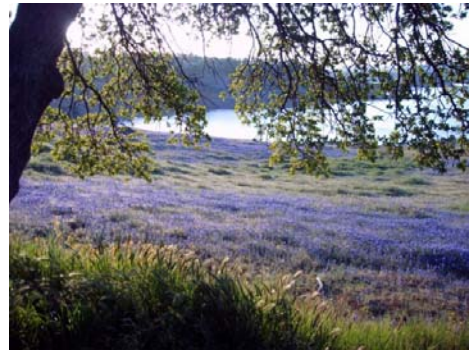


**PROJECT OPERATIONS
WATER BALANCE MODEL
STUDY REPORT
DON PEDRO PROJECT
FERC NO. 2299**



**Prepared for:
Turlock Irrigation District – Turlock, California
Modesto Irrigation District – Modesto, California**

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January 2013

Project Operations/Water Balance Model Study Report

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List of Acronyms

ac	acres
ACEC	Area of Critical Environmental Concern
AF	acre-feet
ACOE	U.S. Army Corps of Engineers
ADA	Americans with Disabilities Act
ALJ	Administrative Law Judge
APE	Area of Potential Effect
ARMR	Archaeological Resource Management Report
BA	Biological Assessment
BDCP	Bay-Delta Conservation Plan
BLM	U.S. Department of the Interior, Bureau of Land Management
BLM-S	Bureau of Land Management – Sensitive Species
BMI	Benthic macroinvertebrates
BMP	Best Management Practices
BO	Biological Opinion
CalEPPC	California Exotic Pest Plant Council
CalSPA	California Sports Fisherman Association
CAS	California Academy of Sciences
CCC	Criterion Continuous Concentrations
CCIC	Central California Information Center
CCSF	City and County of San Francisco
CCVHJV	California Central Valley Habitat Joint Venture
CD	Compact Disc
CDBW	California Department of Boating and Waterways
CDEC	California Data Exchange Center
CDFA	California Department of Food and Agriculture
CDFG	California Department of Fish and Game (as of January 2013, Department of Fish and Wildlife)
CDMG	California Division of Mines and Geology
CDOF	California Department of Finance
CDPH	California Department of Public Health

CDPR	California Department of Parks and Recreation
CDSOD	California Division of Safety of Dams
CDWR	California Department of Water Resources
CE	California Endangered Species
CEII	Critical Energy Infrastructure Information
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CGS	California Geological Survey
CMAP	California Monitoring and Assessment Program
CMC	Criterion Maximum Concentrations
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
CORP	California Outdoor Recreation Plan
CPUE	Catch Per Unit Effort
CRAM	California Rapid Assessment Method
CRLF	California Red-Legged Frog
CRRF	California Rivers Restoration Fund
CSAS	Central Sierra Audubon Society
CSBP	California Stream Bioassessment Procedure
CT	California Threatened Species
CTR	California Toxics Rule
CTS	California Tiger Salamander
CVRWQCB	Central Valley Regional Water Quality Control Board
CWA	Clean Water Act
CWHR	California Wildlife Habitat Relationship
Districts	Turlock Irrigation District and Modesto Irrigation District
DLA	Draft License Application
DPRA	Don Pedro Recreation Agency
DPS	Distinct Population Segment
EA	Environmental Assessment
EC	Electrical Conductivity

EFH.....	Essential Fish Habitat
EIR.....	Environmental Impact Report
EIS.....	Environmental Impact Statement
EPA.....	U.S. Environmental Protection Agency
ESA.....	Federal Endangered Species Act
ESRCD.....	East Stanislaus Resource Conservation District
ESU.....	Evolutionary Significant Unit
EWUA.....	Effective Weighted Useable Area
FERC.....	Federal Energy Regulatory Commission
FFS.....	Foothills Fault System
FL.....	Fork length
FMU.....	Fire Management Unit
FOT.....	Friends of the Tuolumne
FPC.....	Federal Power Commission
ft/mi.....	feet per mile
FWCA.....	Fish and Wildlife Coordination Act
FYLF.....	Foothill Yellow-Legged Frog
g.....	grams
GIS.....	Geographic Information System
GLO.....	General Land Office
GPS.....	Global Positioning System
HCP.....	Habitat Conservation Plan
HHWP.....	Hetch Hetchy Water and Power
HORB.....	Head of Old River Barrier
HPMP.....	Historic Properties Management Plan
ILP.....	Integrated Licensing Process
ISR.....	Initial Study Report
ITA.....	Indian Trust Assets
kV.....	kilovolt
m.....	meters
M&I.....	Municipal and Industrial
MCL.....	Maximum Contaminant Level
mg/kg.....	milligrams/kilogram

mg/L	milligrams per liter
mgd	million gallons per day
mi	miles
mi ²	square miles
MID	Modesto Irrigation District
MOU	Memorandum of Understanding
MSCS	Multi-Species Conservation Strategy
msl	mean sea level
MVA	Megavolt Ampere
MW	megawatt
MWh	megawatt hour
mya	million years ago
NAE	National Academy of Engineering
NAHC	Native American Heritage Commission
NAS	National Academy of Sciences
NAVD 88	North American Vertical Datum of 1988
NAWQA	National Water Quality Assessment
NCCP	Natural Community Conservation Plan
NEPA	National Environmental Policy Act
ng/g	nanograms per gram
NGOs	Non-Governmental Organizations
NHI	Natural Heritage Institute
NHPA	National Historic Preservation Act
NISC	National Invasive Species Council
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPS	U.S. Department of the Interior, National Park Service
NRCS	National Resource Conservation Service
NRHP	National Register of Historic Places
NRI	Nationwide Rivers Inventory
NTU	Nephelometric Turbidity Unit
NWI	National Wetland Inventory

NWIS	National Water Information System
NWR	National Wildlife Refuge
NGVD 29	National Geodetic Vertical Datum of 1929
O&M	operation and maintenance
OEHHA	Office of Environmental Health Hazard Assessment
ORV	Outstanding Remarkable Value
PAD	Pre-Application Document
PDO	Pacific Decadal Oscillation
PEIR	Program Environmental Impact Report
PGA	Peak Ground Acceleration
PHG	Public Health Goal
PM&E	Protection, Mitigation and Enhancement
PMF	Probable Maximum Flood
POAOR	Public Opinions and Attitudes in Outdoor Recreation
ppb	parts per billion
ppm	parts per million
PSP	Proposed Study Plan
QA	Quality Assurance
QC	Quality Control
RA	Recreation Area
RBP	Rapid Bioassessment Protocol
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
RM	River Mile
RMP	Resource Management Plan
RP	Relicensing Participant
RSP	Revised Study Plan
RST	Rotary Screw Trap
RWF	Resource-Specific Work Groups
RWG	Resource Work Group
RWQCB	Regional Water Quality Control Board
SC	State candidate for listing under CESA
SCD	State candidate for delisting under CESA
SCE	State candidate for listing as endangered under CESA

SCT	State candidate for listing as threatened under CESA
SD1	Scoping Document 1
SD2	Scoping Document 2
SE	State Endangered Species under the CESA
SFP	State Fully Protected Species under CESA
SFPUC	San Francisco Public Utilities Commission
SHPO	State Historic Preservation Office
SJRA	San Joaquin River Agreement
SJRG	San Joaquin River Group Authority
SJTA	San Joaquin River Tributaries Authority
SPD	Study Plan Determination
SRA	State Recreation Area
SRMA	Special Recreation Management Area or Sierra Resource Management Area (as per use)
SRMP	Sierra Resource Management Plan
SRP	Special Run Pools
SSC	State species of special concern
ST	California Threatened Species under the CESA
STORET	Storage and Retrieval
SWAMP	Surface Water Ambient Monitoring Program
SWE	Snow-Water Equivalent
SWRCB	State Water Resources Control Board
TAC	Technical Advisory Committee
TAF	thousand acre-feet
TCP	Traditional Cultural Properties
TDS	Total Dissolved Solids
TID	Turlock Irrigation District
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TRT	Tuolumne River Trust
TRTAC	Tuolumne River Technical Advisory Committee
UC	University of California
USDA	U.S. Department of Agriculture

USDOC	U.S. Department of Commerce
USDOI	U.S. Department of the Interior
USFS	U.S. Department of Agriculture, Forest Service
USFWS	U.S. Department of the Interior, Fish and Wildlife Service
USGS	U.S. Department of the Interior, Geological Survey
USR	Updated Study Report
UTM	Universal Transverse Mercator
VAMP	Vernalis Adaptive Management Plan
VELB	Valley Elderberry Longhorn Beetle
VRM	Visual Resource Management
WPT	Western Pond Turtle
WSA	Wilderness Study Area
WSIP	Water System Improvement Program
WWTP	Wastewater Treatment Plant
WY	water year
μS/cm	microSeimens per centimeter

1.0 INTRODUCTION

1.1 General Description of the Don Pedro Project

Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) are the co-licensees of the 168-megawatt (MW) Don Pedro Project (Project) located on the Tuolumne River in western Tuolumne County in the Central Valley region of California. The Don Pedro Dam is located at river mile (RM) 54.8 and the Don Pedro Reservoir formed by the dam extends 24-miles upstream at the normal maximum water surface elevation of 830 ft above mean sea level (msl; NGVD 29). At elevation 830 ft, the reservoir stores over 2,000,000 acre-feet (AF) of water and has a surface area slightly less than 13,000 acres (ac). The watershed above Don Pedro Dam is approximately 1,533 square miles (mi²).

Both TID and MID are local public agencies authorized under the laws of the State of California to provide water supply for irrigation and municipal and industrial (M&I) uses and to provide retail electric service. The Project serves many purposes including providing water storage for the beneficial use of irrigation of over 200,000 ac of prime Central Valley farmland and for the use of M&I customers in the City of Modesto (population 210,000). Consistent with the requirements of the Raker Act passed by Congress in 1913 and agreements between the Districts and City and County of San Francisco (CCSF), the Project reservoir also includes a “water bank” of up to 570,000 AF of storage. CCSF may use the water bank to more efficiently manage the water supply from its Hetch Hetchy water system while meeting the senior water rights of the Districts. CCSF’s “water bank” within Don Pedro Reservoir provides significant benefits for its 2.6 million customers in the San Francisco Bay Area.

The Project also provides storage for flood management purposes in the Tuolumne and San Joaquin rivers in coordination with the U.S. Army Corps of Engineers (ACOE). Other important uses supported by the Project are recreation, protection of the anadromous fisheries in the lower Tuolumne River, and hydropower generation.

The Project Boundary extends from approximately one mile downstream of the dam to approximately RM 79 upstream of the dam. Upstream of the dam, the Project Boundary runs generally along the 855 ft contour interval which corresponds to the top of the Don Pedro Dam. The Project Boundary encompasses approximately 18,370 ac with 78 percent of the lands owned jointly by the Districts and the remaining 22 percent (approximately 4,000 ac) is owned by the United States and managed as a part of the U.S. Bureau of Land Management (BLM) Sierra Resource Management Area.

The primary Project facilities include the 580-foot-high Don Pedro Dam and Reservoir completed in 1971; a four-unit powerhouse situated at the base of the dam; related facilities including the Project spillway, outlet works, and switchyard; four dikes (Gasburg Creek Dike and Dikes A, B, and C); and three developed recreational facilities (Fleming Meadows, Blue Oaks, and Moccasin Point Recreation Areas). The location of the Project and its primary facilities is shown in Figure 1.1-1.

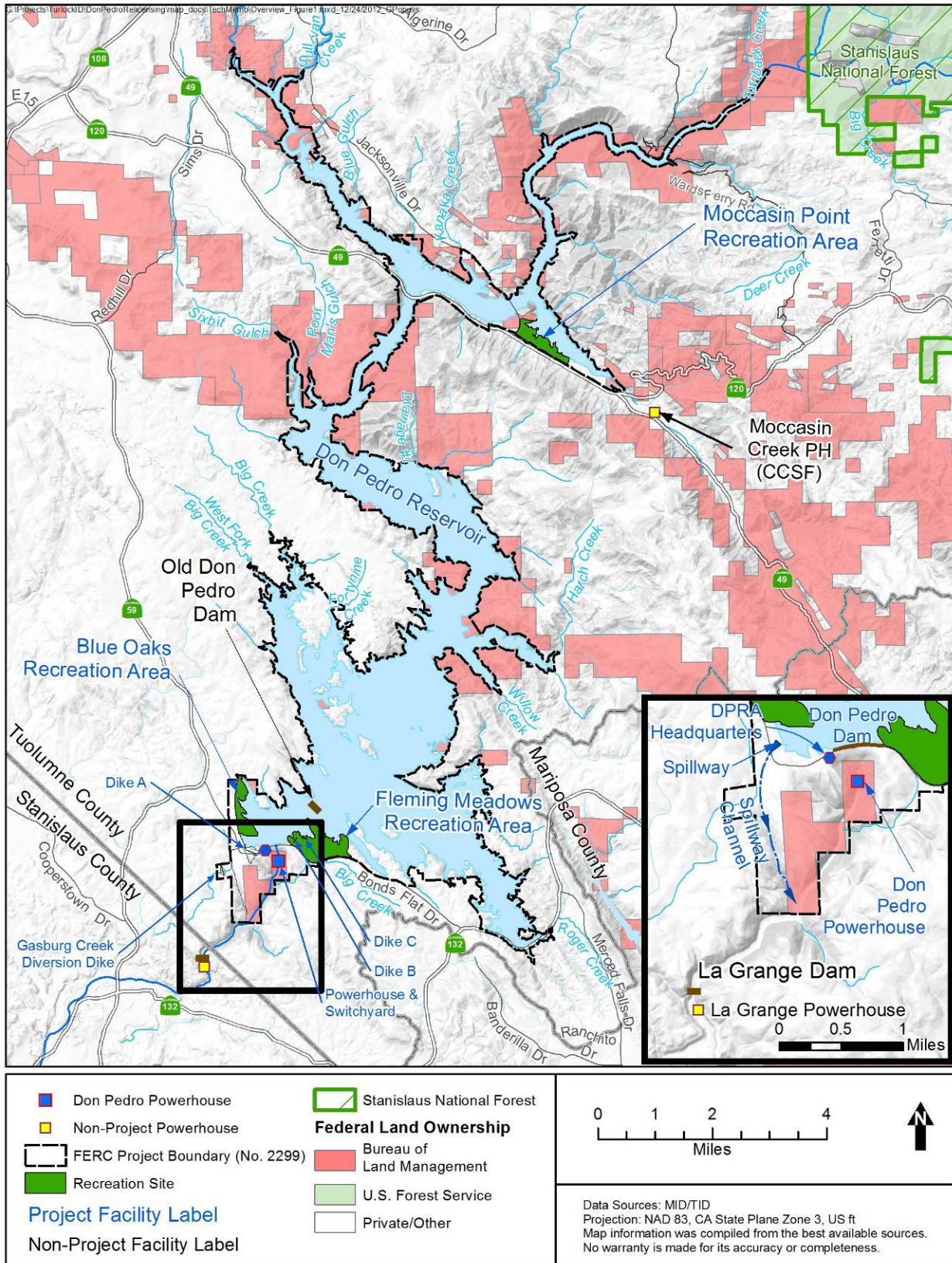


Figure 1.1-1. Don Pedro Project location.

1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2016, and the Districts will apply for a new license no later than April 30, 2014. The Districts began the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on February 10, 2011, following the regulations governing the Integrated Licensing Process (ILP). The Districts' PAD included descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources. The PAD also included ten draft study plans describing a subset of the Districts' proposed relicensing studies. The Districts then convened a series of Resource Work Group meetings, engaging agencies and other relicensing participants in a collaborative study plan development process culminating in the Districts' Proposed Study Plan (PSP) and Revised Study Plan (RSP) filings to FERC on July 25, 2011 and November 22, 2011, respectively.

On December 22, 2011, FERC issued its Study Plan Determination (SPD) for the Project, approving, or approving with modifications, 34 studies proposed in the RSP that addressed Cultural and Historical Resources, Recreational Resources, Terrestrial Resources, and Water and Aquatic Resources. In addition, as required by the SPD, the Districts filed three new study plans (W&AR-18, W&AR-19, and W&AR-20) on February 28, 2012 and one modified study plan (W&AR-12) on April 6, 2012. Prior to filing these plans with FERC, the Districts consulted with relicensing participants on drafts of the plans. FERC approved or approved with modifications these four studies on July 25, 2012.

Following the SPD, a total of seven studies (and associated study elements) that were either not adopted in the SPD, or were adopted with modifications, formed the basis of Study Dispute proceedings. In accordance with the ILP, FERC convened a Dispute Resolution Panel on April 17, 2012 and the Panel issued its findings on May 4, 2012. On May 24, 2012, the Director of FERC issued his Formal Study Dispute Determination, with additional clarifications related to the Formal Study Dispute Determination issued on August 17, 2012.

This study report describes the objectives, methods, and results of the Project Operations/Water Balance Model Study (W&AR-02) as implemented by the Districts in accordance with FERC's SPD and subsequent study modifications and clarifications. Documents relating to the Project relicensing are publicly available on the Districts' relicensing website at www.donpedro-relicensing.com.

1.3 Study Plan

FERC approved the Districts' Operations Model Study Plan in the December 22, 2011 Study Plan Determination. FERC modified the study plan by directing the Districts to include in the Workshops proposed by the Districts a discussion of relicensing participant (RP) preferences for graphical and statistical output to include in the model as appropriate any licenses or agreements that are not part of the FERC license, and to extend the model to the San Joaquin River confluence after the conduct of the accretion/depletion measurements in the lower Tuolumne River.

The model was developed in accordance with the approved study plan. There were no variances from the FERC Study Plan Determination dated December 22, 2011. However, the study plan was modified by FERC in the Director's Formal Study Dispute Determination issued on May 24, 2012. In this May 24 Determination, and subsequent clarification dated August 17, 2012, FERC directed the Districts to use the Consultation Workshop process to define (1) the statistical output required by NMFS in its previous study request NMFS-4, Element 1 and (2) the appropriate number of and locations for accretion flow measurements in the lower Tuolumne River. Subsequently, the Districts on June 6, 2012, forwarded to RPs for review and comment a plan to collect accretion flow measurements at various points along the lower Tuolumne River. No comments were received. The Districts conducted these field measurements on June 25 and 26, and provided the results to the RPs on July 26 in advance of Consultation Workshop No. 2 held on September 21. The Districts' reviewed with RPs an approach for conducting two additional accretion measurements, and consulted with RPs regarding additional measurement locations. The Consultation Workshop on September 21 also was used to discuss the details of all the flow data available to the Districts and the statistical analyses to be conducted in accordance with the Director's May 24 Determination. Draft meeting notes were prepared and submitted to RPs on October 22. The SWRCB provided comments on November 27. No other comments have been received. Two model training sessions were held with RPs, one on October 23, 2012 and the second on December 7, 2012.

2.0 STUDY GOALS AND OBJECTIVES

The study goal is to develop a Project operations computer model (Operations Model) to simulate current Don Pedro Project operations and alternative scenarios for future operations of the Project. The Operations Model is intended to be available to RPs for their use in evaluating existing conditions and potential future Project operations.

Study objectives include developing a model that simulates current Project operations for a period of analysis that covers a range of historical hydrologic conditions. The Operations Model is able to simulate basic decisions made during Project operations for flood control management, water supply, river releases, reservoir levels, and hydropower generation. Objectives for the Operations Model also include:

- adequate reproduction of observed reservoir levels, reservoir releases, and hydropower generation, within acceptable calibration standards over a range of hydrologic conditions,
- providing output to inform other studies, analyses, and models,
- evaluating alternative scenarios of future Project operations to estimate effects on reservoir levels, reservoir releases and hydropower generation, and
- providing the model for use by RPs.

3.0 STUDY AREA

Consistent with the FERC-approved study plan and in consultations with RPs, the Tuolumne River Operations Model extends from the CCSF's Hetch Hetchy system in the upper Tuolumne basin to the Districts' Don Pedro Reservoir, then to the Tuolumne River's confluence with the San Joaquin River. Hydrologic records of Tuolumne River flows at La Grange have been recorded by the Districts and CCSF dating back to the early 1900s in order to implement and monitor the provisions of the 4th Agreement between the Districts and CCSF regarding the allocation of flows of the Tuolumne River. The Districts are in the process of extending the Operations Model to the confluence of the San Joaquin River by a combination of analysis of intervening flows between Don Pedro Dam and the mouth of the river using USGS and CDEC gage records and through actual field measurements of accretion flows in the lower Tuolumne River.

4.0 METHODOLOGY

4.1 Summary of Model Development Process

Model development was completed using an Excel platform in accordance with the approved study plan. A “test case” model and complete Model Description and User’s Guide was provided to RPs prior to an October 23 Workshop. The Operations Model simulates both the Districts’ system and the CCSF Hetch Hetchy system, also as described in the approved study plan. The model development process included four Consultation Workshops with RPs as follows:

- Consultation Workshop No. 1 was held on April 9, 2012, focusing on the development of the hydrology for the model;
- Consultation Workshop No. 2 was held on September 21, focusing on discussing accretion flows in the lower Tuolumne River to support location of nodes, the results of the first set of actual field accretion flow measurements, and additional hydrologic analyses requested by RPs;
- Consultation Workshop No. 3 was held on October 23 and focused on discussing the Operations Model’s architecture and computational methods, and review of the Model User’s Guide; and
- Consultation Workshop No. 4 was held on December 7 and consisted of discussing the Model Validation segment of the overall model development. This workshop included a second hands-on training session on model use with RPs.

The first model training session for RPs interested in using the model was held on October 23 and a second session was held on December 7 in conjunction with workshops.

The Districts have also provided additional materials and analyses relevant to the development of the Tuolumne River Operations Model as described below:

- On November 6, 2012, the Districts provided to RPs for review and comment a report entitled *Lower Tuolumne River Accretion Flows (La Grange to Modesto) -- Estimated Daily Flows (1970-2010) for the Operations Model*. This report described the Districts’ estimate of daily intervening flows occurring on the lower Tuolumne River from WY 1971 to WY 2010. These flows were proposed to be included in the Operations Model to extend the model to the San Joaquin River.
- On December 27, 2012, the Districts responded to a letter dated September 10, 2012 from CDFG to SWRCB regarding the Districts development of the unimpaired hydrology for the Operations Model. In their response to the CDFG letter, the Districts included the results of a study conducted to evaluate the gage proration method for the development of the unimpaired hydrology as suggested by CDFG’s September 10 letter. The study showed that the Districts mass balance approach and the CDFG’s gage proration approach compared well where there were adequate gage records for the evaluation, but that the gage proration approach lacked a sufficient period of record for operations modeling purposes.

4.2 Field Accretion Measurements

The Districts conducted these field measurements on June 25 and 26, and provided the results to the RPs on July 26. An additional accretion flow measurement was conducted on October 3-4, 2012, and results of both field events are included in Attachment A of this ISR. Two sets of accretion flow measurements have been undertaken to date and a third is planned for late January/early February when weather conditions are favorable to permit the measurement of accretion flows occurring from primarily groundwater sources. The January/February accretion measurements will be targeted to occur following a one-two week period with little or no precipitation.

5.0 RESULTS

The Tuolumne River Operations Model development is proceeding on schedule. Four Workshops and two model training sessions have been conducted. Relicensing participants have been actively engaged and provided highly valued comments and feedback. The “base case” model is on schedule to be provided to RPs for review and comment in March 2013. The attached detailed reports document and describe the model development process to date. An electronic version of the model developed for the training session has been provided to interested RPs, and is available upon request from the Districts.

6.0 STUDY FINDINGS

The Operations Model has been vetted within RP workshops and is currently available for use. In accordance with the approved study plan, the “base case” representing Don Pedro and Hetch Hetchy “no action” alternative operations will be developed and provided to RPs for review and comment in March 2013. At that point the model will be ready for evaluation of future operating scenarios. The Districts are considering further refinements to model validation dealing with hydropower generation. These are scheduled for completion by January 31, 2013. These refinements will not alter model operations because both Hetch Hetchy and Don Pedro operate under a “water first” guide, meaning water releases are made for water supply purposes with hydropower generation being an ancillary use.

This report primarily consists of the four fundamental building blocks of model development:

- Hydrology
- Model Description
- User’s Guide
- Validation Report

The first item, concerning Tuolumne River hydrology, is provided as Attachment A entitled Model Hydrology Report. The second two items have been combined into a single report entitled Model Description and User’s Guide, provided as Attachment B, and the Validation Report is provided as Attachment C. Some of these materials have previously been provided as drafts to RPs during the Consultation Workshops.

7.0 STUDY VARIANCES AND MODIFICATIONS

There have been no study variances in the development of the Operations Model. The Districts have discussed accretion field work and preliminary findings through the Workshop process and have undertaken two sets of accretion flow field measurements to date. A third is scheduled for late January/early February 2013, streamflow conditions permitting.