year average escapements were updated as ranges or to reflect more recent escapement data (TID/MID 2016b).

Results of the study indicated the following:

- The estimated historical mass of marine-derived N transported annually by Chinook salmon (all runs) to the Tuolumne River ranging from 34,000 to 315,000 pounds.
- The estimated historical mass of marine-derived N transported annually by spring-run Chinook salmon to the upper Tuolumne River ranging from 4,400 to 147,000 pounds.
- The current annual mass of marine-derived N transported by fall-run Chinook salmon to the Tuolumne River across estimated escapements ranges from 200 to 11,400 pounds.
- The difference from historical to current escapement levels in the annual mass of marine-derived N transported by fall-run Chinook salmon to the Tuolumne River is estimated to range from 18,400 to 167,800 pounds.

Due to the absence of empirical data of historical annual escapement estimates, the results of this study are dependent upon references and quotes from anecdotal accounts. Consequently, historical annual escapement estimates, and resultant estimates of marine-derived N, are highly speculative. The speculative nature of the estimates and necessary assumptions in the estimation methodology are reflected in the extremely broad statistical range of the results (TID/MID 2016b).

In addition to the speculative nature of historical annual escapement estimates, current escapement estimates of fall-run Chinook salmon to the Tuolumne River are influenced by numerous non-Project related factors. A few of these include ocean conditions (e.g., annual variability in coastal upwelling and food availability), Bay-Delta conditions, harvest practices (e.g., commercial and sport fishing), historical and current industrial development, downstream water uses, habitat impacts, invasive species and predation by non-native fish. Consequently, differences between historical and current escapement estimates, and associated estimates of marine-derived N, cannot be completely attributed to the Project. Because of the speculative nature of historical annual escapement estimates and the influence of numerous non-Project-related factors, use of the information provided in this study report should be undertaken in a very cautious manner (TID/MID 2016b).

Upper Tuolumne River Fish Restoration Feasibility Activities

As described in section Section 1.3.7 of this Exhibit E, a collaborative Assessment Framework was established and implemented in 2016 and 2017 to aid in the evaluation of the feasibility of reintroducing spring-run Chinook salmon and steelhead into the Upper Tuolumne River. The Assessment Framework meetings were well attended and membership consisted of federal and state resource agencies, NGOs, and the public (La Grange Hydroelectric Project Consultation Record, attached to this FLA). The Assessment Framework was structured consistent with guidelines suggested by Anderson et al. (2014), a peer-reviewed journal article authored by NMFS and state agencies from the Pacific Northwest which identified the need and guidelines for conducting a comprehensive approach to assessing reintroduction feasibility with the goal of recovery of ESA-listed species. The Assessment Framework was intended to broaden the scope from only evaluating fish passage concepts and feasibility to evaluating the biological, regulatory and socioeconomic aspects as well. Anderson et al. (2014) points out the importance of evaluating the benefits, risks and constraints against an established reintroduction goal (ESA species recovery in this case) by which to gauge feasibility. As noted in Section 1.3.7 of this Exhibit E, the Assessment Framework developed a reintroduction program goal for which to assess feasibility. The final Tuolumne River reintroduction program goal statement as approved by the Plenary Group of participants was to *"Contribute to the recovery of ESA listed salmonids in the Central Valley by establishing viable populations in the Tuolumne River at fair and reasonable cost."* Population viability (McElhany et al. 2000) as associated with ESA Recovery planning (NMFS 2014) is the goal of any reintroduction program involving ESA-listed species. The following sections summarize various studies (required and voluntary) and other information relevant to the feasibility evaluation of achieving the upper Tuolumne River reintroduction goal.

Fish Passage Facilities Alternatives Assessment

The goal of the Fish Passage Facilities Alternatives Assessment (TID/MID 2017d, attached to this FLA) is to investigate the feasibility of providing upstream and downstream passage of spring-run Chinook salmon and steelhead at the La Grange and Don Pedro dams, and includes identifying, developing, and evaluating concept-level passage alternatives. The functionality, configuration, performance and design of such fish passage facilities must be consistent with the resource agencies' goals, objectives, and standard performance criteria established for reintroduction[13] of ESA-listed anadromous fish. Specific objectives of this study include:

- obtain available information to establish existing baseline conditions relevant to La Grange and Don Pedro projects operations and siting passage facilities;

[13] While the word "reintroduction" is used commonly herein to denote the study of establishing anadromous fish runs to the upper Tuolumne River, there is no documented, empirical evidence of either spring-run Chinook salmon or steelhead populations using the study reach of the Tuolumne River.

- obtain available hydrologic data and basic biological design criteria to identify potential types, configurations, and locations of fish passage facilities consistent with estimated run size, fish periodicity, life stage requirements, and anticipated passage efficiency and survival criteria for the selected species of interest;
- formulate and develop preliminary facility sizing and functional passage design for select, alternative potential upstream and downstream fish passage facilities in an attempt to meet agencies' anadromous fish reintroduction goals, objectives, and performance criteria; and
- develop opinions of probable construction cost, annual O&M costs, and summarize overall viability of fish passage concept(s).

As established by FERC in the SPD, the study area "includes the Tuolumne River downstream of La Grange dam at the confluence of the main river channel and the powerhouse tailrace channel to the upper Tuolumne River at the upper most extent of Don Pedro reservoir".

In accordance with the Fish Passage Alternatives Assessment Study Plan, the study was implemented in two phases.

Phase 1 of this study began in May 2015 and consisted of gathering information on facility siting, facility sizing, general biological and engineering design parameters, and operational considerations. The Districts also evaluated watershed hydrology to characterize the anticipated river flows into Don Pedro Reservoir as well as those passing downstream of LGDD. To facilitate this, the Districts simulated data to create a continuous, long-term record of flow. Flow data from USGS gage stations upstream of Don Pedro Reservoir and downstream of LGDD provide limited information to characterize flow and operational data at locations that would be most appropriate to site potential fish passage facilities. These activities were conducted in a collaborative process with licensing participants. The collaborative process included the completion of public Workshops and production of technical memoranda (TMs), the goals of which were to identify key information needs and solicit input and feedback from licensing participants. A summary of Workshops and collaboration in 2015 with licensing participants is provided below.

Workshop No. 1 was held on May 20, 2015. At this initial Workshop, the Districts provided an overview of the types of information needed to inform the development and evaluation of fish passage alternatives, and discussed current design criteria for anadromous fish passage facilities. During the workshop, the Districts outlined the purpose and need for providing fish passage facilities in the broader context of the feasibility of anadromous fish reintroduction to the upper Tuolumne River. Because anadromous fish are not present in the upper Tuolumne River, the design, construction, and operation of fish passage facilities is intrinsically linked to the needs of the fish populations under consideration for reintroduction. The related question of the feasibility of fish reintroduction encompasses consideration of such issues as genetics of introduced and resident species, colonization strategy, source population, habitat suitability, carrying capacity, recreation impacts, socioeconomic effects, and compatibility with current uses, among other variables. Consideration of all these questions suggested the need for a broader reintroduction planning framework within which to evaluate the sizing, characteristics, configuration, operations, effectiveness and cost of fish passage facilities.

Workshop No. 1 resulted in two items of consensus. First, licensing participants agreed that the study process would benefit by active collaboration among the parties; and second, the design, construction and operation of fish passage facilities can be complex and costly, and therefore requires a sound and reliable design basis for facility cost estimation. As such, a thorough investigation of the engineering, biological, regulatory and socioeconomic issues was determined to be warranted. It was recognized that the absence of a thorough and rigorous approach from the outset of the study could result in a set of fish passage facilities that are based on a set of unfounded assumptions that do not reflect realistic biological and/or performance metrics applicable to the Tuolumne River and the Don Pedro and La Grange projects.

Workshop No. 2 was held on September 17, 2015. Prior to the Workshop, the Districts released the planned Technical Memorandum I No. 1 for review and discussion at the Workshop. The Districts' also presented a conceptual framework for considering fish passage feasibility and assessing overall reintroduction viability as advised by Anderson et al. (2014). The conceptual framework is intended to provide a comprehensive, collaborative, and transparent approach for evaluating the full range of potential questions and issues associated with the future reintroduction of anadromous fish to the upper Tuolumne River. In addition to considering aspects of the technical feasibility of building and operating fish passage facilities at the Don Pedro and La Grange projects, the framework considers the interrelated issues of ecological feasibility, biological constraints, economics, regulatory implications, current uses of the resource, and other considerations relevant to reintroduction. The Districts noted that reintroduction assessment frameworks are not a new concept and implementation would be consistent with ongoing processes in other watersheds in California (e.g., U.S. Department of Interior, Bureau of Reclamation 2016) and the Pacific Northwest and with recent peer-reviewed literature on reintroduction planning authored by resource management agencies (e.g., Anderson et al. 2014).

During Workshop No. 2, the Districts summarized engineering technical memorandum I No. 1 which had been distributed on September 4, 2015. TM No. 1 identified the information, analysis, design, and facility performance criteria necessary to characterize site-specific, functional fish passage alternatives. The document summarized existing information relevant to site-specific design considerations that could form the basis for identifying fish passage alternatives to meet the reintroduction program's goals and objectives. TM No. 1 also summarized existing data gaps that required feedback from licensing participants including: target species, verification of migration timing, recovery targets (expected population abundance), and anticipated performance expectations. Such information was agreed to be critical to moving the Fish Passage Facilities Alternatives Assessment forward to functional design and cost estimation. At the Workshop, the Districts emphasized that input was needed on the biological goals and objectives of the reintroduction program to determine appropriate design criteria and constraints that would influence development of fish passage alternatives.[14] At that time, it was also believed that some of the information may be able to be provided from the results of ongoing studies being implemented by NMFS as well as through future Workshops for

[14] Licensing participants agreed to provide comments on TM No. 1 and/or the information gaps identified for fish passage engineering study by October 23, 2015. Although indicated as a "reasonable" timeline by attendees to provide responses, no formal responses were received addressing this specific request for information.

the reintroduction assessment framework.[15] The Districts also provided examples of how biological, ecological, and regulatory information had been used to inform the functional design of fish passage facilities at other projects.

Workshop No. 3 was held on November 19, 2015. The targeted purpose of this workshop was to seek consensus on the usefulness of and need for a structured reintroduction decision-making framework to develop the information needed to, among other things, assess feasibility of and prepare functional designs of potential alternative fish passage facilities which would meet the goals and objectives of an anadromous fish reintroduction program. Licensing participants unanimously indicated their support of and interest in a reintroduction decision-making framework process. With consensus obtained, the group met on January 27, 2016, to begin to implement the reintroduction decision-making framework process. At this next meeting, a draft implementation process and schedule, a summary of existing available information, and a preliminary studies[16] list (to address information gaps) was developed to help define 2016 and 2017 activities.

As discussed in section Section 1.3.7 of this Exhibit E, the Districts, in collaboration with licensing participants, implemented an Assessment Framework in 2016 and 2017. As a result, several voluntary studies to support reintroduction feasibility were completed and are discussed in more detail below. Additionally, several key feasibility assessment parameters related to reintroduction goals and thermal suitability were also developed. However, numerous information gaps identified in TM No. 1 remained and the Districts' engineering and technical study team was required to address these gaps in order to complete and file the Fish Passage Facilities Alternatives Assessment per the FERC licensing schedule.

In 2017, the Districts began Phase II which included the development of functional site layouts, facility sizing, general design parameters, expected fish capture and survival efficiencies, and opinions of probable construction, O&M costs for select fish passage alternatives. Considerations addressed during the development of preliminary functional layouts for upstream and downstream passage alternatives included: (1) major facility design elements; (2) O&M; (3) anticipated facility performance; and (4) facilities costs. The results of these tasks were then used to investigate the overall technical feasibility of each potential fish passage facility alternative.

In order to begin the development of preliminary functional layouts for potential passage alternatives, factors that influence both upstream and downstream fish passage design were identified and included species life history information and migration timing; access to collection and release locations; and operations, flows, and water surface fluctuations (reservoir and tailwater) above and below both La Grange and Don Pedro dams. This information was critical in the development of potential facility alternatives that would comply with agency fish passage

[15] NMFS indicated that population estimates and peak rates of migration could be generated to a conceptual level as part of their Upper Tuolumne Habitat and Carrying Capacity Study (refer to NMFS Comments on the La Grange ISR included in Attachment A). This information was not available at the time this report was completed.

[16] NMFS is also conducting two studies, a Habitat and Carrying Capacity Assessment and an *O. mykiss* Genetics Study in support of the upper Tuolumne River reintroduction assessment, however, these studies were not available at the time of filing the La Grange Hydroelectric Project Final License Application.

technical design criteria and guidelines (CDFW 2009; CDFG 2000; NMFS 1997, 2011; and ACOE 1991).

A key factor to sizing facility alternatives included the assumed population abundance of upstream and downstream migrating fish for which the facility must accommodate. As discussed in Section 1.3.7 above, the Districts implemented a collaborative Assessment Framework in 2016 and 2017. As part of this process, a reintroduction goal statement was established and approved by the Framework's Plenary Group on May 18, 2017. The final Tuolumne River reintroduction program goal statement was to *"Contribute to the recovery of ESA-listed salmonids in the Central Valley by establishing viable populations in the Tuolumne River at fair and reasonable cost."* Consistent with the final Tuolumne River reintroduction program goal statement the fish passage study team referenced the generalized minimum viable population index documented by Lindley et al. 2007 to develop concept population abundance estimates. As stated, in order for a population to be considered viable, it must meet the criteria for low extinction risk for Central Valley salmonids and exhibit a minimum population size of 2,500 individuals. Since this study reflects the passage requirements for both spring-run Chinook and steelhead, it was assumed that the population for each species would therefore require 2,500 returning adults (a combined total of 5,000 returning adult salmonids). Taking the assumed numbers of adults returning to the upper Tuolumne River, various assumptions for fecundity, spawning and rearing success, and survival to smolt phase were identified from the literature (TID/MID 2017d). Overall, it was assumed that approximately 3.1 million smolts could potentially reach a downstream collection facility on an annual basis. Using a peak daily migration rate of 5%, the total number of smolt expected to migrate downstream in a single day could be as high as 155,000 individuals (TID/MID 2017d).

Another key consideration for the identification of potentially feasible upstream and downstream passage alternatives was a detailed evaluation of Don Pedro Reservoir characteristics including reservoir elevation fluctuations; size, purpose, and physical complexity; and other factors that could affect expected performance capability of downstream fish passage and issues related to reservoir transit.

The extent of reservoir fluctuation is a significant factor in determining the type, size, and complexity of upstream and downstream fish passage facilities. Upstream fish passage technologies require safe release or exit of fish to the reservoir. Downstream fish passage technologies occurring in the reservoir either float or possess multiple inlets to maintain a hydraulic connection with the reservoir surface. Each type of technology must maintain some form of continuous hydraulic connection throughout the anticipated range of pool elevations. As the pool fluctuations become larger, so does the facility's size and complexity. In many cases, certain fish passage technologies can be dismissed from evaluation due to their inability to accommodate an acceptable range of reservoir fluctuation while meeting performance criteria related to safe, timely and effective transport of fish (TID/MID 2017h).

The primary purpose of the Don Pedro Reservoir is to provide a reliable water supply for the irrigation of over 200,000 acres of prime farmland in the Central Valley Region of California. The Don Pedro Project also provides substantial flood control storage. Meeting both of these purposes through wet and dry periods results in large seasonal and annual reservoir fluctuations.

The reservoir is generally at its greatest storage volume in June and July. In above normal and wet water years, Don Pedro Reservoir is required to be lowered to at least elevation 801.9 feet by early October to provide flood control storage. During below normal, dry and critical water years, reservoir levels may not ever reach elevation 801.9 ft. During the typical course of each water year, Don Pedro Reservoir is lowered further during late spring and winter months to provide required instream flow releases and possibly to make space for flood storage.

Predicted mean daily reservoir elevations were calculated with the Tuolumne River Daily Operations Model (TID/MID 2013a). The resulting water surface elevations from the Base Case dataset shown in Figure 3.5-10 illustrate pool elevation trends and variation over the available period of record. Don Pedro Reservoir experiences a high level of seasonal and annual fluctuation, with water surface elevation changes of up to 230 feet which is substantially more than any fish passage facilities currently in operation. The Base Case operational scenario results suggest that both upstream and downstream fish passage facilities would need to be designed to be operational between elevations 616 feet to 830 feet. For completeness, a concept fish passage facility is also expected to safely handle reservoir elevations outside this range in times of extreme water conditions, but would be expected to perform fish passage operations within this historical range of reservoir conditions (TID/MID 2017d).

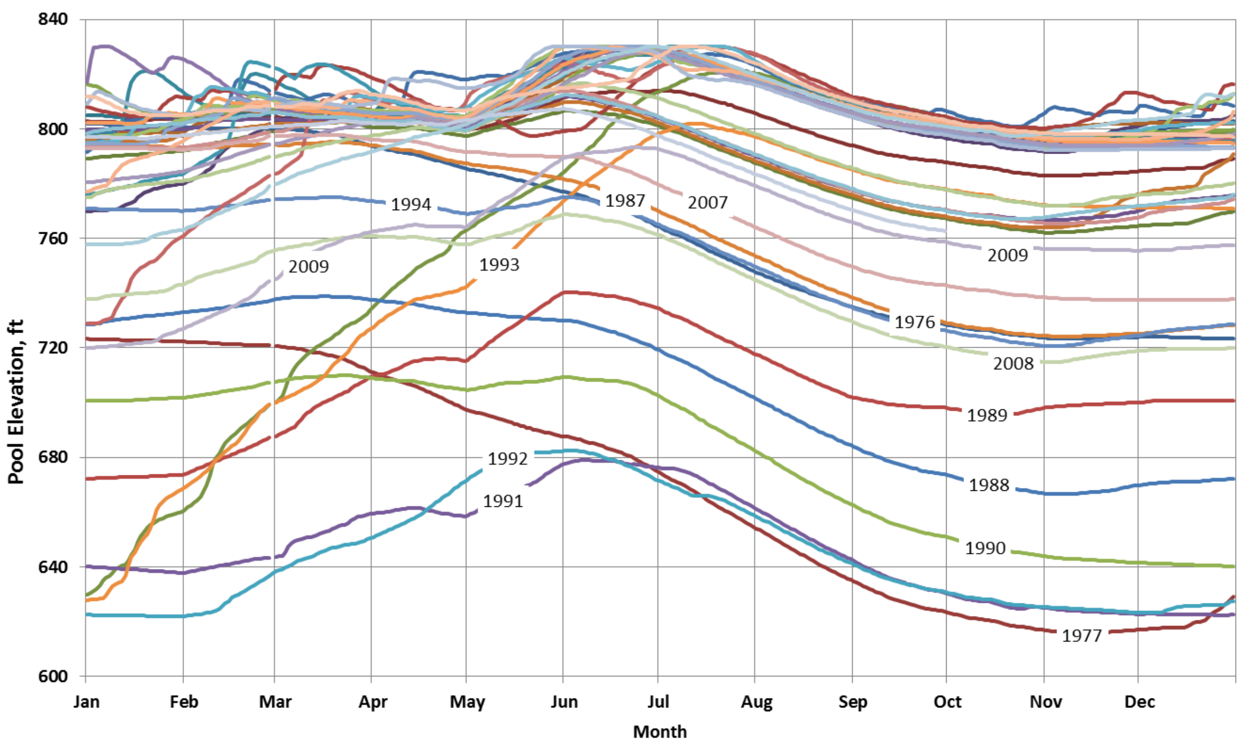

Figure 3.5-10. Mean daily pool elevation for existing (Base Case) Don Pedro Project operations.

Another important consideration, specifically for a head of reservoir fish passage facility is evaluating where the head of reservoir is located and how it can vary throughout the range of anticipated reservoir elevations. Don Pedro Reservoir has a current minimum pool elevation of 600 feet[17]. When the Don Pedro Reservoir is at elevation 600 feet the head of reservoir is located approximately at RM 70.5[18]. The maximum pool elevation is 830 feet, which extends the head of reservoir to approximately RM 79 (approximately 9 miles upstream). Any surface collection system floating on the reservoir surface would not only require accommodation of 230 feet of reservoir fluctuation, but would also need to consider that the head of reservoir would only extend to about RM 70.5. If located upstream of those locations, the facility location would need to be moved as the reservoir elevations recede below a level where there was adequate depth to accommodate the draft of the floating barge. The further upstream the facility was located, the more likely and more frequently it would need to be moved.

Downstream migrating juvenile salmonids rely on a number of environmental factors for behavioral cues that motivate their movements and help direct them down a river channel, eventually to the ocean. The presence of reservoirs provides a physical barrier to downstream migration and may confound a fish's ability to use natural environmental cues to successfully navigate downstream through the impoundment to a dam or reservoir outlet. Reservoir conditions expose downstream migrants to a number of factors that may prolong their residence time the reservoir. The higher residence time increases the probability of predation, residualization, exposure to false pathways, and greater chance of mortality. Juveniles exposed to these factors are no longer able to continue their migration downstream and complete their natural life-cycle, critical to population sustainability for anadromous salmonids.

In light of this, conditions within Don Pedro Reservoir were examined to determine if fish passage alternatives that include a reservoir transit component were likely to inhibit safe and timely migration through the reservoir. Initially, the physical characteristics of Don Pedro Reservoir were compared with other reservoirs where either fish passage performance of an existing passage facility is known or where there are study results available which demonstrate how environmental conditions within the reservoir influence fish behavior. Key factors to consider at a number of select reservoirs are presented in Table 3.5-8. The comparison demonstrates that Don Pedro Reservoir is substantially larger, longer, and more physically complex than reservoirs in the Pacific Northwest that have downstream passage programs, or have been studied for potential passage feasibility. Also of note is that of the reservoir information available, only four of the nine examples are multi-purpose reservoirs that may be operated for numerous objectives such as flood control, municipal/agricultural water supply, and environmental flows in addition to hydropower generation. Information from other reservoirs can be used to inform parameters, but must be considered in light of Don Pedro Reservoir's size, length, physical configuration and operational complexity. From even a qualitative comparison, it is clear that migration patterns in the Don Pedro Reservoir would be significantly more challenging than in comparison to reservoirs where downstream passage programs are currently in operation (TID/MID 2017d).

[17] Note that as part of the Don Pedro Hydroelectric Project amendment to the Final License Application, there is a proposal to change the minimum pool elevation to 550 feet. At this elevation, the upstream extent of the head of reservoir would be located at approximately RM 68.8.

[18] All references to the upstream extent of the reservoir are based on USGS quadrangle maps. Estimated stream thalwegs are approximate and susceptible to large errors.

Table 3.5-8. Comparison of selected example reservoirs to Don Pedro Reservoir.

Project	Dam Height (ft)	Surface Area (acres)	Reservoir Length (miles)	Storage Capacity (ac-ft)	Water Surface Fluctuation (ft)	Facility Type
Upper Baker Dam – Baker Lake, WA	312	4,980	9	285,371	50	Primarily Hydropower[1]
Lower Baker Dam – Lake Shannon, WA	285	2,190	8	161,470	68	Primarily Hydropower[2]
Cushman No. 1 – Lake Cushman, WA	235	4,010	8.6	453,349	20	Hydropower
River Mill Dam – Estacada Lake, OR	85		2.5	2,300	7	Hydropower
North Fork Dam – North Fork Reservoir, OR	207	220	4	19,000	5	Hydropower
Round Butte Dam – Lake Billy Chinook, OR	440	4,000	Metolius R: 13 mi. Deschutes R: 9 mi. Crooked R: 7 mi.	535,000	2	Hydropower
Swift Dam No. 1– Swift Reservoir, WA	512	4,620	9	755,600	122	Multipurpose
Cougar Dam – Cougar Reservoir, OR	519	1,280	5	219,000	167	Multipurpose
Detroit Dam – Detroit Reservoir, OR	463	3,500	9	455,000	119	Multipurpose
Don Pedro Dam – Don Pedro Reservoir, CA	580	13,000	26	2,030,000	230	Multipurpose

1 Baker Lake is only required to provide 16,000 acre-feet of flood storage between October 15 and March 1 and up to an additional 58,000 acre-feet of flood storage during September 1 to April 15, as directed by the USACE.
2 Lake Shannon is only required to provide up to 29,000 acre-feet of flood storage during October 1 to march 1, if directed by the USACE.

In addition to the size, complexity and variability in water surface elevation of Don Pedro Reservoir, velocities, temperature dynamics and potential for predation were also evaluated. Velocity fields within reservoirs generally flow from the head of reservoir (upstream) toward the reservoir outlet (downstream) and provide a pathway for juvenile fish to follow as they migrate downstream. Larger reservoirs generally have larger cross-sectional areas and lower velocities with which to guide fish downstream. Multi-purpose reservoirs store and release water for the purpose of water supply and may make storage adjustments based upon the need to provide flood control storage. These types of operations generally occur in a manner that disrupts the continuity of velocity pathways and inhibits the ability of outmigrating juveniles to find their way through the reservoir in a manner suited to timely outmigration. In addition to flows commensurate with changes in storage volume, temperature stratification, wind, and introduction of tributary flows all influence velocity direction and magnitude within a reservoir system. As flows decrease or as velocities change direction, the ability for fish to successfully follow the velocity field to the outlet of a reservoir diminishes. Velocity magnitudes of less than 0.1 feet per second (0.03 meters per second) are believed to result in juvenile "milling" or "seeking" behavior indicating an overall loss of direction or adequate velocity cue (Beeman et al. 2014a). These behaviors result in misdirection and increased residence times in the reservoir as fish may end up travelling the length of a reservoir multiple times looking for cues that might lead to a suitable outlet (Beeman et al. 2014b; Beeman and Adams 2015).

Seasonal velocity scenarios occurring within Don Pedro Reservoir were examined to evaluate the magnitude of velocities that a fish may experience during outmigration. For the purposes of this study, example inflows were selected to represent velocity fields potentially present within Don Pedro Reservoir. Calculations were performed over a calendar year assuming that the reservoir began at an initial full reservoir condition. Of the results examined, months of the year with the highest inflows exhibited the highest reservoir velocities. Results indicate that example velocity fields representative of late winter conditions in Don Pedro Reservoir are greatest in the narrowest portions of the reservoir which occur at the head of reservoir (RM 79) and downstream of the Highway 49 Bridge near RM 68. In these locations, calculated velocity estimates range from 0.05 meters per second (0.16 feet per second) to 0.03 meters per second (0.1 feet per second). Such low velocities (i.e., less than 0.03 m/s) may fail to cue outmigrating fish (Beeman et al. 2014b; Beeman and Adams 2015). In wider portions of the reservoir downstream of RM 68, velocities appear to diminish to 0.02 meters per second (0.06 feet per second). Downstream of RM 59, the reservoir widens and velocities are reduced further to 0.008 meters per second (0.03 feet per second) at RM 55. Overall, the results show a declining field of velocities as flow approaches Don Pedro Dam. Results also show that velocities simulated throughout the reservoir are significantly less during other months of the year. Velocities downstream of RM 68 range from 0.000 to 0.024 meters per second (0.00 to 0.078 feet per second) in early spring and from 0.000 to .008 meters per second (0.00 to 0.026 feet per second) or less from late spring to early winter. These results are consistent with low velocity conditions that are known to impede downstream migration and which lead to milling behaviors and longer residence times (TID/MID 2017d).

Reservoir temperature and temperature stratification is shown to influence the vertical location of outmigrating smolts in the water column as well as access to suitable migration pathways. Temperature data collected in Don Pedro Reservoir shows that warmer water temperatures that exceed an Upper Optimal Water Temperature Index (UOWTI) value of 63 degrees Fahrenheit for spring-run Chinook smolt outmigration occur each year to depths of 30 to 60 feet near the head of reservoir (RM 72.3), and to depths of 30 to 70 feet near Don Pedro Dam (RM 55.1). At some locations, such warm temperatures are recorded at depths up to 140 feet. Figure 3.5-11 summarizes the depth at which the UOWTI value is met or exceeded over the course of the year at RM 72.3 near Jacksonville Bridge, for years 2004 through 2016. In all twelve years examined, temperatures exceeded the UOWTI value at depths of 30 feet or more from as early as mid-May through as late as mid-November. This period coincides with the early and latter portions of the spring-run Chinook smolt outmigration period. Figure 3.5-12 provides a similar summary of data and shows how the UOWTI value is met or exceeded at depths of 30 feet or more from as early as the beginning of May through as late as mid-November. The data also suggests that the UOWTI value is met or exceeded each year at depths of up to 60 feet or more at both locations with 2015 exceeding depths of 140 feet.

The development of strong thermal stratification throughout Don Pedro Reservoir results in surface temperatures that exceed the smolt outmigration UOWTI value for spring-run Chinook. Available data shows that temperatures become unsuitable for outmigration in the upper 30 to 70 feet of the water column for all years observed and throughout a portion of the anticipated period of migration for spring-run Chinook. In general, these conditions will result in outmigrating juveniles seeking depths of 30 to over 100 feet to find suitable water temperatures throughout portions of their anticipated period of migration. As demonstrated at other floating surface collection systems currently in operation, collection of outmigrating fish at these depths with these types of temperature conditions is not effective, resulting in overall increases in juvenile residence times in Don Pedro Reservoir (TID/MID 2017d).

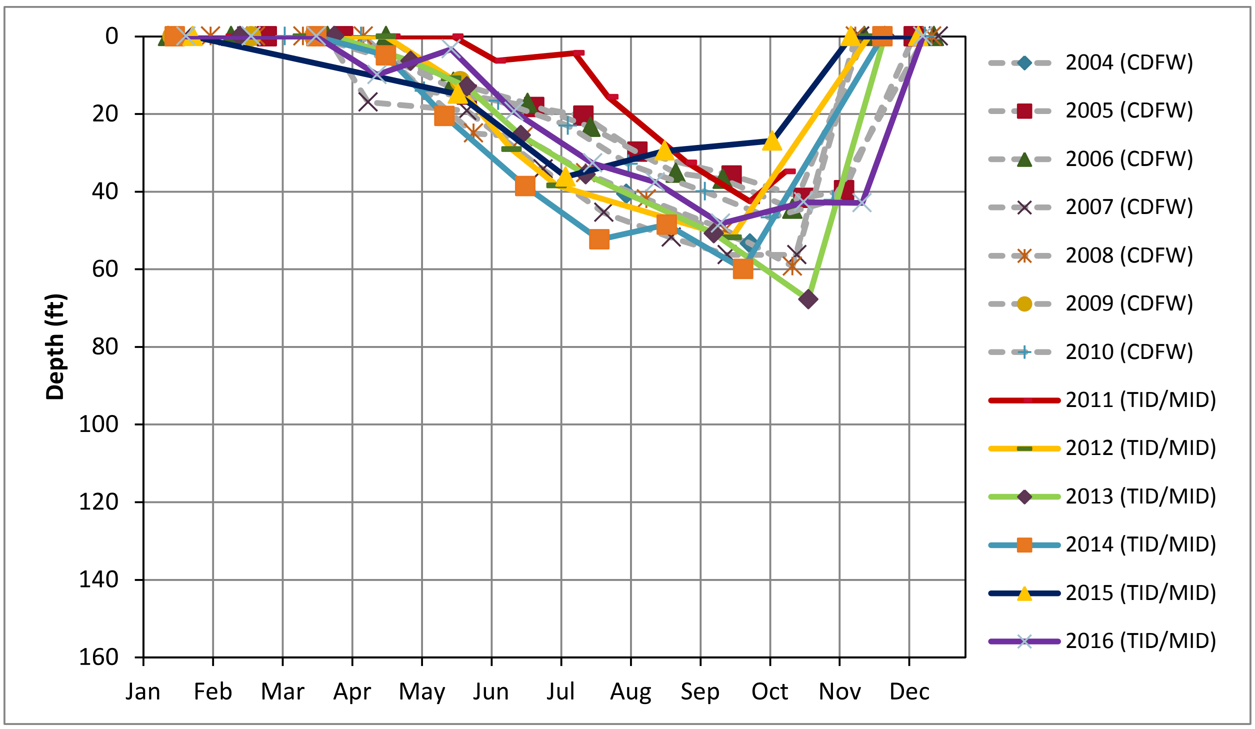

Figure 3.5-11. **Summary of depths where water temperatures met or exceeded the spring-run Chinook smolt outmigration UOWTI value of 63º Fahrenheit near Jacksonville Bridge RM 72.3. Temperature data collected by CDFW in years 2004 through 2010 is shown with grey dashed lines with data collected by the Districts (TID/MID) in 2011 to 2016 shown with colored lines.**

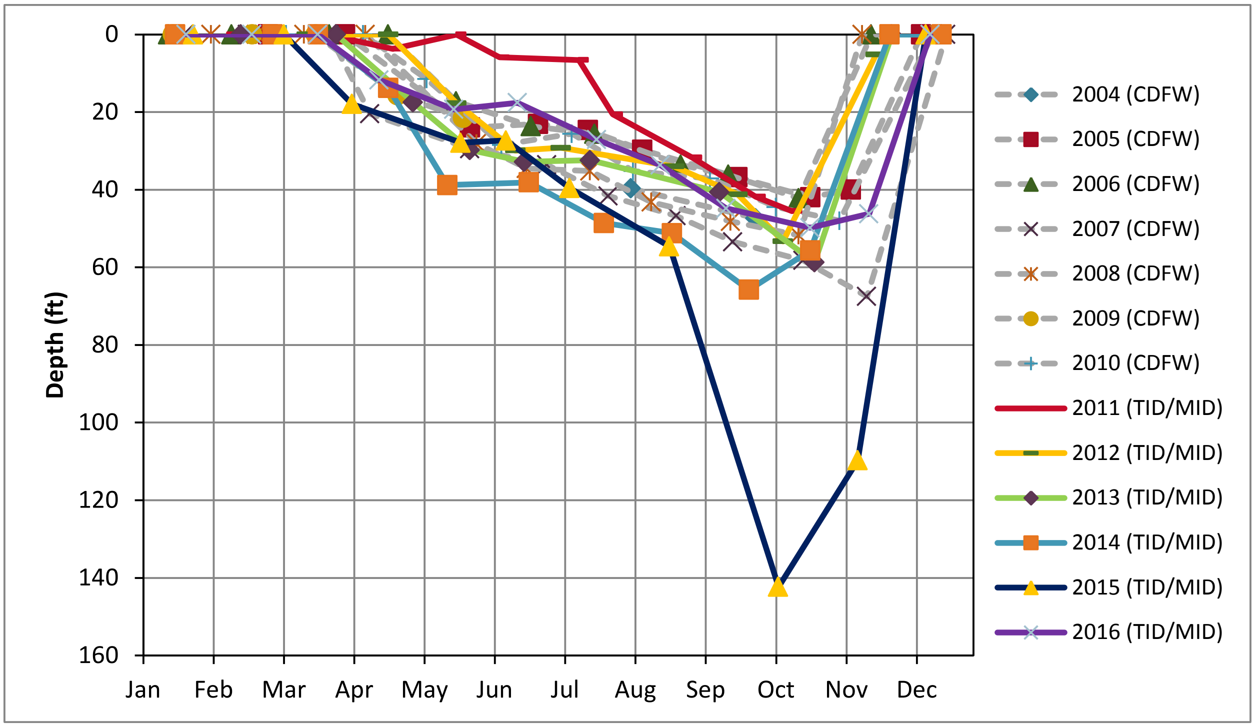

Figure 3.5-12. Summary of depths where water temperatures met or exceeded the spring-run Chinook smolt outmigration UOWTI value of 63° Fahrenheit near Don Pedro Dam, RM 55.1. Temperature data collected by CDFW in years 2004 through 2010 is shown with grey dashed lines with data collected by the Districts (TID/MID) in 2011 to 2016 shown with colored lines.

Predation on native salmonids in Don Pedro Reservoir will likely be significant and will negatively influence juvenile transit through the reservoir. Don Pedro Reservoir contains a diverse fish population, including both native and introduced fish populations that were established through stocking to support game fisheries. CDFW currently manages Don Pedro Reservoir for rainbow trout, Chinook salmon, kokanee, and black bass fisheries and is known to be one of the most successful warmwater fisheries in California. As an example, eleven different organizations are scheduled to hold 21 fishing tournaments at Don Pedro Reservoir in 2017 alone (Don Pedro Recreation Agency 2017). During extensive sampling of the Don Pedro Reservoir conducted in 2012, TID/MID (2013c) identified 14 fish species, including nonnative game species that may prey upon juvenile salmonids. The majority of sampled game fish were sunfishes (Family Centrarchidae), represented primarily by 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)*. Unidentified black bass comprised a large portion of the sampled catch.

Although reservoir-specific data do not exist to document the degree of piscine predation on juvenile salmonids in Don Pedro Reservoir, a lower Tuolumne River predation study (TID/MID 2013b) found black bass to account for significant levels smolt predation. Predation rates (# of Chinook salmon per predator) were generally highest for striped bass, followed by smallmouth bass and largemouth bass. Based on this information, the presence of black bass and other documented piscivorous fish species in the reservoir indicates predation is a variable that must be considered as part of any fish passage or reintroduction effort (TID/MID 2017d).

Given the recreational fisheries that exist in the reservoir, predator presence must be considered as a possible constraint to use of the reservoir as a navigational pathway as well as for reintroduction as a whole. Negative interactions between introduced fish and preexisting species would need to be reduced through physical means for fish passage or reintroduction to have a reasonable chance of success. Nonnative game fishes in Don Pedro Reservoir will increase loss in the reservoir leading to a reduction in reservoir passage effectiveness. Juvenile fish will be vulnerable to size-selective predation in reservoirs (Poe et al. 1991; Fritts and Pearsons 2006) unless they are collected and routed around these “hazards” (Anderson et al. 2014).

A host of factors must be considered when studying the feasibility of fish passage at a project. Engineering projects customarily begin with an understanding of what is intended to be achieved, what constitutes a successful project, and what performance metrics must be met. Feasibility is taken as its common usage: “possible to achieve” (Webster 1992). For a project to be determined to be feasible, it must be able to achieve the objectives established by the project developer(s) and the standards of performance established for projects of a similar nature and purpose.

In the specific case of investigating the likelihood of success of introducing or reintroducing populations of anadromous fish to the reach of the Tuolumne River above the Don Pedro Project, consideration must be given to, among other things, the feasibility of building and operating fish passage facilities that will meet the required performance criteria (i.e., “technical feasibility”), biological and ecological factors affecting the establishment and maintenance of viable populations (i.e., “biological feasibility”), and overall life-cycle cost[19] and reasonable cost:benefit tests (socioeconomic effects, including impacts to existing uses). Although biological and socioeconomic feasibility are critical components in the comprehensive evaluation of a reintroduction/introduction action, the study evaluated only the question of “technical feasibility”. [20]

For the purposes of determining if a potential alternative is technically feasible, alternative concepts were developed and examined using the evaluation factors defined below:

- Factor 1 – Ability to Meet Engineering, Constructability, and Operational Constraints: alternatives must be able to be engineered, constructed, and operated in the context of the existing physical make-up of the site geology, existing structures, site hydrology, reservoir operations, site constraints, and a host of operational and safety requirements.
- Factor 2 - Ability to Operate without Interference with Existing Uses: alternatives must be capable of being implemented without undue interference with existing facilities and uses.

[19] In accordance with 40 CFR 450.11(b)., the Environmental Protection Agency defines infeasible as not technologically possible, or not economically practicable and achievable in light of best industry practices.

[20] As part of the collaborative, it was agreed that fish passage should be able to be accomplished at a “fair and reasonable cost.” (La Grange Hydroelectric Project Reintroduction Assessment Framework Plenary Group 2017a).

- Factor 3 - Ability to Meet Usual and Customary Fish Passage Performance Standards: alternatives must be able to achieve the usual and customary performance standards established for similar facilities, such as collection efficiency, survival through a passage facility, and overall passage efficiency.

A determination of technical feasibility requires a finding that there is a high level of confidence the established project performance criteria for each evaluation factor are able to be achieved. If it is not realistic to expect that these goals or performance criteria can be met, the alternative is judged to be "not feasible." The designation of "not feasible," does not mean that there is no possibility of an alternative functioning at some level of performance; it simply means that it is unlikely to achieve the stated performance thresholds or is unproven given the context in which it is being applied. For example, if a technology is to be applied in a manner in which its performance cannot be reasonably estimated or assured, it is more properly identified as being "experimental". Experimental is defined as “an operation carried out to discover a fact”, or a “method adopted without knowing just how it would work” (Webster 1992). These designations are used in this report to designate whether an alternative is judged to be technically feasible, not feasible, or experimental.

Fish management agencies involved in the oversight of fish passage programs are responsible for designing solutions that facilitate “safe, timely and effective” fish passage through barriers (NMFS 2016). To evaluate whether a facility is achieving the safe, timely and effective passage of fish, numeric performance standards are developed by fish management agencies and applied to upstream and downstream passage facilities. In order to determine “usual and customary” performance standards established for similar facilities that could be used to assess technical feasibility, fish passage facility performance information for the upstream and downstream passage components of programs currently in operation were compiled and evaluated.

When specific performance criteria exist, full scale upstream fish passage facilities are expected to provide Adult Passage Efficiencies of 75 to 95 percent with survival standards of 95 to 98 percent (PacifiCorp 2016, 2017; Northwest Power and Conservation Council 2016). Adult Passage Efficiency is defined as the number of marked or tagged fish passed or recaptured at a facility divided by the number of initial fish collected, marked or tagged, and released downstream of a passage facility.

For downstream passage of juveniles, a list of downstream passage collection facilities and their required performance standards are provided in Table 3.5-9. Additional details and references associated with these facilities are provided in Attachment C of the report (TID/MID 2017d). As demonstrated through review of FERC license documentation for these facilities, the expectation by the resource agencies indicates reservoir passage efficiencies must fall within a range of 75 to 85 percent, collection efficiencies must be as high as 95 percent, and survival of smolt through the passage facilities must be between 98 and 99.5 percent. The overall downstream fish passage efficiency for these existing facilities, as mandated by the resource agencies, is expected to range from 75 to 97 percent (TID/MID 2017d).

Table 3.5-9. Downstream fish passage facilities performance standards[21].

Facility Name and Location	First year of Operation	Reservoir Passage I	Collection I	Survival (S)	Overall Efficiency (RxCxS)
Baker Lake Project – Baker Lake, WA	2008	80%	95%	98%	75%
Baker Lake Project – Lake Shannon, WA	2013	80%	95%	98%	75%
Cushman Project – Lake Cushman, WA	2014	Unspecified	95%	Unspecified	95% target 75% min
Clackamas River Project – North Fork Reservoir, OR	2015	Unspecified	Unspecified	Unspecified	97%
Clackamas River Project (River Mill) – Estacada Lake, OR	2012	Unspecified	Unspecified	Unspecified	97%
Pelton Round Butte Project – Lake Billy Chinook, OR	2009	50% temp facility 75% permanent facility	Unspecified	93% temp facility 96% permanent facility	Unspecified
Lewis River Project – Swift Reservoir, WA	2012	Unspecified (Calculated as 85-86%)	95%	95% fry 99.5% smolt	80%
Cougar Dam – Cougar Reservoir, OR	2014	Unspecified	Unspecified	Unspecified	Unspecified

Note: See Attachment C of TID/MID 2017d for a full list of table citations and references.

Five potential upstream fish passage alternatives representing four upstream technologies were developed to a conceptual level of design and evaluated as part of the fish passage study. Descriptions of the five alternatives considered for upstream fish passage are below:

- Alternative U1A: Technical Fish Ladder – Bypass
- Alternative U1B: Two Separate Technical Fish Ladders
- Alternative U2: Fish Lift with Technical Ladder at La Grange
- Alternative U3: Collection, Handling, Transport and Release (CHTR) Facility
- Alternative U4: Whooshh Fish Transport Tube

After an assessment of major functional elements, advantages, disadvantages, and assessment of technical feasibility based upon the evaluation factors defined above, only Alternative U3: CHTR Facility was determined to be technically feasible. The remaining four alternatives were not determined to be technically feasible based upon the evaluation factors. Of the alternative concepts developed, none of the alternatives investigated that were volitional in nature could be

[21] Reservoir Passage Efficiency (R) is calculated by dividing the number of fish that reach a designed zone of influence in the reservoir by the total number of fish released at a designated point near the head of reservoir. Collection Efficiency (C) is calculated by dividing the number of fish that are collected in a facility by the total number of fish that were released at the zone of influence. Survival (S) represents the number of fish released at a downstream release point divided by the number of fish that were collected.

considered likely to meet performance standards given the 213 feet of total reservoir fluctuation that can occur at Don Pedro Reservoir during the anticipated period of migration. Both the fish ladder and fish lift alternatives would require the integration of an experimental fish return flume or fish transport tube system at the fish passageway exit that would accommodate release of upstream migrating fish into Don Pedro Reservoir. Alternatives U1A, U1B, U2, and U4 also rely on adult upstream migration through Don Pedro Reservoir which is very likely to significantly reduce their overall Adult Passage Efficiency (TID/MID 2017d).

CHTR represents a relatively proven technology with numerous similar facilities in operation that, in general, exhibit high overall fish passage performance characteristics meeting resource agency performance criteria. When sited and designed to accommodate the unique site-specific conditions exhibited at LGDD, this alternative is expected to meet performance criteria. Numerous examples of CHTR facilities exist in the Pacific Northwest that collect and transport adult spring-run Chinook and steelhead with high levels of performance and low levels of injury or direct mortality. In general, these facilities are expected to provide adult passage collection efficiencies of 60 to 95 percent with survival standards of 95 to 100 percent. Table 3.5-10 provides example facilities that are used as a basis of comparison. At comparable sites, survival within the fish ladder entrance, capture, holding tank, and transport portions of comparable CHTR facilities is typically high and non-passage events are documented as either fallback at the entrance or rejection due to water quality issues.

Table 3.5-10. List of selected CHTR type facilities currently in operation.

Facility	Owner	Location
Merwin Dam Adult Collection Facility	PacifiCorp	Lewis River, Washington
North Fork Adult Sorting Facility	Portland General Electric	North Fork Clackamas River, Oregon
Lower Baker Adult Collection Facility	Puget Sound Energy	Baker River, Washington
Cougar Dam Adult Collection Facility	United States Army Corps of Engineers	South Fork McKenzie River, Oregon
Cowlitz Adult Collection Facility	Tacoma Power	Cowlitz River, Washington
White River Diversion Dam Adult Collection Facility	Grant County Public Utility District	White River, Washington
Minto Adult Collection Facility	United States Army Corps of Engineers	North Santiam River, Oregon
Foster Fish Collection Facility	United States Army Corps of Engineers	South Santiam River, Oregon
Fall Creek and Dexter Adult Fish Collection Facilities	United States Army Corps of Engineers	Willamette River, Oregon

Four potential downstream fish passage facility alternatives were developed to a conceptual level and evaluated as part of the fish passage study:

- Alternative D1: Fixed Multi-Port Collector with Helical Bypass near Don Pedro Dam
- Alternative D2A: Floating Surface Collector near Don Pedro Dam
- Alternative D2B: Floating Surface Collector near Head of Reservoir
- Alternative D3: Fixed In-River Collector

None of the downstream alternatives were determined to be technically feasible based upon the evaluation factors defined above. Of the technologies evaluated only one alternative has examples of facilities that are currently in operation: Alternative D2A. The remaining alternatives represent types of downstream fish passage technologies that are yet to be applied in practice at a full scale, and it cannot be known how or whether such a facility will work. Therefore, these alternatives are experimental. In each case, there are no facilities in existence to provide an adequate operational history that can adequately inform the engineering, operational, or performance aspects of the alternatives. For all alternatives, the anticipated reservoir passage efficiency and collection efficiency standards are not likely to meet the performance standards required at other high dam facilities in operation.

For all alternatives, including D2A, the anticipated Don Pedro reservoir passage efficiency and facility collection efficiency standards are highly unlikely to provide safe and effective juvenile passage, or achieve the performance standards required at other high dam facilities in operation. Operation of a floating surface collector near Don Pedro Dam is highly unlikely to provide timely or effective downstream fish passage for outmigrating anadromous salmonids. The high head nature of the dam combined with the dramatic (i.e., up to 213 feet) fluctuations in reservoir surface elevation in Don Pedro Reservoir and associated seasonal changes in temperature and velocity create challenging conditions for fish collection. No existing collection facilities currently operate under such dynamic conditions and operation of a juvenile downstream collection facility at the head of reservoir would be experimental in nature (TID/MID 2017d).

Base opinions of probable construction costs for potential upstream fish passage facility alternatives are estimated to range from $33 to $294 million with annual O&M costs of up to $400,000 per year.

Base opinions of probable construction costs for potential downstream fish passage facility alternatives are estimated to range from $49 to $285 million with annual O&M costs of up to $500,000 per year.

Costs developed for these alternatives do not include implementation costs or costs associated with the periodic refinement, modification, and/or replacement of project components to continuously improve collection and passage performance which are prevalent with existing facilities currently in operation at high dams.

Upper Tuolumne River Basin Fish Migration Barriers Study

The goal of this voluntary study (TID/MID 2017l, attached to this FLA) is to assess barriers to the upstream migration of adult spring-run Chinook salmon and steelhead in the upper Tuolumne River basin from the upper end of the Don Pedro Project Boundary to Early Intake. Study objectives include:

- compile results from any relevant prior studies and conduct field surveys to identify barriers (both total and partial) to upstream anadromous salmonid migration in the mainstem Tuolumne River upstream of the Don Pedro Project Boundary and tributaries, including the

North, Middle, and South forks of the Tuolumne River, Cherry Creek, and the Clavey River; and

- characterize and document the physical structure of each barrier under base flow and high flow (i.e., spring runoff) conditions.

The presence and/or absence of barriers (partial or total) to upstream passage and findings regarding the ability of fish to pass identified features employed a phased approach as described below. More details on methodology are available in the study report (TID/MID 2017l).

- A list of potential barriers to upstream passage was initially developed based upon the information gathered by desktop methods;
- Field surveys were performed to gather physical data at each feature and to characterize major elements which influence fish passage;
- A screening level barrier assessment was performed;
- Each feature identified was classified as one of the following: (1) a "total barrier" to fish passage; (2) a "passable feature"; (3) a "potential barrier"; or a "partial barrier" to fish passage;
- Potential barriers requiring additional field surveys and further evaluation to improve the certainty of final classifications were identified.

Study findings included the identification of the following features:

- One partial barrier and one total barrier on the mainstem of the Tuolumne River;
- Seven potential barriers and one total barrier on North Fork Tuolumne River;
- Two partial barriers and one total barrier on the Clavey River;
- Seventeen partial barriers and one total barrier on the South Fork Tuolumne River; and
- Four partial barriers and one total barrier on Cherry Creek.

Table 3.5-11 summarizes accessible reaches within the study area. Data collected indicate that the mainstem Tuolumne River is accessible by anadromous fish to Lumsden Falls at RM 97.3 and may potentially be accessible from Lumsden Falls to the Early Intake at RM 104.3. Study results indicate that only the lower reaches (i.e., no more than the lower 2 miles) of all major tributaries to the mainstem Tuolumne River are accessible. The lower mile and a half of the North Fork Tuolumne River is also potentially accessible during adequate flow conditions while the reach upstream of RM 1.69 is not accessible due to a total barrier. The lower two miles of the Clavey River are potentially accessible during adequate flow conditions while the Clavey River upstream of RM 2.05 is not accessible by anadromous fish. The lower two miles of the South Fork Tuolumne River are also potentially accessible during adequate flow conditions while the reach upstream of RM 1.9 is not accessible. The Middle Fork Tuolumne River originates upstream of RM 1.9 of the South Fork and therefore would not be accessible by anadromous fish. The lower mile and a half of Cherry Creek are also potentially accessible during adequate flow conditions, while the reach upstream of RM 1.62 is not accessible (TID/MID 2017l).

Table 3.5-11. Summary of upper Tuolumne River reaches accessible by anadromous salmonids.

River/Tributary	River Mile	Current Classification
Mainstem Tuolumne River	Don Pedro Reservoir to 97.3	Accessible
	97.3 to 104.3	Potentially Accessible
	104.3 and upstream	Not Accessible
North Fork Tuolumne River	0 to 0.52	Accessible
	0.52 to 1.69	Potentially Accessible
	1.69 and upstream	Not Accessible
Clavey River	0 to 0.2	Accessible
	0.2 to 2.05	Potentially Accessible
	2.05 and upstream	Not Accessible
South Fork Tuolumne River	0 to 0.45	Accessible
	0.45 to 1.9	Potentially Accessible
	1.9 and upstream	Not Accessible
Middle Fork Tuolumne River	All	Not Accessible
Cherry Creek	0 to 1.62	Potentially Accessible
	1.62 and upstream	Not Accessible

Lumsden Falls exhibits complex hydraulic characteristics at all observed flow conditions. Lumsden Falls possesses velocities, turbulence, air entrainment, and jump heights that are likely to significantly impede the upstream migration of adult Chinook salmon and steelhead populations throughout a wide range of flows experienced in that reach of the mainstem Tuolumne River. There are potentially intermittent windows of opportunity where the strongest of fish could achieve passage. However, the timing of the appropriate hydraulic event that supports passage conditions would need to overlap with the timing of fish presence – thus reducing the probability of passage and likely causing attrition of portions of the population over time. Over periods of years or decades, the intermittent alignment of passable conditions and migratory fish presence at this feature is likely to act as a filter – where passage is likely only possible by the strongest portion of the population (TID/MID 2017l).

In summary, due to the existence of partial and total barriers along the mainstem of the upper Tuolumne River and its major tributaries, anadromous fish access in this reach is comprised of only a small portion of the entire watershed. Total and partial barriers in tributaries indicate that only the lower two miles would be available but in some years, flows might limit access to less of these tributary reaches. Within the mainstem Tuolumne River, approximately 24 miles of river reach upstream of RM 80.8 may be available to anadromous fish however the presence of Lumsden Falls, a significant partial barrier, is likely to have a significant influence on the frequency of access and the proportion of a fish population that can pass this feature. As such, approximately 17 miles below Lumsden Falls may be accessible to anadromous fish (TID/MID 2017l).

Upper Tuolumne River Basin Water Temperature Monitoring and Modeling Study

The goals and objectives of this voluntary study (TID/MID 2017m, TID/MID 2017n; both are attached to this FLA) are as follows:

- use existing data to characterize the thermal regimes of the upper Tuolumne River and tributaries from Early Intake to the upper extent of the Don Pedro Project and includes portions of the North and South forks of the Tuolumne River, Cherry Creek, and the Clavey River. This will form the basis of future work that will identify potential locations where temperatures may be suitable for reintroduction of anadromous salmonids (species to be determined but may include Central Valley steelhead and spring-run Chinook salmon);
- depending on the availability of information, logistical feasibility, and safety, install water temperature and/or stage data loggers to obtain additional information at locations for which existing data are inadequate; and
- develop and test a computer model to simulate existing thermal conditions in the Tuolumne River from below Early Intake to above the Don Pedro Project Boundary. The model will serve as a tool for determining water temperature at any point in the study reach under historical conditions.

Study methodology includes the following task:

- identifying, synthesizing and interpreting existing data (temperature, flow, meteorological, etc.);
- installing additional water temperature and stage data loggers as needed;
- water temperature and stage data collection and review; and
- water temperature modeling.

In 2015, existing geometric, flow and stage, water temperature and meteorological data were used to characterize the thermal regime and provide a general system description of the Tuolumne River below CCSF's Early Intake and upstream of the Don Pedro Project. Existing temperature data were identified for the mainstem Tuolumne River from Early Intake to above the Don Pedro Project Boundary, and the principal tributaries including Cherry Creek (including Eleanor Creek above the confluence with Cherry Creek), South Fork Tuolumne River, Clavey River, and North Fork Tuolumne River. Based on these data, a collaborative effort was undertaken by the Districts and licensing participants to identify locations where additional temperature monitoring stations should be established.

The Districts held a Flow and Temperature Monitoring and Modeling Workshop with licensing participants on May 19, 2015. The objectives of workshop were to: (1) present an overview of the Water Temperature Monitoring and Modeling Study; (2) review and confirm with licensing participants proposed temperature and flow monitoring locations; and (3) review and confirm with licensing participants the modeling approach. After a brief review of the Water Temperature Monitoring and Modeling Study's goal, objectives, scope, and study area, the Districts summarized their findings of the existing data analysis. Data parameters evaluated included flow, water temperature, and meteorology, and data review consisted of location of sources, frequency, and period assessments. Findings included general characterizations of hydrology and thermal conditions, potential modeling periods, identification of data gaps, and recommendations for additional monitoring to support modeling objectives. Multiple mainstem and tributary locations within the study area were recommended for additional monitoring of water temperature and/or stage. Detailed information regarding additional locations and dates of monitoring are presented in the study report (TID/MID 2017n).

In 2016, existing stream description (geometry), flow and stage, temperature, and meteorological data were used to develop a water temperature model to simulate the thermal regime in the Tuolumne River from below Early Intake to above the Don Pedro Project Boundary that has been identified as potentially accessible to reintroduced steelhead and spring-run Chinook salmon. While the monitoring program collected sufficient data to support tributary modeling, the barriers assessment (TID/MID 2017l) indicated that reintroduction efforts would likely be limited to the mainstem Tuolumne River between Early Intake to above Don Pedro Reservoir.

Based on the study objectives and fundamental attributes of the system, appropriate models were evaluated for use. The process of model selection for the Tuolumne River is addressed in Jayasundara et al. (2017). Key considerations included:

- robust hydrodynamics. A model must be able to replicate variable flow conditions on a short time step (e.g., hourly) to assess potential implications of dynamic flow conditions in steep river reaches;
- longitudinal stream temperature gradients. These are important in assessing temperature via the fate and transport of heat energy;
- sub-daily temperatures. Sub-daily temperatures are desirable to identify not only mean daily conditions, but minimum and maximum daily temperatures to develop metrics for thermal suitability assessment and regulatory considerations; and
- open-source code (i.e., code that is accessible for user review and modification).

The RMA models, RMA-2 for hydrodynamics (King 2014) and RMA-11 (King 2013) for water temperature, were used to represent the Tuolumne River in a one-dimensional, depth-averaged, finite element scheme. These models have been applied successfully to the Tuolumne River in simulations below Hetch Hetchy over a wide range of flows (Jayasundara et al. 2017). The utility application RMAGEN (v7.4) (King 2014) was used to create a geometry file of the Tuolumne River that was used by both the hydrodynamic and water temperature models. RMA-2 calculates velocity, water surface elevation, and depth at defined nodes of each grid element in the geometric network representing the river. In this project, the model with a computational time step of 15 minutes was applied in one-dimensional, laterally and depth-averaged form. RMA-11 is a companion finite-element water quality model that uses depth and velocity results from RMA-2 to solve advection and diffusion equations of constituent transport.

Model data development included the process of aggregating all data necessary to implement a model. For a river temperature model, these data included geometric data, meteorological data, hydrologic data, and water temperature data. Detailed information regarding the gathering, synthesis and review of existing data and the QA/QC of newly collected data are included in the study report (TID/MID 2017m).

Overall, the model simulated seasonal variations in diel range and overall tracked observed data well. Detailed calibration statistics are presented in study report however for all years, mean bias was typically low and near zero in several cases, MAE was generally under 1^{o}C, and RMSE was always less than 2^{o}C. Overall, given the level of available data, these results indicate that the model effectively captures a range of hydrologic and water temperature conditions in the upper Tuolumne River system.

As part of the collaborative Assessment Framework process described in Section 1.3.7 of this Exhibit E, technical subcommittees (working in coordination with the larger Plenary Group) comprised of interested licensing participants (i.e., federal and state resource management agencies, non-governmental organizations and the public) on a voluntary basis were formed to support key reintroduction feasibility assessment activities. In general, technical subcommittee meetings focused on specialized technical topics related to the Assessment Framework process and included: (1) the collaborative development of study plans for 2016 voluntary Upper Tuolumne River studies; (2) discussions to define reintroduction goals and objectives to evaluate reintroduction feasibility; and (3) discussions to identify appropriate water temperature criteria to evaluate thermal suitability in the reintroduction reach.

In 2016-2017, the Water Temperature Subcommittee (formed to address topic #3) participated in numerous conference calls to develop and finalize information to develop thermal suitability indices of target species (i.e., steelhead and spring-run Chinook) in the study area. As a starting point, members decided the best path forward was to review and update with additional studies and site-specific information, a literature review already completed for the Yuba Salmon Forum (YSF) in 2012 (Bratovich et al. 2012). This literature review focused on Central Valley temperature experiments and field observations and contains over 100 references. Where data needed to be augmented, the review extended to information collected in the Pacific Northwest. Based upon the information collected, the YSF developed water temperature index values for each life stage for spring-run Chinook and steelhead and used this information to support determination of areas in the Yuba watershed that may be suitable or unsuitable for salmon and steelhead reintroduction.

Similar to the Yuba process, the Water Temperature Subcommittee developed a literature review document (TID/MID 2017o) that included up-to-date regional and site specific information regarding the potential biological effects of water temperature to the growth and survival of salmon and steelhead and based upon this information, the subcommittee developed guidance to assess thermal suitability in the upper Tuolumne River. Information included life stage periodicities and water temperature indices (WTIs) for both optimum and tolerable conditions for spring-run Chinook and steelhead and use of Maximum Weekly Average Temperature (MWAT) as the metric of evaluation (La Grange Hydroelectric Project Reintroduction Assessment Framework Plenary Group 2017b). Temperatures occurring consistently above the upper tolerable limit may have long-term adverse effects and would be judged to be unlikely to support recovery or reintroduction. Table 1.3-2 (as presented in Section 1.3.7 of this Exhibit E) summarizes information developed by the Water Temperature Subcommittee. This information was presented to and approved by the Assessment Framework Plenary Group on May 18, 2017. This information and was input into the upper Tuolumne River Flow and Temperature Model (UTRFT) to assess the thermal suitability of upper Tuolumne River habitat with regard to reintroduction feasibility.

WTIs were evaluated at eleven locations through the study area (Table 3.5-12). These locations were selected to be upstream and downstream of major tributaries, and when reaches between tributaries were more than a few miles apart, an intermediate point on the mainstem Tuolumne River was added. In general, the suite of locations was intended to provide sufficient spatial representation of the thermal characteristics of the study area and to address the thermal influences of major tributaries.

Table 3.5-12. Temperature assessment criteria generic sites (Abbreviations: TR: Tuolumne River; Cr.: Creek; Conf.: Confluence; SF: South Fork; R.: River; NF: North Fork).

Location Number	Location Name[1]	Node Number
1	TR at Early Intake	1
2	TR below the Cherry Cr. Conf.	83
3	TR between Cherry Cr and SF TR conf.	262
4	TR above the SF TR conf.	442
5	TR below the SF TR conf.	448
6	TR between SF TR conf. and Clavey R.	601
7	TR above the Clavey R. conf.	754
8	TR below the Clavey R. conf.	760
9	TR between Clavey R. and NF TR conf.	1015
10	TR above the NF TR conf.	1270
11	TR below the NF TR conf.	1276

[1] TR = Tuolumne River; Cr. = Creek; Conf. = Confluence; SF = South Fork; R. = River; NF = North Fork.

UTRFT model outputs were used to calculate seven-day running averages of the daily average and maximum. The Maximum Weekly Average Temperature (MWAT) was computed by calculating the mathematical mean of multiple, equally spaced, daily water temperatures over a seven-day consecutive period. The MWAT is defined as the highest value calculated for all possible seven-day periods over a given time period, in this case, a particular salmonid lifestage. In order to determine whether the maximum weekly temperature standard is attained, the mathematical mean of multiple, equally spaced, daily temperatures over a seven-day consecutive period is compared to the associated upper optimal WTIs (UOWTI) and upper tolerable WTIs (UTWTI). These statistics were subsequently used to estimate the number of days which the given WTIs were exceeded in each of the fish life stages identified in Table 1.3-2 presented in Section 1.3.7 of this Exhibit E.

WTIs were applied to simulated temperatures for all years (2008-2016) for target species' life stages and associated periodicities (TID/MID 2017n). Hydrology information for the upper Tuolumne River (USGS gage 11274790) above the Hetch Hetchy system (i.e., essentially unimpaired) was acquired for the period (2008-2016). Of the nine-year period, the range of annual average flows was 64 percent to 195 percent. However, 2008 was 95 percent of the average and closest to representative of runoff of the Tuolumne River above the Hetch Hetchy system for this time period[22]. For 2008, the calculated MWAT values are presented, and percentage of days when index values is exceeded enumerated for spring-run Chinook salmon UOWTI value (Table 3.5-13 and Table 3.5-14), spring-run Chinook salmon UTWTI value

[22] As described in Section 4.0, 2008-2016 is a drier than average period of time when considering hydrology from 1971 to 2016 based upon the USGS gage (11276900) below Early Intake.

(Table 3.5-15 and Table 3.5-16), steelhead UOWTI (Table 3.5-17 and Table 3.5-18), and steelhead UTWTI (Table 3.5-19 and Table 3.5-20).

In addition to application of WTIs to the historical period from 2008-2016, a brief review of hydrologic records was completed to identify any operations that may affect water temperature conditions in the study reach. Specifically, a review of potential planned and unplanned outages were explored. These include regular scheduled outages (a day or two) and longer duration (on the order of weeks), unplanned outages that, while infrequent, would be typical for operations of a hydroelectric project.

During typical summer peaking operations, the Holm powerhouse is regularly taken offline approximately every two weeks, and these changes in peaking operations have direct impacts on water temperature. Representative data from 2013 is presented to illustrate these operations (Figure 3.5-13). During peaking operations, daily minimum water temperatures decrease to approximately 48°F to 49°F due to cold water conveyed from Cherry Lake to support hydropower operations, and during non-peaking operations, minimum water temperatures are in the 63°F to 68°F range, reflecting local, upstream Cherry Creek stream temperatures. While daily maximum temperatures in Cherry Creek are similar, the implications of peaking on daily average water temperatures are notable. The 15-minute and daily average metrics are presented herein because the 7-day average metric masks these one day events.

The UTRFT Model simulates the effects of the planned outages downstream in the mainstem Tuolumne River. Below the Cherry Creek confluence, daily maximum temperatures were not markedly affected by the changes in flow pattern, but daily average temperatures during planned outages were higher than the adjacent days (Figure 3.5-14). This one-day increase is masked in a 7-day running average metric, but these short-term increases in temperature could have a biological effect, hence they are presented here as supplemental information.

The temperature implications in daily average water temperature associated with planned outages were less pronounced at locations further downstream due to the influence of tributary flows and the cumulative effect of heating associated with meteorological conditions (Figure 3.5-15 through Figure 3.5-17).

Occasionally extended, unplanned outages occur at Holm Powerhouse. These unplanned outages are an expected element of hydropower generation facilities and can run for several weeks. One example of an unplanned extended outage was during the Rim Fire in the late summer of 2013, when the powerhouse was taken offline and staff evacuated for safety reasons. Flows in lower Cherry Creek for the period August 1 through September 30, 2013 illustrate the extended outage from approximately August 19 through September 30. There are periods in mid- and late-September when partial operation of the powerhouse is evident.

Table 3.5-13. Spring-run Chinook salmon UOWTI MWAT for each fish life stage for the calendar year 2008.

Fish Life Stage	Assessment WTI (MWAT)	Location No.										
		1	2	3	4	5	6	7	8	9	10	11
		MWAT[1], ºF										
Adult Upstream Migration (03/01 – 05/31)	64.0	66.4	52.5	53.5	55.5	55.9	56.4	57.8	58.2	58.9	59.5	59.5
Adult Holding (04/01 – 09/15)	61.0	70.1	64.0	63.8	64.7	65.0	65.0	66.3	66.9	66.7	66.7	66.7
Adult Spawning (08/15 – 10/31)	56.0	66.4	61.5	61.6	62.6	63.0	63.1	64.4	64.8	64.8	65.0	65.2
Embryo Incubation and Emergence (08/15 – 12/31)	56.0	66.4	61.5	61.6	62.6	63.0	63.1	64.4	64.8	64.8	65.0	65.2
Fry Rearing (11/01 – 03/31)	65.0	53.7	50.3	50.8	51.2	51.1	51.6	52.1	52.1	53.3	53.8	53.9
Juvenile Rearing and Downstream Movement (01/01 – 12/31)	65.0	70.1	64.0	63.8	64.7	65.0	65.0	66.3	66.9	66.7	66.7	66.7
Smolt Outmigration (10/01 – 05/31)	63.0	66.4	56.1	56.7	57.4	57.5	57.9	58.6	58.7	59.6	60.2	60.3

[1] Cells which exceed the assessment water temperature index value (MWAT) are highlighted in gray.

Table 3.5-14. Percentages of days when spring-run Chinook salmon UOWTI values are exceeded for the calendar year 2008.

Fish Life Stage	Location No.										
	1	2	3	4	5	6	7	8	9	10	11
	% of Days Exceeded										
Adult Upstream Migration (03/01 – 05/31)	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Adult Holding (04/01 – 09/15)	50.6	14.9	17.3	20.8	23.2	25.0	32.7	35.1	34.5	35.1	35.7
Adult Spawning (08/15 – 10/31)	76.9	52.6	57.7	65.4	66.7	67.9	69.2	70.5	71.8	71.8	71.8
Embryo Incubation and Emergence (08/15 – 12/31)	43.2	29.5	32.4	36.7	37.4	38.1	38.8	39.6	40.3	40.3	40.3
Fry Rearing (11/01 – 03/31)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Juvenile Rearing and Downstream Movement (01/01 – 12/31)	16.7	0.0	0.0	0.0	0.0	0.3	3.6	3.8	3.8	4.1	4.9
Smolt Outmigration (10/01 – 05/31)	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 3.5-15. Spring-run Chinook salmon UTWTI MWAT for each fish life stage for the calendar year 2008.

Fish Life Stage	Assessment WTI (MWAT)	Location No.										
		1	2	3	4	5	6	7	8	9	10	11
		MWAT[1], ºF										
Adult Upstream Migration (03/01 – 05/31)	68.0	66.4	52.5	53.5	55.5	55.9	56.4	57.8	58.2	58.9	59.5	59.5
Adult Holding (04/01 – 09/15)	65.0	70.1	64.0	63.8	64.7	65.0	65.0	66.3	66.9	66.7	66.7	66.7
Adult Spawning (08/15 – 10/31)	58.0	66.4	61.5	61.6	62.6	63.0	63.1	64.4	64.8	64.8	65.0	65.2
Embryo Incubation and Emergence (08/15 – 12/31)	58.0	66.4	61.5	61.6	62.6	63.0	63.1	64.4	64.8	64.8	65.0	65.2
Fry Rearing (11/01 – 03/31)	68.0	53.7	50.3	50.8	51.2	51.1	51.6	52.1	52.1	53.3	53.8	53.9
Juvenile Rearing and Downstream Movement (01/01 – 12/31)	68.0	70.1	64.0	63.8	64.7	65.0	65.0	66.3	66.9	66.7	66.7	66.7
Smolt Outmigration (10/01 – 05/31)	68.0	66.4	56.1	56.7	57.4	57.5	57.9	58.6	58.7	59.6	60.2	60.3

[1] Cells which exceed the assessment water temperature index value (MWAT) are highlighted in gray.

Table 3.5-16. Percentages of days when spring-run Chinook salmon UTWTI values are exceeded for the calendar year 2008.

Fish Life Stage	Location No.										
	1	2	3	4	5	6	7	8	9	10	11
	% of Days Exceeded										
Adult Upstream Migration (03/01 – 05/31)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Adult Holding (04/01 – 09/15)	36.3	0.0	0.0	0.0	0.0	0.6	7.7	8.3	8.3	8.9	10.7
Adult Spawning (08/15 – 10/31)	74.4	26.9	32.1	33.3	34.6	38.5	53.8	56.4	64.1	70.5	70.5
Embryo Incubation and Emergence (08/15 – 12/31)	41.7	15.1	18.0	18.7	19.4	21.6	30.2	31.7	36.0	39.6	39.6
Fry Rearing (11/01 – 03/31)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Juvenile Rearing and Downstream Movement (01/01 – 12/31)	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Smolt Outmigration (10/01 – 05/31)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 3.5-17. Steelhead UOWTI MWAT for each fish life stage for the calendar year 2008.

Fish Life Stage	Assessment WTI (MWAT)	Location No. 1	2	3	4	5	6	7	8	9	10	11
		MWAT[1], ºF										
Adult Upstream Migration (10/01 – 03/31)	64.0	62.5	56.1	56.7	57.4	57.5	57.9	58.6	58.7	59.6	60.2	60.3
Adult Holding (10/01 –12/15)	61.0	62.5	56.1	56.7	57.4	57.5	57.9	58.6	58.7	59.6	60.2	60.3
Adult Spawning (12/15 – 04/30)	54.0	50.7	47.0	47.5	48.1	48.1	48.5	49.0	49.1	49.6	50.2	50.2
Embryo Incubation and Emergence (12/15 – 05/31)	54.0	66.4	52.5	53.5	55.5	55.9	56.4	57.8	58.2	58.9	59.5	59.5
Fry Rearing (02/01 – 07/15)	68.0	70.1	64.0	63.8	64.7	65.0	65.0	66.2	66.8	66.7	66.7	66.7
Juvenile Rearing and Downstream Movement (01/01 – 12/31)	68.0	70.1	64.0	63.8	64.7	65.0	65.0	66.3	66.9	66.7	66.7	66.7
Smolt Outmigration (12/01 – 04/30)	55.0	50.7	47.8	48.3	48.9	48.9	49.4	49.8	49.9	50.6	51.2	51.2

[1] Cells which exceed the assessment water temperature index value (MWAT) are highlighted in gray.

Table 3.5-18. Percentages of days when Steelhead UOWTI values are exceeded for the calendar year 2008.

Fish Life Stage	Location No. 1	2	3	4	5	6	7	8	9	10	11
	% of Days Exceeded										
Adult Upstream Migration (10/01 – 03/31)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Adult Holding (10/01 –12/15)	9.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Adult Spawning (12/15 – 04/30)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Embryo Incubation and Emergence (12/15 – 05/31)	13.0	0.0	0.0	3.0	3.6	4.1	5.9	5.9	7.1	8.9	8.9
Fry Rearing (02/01 – 07/15)	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Juvenile Rearing and Downstream Movement (01/01 – 12/31)	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Smolt Outmigration (12/01 – 04/30)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 3.5-19. Steelhead UTWTI MWAT for each fish life stage for the calendar year 2008.

Fish Life Stage	Assessment WTI (MWAT)	Location No.										
		1	2	3	4	5	6	7	8	9	10	11
		MWAT[1], °F										
Adult Upstream Migration (10/01 – 03/31)	68.0	62.5	56.1	56.7	57.4	57.5	57.9	58.6	58.7	59.6	60.2	60.3
Adult Holding (10/01 –12/15)	65.0	62.5	56.1	56.7	57.4	57.5	57.9	58.6	58.7	59.6	60.2	60.3
Adult Spawning (12/15 – 04/30)	57.0	50.7	47.0	47.5	48.1	48.1	48.5	49.0	49.1	49.6	50.2	50.2
Embryo Incubation and Emergence (12/15 – 05/31)	57.0	66.4	52.5	53.5	55.5	55.9	56.4	57.8	58.2	58.9	59.5	59.5
Fry Rearing (02/01 – 07/15)	72.0	70.1	64.0	63.8	64.7	65.0	65.0	66.2	66.8	66.7	66.7	66.7
Juvenile Rearing and Downstream Movement (01/01 – 12/31)	72.0	70.1	64.0	63.8	64.7	65.0	65.0	66.3	66.9	66.7	66.7	66.7
Smolt Outmigration (12/01 – 04/30)	57.0	50.7	47.8	48.3	48.9	48.9	49.4	49.8	49.9	50.6	51.2	51.2

[1] Cells which exceed the assessment water temperature index value (MWAT) are highlighted in gray.

Table 3.5-20. Percentages of days when Steelhead UTWTI values are exceeded for the calendar year 2008.

Fish Life Stage	Location No.										
	1	2	3	4	5	6	7	8	9	10	11
	% of Days Exceeded										
Adult Upstream Migration (10/01 – 03/31)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Adult Holding (10/01 –12/15)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Adult Spawning (12/15 – 04/30)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Embryo Incubation and Emergence (12/15 – 05/31)	10.1	0.0	0.0	0.0	0.0	0.0	1.8	3.0	3.6	4.1	4.1
Fry Rearing (02/01 – 07/15)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Juvenile Rearing and Downstream Movement (01/01 – 12/31)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Smolt Outmigration (12/01 – 04/30)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

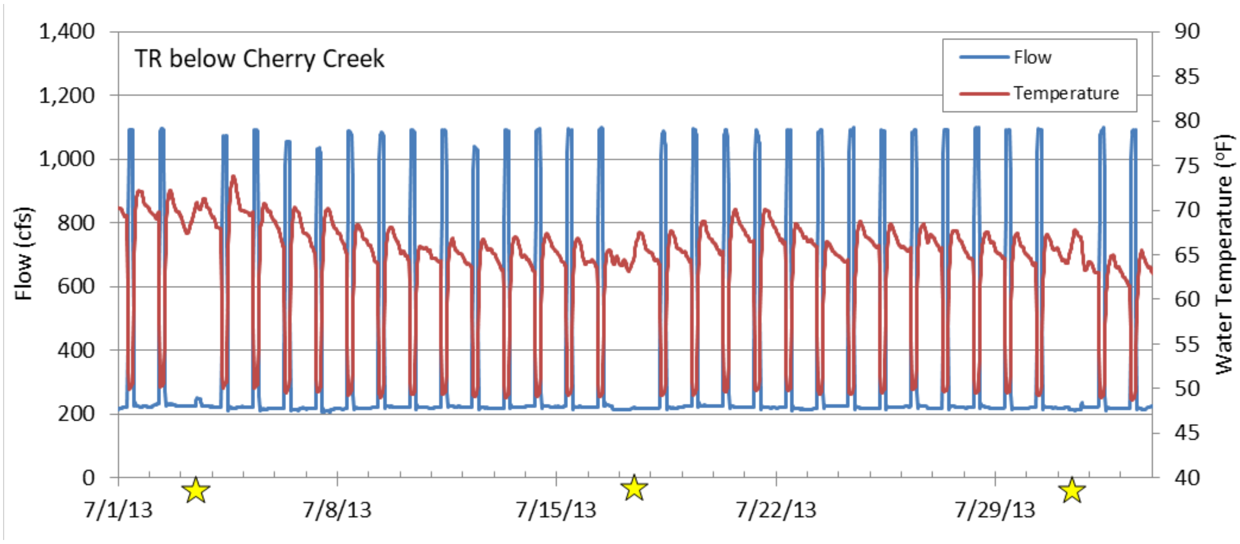

Figure 3.5-13. **15-minute flow and water temperature at for Cherry Creek below Dion R Holm Powerhouse near Mather, CA (USGS 11278400): July 2013 (stars denote days with planned outages).**

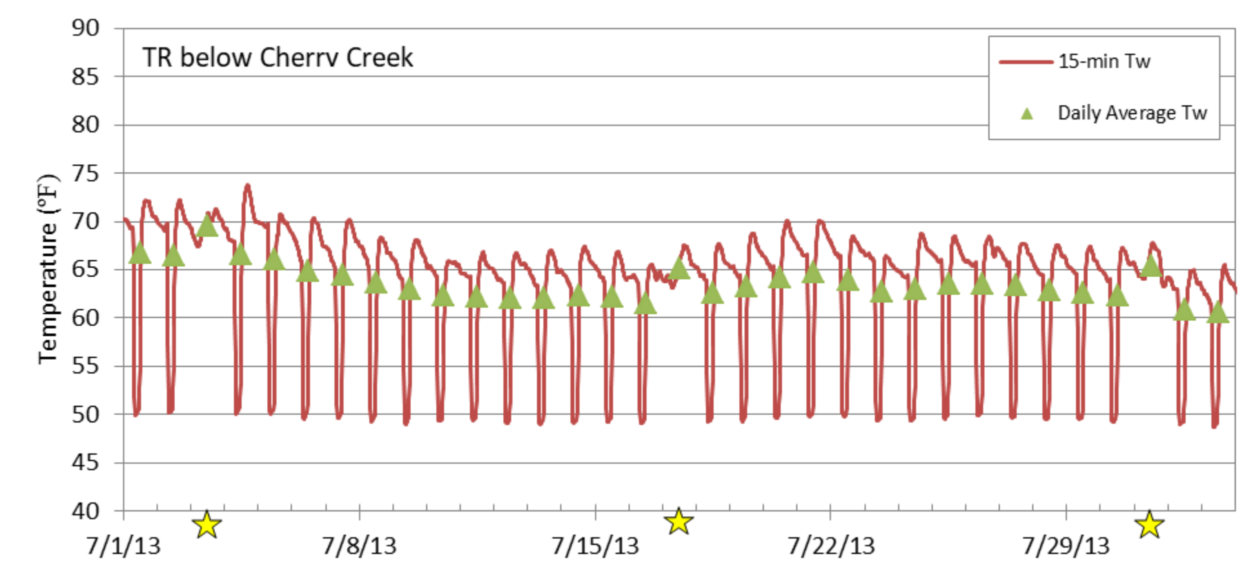

Figure 3.5-14. **Simulated water temperature (Tw) at Tuolumne River below Cherry Creek confluence in July 2013 (stars denote days with planned outages).**

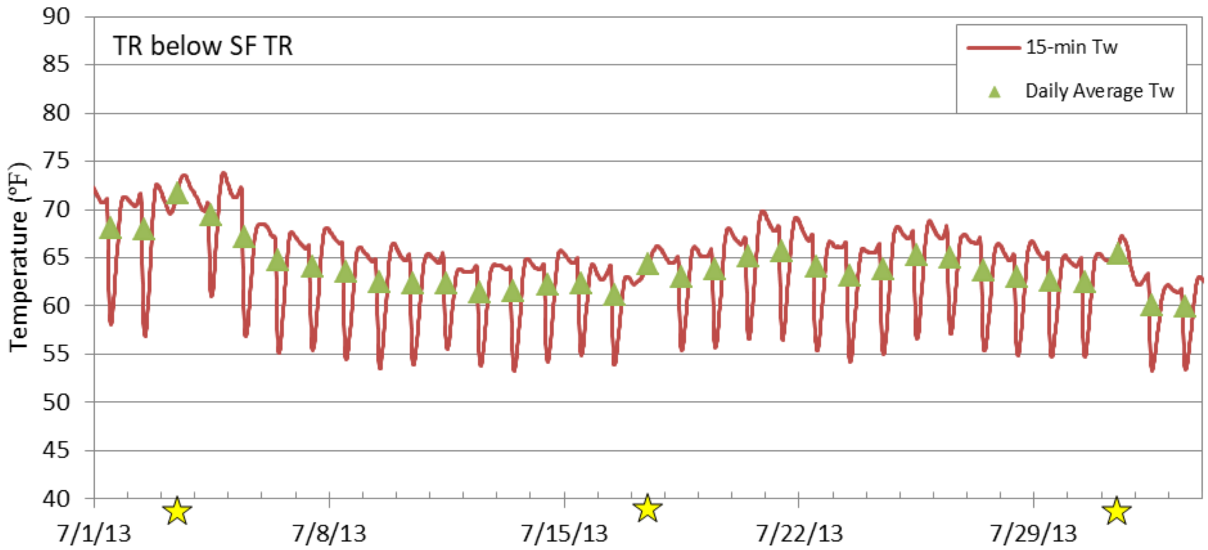

Figure 3.5-15. Simulated water temperature (Tw) at Tuolumne River below South Fork Tuolumne River confluence in July 2013 (stars denote days with planned outages).

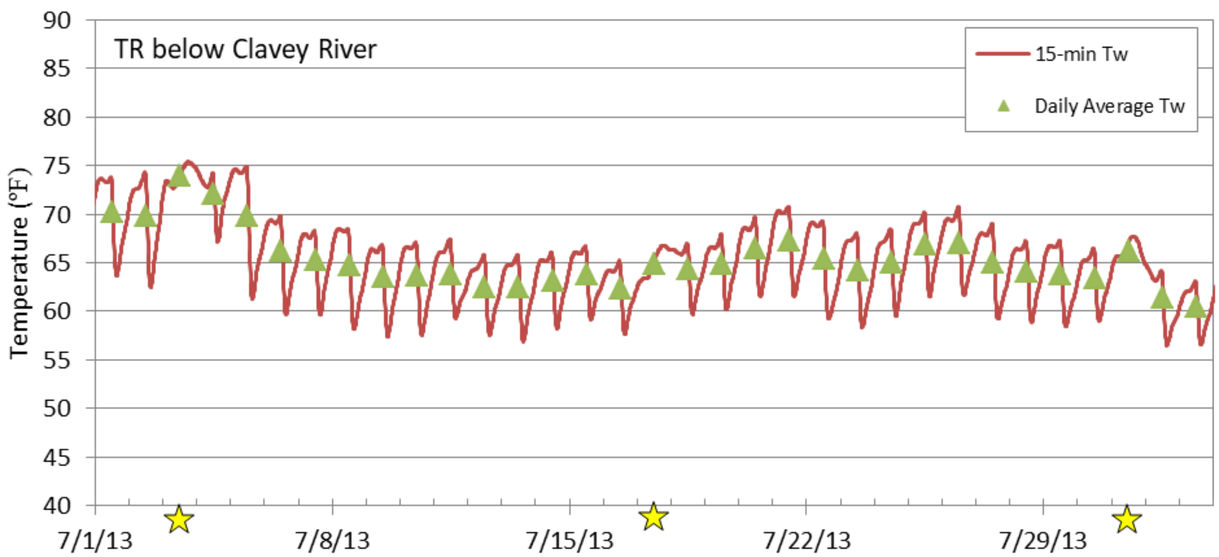

Figure 3.5-16. Simulated water temperature (Tw) at Tuolumne River below Clavey River confluence in July 2013 (stars denote days with planned outages).

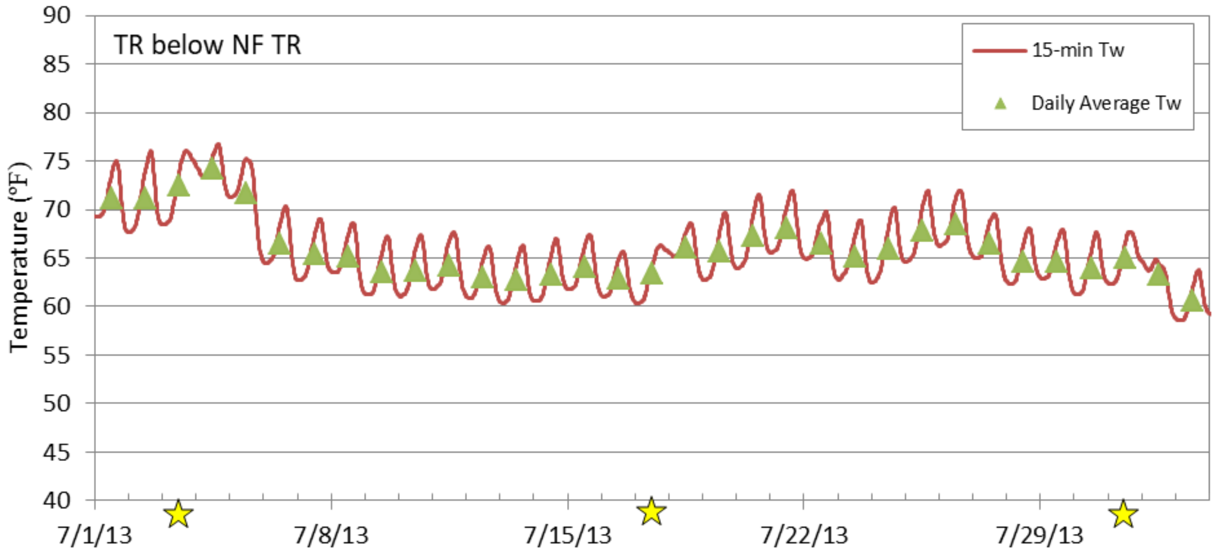

Figure 3.5-17. Simulated water temperature (Tw) at Tuolumne River below North Fork Tuolumne River confluence in July 2013 (stars denote days with planned outages).

During peaking operations prior to August 19, daily minimum water temperatures ranged from approximately 46°F to 47°F, and during non-peaking operations, maximum water temperatures were in the 60°F to 65°F range depending on the number of units in service at Holm Powerhouse. When the powerhouse went offline in mid-August, daily minimum water temperatures in Cherry Creek were in the 63°F to 67°F degree range over the next two weeks, and maximum temperatures regularly ranged from 66°F to over 70°F for the same period (Figure 3.5-18). The implications of this outage on downstream river reaches for locations in the Tuolumne River below Cherry Creek, South Fork Tuolumne River, Clavey River and North Fork Tuolumne River are shown in Figure 3.5-19. Water temperatures increase with distance downstream, with temperatures below Cherry Creek ranging from approximately 65°F to 69°F through September 5. Temperatures were 2°F to 3°F warmer below the North Fork Tuolumne River. Fall cooling is reflected in the decreasing temperatures through September. Powerhouse Operations in mid-September (16th to 21st), even at a modest flow rate at about 150 cfs to 200 cfs, have a notable impact (6°F to 10°F decrease) on water temperature in Cherry Creek and the downstream Tuolumne River.

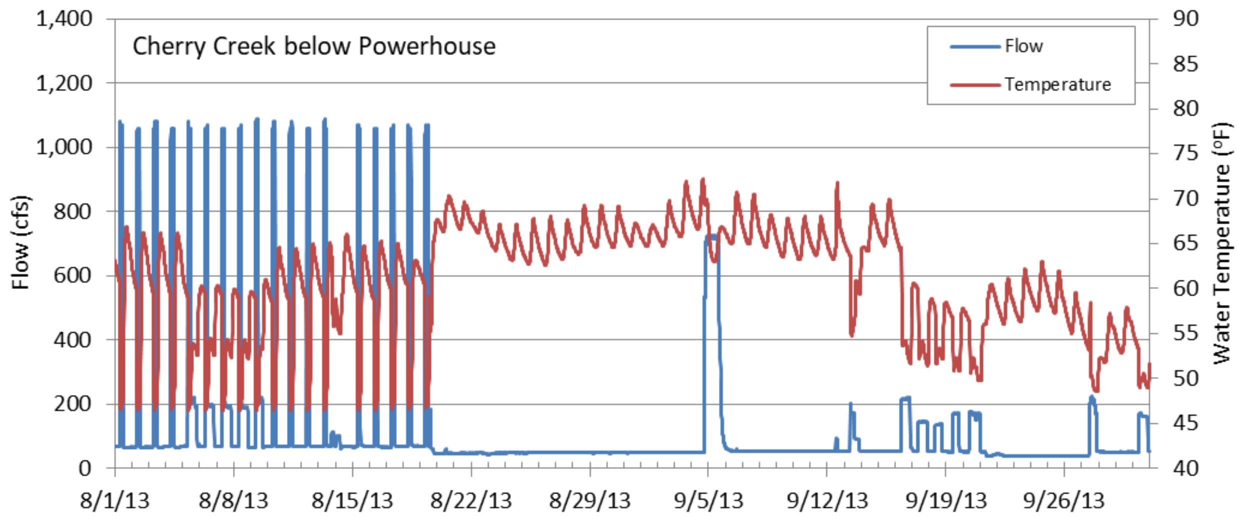

Figure 3.5-18. 15-minute flow and water temperature at for Cherry Creek below Dion R Holm Powerhouse near Mather, CA (USGS 11278400): August and September 2013.

Application of the UTRFT Model provided a means to evaluate WTI values for spring-run Chinook and steelhead life stages for a range of hydrologic, operational, and meteorological conditions. WTI values for both species were based upon a literature review that included up-to-date regional and site specific information regarding the potential biological effects of water temperature to the growth and survival of salmon and steelhead. Findings include:

- Utilizing the WTIs and the simulated model temperatures for each species, WTIs are exceeded in all years for at least one lifestage at one of the investigated locations for spring-run Chinook salmon[23].
- For steelhead, WTIs are exceeded in many years for at least one lifestage at one of the investigated locations.
- Hydropeaking operations appear to mitigate against warmer thermal conditions in the upper Tuolumne River. Extended power outages (planned or unplanned) can have an impact on thermal conditions in the upper Tuolumne River during summer and early fall.

[23] Note that in the Tuolumne River below the La Grange Diversion Dam, EPA (2003) temperature benchmarks were applied as indices of temperature suitability for fall-run Chinook and *O. mykiss*. The EPA (2003) temperature benchmarks are significantly lower than the WTI values collaboratively established in the Assessment Framework.

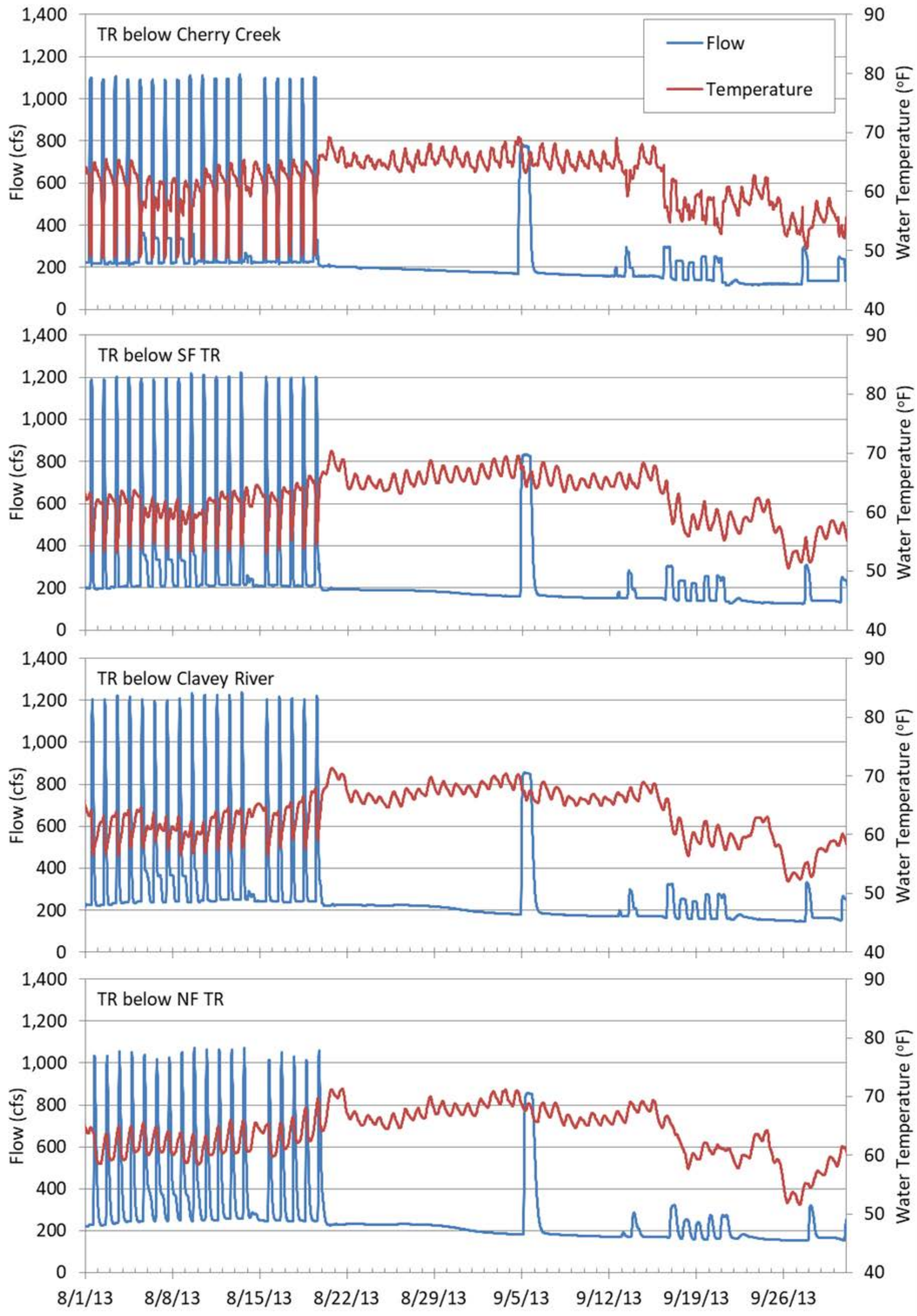

Figure 3.5-19. **15-minute flow and water temperature at for Tuolumne River below Cherry Creek, below South Fork Tuolumne River, below Clavey River, and below North Fork Tuolumne River: August and September 2013.**

Hatchery and Stocking Practices Review

The overall goal of this voluntary study (TID/MID 2017f, attached to this FLA) was to assess historical and current hatchery stocking practices in the Tuolumne River Basin (and adjacent watersheds) and identify potential interactions between stocking activities and the reintroduction of anadromous salmonids to the reach of the Tuolumne River between the upstream end of the Don Pedro Project and the CCSF's Early Intake. Specific objectives of this study are listed below:

- identify species, source hatcheries and their stocking practices in the area, and time periods of fish that were historically stocked in the Tuolumne River, tributaries to the Tuolumne River, and in Don Pedro Reservoir;
- identify stocking location and seasonal timing of stocking for species currently stocked (and that may be stocked in the future) in the Tuolumne River, tributaries to the Tuolumne River, and in Don Pedro Reservoir;
- identify stocking activities in the San Joaquin River and its other tributaries;
- identify and describe self-sustaining potamodromous populations (species of fish that migrate [upstream or downstream] exclusively in freshwater) originating from previously stocked species, their life history characteristics, and population characteristics, as available;
- identify available information on documented incidents of disease in hatchery stocks and in the Tuolumne River basin;
- describe life histories of stocked species, as well as their spatial and temporal migrations and distributions to identify the potential to interact with reintroduced anadromous salmonids;
- describe potential spatial and temporal overlap of stocked species and lifestages with potentially-reintroduced species and lifestages (i.e., steelhead and spring-run Chinook salmon) in the Tuolumne River; and
- identify potential effects of historical and existing/future hatchery and stocking practices on efforts to reintroduce anadromous salmonids to the Tuolumne River.

A desktop literature review was conducted and includes a review of agency technical memoranda, fish stocking data, fish health information, journal articles, and websites used to identify and describe historical, current, and future hatchery and stocking practices in the Tuolumne River watershed and greater San Joaquin River Basin. Agencies and organizations involved with hatchery and stocking activities were contacted to gather additional information on historical and existing fish stocking activities in the study area, including the Don Pedro Recreation Agency (DPRA) and CDFW.

Because the Tuolumne River is a tributary to the San Joaquin River, individual and population movement and gene flow can occur between Tuolumne River fishes and fish populations in adjacent San Joaquin River tributaries (i.e., Merced River, Stanislaus River, and Mokelumne River). Therefore, a reintroduction program that transports anadromous salmonids returning to the lower Tuolumne River to the upper Tuolumne River should also consider the potential effects of hatchery activities in the lower San Joaquin River and its other tributaries, given their proximity and connectivity to the Tuolumne River.

Formal stocking of fish within the San Joaquin River watershed began in the 1930s by the CDFW. Currently, CDFW operates four hatcheries within the San Joaquin River watershed, including: (1) the San Joaquin Hatchery along the San Joaquin River in the town of Friant; (2) the Merced River Hatchery along the Merced River in the town of Snelling; (3) the Mokelumne River Hatchery along the Mokelumne River in the town of Clements; and (4) the Moccasin Creek Hatchery along Moccasin Creek (a tributary to the upper Tuolumne River) in the town of Moccasin.

Fish species raised at these hatcheries include brook trout (*Salvelinus fontinalis*), Eagle Lake trout (*Oncorhynchus mykiss aquilarum*), golden trout (*Oncorhynchus aguabonita*), kokanee (*Oncorhynchus nerka*), rainbow trout/steelhead (*Oncorhynchus mykiss*), Chinook salmon (*Oncorhynchus tshawytscha*), brown trout (*Salmo trutta*), and Lahontan cutthroat trout (*Oncorhynchus clarkii henshawi*). However, only steelhead and Chinook salmon are released by these hatcheries into the lower San Joaquin, Merced, Mokelumne and Tuolumne rivers.

In addition to the CDFW hatcheries, the San Joaquin River Restoration Program (SJRRP) operates the Interim Salmon Conservation and Research Facility (Interim Facility), located immediately west of the existing San Joaquin Hatchery below Friant Dam on the San Joaquin River. The SJRRP has released juvenile Central Valley spring-run Chinook salmon into the San Joaquin River annually since 2014.

Additional details regarding species raised, production numbers, stocking, and fish health management for these hatcheries are available in the study report (TID/MID 2017f).

In the upper Tuolumne River watershed (i.e., the reach under consideration for reintroduction), CDFW stocks a variety of trout, including rainbow trout and Eagle Lake trout in the North, Middle, and South Forks of the Tuolumne River (CDFW 2016). Specifically, rainbow trout and Eagle Lake trout are stocked at: (1) Hulls Crossing, Jenness Park, and Camp High Sierra in the North Fork; (2) San Jose Camp within Lee’s Resort, a bridge upstream from Lee’s Resort, the Spinning Wheel USFS facility at Sawmill Mt. Road, Diamond O Campground, and a bridge on Evergreen Road in the Middle Fork; and (3) the Highway 120 bridge and the Carlon Day Use area in the South Fork (J. Kroeze, personal communication April 9, 2015).

In response to legislation codified in the Fish and Game Code in 2012, CDFW now raises and stocks sterile (triploid) trout in most areas where native trout occur, including the upper Tuolumne River watershed. Therefore, Moccasin Creek Hatchery currently stocks triploid rainbow trout and triploid brown trout in the upper Tuolumne River watershed.

Fish species in Cherry Creek are dominated by rainbow trout. Sacramento sucker, riffle sculpin, and California roach have been observed during stream surveys in Cherry Creek, particularly near the confluence with the mainstem Tuolumne River where water temperatures are generally warmer (CCSF 2008).

Eleanor Creek, a tributary to Cherry Creek, reportedly supports fishes mostly comprised of non-native brown trout and rainbow trout. Eleanor Creek is not currently stocked, but a hatchery was reportedly historically operated on one of its tributaries (Frog Creek) until the 1950s, and raised rainbow trout sourced from Lake Eleanor. Sacramento sucker, sculpin and roach may be present in Eleanor Creek, and would be expected to occur in greater abundance towards the confluence with Cherry Creek, where water temperatures are generally slightly warmer (CCSF 2008).

The Clavey River is designated by the California Fish and Game Commission as Wild Trout Waters and Heritage Trout Waters, and supports mostly native fish species including rainbow trout, Sacramento sucker, California roach, hardhead and Sacramento pikeminnow. However, non-native brook trout reportedly occur in the headwaters of Clavey Creek due to historical fish stocking in the upper meadows (De Carion et al. 2010). In addition, during 1975 and 1976, more than 100,000 brown trout fingerlings were stocked by California Department of Fish and Game (CDFG, now CDFW) into the Clavey River. Although they reportedly grew faster than the rainbow trout, the brown trout did not establish a self-sustaining population (De Carion et al. 2010).

The North Fork Tuolumne River exhibits different hydrologic and water temperature conditions than the mainstem Tuolumne River and Clavey River due to lower spring flows and higher water temperatures during the spring and summer (De Carion et al. 2010). Smallmouth bass is reportedly the primary biological driver of the fish assemblage of the North Fork Tuolumne River, which preys upon other fishes, invertebrates, amphibians and small mammals. Preliminary snorkel surveys at the confluence of the North Fork and mainstem Tuolumne rivers suggested that smallmouth bass and invasive crayfish, and rainbow trout were the dominant species, while juvenile Sacramento pikeminnow, Sacramento sucker and California roach were present in limited numbers (De Carion et al. 2010).

Don Pedro Reservoir supports a diverse assemblage of native and introduced fishes, primarily centrarchid, catfish, trout and salmon species, which support several popular fisheries. The principal fish species in the reservoir include black bass (i.e., largemouth bass, spotted bass, and smallmouth bass), rainbow trout, brown trout, brook trout, Chinook salmon, kokanee salmon, black crappie (*Pomoxis nigromaculatus*), white crappie (*Pomoxis annularis*), channel catfish (*Ictalurus punctatus*), white catfish (*Ameiurus catus*), green sunfish (*Lepomis cyanellus*), bluegill (*Lepomis macrochirus*), and threadfin shad (*Dorosoma petenese*) (DPRA 2016; TID/MID 2013a; CCSF 2008). Although relatively few were caught during Don Pedro Reservoir fish population surveys in 2012, kokanee was the most abundant coldwater fish species captured, all of which were collected during gillnetting surveys (TID/MID 2013c). Largemouth bass comprised the greatest amount of fish biomass caught during the reservoir fish population surveys (TID/MID 2013c).

The CDFW and DPRA have been releasing hatchery-raised fish into Don Pedro Reservoir since 1953. The DPRA has been stocking Florida-strain largemouth bass, from Willow Creek Fisheries in O'Neals, CA, in the lake on an annual basis since the early 1980s (D. Jigour, personal communication, September 22, 2016; TID/MID 2011). Stocked kokanee salmon originate from the San Joaquin Hatchery. Chinook salmon planted in the 1980s and 90s originated from the Feather River Hatchery, while Chinook salmon stocked in 2001 were sourced from the Nimbus Fish Hatchery, and plantings since 2002 have originated from the Iron Gate Hatchery on the Klamath River (which were subsequently quarantined at the Silverado Fisheries Base near Napa, CA) (Perales et al. 2015). Because Iron Gate Hatchery raises Klamath River fall-run Chinook salmon, it is presumed that Chinook salmon in Don Pedro Reservoir are of Klamath River fall-run origin. Starting in 2014, sterile (triploid) Chinook salmon from the Iron Gate Hatchery/Silverado Fisheries Base have been stocked in Don Pedro Reservoir (Perales et al. 2015). It has previously been reported that both Chinook salmon and kokanee salmon (presumably originating from Don Pedro Reservoir stocking) may naturally reproduce in the upper Tuolumne River above the reservoir – natural reproduction of kokanee salmon was reportedly documented in 1992, and Chinook salmon were believed to have spawned in the upper Tuolumne River during the mid-1990s, when Chinook salmon was not being stocked in the reservoir (CCSF 2008; Bacher 2013). Perales et al. (2015) noted that over two sampling events in 2012, 8 and 2 juvenile Chinook were collected above the reservoir. These collected fish were "silvery bright, which suggests they were smolts moving downstream". The study also notes the stocking of Don Pedro Reservoir between 2007 to 2012 of juvenile Chinook salmon ranging from 90,000 to 100,000 fish annually and concludes by stating that the evidence is limited to observational data and that the only "population" that authors can conclude is maintaining itself is the Folsom Reservoir population (setting it apart from Don Pedro Reservoir which has received constant annual stocking). Of equal interest is the conclusion that most salmon planted in Central Valley reservoirs originate from the Klamath River (Iron Gate Hatchery) which are genetically distinguishable from local salmon populations below reservoirs. The authors state the possibility of behavioral and genetic interactions that may lead to complications in restoration efforts via trap and haul programs and that this phenomenon should be evaluated fully prior to the initiation of such programs.

The Don Pedro Reservoir largemouth bass fishery is one of the most successful warmwater fisheries in California, and supports approximately 45-80 official black bass contests annually based on CDFW black bass fishing contest reports (Murphy 2009, 2010, 2011; Krogman 2012, 2013; Fish 2014, 2015, 2016). Based on data compiled by CDFW on black bass fishing contests from 1985-2016, the reported mean weight per fish caught during fishing tournaments in Don Pedro Reservoir generally gradually increased from 1985 to about 2007. Between 2007 and 2016, the average weight per fish caught has fluctuated between about 1.9 and 2.3 pounds (TID/MID 2017f).

Don Pedro Reservoir fish population surveys conducted by TID and MID (2013a) during 2012 indicate that largemouth bass represented the largest proportion (~32 percent) of the total biomass of fish collected in the reservoir, and included a broad representation of age classes (ages 0-3+). Although fewer were collected, smallmouth bass and spotted bass collected also represented age-0 through age-3 fish. Consistent with the abundances and associated age classes of black bass found in the reservoir, and consistent with bass nesting habitat analyses conducted by TID and MID (2013a), Don Pedro Reservoir provides suitable conditions for successful black bass nesting and growth.

The potential for hybridization (and associated genetic effects), competition, or predation between stocked fish species and introduced anadromous salmonids would depend on the spatial and temporal overlap in distributions of particular lifestages. Potential overlap in spatial and temporal distributions were identified to address potential interactions associated with: (1) competition during the spawning and juvenile rearing lifestages of reintroduced salmonids; (2) hybridization during the spawning lifestages of reintroduced salmonids; and (3) predation (i.e., predation of reintroduced salmonids) during the juvenile rearing and emigration lifestages of reintroduced salmonids. Although not specific to one geographic area, a reintroduction effort may also increase the potential for incidence of disease transmission between resident, stocked and reintroduced anadromous salmonids

Due to similar spawning habitat preferences and overlapping temporal distributions, reintroduced spring-run Chinook salmon may need to compete for spawning habitat with brown trout, brook trout, and potamodromous kokanee and Chinook salmon. In addition, reintroduced steelhead may need to compete for spawning habitat with resident rainbow trout, and to a lesser extent, brown trout, brook trout, kokanee and smallmouth bass. Competition for spawning habitat may result in reintroduced Chinook salmon and steelhead utilizing less suitable spawning areas and/or may result in increased potential for redd superimposition among individuals, potentially resulting in relatively lower survival of embryos and subsequent year-class abundance.

In addition to the potential for competition for spawning habitat, intraspecific hybridization may occur between reintroduced and potamodromous Chinook salmon, and between reintroduced steelhead and resident rainbow trout. Hybridization of different strains of rainbow trout or Chinook salmon can have unanticipated genetic effects on hybrid progeny and subsequent effects to the resident and introduced populations. Generally, hybridization can result in the loss of unique genetic composition of the parental taxa, outbreeding depression (i.e., relative reduction in fitness of hybrid), gametic wastage, or a combination of these (Allendorf et al. 2001). Intraspecific hybridization specifically can be harmful to locally adapted populations due to the potential loss of local adaptations.

There is substantial overlap in temporal distributions of reintroduced juvenile salmonids and juveniles of stocked fish species, particularly between year-round rearing reintroduced spring-run Chinook salmon and steelhead and year-round rearing brown trout, brook trout, rainbow trout, and smallmouth bass.

Juveniles of reintroduced species are expected to be susceptible to predation by resident stocked fishes in the upper Tuolumne River watershed, particularly brown trout and smallmouth bass in the upper Tuolumne River, and largemouth bass and smallmouth bass in Don Pedro Reservoir.

Predation of juvenile salmon by introduced black bass is considered to be a primary factor limiting survival of juvenile Chinook salmon in the lower Tuolumne River.

During 2012, TID and MID (2013b) conducted studies on predation of juvenile Chinook salmon and predatory fish species in the lower Tuolumne River, including estimating abundances of predatory fish species, estimating predation rates of juvenile Chinook salmon, and tracking movements of predatory fish species in relation to juvenile Chinook salmon. The abundance of largemouth bass (>150 mm FL) in the lower Tuolumne River from RM 0 to RM 39.4 was estimated to be 3,796 to 5,843, depending on the method used to expand abundances from sampled areas to non-sampled areas. Largemouth bass were found to occur downstream of RM

34.8, while smallmouth bass (>150 mm FL) were captured throughout the study reach (RM 3.7 to RM 38.4), and striped bass (>150 mm FL) were found throughout most of the study reach (RM 3.7 to RM 35.0).

The estimated number of juvenile Chinook salmon potentially consumed during March 1 – May 31 of 2012 was 15,495 from largemouth bass, 20,501 from smallmouth bass, and 6,193 from striped bass. Based on estimated losses of juvenile Chinook salmon between rotary screw traps in the Tuolumne River during 2007-2011 (74-98 percent), the estimated number of juvenile Chinook salmon estimated to have been lost ranged from 47,000 to 270,000. If the predation rates and predator abundances during 2007-2011 were similar to those documented in the 2012 study, the authors determined that it is plausible that the majority of juvenile Chinook salmon mortality in the Tuolumne River during most years is due to predation (TID/MID 2013b).

In addition to ecological interactions between reintroduced species and existing stocked species, stocked species of salmonids can carry and transmit many of the same diseases (e.g., PKD, whirling disease) that salmonids considered to be introduced into the upper watershed could potentially carry and transmit. Disease outbreaks can be more common under hatchery conditions than in natural settings. Any disease outbreak in the upper Tuolumne River watershed could limit the success of both existing populations and reintroduced populations. In addition, the transport of salmonids from below La Grange Diversion Dam to the upper Tuolumne River would effectively connect the upper Tuolumne River Watershed not only to the lower Tuolumne River, but also to the San Joaquin River system and all of its tributaries.

Upper Tuolumne River Hydrology and the Effects of Peaking Operations

The upper Tuolumne River and its principal tributaries all exhibit a seasonal rainfall and snowmelt hydrograph typical of a Mediterranean climate, where summers are typically warm and dry, and winters cool and wet. Winter rainfall that takes place below the snowline is prone to runoff, increasing stream flows. Winter precipitation that falls as snow typically runs off in the spring and early summer, in response to seasonal meteorological conditions. Flows subsequently diminish through the drier summer and fall months. The flow regime in certain stream reaches of the study area is regulated by reservoirs.

The Tuolumne River and Cherry Creek are both regulated streams and thus have modified flow regimes in response to hydropower, storage and water management operations. An example of Cherry Creek flows below Cherry Valley Dam, contributions from Eleanor Creek, and flows below Holm Powerhouse are shown in Figure 3.5-20 for 2010. Releases to the upper section of Cherry Creek (above Holm Powerhouse) from Cherry Valley Dam are typically below 20 cfs unless associated with high flow conditions and reservoir spill or storage management operations. Releases from Eleanor Dam are likewise small except during spill; in 2010, for example, maximum release was less than 10 cfs. Releases to the lower section of Cherry Creek from Holm Powerhouse due to hydropower and other water management operations dominate the flow regime at the mouth of Cherry Creek.

The mainstem Tuolumne River exhibits a similar hydrograph as Hetch Hetchy Reservoir captures winter rainfall flow events and spring and summer snowmelt runoff for storage during drier periods of the year. Examining flows for a typical summer week at the Tuolumne River below Early Intake, Cherry Creek below Holm Powerhouse, and Tuolumne River near Wards Ferry illustrates how relatively low, stable flows at Early Intake are overshadowed by the signature of dynamic hydroelectric peaking operations from Holm Powerhouse, and that these conditions persist some 26 miles downstream to Wards Ferry (Figure 3.5-21). Travel time, peak attenuation, and the contribution of other tributaries are all apparent in this figure.

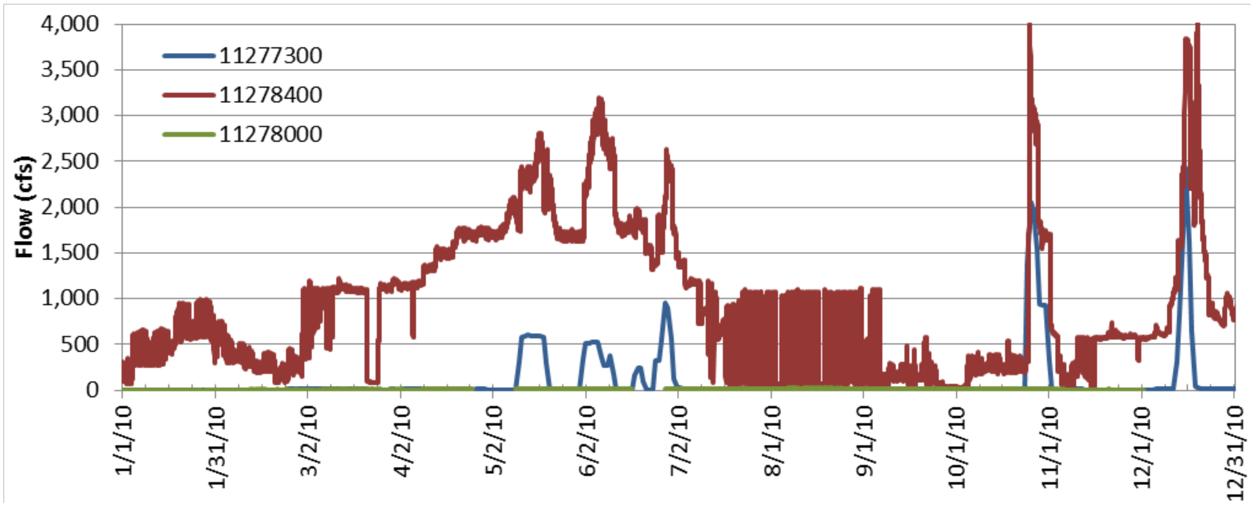

Figure 3.5-20. Cherry Creek flow below Cherry Valley Dam (USGS Gage 11277300) and below Holm Powerhouse (USGS Gage 11278400), and Eleanor Creek flow below Eleanor Dam (USGS Gage 11278000), 2010.

Due to hydropower peaking operations at Holm Powerhouse, hourly flows in the Tuolumne River upstream of Don Pedro Reservoir can vary greatly. Data summarized in Tables 3.5-21 through 3.5-23, characterize how flows may vary within a single day in the Tuolumne River downstream of the Clavey River confluence during Critical, Below Normal, and Above Normal water years[24]. Depending upon water year type and time of year, the magnitude of within-day fluctuations within the upper Tuolumne River may vary widely. The 95th percentile of observed within day fluctuations across all water year types and months range from a low of 478 cfs (October of Critical water year) to 2,562 cfs (May of Above Normal water year).

[24] California Department of Water Resources CDEC Historical Water Year Hydrologic Classification Indices.

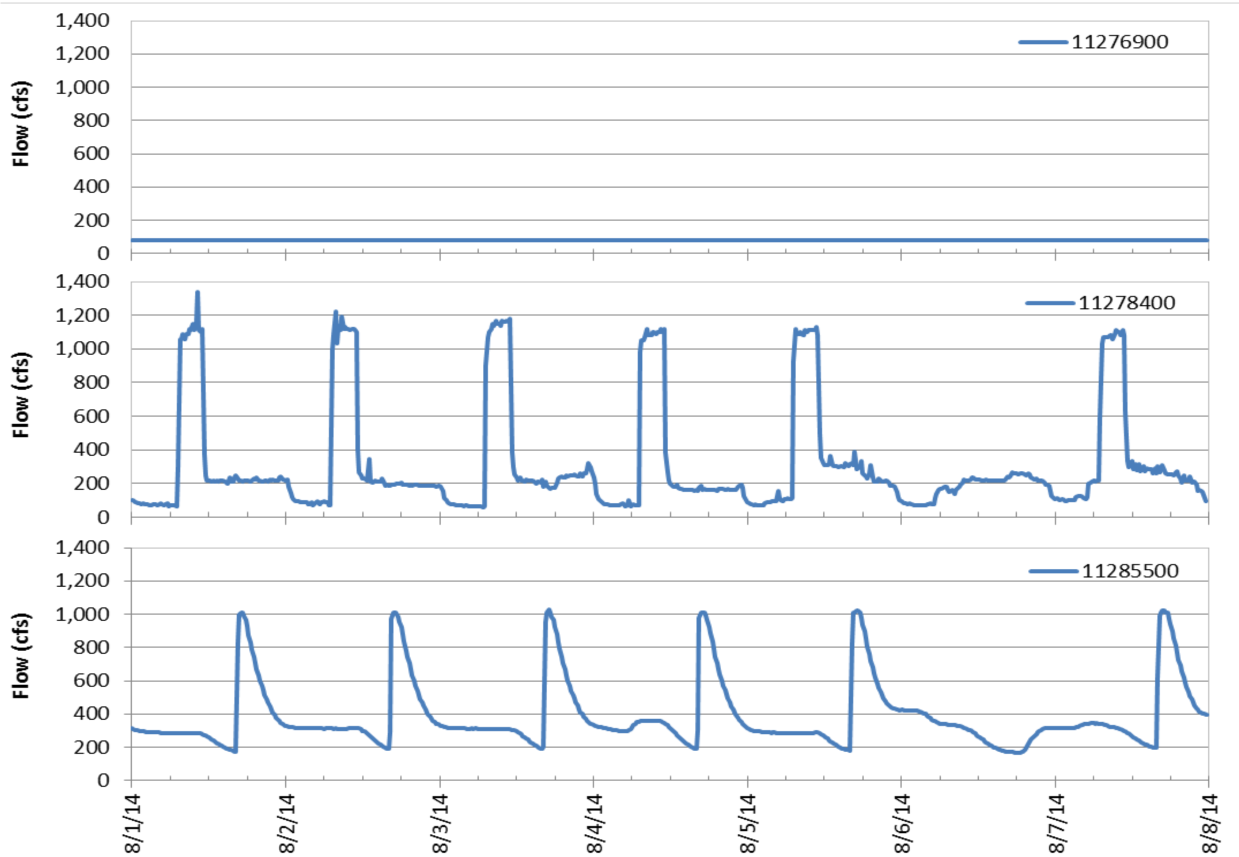

Figure 3.5-21. Flow in the Tuolumne River below Early Intake (USGS Gage 11276900) – top; Cherry Creek below Holm Powerhouse (USGS Gage 11278400) – middle; and Tuolumne River near Wards Ferry (USGS Gage 11285500) – bottom; August 1-8, 2014.

Table 3.5-21. Within-day flow fluctuation (cfs) in Critical water years, by month, in the Tuolumne River below Clavey River confluence.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum	0	0	7	19	9	6	2	2	1	0	0	0
Percentile (5th)	1	1	39	55	28	38	397	286	49	3	1	4
Median	135	218	223	517	620	794	798	688	377	184	134	157
Percentile (95th)	721	736	783	1,033	1,021	1,209	1,142	1,071	805	478	582	746
Maximum	5,142	1,549	1,110	2,122	1,058	1,285	1,209	1,366	1,109	1,074	1,211	3,822

Table 3.5-22. Within-day flow fluctuation (cfs) in Below Normal water years, by month, in the Tuolumne River below Clavey River confluence.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum	0	3	8	8	7	2	5	3	1	0	1	0
Percentile (5th)	4	110	34	55	23	18	48	10	2	3	14	11
Median	337	451	545	513	354	651	984	818	269	223	260	283

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Percentile (95th)	1,245	756	964	950	1,163	1,293	1,021	1,016	619	638	826	796
Maximum	6,105	906	2,064	2,410	6,101	2,576	1,249	1,066	1,032	1,207	2,009	1,998

Table 3.5-23. Within-day flow fluctuation (cfs) in Above Normal water years, by month, in the Tuolumne River below Clavey River confluence.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum	0	14	9	14	8	35	7	2	1	0	0	0
Percentile (5th)	35	36	36	45	74	129	63	50	6	2	1	2
Median	319	331	196	218	420	684	816	923	411	180	136	231
Percentile (95th)	1,162	1,243	1,364	1,002	2,562	2,341	1,599	1,152	977	688	828	1,320
Maximum	14,307	5,571	12,910	5,774	20,390	5,789	6,934	1,365	1,160	4,095	1,975	23,764

This hydraulic variability is further illustrated in three select water years: 2008, 2009 and 2013 in Figures 3.5-22, 3.5-23, and 3.5-24, respectively. Data illustrated in each year shows how flows downstream of Holm Powerhouse can fluctuate from approximately 150 or 200 cfs up to 1,000 or 1,200 cfs on a daily basis, especially during the late summer months.

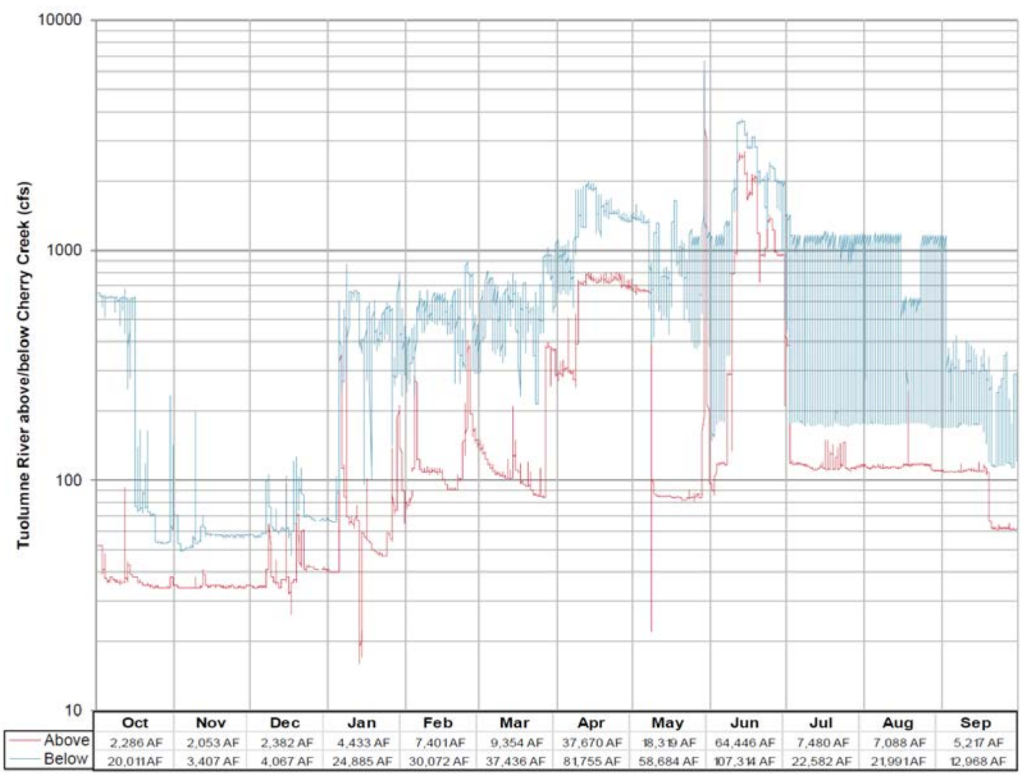

Figure 3.5-22. Tuolumne River Flow above/below Cherry Creek for Water Year 2008.

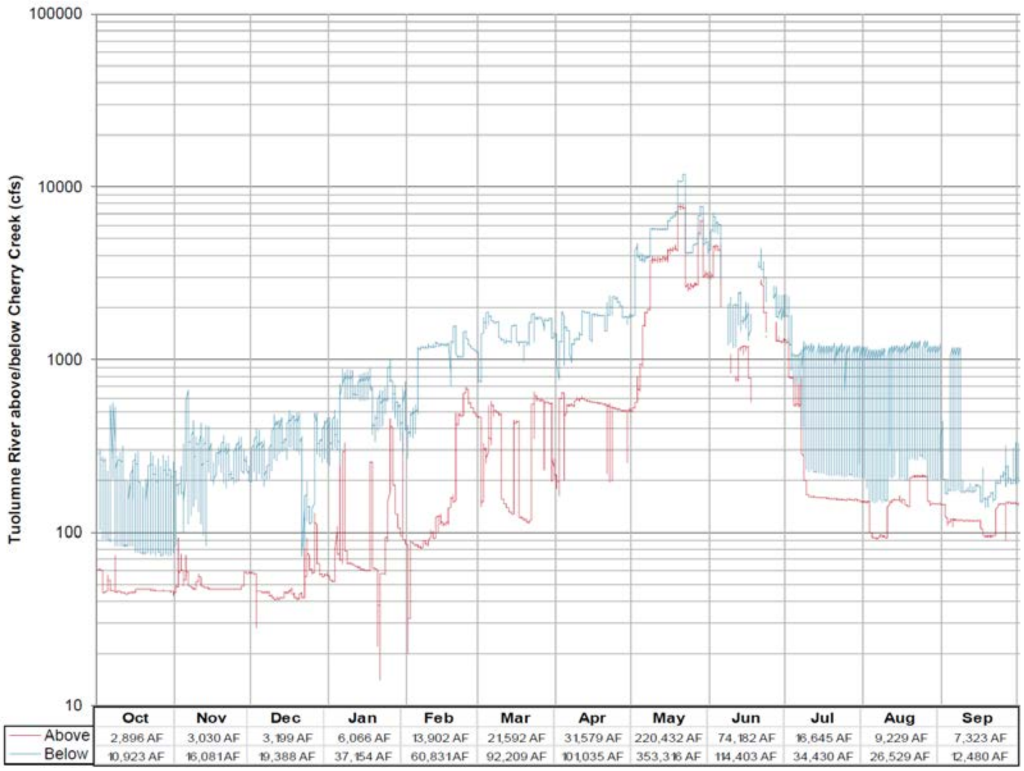

Figure 3.5-23. Tuolumne River Flow above/below Cherry Creek for Water Year 2009.

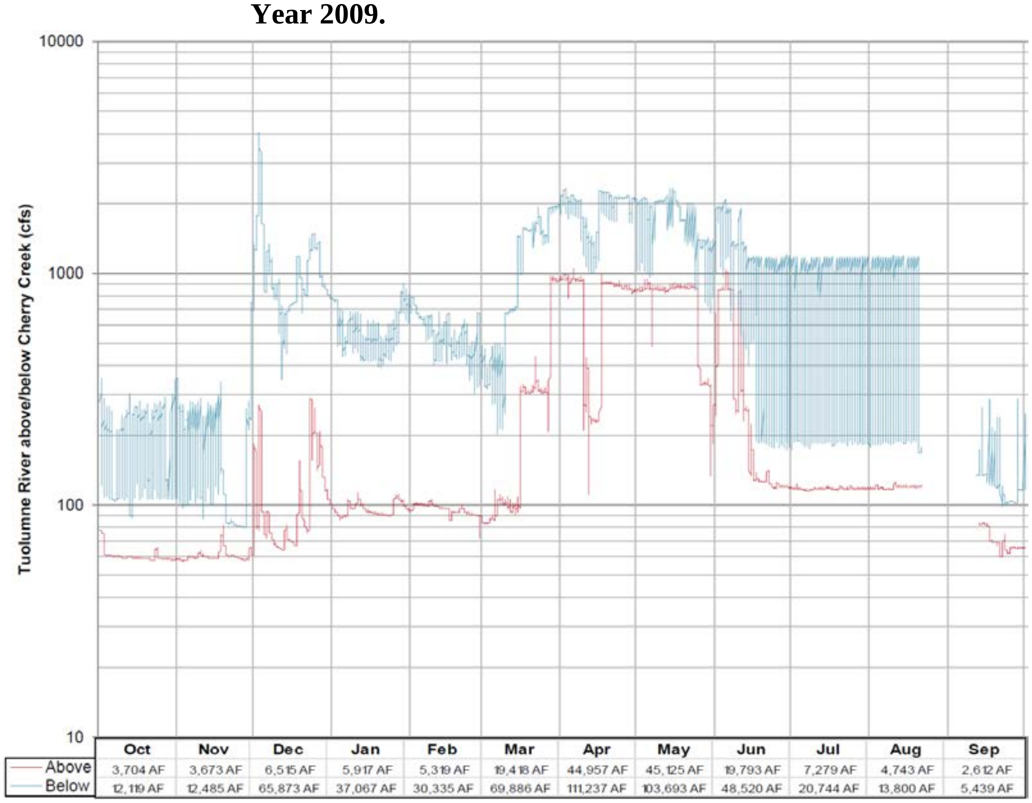

Figure 3.5-24. Tuolumne River Flow above/below Cherry Creek for Water Year 2013.

Hydropower peaking flows (outside of spring runoff) in the upper Tuolumne River vary in a somewhat seasonal pattern generally staying in the range of 500 (one unit peaking operation) to 1,100 cfs (two unit peaking operation).

Based on physical descriptions (RMC and McBain & Trush 2007) the general hydraulic response to hydropower peaking releases in this river reach is predictably rapid due to the high gradient and narrow confinement of the channel. At the onset of peaking flows, stage and velocity increase is rapid and water velocity increases are proportionally greater than stage in response to the steep gradient and confinement of the channel. Similarly at the end of peaking flows, stage and velocity drop rapidly and the channel drains down to base flow conditions rapidly due to channel gradient and lack of significant pool and bank water storage. The lack of up or down ramping rate reduction measures in this reach is exacerbated by the channel hydraulics and results in rapid changes between base and peak flow conditions. The general lack of alluvial sediment (cobble, gravel, and sand) in the upper reach (RM 91 to 104) is direct evidence of the high velocity scour in the channel under high flows combined with a lack of alluvial sediment recruitment due to upstream dams (RMC and McBain & Trush 2007).

Aquatic resource managers and scientists have frequently evaluated the effects of hydropeaking flows on fish and their riverine habitats. Numerous literature reviews summarizing the body of information on the effects of peaking flows on aquatic biota and habitat have been prepared (e.g., Cushman 1985; Hunter 1992; Annear et al. 2004; Reiser et al. 2005; Clarke et al. 2008). The impacts of peaking flows on fish and aquatic habitat are often broken down into direct and indirect effects.

Direct effects potentially include:

- Fish mortality from stranding, trapping, and dewatering of juvenile life stages
- Dewatering of redds/spawning habitats resulting in egg desiccation and mortality
- Disruption or prevention of spawning through habitat alterations or restricted access
- Flushing and dislodging of eggs and fry

Indirect effects potentially include:

- Bioenergetic losses in juvenile and adult fish seeking to maintain preferred habitat
- Food chain disruption
- Dewatering and mortality of benthic macroinvertebrates
- Interference with fish migrations and stream connectivity
- Habitat loss and alteration of geomorphology process
- Increased vulnerability of fish to predation
- Altered water quality (temperature, dissolved oxygen)

To protect against these potential direct and indirect effects, resource management agencies often have required substantial studies be undertaken to determine site-specific implications of hydropeaking operations. Following these studies, resource agencies frequently, require significant upramping and downramping restrictions on hydropeaking operations. Hunter (1992) reported that downramping rates exceeding 2 inches/hour are known to cause stranding of salmonids and macroinvertebrates. To mitigate adverse effects caused by juvenile fish stranding, temporary loss of habitat for fish and other aquatic biota, and redd dewatering, downramping rates at projects have ranged from 1-2 inches/hour (Baker Hydroelectric Project) to 6 inches/hour (Jackson Hydroelectric Project) .

Upramping limits have also been identified at some projects where anadromous fish are present, such as 18 inches/hour at the Lewis River Hydroelectric Project in Washington. Downramping frequency limitations restricting the amount of time downramping is allowed over a period of time (e.g., over a three month period) and when downramping rates are allowed to be exceeded (e.g., greater than 1 inch/hour) are also common.

As noted above, the hourly flow fluctuations observed in the upper Tuolumne River can vary widely with peak to base flow ratios varying up to 12:1 (RMC and McBain & Trush 2007). Flow changes of this magnitude and frequency can occur throughout the year and may overlap with spawning and rearing life stage periodicities of species that are being considered for reintroduction. Pressure transducer (level logger) information at three locations in the mainstem Tuolumne River downstream of Lumsden Falls were collected over five- to six-day periods in late summer 2016 (Table 3.5-24). The information indicates that on a daily basis, hourly stage increases ranged from 11 to 28 inches per hour and hourly stage decreases ranged from 5 to 10 inches per hour at these sites, far exceeding agency prescriptions at other projects.

Table 3.5-24. Level logger summary data at the Tin Can Cabin, Wheelbarrow, and Mohican locations on the upper Tuolumne River from late August/early September 2016.

Tin Can Cabin (approximately RM 93.5)		8/30/2016	8/31/2016	9/1/2016	9/2/2016	9/3/2016	9/4/2016
Primary Logger	Maximum Daily Stage Change (in)	--*	20.73	20.00	20.43	20.79	--*
	Maximum Hourly Stage Increase (in)	--*	16.87	16.26	17.66	18.37	--*
	Maximum Hourly Stage Decrease (in)	--*	-8.58	-8.35	-8.51	-8.96	--*
Secondary Logger	Maximum Daily Stage Change (in)	21.93	23.78	22.83	23.53	24.07	24.09
	Maximum Hourly Stage Increase (in)	20.28	19.88	19.53	20.84	21.63	23.33
	Maximum Hourly Stage Decrease (in)	-10.28	-9.91	-9.52	-9.53	-10.24	-10.11
Wheelbarrow (approximately RM 87.3)		**8/16/2016**	**8/17/2016**	**8/18/2016**	**8/19/2016**	**8/20/2016**	**--***
Primary Logger	Maximum Daily Stage Change (in)	16.28	15.96	14.90	16.33	17.77	--*
	Maximum Hourly Stage Increase (in)	14.12	11.60	11.20	13.85	15.41	--*

Tin Can Cabin (approximately RM 93.5)		8/30/2016	8/31/2016	9/1/2016	9/2/2016	9/3/2016	9/4/2016
	Maximum Hourly Stage Decrease (in)	-5.54	-5.67	-5.56	-5.46	-5.91	--*
Secondary Logger	Maximum Daily Stage Change (in)	25.48	25.08	23.43	25.52	27.72	--*
	Maximum Hourly Stage Increase (in)	22.37	18.36	17.89	22.01	24.43	--*
	Maximum Hourly Stage Decrease (in)	-8.37	-8.62	-8.44	-8.31	-8.77	--*
Mohican (approximately RM 82.0)		**8/30/2016**	**8/31/2016**	**9/1/2016**	**9/2/2016**	**9/3/2016**	**9/4/2016**
Primary Logger	Maximum Daily Stage Change (in)	28.74	28.82	27.80	28.62	28.50	29.13
	Maximum Hourly Stage Increase (in)	26.81	27.40	26.46	27.56	27.72	28.50
	Maximum Hourly Stage Decrease (in)	-7.40	-7.52	-7.17	-7.01	-7.28	-7.28
Secondary Logger	Maximum Daily Stage Change (in)	28.66	29.09	27.87	28.46	28.39	29.25
	Maximum Hourly Stage Increase (in)	26.54	26.85	26.18	28.11	27.64	28.15
	Maximum Hourly Stage Decrease (in)	-7.87	-7.56	-7.64	-7.80	-7.87	-8.11

* Level logger was yet to be installed prior to peaking or was removed before peaking.

Hydrology information associated with the stage data reported in the table above reflect peaking operations going from no generation base flows (150-200 cfs) to maximum generation using two unit operations (approximately 1,200-1,300 cfs) and then to a decrease in generation to a single unit operation (500-600 cfs). As such, this empirical data may not represent the full range of possible stage change rates at these sites (i.e., maximum generation to no generation flows). Peaking events with daily hydraulic variability from maximum generation to base flows do occur with some frequency. By example, on June 30, 2014 flows decreased rapidly from 1,300 cfs to 150 cfs (Figure 3.5-25). At the Cherry Creek location nearest to Holm Powerhouse, stage decreases reflective of this change in operations are greater than 30 inches per hour. At the Ward’s Ferry location, approximately 24 miles downstream, observed decreases in stage are approximately 4.5 to 5 inches per hour. At the Tin Can Cabin location (RM 93.5, approximately 13 miles upstream of Ward’s Ferry), estimated stage change during the downramp period is approximately 16 inches per hour.

The extent to which fluctuations of this magnitude and frequency may adversely impact spring-run Chinook or steelhead are unknown, but certainly must be examined before attempting reintroduction.

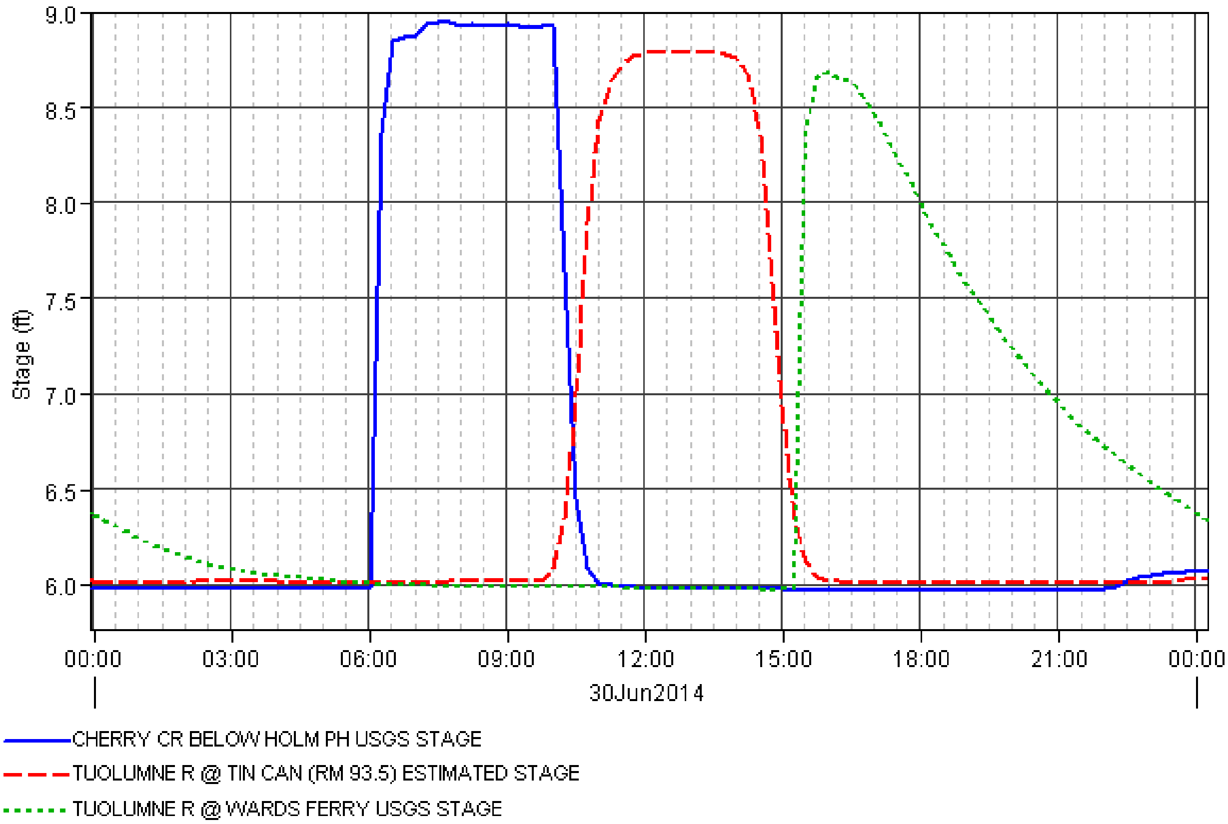

Figure 3.5-25. USGS stage data at Cherry Creek below Holm Powerhouse and at Ward's Ferry and estimated stage information from Tin Can Cabin (RM 93.5) indicative of a 1,300 to 150 cfs decrease in flows observed on June 30, 2014.

Upper Tuolumne River Restoration Feasibility Conclusion

Many variables influence the potential for success of a fish restoration/reintroduction program. This is especially the case for the upper Tuolumne River for reasons generally discussed and presented above. Reach accessibility, physical spawning and rearing habitat availability and suitability, gravel quality, thermal suitability for the target species, effects to the source population, and interaction with resident fish populations are just some of the significant factors which may affect viability.

Much of the riverine habitat (whether suitable or not) in the upper Tuolumne River basin would be inaccessible to anadromous fish due to natural barriers to upstream migration. The Migration Barriers Study (TID/MID 2017l) found that due to the existence of partial and total barriers along the mainstem of the upper Tuolumne River and its major tributaries, anadromous fish access in this reach is limited to a very small portion of the entire watershed, and the accessible reach is at low elevations, from 830 ft to approximately 1,550 ft at Lumsden Falls, which is a significant partial barrier that is likely to have a significant influence on the frequency of access and the proportion of a fish population that can pass this feature. Total and partial barriers in tributaries indicate that only the lower two river miles would be available but in some years, flows might limit access to even less of these tributary reaches[25].

As such, approximately 17 miles below Lumsden Falls are likely to be consistently accessible to anadromous fish (TID/MID 2017l). The mainstem habitat that is available to fish is subject to significant hourly flow fluctuations with peak flows that are often 10 to 12 times higher than base flows. These hourly flow fluctuations can occur throughout the year but are most apparent during the late summer and fall months, which correspond to critical spawning, incubation, and early rearing phases of the species targeted for reintroduction. Examples of the potential effects of peaking include spawning disruption and prevention; redd dewatering, egg desiccation and mortality; fry and juvenile stranding and trapping; increased vulnerability to predation; and bioenergetics impacts. The direct and indirect impacts of hydropeaking operations on fish populations is frequently raised as a concern by resource agencies l and often considered as a significant limiting factor in the sustainability of any fish population (Cushman 1985; Hunter 1992; Annear et al. 2004; Reiser et al. 2005; Clarke et al 2008). Temperature modeling of the mainstem upper Tuolumne River indicates that habitat may not be thermally suitable for spring-run Chinook adult holding and spawning, embryo incubation, and fry and juvenile rearing and for steelhead embryo incubation and emergence on a consistent basis. Also it is noteworthy that WTI values developed collaboratively through the Assessment Framework and utilized for assessing thermal suitability conditions for spring-run Chinook and steelhead are less conservative (i.e., are higher) than the EPA (2003) water temperature benchmarks being applied to the lower Tuolumne River[26].

Other factors, such as competition with resident fish, predation, and food availability within this 17 mile river reach would also influence the productivity of any reintroduced stocks. Hatchery stocking of native and non-native species have occurred in Don Pedro Reservoir and the upper Tuolumne River since the early 1950s and continue to occur today. Don Pedro Reservoir is considered one of the most successful warmwater fisheries in California and supports numerous official black bass contests annually (Murphy 2009, 2010, 2011). Black bass are known to be a significant predator on juvenile salmon (TID/MID 2013b). In addition to predation concerns, stocked species are likely to compete with reintroduced species for spawning and rearing habitat and food resources. Additional threats to population viability are hybridization and genetic effects (i.e., introgression) as well as the transmission of diseases between stocked and reintroduced species. Risks associated with genetics and disease as well as ecological interactions with the existing fish community have not been quantitatively assessed as part of reintroduction feasibility and remain a significant information gap.

Fish that are able to grow to smolts and migrate downstream may be required to navigate Don Pedro Reservoir or a portion of the reservoir which, as discussed in the Fish Passage Facilities Alternatives Assessment, is a physically, hydraulically and thermally complex reservoir with a

[25] This field-based finding of reach accessibility, the first definitive study of barriers on the upper Tuolumne River, is contrary to conclusions based upon anecdotal information or desktop analysis from other available literature on the hypothesized amounts of "habitat" available to anadromous fish above Don Pedro Reservoir (Lindley et al. 2006; Yoshiyama et al. 1996, 2001).

[26] Note that in the Tuolumne River below the La Grange Diversion Dam, EPA (2003) temperature benchmarks were applied as indices of temperature suitability for fall-run Chinook and *O. mykiss*. The EPA (2003) temperature benchmarks are significantly lower than the WTI values collaboratively established in the Assessment Framework.

large predator population. Most all of the salmon passage programs in the Pacific Northwest have smaller and less physically complex reservoirs with more favorable thermal and hydraulic conditions yet still have identified safe, timely, and effective reservoir transit and survival as a limiting factor to meeting their program's performance requirements. Additionally, the Fish Passage Facilities Alternatives Assessment results indicate that a technically feasible downstream collection technology does not currently exist since available downstream surface collection technologies would fail to meet agency mandated performance standards that are currently in place for existing fish passage programs. All of these aspects of biological uncertainty and risk of achieving success must also be considered in the face of the very high cost of what would likely be an experiment in fish passage at a capital cost of $115 million dollars.

Even beyond all of these factors dealing with the upper Tuolumne River, another significant limiting factor to upper river population viability is outmigration survival once the target juvenile fish are below La Grange Diversion Dam. Current levels of survival in the lower Tuolumne River, the San Joaquin River, Delta, Bay, ocean, and adult escapement back to the LGDD are unlikely to support a viable population. Studies on the lower Tuolumne River have documented high rates of mortality to fall-run Chinook salmon smolts (TID/MID 2013b) and other studies of survival on the San Joaquin River, the Sacramento River and Delta have also documented significant losses of juvenile salmon (TID/MID 2017b,; SJRGA 2013; Hendrix et al. 2017).

An evaluation of the available information indicates that the goal of establishing a successful upper Tuolumne River salmon or steelhead reintroduction program (*i.e., Contribute to the recovery of ESA listed salmonids in the Central Valley by establishing viable populations in the Tuolumne River at fair and reasonable cost.*) is not achievable. The limiting factors are numerous, complex and broader than just the upper Tuolumne River in geographic scope, and all of these have yet to be investigated.

As public utilities responsible to their public ratepayers, the Boards of Directors' of TID and MID are required to make financial decisions guided by prudency; that is, to justify the expenditure of ratepayer monies, a project must be expected to accomplish the desired result at the lowest reasonable cost consistent with reliability, safety and performance. In consideration of the factors evaluated above, the implementation of a reintroduction program would be a high risk action (i.e., high cost with low probability of success) and would not be prudent. Undertaking high cost, experimental activities with uncertain outcomes is generally considered imprudent. Based upon the conclusion that safe, timely and effective fish passage at the La Grange and Don Pedro projects is technically infeasible and an upper Tuolumne River reintroduction program has a high cost and low likelihood of meeting the stated goal, the Districts have determined that the remaining voluntary studies do not require completion at this time.

3.5.5 Potential Aquatic Resource Effects

FERC's SD2 (pages 19 and 20) identifies the following issues related to aquatic resources:

- Effects of Project O&M on fish populations in the Project reservoir and the Project-affected stream reach.
- Effects of retention of sediment in the Project reservoir on downstream fish spawning habitat and benthic macroinvertebrate populations.
- Effects of Project-related changes in the recruitment and movement of large woody debris on aquatic resources and their habitat.
- Effects of Project operations on stranding or displacement of fish.
- Effects of the Project on upstream and downstream migration of anadromous fish.
- Effects of entrainment at the Project dam and intake on fish populations.

The Project operates in a run-of-river mode diverting flows from the Don Pedro Project for water supply purposes or safely passing it downstream, without affecting the rate of flows by use of storage. Streamflows diverted for water supply purposes affect the quantity of water passing downstream and are depicted in the Water Resources Section 3.4, Table 3.4-4, above. Hydropower generation at TID's powerhouse safely passes a portion of the flows not diverted for water supply purposes. Absent hydropower generation, the same quantity of flow would be passed downstream by other means, most likely continuing to be passed at the powerhouse structure through PRVs installed to replace the existing turbines, or by use of the existing sluice gates in the TID forebay. Therefore, absent hydropower generation, the approximate quantity, timing, distribution and discharge location of downstream flows would not change. Absent hydropower generation, the LGDD would continue to divert the Districts' water supplies and pass downstream flows not needed for water supplies. These independent actions contribute to cumulative effects in the Tuolumne and San Joaquin river basins but hydropower operations do not.

Continuing Project O&M activities would have no adverse effects on the following:

- Fish populations in the La Grange headpond (i.e., Project reservoir);
- Retention of sediment in the Project reservoir on downstream fish spawning habitat and benthic macroinvertebrate populations;
- Recruitment and movement of large woody debris on aquatic resources and their habitat.
- Upstream and downstream migration of anadromous fish.

Potential adverse effects due to the issues identified above would be due to the presence of the LGDD and associated O&M of its primary purpose for irrigation and M&I uses in addition to other past, present, and reasonably foreseeable future actions (i.e., cumulative effects). Even with continuing hydroelectric project operations under an original license, there would be no adverse effects to the above identified issues. The Project is and will continue to be operated as a run-of-river project and existing information indicates the headpond fish community is healthy and reproducing. Sediment retention and the lack of large woody debris recruitment into the Project area is primarily an effect of the upstream Don Pedro Project and other Hetch Hetchy system dams. Available information indicates that downstream fish passage technology is infeasible and recovery goals for anadromous fish above the La Grange and Don Pedro projects into the upper Tuolumne River are not achievable. The above items are discussed in more detail in the Cumulative Effects section below.

FERC's SD2 identifies as a potential issue the effects of Project operations on stranding or displacement of fish. Daily observations of fish presence reveal that the tailrace channel supports a variety of fish species, native and non-native and resident and migratory. Migratory fall-run Chinook salmon, which are primarily hatchery strays from other Central Valley river systems, are present in the tailrace channel from October to December, as are striped bass, a non-native predatory gamefish. Other species present in the tailrace include resident *O. mykiss*, Sacramento pikeminnow, and Sacramento sucker. Powerhouse flows in the tailrace can be disrupted During La Grange powerhouse outages (planned or unplanned). During a powerhouse outage, flow is immediately diverted to the TID sluice gate channel in order to remain in compliance with minimum flows required by the Don Pedro Project FERC license. The TID sluice gate channel has a constant flow of approximately 5 to 10 cfs to allow sufficient egress back to the tailrace channel for any fish that enter the TID sluice gate channel. During outages, diverted powerhouse flows through the TID sluice gate channel may create attraction flows for fish present in the tailrace channel. Fish present in the tailrace channel may also enter the TID sluice gate channel during the base flow of 5 to 10 cfs. The Fish Presence and Stranding Study (TID/MID 2017e) found that during powerhouse outages, fall-run Chinook salmon entered the TID sluice gate channel. Over two years of study, observations indicated that constant TID sluice gate channel flows allowed fall-run Chinook sufficient egress to exit the channel as the powerhouse came back online and sluice gate channel flows receded to the base flow of 5 to 10 cfs. HEC-RAS unsteady flow model runs developed as part of the Topographic Survey also confirm sufficient connectivity throughout the sluice gate and tailrace channels during flow changes (TID/MID 2017k). During the 2-year study, however, several fall-run Chinook were relocated by biologists to the tailrace channel (in consultation with CDFW) and a single female Chinook was found stranded outside of the channel indicating that Project operations may have a minor adverse effects due to stranding fish in the sluice gate channel once powerhouse operations resume after an outage event.

Under non-spill conditions, flows to the Tuolumne River mainstem are provided by discharges delivered through MID's tainter gates and Hillside gates to the plunge pool below LGDD. Historically, a discretionary flow of 5 to 10 cfs has been maintained and this is proposed to continue to be provided under a FERC license in support of maintaining the existing water quality and flow regime in the Tuolumne River main channel. Flows are also able to be delivered to the plunge pool below LGDD through the Districts' Portal Gate No. 1 when the MID Hillside gates require maintenance.

Another potential adverse effect of the Proposed Action investigated during the licensing process is the dewatering of fall-run Chinook salmon redds in the tailrace channel in the event of an unscheduled powerhouse outage. Under current operations, upon the occurrence of an unscheduled outage, operators located in the Control Center immediately open the sluice gate(s) which are located in the TID forebay and flows move rapidly down the steep sluice gate channel to the tailrace. The amount of time it takes for TID sluice gate channel flows to manifest in the tailrace channel has a direct influence on flows and water surface elevations in the tailrace channel. Fall-run Chinook salmon redds have been observed in the tailrace channel and may be at risk of being dewatered during powerhouse outages. Level logger data collected at the single redd observed during the 2015 spawning season was subject to a number of powerhouse outage events. Based on water level data recorded at 15-minute intervals, the maximum elevation reduction was 0.57 feet. The single redd observed in the tailrace channel was not dewatered during the monitoring period (TID/MID 2017k), as the depth of the redd was always inundated at least 1 ft deeper than tailrace water surface elevations. These data indicate that operations of the La Grange powerhouse and the sluice gates are well synchronized when the powerhouse trips offline resulting in a rapid response to a flow disruption and no adverse effects to fish using the tailrace channel. Therefore, the Proposed Action would not have an adverse effect to fish or to fish spawning in the tailrace

Although not explicitly identified by FERC's SD2, a potential effect of the Proposed Action is injury or mortality to fish that may enter the La Grange powerhouse draft tubes while in operation. Results of the Investigation of Fish Attraction to La Grange Powerhouse Draft Tubes (TID/MID 2017g) suggested that although adult fall-run Chinook, *O. mykiss* and other species may be in the general vicinity of the powerhouse and draft tube entrances, there is an extremely low risk of fish entering the powerhouse's conical draft tubes and leaping or swimming vertically up into the turbine runners (both units are vertically oriented Francis units with conical, straight-drop draft tubes). The low steel of the turbine runner is significantly above tailwater elevation during normal operation. These results were also corroborated in the field where daily fish observation surveys in the tailrace channel were being implemented (Fish Presence and Stranding Assessment [TID/MID 2017e]) throughout the study period and reported no observations of injuries or mortalities of adult fish that would have indicated evidence of fish being struck by turbine blades (TID/MID 2017g). Furthermore, the powerhouse (during start up and while in operation) creates noise and turbulence that is likely to deter fish from attempting to enter unit draft tubes. The evidence demonstrates that the Proposed Action would not adversely affect fish due to injury or mortality from entering the powerhouse draft tubes.

FERC's SD2 also identifies as an issue the potential effects of entrainment at the Project dam and intake on fish populations. The LGDD and appurtenant facilities (MID and TID non-Project diversion tunnels and intakes, etc.) associated with water conveyance for irrigation and to support Don Pedro FERC required flows to support aquatic resources in the lower Tuolumne River are the primary mechanisms for entrainment of fish from the La Grange headpond. As discussed above, these primary purpose activities would occur independent of the Proposed Action. However, electricity is generated from water diverted to support aquatic resources in the lower Tuolumne River and has the potential to injure any fish entrained to the Project forebay, into penstocks and through the powerhouse (Figure 1.0-2). However, results of the Fish Assemblage and Population between Don Pedro Dam and La Grange Diversion Dam Study conducted in 2012 (TID/MID 2013a) as part of the Don Pedro Project relicensing indicate that the existing fish assemblage (rainbow trout and prickly sculpin) in the La Grange headpond is healthy and exhibit multiple age classes (indicating reproduction is occurring within this reach and there are no records of stocking in this reach) and as indicated by average condition factors near 1.0 (average Kn=0.99). These findings are consistent with all available evidence, which demonstrates that current conditions in the La Grange headpond support a stable and healthy fish assemblage. Since the Proposed Action would not significantly influence the operation or maintenance activities of the LGDD, no adverse effects associated with entrainment and injury on fish resources in the La Grange headpond are anticipated.

3.5.6 Proposed Environmental Measures

To address fish entering the TID sluice gate channel and becoming stranded, the Districts propose to install a fish exclusion barrier at the channel entrance. The fish exclusion barrier will allow the sluice gate to divert powerhouse flows during an outage while preventing fish from entering the sluice gate channel where dewatering or stranding could occur once hydropower generation is restored. The barrier is designed to function during flows of up to 7,000 cfs and is projected to cost $600,000. Once constructed, sluice gate channel maintenance flows of approximately 5 to 10 cfs will no longer be necessary.

The Districts also propose two additional measures: (1) to formalize the flow of approximately 5 to 10 cfs to the plunge pool below the LGDD ; and (2) conduct dissolved oxygen monitoring in the vicinity of the La Grange powerhouse. Both are discussed in Section 3.4 of this Exhibit E.

3.5.7 Cumulative Effects to Aquatic Resources

FERC's SD2 identified the geographic scope for aquatic resources as extending upstream on the Tuolumne River to Hetch Hetchy and downstream to San Francisco Bay. The temporal scope considered for cumulative effects to aquatic resources includes past, present, and reasonably foreseeable future actions. The temporal scope extends 30 to 50 years into the future in order to coincide with the potential term of an original license for the Project.

Water diversion to meet the La Grange Project's primary purposes are not dependent on the issuance of a FERC license for the Proposed Action, and will occur with or without the continuation of hydropower generation. As such, these uses are not interrelated or interdependent with the issuance of a FERC license for hydroelectric power generation. Because the Districts are seeking a license to permit the Proposed Action, the non-hydropower water uses are independent actions. These independent actions (i.e., primary uses) contribute to cumulative effects to water resources in the Tuolumne and San Joaquin river basins but do not constitute direct or indirect effects associated with the Proposed Action.

The Proposed Action of continued hydroelectric power generation would not result in any cumulative effects on aquatic resources over the geographic and temporal scopes defined for this resource in FERC's SD2. Diversions from the headpond and flows into the lower river are independent of the hydroelectric operations at the Project. Therefore, the continuance of power generation would not have an effect on stage or flows in the La Grange headpond or lower Tuolumne River, and thus will not contribute to cumulative effects to aquatic resources in the past, present, or next 30 to 50 years.

Other actions conducted within the Tuolumne River basin that contribute to cumulative effects include CCSF's operations of the Hetch Hetchy system, water diversions and hydroelectric operations at Don Pedro Dam, water diversions at LGDD, riparian withdrawals by water users, discharge of irrigation return flows, historic and current mining activities, agricultural and urban land uses, the presence of non-native species, and stocking of hatchery salmonids. In addition, ongoing operation of reservoir and diversion facilities in the San Joaquin River and its tributaries, along with an array of other actions, also contribute to cumulative effects on aquatic organisms within the analysis area for cumulative effects. As noted above, FERC's SD2 identified a number of aquatic resource issues that are more appropriately discussed as cumulative effects. Analysis of these issues is the focus of the remainder of this Cumulative Effects section. For a comprehensive analysis of all actions that contribute to cumulative effects, refer to Section 4.1 of the Don Pedro AFLA (TID/MID 2017c).

More than a century of cumulative impacts have transformed the lower Tuolumne River from a dynamic alluvial system capable of forming its own bed and bank morphology to a river highly constrained between either man-made dikes or agricultural fields, or constrained by riparian vegetation that has encroached into the low water channel (McBain and Trush 2000). Hydrologic alterations have occurred as a result of development of upstream dams developed for storage, flood control, irrigation, M&I, and hydroelectric purposes. The presence of dams, in-channel aggregate extraction (gravel and gold mining), agricultural and urban encroachment, and other land uses, including hydraulic mining practices near La Grange, have resulted in physical habitat and riparian alteration such as sediment supply and transport in the lower Tuolumne River Channel (McBain and Trush 2000). Don Pedro Dam and Hetchy Hetchy system dams, and to a much smaller extent, LGDD, trap all coarse sediment and large woody debris (LWD) that would otherwise pass downstream.

As noted above, the Proposed Action would have no adverse effects on the retention of sediment in the La Grange headpond on downstream spawning habitat and benthic macroinvertebrates or the recruitment and movement of LWD on lower Tuolumne River aquatic resources and their habitat. The presence and continued water supply operations of the La Grange and Don Pedro dams do retain sediment and hinder woody debris transport which may have cumulative effects for aquatic resources and habitat in the lower Tuolumne River. However, past studies indicate that the current invertebrate community in the Lower Tuolumne River has high diversity and a species composition with higher food value for juvenile salmonids and other fish species as opposed to pollution-tolerant organisms (TID/MID 2010e). Spawning gravel and salmonid habitat mapping studies (TID/MID 2013e, 2016c) conducted as part of Don Pedro relicensing and La Grange licensing processes have identified suitable spawning habitat that if fully utilized under current Don Pedro FERC flow requirements, would be supportive of robust salmonid populations (TID/MID 2013e). It is also unclear to what degree woody debris retention by upstream dams has contributed to adverse habitat effects in the lower river. Previous studies showed that most woody debris in the lower Tuolumne River is partially or wholly out of the channel, and due to its small size, it does not provide significant cover for fish, which in turn limits its value as protection from avian and aquatic predators (TID/MID 2016c). Furthermore, Districts studies for the Don Pedro Project relicensing demonstrate that woody debris collected in the reservoir is not of sufficient size to effectively serve as habitat and would likely be short-lived in the lower Tuolumne River (TID/MID 2016c). Despite these conclusions, to maintain and improve aquatic habitat in the lower Tuolumne River, additional gravel augmentation and cleaning through a Coarse Sediment Management Program and instream habitat improvements (i.e., boulder-sized rock placements) are being proposed as part of the Don Pedro Project FERC license (refer to the Don Pedro Hydroelectric Project AFLA for more details; TID/MID 2017c). These measures, if implemented, are anticipated to have positive effects on aquatic habitat in the lower Tuolumne River.

Historical spawning and rearing habitat was significantly restricted beginning in the 1870s, when a number of dams and irrigation diversion projects were constructed. Wheaton Dam, built in 1871 near the site of the present-day LGDD, 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). The presence of the LGDD (not the Project) blocks the migration of anadromous fish. The diversion dam exists to support the primary purposes of water supply and M&I uses and would continue to operate as it does currently independent of hydroelectric generation. Anadromous fish do not exist upstream of the LGDD. Results of the Fish Barrier Assessment (TID/MID 2017h) indicate that fall-run Chinook salmon are present below the La Grange Project although the study did conclude that fish exhibiting persistent upstream migration (i.e., defined as fish that move upstream to the La Grange facilities and don't return to downstream spawning habitat) was less than 1 percent during the 2-year monitoring period. This may be due to the fact that nearly all fall-run Chinook salmon below the LGDD and Project during the study were hatchery strays (TID/MID 2017h). Previous study in the lower Tuolumne River has also found that hatchery fish make up a large proportion of the annual spawning runs and the proportions of hatchery fish have been increasing in recent years (TID/MID 2016c). There are no hatcheries on the lower Tuolumne River. Anadromous salmonids are known to home to natal streams with high fidelity (Hasler et al. 1978; Cooke et al. 2011). As above, Chinook of hatchery origin that stray into the lower Tuolumne River are likely exhibiting a variety of movement behavior including upstream and downstream movement and searching in order to identify appropriate homing cues to return to natal locations. Furthermore, although the Tuolumne River population may consist primarily of hatchery strays, these fish appear to be reproducing successfully in the Tuolumne River with little impact to overall in-river production due to lack of suitable habitat. Past study (TID/MID 2017h) and monitoring information (CDFW 2014) suggest that pre-spawn or partial-spawn mortality is extremely low. Only one and three observations of pre-spawn mortality were observed during the 2015/2016 and 2016/2017 study monitoring periods, respectively. Additionally, low levels of pre-spawn or partial-spawn mortality of fall-run Chinook in the Tuolumne River were observed during surveys conducted in 1993, 1999, 2008, 2013, and 2014 (CDFW 2014). Of the years evaluated, the maximum annual occurrence of pre-spawn or partial spawn mortality documented was five individuals in (2013). Adult, adiposed fin-clipped *O. mykiss* (presumably migratory steelhead from out-of-basin hatcheries) have also been observed in the lower Tuolumne River but observations are extremely rare. The Fish Barrier Assessment (TID/MID 2017h) concluded that adult (>30 cm) *O. mykiss* passages detected at the tailrace weir during the 2015/16 monitoring period, represent movement of "resident" *O. mykiss* rearing in and around the La Grange powerhouse tailrace. A Fall-run Chinook Restoration Hatchery is being proposed as a part of the Don Pedro Hydroelectric Project AFLA. The purpose of the facility would be to artificially propagate fall-run Chinook to support the restoration of a local Tuolumne River stock. More details of this proposed measure are available in the Don Pedro Hydroelectric Project AFLA but if implemented, this measure is anticipated to improve aquatic resources within the lower Tuolumne River by maximizing genetic diversity, enhancing life history strategies, and improving post-release survival of Tuolumne River origin fall-run Chinook.

The existence of the La Grange and Don Pedro diversion dams has isolated fish populations within the reach of the Tuolumne River between them (i.e., La Grange headpond). Results of the Fish Assemblage and Population between Don Pedro Dam and La Grange Diversion Dam Study conducted in 2012 (TID/MID 2013a) as part of the Don Pedro Project relicensing indicate that the existing fish assemblage (rainbow trout and prickly sculpin) appears to be healthy exhibiting multiple age classes (suggesting that reproduction is occurring within this reach; there are no records of stocking in this reach) and as indicated by average condition factors near 1.0 (average Kn=0.99).

3.5.8 Unavoidable Adverse Impacts

With the inclusion of the proposed environmental measures summarized in Section 3.5.6 above, no unavoidable adverse impacts to aquatic resources are anticipated as a result of the Proposed Action of continued hydroelectric power generation at the La Grange powerhouse.

3.6 Wildlife and Botanical Resources

The Project is situated near the western edge of the foothills of the west slope of California's Sierra Nevada. The terrestrial habitat in the Project area is dominated by blue oak woodlands, open annual grass-forb vegetation, and substantial components of shrub-dominated chaparral. Wetland and riparian habitats are mostly restricted to areas adjacent to the Tuolumne River, which flows through a bedrock valley in the Project vicinity. The majority of terrestrial habitats within the Project vicinity are above the maximum water surface elevation of the La Grange headpond and geographically removed from any Project activities.

3.6.1 Mammals

The vegetative community types associated with the Project vicinity provide suitable habitat for a variety of wildlife species. Although the area is dominated by annual grass-forb and blue oak vegetation associations (described in Section 3.6.3 below), wetland and riverine areas increase the diversity of wildlife habitats available to indigenous and transient mammal species in the Project vicinity. Mammal species that may exist or may use habitats in the vicinity of the Project are shown in Table 3.6-1.

Table 3.6-1. Partial list of mammals potentially occurring in the Project vicinity.

Common Name	Scientific Name
Virginia opossum	*Didelphis virginiana*
Pallid bat	*Antrozous pallidus*
Townsend's bigeared bat	*Corynorhinus townsendii*
Spotted bat	*Euderma maculatum*
Western mastiff bat	*Eumops perotis*
Western red bat	*Lasiurus blossevillii*

Common Name	Scientific Name
Western smallfooted myotis	*Myotis ciliolabrum*
Long-eared myotis	*Myotis evotis*
Fringed myotis	*Myotis thysanodes*
Yuma myotis	*Myotis yumanensis*
Black-tailed jackrabbit	*Lepus californicus*
Beaver	*Castor canadensis*
Porcupine	*Erethizon dorsatum*
Brush mouse	*Peromyscus boylii*
Dusky-footed woodrat	*Neotoma fuscipes*
Bushy-tailed woodrat	*Neotoma cinerea*
Muskrat	*Ondatra zibethicus*
Western gray squirrel	*Sciurus griseus*
Coyote	*Canis latrans*
Red fox	*Vulpes vulpes*
Gray fox	*Urocyon cinereoargenteus*
Black bear	*Ursus americanus*
Raccoon	*Procyon lotor*
Short-tailed weasel	*Mustela erminea*
Long-tailed weasel	*Mustela frenata*
Mink	*Mustela vison*
Spotted skunk	*Spilogale putorius*
Striped skunk	*Mephitis mephitis*
Bobcat	*Lynx rufus*
Elk	*Cervus elaphus*
Mule deer	*Odocoileus hemionus*
Brush rabbit	*Sylvilagus bachmani*
Desert cottontail	*Sylvilagus audubonii*
American badger	*Taxidea taxus*
Wild pig	*Sus scrofa*

Sources: American Society of Mammalogists 2013; TID/MID 2011; TID/MID 2013a.

3.6.2 Birds

Bird species with the potential to occur in the Project vicinity are listed in Table 3.6-2.

Table 3.6-2. Bird species with the potential to occur in the Project vicinity.

Common Name	Scientific Name
Greater white-fronted goose	*Anser albifrons*
Snow goose	*Chen caerulescens*
Ross's goose	*Chen rossii*
Canada goose	*Branta canadensis*
Wood duck	*Aix sponsa*
Gadwall	*Anas strepera*
American wigeon	*Anas americana*
Mallard	*Anas platyrhynchos*
Cinnamon teal	*Anas cyanoptera*
Northern shoveler	*Anas clypeata*
Northern pintail	*Anas acuta*
Green-winged teal	*Anas carolinensis*
Canvasback	*Aythya valisineria*
Ring-necked duck	*Aythya collaris*
Lesser scaup	*Aythya affinis*

Common Name	Scientific Name
Bufflehead	*Bucephala albeola*
Common goldeneye	*Bucephala clangula*
Barrow’s goldeneye	*Bucephala islandica*
Hooded merganser	*Lophodytes cucullatus*
Common merganser	*Mergus merganser*
Ruddy duck	*Oxyura jamaicensis*
White-tailed ptarmigan	*Lagopus leucura*
Sooty grouse	*Dendragapus fuliginosus*
Wild turkey	*Meleagris gallopavo*
Mountain quail	*Oreortyx pictus*
California quail	*Callipepla californica*
Common loon	*Gavia immer*
Pied-billed grebe	*Podilymbus podiceps*
Eared grebe	*Podiceps nigricollis*
Western grebe	*Aechmophorus occidentalis*
Clark’s grebe	*Aechmophorus clarkii*
Great blue heron	*Ardea herodias*
Great egret	*Ardea alba*
Turkey vulture	*Cathartes aura*
Osprey	*Pandion haliaetus*
Northern harrier	*Circus cyaneus*
Sharp-shinned hawk	*Accipiter striatus*
Cooper’s hawk	*Accipiter cooperii*
Northern goshawk	*Accipiter gentilis*
Peregrine falcon	*Falco peregrinus*
American kestrel	*Falco sparverius*
Merlin	*Falco columbarius*
Ferruginous hawk	*Buteo regalis*
Red-shouldered hawk	*Buteo lineatus*
Red-tailed hawk	*Buteo jamaicensis*
Golden eagle	*Aquila chrysaetos*
Bald eagle	*Haliaeetus leucocephalus*
Killdeer	*Charadrius vociferus*
Spotted sandpiper	*Actitis macularius*
Greater yellowlegs	*Tringa melanoleuca*
Wilson’s snipe	*Gallinago delicata*
Mourning dove	*Zenaida macroura*
Barn owl	*Tyto alba*
Western screech owl	*Megascops kennicottii*
Great horned owl	*Bubo virginianus*
Northern saw-whet owl	*Aegolius acadicus*
White-throated swift	*Aeronautes saxatalis*
Black-chinned hummingbird	*Archilochus alexandri*
Anna’s hummingbird	*Calypte anna*
Rufous hummingbird	*Selasphorus rufus*
Belted kingfisher	*Megaceryle alcyon*
Lewis’s woodpecker	*Melanerpes lewis*
Acorn woodpecker	*Melanerpes formicivorus*
Williamson’s sapsucker	*Sphyrapicus thyroideus*
Red-breasted sapsucker	*Sphyrapicus ruber*
Downy woodpecker	*Picoides pubescens*
Hairy woodpecker	*Leuconotopicus villosus*
Black-backed woodpecker	*Picoides arcticus*

Common Name	Scientific Name
Northern flicker	*Colaptes auratus*
Pileated woodpecker	*Hylatomus pileatus*
Olive-sided flycatcher	*Contopus cooperi*
Western wood-peewee	*Contopus sordidulus*
Willow flycatcher	*Empidonax traillii*
Hammond's flycatcher	*Empidonax hammondii*
Black phoebe	*Sayornis nigricans*
Ash-throated flycatcher	*Myiarchus cinerascens*
Western kingbird	*Tyrannus verticalis*
Loggerhead shrike	*Lanius ludovicianus*
Steller's jay	*Cyanocitta stelleri*
Western scrub jay	*Aphelocoma californica*
American crow	*Corvus brachyrhynchos*
Common raven	*Corvus corax*
Tree swallow	*Tachycineta bicolor*
Cliff swallow	*Petrochelidon pyrrhonota*
California thrasher	*Toxostoma redivivum*
Cedar waxwing	*Bombycilla cedrorum*
Orange-crowned warbler	*Vermivora celata*
Yellow warbler	*Setophaga petechia*
Yellow-rumped warbler	*Setophaga coronata*
Townsend's warbler	*Setophaga townsendi*
Wilson's warbler	*Cardellina pusilla*
Western tanager	*Piranga ludoviciana*
Spotted towhee	*Pipilo maculatus*
California towhee	*Melozone crissalis*
Chipping sparrow	*Spizella passerina*
Lark sparrow	*Chondestes grammacus*
Fox sparrow	*Passerella iliaca*
Song sparrow	*Melospiza melodia*
White-throated sparrow	*Zonotrichia albicollis*
Dark-eyed junco	*Junco hyemalis*
Black-headed grosbeak	*Pheucticus melanocephalus*
Red-winged blackbird	*Agelaius phoeniceus*
Western meadowlark	*Sturnella neglecta*
Pine grosbeak	*Pinicola enucleator*
Purple finch	*Haemorhous purpureus*
House finch	*Haemorhous mexicanus*
Red crossbill	*Loxia curvirostra*
Pine siskin	*Spinus pinus*
Lesser goldfinch	*Spinus psaltria*
Lawrence's goldfinch	*Spinus lawrencei*
American goldfinch	*Spinus tristis*
Evening grosbeak	*Coccothraustes vespertinus*
House sparrow	*Passer domesticus*
Chestnut-backed chickadee	*Poecile rufescens*
Oak titmouse	*Baeolophus inornatus*
Red-breasted nuthatch	*Sitta canadensis*
White-breasted nuthatch	*Sitta carolinensis*
Rock wren	*Salpinctes obsoletus*
Western bluebird	*Sialia mexicana*
Mountain bluebird	*Sialia currucoides*

Source: Central Sierra Audubon Society 2013.

3.6.3 Botanical Resources

Areas immediately adjacent to the La Grange headpond are in a natural condition, dominated by various grass species and scattered trees and underbrush. Based on review of aerial photography, a site visit conducted in 2013, and information derived from the USFS CalVeg mapping system (USFS 2017), the study area within 1 mile of the Project Boundary is dominated by four vegetation alliances: Blue Oak, Annual Grasses and Forbs, Chamise, and Lower Montane Mixed Chaparral (Figure 3.6-1). Descriptions of these vegetation alliances are provided below, and the acreage of each within 1 mile of the Project Boundary is presented in Table 3.6-3.

- **Blue Oak Alliance –** This alliance occurs below about 3,900 feet (TID/MID 2011) and is dominated by blue oak (*Quercus douglasii*), which is found in an oak-grass association on well-drained, gentle slopes. The alliance typically contains gray pine (*Arceuthobium occidentale*), and interior live oak (*Quercus wislizeni*), valley oak (*Quercus lobata*) and/or California buckeye (*Aesculus californica*) may also be present. Chaparral shrubs such as wedgeleaf ceanothus (*Ceanothus cuneatus*), manzanitas (*Arctostaphylos* spp.), coffeeberry (Rhamnus spp.), birchleaf mountain mahogany (*Cercocarpus montanus* var. *glaber*), and poison oak (*Toxicodendron diversilobum*) are also part of this alliance. The understory is dominated by annual grasses such as wild oats (*Avena* spp.) and cheatgrass (*Bromus* spp.).
- **Annual Grasses and Forbs Alliance –** Annual grasslands are abundant in the Project vicinity, generally occurring between urban/agricultural developments and foothill woodlands. Dominant species in this vegetation alliance include ripgut brome (*Bromus diandrus*), Italian ryegrass (*Lolium multiflorum*), soft chess (*Bromus hordeaceus*), wild oats (*Avena* spp.), and silver hairgrass (*Aira carophyllea*). Invasive Bermudagrass (*Cynodon dactylon*) is also common. Vernal pools (small depressions often containing hardpan soil layers) occur throughout the Annual Grasses and Forbs Alliance; however, no vernal pools occur within 1 mile of the Project Boundary. Plant species in these 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.) (TID/MID 2011).
- **Chamise Alliance –** Relatively pure stands of chamise (*Adenostoma fasciculatum*) occupy xeric sites at elevations up to about 4,000 feet and often are found in upper ridge slope positions. Chaparral shrubs such as wedgeleaf ceanothus, whiteleaf manzanita (*Arctostaphylos manzanita*) and birchleaf mountain mahogany are associated shrubs. Scattered gray pine and interior live oak are also found in this alliance (TID/MID 2011).
- **Lower Montane Mixed Chaparral –** 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. It has been mapped generally within an elevation range of about 1,300 to 5,200 feet (TID/MID 2011).

Multiple studies were conducted by the Districts within the Project vicinity as part of the Don Pedro Project relicensing. Additional information describing botanical resources in the Project vicinity can be found in the Don Pedro Hydroelectric Project AFLA (TID/MID 2017a) and the Districts' Special-Status Plants Study Report (TID/MID 2013c).

Table 3.6-3. Vegetation alliance acreage within 1 mile of the Project Boundary.

Vegetation Alliance	Acreage within 1 mile of the Project Boundary
Barren	7.11
Blue Oak Alliance	1,601.36
Annual Grasses and Forbs Alliance	3,037.98
Chamise Alliance	58.13
Lower Montane Mixed Chaparral Alliance	4.67
Water	162.09
Total	**4.871.34**

Source: California Natural Diversity Database (CNDDB) 2017.

3.6.4 Noxious Weeds

Non-native invasive species and noxious weeds are typically prolific, pioneering species that have the ability to quickly outcompete native vegetation. They grow rapidly, mature early, and effectively spread seeds that can survive for significant periods in the soil until site conditions are favorable for their growth. Invasive plants often form vast single-species communities that are less suitable to birds and wildlife than native plant communities and can compromise native ecosystems by altering soil and water resources on a site. The introduction of non-indigenous invasive aquatic plant species to the United States has been escalating with widespread adverse consequences.

For the purpose of this FLA, noxious weeds are defined as those plant species listed as such by the California Department of Food and Agriculture (CDFA 2016) and the Sierra-San Joaquin Noxious Weeds Alliance (SSJNWA 2003). Additionally, the California Invasive Plant Inventory Database was reviewed for applicable additions to the list. Based on these sources, 34 noxious weed species have the potential to occur within the Project vicinity (Table 3.6-4). State-designated noxious weeds are typically assigned one of three ratings: (1) A-list species are mandated for eradication or control, (2) B-list species are widespread plants that Agricultural Commissioners can designate for local control efforts, and (3) C-list species are considered too widespread for funding of control efforts (CDFA 2013). California Invasive Plant Council ratings include (1) High – species with severe ecological impacts; (2) Moderate – species with substantial ecological impacts; and (3) Limited – species with minor ecological impacts (Cal-IPC 2017).

Additional information describing noxious weeds that occur within the Project vicinity can be found in the Districts' Noxious Weeds Study Report, which was conducted as part of the Don Pedro Project relicensing (TID/MID 2013b). Twelve noxious weed species were observed and mapped in the Don Pedro Project vicinity. Of these, tree of heaven (*Ailanthus altissima*) and giant reed (*Arundo donax*) were documented downstream of Don Pedro Dam (i.e., near the La Grange headpond). Two other species, Bermudagrass (*Cynodon dactylon*) and medusahead grass (*Elymus caput-medusae*), are known to occur near the eastern edge of the La Grange headpond (TID/MID 2013b).

3.6.4.1 Water Hyacinth

Water hyacinth (*Eichhornia crassipes*), a plant species native to the Amazon River basin, has spread to all tropical and subtropical countries and is considered one of the world's most invasive aquatic weeds (Parsons 1992, as cited in Cal-IPC 2014). It was introduced into the United States in 1884 as an ornamental plant, spread rapidly in the warmer states, and was first documented in California in 1904 (Thomas and Anderson 1984, as cited in Cal-IPC 2014). In California, water hyacinth is usually found below about 650 feet elevation in the San Francisco Bay Area, along the South Coast, and in the Central Valley (Cal-IPC 2014), including the lower Tuolumne River.

Water hyacinth can quickly dominate an aquatic system because of its rapid proliferation. It often degrades waterfowl habitat by reducing open water areas and displaces native aquatic plants used for food or shelter by other wildlife species (Cal-IPC 2014). Water hyacinth can increase water losses from lakes and rivers because of the plant's high transpiration rate (Parsons 1992, as cited in Cal-IPC 2014) and can alter water quality beneath dense mats by reducing dissolved oxygen and affecting pH and turbidity (Penfound and Earle 1948; Center and Spencer 1981, as cited in Cal-IPC 2014). Alteration in water quality can lead to adverse effects on aquatic biota, and decaying water hyacinth beds can make water unsuitable for drinking by wildlife.

Water hyacinth can obstruct navigable waterways, impede drainage, foul hydroelectric generators and water pumps, and block irrigation channels (Cal-IPC 2014). By 1897 it had occluded many waterways in the United States and was interfering with shipping (Parsons 1992, as cited in Cal-IPC 2014). Agricultural production in California's Central Valley was at one time threatened by significant reductions in the efficiency of irrigation channels and pumping equipment caused by water hyacinth. However, control efforts have reduced the problem significantly in recent years (Parsons 1992, as cited in Cal-IPC 2014). Decaying water hyacinth beds can also make water unsuitable for drinking by humans and livestock.

During the 2012 Lower Tuolumne River Lowest Boatable Flow Study researchers documented the existence of dense mats of water hyacinth, and in the reach between Riverdale Park (RM 12.3) and Shiloh Bridge (RM 4.0) these mats blocked the entire river in two locations, interfering with boat passage (TID/MID 2013a). The California Division of Boating and Waterways considers water hyacinth to be too well established in the lower Tuolumne River for eradication, although herbicides are used to control its abundance when no undue risks to special-status species or subsequent human water uses are anticipated.

The La Grange annual fall fish migration monitoring has documented the presence of water hyacinth downstream of the LGDD at RM 24.5 on the Tuolumne River. During the study, extensive growth of water hyacinth was found along both banks of the Tuolumne River between Riverdale Park (RM 12.3) and the confluence with the San Joaquin River. The fish collection weir located at RM 24.5 was checked daily during the course of the study for the presence of water hyacinth and cleared when necessary. On several occasions, heavy clumps of water hyacinth washed into the fish collection weir (TID/MID 2014). As part of the 2016 fall fish migration monitoring, the coverage and distribution of water hyacinth was further analyzed using satellite imagery obtained through Apollo Mapping (Boulder, Colorado). Satellite imagery analysis revealed that a total of nine large rafts of water hyacinth covering 3.3 percent (4,230.3 feet) of riverine habitat were identified on the Tuolumne River between the weir located at RM 24.5 and the confluence with the San Joaquin River (RM 0) (TID/MID 2017b).

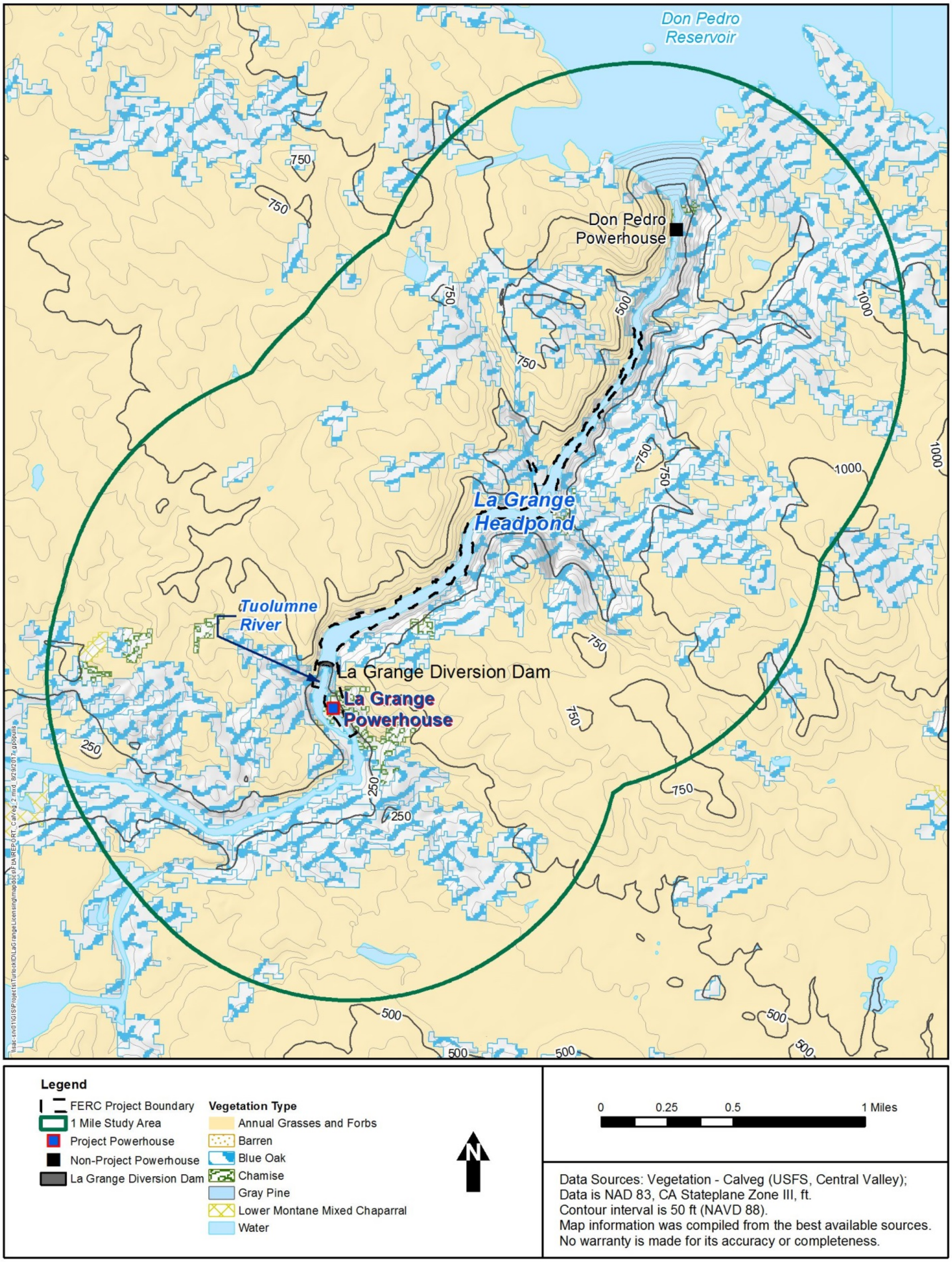

Figure 3.6-1. USFS CalVeg map of the Project vicinity.

Table 3.6-4. Noxious weed species occurring or potentially occurring in the Project vicinity.

Common Name	Scientific Name	CDFA Status[1/] Cal-IPC Rating
Russian knapweed	*Acroptilon repens*	B, Moderate
Barbed goat grass	*Aegilops triuncialis*	B, High
Tree-of-heaven	*Ailanthus altissima*	C, Moderate
Giant reed	*Arundo donax*	B, High
Cheat grass	*Bromus tectorum*	C, High
Italian thistle	*Carduus pycnocephalus*	C, Moderate
Distaff thistle	*Carthamus* spp.	A,/B, Moderate
Tocalote	*Centaurea melitensis*	C, Moderate
Jubata grass	*Cordateria jubata*	--, High
Pampas grass	*Cortaderia selloana*	--, High
Purple starthistle	*Centaurea calcitrapa*	B, Moderate
Diffuse knapweed	*Centaurea diffusa*	A, Moderate
Iberian starthistle	*Centaurea iberica*	A, --
Yellow starthistle	*Centaurea solstitialis*	C, High
Spotted knapweed	*Centaurea stobe* ssp. *Micranthos*	A, High
Rush skeletonweed	*Chondrilla juncea*	A, Moderate
Canada thistle	*Cirsium arvense*	B, Moderate
Bermudagrass	*Cynodon dactylon*	C, Moderate
Scotch broom	*Cytisus scoparius*	A, High
French broom	*Genista monspessulana*	C, High
Medusahead	*Taeniatherum caput-medusae*	C, High
Oblong spurge	*Euphorbia oblongata*	B, Limited
Klamath weed	*Hypericum perforatum*	C, Moderate
Dyer’s woad	*Isatis tinctoria*	B, Moderate
Lens-pod whitetop	*Lepidium chalepense*	B, Moderate
Perennial pepperweed	*Lepidium latifolium*	B, High
Hoarycress	*Cardaria* spp.	B
Purple loosestrife	*Lythrum salicaria*	B, High
Scotch thistle	*Onopordum acanthium*	A, High
Russian thistle	*Salsola tragus*	C, Limited
Red sesbiana	*Sesbiana punicea*	C, High
White horsenettle	*Solanum elaeagnifolium*	B, --
Tamarisk	*Tamarix* spp.	B, High
Puncturevine	*Tribulus terrestris*	C, Limited

Sources: TID/MID 2013b, CDFA 2016, and Cal –IPC 2017.

[1] CDFA Noxious Weed Rating: A-rated weeds are highest priority for eradication in the State, followed by B- may be subject to immediate quarantine actions, C- not subject to any State enforced regulatory actions, and then D-rated no authorized mitigating regulatory actions.

3.6.5 Wetland, Riparian, and Littoral Habitat

Wetlands are commonly understood to be transitional lands that occur between uplands and aquatic systems. However, wetlands include certain shallow aquatic areas and are more accurately defined according to the following attributes (Cowardin et al. 1979):

(1) At least periodically, the land supports predominantly hydrophytes (i.e., vegetation associated with moist soil conditions);

(2) The substrate is predominantly un-drained hydric soil (i.e., soils characterized by anaerobic conditions); and

(3) The substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year.

Wetlands along the Tuolumne River in the Project vicinity are primarily confined to narrow bands or small isolated wetlands adjacent to the river channel. A 1-mile buffer of the Project Boundary was used as a study area to assess wetlands within the vicinity of the Project. Based on the classification system described by Cowardin et al. (1979), wetlands identified by the USFWS National Wetland Inventory (NWI) maps in the study area consist of seven types: palustrine emergent, palustrine scrub-shrub, palustrine unconsolidated bottom, palustrine unconsolidated shore, riverine unconsolidated bottom, and lacustrine unconsolidated bottom, and lacustrine unconsolidated shore (Figure 3.6-2; USFWS 2017). Each of these wetland types is described below, and acreages of each type are presented in Table 3.6-5.

Palustrine Emergent (PEM) – Palustrine emergent wetlands are defined by rooted herbaceous species growing in relatively shallow water or saturated soil (Cowardin et al. 1979); the term “emergent” is a reference to plants that emerge above the water surface (in contrast to submerged aquatic plants). Examples of PEM wetlands are meadows, marshes, fens and bogs. Comparable categories in the CWHR classification system are Fresh Emergent Wetland and Wet Meadow. Given the variety of habitats that meet the definition of the emergent wetland class, further description requires information on hydrology, morphology, topographic setting, and plant species composition. PEM wetlands occupy approximately 5.69 percent of the total acreage of wetlands mapped by NWI in the study area (Table 3.6-5).

Palustrine Scrub-Shrub (PSS) – Palustrine scrub-shrub wetlands are dominated by hydrophytic shrubs, small trees or a combination of these elements growing in temporarily or (rarely) permanently flooded, shallow water; by definition, dominant vegetation is less than 18 feet tall (Cowardin et al. 1979). This wetland type occupies approximately 0.45 percent of the total acreage of wetlands mapped by NWI in the study area (Table 3.6-5).

Palustrine Unconsolidated Bottom (PUB) – Palustrine unconsolidated bottom wetlands are characterized by the occurrence of loose substrate (e.g. gravel, cobble, or boulders), little or no vegetation, and extreme water regimes (e.g., permanently or semi-permanently flooded and relatively deep water) that favor the retention of these characteristics (Cowardin et al. 1979). PUB wetlands occupy approximately 3.99 percent of total mapped wetland acreage in the study area (Table 3.6-5).

Palustrine Unconsolidated Shore (PUS) – Palustrine unconsolidated shore wetlands are characterized by substrates lacking vegetation except for pioneering plants that grow at rare times when conditions are favorable. A number of landforms—beaches, bars, and flats—formed by erosion and water deposition are included in this class (Cowardin et al. 1979). PUS wetlands occupy approximately 1.97 percent of total mapped wetland acreage in the study area (Table 3.6-5).

Riverine Unconsolidated Bottom (RUB) – Riverine unconsolidated bottom wetlands are characterized by at least 25 percent cover of particles smaller than stones and vegetation cover less than 30 percent, existing within a channel (Cowardin et al. 1979). RUB wetlands occupy approximately 11.22 percent of the total mapped NWI wetland acreage in the study area (Table 3.6-5).

Lacustrine Unconsolidated Bottom (LUB) – Lacustrine unconsolidated bottom wetlands are permanently flooded lakes and reservoirs characterized by at least 25 percent cover of particles smaller than stones and vegetation cover less than 30 percent (Cowardin et al. 1979). LUB wetlands occupy approximately 70.75 percent of the total mapped NWI wetland acreage in the study area (Table 3.6-5).

Lacustrine Unconsolidated Shore (LUS) – Lacustrine unconsolidated shore wetlands are permanently flooded lakes and reservoirs characterized by substrates lacking vegetation except for pioneering plants that grow at rare times when conditions are favorable. A number of landforms—beaches, bars, and flats—formed by erosion and water deposition are included in this class (Cowardin et al. 1979). LUS wetlands occupy approximately 5.69 percent of the total mapped NWI wetland acreage in the study area (Table 3.6-5).

Table 3.6-5. Wetland habitat acreage within 1 mile of the Project Boundary.

Wetland Type	Definition	Acres in Study Area	Acres in Project Boundary
Palustrine Emergent (PEM)			
PEMA	Palustrine emergent, temporarily flooded	2.92	--
PEMB	Palustrine emergent, saturated	0.42	--
PEMC	Palustrine emergent, seasonally flooded	6.54	--
PEMCh	Palustrine emergent, seasonally flooded, impounded	1.69	0.09
PEMFx	Palustrine emergent, semipermanently flooded, excavated	0.59	--
Palustrine Scrub-Shrub (PSS)			
PSSA	Palustrine scrub-shrub, temporarily flooded	0.18	--
PSSCx	Palustrine scrub-shrub, seasonally flooded, excavated	0.79	--
Palustrine Unconsolidated Shore (PUB)			
PUBFh	Palustrine unconsolidated bottom, semi-permanently flooded, impounded	3.13	--
PUBHh	Palustrine unconsolidated bottom, permanently flooded, impounded	4.17	--
PUBHx	Palustrine unconsolidated bottom, permanently flooded, excavated	1.24	--
Palustrine Unconsolidated Shore (PUS)			
PUSAh	Palustrine unconsolidated shore, temporarily flooded, diked/impounded	0.24	--
PUSC	Palustrine unconsolidated shore, seasonally flooded	1.9	--
PUSCh	Palustrine unconsolidated shore, seasonally flooded, diked/impounded	2.08	--
Riverine Unconsolidated Bottom (RUB)			
R2UBH	Riverine lower perennial, unconsolidated bottom, permanently flooded	0.72	--
R3UBH	Riverine upper perennial, unconsolidated bottom, permanently flooded	23.28	1.91
Lacustrine Unconsolidated Bottom (LUB)			
L1UBHh	Lacustrine limnetic, unconsolidated bottom, permanently flooded, diked/impounded	151.26	42.85
Lacustrine Unconsolidated Shore (LUS)			
L2USCh	Lacustrine littoral, unconsolidated shore, seasonally flooded, diked/impounded	12.66	--
	Total	**213.81**	**44.85**

Source: USFWS NWI.

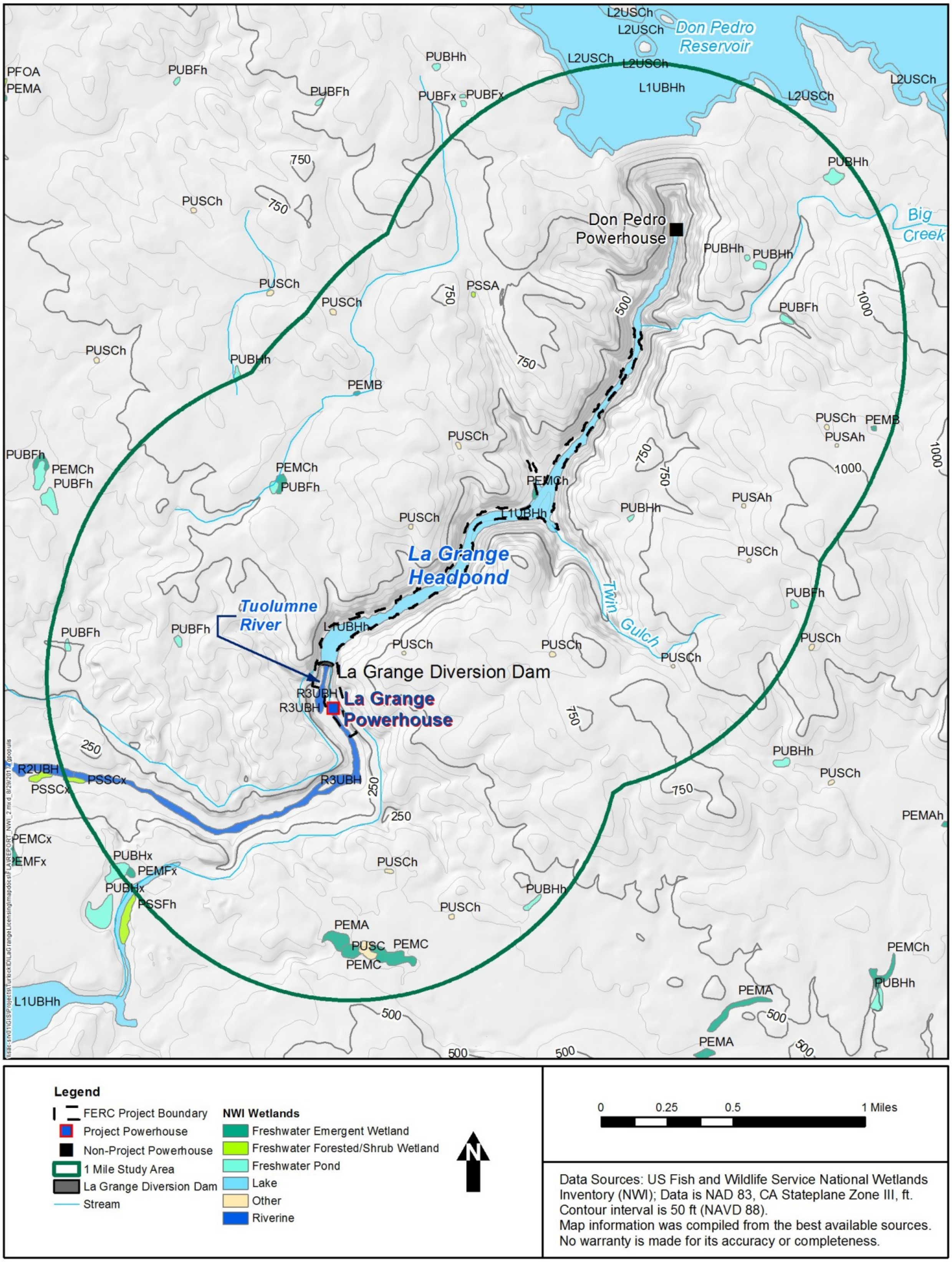

Figure 3.6-2. U.S. Fish and Wildlife Service National Wetland Inventory map of the Study Area.

3.6.5.1 Wetland and Riparian Vegetation

The Districts conducted a Wetland Habitats Associated with Don Pedro Reservoir Study (TID/MID 2013e) as part of the relicensing of the Don Pedro Project. Table 3.6-6 provides a list of wetland and riparian plants that have the potential to occur in the Project vicinity based on the results of the Districts' wetland study conducted within and adjacent to the Don Pedro Project area. Many of the sites surveyed for the Districts' wetland study are located far from the La Grange headpond, and the inclusion of a particular species in Table 3.6-6 does not necessarily mean that species occurs in or even near the Project.

Table 3.6-6. A partial list of wetland and riparian plants that have the potential to occur in the Project vicinity.

Common Name	Scientific Name
California barley	*Hordeum brachyantherum*
Rabbitfoot grass	*Polypogon monspeliensis*
Seepspring monkeyflower	*Mimulus guttatus*
Hedge nettle	*Stachys stricta*
Naked sedge	*Carex nudata*
Curly dock	*Rumex crispus*
Narrow leaf milkweed	*Asclepias fascicularis*
Red willow	*Salix laevigata*
Mountain rush	*Juncus balticus*
Spike rush	*Eleocharis ovata*
Leather root	*Hoita macrostachya*
Greensheath sedge	*Carex feta*
Spicebush	*Calycanthus occidentalis*
Western blue-eyed grass	*Sisyrinchium bellum*
Poison hemlock	*Conium maculatum*
Narrowleaf willow	*Salix exigua*
Field mint	*Mentha arvensis*
Oregon ash	*Fraxinus latifolia*
Common rush	*Juncus effusus*
Leather root	*Hoita macrostachya*
Alder	*Alnus incana*
Western sycamore	*Platanus racemosa*
Water buttercup	*Ranunculus aquatilis*
Rosella	*Helenium puberulum*
Tall flatsedge	*Cyperus eragrostis*
Broadleaf cattail	*Typha latifolia*
Lady's thumb	*Persicaria maculosa*
Floating primrose	*Ludwigia peploides*
Duckweed	*Lemna minor*
Yellow watercress	*Rorippa nasturtiumaquaticum*

Source: TID/MID 2013e.

Of the sites mapped for the wetland habitat study (TID/MID 2013e), one (i.e., the Big Creek site), is located near the upstream end of the La Grange headpond. The Big Creek wetland site 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*).

3.6.5.2 Wetland and Riparian Wildlife

Many of the species likely to occur typically use wetland or riparian habitats at some time during their lives. Great blue herons (*Ardea herodias*), common mergansers (*Mergus merganser*), and mallards (*Anas platyrhynchos*) likely use the wetland and riparian habitats in the vicinity of the Project on a limited/seasonal basis. Many amphibians and reptiles including California toad (*Anaxyrus boreas halophilus*), American bullfrog (*Lithobates catesbeianus*), western yellow-bellied racer (*Coluber constrictor mormon*), Pacific gopher snake (*Pituophis catenifer catenifer*), and valley gartersnake (*Thamnophis sirtalis fitchi*) may occur in the Project vicinity. Other species likely to occur in the wetland or riparian habitats include raccoon (*Procyon lotor*), mule deer (*Odocoileus hemionus*), mink (*Mustela vison*), and coyote (*Canis latrans*) (California Herps 2013; American Society of Mammalogists 2013).

3.6.5.3 Wetland, Riparian Zone, and Littoral Maps

As noted previously, a wetland, riparian zone, and littoral map for the Project vicinity (Figure 3.6-2) was compiled from a USFWS NWI map (USFWS 2017).

3.6.5.4 Estimates of Wetland, Riparian, and Littoral Habitat Acreage

Estimates of wetland, riparian, and littoral habitat acreage within 1 mile of the Project Boundary are provided in Table 3.6-5 above.

3.6.6 Potential Wildlife and Botanical Resource Effects

FERC's SD2 identifies the following potential resource issues associated with terrestrial resources:

- Effects of Project O&M on state-listed and special-status wildlife and plant species not protected under the ESA, occurring within the Project boundary and related access roads and rights-of-way.
- Effects of Project O&M on the presence and spread of terrestrial and aquatic noxious weeds, including water hyacinth and Ailanthus, within the Project boundary and related access roads and rights-of-way.
- Effects of vegetation clearing and maintenance within the Project boundary and related access roads and rights-of-way on wildlife and botanical resources.

There is no evidence of any significant ongoing effects on wildlife resources due to present and future run-of-river operation of the Project, including state-listed and special-status wildlife and plant species not protected under the ESA, based on observations during field visits to the site. The occurrence and distribution of wildlife resources near the Project are generally unrelated to operations. The use of roads and performance of maintenance tasks may at times result in limited, short duration disturbance of some wildlife species, but this is not considered a significant effect. Because water management is a result of the La Grange Project's primary purposes, i.e., it is not driven by hydroelectric power generation, there would be no effects on riparian-dependent wildlife as the result of the Proposed Action.

Based on field visits to the site and studies undertaken by the Districts in the vicinity of the Project, there is no evidence that O&M activities connected to hydroelectric power generation have contributed to the presence or spread of invasive species, including water hyacinth and Ailanthus. Ground disturbance and the presence and use of roads associated with the Hydroelectric Project have the potential to enhance the establishment and spread of invasive plant species. Areas where vegetation and soils have been disturbed are more susceptible to colonization by invasive weeds than undisturbed environments. Non-native invasive plant species can impact both human and environmental resources. Aggressive invasive weeds crowd out native vegetation and alter the natural environment and habitat for wildlife species, as well as affecting agricultural water-use efficiency, and recreational land values. They can adversely affect native plant species, plant communities, and wildlife through competition. The Districts conduct vegetation management as part of routine activities. Vegetation management activities at the La Grange Project include mechanical vegetation trimming along roads and paths parallel to canals to keep these areas safe and usable. The Districts comply with California Public Resources Code (CPRC) Section 4291 that requires maintenance of vegetation within 30 to 100 feet of a structure (defensible space). Additionally, the Districts maintain vegetation around Project roads and parking areas. The vegetation maintenance includes mowing/trimming of all vegetation in a 30 foot perimeter around structures and along road edges. Pruning of trees and shrubs is done around structures and buildings to remove ladder fuels that are subject to spreading fire up into the trees and into structures, and to eliminate low branches that could injure passing humans.

No significant ongoing adverse effects to botanical resources have been identified as a result of O&M activities connected to hydroelectric power generation, based on field visits to the site and studies undertaken by the Districts in the vicinity of the Project (i.e., for the Don Pedro Project relicensing). The only potential impacts to upland botanical resources associated with the Project include vegetation management along the perimeter of TID's powerhouse and associated facilities, and the maintenance of roads used to access the powerhouse. The degree of impact resulting from routine vegetation management is considered insignificant.

Because hydroelectric power generation at the Project does not alter flows in the Lower Tuolumne River, no impacts to the spread or distribution of water hyacinth are anticipated as a result of issuing an original license for the Project.

Based on field visits to the site and multiple studies undertaken by the Districts in the vicinity of the Project, conducted as part of the Don Pedro Project relicensing, there is no evidence of any ongoing effects on wetland resources due to hydroelectric power generation. As explained above, water management is dictated by the independent, primary purposes of the overall La Grange Project.

3.6.7 Proposed Wildlife and Botanical Resource Measures

Because the Proposed Action of continuing to generate hydroelectric power at the La Grange powerhouse would have no adverse effects on terrestrial resources in the Project vicinity, the Districts are proposing no resource measures related to wildlife or botanical resources.

As part of the Don Pedro Hydroelectric Project AFLA, the Districts are proposing a measure that is intended to control water hyacinth, which would benefit the Tuolumne River below the Don Pedro Project (TID/MID 2017a).

3.6.8 Cumulative Effects to Wildlife and Botanical Resources

FERC's SD2 did not require an analysis of cumulative effects to wildlife and botanical resources. However, the Districts have considered cumulative effects to wildlife and botanical resources and have concluded that no cumulative effects to these resources are expected as a result of the Proposed Action of continued hydroelectric power generation at the La Grange powerhouse. The Districts' proposed water hyacinth control measure at the Don Pedro Project would provide cumulative beneficial effects by helping to prevent spread and distribution of water hyacinth downstream of the Don Pedro Project (TID/MID 2017a).

3.6.9 Unavoidable Adverse Impacts to Wildlife and Botanical Resources

No unavoidable adverse impacts to terrestrial resources are anticipated as a result of the Proposed Action of continued hydroelectric power generation at the La Grange powerhouse.

3.7 Rare, Threatened, Endangered, Protected, and Special Status Species

This section discusses species potentially occurring in the vicinity of the Project that are listed as threatened or endangered under either the federal ESA, the California Endangered Species Act (CESA), or both, or are designated as fully protected,[27] rare, or special-status under California State law. Rare, threatened, and endangered; protected; and special-status species surveys conducted as part of the Don Pedro Project relicensing (referenced in subsequent sections) in some cases extended 0.25 miles outside the Don Pedro Project Boundary and, therefore, extended into a portion of the immediate Project vicinity. The Districts conducted studies to investigate the habitat and populations of special status plants, bald eagles, and amphibians as part of the Don Pedro Project relicensing (TID/MID 2013a, 2013d, 2013c). These studies provide information on listed species in the La Grange Project vicinity.

[27] In addition to the CESA, CDFW affords special protection to some fish and wildlife species, referring to them as "fully protected". Fishes are authorized under the California Fish and Game Code § 5515 and California Code of Regulations, Title 14, Division 1, Chapter 2, Article 4, Section 5.93. FP designations for amphibians and reptiles are authorized under § 5050 of the California Fish and Game Code.

3.7.1 Federal and State Listed Species

In July 2017, the Districts generated an official list of ESA-listed species for the Project study area, a 1-mile area surrounding the Project Boundary, using the on-line request service available at the USFWS's website (USFWS 2017).[28] The results of this search are included in Appendix E-1 to this Exhibit E. The Districts eliminated from this list three fish species (Delta smelt, *Hypomesus transpacificus;* Central Valley spring-run Chinook salmon, *Oncorhynchus tschawytscha*; and winter-run Chinook salmon, *O. tschawytscha)* and one invertebrate species (Conservancy fairy shrimp, *Branchinecta ajoredus*) because the fish species do not occur in the Tuolumne River basin, and the closest designated critical habitat for Conservancy fairy shrimp is over 10 miles from the Project, and no vernal pool habitats, which are required by Conservancy fairy shrimp, occur within 1 mile of the Project Boundary (CNDDB 2017).

To identify CESA-listed animals, the Districts reviewed the CNDDB (2017) for the Project study area, the CDFW July 2017 list of State and Federally Listed Endangered and Threatened Animals of California (CDFW 2017a), and the CDFW List of State Fully Protected Animals. To identify CESA-listed plants, the Districts reviewed the CDFW April 2013 list of State and Federally Listed Endangered, Threatened, and Rare Plants of California (CDFW 2017b), the U.S. Department of Agriculture's (USDA) PLANTS database, and the California Native Plant Society (CNPS) database.

The Districts then compiled information for each of the relevant listed, protected, and special-status species, including: (1) a description of the species' habitat requirements, (2) any known occurrences of the species within the Project study area, and (3) references to any recovery plans or status reports pertaining to the ESA-listed species (Table 3.7-1).

Table 3.7-1. Federal and State of California threatened or endangered species and state rare or fully protected species occurring or potentially occurring in the vicinity of the Project.

Common Name / Scientific Name	Status	Suitable Habitat Type	Occurrence in Project Vicinity	Status Reports, Recovery Plans Relevant to Project Vicinity
Plants				
Hartweg's golden sunburst *Pseudobahia bahiifolia*	FE, SE	Cismontane woodland, valley and foothill grassland (CNDDB 2017)	Occurs within La Grange quadrangle (CNPS 2010). Reported on the USFWS species list within the Project study area (USFWS 2017).	5-Year Review (USFWS 2007c)
Succulent owl's clover *Castilleja campestris* ssp. *Succulent*	FT, SE	Vernal pools (CNPS 2010)	Reported to occur in Stanislaus County (USDA 2013). Not reported on the USFWS species within the Project study area (USFWS 2017).	Recovery Plan (USFWS 2005)

[28] Source: https://ecos.fws.gov/.

Common Name / Scientific Name	Status	Suitable Habitat Type	Occurrence in Project Vicinity	Status Reports, Recovery Plans Relevant to Project Vicinity
Colusa grass *Neostapfia colusana*	FT, SE	Vernal pools (CNPS 2010)	Reported to occur in Stanislaus County (USDA 2013). Reported on the USFWS species list within the Project study area (USFWS 2017).	Recovery Plan (USFWS 2005) 5-Year Review (USFWS 2008)
Hairy orcutt grass *Orcuttia pilosa*	FE, SE	Vernal pools (CNPS 2010)	Reported to occur in Stanislaus County (USDA 2013). Not reported on the USFWS species list within the Project study area (USFWS 2017).	Recovery Plan (USFWS 2005) 5-Year Review (USFWS 2009)
Chinese Camp brodiaea *Brodiaea pallida*	FT, SE	Ultramafic, valley and foothill grassland, cismontane woodland, vernal streambeds, often serpentine (CNPS 2010)	Reported to occur in Tuolumne County (USDA 2013). Not reported on the USFWS species list within the Project study area (USFWS 2017).	5-Year Review (USFWS 2007a)
California vervain *Verbena californica*	FT, ST	Cismontane woodland, valley and foothill grassland, usually serpentine seeps and creeks (CNPS 2010)	Reported to occur in Tuolumne County (USDA 2013). Not reported on the USFWS species list within the Project study area (USFWS 2017).	5-Year Review (USFWS 2007d)
Layne's ragwort *Packera layneae*	FT, SR	Chaparral, cismontane woodland, serpentine or gabbroic, rocky (CNPS 2010)	Reported to occur in Tuolumne County (USDA 2013). Not reported on the USFWS species list within the Project study area (USFWS 2017).	Recovery Plan (USFWS 2002a)
Greene's tuctoria *Tuctoria greenei*	FE, SR	Vernal pools (CNPS 2010)	Reported to occur in Stanislaus County (USDA 2013). Critical habitat identified in USFWS search within the Project study area (USFWS 2017).	Recovery Plan (USFWS 2005) 5-Year Review (USFWS 2007b)
Invertebrates				
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	FT	Occurs only in the Central Valley and adjacent foothills up to 3,000 ft elevation in association with Blue elderberry.	Reported on the USFWS species list within the Project study area (USFWS 2017).	Recovery Plan (USFWS 1984)

Common Name / Scientific Name	Status	Suitable Habitat Type	Occurrence in Project Vicinity	Status Reports, Recovery Plans Relevant to Project Vicinity
Vernal pool fairy shrimp *Branchinecta lynchi*	FT	Occurs mostly in vernal pools although it also inhabits a variety of natural and artificial seasonal wetland habitats, such as alkali pools, ephemeral drainages, stock ponds, roadside ditches, vernal swales, and rock outcrop pools (NatureServe 2012).	Reported on the USFWS species list within the Project study area (USFWS 2017).	Recovery Plan (USFWS 2005)
Amphibians				
California tiger salamander, Central Valley DPS *Ambystoma californiense*	FT, ST	Breeds in seasonal ponds (or permanent ponds where fish are absent) and occasionally in intermittent streams. Occurs terrestrially in vacant or mammal-occupied burrows, occasionally other underground retreats, throughout most of the year; in grassland, savanna, or open woodland habitats (NatureServe 2012).	One occurrence found on CNDDB within the Project study area (CNDDB 2017). Reported on the USFWS species list for critical habitat within the Project study area (USFWS 2017).	None
California red-legged frog *Rana aurora draytonii*	FT	Suitable habitat is located in deep (>2.3 ft), still or slow- moving water within dense, shrubby riparian and upland habitats (Jennings and Hayes, 1994).	Reported on the USFWS species list within the Project study area (USFWS 2017). The nearest known occurrence is at Piney Creek, where CRLF was last documented in 1984 at locations ranging from 0.96 mi east to 1.06 mi east of the Don Pedro Project Boundary (Basey, pers. Comm., 2010, Jennings, pers. Comm. 2010 *as cited in* TID/MID 2011).	Recovery Plan (USFWS 2002b)

Common Name / Scientific Name	Status	Suitable Habitat Type	Occurrence in Project Vicinity	Status Reports, Recovery Plans Relevant to Project Vicinity
		Fish		
Steelhead[29], California Central Valley DPS *Oncorhynchus mykiss irideus*	FT	CCV steelhead spawn from December – April in cool, well oxygenated streams (NMFS 2014). Juveniles migrate to the ocean after spending two years in fresh water. They reside in the ocean for two or three years before returning to their natal streams to spawn. In the Central Valley, spawning occurs within the Sacramento and San Joaquin rivers and their tributaries. The majority of native, natural production occurs in upper Sacramento River tributaries below Red Bluff Diversion Dam (NatureServe 2012).	Reported on the USFWS species list for critical habitat within the Project study area (USFWS 2017; CNDDB 2017).	Recovery Plan for Sacramento River Winter-run Chinook Salmon, Central Valley Spring-run Chinook Salmon and Central Valley Steelhead (NMFS 2014)
		Birds		
Golden eagle *Aquila chrysaetos*	SFP	Generally open country, in prairies, arctic and alpine tundra, open wooded country, and barren areas, especially in hilly or mountainous regions. Nests on rock ledge of cliffs or in large trees (NatureServe 2012).	Observed during the BLM and Central Sierra Audubon Society (CSAS) mid-winter eagle surveys on Don Pedro Reservoir. Eagles were observed during surveys in 1997 and each year between 1999 and 2009.	None
		Mammals		
San Joaquin kit fox *Vulpes macrotis mutica*	FE, ST	Alkali sink, valley grassland, foothill woodland. Hunts in areas with low sparse vegetation that allows good visibility and mobility (NatureServe 2012).	One occurrence found on CNDDB within La Grange quadrangle (CNDDB 2017). Reported on the USFWS species list within the Project study area (USFWS 2017).	Recovery Plan (USFWS 1998)

FE: - Federally Endangered: Any species that is in danger of extinction throughout all or a significant portion of its range.
FT: - Federally Threatened: Any species likely to become endangered within the near future.
SE: - State Endangered: California State listed as Endangered.
ST: - State Threatened: California State listed as Threatened.
SFP: - California State listed as Fully Protected.
SR: - California State listed as Rare.

[29] CCV steelhead is addressed in Section 3.5 of this Exhibit E.

3.7.2 Potential Resource Effects to Threatened and Endangered Species

FERC's SD2 (page 21) identifies the following potential resource issues associated with threatened and endangered species:

- Effects of Project O&M on plants and wildlife species listed as threatened under the ESA.
- Effects of Project O&M on designated critical habitat under the ESA.
- Effects of vegetation clearing and maintenance on species listed as threatened or endangered under the ESA.

Water releases for the La Grange Project's primary purposes, i.e., irrigation and M&I uses, are not dependent on the issuance of a FERC license for the Proposed Action, and would occur with or without the licensing of the Project. As such, these uses are not interrelated or interdependent with the issuance of a FERC license for hydroelectric power generation. Because the Districts are seeking a license to permit the Proposed Action, the non-hydropower water uses are independent actions. These independent actions (i.e., primary purposes) contribute to cumulative effects in the Tuolumne and San Joaquin river basins but do not constitute direct or indirect effects associated with the Proposed Action. Cumulative effects to resources are discussed in Section 3.0 of this Exhibit E.

Hydroelectric power is generated at the Project using flows released to satisfy the overall La Grange Project's independent, primary purposes (i.e., irrigation and M&I releases) and to provide flows to the lower Tuolumne River for the benefit of aquatic resources. Water deliveries and high-flow releases are pre-scheduled based on forecasted demands and actual projected inflows and then released through the powerhouse up to its hydraulic capacity.

Based on surveys and existing studies, there is no evidence of any significant ongoing effects on rare, threatened, endangered, protected, or special-status wildlife or plant species due to operation of the Project. The occurrence and distribution of these species near the Project are generally unrelated to operations.

Dewatering of the tailrace channel during a powerhouse outage is a potential Project effect on *O. mykiss* residents using tailrace channel critical habitat for rearing (see Section 3.5 of this Exhibit E for further discussion), but studies have shown minimal impact to the water surface elevations or deleterious disruptions to flows in this area due to outages. The amount of time it takes for TID sluice gate channel flows to manifest in the tailrace channel in order to offset the loss of powerhouse flows has a direct influence on water surface elevations in the tailrace channel. The powerhouse operation is monitored around-the-clock from the TID remote operations desk located at TID's central control. Although remote start-up is possible, for safety reasons, operators are generally dispatched to the Project to check conditions following a station trip and to start the unit(s). If a unit or station trip, remote operators immediately open the two sluice gates to make certain flows continue downstream without disruption. The disruption to downstream flow as measured at the nearby USGS La Grange gage was examined by the Districts at the request of NMFS and FERC as part of the Don Pedro Project relicensing. The results of this analysis showed that flow fluctuations were less than 2 inches 99.4 percent of the time. This study (attachment to TID/MID 2014 [Districts' Response to NMFS-4, Element 1 through 6] is attached to this FLA. These data indicate that operations of the La Grange powerhouse and the sluice gates are well synchronized if the powerhouse trips offline resulting in a relatively stable flow in the tailrace channel, thus having a minimal effect on *O. mykiss* critical habitat as a result of the Proposed Action.

The use of roads and performance of maintenance tasks may at times result in limited, short duration disturbance of some species, to the extent that they occur, but this is not considered a significant effect. Vegetation management activities at the La Grange Project include mechanical vegetation trimming along roads and paths parallel to canals to keep these areas safe and usable. The Districts comply with California Public Resources Code (CPRC) Section 4291 that requires maintenance of vegetation within 30 to 100 feet of a structure (defensible space). Additionally, the Districts maintain vegetation around Project roads and parking areas. The vegetation maintenance includes mowing/trimming of all vegetation in a 30 foot perimeter around structures and along road edges. Pruning of trees and shrubs is done around structures and buildings to remove ladder fuels that are subject to spreading fire up into the trees and into structures, and to eliminate low branches that could injure passing humans. The degree of impact resulting from this vegetation management is considered insignificant. Because water management is a result of the La Grange Project's primary purposes (i.e., it is not driven by hydroelectric power generation, there would be no effects on riparian-dependent wildlife as the result of the Proposed Action).

Based on field visits to the site and studies undertaken by the Districts in the vicinity of the Project (i.e., for the Don Pedro Project relicensing), there is no evidence of any significant ongoing adverse effects on rare, threatened, endangered, protected, or special-status species due to O&M activities connected to hydroelectric power generation.

3.7.3 Proposed Threatened and Endangered Species Resource Measures

The Districts are proposing two measures aimed at aquatic resources that are expected to benefit *O. mykiss*. To address fish entering the TID sluice gate channel and becoming stranded, the Districts have proposed to install a fish exclusion barrier at the channel entrance.

The Districts also propose to formalize the 5 to 10 cfs release to the plunge pool below the LGDD to support water quality (discussed in Section 3.4 of this Exhibit E) and to maintain a stable flow regime for fish present in the plunge pool (discussed in Section 3.5 of this Exhibit E).

3.7.4 Cumulative Effects to Threatened and Endangered Species

FERC's SD2 did not require an analysis of cumulative effects to threatened and endangered species. However, the Districts have considered cumulative effects to threatened and endangered species and have concluded that no cumulative effects to threatened and endangered species are expected as a result of the Proposed Action of continued hydroelectric power generation at the La Grange powerhouse.

3.7.5 Unavoidable Adverse Impacts to Threatened and Endangered Species

No unavoidable adverse impacts to threatened or endangered species are anticipated as a result of the Proposed Action of continued hydroelectric power generation at the La Grange powerhouse.

3.8 Recreation and Land Use

The Project is located on the Tuolumne River in Tuolumne and Stanislaus counties, California. Extending from the foothills to the crest of the Sierra Nevada Mountains, Tuolumne County is a popular recreation area. The County contains historical gold mining towns, the Emigrant Wilderness area, Yosemite National Park, and numerous lakes and rivers, including the Wild and Scenic Tuolumne River (Tuolumne County 2005 as cited in TID/MID 2011).

Since the incorporation of Tuolumne County, the region has been a prominent area for industry and recreation. The principal industries were originally related to mining and timber. Early recreational visitors to Tuolumne County were primarily focused on Yosemite National Park. As transportation improved, many locations that were once inaccessible became popular for hiking, camping, gold panning, fishing, swimming, picnicking, climbing, and general river recreation activities (TID/MID 2011).

Stanislaus County is situated in the San Joaquin Valley within 100 miles of San Francisco Bay. Land uses in Stanislaus County include diversified agriculture and livestock husbandry. Recreation activities include fishing, hunting, public recreation areas, community parks, and access to reservoirs.

3.8.1 Existing Recreational Facilities and Opportunities in the Tuolumne River Basin

Recreation opportunities abound in the Tuolumne River basin. Upstream of the Don Pedro Project Boundary, the Tuolumne River is designated as a National Wild and Scenic River all the way to its source (except for Hetch Hetchy Reservoir), a total of about 80 miles. Yosemite National Park and Stanislaus National Forest provide opportunities for camping, fishing, whitewater boating, and other outdoor activities (TID/MID 2011).

Don Pedro Reservoir provides ample recreational opportunities. The public has access to the entire shoreline from the high-water line down and has vehicle access via a variety of small roads outside the major recreation areas (TID/MID 2011). Three developed recreation areas at Don Pedro Reservoir, managed by the DPRA, cumulatively provide 4 picnic areas, 3 boat ramps, 3 fish cleaning stations, 33 toilet buildings (12 of which have showers), and over 500 campsites (TID/MID 2013).

Don Pedro Reservoir supports year-round fishing and supports populations of rainbow, brown, and brook trout; kokanee, coho and Chinook salmon; largemouth, smallmouth, and spotted bass; black and white crappie; bluegill and green sunfish; channel, white, and black bullhead catfish. Day use visitors have access to fishing opportunities both along the shoreline and via boating. The many forks of the Don Pedro Reservoir afford opportunities for isolated and quiet settings for fishing. Don Pedro Reservoir is also a site for frequent bass and fishing tournaments. For example, in 2017, 11 different organizations are scheduled to hold 21 fishing tournaments at Don Pedro Reservoir (DPRA 2017).

There are no recreation facilities located along the reach of the Tuolumne River between Don Pedro Dam and the LGDD, and access to the area is limited. Boating above the LGDD is made difficult by infeasibility of portage at the spillway because the dam's abutments are vertical canyon walls, and the spillway spans directly between the two Districts' canal intakes, which creates hazardous conditions. TID maintains signage, warning buoys, and a boat restraining barrier to protect the public from dangers associated with LGDD and the Project (TID 2014).

Downstream of the Project, most recreation takes place at Turlock Lake and Modesto Reservoir, although fishing, canoeing, and kayaking occur on the lower Tuolumne (TID/MID 2011). Public fishing access to the area downstream of the Project is available to individuals by walking upstream parallel to the private road that is gated where the main canal crosses highway 132, and individuals boating upstream from a public access point in the town of La Grange, approximately 1.5 to 2 miles downstream. Signage on the downstream side of the Project facilities provides public warning regarding high voltage structures and hillside discharge (TID 2014).

Turlock Lake State Recreation Area is located in eastern Stanislaus County approximately six miles from the Project, and houses the only developed camping facilities along the Tuolumne River downstream of the Project. It is open year-round and features camping, picnicking, fishing, swimming, boating, and water skiing. Bounded on the north by the Tuolumne River and on the south by Turlock Lake, the recreation area provides an ideal setting for water-oriented outdoor activities. Picnicking, day-use, and boat launch ramps are available as well as overnight camping on the south bank of the Tuolumne River (California Department of Parks and Recreation [CDPR] 2013).

Modesto Reservoir Regional Park is located a few miles east of the town of Waterford off Highway 132. This regional park offers 3,240 acres of land and 2,800 acres of reservoir for recreation and camping. Campsites 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 (TID/MID 2011).

The Tuolumne River from LGDD to the San Joaquin River provides opportunities for kayaking, rafting, and tubing, with a few Class I-II rapids (TID/MID 2011). From below the La Grange tailrace down to the Basso Bridge boat ramp (RM 47.4), the Tuolumne is scenic and constitutes a beginner's run. This approximately five-mile section of river is primarily flat, generally wide, with several small riffles and a small ledge drop. Turns are all fairly gradual. From Basso Bridge to Turlock Lake State Park, which is approximately six miles in length, the river alternates between flat wide slow water and narrow channels that are fast and sinuous (American Whitewater 2013). Most people take out at Turlock Lake, as there are limited river access and parking options farther downstream (TID/MID 2011).

The Tuolumne River downstream of the Project provides fishing opportunities with special regulations for trout and salmon fishing. From LGDD 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 and anglers fish from boats or from the shoreline (TID/MID 2011).

There is limited developed river and fishing access along the lower Tuolumne River outside of Turlock Lake State Recreation Area. The two most common public access points are at Basso Bridge and Fox Grove. Basso Bridge is located off Route 132 west of the town of La Grange. Basso Bridge is part of the La Grange Regional Park, which provides about two acres of river access. The Regional Park includes a parking lot, restrooms, informal boat launch, gravel beach area for swimming, trails and pathways, barbecues, picnic tables, and handicapped access. Fishing is permitted with only barbless hooks, synthetic baits, and tackles. Trout may not be taken and must be released. Basso Bridge fishing access is closed from October 16 through December 31 due to the Chinook salmon run (Stanislaus County 2010 as cited in TID/MID 2011). Existing parking lots and public river access sites downstream of the Project are identified on Figure 3.8-1.

3.8.2 Land Use

Lands in the Project vicinity are within Tuolumne and Stanislaus counties and are subject to the Tuolumne County and Stanislaus County general plans and zoning ordinances. Primary land uses in the Project vicinity are single-family residential, non-irrigated farmland, and irrigated farmland.

Land use downstream of the Project is predominately irrigated agriculture and related uses, urban/suburban, and rural residential. The Districts serve over 200,000 acres of high value farmland in the Central Valley.

3.8.3 Recreation Needs Identified in Management Plans

Management plans that address recreation resources within the Tuolumne River basin include the California Department of Parks and Recreation's State Comprehensive Outdoor Recreation Plan (SCORP), including the Survey on Public Opinions and Attitudes in Outdoor Recreation (CDPR 2015); the U.S. Department of Interior, USFWS Recreational Fisheries Policy (USFWS 1989); the Tuolumne County General Plan (Tuolumne County 1996); and the Stanislaus County General Plan (Stanislaus County 1994).

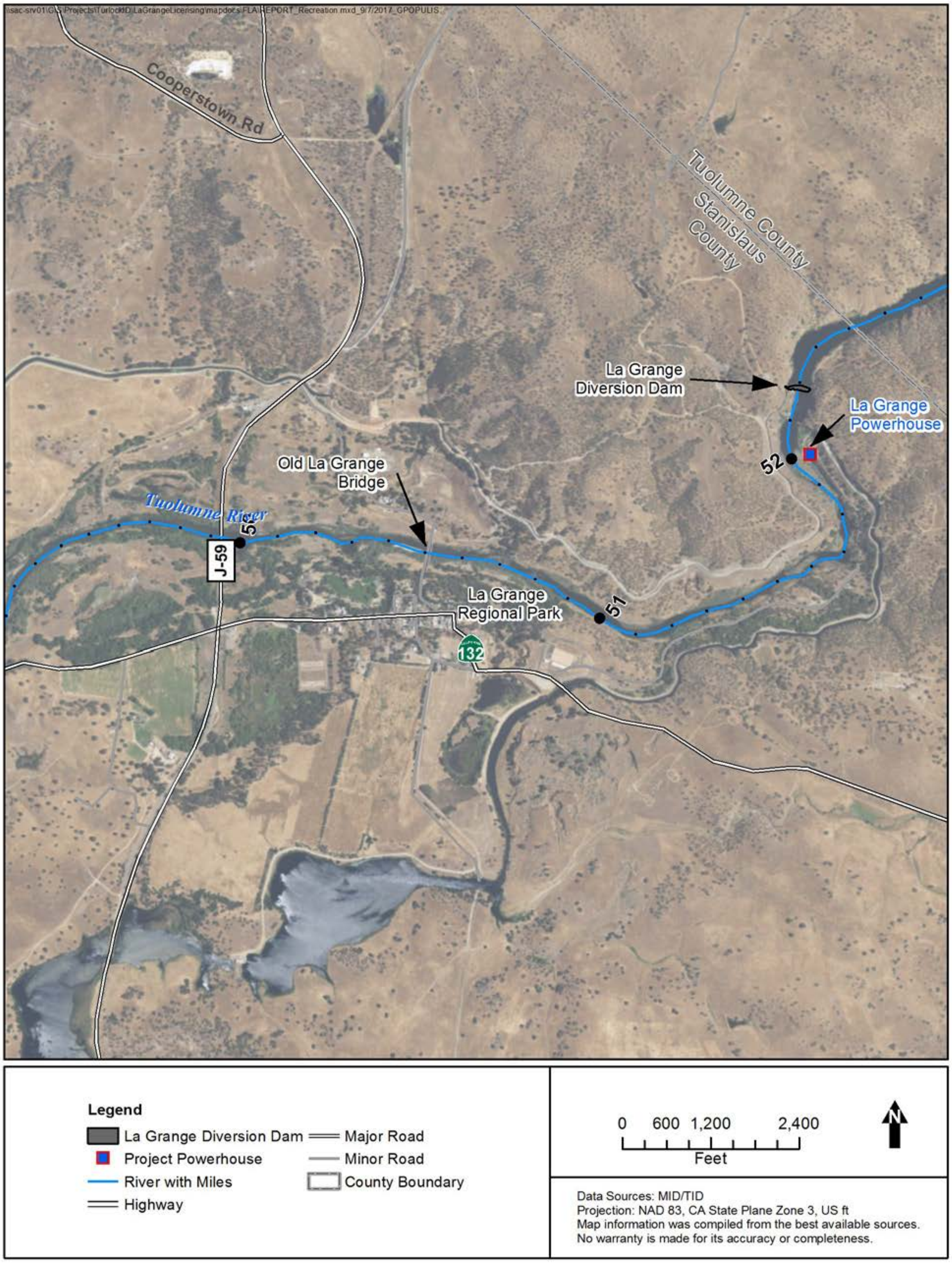

Figure 3.8-1. Existing parking lots and public river access sites downstream of the Project.

3.8.3.1 California Outdoor Recreation Plan

The 2015 SCORP, among other things, identifies and prioritizes outdoor recreation opportunities and constraints most critical in California. The 2015 SCORP summarizes key findings, introduces new GIS tools to assess local park needs, and establishes priorities for statewide actions including the use of Land and Water Conservation Fund allocations to California. The 2015 SCORP establishes the following actions to address California's park and recreation needs:

- Inform decision-makers and communities of the importance of parks.
- Improve the use, safety, and condition of existing parks.
- Use GIS mapping technology to identify park deficient communities and neighborhoods.
- Increase park access for Californians including residents in underserved communities.
- Share and distribute success stories to advance park and recreation services.

The Survey on Public Opinions and Attitudes in Outdoor Recreation in California (POAOR), an element of the SCORP, uses various types of surveys, including an adult telephone survey, adult online/mail-back survey, and online/mail-back youth survey, to provide a comprehensive perspective of the outdoor recreation opinions and attitudes of Californians.

As determined by the 2012 POAOR, the top five recreational activities in California with the highest latent demand are listed in Table 3.8-1. These are activities that Californians would participate in, from a statewide perspective, if more facilities and opportunities were provided. The table provides an overview of the results from the adult and youth surveys.

Table 3.8-1. Top five recreational activities with the highest latent demand in California.

Activity (Adults)	Would Participate More Often (% Yes)	Activity (Youths)	Would participate More Often (% Yes)
Picnicking in picnic areas (with tables, fire pits, or grills)	55.1	Horseback riding	50.2
Walking for fitness or pleasure on paved surfaces	37.4	Camping (tent, recreational vehicle, trailer)	47.1
Camping in developed sites with facilities such as toilets and tables (not including backpacking)	35.1	Mountain biking	46.3
Beach activities (swimming, sunbathing, surf play, wading, playing on beach)	34.6	Backpacking (overnight hiking)	46.3
Swimming in a pool	33.0	Archery	44.9

3.8.3.2 Tuolumne County General Plan

The Tuolumne County General Plan (1996) includes seven mandated elements and an unlimited number of optional elements. The mandatory elements are Land Use, Circulation, Housing, Conservation, Open Space, Noise, and Safety. Currently, the plan includes the following optional elements: Cultural Resource, Economic Development, Agricultural, Recreation, Community Identity, Air Quality, and Public Facilities and Services (TID/MID 2011).

The Recreation Element focuses on the needs associated with its visitors and local residents as well as identifying acquisition funding sources and developing and maintaining parks and recreational facilities. Implementation of the Recreation Element revolves around the following seven key goals:

- Provide an adequate supply and equitable distribution of recreation facilities for residents;
- Cooperate with other public agencies and private enterprise to provide park and recreation facilities;
- Further the goals of other General Plan elements in the acquisition and development of lands for recreation facilities and opportunities;
- Address the impacts of new developments on the County's recreational facilities;
- Acquire, manage, and develop recreational lands according to principles which protect private property rights, maximize cost efficiency, promote accessibilities by all residents, advocate safety, and encourage public participation;
- Develop a broad-based financing program with a wide variety of revenue sources which equitably distributes and/or reduces the cost of providing new recreation facilities; and
- Provide for the ongoing acquisition, construction, and maintenance of recreation facilities.

3.8.3.3 Stanislaus County General Plan

The Stanislaus County General Plan (Stanislaus County 1994) consists of seven mandatory elements and as many optional elements as the local jurisdiction deems desirable. The mandatory elements include Land Use, Circulation, Housing, Open Space, Conservation, Safety, and Noise. Since the Open Space and Conservation Elements have overlapping requirements, they have been combined in the Stanislaus County General Plan. The County has also adopted one optional element, the Agricultural Element.

The Land Use Element focuses on the general distribution and general location and extent of the uses of the land for housing, business, industry, and open space, agriculture, natural resources, recreation, and enjoyment of scenic beauty, education, public buildings and grounds, solid and liquid waste disposal facilities, and other categories of public and private uses of land. The plan includes the following goals:

- Provide for diverse land use needs by designating patterns which are responsive to the physical characteristics of the land as well as to environmental, economic, and social concerns of the residents of Stanislaus County.
- Foster stable economic growth through appropriate land use policies.
- Ensure that an effective level of public service is provided in unincorporated areas.

3.8.4 Recreation Access and Safety Assessment Study

The Recreation Access and Safety Assessment (TID/MID 2017, attached to this FLA) states that significant portions of the west bank upstream of LGDD, and both banks of the river immediately downstream of it, are owned by TID or MID or are administered by the BLM. This combination of Districts' ownership and public land may present opportunities for public access, subject to considerations of risk, safety, LGDD security, and environmental impact (TID/MID 2017).

Upstream of LGDD, an assessment of bank slope within 1 mile of Bonds Flat Road (the nearest public road) and within 75 feet of the high water line indicated that although slopes immediately adjacent to the La Grange headpond are generally less than seven percent in grade, the slopes steepen sharply as you move away from the river bank. Downstream of LGDD grades along this stretch of the river bank are generally less steep (TID/MID 2017).

From Don Pedro Dam to a point approximately 100 yards upstream of the MID and TID diversion tunnel intakes, current activities are limited to occasional use by the adjacent private property owners. Normal operation of the Don Pedro Project during the irrigation season can cause rapid changes in water velocities through the entire reach of the La Grange headpond. While localized shoreline activities could be considered reasonably safe, in-water activities would be high risk.

The stretch of river between LGDD and a point approximately 100 yards upstream of the MID and TID diversion tunnel intakes may be accessible via the upstream reach of the La Grange headpond; access from the shore is unlikely due to steep slopes and private property. Public hazards in this stretch of river are extreme. One such hazard is the diversion dam overflow spillway. The La Grange spillway has a unique configuration in that there are no abutments; the spillway extends from canyon wall to canyon wall. This area spills when the forebay inflow exceeds the hydraulic capacity or gate settings of the TID and MID diversion tunnel intakes. Flow velocities in the area are frequently high. An individual or boat within this stretch of river is subject to being swept over the spillway and falling over about 100 feet to the rocks below.

Downstream of LGDD, access for fishing and other activities is available to individuals by walking along La Grange Dam Road, which is gated near where the main canal crosses Highway 132. Individuals also walk and wade upstream from a public access point in the town of La Grange near the Old La Grange Bridge (RM 50). Safety signs are installed throughout the dam and powerhouse area to warn users of potential hazards. The most significant potential risk downstream of LGDD appears to be to individuals fishing in close proximity to LGDD or the powerhouse at the time of a spill event or an increase in flows. In addition, plant and LGDD security issues associated with allowing public access directly to the powerhouse or dam infrastructure must be recognized. Risk levels for a range of recreation activities associated with the La Grange headpond and immediately downstream of LGDD under an increased use scenario are shown in Table 3.8-2.

Table 3.8-2. Risk levels for a range of recreation activities associated with the La Grange headpond under an increased use scenario.

Risk Level	Activity
La Grange Headpond	
High	• Fishing from Boat • Boating (under power) • Canoeing / Kayaking / Rowing • Swimming / Diving • Climbing
Medium	• Fishing from Shore • Walking / Hiking • Picnicking • Bird watching
Low	• None at this time
Downstream of LGDD	
High	• Fishing from Boat • Boating (under power) • Canoeing / Kayaking / Rowing • Swimming / Diving
Medium	• Fishing from Shore • Walking / Hiking • Climbing • Bird watching
Low	• None at this time

3.8.5 Potential Recreation Resource Effects

FERC's SD2 identifies the following potential effects of the Project on recreation and land use resources:

- Effects of Project operation on recreation.
- Adequacy of existing public access to support future recreation use.

No developed recreational facilities are owned and/or maintained by the Districts at the Project. No effects on recreation and land use would result from continued operation of the hydropower facilities. Public access upstream of the Project has been limited to occasional access by the adjacent private property owner. General public use has not occurred historically; however, public use is not currently prohibited. Members of the public currently access the reach downstream of the Project by walking along La Grange Dam Road and/or by wading and boating upstream from a public access point near the Old La Grange Bridge, where a public parking lot is located.

3.8.6 Proposed Recreation Resource Measures

To support appropriate recreational day use and access of the Project area, a recreational foot trail extending from the former Don Pedro Visitor Center parking lot to the La Grange headpond would be provided with an estimated cost of $80,000. Because this trail would be inside an area of the Don Pedro Project Boundary which leads to Don Pedro dam and powerhouse, security concerns must be addressed. At this time, the most appropriate measures would appear to be a sign-in at the Don Pedro Fleming Meadows campground, and a requirement to leave a driver's license and a deposit in exchange for an electronic access card. If the foot trail is approved by FERC, security issues will be finalized and an exact location for the trail extending from the old parking lot to the headpond would be completed and filed with FERC. The following improvements are planned as part of trail construction:

- Install information signage at trailhead.
- Provide signage at the base of the trail to indicate potential hazards associated with the spillway, rapidly changing river levels and flows, strong currents, tunnel intakes, and lack of egress.
- Provide signage to delineate private property in the area.

3.8.7 Cumulative Effects to Recreation Resources

As described in FERC's SD2, the geographic scope over which to evaluate cumulative effects to recreation resources as a result of the Proposed Action extends upstream to the upper extent of Don Pedro Reservoir and downstream to the confluence of the Tuolumne and San Joaquin Rivers. Many recreational opportunities are present within this geographic area. In particular, Don Pedro Reservoir provides public access for boating, fishing, camping, swimming, and picnicking. These facilities appear to meet current demand and are generally in good condition (TID/MID 2013).

There are currently no recreation facilities located between Don Pedro Dam and the LGDD. Section 3.8.6 describes the Districts' proposed measure to establish a recreation foot trail to the La Grange headpond, which will be a new recreation facility for public use.

Recreation in the form of fishing, kayaking, rafting, and tubing is available downstream of the Project, between LGDD and the confluence of the Tuolumne and San Joaquin Rivers, and several access points are available for public use.

The operation of the Project does not negatively affect any recreation resources available in the geographic area specified in FERC's SD2. Operation of Project has had no impacts to recreation resources in the past and has no impacts presently. Continued operation of the Project is not expected to have impacts within the next 30 to 50 years. The construction of the recreation foot trail discussed in Section 3.8.6 of this Exhibit E will provide a beneficial effect on recreation resources in the Project vicinity, as a new recreation opportunity will exist where none existed previously. This recreation facility will be maintained over the term of the Project license, thus providing benefits to the public over the next 30 to 50 years. Therefore, positive cumulative effects to recreation resources have been identified as a result of the Proposed Action, and are expected to persist over the temporal scope specified in FERC's SD2.

3.8.8 Unavoidable Adverse Impacts to Recreation Resources

No unavoidable adverse impacts to recreation resources are anticipated as a result of the Proposed Action of continued hydroelectric power generation at the La Grange powerhouse.

3.9 Aesthetic Resources

The Project is located on the Tuolumne River near the border of Stanislaus and Tuolumne counties in Central California. The LGDD, which was originally constructed between 1891 and 1893, replaced Wheaton Dam, which was built by other parties in the early 1870s. The original 127.5-foot-high arched LGDD was constructed of boulders set in concrete and faced with roughly-dressed stones from a nearby quarry. In 1923, an 18-inch-high concrete cap was added, and in 1930 an additional 24-inch-high concrete cap was added, resulting in the current height of 131 feet (Figures 3.9-1 and 3.9-2).

Figure 3.9-1. Current photograph of the downstream face of La Grange Diversion Dam.

Figure 3.9-2. Water spilling at La Grange Diversion Dam (February 2017).

The La Grange headpond extends approximately one mile upstream from the LGDD and is contained in a narrow, steep-sided canyon (Figure 3.9-3). Views of the La Grange headpond are scenic, and because residential and commercial development do not occur along the headpond's shoreline, vegetation along the reservoir is generally established, and lands around the headpond blend into the surrounding landscape.

Figure 3.9-3. La Grange headpond.

The La Grange powerhouse is a 72-foot by 29-foot structure with reinforced concrete substructure and steel superstructure located approximately 0.2 miles downstream of the LGDD on the east bank of the Tuolumne River (Figure 3.9-4). A portion of the water discharged from the La Grange headpond is routed to a concrete forebay that contains the TID non-Project irrigation canal headworks and, separately, the intakes for the two powerhouse penstocks. The penstock for Unit 1 is a 235-foot-long, 5-foot-diameter riveted steel pipe. The penstock for Unit 2 is a 212-foot-long, 7-foot-diameter riveted steel pipe. Turbine discharges at the La Grange Powerhouse flow into a tailrace that joins the lower Tuolumne River about 0.5 mile below the LGDD. The Project facilities are structural elements that visually contrast with the surrounding landscape.

Figure 3.9-4. Penstock and powerhouse viewed from the MID canal.

3.9.1 Potential Aesthetic Resource Effects

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

- Effects of the Project's features, operation, and maintenance on the surrounding landscape.

The Project has only minor visual impacts on the surrounding area. Because the Districts are proposing no changes to the existing structure or operation of the hydroelectric facilities, there will be no change relative to baseline conditions. No issues related to aesthetic resources at the Project have been identified by licensing participants.

3.9.2 Proposed Aesthetic Resource Effects

Because the Proposed Action of continuing to generate hydroelectric power at the La Grange powerhouse would have no adverse effects on aesthetic resources in the Project vicinity, the Districts are proposing no resource measures related to aesthetic resources.

3.9.3 Cumulative Effects to Aesthetic Resources

FERC's SD2 did not require an analysis of cumulative effects to aesthetic resources. However, the Districts have considered cumulative effects to aesthetic resources and have concluded that no cumulative effects to aesthetic resources are expected as a result of the Proposed Action of continued hydroelectric power generation at the La Grange powerhouse.

3.9.4 Unavoidable Adverse Impacts to Aesthetic Resources

No unavoidable adverse impacts to aesthetic resources are anticipated as a result of the Proposed Action of continued hydroelectric power generation at the La Grange powerhouse.

3.10 Cultural and Tribal Resources

The La Grange Project area has a varied and rich history related to cultural resources. The Districts have conducted a Cultural Resources Study in consultation with potentially affected Tribes, BLM, the SHPO, and other interested parties, to identify cultural resources within the APE, formulate a plan to evaluate their eligibility to the NRHP, if needed, and identify Project-related effects on those resources. The Cultural Resources Study Report, filed as an appendix to the Districts' USR, presented a detailed description of the history of cultural resources in the Project vicinity and the full results of the Cultural Resources Study (TID/MID 2017a, filed with this FLA as Privileged). A brief summary of Cultural Resources Study Report results is presented below.

The Cultural Resources Study resulted in the identification of 20 archaeological and built environment resources, of which 18 have been evaluated as ineligible for inclusion on the NRHP, and two have been evaluated as eligible for inclusion on the NRHP (Table 3.10-1).

A total of two isolated finds were located and documented within the APE. Both of these isolated finds are historic-era isolates and have been evaluated as ineligible for inclusion on the NRHP.

Table 3.10-1. Summary of NRHP recommendations for resources identified within the APE.

Resource Type	Ineligible	Unevaluated	Eligible	Totals
Isolated Find	2	0	0	**2**
Archaeological Site	5	0	0	**5**
Built Environment	11	0	2	**13**
TCP	0	0	0	**0**
Totals	**18**	**0**	**2**	**20**

A total of five archaeological sites were located and documented within the APE, of which all five were newly identified. Of the five archaeological sites identified, four contain historic-era deposits and features and one represents prehistoric or Native American use. Of the archaeological sites identified within the APE, all five have been evaluated as ineligible for inclusion on the NRHP.

A total of 13 built environment resources, 11 newly recorded, were identified and recorded. Of these, 11 are recommended ineligible for inclusion in the NRHP, and two are recommended eligible for inclusion: the LGDD and the La Grange Ditch. The La Grange Ditch was previously determined eligible and SHPO concurred with this determination in a letter dated December 12, 2014. The La Grange Project was also evaluated as a potential historic district comprised of those built environment facilities that represent the operation and support infrastructure facilities of the La Grange Project as a hydroelectric generation and water irrigation project and were part of the original Project facilities built between 1893 and 1924. The La Grange Project as a whole was found to have insufficient physical integrity to be eligible for listing in the NRHP as a historic district.

Interviews and background research were conducted to identify and evaluate traditional cultural properties within the Project APE; however, no evidence of traditional cultural properties within the APE were revealed during the study. The Cultural Resources Study identified two historic properties (assuming SHPO concurs with the eligibility of the LGDD), the LGDD and the La Grange Ditch.

3.10.1 Potential Cultural Resource Effects

Page 22 of FERC's SD2 identifies the following issues associated with cultural resources:

- Effects related to the O&M on historic, archaeological, and traditional cultural resources that may be eligible for inclusion in the NRHP.

The Cultural Resources Study identified two historic properties, the LGDD and the La Grange Ditch (SHPO concurred with the eligibility of the LGDD in a letter dated September 18, 2017 and concurred with the eligibility of the La Grange Ditch in a letter dated on December 12, 2014). No ongoing Project-related effects were observed to be occurring to either of these resources at the time of documentation for the Project licensing efforts. However, O&M activities conducted under the FERC license could adversely affect these historic properties. Such activities could include the use and maintenance of Project facilities, construction of new facilities, or other as yet undetermined activities. The Districts plan to develop an HPMP in consultation with the Tribes, BLM, and the SHPO to manage potential effects on historic properties throughout the term of any new license issued by FERC.

3.10.2 Proposed Cultural Resource Measures

The Districts plan to develop an HPMP in consultation with Tribes, BLM, and SHPO to manage potential effects on historic properties throughout the term of an original license (TID/MID 2017b). The purpose of an HPMP is to outline actions and processes to manage historic properties within the APE under an original 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.

3.10.3 Cumulative Effects to Cultural Resources

FERC's SD2 did not require an analysis of cumulative effects to cultural resources. However, the Districts have considered cumulative effects to cultural resources and have concluded that no cumulative effects to cultural resources are expected as a result of the Proposed Action of continued hydroelectric power generation at the La Grange powerhouse.

3.10.4 Unavoidable Adverse Impacts to Cultural Resources

No unavoidable adverse impacts to cultural resources are anticipated as a result of the Proposed Action of continued hydroelectric power generation at the La Grange powerhouse.

3.11 Socioeconomic Resources

LGDD was constructed from 1891 to 1893. The purpose of the dam was to raise the level of the Tuolumne River to permit the diversion and delivery of water by gravity to irrigation systems owned by TID and MID. Built in 1924, the La Grange hydroelectric plant is owned and operated by TID and has a capacity of about 4.6 MW. LGDD provides no flood control benefits, and there are no recreation facilities associated with the Project or the La Grange headpond.

LGDD is located on the Tuolumne River near the border of Stanislaus and Tuolumne counties in the Central Valley of California. The dam is located in Stanislaus County, and the La Grange headpond spans both Stanislaus County and Tuolumne County. The following section provides population, demographic, employment, and household income information for Stanislaus County and Tuolumne County.

3.11.1 Historical and Current Population

Table 3.11-1 provides population data from 1980 to 2015 for Stanislaus County, Tuolumne County, and the state of California. From 1980 to 2015, the population of Stanislaus County grew by more than 98 percent. The population of Tuolumne County also grew during that time, but at a more modest pace. Since the 1980s and 1990s, population growth in both counties, as well as across the state, has slowed.

Table 3.11-1. Population growth in Stanislaus and Tuolumne counties, 1980 to 2015.

Year	Stanislaus County	Tuolumne County	California
Population			
1980	265,900	33,928	23,667,902
1990	370,522	48,456	29,758,213
2000	446,997	54,504	33,873,086
2010	514,453	55,365	37,253,956
2015	527,367	54,079	38,993,940
Population Percent Change			
1980-1990	39.3%	42.8%	25.7%
1990-2000	20.6%	12.5%	13.8%
2000-2010	15.1%	1.6%	10.0%
2010-2015	2.5%	-2.3%	4.7%
1980-2015	98.3%	59.4%	64.7%

Sources: California Department of Finance (undated; 2007; 2012a; 2012b), U.S Department of Commerce, Census Bureau (2015 and 2016).

3.11.2 Projected Population

Between 2010 and 2060, the population of Stanislaus County is expected to grow by more than 85 percent and the population of Tuolumne County is estimated to grow by more than 15 percent (Table 3.11-2). The combined population of both counties is projected to increase from about 569,818 people in 2010 to about 1,018,000 in 2060, an increase of 78.6 percent. This growth outpaces the growth expected statewide, which is estimated to be about 41 percent.

Table 3.11-2. Population projections in the study area through 2060.

Region	2010	Projections				
		2020	2030	2040	2050	2060
Stanislaus County	514,453	589,156	674,859	759,027	861,984	953,580
Tuolumne County	55,365	55,938	57,982	60,593	61,678	69,947
California	37,253,956	40,643,643	44,279,354	50,365,074	50,365,074	52,693,583

Source: California Department of Finance 2013.

3.11.3 Race and Ethnicity

Table 3.11-3 provides data on the racial and ethnic compositions of Stanislaus County and Tuolumne County in 2010. The predominant racial group in both counties is White (Caucasian). Stanislaus County has a relatively large minority and Hispanic population. Tuolumne County is less diverse, with Whites accounting for 87.2 percent of its population.

Table 3.11-3. Race and ethnicity in Stanislaus County and Tuolumne County, 2010.[30]

Race / Ethnicity	Stanislaus County		Tuolumne County	
	Number	Percent	Number	Percent
White	337,342	65.6%	48,274	87.2%
Black or African American	14,721	2.9%	1,143	2.1%
American Indian and Alaska Native	5,902	1.1%	1,039	1.9%
Asian	26,090	5.1%	572	1.0%
Native Hawaiian and Other Pacific Islander	3,401	0.7%	76	0.1%
Some Other Race	99,210	19.3%	2,238	4.0%
Two or More Races	27,787	5.4%	2,023	3.7%
Hispanic or Latino of Any Race	215,658	41.9%	5,918	10.7%

Source: U.S Department of Commerce, Census Bureau 2010.

3.11.4 Regional Employment and Income

Information on employment characteristics in Stanislaus and Tuolumne counties is presented in Table 3.11-4. Between 2007 and 2011, the unemployment rate in Tuolumne County and Stanislaus County averaged 13.1 percent and 14.2 percent, respectively. During this time period, rates of unemployment in each county were greater than the rate of unemployment experienced statewide.

Table 3.11-4. Employment status in Stanislaus and Tuolumne counties and the State of California, 2007 through 2011 (annual average).

Employment Type	Stanislaus County	Tuolumne County	California
Civilian labor force	240,165	23,645	18,472,288
Employed	205,958	20,559	16,603,417
Unemployed	34,207	3,086	1,868,871
Unemployment Rate	14.2%	13.1%	10.1%

Source: U.S Department of Commerce, Census Bureau 2012.

[30] The source data (U.S. Department of Commerce, Census Bureau 2010) includes percentages of the population that total greater than 100%.

Table 3.11-5 lists 10 of the largest employers in Stanislaus County. Eight of the 10 are in agricultural production or food processing, and the remaining two are in health-related industries.

Table 3.11-5. Major employers in Stanislaus County.

Employer	Employment Range
Alcott Ridge Vineyards	1,000-4,999
Carlo Rossi Vineyards	1,000-4,999
Con Agra Foods	1,000-4,999
Del Monte Foods	1,000-4,999
Doctors Medical Center	1,000-4,999
E&J Gallo Winery	1,000-4,999
Ecco Domani Winery	1,000-4,999
Emanuel Medical Center	1,000-4,999
Fairbanks Cellars	1,000-4,999
Foster Farms	1,000-4,999

Source: California Employment Development Department 2013a.

Table 3.11-6 lists 10 of the largest employers in Tuolumne County. The mix of employers in Tuolumne County includes two health-related businesses, three entertainment and recreation entities, a prison, a college, a utility, a nonprofit, and a big box retail store.

Table 3.11-6. Major employers in Tuolumne County.

Employer	Employment Range
Corrections Department	1,000-4,999
Sonora Regional Convalescent Home	1,000-4,999
Sonora Regional Hospital	1,000-4,999
Black Oak Casino	500-999
Dodge Ridge Ski Resort	500-999
Hetch Hetchy Water & Power	250-499
National Audubon Society	250-499
Wal-Mart	250-499
Chicken Ranch Bingo & Casino	100-249
Columbia College	100-249

Source: California Employment Development Department 2013b.

Table 3.11-7 provides data on median household income in Stanislaus County and Tuolumne County. Median household incomes in both counties trail statewide values.

Table 3.11-7. Median household income (dollars).[1]

Year	Stanislaus County	Tuolumne County	California
2010	$57,443	$47,462	$60,883
2011	$56,996	$47,359	$61,632
2012	$55,548	$48,169	$61,400
2013	$55,432	$48,426	$61,049
2014	$55,357	$48,493	$61,489

[1] Values are not adjusted for inflation.
Source: U.S Department of Commerce, Census Bureau 2015.

3.11.5 Potential Socioeconomic Resource Effects

Page 22 of FERC's SD2 identifies the following issues associated with socioeconomic resources:

- Socioeconomic effects of any proposed measures to change La Grange operations on affected governments, residents, agriculture, businesses, and other related interests.

There are currently no proposed measures to change Project operations, so no socioeconomic resource effects are anticipated under the Proposed Action.

3.11.6 Proposed Socioeconomic Resource Measures

Because the Proposed Action of continuing to generate hydroelectric power at the La Grange powerhouse would have no adverse effects on socioeconomic resources in the Project vicinity, the Districts are proposing no resource measures related to socioeconomic resources.

3.11.7 Cumulative Effects to Socioeconomic Resources

FERC's SD2 defined the geographic scope for cumulative effects to socioeconomic resource as extending from Hetch Hetchy Reservoir to San Francisco Bay. The temporal scope considered for cumulative effects to socioeconomic resources includes the past, present, and reasonably foreseeable future actions. The temporal scope extends 30 to 50 years into the future in order to coincide with the potential term of an original license for the Project.

As described in Section 3.11, the La Grange Hydroelectric provides no flood control benefits and there are no recreation facilities associated with the Project or the La Grange headpond. However, the Project has minor cumulative benefits to socioeconomic resources in the Project vicinity in the form of electricity generated and employment opportunities. These benefits have existed since hydroelectric generation began at the Project in 1924, and would continue throughout the next 30 to 50 years if a license for continued hydroelectric generation is granted. Therefore, the Proposed Action is not expected to result in any adverse effects to socioeconomic resources, but will result in minor cumulative benefits to socioeconomic resources in the Project vicinity.

3.11.8 Unavoidable Adverse Impacts to Socioeconomic Resources

No unavoidable adverse impacts to socioeconomic resources are anticipated as a result of the Proposed Action of continued hydroelectric power generation at the La Grange powerhouse.

4.0 DEVELOPMENTAL ANALYSIS

The Developmental Analysis section of this Exhibit E contains the assessment of the cost of generation under the Districts' proposed plan for future operation of the Project. This FLA also evaluates PM&E measures adopted by the Districts or proposed by others and not adopted. The Districts' analysis includes a comparison of costs under the Districts' Proposed Action with those associated with the No Action alternative.

With this license application to FERC, the Districts are seeking an original license to continue generating hydroelectric power. Based on the information contained in this application, and other information on the record, FERC will consider whether, and under what conditions, to issue an original license for the continued generation of hydropower at the Project. The Districts are providing a complete description of all the facilities and operation of the La Grange Project so the effects of the O&M of the hydroelectric facilities can be distinguished from the effects of the O&M activities of the overall La Grange Project's water supply/consumptive use purposes.

The primary purpose of the Districts' La Grange Project is to divert water for the beneficial uses of irrigation and M&I supply. Hydroelectric generation at TID's two-unit, 4.7 MW powerhouse is a secondary purpose of the La Grange Project. The diversion of water for water supply purposes is not dependent on the issuance of a FERC license for TID's power plant and will continue to occur in the event FERC decides against such issuance.

4.1 Power and Economic Benefits of the Project

The Project's net economic benefit under a given alternative is the difference between the cost of producing power and the value of that power. Consistent with FERC's approach to economic analysis, the power benefit of the Project is estimated based on the cost of obtaining an equivalent amount of energy and capacity using the most likely alternative generating resources in the region. The analysis is based on current costs and does not consider future escalation in estimating the value of the Project's benefits.

4.1.1 Cost of Districts' Proposed Environmental Measures

The Districts' Proposed Action includes several PM&E measures that would increase operating costs. Details of each PM&E are presented in Sections 3.4, 3.5, 3.8, and 3.10. Annualized costs of the Districts' Proposed PM&E measures are presented in Table 4.1-1.[31]

[31] The estimated annual cost of Project O&M does not include the one-time cost of the investigation of the occurrence and causes of observed low dissolved oxygen levels in the Project tailrace. If the investigation leads to a PM&E measure, this could affect future Project costs.

Table 4.1-1. Summary of estimated costs associated with the Districts' PM&E proposal (All costs in 2016 dollars).

Component and Resource Area	Estimated Capital	Annual O&M	Annualized Cost[1]
Flow to plunge pool (5-10 cfs) (Aquatic Resources)	$0	$25,000	$25,000
Sluice gate barrier (Aquatic Resources)	$600,000	$10,000	$40,610
Foot path trail construction and maintenance (Recreation Resources)	$80,000	$10,000	$14,100
HPMP implementation (Cultural Resources)	$0	$8,000	$8,000
Dissolved oxygen monitoring	$30,000	$7,500	$1,550
Total	**$710,000**	**$60,500**	**$89,260**

[1] Capital costs are annualized at 3 percent/30yr.

4.1.2 Evaluation of Measures Proposed by Others

As of the date of the filing of the FLA, no specific PM&E measures have been proposed by other parties. The Districts reserve the right to evaluate measures proposed by others submitted as part of the licensing proceeding.

4.1.3 Comparison of Project Alternatives

The Project's installed generating capacity is approximately 4.7 MW, and the power generated by the Project benefits TID's electric service customers by providing low-cost electricity from an emission-free renewable resource. From 2005 through 2016, the average annual generation of the La Grange powerhouse was 17,500 MWh, and ranged from a low of 7,765 MWh in 2014 to a high of 35,953 MWh in 2011. Monthly and annual generation data are provided in Exhibit A of this FLA. Since 2005, the capacity factor of the TID plant has been approximately 47 percent.

Based on the cost of energy on California's day-ahead electricity market, the current value of the hydropower generation at the Project is $525,000/year. The average annual O&M cost associated with the hydropower facilities over the last five years has been $451,000/yr, or $25.80/MWh, inclusive of all operation, maintenance and repair costs. Therefore, the current net economic benefit of the Project to TID is approximately $73,500/year, or $4.20/MWh. Adding the renewable credit of approximately $7/MWh yields a value of $11.20/MWh.

Under the No Action Alternative, the Project powerhouse would cease generating electricity, the turbine-generators removed from the powerhouse, and PRVs would be installed in the existing water passages. Equipment removal and PRV installation is estimated to cost $1.3 million. The most reasonable alternative source of energy would be purchasing electricity at California's market rates, at an average cost of approximately $30/MWh. Therefore, purchasing an equivalent quantity of energy would cost TID approximately $525,000/year. Additional annualized cost for decommissioning the generation and installing PRVs is estimated to be approximately $70,000 (3 percent/30 years) and annual O&M cost of the PRVs is estimated to be $60,000. The annual cost of the No Action alternative (ceasing generation) to TID customers would therefore be $655,000/yr or $37.40/MWh.

Under the Districts' preferred alternative of continuing generation and implementing the proposed PM&E measures, the annual cost of generation would be $622,000, including the annualized cost of the sluice channel fish barrier and the annual O&M cost of maintaining the foot trail, dissolved oxygen monitoring, and Hillside discharge gates. Therefore the future cost of Project power under the preferred alternative would be $35.50/MWh. Comparing the cost of the two alternatives, including the renewable credit, show the net value of Project power to be $1.50/MWh.

5.0 CONSISTENCY WITH COMPREHENSIVE PLANS

The Districts have reviewed relevant comprehensive plans during conduct of licensing studies and development of the proposed measures, and have included applicable information in this FLA. Section 3.12.1 below describes comprehensive plans that Section 10(a) of the FPA requires FERC to consider. These plans are referred to as Qualifying Comprehensive Plans.

5.1 Qualifying Comprehensive Plans

As described above, Section 10(a) of the FPA requires FERC to consider the extent to which a project is consistent with federal and state comprehensive plans for improving, developing, or conserving a waterway or waterways affected by the Project. On April 27, 1988, FERC issued Order No. 481-A which revised Order No. 481, issued October 26, 1987, establishing that FERC will accord FPA Section 10(a)(2)(A) comprehensive plan status to any federal or state plan that meets the following three criteria:

- Is a comprehensive study of one or more of the beneficial uses of a waterway or waterways,
- Specifies the standards, the data, and the methodology used to develop the plan, and
- Is filed with FERC.

A review of FERC's Revised List of Comprehensive Plans (July 2017) shows that 76 comprehensive plans have been filed with FERC specifically for the State of California (FERC 2017). The Districts identified 23 of these qualifying comprehensive plans that have the potential to be related to the Project. Each of these plans is discussed below by resource area. It is important to note that all of the qualifying comprehensive plans that may apply to the Project were developed after project construction. Consequently, the Project was an existing condition during each qualifying comprehensive plan's development.

5.1.1 Water Resources

5.1.1.1 The California Water Plan: Projected Use and Available Water Supplies to 2010. (CDWR 1983) and California Water Plan Update (CDWR 1994)

The CDWR first published the California Water Plan in 1957. The plan focused on the quantity and quality of water available to meet the State of California's water needs, and management actions that could be implemented to improve the state's water supply reliability. Since then, CDWR has updated the plan numerous times including in 1983 (the reference used in FERC's July 2010 List of Comprehensive Plans for the California Water Plan) and 1994 (the reference used in FERC's July 2010 List of Comprehensive Plans for the California Water Plan Update). The most recent update was in March 2009. The Project is located in what the Water Plan calls the "San Joaquin River Hydrologic Region." The La Grange Project represents a small portion of the water supply in the hydrologic region.

5.1.1.2 Final Programmatic Environmental Impact Statement (EIS)/Environmental Impact Report (EIR) for the CALFED Bay-Delta Program (CDWR 2000)

The California Water Policy Council and the Federal Ecosystem Directorate united in June 1994 to form CALFED. In June 1995, CALFED established its Bay-Delta Program (Program) to develop a long-term, comprehensive solution to environmental issues in the Sacramento-San Joaquin Delta and San Francisco Bay. The Program is a cooperative, interagency effort involving 15 state and federal agencies with management and regulatory responsibilities in the San Francisco Bay-San Joaquin Delta Estuary (Bay-Delta).

The Program was divided into three phases. In Phase I, completed in September 1996, the Program identified the problems confronting the Bay-Delta, developed a mission statement, and developed guiding principles. Following scoping, public comment, and agency review, the Program identified three preliminary alternatives to be further analyzed in Phase II. The three Phase II preliminary alternatives each included Program elements for levee system integrity, water quality improvements, ecosystem restoration, water use efficiency, and three differing approaches to conveying water through the Bay-Delta.

In Phase II, completed in July 2000, the Program refined the preliminary alternatives, conducted a comprehensive programmatic environmental review, and developed implementation strategies. The Program added greater detail to each of the Program elements and crafted frameworks for two Program elements: water transfers and watershed management. The Phase II report contains a general summary of the Program plans. More fundamentally, the report also describes the Program process, the fundamental Program concepts that have guided their development, and analyses that have contributed to Program development. Further, this report describes how this large, complex Program may be implemented, funded, and governed in the future. The following plans outline Program actions:

- Ecosystem Restoration Program Plan (Volumes 1, 2, and 3)
- Water Quality Program Plan
- Water Use Efficiency Program Plan
- Water Transfer Program Plan
- Levee System Integrity Program Plan
- Watershed Program Plan

The goals of the Water Quality and Watershed programs under CALFED include improving overall water quality by reducing the loadings of many constituents of concern that enter Bay-Delta tributaries from point and non-point sources. Principal targeted constituents include heavy metals (such as mercury), pesticide residues, salts, selenium, pathogens, suspended sediments, adverse temperatures, and disinfection byproduct precursors such as bromide and total organic carbon. The remaining Program plans include the:

- Implementation Plan
- Multi-species Conservation Strategy
- Comprehensive Monitoring, Assessment, and Research Program

Phase II was completed, with publication of the final programmatic EIS/EIR in July 2000. Phase III is on-going and consists of implementation of the Preferred Program Alternative over 20-30 years. Information from the final programmatic EIS/EIR will be incorporated by reference into subsequent tiered environmental documents for specific projects in accordance with NEPA and California Environmental Quality Act (CEQA) guidelines. The La Grange headpond does not flow directly into the Bay-Delta.

5.1.1.3 Water Quality Control Plan Report (CSWRCB 1995)

This reference is to the first edition of the water quality control plans adopted by the California SWRCB pursuant to the CWA. The nine plans, which apply to different areas of California, formally designate existing and potential beneficial uses and water quality objectives. The water quality control plan applicable to the Project area is the CVRWQCB Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (referred to as the Basin Plan in this document). The SWRCB has updated the water quality control plans a number of times since 1995 and details of the current plan relevant to the Project are included in Section 3.4 of this Exhibit E.

5.1.1.4 Water Quality Control Plans and Policies Adopted as Part of the State Comprehensive Plan (CSWRCB 1999)

This reference refers to an April 1999 submittal by the SWRCB to FERC of a listing of all SWRCB plans and policies. This submittal stated that all of the listed plans and policies are part of the "State Comprehensive Plan," even though it does not exist as a single plan. Relevant SWRCB plans are discussed in Section 3.4 of this Exhibit E.

5.1.2 Aquatic Resources

5.1.2.1 Strategic Plan for Trout Management: A Plan for 2004 and Beyond (CDFG 2003)

This plan identifies key issues and concerns relative to trout resources and fisheries in California, with strategies aimed at addressing these issues during the next 10 to 15 years and beyond. The plan considers resource management strategies that will enable trout managers to meet their public trust responsibilities of protecting and maintaining California's native trout and other aquatic resources. Section 3.5 of this Exhibit E discusses trout population and habitat in the Project area, as well as the Districts' efforts to protect and conserve these resources.

5.1.2.2 Habitat Restoration Plan for the Lower Tuolumne River Corridor (CDFG 2000)

The Tuolumne River Technical Advisory Committee (TRTAC) prepared this plan to assist in identifying and implementing habitat restoration projects to benefit the Tuolumne River's Chinook salmon population. The plan provides historical information about the Tuolumne River basin and development of the region over time. The plan discusses current and future restoration plans that may benefit Chinook salmon. Section 3.5 of this Exhibit E further discusses Chinook salmon populations in the vicinity of the Project, and measures intended to benefit this resource.

5.1.2.3 Final Hatchery and Stocking Program Environmental Impact Report/Environmental Impact Statement (CDFG and USFWS 2010)

CDFG operates a statewide system of fish hatchery facilities that rear and release millions of trout, salmon, and steelhead of various age and size classes into state waters. In 2006, CDFG initiated an internal environmental review of its stocking program, and prepared this document to describe potential impacts associated with its hatchery and stocking activities.

5.1.2.4 California Aquatic Invasive Species Management Plan (CDFW 2008)

This plan, developed by CDFW, proposes management actions for addressing threats to the State of California due to aquatic invasive species. It focuses on the non-native algae, crabs, clams, fish, plants and other species that continue to invade California's creeks, wetlands, rivers, bays and coastal waters. The plan identifies and prioritizes actions that should be undertaken to minimize impacts from established aquatic invasive species and prevent new species invasions. Aquatic invasive species in the Project vicinity are discussed extensively in Section 3.6 of this Exhibit E.

5.1.3 Wildlife and Botanical Resources

5.1.3.1 Central Valley Habitat Joint Venture Implementation Plan (Central Valley Joint Venture 2006) and North American Waterfowl Management Plan (USFWS 1986)

The California Central Valley Habitat Joint Venture (CCVHJV) is one of 12 current joint ventures charged with implementation of the North American Waterfowl Management Plan, an agreement between Canada, Mexico, and the U.S. to restore waterfowl populations through habitat protection, restoration, and enhancement (USFWS 1986). The CCVHJV was formally established by a working agreement signed in July 1988 and is guided by an Implementation Board comprised of representatives from the California Waterfowl Association, Defenders of Wildlife, Ducks Unlimited, National Audubon Society, Waterfowl Habitat Owners Alliance, and The Nature Conservancy. Technical Assistance is provided to the Board by the USDOI, USFWS, CDFG, CDFA, and other organizations and agencies.

The Central Valley of California is the most important wintering area for waterfowl in the Pacific Flyway, supporting 60 percent of the total population. Historically, the Central Valley contained more than four million acres of wetlands; however, only 291,555 acres remained in 1990 when the CCVHJV was first implemented. The primary cause of this wetland loss was conversion to agriculture, flood control, and navigation projects, and urban expansion.

When completed, the CCVHJV will (1) protect 80,000 acres of existing wetlands through the fee acquisition or conservation easement; (2) restore 120,000 acres of former wetlands; (3) enhance 291,555 acres of existing wetlands; (4) enhance waterfowl habitat on 443,000 acres of private agricultural land; and (5) secure 402,450 ac-ft of water for existing State Wildlife Areas, National Wildlife Refuges, and the Grasslands Resource Conservation District. These habitat conservation efforts are intended to result in a fall flight of one million ducks and 4.7 million wintering ducks. The wintering bird totals will include 2.8 million pintails, a species whose wintering population is vitally dependent on the Central Valley.

The CCVHJV is a regional approach to conservation and management of waterfowl populations in the Central Valley, but has no specific relevance to operation and management of the Project.

5.1.3.2 California Wildlife: Conservation Challenges: California's Wildlife Action Plan (CDFG 2007)

This plan was developed as a partnership between the CDFW and the Wildlife Health Center at the University of California, Davis. The plan is aimed at answering three primary questions (1) what are the species and habitats of greatest conservation need; (2) what are the major stressors affecting California's native wildlife and habitats; and (3) what are the actions needed to restore and conserve California's wildlife, thereby reducing the likelihood that more species will approach the condition of threatened or endangered? The plan recommends region-specific conservation actions to protect, restore, and conserve California's native wildlife and habitats. The Project is located in the Central Valley and Bay-Delta Region. The plan recommendations include a number of actions that are discussed throughout this license application, and are addressed by the Districts' PM&E measures.

5.1.4 Rare, Threatened, Endangered, and Special Status Species

5.1.4.1 Restoring the Balance: 1988 Annual Report (California Advisory Committee on Salmon and Steelhead Trout 1988)

The California Advisory Committee on Salmon and Steelhead Trout was established by California legislation in 1983 to develop a strategy for the conservation and restoration of salmon and steelhead resources in California. To streamline its process, the committee divided California's steelhead and salmon resources into 11 groups—the Tuolumne River is located in the San Joaquin River System. The report focuses mostly on the Central Valley, and the Project Boundary was not specifically identified. The committee recommended among other things that California should seek to double its steelhead and salmon populations, and recommended strategies to do so. Many of the recommendations were advanced and discussed in subsequent related publications described below.

5.1.4.2 Central Valley Salmon and Steelhead Restoration and Enhancement Plan (CDFG 1990)

This plan was released by CDFW in April 1990. This plan is intended to outline CDFW's restoration and enhancement goals for salmon and steelhead resources of the Sacramento and San Joaquin river systems and to provide direction for various CDFW programs and activities. This plan is also intended to provide the basis for the restoration and enhancement of the state's salmon and steelhead resources.

5.1.4.3 Restoring Central Valley Streams: A Plan for Action (CDFG 1993)

This plan was released by CDFG in November 1993. The goals of the plan, all targeted toward anadromous fish, are to restore and protect California's aquatic ecosystems that support fish and wildlife, to protect threatened and endangered species, and to incorporate the state legislature mandate and policy to double populations of anadromous fish in California. The plan encompasses only Central Valley waters accessible to anadromous fish, excluding the Sacramento-San Joaquin Delta.

5.1.4.4 Steelhead Restoration and Management Plan for California (CDFG 1996)

This plan was released by CDFG in February 1996. This plan focuses on restoration of native and naturally produced (wild) stocks because these stocks have the greatest value for maintaining genetic and biological diversity. Goals for steelhead restoration and management are: (1) increase natural production, as mandated by The Salmon, Steelhead Trout, and Anadromous Fisheries Program Act of 1988, so that steelhead populations are self-sustaining and maintained in good condition and (2) enhance angling opportunities and non-consumptive uses. Information presented in Sections 3.5 and 4.0 of this Exhibit E may be used to determine consistency with CDFW's restoration goals.

5.1.4.5 Final Restoration Plan for Anadromous Fish Restoration Program (USFWS 2001)

This plan was prepared for the Secretary of the Interior by the USFWS under authority of the Central Valley Project Improvement Act. The Central Valley Project Improvement Act directs the Secretary of the Interior to develop and implement a program that makes all reasonable efforts to double natural production of anadromous fish in Central Valley Streams. The program is known as the Anadromous Fish Restoration Program (AFRP). This restoration plan broadly describes the AFRP, and is intended for use in guiding the long-term development of the AFRP. The AFRP works to coordinate restoration efforts among state and federal agencies, as well as other groups in the Central Valley. Anadromous fish resources are addressed in Section 3.5 of this Exhibit E.

5.1.4.6 Recovery Plan for the Evolutionarily Significant Units of Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon and the DPS of CCV Steelhead (NMFS 2014)

This recovery plan was developed for three salmon and steelhead species: the Sacramento River winter-run Chinook salmon ESU, the Central Valley spring-run Chinook salmon ESU, and the CCV steelhead DPS. The purpose of this recovery plan is to provide a framework for the conservation and survival of the listed species addressed in the plan that focuses and prioritizes threat abatement and restoration actions necessary to recover, and eventually delist, a species. This recovery plan covers the geographic area of the CCV, including the Sacramento and San Joaquin River Basins. The species addressed in this recovery plan are discussed further in Section 3.5 and 4.0 of this Exhibit E.

5.1.5 Recreation Resources

5.1.5.1 California Outdoor Recreation Plan (CDPR 1994)

The objectives of the CDPR California Outdoor Recreation Plan (CORP, the most recent version of which is 2008, are to determine outdoor recreation issues that are currently the problems and opportunities most critical in California, and to explore the most appropriate actions by which State of California, federal and local agencies might address these issues. The CORP also provides valuable information on the state's recreation policy, code of ethics, and statewide recreation demand, demographic, economic, political, and environmental conditions. The plan lists the following major issues: (1) improving resource stewardship, (2) serving a changing population, (3) responding to limited funding, (4) building strong leadership, (5) improving recreation opportunities through planning and research, (6) responding to the demand for trails, and (7) halting the loss of wetlands. The CORP applies to state and local parks and recreation agencies, and does not apply to federal and private-sector recreational providers.

Because the recreation facilities in the Project Boundary are not state or local parks, the CORP has little direct application other than general guidance. However, information on regional trends in recreation from the most recent version of the CORP was incorporated into the Recreation Access and Safety Assessment (TID/MID 2017).

5.1.5.2 Public Opinions and Attitudes on Outdoor Recreation in California (CDPR 1998)

CDPR's POAOR survey, the most recent version of which is 2002, provides information used in the development of the CDPR's CORP. The POAOR identifies: (1) California's attitudes, opinions, and values with respect to outdoor recreation; and (2) demand for and participation in 42 selected outdoor recreation activities.

5.1.5.3 Recreation Needs in California (The Resources Agency 1983)

In response to the Roberti-Z'berg Urban Open Space and Recreation Program Act of 1976, the CDPR conducted a statewide recreational needs assessment. The report consisted of two major elements: (1) the Recreation Patterns Study that surveyed current participation and projected recreation demand; and (2) the Urban Recreation Case Studies that examined the leisure behavior and needs of seven underserved populations. The purpose of the needs analysis was to: (1) develop statewide recreation planning data; (2) analyze the recreation needs of California's urban residents; and (3) modify project selection criteria used in the administration of grants to local agencies under the Roberti-Z'berg Act.

In general, this report is a wide-ranging, programmatic document providing guidance for statewide planning. The urban-specific study has little relevance to the Project Boundary, which is mostly remote.

5.1.5.4 The Recreational Fisheries Policy of the USFWS (USFWS 1989)

This is a 12-page policy signed by John F. Turner, then Director of the USFWS, on December 5, 1989. Its purpose is to unite all of the USFWS' recreational fisheries capabilities under a single policy to enhance the nation's recreational fisheries. Regional and Assistant directors are responsible for implementing the policy by incorporating its goals and strategies into planning and day-to-day management efforts. The USFWS carries out this policy relative to FERC-licensed hydroelectric projects through such federal laws as the Fish and Wildlife Coordination Act, the CWA, the ESA, NEPA, and the FPA, among others.

5.1.5.5 The Nationwide Rivers Inventory (NPS 1982)

The Nationwide Rivers Inventory is a listing by the USDOI, NPS of more than 2,400 free-flowing river segments in the U.S. that are believed to possess one or more "outstandingly remarkable" natural or cultural values judged to be of more than local or regional significance. In addition to these eligibility criteria, river segments are divided into three classifications: Wild, Scenic, and Recreational river areas. Under a 1979 Presidential Directive and related Council on Environmental Quality procedures, all federal agencies must seek to avoid or mitigate actions that would adversely affect one or more Nationwide Rivers Inventory segments. Such adverse impacts could alter the river segment's eligibility for listing and/or alter their classification. This Exhibit E includes information in Section 1 and Section 3.8 regarding Wild and Scenic designation in the upper Tuolumne River.

6.0 CONSULTATION RECORD

The following excerpt from the Code of Federal Regulations (CFR) at 18 CFR § 5.18(b)(5)(G) describes the required content of the Consultation Record.

> *5.18(b)(5)(G) Consultation Documentation. Include a list containing the name, and address of every Federal, state, and interstate resource agency, Indian tribe, or member of the public with which the applicant consulted in preparation of the Environmental Document.*

The Districts have established and maintained an extensive licensing participant email group, which has been used to keep all licensing participants, including agencies, Tribes, NGOs, and interested members of the public, advised of all licensing activities. A full consultation record of all communication with licensing participants is attached to this FLA.

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LA GRANGE HYDROELECTRIC PROJECT
FERC NO. 14581

FINAL LICENSE APPLICATION

EXHIBIT E – ENVIRONMENTAL REPORT

APPENDIX E-1
USFWS IPAC SEARCH RESULTS FOR THE LA GRANGE HYDROELECTRIC PROJECT STUDY AREA

IPaC **U.S. Fish & Wildlife Service**

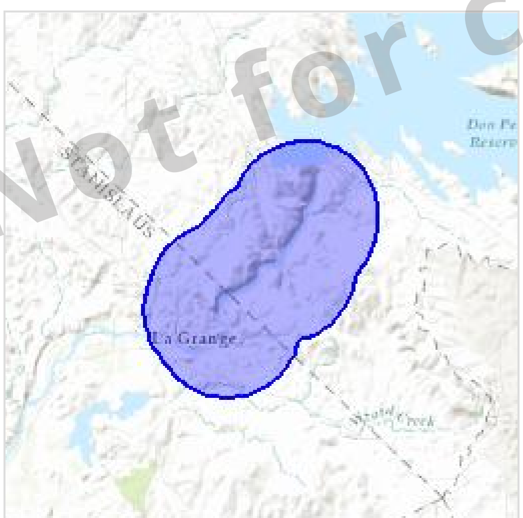
IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Stanislaus and Tuolumne counties, California



Local office

Sacramento Fish And Wildlife Office

(916) 414-6600
(916) 414-6713

Federal Building
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population, even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species

[1] are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service.

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1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
San Joaquin Kit Fox *Vulpes macrotis mutica* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/2873	Endangered

Amphibians

NAME	STATUS
California Red-legged Frog *Rana draytonii* There is a **final** critical habitat designated for this species. Your location is outside the designated critical habitat. https://ecos.fws.gov/ecp/species/2891	Threatened
California Tiger Salamander *Ambystoma californiense* There is a **final** critical habitat designated for this species. Your location overlaps the designated critical habitat. https://ecos.fws.gov/ecp/species/2076	Threatened

Fishes

NAME	STATUS
Delta Smelt *Hypomesus transpacificus* There is a **final** critical habitat designated for this species. Your location is outside the designated critical habitat. https://ecos.fws.gov/ecp/species/321	Threatened
Steelhead *Oncorhynchus (=Salmo) mykiss* There is a **final** critical habitat designated for this species. Your location overlaps the designated critical habitat. https://ecos.fws.gov/ecp/species/1007	Threatened

Insects

NAME	STATUS
Valley Elderberry Longhorn Beetle Desmocerus californicus dimorphus There is a **final** critical habitat designated for this species. Your location is outside the designated critical habitat. https://ecos.fws.gov/ecp/species/7850	Threatened

Crustaceans

NAME	STATUS
Conservancy Fairy Shrimp Branchinecta conservatio There is a **final** critical habitat designated for this species. Your location is outside the designated critical habitat. https://ecos.fws.gov/ecp/species/8246	Endangered
Vernal Pool Fairy Shrimp Branchinecta lynchi There is a **final** critical habitat designated for this species. Your location is outside the designated critical habitat. https://ecos.fws.gov/ecp/species/498	Threatened

Flowering Plants

NAME	STATUS
Hartweg's Golden Sunburst Pseudobahia bahiifolia No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/1704	Endangered

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

This location overlaps the critical habitat for the following species:

NAME	TYPE
California Tiger Salamander Ambystoma californiense https://ecos.fws.gov/ecp/species/2076#crithab	Final designated

Colusa Grass Neostapfia colusana — Final designated

For information on why this critical habitat appears for your project, even though Colusa Grass is not on the list of potentially affected species at this location, contact the local field office.
https://ecos.fws.gov/ecp/species/5690#crithab

Greene's Tuctoria Tuctoria greenei — Final designated

For information on why this critical habitat appears for your project, even though Greene's Tuctoria is not on the list of potentially affected species at this location, contact the local field office.
https://ecos.fws.gov/ecp/species/1573#crithab

Hoover's Spurge Chamaesyce hooveri — Final designated

For information on why this critical habitat appears for your project, even though Hoover's Spurge is not on the list of potentially affected species at this location, contact the local field office.
https://ecos.fws.gov/ecp/species/3019#crithab

Steelhead Oncorhynchus (=Salmo) mykiss — Final designated

South-Central California Coast DPS
https://ecos.fws.gov/ecp/species/1007#crithab

Steelhead Oncorhynchus (=Salmo) mykiss — Final designated

Northern California DPS
https://ecos.fws.gov/ecp/species/1007#crithab

Steelhead Oncorhynchus (=Salmo) mykiss — Final designated

California Central Valley DPS
https://ecos.fws.gov/ecp/species/1007#crithab

Steelhead Oncorhynchus (=Salmo) mykiss — Final designated

Central California Coast DPS
https://ecos.fws.gov/ecp/species/1007#crithab

Steelhead Oncorhynchus (=Salmo) mykiss — Final designated

Southern California DPS
https://ecos.fws.gov/ecp/species/1007#crithab

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act

[1] and the Bald and Golden Eagle Protection Act[2].

Any activity that results in the take (to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct) of migratory birds or eagles is prohibited unless authorized by the U.S. Fish and Wildlife Service

[3]. There are no provisions for allowing the take of migratory birds that are unintentionally killed or injured.

Any person or organization who plans or conducts activities that may result in the take of migratory birds is responsible for complying with the appropriate regulations and implementing appropriate conservation measures.

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1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.
3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Conservation measures for birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Year-round bird occurrence data http://www.birdscanada.org/birdmon/default/datasummaries.jsp

The migratory birds species listed below are species of particular conservation concern (e.g. Birds of Conservation Concern) that may be potentially affected by activities in this location. It is not a list of every bird species you may find in this location, nor a guarantee that all of the bird species on this list will be found on or near this location. Although it is important to try to avoid and minimize impacts to all birds, special attention should be made to avoid and minimize impacts to birds of priority concern. To view available data on other bird species that may occur in your project area, please visit the AKN Histogram Tools and Other Bird Data Resources. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

NAME	SEASON(S)
Allen's Hummingbird Selasphorus sasin https://ecos.fws.gov/ecp/species/9637	Migrating
Bald Eagle Haliaeetus leucocephalus https://ecos.fws.gov/ecp/species/1626	Year-round
Black Rail Laterallus jamaicensis https://ecos.fws.gov/ecp/species/7717	Breeding
Burrowing Owl Athene cunicularia https://ecos.fws.gov/ecp/species/9737	Year-round
California Spotted Owl Strix occidentalis occidentalis https://ecos.fws.gov/ecp/species/7266	Year-round
Calliope Hummingbird Stellula calliope https://ecos.fws.gov/ecp/species/9526	Migrating
Costa's Hummingbird Calypte costae https://ecos.fws.gov/ecp/species/9470	Year-round
Fox Sparrow Passerella iliaca	Year-round
Green-tailed Towhee Pipilo chlorurus https://ecos.fws.gov/ecp/species/9444	Breeding
Lewis's Woodpecker Melanerpes lewis https://ecos.fws.gov/ecp/species/9408	Wintering
Loggerhead Shrike Lanius ludovicianus https://ecos.fws.gov/ecp/species/8833	Year-round
Long-billed Curlew Numenius americanus https://ecos.fws.gov/ecp/species/5511	Wintering

Nuttall's Woodpecker Picoides nuttallii https://ecos.fws.gov/ecp/species/9410	Year-round
Oak Titmouse Baeolophus inornatus https://ecos.fws.gov/ecp/species/9656	Year-round
Olive-sided Flycatcher Contopus cooperi https://ecos.fws.gov/ecp/species/3914	Breeding
Peregrine Falcon Falco peregrinus https://ecos.fws.gov/ecp/species/8831	Wintering
Rufous Hummingbird selasphorus rufus https://ecos.fws.gov/ecp/species/8002	Migrating
Rufous-crowned Sparrow Aimophila ruficeps https://ecos.fws.gov/ecp/species/9718	Year-round
Short-eared Owl Asio flammeus https://ecos.fws.gov/ecp/species/9295	Wintering
Snowy Plover Charadrius alexandrinus	Breeding
Swainson's Hawk Buteo swainsoni https://ecos.fws.gov/ecp/species/1098	Breeding
Western Grebe aechmophorus occidentalis https://ecos.fws.gov/ecp/species/6743	Wintering
Williamson's Sapsucker Sphyrapicus thyroideus https://ecos.fws.gov/ecp/species/8832	Year-round
Yellow-billed Magpie Pica nuttalli https://ecos.fws.gov/ecp/species/9726	Year-round

What does IPaC use to generate the list of migratory bird species potentially occurring in my specified location?

Landbirds:

Migratory birds that are displayed on the IPaC species list are based on ranges in the latest edition of the National Geographic Guide, Birds of North America (6th Edition, 2011 by Jon L. Dunn, and Jonathan Alderfer). Although these ranges are coarse in nature, a number of U.S. Fish and Wildlife Service migratory bird biologists agree that these maps are some of the best range maps to date. These ranges were clipped to a specific Bird Conservation Region (BCR) or USFWS Region/Regions, if it was indicated in the 2008 list of Birds of Conservation Concern (BCC) that a species was a BCC species only in a particular Region/Regions. Additional modifications have been made to some ranges based on more local or refined range information and/or information provided by U.S. Fish and Wildlife Service biologists with species expertise. All migratory birds that show in areas on land in IPaC are those that appear in the 2008 Birds of Conservation Concern report.

Atlantic Seabirds:

Ranges in IPaC for birds off the Atlantic coast are derived from species distribution models developed by the National Oceanic and Atmospheric Association (NOAA) National Centers for Coastal Ocean Science (NCCOS) using the best available seabird survey data for the offshore Atlantic Coastal region to date. NOAANCCOS assisted USFWS in developing seasonal species ranges from their models for specific use in IPaC. Some of these birds are not BCC species but were of interest for inclusion because they may occur in high abundance off the coast at different times throughout the year, which potentially makes them more susceptible to certain types of development and activities taking place in that area. For more refined details about the abundance and richness of bird species within your project area off the Atlantic Coast, see the Northeast Ocean Data Portal. The Portal also offers data and information about other types of taxa that may be helpful in your project review.

About the NOAANCCOS models: the models were developed as part of the NOAANCCOS project: Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf. The models resulting from this project are being used in a number of decision-support/mapping products in order to help guide decision-making on activities off the Atlantic Coast with the goal of reducing impacts to migratory birds. One such product is the Northeast Ocean Data Portal, which can be used to explore details about the relative occurrence and abundance of bird species in a particular area off the Atlantic Coast.

All migratory bird range maps within IPaC are continuously being updated as new and better information becomes available.

Can I get additional information about the levels of occurrence in my project area of specific birds or groups of birds listed in IPaC?

Landbirds:

The Avian Knowledge Network (AKN) provides a tool currently called the "Histogram Tool", which draws from the data within the AKN (latest,survey, point count, citizen science datasets) to create a view of relative abundance of species within a particular location over the course of the year. The results of the tool depict the frequency of detection of a species in survey events, averaged between multiple datasets within AKN in a particular week of the year. You may access the histogram tools through the Migratory Bird Programs AKN Histogram Tools webpage.

The tool is currently available for 4 regions (California, Northeast U.S., Southeast U.S. and Midwest), which encompasses the following 32 states: Alabama, Arkansas, California, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Hampshire, New Jersey, New York, North, Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, Tennessee, Vermont, Virginia, West Virginia, and Wisconsin.

In the near future, there are plans to expand this tool nationwide within the AKN, and allow the graphs produced to appear with the list of trust resources generated by IPaC, providing you with an additional level of detail about the level of occurrence of the species of particular concern potentially occurring in your project area throughout the course of the year.

Atlantic Seabirds:

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAANCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Facilities

Wildlife refuges

Any activity proposed on National Wildlife Refuge lands must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGES AT THIS LOCATION.

Fish hatcheries

THERE ARE NO FISH HATCHERIES AT THIS LOCATION.

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

WETLAND INFORMATION IS NOT AVAILABLE AT THIS TIME

This can happen when the National Wetlands Inventory (NWI) map service is unavailable, or for very large projects that intersect many wetland areas. Try again, or visit the NWI map to view wetlands at this location.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.