Operations Model Workshop No. 3

And Discussion of User's Guide

October 23, 2012

From: Staples, Rose
Sent: Friday, October 12, 2012 7:41 PM
To: Alves, Jim; Anderson, Craig; Asay, Lynette; Barnes, James; Barnes, Peter; Beniamine Beronia; Blake, Martin; Bond, Jack; Borovansky, Jenna; Boucher, Allison; Bowes, Stephen; Bowman, Art; Brenneman, Beth; Brewer, Doug; Buckley, John; Buckley, Mark; Burt, Charles; Byrd, Tim; Cadagan, Jerry; Carlin, Michael; Charles, Cindy; Colvin, Tim; Costa, Jan; Cowan, Jeffrey; Cox, Stanley Rob; Cranston, Peggy; Cremeen, Rebecca; Damin Nicole; Day, Kevin; Day, P; Denean; Derwin, Maryann Moise; Devine, John; Donaldson, Milford Wayne; Dowd, Maggie; Drekmeier, Peter; Edmondson, Steve; Eicher, James; Fargo, James; Ferranti, Annee; Ferrari, Chandra; Fety, Lauren; Findley, Timothy; Fuller, Reba; Furman, Donn W; Ganteinbein, Julie; Giglio, Deborah; Gorman, Elaine; Grader, Zeke; Gutierrez, Monica; Hackamack, Robert; Hastreiter, James; Hatch, Jenny; Hayat, Zahra; Hayden, Ann; Hellam, Anita; Heyne, Tim; Holley, Thomas; Holm, Lisa; Horn, Jeff; Horn, Timi; Hudelson, Bill; Hughes, Noah; Hughes, Robert; Hume, Noah; Jackman, Jerry; Jackson, Zac; Jauregui, Julia; Jennings, William; Jensen, Art; Jensen, Laura; Johannis, Mary; Johnson, Brian; Justin; Keating, Janice; Kempton, Kathryn; Kinney, Teresa; Koepele, Patrick; Kordella, Lesley; Lein, Joseph; Levin, Ellen; Lewis, Reggie; Linkard, David; Looker, Mark; Loy, Carin; Lwenya, Roselynn; Lyons, Bill; Madden, Dan; Manji, Annie; Marko, Paul; Marshall, Mike; Martin, Michael; Martin, Ramon; Mathiesen, Lloyd; McDaniel, Dan; McDevitt, Ray; McDonnell, Marty; McLain, Jeffrey; Mein Janis; Mills, John; Minami Amber; Monheit, Susan; Morningstar Pope, Rhonda; Motola, Mary; Murphey, Gretchen; O'Brien, Jennifer; Orvis, Tom; Ott, Bob; Ott, Chris; Paul, Duane; Pavich, Steve; Pinhey, Nick; Pool, Richard; Porter, Ruth; Powell, Melissa; Puccini, Stephen; Raeder, Jessie; Ramirez, Tim; Rea, Maria; Reed, Rhonda; Richardson, Kevin; Ridenour, Jim; Robbins, Royal; Romano, David O; Roos-Collins, Richard; Roseman, Jesse; Rothert, Steve; Sandkulla, Nicole; Saunders, Jenan; Schutte, Allison; Sears, William; Shakal, Sarah; Shipley, Robert; Shumway, Vern; Shutes, Chris; Sill, Todd; Slay, Ron; Smith, Jim; Staples, Rose; Steindorf, Dave; Steiner, Dan; Stone, Vicki; Stork, Ron; Stratton, Susan; Taylor, Mary Jane; Terpstra, Thomas; TeVelde, George; Thompson, Larry; Vasquez, Sandy; Verkuil, Colette; Vierra, Chris; Wantuck, Richard; Welch, Steve; Wesselman, Eric; Wheeler, Dan; Wheeler, Dave; Wheeler, Douglas; Wilcox, Scott; Williamson, Harry; Willy, Allison; Wilson, Bryan; Winchell, Frank; Wooster, John; Workman, Michelle; Yoshiyama, Ron; Zipser, Wayne
Subject: Don Pedro Operations Modeling Training - Validation Meeting October 23 2012
Attachments: OpsModelTraining-ValidationMtg-Oct 23 2012_W-AR-02_AGENDA_20121012.pdf

Please find attached the AGENDA for the upcoming **October 23, 2012** (9:00 a.m. to 4:00 p.m.) **Don Pedro Operations Modeling & Validation Meeting** scheduled to be held at the MID Offices in Modesto. A copy of the DRAFT *Tuolumne River Daily Operations Model – Model Description and User's Guide* that will be presented during the meeting has been uploaded to the www.donpedro-relicensing.com website (INTRODUCTION tab/ANNOUNCEMENTS). Please note that you will need to bring your computer to the meeting to have the model loaded onto it.

If you are unable to access and/or download the posting on the Don Pedro relicensing website, please let me know. Thank you.

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CAP-OM

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Operations Model Training / Validation Meeting
Don Pedro Relicensing Study W&AR-2
October 23, 2012 – 9:00 a.m. to 4:00 p.m. - MID Offices

Audio Call-In Number: 866-994-6437, Conference Code 5424697994
To LINK to LIVE Meeting, please see below

AGENDA

9:00 a.m. to 9:10 a.m.	Introductions
9:10 a.m. to 9:20 a.m.	Review of Agenda
9:20 a.m. to 9:30 a.m.	Purpose of Meeting
9:30 a.m. to 9:45 a.m.	Overview of FERC-Approved Study Plan
9:45 a.m. to 10:00 a.m.	Summary of Prior Workshops
10:00 a.m. to 12:30 p.m.	Presentation of Model Architecture, Model Description, and User's Guide
12:30 p.m. to 1:15 p.m.	Lunch: On Your Own
1:15 p.m. to 1:30 p.m.	Load Model on Computers *Note to Participants: Bring Your Computer!*
1:30 p.m. to 4:00 p.m.	Model Operation and Introduction to Running the Model

LINK to LIVE MEETING:
TO JOIN THE DISCUSSION VIA "LIVE MEETING":

....

Join online meeting
https://meet.hdrinc.com/jenna.borovansky/3D64F0F5

First online meeting?

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DRAFT
Tuolumne River Daily Operations Model
Model Description and User's Guide

Modesto Irrigation District
Turlock Irrigation District

Don Pedro Project Relicensing
FERC No. 2299

DRAFT Working Document
October, 2012

Tuolumne River Daily Operations Model
Model Description and User's Guide

Contents

1.0 Introduction

The Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) have developed a computerized Project Operations Model (Model) to assist in evaluating the relicensing of the Don Pedro Project (Project) (FERC Project 2299). On November 22, 2011, in accordance with the Integrated Licensing Process schedule for the relicensing of the Don Pedro Project, the Districts filed their Revised Study Plan containing 35 proposed studies with the Federal Energy Regulatory Commission (FERC) and relicensing participants. On December 22, 2011, FERC issued its Study Plan Determination approving, with modifications, the proposed studies, including Study Plan W&AR-2: Project Operations /Water Balance Model Study Plan. Consistent with the FERC-approved study plan, the objective of the Model is to provide a tool to compare current and potential future operations of the Project. Due to the fact that the geographic scope of the Model extends from the City and County of San Francisco's (CCSF) Hetch Hetchy system in the upper part of the watershed to the confluence of the Tuolumne and San Joaquin rivers, the Model is now entitled the Tuolumne River Daily Operations Model.

In accordance with the study plan, the Districts are preparing a Model Development Report due to be filed with FERC in January 2013 (W&AR-2 Study Plan, page 7). The Model Development Report will contain three components: (1) this Model Description and User's Guide (User's Guide), (2) a Validation Report, and (3) an executable version of the Model. Also in accordance with the FERC-approved study plan, the Districts are organizing and conducting a number of workshops with relicensing participants associated with the development of the Model. The first Workshop, held on April 9, 2012, was focused on the development of the hydrologic dataset; the second Workshop, held on September 21, dealt with accretion flows, Dry Creek flows, downstream nodes, and other related hydrologic investigations. The third Workshop, scheduled for October 23, will focus on Model architecture, logic, and functionality and provide an initial training opportunity for potential Model users. This Model Description and User's Guide provides information to be covered in the Workshop No. 3.

As fully described in this User's Guide, and consistent with the FERC-approved study plan, the Model includes numerous user-controlled parameters that allow the simulation of alternative Project operations, such as alternative flow regimes for the lower Tuolumne River. The Model performs a simulation of Project operations for a sequential period of years that covers a range of historical hydrologic conditions. The period of hydrologic record selected for the Model is Water Year 1971 through Water Year 2009, which includes extreme years of hydrology (1977 dry and 1983 wet) and multi-year periods of challenging water supply conditions such as 1976-1977, 1987-1992, and 2001-2004. The purpose of this User's Guide is to describe the structure of the Model, the interfaces available for operation of the Model, and methods available for the reviewing Model results. Procedures for development of input files for running alternative future operations are also described and illustrated. The data presented in this document are referenced to a "Test-Case" simulation of operations and are being incorporated for illustrative purposes of the Workshop.

As is the case with any model, the Tuolumne River Daily Operations Model is only a depiction of project operations, and is limited to representing CCSF and District operations to the extent that their operations can be described systematically by various equations and algorithms. Actual project operations may vary from those depicted by the Model due to circumstantial conditions of hydrology and weather,

facility operation, and human intervention. The FERC-approved study plan has identified a number of user-controlled variables for running alternatives. The fact that the Model provides these user-controlled inputs is not an indication that either the Districts or CCSF endorse or support any specific alternative developed by manipulating these inputs.

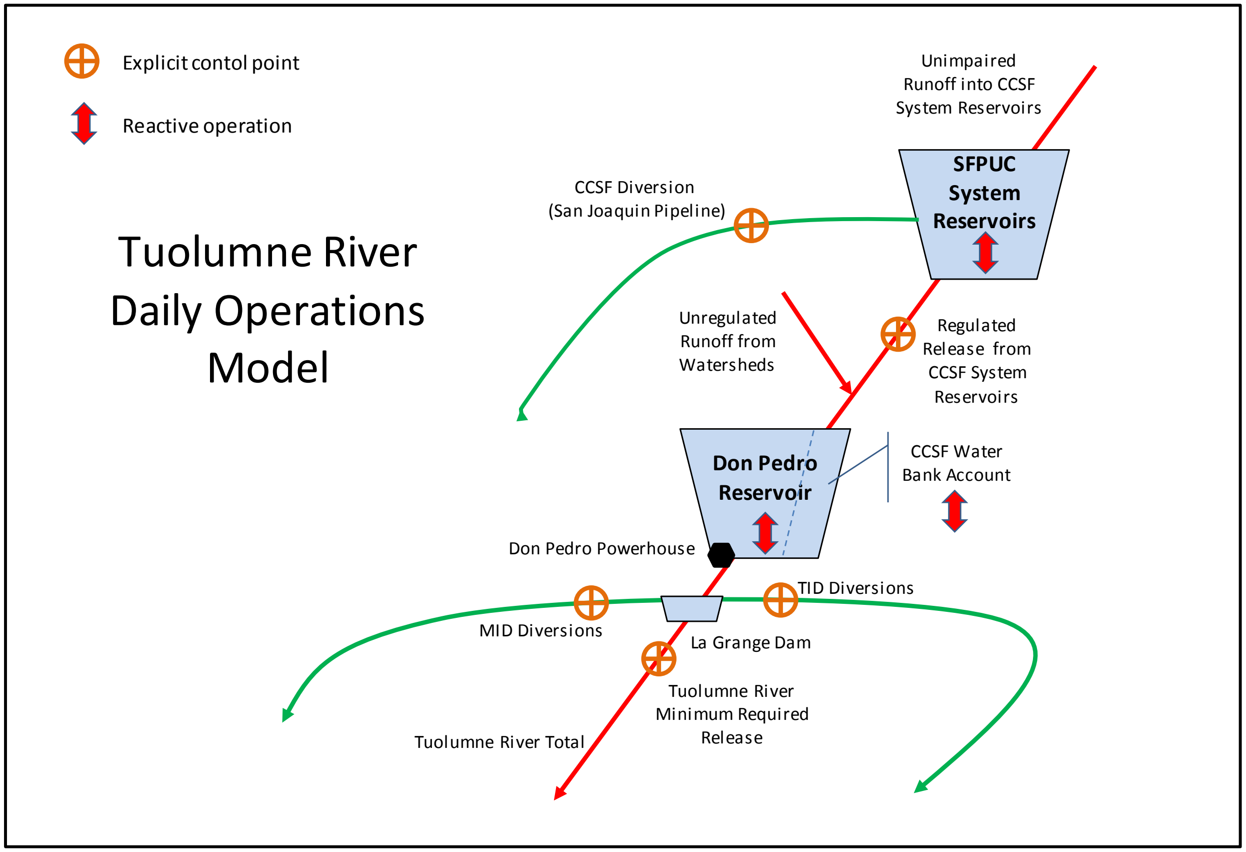
2.0 Geographical Range of Model and Underlying System Operation

As mentioned above, the geographic scope of the Model extends for CCSF's Hetch Hetchy system to the confluence of the Tuolumne and San Joaquin Rivers, as generally depicted in Figure 2.0-1. The Model comprises two primary subsystems -- the Districts' Don Pedro Project and CCSF's Hetch Hetchy Project, which are independently owned and operated by the respective parties. The Don Pedro Project includes the Don Pedro Reservoir and powerhouse. It provides water storage and flood control benefits. Water that flows into Don Pedro Reservoir is either stored or passed through to the lower Tuolumne River. Included in the model is the projected diversion of water at La Grange to serve irrigation and M&I customers of MID and TID. A model "node" (calculation point) is provided at the Districts' La Grange diversion dam, where the Model simulates flows to the Modesto Canal, the Turlock Canal, and the Tuolumne River below the La Grange diversion dam. The CCSF System is modeled as three physical reservoirs (Hetch Hetchy Reservoir, Lake Lloyd and Lake Eleanor), the San Joaquin Pipeline (SJPL), and an accounting for the Don Pedro Water Bank Account. All releases from the CCSF System, except those diverted to the SJPL enter Don Pedro Reservoir. A node is also provided to represent the location of the existing USGS stream flow gage entitled "Tuolumne River at Modesto" (Modesto). Additional nodes may be established above and/or below the Modesto gage node depending on the results of ongoing lower Tuolumne River accretion flow measurements.

The Model components operate with systematic algorithms that attempt to mimic operational decisions for reservoir and facility operations. For each subsystem, certain operation constraints can be user-controlled consistent with the FERC-approved study plan. Within each subsystem, each reservoir has the same underlying operation protocol. A daily mass balance is performed: *change in reservoir storage = inflow, minus outflow (releases), minus reservoir losses*. If the calculation results in a reservoir storage that is in excess of preferred/maximum capacity, an additional release is made.

Minimum releases for each modeled reservoir are in accordance with current stream flow requirements and diversion requirements. Each reservoir assumes a common "hold-unless-need-to-release" protocol, except as conditioned by minimum stream release requirements, diversions, preferred/maximum storage, snowmelt management releases, or other specified releases. In essence, each reservoir operates for its own "reservoir conservation" goal and retains storage as much as possible, only drawn down as needed to meet release requirements, diversions, or to achieve reservoir or flow management goals such as flood control or, in some cases hydropower.

Figure 2.0-1 - Tuolumne River Daily Operations Model



3.0 Don Pedro Project and La Grange Diversion Dam

The Don Pedro Project and the La Grange diversion dam operations are modeled to represent current operations for irrigation and municipal water deliveries, fishery and instream flow requirements and flood control. Hydropower production is a function of the releases made for these other purposes. The following elements of hydrology and objectives guide the modeled operation.

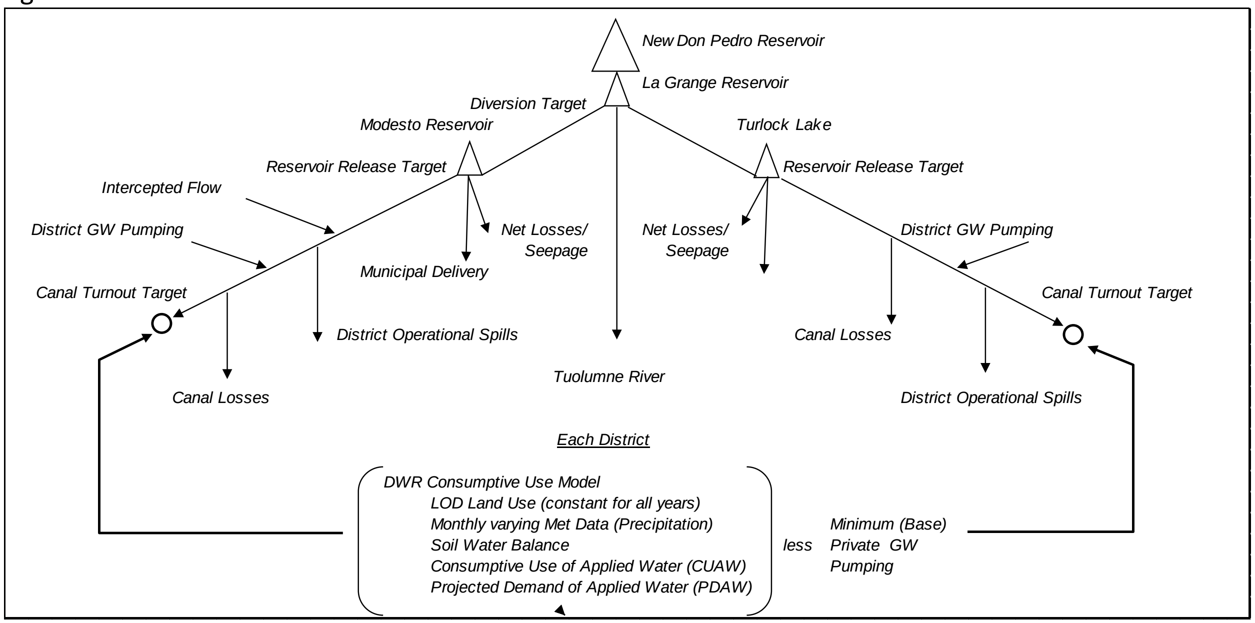
3.1 Reservoir Inflow

Inflow to Don Pedro Reservoir is modeled as two components: 1) a fluctuating unregulated inflow to Don Pedro Reservoir, and 2) the regulated releases (regulated Don Pedro Reservoir inflow) from the CCSF System. The inflow will reflect a daily fluctuating pattern which is mostly associated with the unregulated component of runoff in the basin, which is approximately 40 percent of the total runoff in the basin. The unregulated component of inflow to Don Pedro Reservoir remains the same among all operation simulations. The regulated inflow to Don Pedro is based on a projected level of development and operation for the CCSF System. This component of Don Pedro Reservoir inflow may change among operation simulations due to changed assumptions for CCSF System demands and level of development, or due to user-controlled parameters.

3.2 MID and TID Canal Demand

Figure 3.2-1 is a schematic of the parameters used by modeling to create each District's diversion demand at La Grange diversion dam.

Figure 3.2-1 - District Canal Demand Parameters



Due to changing land use and cropping patterns, groundwater use and irrigation and canal management practices throughout history, the historical record of recorded diversions does not provide a consistent definition of water diversion needs. Similar to depicting inflow, the Model uses a projected level of development for establishing irrigation and canal diversion demand.

The canal diversions are assumed to be driven by three components: 1) a fluctuating customer component, the (P)rojected (D)emand of (A)pplied (W)ater (PDAW), 2) a relatively constant depiction of operational system losses/efficiencies, and 3) a water supply availability factor based on Don Pedro Reservoir storage and inflow.

The PDAW is developed through use of DWR's consumptive use model, and considers precipitation, ET rates, soil moisture criteria, rooting depth, irrigation indicators, and other factors along with land use to estimate the CUAW on a monthly basis. Monthly water use varies based on input ET rates, which are constant each year. CUAW will only vary each year based on variation in precipitation. The PDAW has been adjusted to

reflect other routine irrigation practices not identifiable with strict ET, such as pre-irrigation. The estimate of monthly PDAW is distributed daily based on the historical (2009-2011) distribution of canal diversions within months.

In addition to the PDAW requirement, several canal operation and management components are incorporated into the projected diversion demand. The following tables provide the monthly estimates used for each component, Table 3.2-1 for MID and Table 3.2-2 for TID.

Table 3.2-1 – Canal Demand and Operation Components for MID

Modesto Irrigation District

	Turnout Delivery Factor	Nominal Private GW Pumping	Canal Operational Spills Critical	Canal Operational Spills Non-crit	System Losses below Modesto Res	Intercepted Flows	Nominal MID GW Pumping	Modesto Res and Upper Canal Losses/Div	Municipal Delivery from Modesto Res	Modesto Res Target Storage
Month	%	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF
January	35	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	17.0
February	35	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	18.0
March	65	1.0	1.0	3.0	0.6	0.9	1.0	2.0	2.7	18.0
April	70	2.0	3.0	6.0	0.6	0.9	2.3	2.9	2.7	19.0
May	85	3.0	4.0	6.5	0.6	1.2	2.3	3.9	3.0	20.0
June	85	4.0	3.5	6.5	0.6	1.0	2.3	4.3	3.2	20.0
July	77.5	4.0	3.5	6.5	0.6	1.0	2.6	4.9	3.3	21.0
August	70	4.0	4.9	7.0	0.6	1.4	2.4	4.9	3.3	22.0
September	65	2.0	5.0	7.0	0.6	1.2	2.3	4.2	3.3	20.0
October	40	1.0	2.8	6.9	0.6	0.9	2.1	2.0	3.2	17.0
November	30	0.0	2.0	2.0	0.1	0.0	0.0	2.0	2.7	15.0
December	35	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.5	15.0
Total		21.0	35.7	57.4	5.4	8.5	17.3	31.1	34.5	

Table 3.2-2 – Canal Demand and Operation Components for TID

Turlock Irrigation District

Month	Turnout Delivery Factor	Nominal Private GW Pumping	Canal Operational Spills Critical	Canal Operational Spills Non-crit	System Losses below Turlock Lk	Intercepted Flows	Nominal TID GW Pumping	Turlock Lk and Upper Canal Losses	Other Delivery from Turlock Lk	Turlock Lk Target Storage
	%	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF
January	30	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	18.0
February	30	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	25.0
March	65	1.2	3.0	3.0	4.5	0.0	4.1	1.0	0.0	30.0
April	57.5	2.4	5.1	6.3	4.5	0.0	8.0	6.6	0.0	30.0
May	85	3.6	4.6	6.7	4.5	0.0	10.3	7.7	0.0	32.0
June	92.5	5.2	4.2	6.7	4.5	0.0	12.4	8.2	0.0	32.0
July	72.5	6.4	4.2	6.7	4.5	0.0	14.6	8.7	0.0	32.0
August	62.5	6.2	4.0	7.3	4.5	0.0	13.3	9.0	0.0	30.0
September	67.5	3.9	3.2	7.3	4.5	0.0	9.1	5.0	0.0	27.0
October	40	2.4	2.3	7.3	4.5	0.0	5.3	2.0	0.0	13.0
November	30	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0
December	30	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0
Total		31.3	38.6	59.3	39.2	0.0	77.1	52.2	0.0	

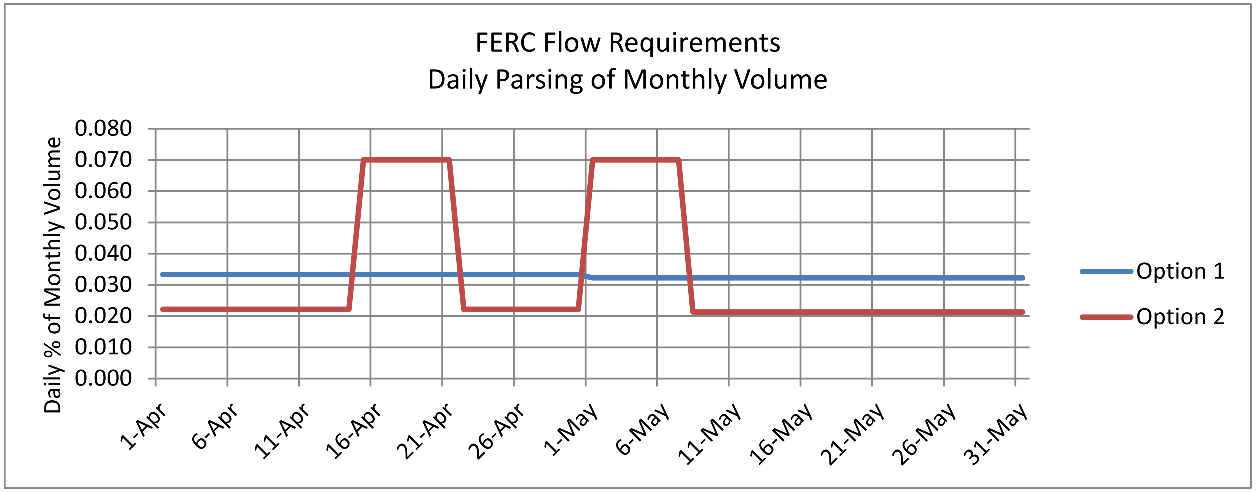
The turnout delivery factor is unique to each District and represents a modeling mechanism to adjust the PDAW for irrigation practices that are not included in the estimation of the CUAW, such as irrigation that provides for groundwater recharge.

3.3 Required FERC flows at La Grange Bridge

The current FERC minimum flow requirements at La Grange Bridge are included in the Model. In the Model the terms "La Grange releases", "flows at La Grange Bridge" or "releases at La Grange diversion dam" are used interchangeably to mean the minimum flow requirements under the Project's current FERC license as measured at the USGS gage "Tuolumne River at La Grange, CA". The annual flow requirement is established for the April-March flow year beginning April based on pre-knowledge of the final San Joaquin River Index (60-20-20) for the year. The annual volume including "interpolation water" is computed using the FERC Settlement Agreement procedures, which includes a revised year type distribution using a 1906-2011 population of historical years. The interpolation water is assumed to be spread among April and May volumes.

The Model assumes each month's volume of the annual volume is spread evenly across the days of the months, except during April and May where the user can define the distribution of daily flows. The user can define the distribution as: 1) total monthly volume spread evenly across all days of a month, or 2) a user-specified daily distribution of monthly volume during April and May. Figure 3.3-1 illustrates the outcome of the two assumed flow distributions during April and May. The pulsing pattern option shown in Figure 3.3-1 is being used by the Model.

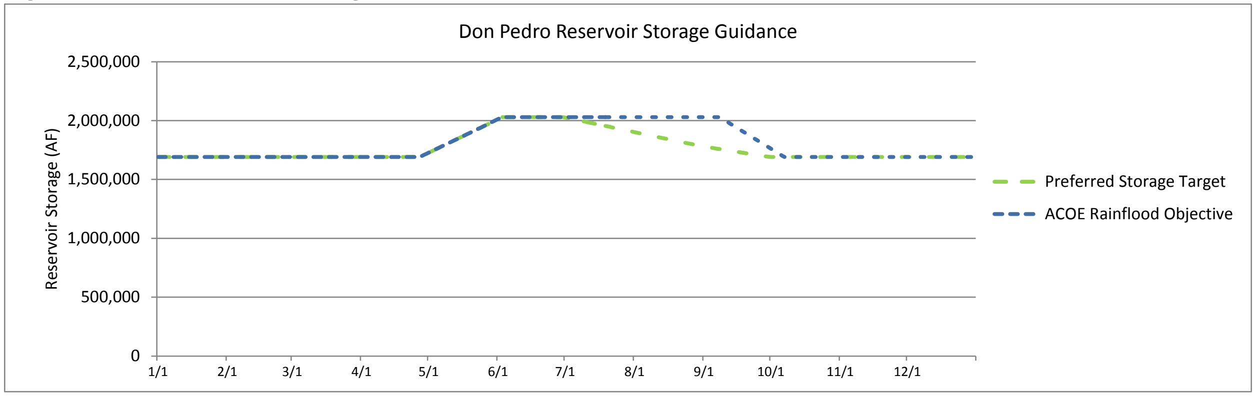
Figure 3.3-1 – User-specified Distribution of April and May FERC Flow Requirements



3.4 Reservoir and Release Management

Don Pedro Reservoir storage is initially checked against a preferred storage target. The Model allows the user to establish the preferred storage target. The preferred storage target is the ACOE rainflood reservation objective, except after July 1, when there is no required reservation space. The preferred storage target reflects a drawdown to evacuate storage during the summer in late and wet runoff years. The preferred target storage is again equal to the ACOE objective on October 7. Figure 3.4-1 illustrates the reservoir storage target used in the Model.

Figure 3.4-1 –Reservoir Storage Guidance



For a day of Don Pedro Reservoir operation, the day's inflow is a computed amount from upstream CCSF System operations and unregulated inflow. The stream flow requirements contained in the FERC license at La Grange Bridge and the MID and TID canal diversions are the release from Don Pedro Reservoir. The prior day's reservoir evaporation is included in the calculation. If the computation produces resulting Don Pedro Reservoir storage in excess (encroachment) of the preferred storage target, the encroachment is computed. Every 7th day the model checks for an encroachment, and if it exists a "check" release is computed. It is assumed that a constant supplemental release (in excess of minimum releases) will be initiated at a rate equal to the encroachment divided equally over the next 10 days. This protocol repeats itself every 7th day, reestablishing the level of check release each time. The end result of this procedure will allow encroachment of storage space above the preferred storage target and not require unrealistic "hard" releases of water to exactly conform to the target.

A second check release is made during the April through June period for management of anticipated snowmelt runoff. On the first day of each of these months a forecast is made of anticipated runoff into the reservoir and minimum releases and losses from the reservoir from the date of forecast through the end of June (the assumed target date of reservoir filling). These forecasts determine the volume of water (if any) that will require release in excess of minimum releases and losses and storage gain by the end of June. For April and May, the DWR "90 percent exceedence forecast" is used for anticipated runoff, along with known minimum releases and losses, and upstream impairment. The user defines

the percentage of volume (of the total volume) to be additionally released during each month. For April, 30 percent of the 3-month volume is advised for release, and during May 50 percent of the 2-month volume is advised for released. For June, the historically reported unimpaired flow (UF) flow is assumed for the runoff computation. This assumes pre-knowledge of the runoff volume for the month, and 100 percent of the excess is spread across the month. The snowmelt check release is evenly distributed across the days of the month. The release made in a day is the greater of the two check releases or the minimum release. At no time is the maximum capacity of the reservoir (2,030,000 acre-feet) allowed to be exceeded, and if necessary a release, regardless of magnitude, will be made by the Model to not exceed maximum storage capacity.

A Modesto flood control objective is incorporated into the release logic. The objective is to maintain a flow at Modesto no greater than a user specified flow rate (assumed as 9,000 cfs). The logic checks against an "allowable" La Grange release considering the lower Tuolumne River accretions and Dry Creek flow. Model logic compares the La Grange allowable release to the other check releases. The La Grange release is then reduced if necessary to not exceed the Modesto flow target objective, even if it results in an encroachment in Don Pedro Reservoir. The exception is when the reservoir reaches full (2,030,000 AF). Any computed encroachment above a full reservoir is passed and the Modesto flow objective will be exceeded.

Consistent with the original FERC license filings for the new Don Pedro Project, the minimum operating reservoir level is established at elevation 600 feet, corresponding to a storage volume of 308,960 AF. Below this elevation is referred to as the "dead pool" storage.

3.5 Water Supply Factor

A constraint to the Districts' canal diversions is recognized when there is a reduced water supply at Don Pedro Reservoir. The premise of the (W)ater (S)upply (F)actor (WSF) is to reduce the amount of water diverted to the canals during years when lack of carryover storage at Don Pedro Reservoir becomes a concern.

The modeling mechanism used to reduce canal diversions is a factor applied to the PDAW of the canal demand. This mechanism results in a reduction to the amount of water "turned out" to the customers while still recognizing the relatively constant efficiencies of canal operations.

The WSF is established by forecasting upcoming water supply, based on antecedent storage and anticipated inflow to Don Pedro Reservoir. The forecasting procedure begins in February and ends in April. The Factor Table is based on April forecast results. The February and March Forecasts act as adjustments to get to the April 1 state. The forecasts have the following protocol:

February Forecast (forecasting April 1 state):
    End of January storage + Feb-Jul UF - Feb-Jul Upstream adjustment - Feb-Mar minimum river
March Forecast (forecasting April 1 state):
    End of February storage + Mar-Jul UF - Mar-Jul Upstream adjustment - Mar minimum river
April Forecast: (final)
    End of March storage + Apr-Jul UF - Apr-Jul Upstream adjustment

Pre-knowledge of unimpaired runoff for each forecast period is assumed, as well as knowledge of upcoming upstream impairment of the runoff.

The WSF factor / Don Pedro Storage + Inflow relationship is developed through iterations of multi-year system operation simulations. The WSF depicts actions that may be implemented during times of drought, and the projected canal diversions and reservoir storage operation during drought periods. The factors and index triggers were developed reviewing reservoir storage levels that occurred during the 1987-1992 drought.

3.6 Power Generation

Equations of Don Pedro powerhouse generation characteristics define capacity (MW) and efficiency (kWh/AF), based on reservoir storage. Capacity potential uses minimum storage of the day, while efficiency uses average storage of the day. The maximum flow through plant is assumed to be 5,400 cfs. Water that does not appear as passing through the generators is computed to be "spilled-bypassed". The power generation "cutoff" also occurs at the reservoir storage of 308,960 acre-feet or the top of dead pool.

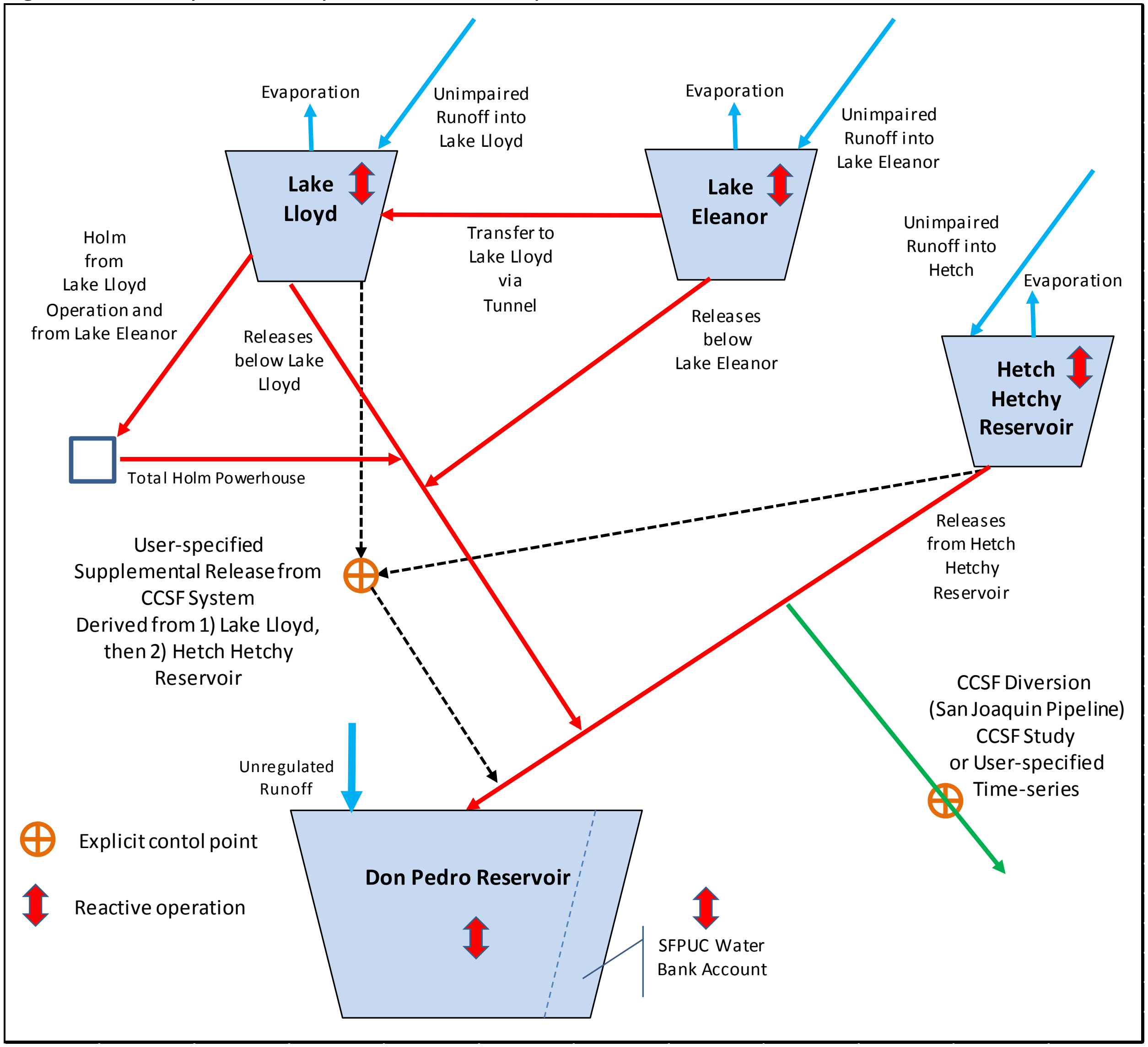
3.7 User-Interface Adjustments

The Model allows alternative user-specified data for two components of District operations: 1) user-specified assumptions for the La Grange Bridge minimum flow requirements, and 2) a user-specified diversion for the Districts' canals. An alternative La Grange Bridge flow requirement can be incorporated by definition of required flows by periods within a year, based on year type. Entered in this protocol the input will result as a daily time series for the Model. Alternatively, a flow requirement can be entered as a daily time series. For an alternative canal diversion, an array has been provided to input a monthly by 39-year matrix of alternative canal diversions. The monthly array of data is parsed by the Model into daily distributions reflecting the current depicted daily distribution of canal diversions.

4.0 City and County of San Francisco System

The Model representation of the CCSF System on the Tuolumne River includes the three physical reservoirs (Hetch Hetchy Reservoir, Lake Lloyd and Lake Eleanor), diversions to the Bay Area through the San Joaquin Pipeline, and an accounting for the Don Pedro Water Bank Account. The CCSF System is illustrated in Figure 4.0-1, with detail provided for the components of explicitly modeled hydrologic parameters.

Figure 4.0-1 – City and County of San Francisco System



Each CCSF System reservoir has the same underlying operation protocol. A daily mass balance is performed: *change in reservoir storage = inflow, minus outflow (releases), minus reservoir losses*. If the calculation results in reservoir storage exceeding preferred/maximum capacity, an additional release of water is made.

Minimum releases from each reservoir are in accordance with current requirements for Hetch Hetchy Reservoir, Lake Lloyd and Lake Eleanor.

Each reservoir assumes a common “hold-unless-need-to-release” protocol, except as conditioned by minimum release requirements, diversions, preferred/maximum storage, snowmelt management releases, hydropower, or other flow or management objectives. In essence, each reservoir operates for its own “reservoir conservation” goal of retaining storage unless drawn down by demands or reservoir management objectives. CCSF is required by State law and its Charter to operate its system for “water first”.

4.1 Hetch Hetchy Reservoir

Hetch Hetchy Reservoir storage is initially checked against a preferred storage target. The day's inflow is a given amount, and the SJPL diversion and minimum stream flow requirements below Hetch Hetchy Reservoir determine the release. The prior day's reservoir evaporation is included in the calculation. If the computation produces storage in excess (encroachment) of the preferred storage target, the encroachment is computed. Every 7th day the model checks for the encroachment, and if it exists a check release is computed. It is assumed that a constant supplemental release (in excess of minimum releases) will be initiated at a rate equal to the encroachment divided equally over the next 7 days. This protocol repeats itself every 7th day, reestablishing the level of check release each time. The end result of this procedure will allow encroachment of storage space above the preferred target storage and not require unrealistic releases of water to exactly conform to the target.

A second check release is made during the February through June period for management of anticipated snowmelt runoff. On the first day of each of these months a forecast is made of anticipated runoff into the reservoir and minimum releases and losses from the reservoir from the date of forecast through the end of June (assumed target of reservoir filling). These forecasts determine the volume of water (if any) that will require release in excess of minimum releases and losses and storage gain by the end of June. Pre-knowledge is used for anticipated runoff, minimum releases and losses. The user defines the percentage of volume (of the total volume for the period) to be additionally released during each month. For February through April, 10 percent of the additional release volume is advised for release, and may be additionally capped. This approach tends to hold Hetch Hetchy Reservoir releases for later release during May. The snowmelt check release is evenly distributed across the days of the month and can be capped in terms of rate (cfs) or minimum volume of the reservoir to which it can be drawn during the month. The particular release made in a day is the greater of the two check releases or the minimum release. At no time is the maximum capacity of the reservoir allowed to be exceeded, and if necessary a release, regardless of magnitude, will be made by the Model to not exceed maximum storage capacity.

For Hetch Hetchy Reservoir these two check releases typically guide the operation of the reservoir during the winter and spring. After reservoir filling, summer-time stream release requirements and the SJPL demand typically draw the reservoir down below the preferred storage targets.

Canyon Tunnel, Kirkwood Powerhouse, Mountain Tunnel and Moccasin Powerhouse are not explicitly modeled. The structure of the Model depicts the component of inflow to Don Pedro Reservoir that originates from the Hetch Hetchy Reservoir watershed. The detail of flow reaches below Hetch Hetchy Reservoir is not needed. Therefore, the simple gradation of flow between flow removed from the stream system by the SJPL and the remaining flow that will eventually reach Don Pedro Reservoir is sufficient for purposes related to the relicensing of the Districts' Don Pedro Project.

4.2 Lake Lloyd

The same underlying reservoir operation protocols of Hetch Hetchy Reservoir apply to Lake Lloyd, with a couple of modifications. Instead of the SJPL demand being assumed as an initial release requirement, a minimum Holm Powerhouse release during May through August is assumed from Lake Lloyd.

Both the initial check release for preferred storage encroachment and the snowmelt check release are computed and advised for reservoir operations. If supplemental releases above minimum releases are computed the Model routes the additional release through Holm Powerhouse up to its available capacity. The remainder of the supplemental release is routed to the stream below Lake Lloyd. A comparison is made between "Lloyd-only" use of Holm Powerhouse capacity and maximum capacity for passage to the Lake Eleanor model component.

The operation goal linkage between Lake Lloyd and Lake Eleanor assumes that Lake Eleanor will transfer water from its watershed to Lake Lloyd for the purpose of enhancing power generation at Holm Powerhouse. Thus, any available capacity at Holm Powerhouse <u>after</u> the Lloyd-only operation is assumed available and desired for use of a Lake Eleanor transfer. If water is transferred from Lake Eleanor the Model assumes the water to be directly routed to Holm Powerhouse which then becomes additional release from Lake Lloyd. The inclusion of the Holm Powerhouse logic in the Lloyd/Eleanor watershed logic is only done to facilitate the interaction between the two watersheds.

4.3 Lake Eleanor

Both the initial check release for preferred storage encroachment and the snowmelt check release are computed and employed into reservoir operations. In this instance of Lake Eleanor operations, the transfer “desire” for Holm Powerhouse generation is considered a disposition of the Lake Eleanor releases determined to be in excess of minimum stream requirements. To the extent that check (stream) releases are available from Lake Eleanor, they will be transferred. The amount transferred is limited by available Holm Powerhouse capacity and the assumed capacity of the Eleanor-Cherry Diversion Tunnel. The Lake Eleanor operation protocol will transfer water that would otherwise be released in excess of minimum flow requirements (largely dependent upon the preferred storage target and snowmelt releases) but it will not allow water to be “pulled” from Lake Eleanor to Lake Lloyd.

4.4 Don Pedro Inflow

The three components of regulated releases from Hetch Hetchy Reservoir (not including the SJPL), Lake Lloyd and Lake Eleanor are combined with the unregulated runoff below CCSF System reservoirs to provide the inflow data set for Don Pedro Reservoir.

4.5 Water Bank Account

A Water Bank Account calculation procedure is included in the Model. A running account of the Water Bank Account balance is computed daily, as limited by the Fourth Agreement and implementing agreement. The Model allows the computation of a "negative" balance. The accounting of the balance is incidental to model operations, and there is no auto-default feedback linkage to upstream operations if the balance is negative. To be consistent with current operations in the watershed, the user must employ the user-specified adjustment mechanism for supplemental CCSF System releases to remedy any negative balances.

For purposes of the FERC investigation, the protocols of Fourth Agreement Water Bank Accounting have been amended to incorporate a hypothetical implementation of "shared responsibility" for incremental increases in FERC-required flows for the Tuolumne River.[1] The incremental increase in FERC-required flows is determined by the daily difference between the current FERC requirements and scenario-required minimum flows. Approximately fifty-two percent (51.7121%) of the incremental difference between the flow schedules is assigned as CCSF's responsibility and counted as a debit within Water Bank Accounting.

[1] The "shared responsibility" assumption is presented for the purpose of evaluating alternative operations. The assumption shall not be used as evidence in any proceeding relating to and shall not act as precedence for any allocation of Tuolumne River water between CCSF and the Districts for any purpose under the Fourth Agreement.

4.6 User Interface Adjustments

The Model allows alternative user-specified data for two components of CCSF operations: 1) user-specified supplemental releases from the CCSF System, and 2) user-specified SJPL diversions.

The user-specified release from the CCSF System is to allow the user to "pull" additional water from the CCSF System as supplemental inflow to Don Pedro Reservoir. A single entry is established that will first pull water from Lake Lloyd so that water supply is preserved in the Hetch Hetchy Reservoir system for diversion to the SJPL. At a point when such supplemental releases strain Lake Lloyd storage, the supplemental releases are directed to Hetch Hetchy Reservoir. When employed, a daily flow release is directed from a reservoir at a point in logic after most of the previously described logic occurs. Thus, this release occurs in addition to what operation is already occurring by default. Such a release can affect the following day's default operation or previous periods' operations, thus results require review to determine if the user's desired result occurs. It is also necessary to determine at the end of each simulation whether the operations depicted are consistent with the keeping of the Water Bank Account Balance from being negative.

This adjustment capability is used to maintain the Water Bank Account Balance greater than zero. There is no auto-default logic to keep the Water Bank Account Balance from going negative. In a typical scenario of normal CCSF System operations during most years, for this level of modeling, the Water Bank Account would not affect CCSF upstream operations. The exception is during prolonged drought when the default reservoir operation of CCSF System reservoirs attempts to hold stream releases to a minimum. In the modeled WY 1971 to 2009, the period 1987 through 1992, and possibly other periods may drive the Water Bank Account to a negative condition. The release adjustment is used to provide additional releases from the CCSF System to avoid driving the Water Bank Account negative.

The second adjustment to SF System hydrology can be made to the pre-specified time series of monthly SJPL diversion. The user is provided a tool to enter an alternative time series of data. This capability can be used to adjust CCSF System diversions from the Tuolumne River.

5.0 General Model Structure

The Model was constructed within the platform of a Microsoft Excel 2010 workbook. All Model logic is contained within cells of the workbook with no macros or calls to other forms of programming such as Visual Basic for Applications. Numerous worksheets within the workbook represent logical groupings of either sub-system facilities and operations, or input/output functionality. The worksheets of the Model are briefly described in Table 5.0-1. Some of the worksheets in the Model are fixed to prevent inadvertent changes to certain facility functions and operations. These aspects of the Model are consistent with the FERC-approved study plan.

Table 5.0-1 – Model Worksheets

Purpose	Worksheet Name	Description
Model Operations	UserInput*	Contains user inputs for La Grange Requirements, Canal Diversions, CCSF SJPL and CCSF Supplemental Releases
	Control	Contains inputs for facility characteristics and Test Case configuration
	DonPedro	Contains model logic for Don Pedro Reservoir operation
	SFHetchHetchy	Contains model logic for Hetch Hetchy Reservoir operation
	SFLloyd	Contains model logic for Lake Lloyd operation
	SFEleanor	Contains model logic for Lake Eleanor operation
	SFWaterBank	Contains model logic for Water Bank operation
	WaterBankRel*	Contains mode logic and user input for CCSF Supplemental Releases
View Model Results	DPGroup*	Plots simulation of Don Pedro Reservoir operations and River flows
	HHGroup*	Plots simulation of Hetch Hetchy Reservoir operation
	LloydGroup*	Plots simulation of Lake Lloyd operation
	ELGroup*	Plots simulation of Lake Eleanor operation
	WBGroup*	Plots simulation of Water Bank Balance computation
	SFSysGroup*	Plots simulation of CCSF System reservoirs
	DPGroup86_94*	Plots simulation of Don Pedro Reservoir operation during 1986-1994
	SFGroup86_94*	Plots simulation of CCSF System operation during 1986-1994
	ModelYearofDaily*	Plots and tables any single parameter for a calendar or water year
	ModelAnyGroup*	Plots any group of parameters for a calendar year
	ModelMonthTable*	Plots and tables up to four parameters, summarizing daily data by month
Model Operations	LaGrangeSchedule	Contains model logic for 1995 FERC minimum flow requirements
	DailyCanalsCompute	Contains model logic for computation of daily District canal demand
	DailyCanals	Contains model logic for computation of user-defined canal demand
	DPWSF	Contains model logic for computation of Don Pedro water supply factor
	CCSF	Contains model logic for CCSF release and diversion requirements
Model Inputs	Hydrology	Contains input data for hydrology
	602020	Contains input data for forecasting hydrology
View Output	Output*	Results of scenario specific simulation in HEC-DSS format
	DSSAnyGroup*	Plots any group of parameters for a calendar year from HEC-DSS format
	DSSMonthTable*	Plots and tables up to four parameters, summarizing daily data by month from HEC-DSS format
"*" Identifies worksheets accessible as user interfaces.		

5.1 UserInput Worksheet

This worksheet (UserInput) provides the interface for entering assumptions for minimum flow schedules for the lower Tuolumne River at La Grange Bridge, canal diversions by the Modesto Irrigation District and Turlock Irrigation District, supplemental releases to Don Pedro Reservoir from the CCSF System, and diversions by CCSF through the San Joaquin Pipeline. The worksheet is described below.

Contents Description and Study Name

User Defined Input
Variables Affected by User Entered in Blue Shaded Cells

Contents:
Section 1 - Alternative Flow Requirements at La Grange Bridge
Section 2 - Alternative Modesto and Turlock Canal Diversions
Section 3 - Supplemental Release from CCSF Upstream Reservoirs
Section 4 - Alternative CCSF San Joaquin Pipeline

(UI 1.00) Enter Study Reference: Test_Case *For Part 6 of DSS file (minimize length of name)*

This section provides an index of the contents included in the worksheet, and identifies a named label for the particular study. An alpha numeric entry is entered (UI 1.00) for the study name, which is then incorporated into the DSS output interface tab (see worksheet Output description).

Section 1: Minimum Flow Requirements at La Grange Bridge

Section 1 - Alternative Flow Requirements La Grange Bridge

This table is used to enter a user-specified minimum flow schedule at La Grange Bridge. Twenty-four time periods are available to define a flow rate. Six different water year types can be established.
The year types correspond to the Preliminary Relicensing Year Type which is based on Tuolumne River unimpaired flow.

(UI 1.10) Turn alterantive flow requirement on: 0 *(1) on, and use alternative flow requirement, or (0) off, use current FERC flow requirement*

(UI 1.20) Use year type table below, or time series: 0 *(1) for table below, or (0) for time series (Column BM)* N/A

(UI 1.30) Alternative Flow Requirements

Enter values in CFS

CYMo Day MM.DD	W 1	AN 2	N 3	BN 4	D 5	C 6
1.01	300	300	233	150	157	150
1.16	300	300	233	150	157	150
2.01	1,287	994	729	419	409	359
2.15	1,287	994	729	419	409	359
3.01	1,627	1,172	912	931	627	421
3.16	1,627	1,172	912	931	627	421
4.01	1,960	1,533	1,508	1,211	1,075	785
4.16	1,960	1,533	1,508	1,211	1,075	785
5.01	2,767	2,744	2,476	1,696	1,258	905
5.16	2,767	2,744	2,476	1,696	1,258	905
6.01	2,857	2,200	1,619	924	566	382
6.16	2,857	2,200	1,619	924	566	382
7.01	250	250	150	61	56	50
7.16	250	250	150	61	56	50
8.01	250	250	150	61	56	50
8.16	250	250	150	61	56	50
9.01	250	250	150	61	56	50
9.16	250	250	150	61	56	50
10.01	397	397	295	143	152	126
10.16	397	397	295	143	152	126
11.01	300	300	233	150	158	150
11.16	300	300	233	150	158	150
12.01	300	300	233	150	157	150
12.16	300	300	233	150	157	150

(UI 1.40) Enter beginning month of annual flow requirement schedule: Feb-Jun / Feb / 2

Preliminary Relicensing Year Type is based on a rank-ordering of the water-year runoff for the years 1921-2011. Each water year type W, AN, N, and BN represent 20% of the years of ranking. D and C year types each represent 10% of the years.

<u>CCSF Responsibility* for La Grange Minimum Flows</u>

CCSF responsibility is applied as a daily debit in the computation of CCSF debit or credit in the Water Bank Account.

0 *(0) not responsible, or*

(UI 1.31) *(1) responsible for 51.7121% of difference between 1995 FERC and scenario requirement.*

If responsibility option is selected, user should go to Section 3 of UserInput and use supplemental CCSF releases to maintain Water Bank Account > zero.

Existing FERC Flow Requirements at La Grange Bridge

Values in CFS

CYMo Day MM.DD	W 1	AN 2	N 3	BN 4	D 5	C 6
1.01	300	300	225	150	157	150
1.16	300	300	225	150	157	150
2.01	300	300	225	150	158	150
2.15	300	300	225	150	158	150
3.01	300	300	225	150	157	150
3.16	300	300	225	150	157	150
4.01	300	300	225	150	158	150
4.15	1,762	1,762	1,562	776	655	461
5.01	1,762	1,762	1,562	776	655	461
5.16	300	300	225	150	157	150
6.01	250	250	150	61	56	50
6.16	250	250	150	61	56	50
7.01	250	250	150	61	56	50
7.16	250	250	150	61	56	50
8.01	250	250	150	61	56	50
8.16	250	250	150	61	56	50
9.01	250	250	150	61	56	50
9.16	250	250	150	61	56	50
10.01	397	397	284	143	152	126
10.16	397	397	284	143	152	126
11.01	300	300	225	150	158	150
11.16	300	300	225	150	158	150
12.01	300	300	225	150	157	150
12.16	300	300	225	150	157	150

Existing FERC flow requirements averaged within Preliminary Relicensing Year Type designations. Existing annual FERC schedules are assumed to begin April 1. Values shown for comparison purposes.

*The "shared responsibility" assumption is presented for the purpose of evaluating alternative operations. The assumption shall not be used as evidence in any proceeding relating to and shall not act as precedence for any allocation of Tuolumne River water between CCSF and the Districts for any purpose under the Fourth Agreement.

This section provides an entry of the minimum flow schedule for the lower Tuolumne River. Switch UI 1.10 directs the use of the current 1995 FERC schedule (UI 1.10 = 0) or an alternative schedule (UI 1.10 = 1). If an alternative schedule is directed, Switch UI 1.20 directs the use of a user-defined daily times series (UI 1.20 = 0) or the use of a user-specified year type schedule (UI 1.20 = 1).

<u>*Daily Time Series*</u>

If the daily time series is directed, a flow value (expressed in average daily flow – cfs) must be entered in Column BM of this worksheet for each day beginning October 1, 1970 through September 30, 2009.

<u>*Year Type Schedule*</u>

If the year type schedule is directed, values must be entered into the matrix provided at UI 1.30. Values are entered as average daily flow (cfs) for 6 year types, for up to 24 discrete periods during the year. The periods are identified in MM.DD format. For instance, for a flow to be provided for January 1 through January 15 the flow would be identified with a period starting 01.01 (January [01], day 1) and ending

with a different flow identified with a starting period of 01.16 (January [01], day 16). The year type has been established by the naming of 6 year types, wet, above normal, normal, below normal, dry and critical. Using the water year runoff for the years 1921 through 2011 (91 years), the years were rank ordered from wettest to driest. The wettest 20 percent of the years (18 years) are designated the wet year type. The next wettest 18 years are designated the above normal year type. And so on for the normal and below normal year types. The driest 20 percent of years are split between the dry and critical year types. After the demarcation occurs for each year the data set is reduced to only the 1971 through 2009 modeling period (39 years). The reduced set of years of the modeling period maintains a year type frequency distribution similar to the larger data set's 20/20/20/20/10/10 percent frequency. Switch UI 1.40 directs the monthly sequence of the flow requirement year. For instance, if the flow schedule is to be established for a year beginning February 1 of the year, UI 1.40 would be set to "Feb". The applicable year type schedule would be applied beginning February 1 of the year and continue through January 31 of the following year. Switch UI 1.40 can be set to any month February (Feb) through June (Jun).

The current 1995 FERC minimum flows to the lower Tuolumne River at La Grange Bridge are illustrated in this section for comparison purposes only, and the values are arranged in the context of the year type designations described above. The values reflect an assumption of two equal periods of flow requirements during each month. If Switch UI 1.10 directs the use of the current schedule, the 1995 FERC schedule as defined by the 1995 FERC Settlement Agreement is implemented including the use of its definition of year types and discrete periods of flow requirements during the year. The 1995 FERC schedule is computed in worksheet LaGrangeSchedule.

Shared responsibility for incremental increases in FERC-required flows for the Tuolumne River is enabled with Switch 1.31.[2] The incremental increase in FERC-required flows is determined by the daily difference between the current FERC requirements and scenario-required minimum flows. Approximately fifty-two percent (51.7121%) of the incremental difference between the flow schedules is assigned as CCSF's responsibility and counted as a debit within Water Bank Accounting. If enabled, shared responsibility will cause an effect in the CCSF Water Bank Account which requires review and possible revision to CCSF supplemental releases.

[2] The "shared responsibility" assumption is presented for the purpose of evaluating alternative operations. The assumption shall not be used as evidence in any proceeding relating to and shall not act as precedence for any allocation of Tuolumne River water between CCSF and the Districts for any purpose under the Fourth Agreement.

Section 2: Canal Diversions of Modesto Irrigation District and Turlock Irrigation District

Section 2 - Alternative Modesto and Turlock Canal Diversions

These tables are used to enter user-specified canal diversions for Modesto ID and Turlock ID. Enter a value for each month of each year.
The monthly volumes of canal diversions are distributed daily within a month based on the daily distribution used for the Base case.

(UI 2.10) Turn alterantive canal diversion on: 0 *(1) on, and use table below, or (0) off, use Test Case canal diversion*

(UI 2.20)

Alternative MID Canal Diversion

Enter values in acre-feet

Prelim Relicense Yr-Type	WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total WY
N	1971	20,952	2,700	2,500	4,300	3,300	14,746	30,656	42,917	47,253	54,987	49,086	32,192	305,589
BN	1972	20,952	5,130	2,500	4,300	5,679	24,844	46,800	46,544	46,542	54,987	49,086	30,637	338,001
N	1973	20,952	2,700	2,500	4,300	3,300	14,746	23,737	45,374	47,016	54,987	49,086	32,658	301,356
AN	1974	20,952	2,700	2,500	4,300	3,300	14,746	18,115	42,917	45,239	49,733	49,086	32,658	286,246
AN	1975	20,952	5,460	2,500	4,300	3,300	14,746	28,782	44,672	47,253	54,859	43,423	32,658	302,906
C	1976	20,952	6,451	2,500	4,300	6,350	30,232	34,676	38,540	38,163	44,939	35,682	24,524	287,308
C	1977	14,568	5,081	2,500	4,300	6,379	17,127	30,279	23,572	28,282	33,405	30,961	19,432	215,886
W	1978	10,761	2,700	2,500	4,300	3,300	14,746	10,143	39,642	47,253	54,987	49,086	25,506	264,924
N	1979	23,490	2,700	2,500	4,300	3,300	14,746	27,340	45,140	47,253	53,962	49,086	32,658	306,475
W	1980	20,952	2,700	2,500	4,300	3,300	14,746	24,602	43,034	47,253	50,758	49,086	32,658	295,889
D	1981	23,236	7,441	2,500	4,300	3,300	14,746	33,395	45,608	47,253	54,987	49,086	32,658	318,510
W	1982	20,952	2,700	2,500	4,300	3,300	14,746	12,687	42,917	45,476	54,987	49,086	17,265	270,916
W	1983	20,952	2,700	2,500	4,300	3,300	14,746	11,058	40,110	47,253	54,987	47,529	15,866	265,301
AN	1984	20,952	2,700	2,500	4,300	3,300	14,746	37,719	46,777	47,253	54,859	49,086	32,502	316,695
BN	1985	20,952	2,700	2,500	4,300	3,300	14,746	33,106	46,193	45,950	54,987	49,086	31,881	309,700
W	1986	20,952	2,700	2,500	4,300	3,300	14,746	19,701	42,215	47,253	54,987	49,086	32,192	293,932
C	1987	20,952	7,441	2,500	4,300	3,300	11,348	33,450	38,540	38,264	45,048	40,977	26,903	273,023
C	1988	14,568	5,081	2,500	4,300	3,300	10,522	20,959	28,485	29,064	35,631	32,822	21,807	209,039
BN	1989	13,109	2,700	2,500	4,300	5,631	11,348	37,004	38,341	38,264	45,048	40,375	15,537	254,156
D	1990	14,568	5,361	2,500	4,300	5,590	15,190	29,936	21,644	29,236	34,588	31,919	20,952	215,784
BN	1991	11,125	6,242	2,500	4,300	5,812	10,324	26,779	32,222	30,198	37,899	33,900	23,035	224,335
C	1992	12,215	6,407	2,500	4,300	3,300	9,811	16,590	29,752	29,193	35,255	32,639	21,693	203,656
AN	1993	11,399	2,700	2,500	4,300	3,300	14,746	23,160	36,951	44,528	54,987	49,086	32,658	280,315
D	1994	20,952	2,700	2,500	4,300	3,300	17,718	28,427	26,707	38,264	45,048	40,977	26,639	257,531
W	1995	14,568	2,700	2,500	4,300	3,300	14,746	15,953	32,974	43,936	54,987	49,086	32,658	271,707
AN	1996	23,490	7,441	2,500	4,300	3,300	14,746	24,746	30,868	47,134	54,987	49,086	32,658	295,257
W	1997	20,952	2,700	2,500	4,300	3,300	14,746	45,935	45,491	46,542	54,987	49,086	32,658	323,197
W	1998	21,967	2,700	2,500	4,300	3,300	14,746	20,421	19,404	43,462	54,987	49,086	32,502	269,376
AN	1999	20,952	2,700	2,500	4,300	3,300	14,746	31,232	43,619	47,134	54,987	49,086	32,347	306,904
N	2000	23,236	6,781	2,500	4,300	3,300	14,746	19,989	29,347	38,722	54,987	49,086	32,192	279,187
BN	2001	20,952	5,790	2,500	4,300	3,300	14,746	21,863	44,204	46,898	54,987	49,086	31,414	300,040
N	2002	21,713	2,700	2,500	4,300	3,300	14,746	36,133	45,959	47,253	54,987	49,086	32,658	315,335
N	2003	23,490	2,700	2,500	4,300	3,300	14,746	27,196	44,087	47,253	54,987	47,670	32,658	304,888
BN	2004	23,490	6,781	2,500	4,300	5,959	25,777	51,269	46,777	47,253	54,987	49,086	32,192	350,369
W	2005	20,952	2,700	2,500	4,300	3,300	14,746	36,422	46,193	47,134	54,987	49,086	30,792	313,112
W	2006	22,982	6,121	2,500	4,300	3,300	14,746	13,115	41,747	47,253	54,987	49,086	32,502	292,640
D	2007	20,952	2,700	2,500	4,300	5,672	22,068	36,391	38,142	38,264	45,048	40,977	25,317	282,330
BN	2008	14,568	5,923	2,500	4,300	3,300	11,348	31,368	38,540	38,264	45,048	40,977	26,903	263,037
N	2009	14,568	5,361	2,500	4,300	3,300	14,746	47,088	44,204	46,661	54,987	49,086	31,259	318,060
	Ave	19,262	4,197	2,500	4,300	3,830	15,412	28,160	38,984	42,875	50,662	45,333	28,663	284,177

Test Case MID Canal Diversion

Values in acre-feet

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total WY	Full Dem Total WY
1971	20,952	2,700	2,500	4,300	3,300	14,746	30,656	42,917	47,253	54,987	49,086	32,192	305,589	305,589
1972	20,952	5,130	2,500	4,300	5,679	24,844	46,800	46,544	46,542	54,987	49,086	30,637	338,001	338,001
1973	20,952	2,700	2,500	4,300	3,300	14,746	23,737	45,374	47,016	54,987	49,086	32,658	301,356	301,356
1974	20,952	2,700	2,500	4,300	3,300	14,746	18,115	42,917	45,239	49,733	49,086	32,658	286,246	286,246
1975	20,952	5,460	2,500	4,300	3,300	14,746	28,782	44,672	47,253	54,859	43,423	32,658	302,906	302,906
1976	20,952	6,451	2,500	4,300	6,350	30,232	34,676	38,540	38,163	44,939	35,682	24,524	287,308	324,478
1977	14,568	5,081	2,500	4,300	6,379	17,127	30,279	23,572	28,282	33,405	30,961	19,432	215,886	316,195
1978	10,761	2,700	2,500	4,300	3,300	14,746	10,143	39,642	47,253	54,987	49,086	25,506	264,924	271,015
1979	23,490	2,700	2,500	4,300	3,300	14,746	27,340	45,140	47,253	53,962	49,086	32,658	306,475	306,475
1980	20,952	2,700	2,500	4,300	3,300	14,746	24,602	43,034	47,253	50,758	49,086	32,658	295,889	295,889
1981	23,236	7,441	2,500	4,300	3,300	14,746	33,395	45,608	47,253	54,987	49,086	32,658	318,510	318,510
1982	20,952	2,700	2,500	4,300	3,300	14,746	12,687	42,917	45,476	54,987	49,086	17,265	270,916	270,916
1983	20,952	2,700	2,500	4,300	3,300	14,746	11,058	40,110	47,253	54,987	47,529	15,866	265,301	265,301
1984	20,952	2,700	2,500	4,300	3,300	14,746	37,719	46,777	47,253	54,859	49,086	32,502	316,695	316,695
1985	20,952	2,700	2,500	4,300	3,300	14,746	33,106	46,193	45,950	54,987	49,086	31,881	309,700	309,700
1986	20,952	2,700	2,500	4,300	3,300	14,746	19,701	42,215	47,253	54,987	49,086	32,192	293,932	293,932
1987	20,952	7,441	2,500	4,300	3,300	11,348	33,450	38,540	38,264	45,048	40,977	26,903	273,023	307,868
1988	14,568	5,081	2,500	4,300	3,300	10,522	20,959	28,485	29,064	35,631	32,822	21,807	209,039	288,428
1989	13,109	2,700	2,500	4,300	5,631	11,348	37,004	38,341	38,264	45,048	40,375	15,537	254,156	293,803
1990	14,568	5,361	2,500	4,300	5,590	15,190	29,936	21,644	29,236	34,588	31,919	20,952	215,784	304,883
1991	11,125	6,242	2,500	4,300	5,812	10,324	26,779	32,222	30,198	37,899	33,900	23,035	224,335	299,335
1992	12,215	6,407	2,500	4,300	3,300	9,811	16,590	29,752	29,193	35,255	32,639	21,693	203,656	285,286
1993	11,399	2,700	2,500	4,300	3,300	14,746	23,160	36,951	44,528	54,987	49,086	32,658	280,315	285,768
1994	20,952	2,700	2,500	4,300	3,300	17,718	28,427	26,707	38,264	45,048	40,977	26,639	257,531	287,956
1995	14,568	2,700	2,500	4,300	3,300	14,746	15,953	32,974	43,936	54,987	49,086	32,658	271,707	273,991
1996	23,490	7,441	2,500	4,300	3,300	14,746	24,746	30,868	47,134	54,987	49,086	32,658	295,257	295,257
1997	20,952	2,700	2,500	4,300	3,300	14,746	45,935	45,491	46,542	54,987	49,086	32,658	323,197	323,197
1998	21,967	2,700	2,500	4,300	3,300	14,746	20,421	19,404	43,462	54,987	49,086	32,502	269,376	269,376
1999	20,952	2,700	2,500	4,300	3,300	14,746	31,232	43,619	47,134	54,987	49,086	32,347	306,904	306,904
2000	23,236	6,781	2,500	4,300	3,300	14,746	19,989	29,347	38,722	54,987	49,086	32,192	279,187	279,187
2001	20,952	5,790	2,500	4,300	3,300	14,746	21,863	44,204	46,898	54,987	49,086	31,414	300,040	300,040
2002	21,713	2,700	2,500	4,300	3,300	14,746	36,133	45,959	47,253	54,987	49,086	32,658	315,335	315,335
2003	23,490	2,700	2,500	4,300	3,300	14,746	27,196	44,087	47,253	54,987	47,670	32,658	304,888	304,888
2004	23,490	6,781	2,500	4,300	5,959	25,777	51,269	46,777	47,253	54,987	49,086	32,192	350,369	350,369
2005	20,952	2,700	2,500	4,300	3,300	14,746	36,422	46,193	47,134	54,987	49,086	30,792	313,112	313,112
2006	22,982	6,121	2,500	4,300	3,300	14,746	13,115	41,747	47,253	54,987	49,086	32,502	292,640	292,640
2007	20,952	2,700	2,500	4,300	5,672	22,068	36,391	38,142	38,264	45,048	40,977	25,317	282,330	315,945
2008	14,568	5,923	2,500	4,300	3,300	11,348	31,368	38,540	38,264	45,048	40,977	26,903	263,037	299,996
2009	14,568	5,361	2,500	4,300	3,300	14,746	47,088	44,204	46,661	54,987	49,086	31,259	318,060	320,443
Ave	19,262	4,197	2,500	4,300	3,830	15,412	28,160	38,984	42,875	50,662	45,333	28,663	284,177	300,954

This section provides an entry of the diversions of the Modesto Irrigation District and Turlock Irrigation District. Switch UI 2.10 directs the use of Test Case diversions (UI 2.10 = 0) or user specified canal diversions (UI 2.10 = 1). If Test Case diversions are directed, a pre-processed daily time series of canal diversions is used. If directed to use user-specified canal diversions, the matrix tables shown at UI 2.30 (above for Modesto Irrigation District) and at UI 2.40 (below for Turlock Irrigation District) require input values for each month of each simulation year, beginning October 1970 (water year 1971) through September 2009. Values are entered as monthly volumes (acre-feet), which will be parsed by the Model into a daily distribution each month represented by the distribution pattern of the Test Case diversions. The Test Case diversions to the Modesto Canal and Turlock Canal are illustrated in this section for comparison purposes.

Alternative TID Canal Diversion

Enter values in acre-feet

	Prelim Relicense Yr-Type	WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total WY
(UI 2.30)	N	1971	31,487	1,000	1,000	6,000	8,000	42,220	71,385	79,506	96,454	118,397	101,372	51,350	608,171
	BN	1972	31,487	4,120	1,000	6,000	12,542	70,210	104,879	92,357	95,639	118,397	101,372	50,168	688,170
	N	1973	31,487	1,000	1,000	6,000	8,000	42,220	44,833	89,056	96,105	118,397	101,372	52,681	592,149
	AN	1974	31,487	1,000	1,000	6,000	8,000	42,220	39,626	82,689	92,845	106,930	101,372	52,681	565,851
	AN	1975	31,487	4,761	1,000	6,000	8,000	42,220	59,410	85,755	96,454	117,430	92,559	52,681	597,756
	C	1976	31,487	6,684	1,000	6,000	13,169	81,414	79,704	77,553	79,063	97,737	72,955	32,004	578,770
	C	1977	20,773	1,000	1,000	6,000	13,371	50,509	72,025	45,645	54,416	68,098	57,243	26,675	416,755
	W	1978	11,340	4,569	1,000	6,000	8,000	42,220	9,548	72,786	96,454	118,397	101,372	37,013	508,698
	N	1979	31,487	1,000	1,000	6,000	8,000	42,220	53,683	87,405	96,454	115,219	101,372	52,681	596,521
	W	1980	31,487	1,000	1,000	6,000	8,000	42,220	49,345	81,864	96,454	112,318	101,372	52,681	583,741
	D	1981	31,487	7,966	1,000	6,000	11,130	42,220	78,153	90,235	96,454	118,397	101,372	52,681	637,093
	W	1982	31,487	1,000	1,000	6,000	8,000	42,220	18,801	79,506	93,427	118,397	101,372	26,075	527,285
	W	1983	31,487	1,000	1,000	6,000	8,000	42,220	14,289	73,376	96,454	118,397	97,046	25,780	515,047
	AN	1984	31,487	1,000	1,000	6,000	8,000	42,220	89,260	92,475	95,173	118,120	101,372	51,794	637,901
	BN	1985	31,487	1,000	1,000	6,000	8,000	42,220	80,930	92,003	92,845	118,397	101,372	51,942	627,195
	W	1986	31,487	1,000	1,000	6,000	8,000	42,220	36,155	80,567	96,454	118,397	101,372	50,168	572,820
	C	1987	31,487	7,645	1,000	6,000	11,080	37,117	80,884	77,453	79,756	97,972	82,761	40,798	553,954
	C	1988	20,773	4,345	1,000	6,000	8,000	34,416	44,841	54,744	59,435	73,648	61,984	30,238	399,424
	BN	1989	13,087	1,000	1,000	6,000	11,360	37,117	89,292	76,551	79,756	97,972	80,991	19,063	513,190
	D	1990	20,773	4,889	1,000	6,000	11,491	42,592	67,733	41,090	58,355	70,954	59,683	28,700	413,261
	BN	1991	12,239	5,799	1,000	6,000	12,548	33,362	63,975	63,689	62,376	79,506	64,759	32,781	438,033
	C	1992	14,931	5,806	1,000	6,000	8,000	31,457	37,881	58,023	58,785	71,771	61,517	30,001	385,173
	AN	1993	12,915	5,034	1,000	6,000	8,000	42,220	43,271	70,428	88,770	118,397	101,372	52,681	550,087
	D	1994	31,487	4,441	1,000	6,000	8,000	42,220	67,460	54,104	79,756	97,972	82,761	39,040	514,241
	W	1995	20,773	1,000	1,000	6,000	8,000	42,220	25,049	58,874	87,023	118,120	101,372	52,681	522,113
	AN	1996	31,487	7,966	1,000	6,000	8,000	42,220	46,047	59,228	96,454	118,397	101,372	52,681	570,851
	W	1997	31,487	1,000	1,000	6,000	8,000	42,220	107,135	91,532	95,173	118,397	101,372	52,089	655,405
	W	1998	31,487	1,000	1,000	6,000	8,000	42,220	31,470	38,950	81,784	118,397	101,372	52,681	514,360
	AN	1999	31,487	1,000	1,000	6,000	8,000	42,220	75,897	88,702	96,454	118,397	101,372	52,681	623,209
	N	2000	31,487	5,723	1,000	6,000	8,000	42,220	36,503	56,634	83,065	118,397	101,372	52,681	543,081
	BN	2001	31,487	4,761	1,000	6,000	8,000	42,220	49,518	83,515	96,105	118,397	101,372	50,168	592,542
	N	2002	31,487	1,000	1,000	6,000	8,000	42,220	84,748	81,510	96,454	118,397	101,372	52,681	624,868
	N	2003	31,487	1,000	1,000	6,000	8,000	42,220	66,179	82,454	96,454	118,397	99,129	52,681	604,999
	BN	2004	31,487	6,363	1,000	6,000	8,000	42,220	111,474	89,763	91,215	112,042	96,725	52,681	648,970
	W	2005	31,487	1,000	1,000	6,000	8,000	42,220	54,725	81,275	96,454	118,397	100,731	48,099	589,386
	W	2006	31,487	6,363	1,000	6,000	8,000	42,220	29,387	71,607	96,454	118,397	101,372	52,681	564,968
	D	2007	31,487	1,000	1,000	6,000	12,448	70,365	85,162	76,852	79,756	97,972	82,761	36,904	581,706
	BN	2008	20,773	5,707	1,000	6,000	8,000	37,117	76,901	76,952	79,756	97,972	82,761	40,798	533,738
	N	2009	20,773	4,617	1,000	6,000	8,000	42,220	103,144	85,047	95,522	118,397	101,372	50,611	636,704
		Ave	27,456	3,271	1,000	6,000	8,952	43,791	61,044	74,917	87,340	108,669	92,511	44,747	559,697

Test Case TID Canal Diversion

Values in acre-feet

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total WY	Full Dem Total
1971	31,487	1,000	1,000	6,000	8,000	42,220	71,385	79,506	96,454	118,397	101,372	51,350	608,171	608,171
1972	31,487	4,120	1,000	6,000	12,542	70,210	104,879	92,357	95,639	118,397	101,372	50,168	688,170	688,170
1973	31,487	1,000	1,000	6,000	8,000	42,220	44,833	89,056	96,105	118,397	101,372	52,681	592,149	592,149
1974	31,487	1,000	1,000	6,000	8,000	42,220	39,626	82,689	92,845	106,930	101,372	52,681	565,851	565,851
1975	31,487	4,761	1,000	6,000	8,000	42,220	59,410	85,755	96,454	117,430	92,559	52,681	597,756	597,756
1976	31,487	6,684	1,000	6,000	13,169	81,414	79,704	77,553	79,063	97,737	72,955	32,004	578,770	669,740
1977	20,773	1,000	1,000	6,000	13,371	50,509	72,025	45,645	54,416	68,098	57,243	26,675	416,755	669,171
1978	11,340	4,569	1,000	6,000	8,000	42,220	9,548	72,786	96,454	118,397	101,372	37,013	508,698	524,472
1979	31,487	1,000	1,000	6,000	8,000	42,220	53,683	87,405	96,454	115,219	101,372	52,681	596,521	596,521
1980	31,487	1,000	1,000	6,000	8,000	42,220	49,345	81,864	96,454	112,318	101,372	52,681	583,741	583,741
1981	31,487	7,966	1,000	6,000	11,130	42,220	78,153	90,235	96,454	118,397	101,372	52,681	637,093	637,093
1982	31,487	1,000	1,000	6,000	8,000	42,220	18,801	79,506	93,427	118,397	101,372	26,075	527,285	527,285
1983	31,487	1,000	1,000	6,000	8,000	42,220	14,289	73,376	96,454	118,397	97,046	25,780	515,047	515,047
1984	31,487	1,000	1,000	6,000	8,000	42,220	89,260	92,475	95,173	118,120	101,372	51,794	637,901	637,901
1985	31,487	1,000	1,000	6,000	8,000	42,220	80,930	92,003	92,845	118,397	101,372	51,942	627,195	627,195
1986	31,487	1,000	1,000	6,000	8,000	42,220	36,155	80,567	96,454	118,397	101,372	50,168	572,820	572,820
1987	31,487	7,645	1,000	6,000	11,080	37,117	80,884	77,453	79,756	97,972	82,761	40,798	553,954	640,376
1988	20,773	4,345	1,000	6,000	8,000	34,416	44,841	54,744	59,435	73,648	61,984	30,238	399,424	595,199
1989	13,087	1,000	1,000	6,000	11,360	37,117	89,292	76,551	79,756	97,972	80,991	19,063	513,190	610,352
1990	20,773	4,889	1,000	6,000	11,491	42,592	67,733	41,090	58,355	70,954	59,683	28,700	413,261	632,968
1991	12,239	5,799	1,000	6,000	12,548	33,362	63,975	63,689	62,376	79,506	64,759	32,781	438,033	624,153
1992	14,931	5,806	1,000	6,000	8,000	31,457	37,881	58,023	58,785	71,771	61,517	30,001	385,173	586,401
1993	12,915	5,034	1,000	6,000	8,000	42,220	43,271	70,428	88,770	118,397	101,372	52,681	550,087	564,462
1994	31,487	4,441	1,000	6,000	8,000	42,220	67,460	54,104	79,756	97,972	82,761	39,040	514,241	588,710
1995	20,773	1,000	1,000	6,000	8,000	42,220	25,049	58,874	87,023	118,120	101,372	52,681	522,113	527,941
1996	31,487	7,966	1,000	6,000	8,000	42,220	46,047	59,228	96,454	118,397	101,372	52,681	570,851	570,851
1997	31,487	1,000	1,000	6,000	8,000	42,220	107,135	91,532	95,173	118,397	101,372	52,089	655,405	655,405
1998	31,487	1,000	1,000	6,000	8,000	42,220	31,470	38,950	81,784	118,397	101,372	52,681	514,360	514,360
1999	31,487	1,000	1,000	6,000	8,000	42,220	75,897	88,702	96,454	118,397	101,372	52,681	623,209	623,209
2000	31,487	5,723	1,000	6,000	8,000	42,220	36,503	56,634	83,065	118,397	101,372	52,681	543,081	543,081
2001	31,487	4,761	1,000	6,000	8,000	42,220	49,518	83,515	96,105	118,397	101,372	50,168	592,542	592,542
2002	31,487	1,000	1,000	6,000	8,000	42,220	84,748	81,510	96,454	118,397	101,372	52,681	624,868	624,868
2003	31,487	1,000	1,000	6,000	8,000	42,220	66,179	82,454	96,454	118,397	99,129	52,681	604,999	604,999
2004	31,487	6,363	1,000	6,000	8,000	42,220	111,474	89,763	91,215	112,042	96,725	52,681	648,970	648,970
2005	31,487	1,000	1,000	6,000	8,000	42,220	54,725	81,275	96,454	118,397	100,731	48,099	589,386	589,386
2006	31,487	6,363	1,000	6,000	8,000	42,220	29,387	71,607	96,454	118,397	101,372	52,681	564,968	564,968
2007	31,487	1,000	1,000	6,000	12,448	70,365	85,162	76,852	79,756	97,972	82,761	36,904	581,706	662,937
2008	20,773	5,707	1,000	6,000	8,000	37,117	76,901	76,952	79,756	97,972	82,761	40,798	533,738	625,483
2009	20,773	4,617	1,000	6,000	8,000	42,220	103,144	85,047	95,522	118,397	101,372	50,611	636,704	642,676
Ave	27,456	3,271	1,000	6,000	8,952	43,791	61,044	74,917	87,340	108,669	92,511	44,747	559,697	601,215

Section 3: Supplemental Releases of City and County of San Francisco

This section provides entry of supplemental releases from CCSF upstream facilities. Switch UI 3.10 directs the use of a suggested method for defining daily supplemental releases (UI 3.10 = 1) or the use of a user-specified table of supplemental releases with or without consideration of Test Case supplemental releases (UI 3.10 = 0), other methods. If the suggested daily supplemental releases method is selected (UI 3.10 = 1) the user must go to worksheet WaterBankRel to complete Model input (see worksheet WaterBankRel description). If the "other methods" path is selected (UI 3.10 = 0) the user must provide additional direction. Switch UI 3.20 directs the use of Test Case supplemental releases (UI 3.20 = 0) or the use of a user-specified table of supplemental releases (UI 3.20 = 1). The user must also direct the consideration of Test Case supplemental releases. To only use the user-specified table of supplement releases, Switch UI 3.30 is set to 0. To add Test Case supplemental releases to the user-specified table of supplemental releases, Switch UI 3.30 is set to 1. The format and application of the user-specified table is the same as described for the entry of alternative flow requirements in Section 1. Values must be entered into the matrix provided at UI 3.40. Values are entered as a daily volume (acre-feet) for 6 year types, for up to 24 discrete periods during the year. The periods are identified in MM.DD format. The year type has been established by the naming of 6 year types, wet, above normal, normal, below normal, dry and critical. Switch UI 3.50 directs the monthly sequence of the supplemental release year. For instance, if the schedule is to be established for a year beginning February 1 of the year, UI 3.50 would be set to "Feb". The applicable year type schedule would be applied beginning February 1 of the year and continue through January 31 of the following year. Switch UI 3.50 can be set to any month February (Feb) through June (Jun). The Test Case supplemental release schedule is illustrated in this section for information purposes.

Section 3 - Supplemental Release from CCSF Upstream Reservoirs

This table is used to enter a user-specified supplemental release from CCSF upstream reservoirs. Twenty-four time periods are available to define the period and flow rate. Six different water year types can be established.
The year types correspond to the Preliminary Relicensing Year Type which is based on Tuolumne River unimpaired flow.
The supplemental release will be directed to Lake Lloyd until the reservoir storage reaches a defined limit, then the supplemental release is directed to Hetch Hetchy Reservoir.
User specifies whether or not Table supplemental releases are added to Test Case supplemental releases.
Alternatively, user can define a daily supplemental release from CCSF facilities. This option is the same method used to define Test Base supplemental releases to maintain the Water Bank Balance at or above zero. (Suggested method)

(UI 3.10)	Use daily supplemental release option:	1	*(1) on, use daily defined option - go to worksheet WaterBankRel, or (0) off, use other supplemental release options*
	If using other supplement release options, Switch UI 3.10 = 0, enter choices below.		
(UI 3.20)	Turn other user-specified supplemental releases on:	0	*(1) on, and use table below, or (0) off, use existing Test Case supplemental releases* N/A
(UI 3.30)	If using table below, add to existing supplemental releases:	1	*(1) yes, add table to existing releases, or (0) no use table only*

Alternative Supplemental Releases

Enter values in acre-feet per day

(UI 3.40)

CYMo Day	W	AN	N	BN	D	C
MM.DD	1	2	3	4	5	6
1.01	0	0	0	0	0	0
1.16	0	0	0	0	0	0
2.01	0	0	0	0	2,000	2,000
2.15	0	0	0	0	2,000	2,000
3.01	0	0	0	0	2,000	2,000
3.16	0	0	0	0	2,000	2,000
4.01	0	0	0	0	2,000	2,000
4.16	0	0	0	0	2,000	2,000
5.01	0	0	0	0	2,000	2,000
5.16	0	0	0	0	2,000	2,000
6.01	0	0	0	0	2,000	2,000
6.16	0	0	0	0	2,000	2,000
7.01	0	0	0	0	0	0
7.16	0	0	0	0	0	0
8.01	0	0	0	0	0	0
8.16	0	0	0	0	0	0
9.01	0	0	0	0	0	0
9.16	0	0	0	0	0	0
10.01	0	0	0	0	0	0
10.16	0	0	0	0	0	0
11.01	0	0	0	0	0	0
11.16	0	0	0	0	0	0
12.01	0	0	0	0	0	0
12.16	0	0	0	0	0	0

(UI 3.50) Enter beginning month of annual supplemental release schedule: Feb-Jun / Jun / 6

Preliminary Relicensing Year Type is based on a rank-ordering of the water-year runoff for the years 1921-2011. Each water year type W, AN, N, and BN represent 20% of the years of ranking. D and C year types each represent 10% of the years.

Test Case Supplemental Releases (made to retain WB Balance above zero)

Prelim Relicense Yr-Type	WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
	Monthly Acre-feet													
N	1971	0	0	0	0	0	0	0	0	0	0	0	0	0
BN	1972	0	0	0	0	0	0	0	0	0	0	0	0	0
N	1973	0	0	0	0	0	0	0	0	0	0	0	0	0
AN	1974	0	0	0	0	0	0	0	0	0	0	0	0	0
AN	1975	0	0	0	0	0	0	0	0	0	0	0	0	0
C	1976	0	0	0	0	0	0	0	0	0	0	0	0	0
C	1977	0	0	0	0	0	0	0	0	0	0	0	0	0
W	1978	0	0	0	0	0	0	0	0	0	0	0	0	0
N	1979	0	0	0	0	0	0	0	0	0	0	0	0	0
W	1980	0	0	0	0	0	0	0	0	0	0	0	0	0
D	1981	0	0	0	0	0	0	0	0	0	0	0	0	0
W	1982	0	0	0	0	0	0	0	0	0	0	0	0	0
W	1983	0	0	0	0	0	0	0	0	0	0	0	0	0
AN	1984	0	0	0	0	0	0	0	0	0	0	0	0	0
BN	1985	0	0	0	0	0	0	0	0	0	0	0	0	0
W	1986	0	0	0	0	0	0	0	0	0	0	0	0	0
C	1987	0	0	0	0	0	0	0	0	0	0	0	0	0
C	1988	0	0	0	0	0	0	0	0	0	0	0	0	0
BN	1989	0	0	0	0	0	0	0	0	0	0	0	0	0
D	1990	0	0	0	0	0	0	0	0	0	0	0	0	0
BN	1991	0	0	0	0	0	0	0	0	0	0	0	0	0
C	1992	0	0	0	0	0	0	59,864	70,684	19,366	21,794	0	0	171,708
AN	1993	0	0	0	0	0	0	0	0	0	0	0	0	0
D	1994	0	0	0	0	0	0	0	0	0	0	0	0	0
W	1995	0	0	0	0	0	0	0	0	0	0	0	0	0
AN	1996	0	0	0	0	0	0	0	0	0	0	0	0	0
W	1997	0	0	0	0	0	0	0	0	0	0	0	0	0
W	1998	0	0	0	0	0	0	0	0	0	0	0	0	0
AN	1999	0	0	0	0	0	0	0	0	0	0	0	0	0
N	2000	0	0	0	0	0	0	0	0	0	0	0	0	0
BN	2001	0	0	0	0	0	0	0	0	0	0	0	0	0
N	2002	0	0	0	0	0	0	0	0	0	0	0	0	0
N	2003	0	0	0	0	0	0	0	0	0	0	0	0	0
BN	2004	0	0	0	0	0	0	0	0	0	0	0	0	0
W	2005	0	0	0	0	0	0	0	0	0	0	0	0	0
W	2006	0	0	0	0	0	0	0	0	0	0	0	0	0
D	2007	0	0	0	0	0	0	0	0	0	0	0	0	0
BN	2008	0	0	0	0	0	0	0	0	0	0	0	0	0
N	2009	0	0	0	0	0	0	0	0	0	0	0	0	0

Values are associated with Test Case scenario and are equal to daily supplemental releases made from CCSF facilities to maintain the Water Bank Account Balance at or above zero. Values are shown for comparison purposes.

Section 4: San Joaquin Pipeline Diversions of City and County of San Francisco

Section 4 - Alternative CCSF San Joaquin Pipeline

This section specifies the CCSF San Joaquin Pipeline diversion. Use Test Case diversions, or user-specified values by entering a value for each month of each year.
The monthly volumes of pipeline diversions will be distributed daily within a month equally.

(UI 4.10) Turn alterantive pipeline diversion on: 0 *(0) off, use Test Case pipeline diversion, (1) on, use table below*

(UI 4.20)

Alternative SJPL Diversion — Enter values in acre-feet

Prelim Relicense Yr-Type	WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total WY
N	1971	19,027	11,969	6,660	6,660	6,015	25,782	24,950	25,782	24,950	29,778	29,778	23,937	235,286
BN	1972	21,881	16,572	12,368	17,124	15,467	25,782	25,779	25,782	24,950	29,778	29,778	24,950	270,211
N	1973	21,881	14,731	12,368	6,660	6,015	6,660	16,572	25,782	24,950	29,778	29,778	23,937	219,110
AN	1974	17,124	10,127	6,660	6,660	6,015	6,660	7,365	24,735	23,937	29,778	29,778	24,950	193,789
AN	1975	17,124	0	0	25,782	11,171	6,660	10,127	24,735	23,937	29,778	29,778	24,950	204,042
C	1976	17,124	13,810	12,368	19,027	17,186	25,782	26,699	25,782	24,950	29,778	29,778	24,950	267,234
C	1977	21,881	16,572	17,124	17,124	15,467	25,782	27,620	26,638	25,779	27,589	25,782	21,175	268,535
W	1978	19,027	16,572	12,368	6,660	6,015	6,660	9,023	22,833	22,096	29,778	29,778	23,937	204,745
N	1979	17,124	13,810	17,124	15,222	6,015	17,124	22,096	25,782	24,950	29,778	29,778	23,937	242,741
W	1980	17,124	0	0	14,270	6,015	6,660	19,334	25,782	24,950	29,778	29,778	23,937	197,628
D	1981	17,124	13,810	12,891	12,368	11,171	22,833	23,937	25,782	24,950	29,778	29,778	23,937	248,358
W	1982	17,124	11,969	9,323	6,660	6,015	6,660	6,445	19,979	19,334	29,778	29,778	26,239	189,302
W	1983	19,979	11,969	6,660	6,660	6,015	6,660	7,365	12,368	11,969	29,778	29,778	28,817	178,015
AN	1984	22,833	9,023	6,660	6,660	6,015	25,782	24,950	24,735	23,937	29,778	29,778	24,950	235,099
BN	1985	21,881	0	0	25,782	20,623	25,782	28,817	25,782	24,950	29,778	29,778	23,937	257,109
W	1986	21,881	18,413	12,368	19,027	6,015	6,660	14,731	25,782	24,950	29,778	29,778	23,937	233,319
C	1987	17,124	13,810	17,124	17,124	15,467	25,782	26,239	25,782	24,950	29,778	29,778	24,950	267,909
C	1988	21,881	16,572	12,368	19,027	17,186	25,782	27,620	25,782	24,950	27,589	26,638	21,175	266,571
BN	1989	19,027	16,572	15,222	15,222	13,749	25,782	23,937	22,833	22,096	28,541	25,782	21,175	249,937
D	1990	19,027	0	0	25,782	20,623	25,782	28,817	22,833	22,096	28,541	25,782	21,175	240,458
BN	1991	19,027	16,572	12,891	17,124	15,467	19,979	22,096	22,833	22,096	27,589	25,782	21,175	242,632
C	1992	19,027	16,572	15,222	15,222	6,015	21,881	21,175	22,833	22,096	27,589	25,782	21,175	234,590
AN	1993	19,027	16,572	12,368	6,660	6,015	6,660	16,572	21,881	21,175	29,778	29,778	24,950	211,435
D	1994	17,124	13,810	17,124	17,124	13,749	24,735	24,950	25,782	24,950	29,778	29,778	24,950	263,855
W	1995	19,979	0	0	12,368	6,874	6,660	13,810	22,833	22,096	29,778	29,778	24,950	189,124
AN	1996	17,124	13,810	12,891	6,660	6,015	6,660	18,413	24,735	23,937	29,778	29,778	24,950	214,751
W	1997	17,124	7,365	6,660	6,660	6,015	19,979	23,937	25,782	24,950	29,778	29,778	23,937	221,964
W	1998	21,881	11,969	12,368	6,660	6,015	6,660	6,445	19,979	19,334	29,778	29,778	24,950	195,814
AN	1999	17,124	13,810	15,222	14,270	6,015	12,368	13,810	24,735	23,937	29,778	29,778	23,937	224,785
N	2000	17,124	0	0	25,782	11,171	6,660	23,937	25,782	24,950	29,778	29,778	23,937	218,898
BN	2001	19,027	13,810	12,368	19,027	12,889	17,124	22,096	25,782	24,950	29,778	29,778	23,937	250,566
N	2002	17,124	13,810	9,323	15,222	13,749	24,735	23,937	25,782	24,950	29,778	29,778	24,950	253,138
N	2003	19,979	14,731	6,660	6,660	6,015	25,782	24,950	22,833	22,096	29,778	29,778	24,950	234,209
BN	2004	21,881	13,810	14,270	15,222	6,015	19,027	24,950	25,782	24,950	29,778	29,778	23,937	249,400
W	2005	19,979	0	0	12,368	6,874	6,660	13,810	24,735	23,937	29,778	29,778	24,950	192,868
W	2006	17,124	13,810	10,465	6,660	6,015	9,323	6,445	22,833	22,096	29,778	29,778	24,950	199,276
D	2007	19,027	13,810	15,222	17,124	15,467	24,735	23,937	25,782	24,950	29,778	29,778	24,950	264,561
BN	2008	21,881	16,572	12,368	9,323	6,015	21,881	23,937	25,782	24,950	29,778	29,778	24,950	247,215
N	2009	19,979	14,731	17,124	17,124	6,015	6,660	23,937	25,782	24,950	29,778	29,778	23,937	239,795
	Ave	19,174	11,586	10,056	13,763	9,761	16,390	19,886	24,296	23,512	29,490	29,185	24,138	231,238

Test Case SJPL Diversion — Values in acre-feet

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total WY	CCSF Sys Action
1971	19,027	11,969	6,660	6,660	6,015	25,782	24,950	25,782	24,950	29,778	29,778	23,937	235,286	0
1972	21,881	16,572	12,368	17,124	15,467	25,782	25,779	25,782	24,950	29,778	29,778	24,950	270,211	0
1973	21,881	14,731	12,368	6,660	6,015	6,660	16,572	25,782	24,950	29,778	29,778	23,937	219,110	0
1974	17,124	10,127	6,660	6,660	6,015	6,660	7,365	24,735	23,937	29,778	29,778	24,950	193,789	0
1975	17,124	0	0	25,782	11,171	6,660	10,127	24,735	23,937	29,778	29,778	24,950	204,042	0
1976	17,124	13,810	12,368	19,027	17,186	25,782	26,699	25,782	24,950	29,778	29,778	24,950	267,234	0
1977	21,881	16,572	17,124	17,124	15,467	25,782	27,620	26,638	25,779	27,589	25,782	21,175	268,535	1
1978	19,027	16,572	12,368	6,660	6,015	6,660	9,023	22,833	22,096	29,778	29,778	23,937	204,745	0
1979	17,124	13,810	17,124	15,222	6,015	17,124	22,096	25,782	24,950	29,778	29,778	23,937	242,741	0
1980	17,124	0	0	14,270	6,015	6,660	19,334	25,782	24,950	29,778	29,778	23,937	197,628	0
1981	17,124	13,810	12,891	12,368	11,171	22,833	23,937	25,782	24,950	29,778	29,778	23,937	248,358	0
1982	17,124	11,969	9,323	6,660	6,015	6,660	6,445	19,979	19,334	29,778	29,778	26,239	189,302	0
1983	19,979	11,969	6,660	6,660	6,015	6,660	7,365	12,368	11,969	29,778	29,778	28,817	178,015	0
1984	22,833	9,023	6,660	6,660	6,015	25,782	24,950	24,735	23,937	29,778	29,778	24,950	235,099	0
1985	21,881	0	0	25,782	20,623	25,782	28,817	25,782	24,950	29,778	29,778	23,937	257,109	0
1986	21,881	18,413	12,368	19,027	6,015	6,660	14,731	25,782	24,950	29,778	29,778	23,937	233,319	0
1987	17,124	13,810	17,124	17,124	15,467	25,782	26,239	25,782	24,950	29,778	29,778	24,950	267,909	0
1988	21,881	16,572	12,368	19,027	17,186	25,782	27,620	25,782	24,950	27,589	26,638	21,175	266,571	1
1989	19,027	16,572	15,222	15,222	13,749	25,782	23,937	22,833	22,096	28,541	25,782	21,175	249,937	1
1990	19,027	0	0	25,782	20,623	25,782	28,817	22,833	22,096	28,541	25,782	21,175	240,458	1
1991	19,027	16,572	12,891	17,124	15,467	19,979	22,096	22,833	22,096	27,589	25,782	21,175	242,632	1
1992	19,027	16,572	15,222	15,222	6,015	21,881	21,175	22,833	22,096	27,589	25,782	21,175	234,590	1
1993	19,027	16,572	12,368	6,660	6,015	6,660	16,572	21,881	21,175	29,778	29,778	24,950	211,435	0
1994	17,124	13,810	17,124	17,124	13,749	24,735	24,950	25,782	24,950	29,778	29,778	24,950	263,855	0
1995	19,979	0	0	12,368	6,874	6,660	13,810	22,833	22,096	29,778	29,778	24,950	189,124	0
1996	17,124	13,810	12,891	6,660	6,015	6,660	18,413	24,735	23,937	29,778	29,778	24,950	214,751	0
1997	17,124	7,365	6,660	6,660	6,015	19,979	23,937	25,782	24,950	29,778	29,778	23,937	221,964	0
1998	21,881	11,969	12,368	6,660	6,015	6,660	6,445	19,979	19,334	29,778	29,778	24,950	195,814	0
1999	17,124	13,810	15,222	14,270	6,015	12,368	13,810	24,735	23,937	29,778	29,778	23,937	224,785	0
2000	17,124	0	0	25,782	11,171	6,660	23,937	25,782	24,950	29,778	29,778	23,937	218,898	0
2001	19,027	13,810	12,368	19,027	12,889	17,124	22,096	25,782	24,950	29,778	29,778	23,937	250,566	0
2002	17,124	13,810	9,323	15,222	13,749	24,735	23,937	25,782	24,950	29,778	29,778	24,950	253,138	0
2003	19,979	14,731	6,660	6,660	6,015	25,782	24,950	22,833	22,096	29,778	29,778	24,950	234,209	0
2004	21,881	13,810	14,270	15,222	6,015	19,027	24,950	25,782	24,950	29,778	29,778	23,937	249,400	0
2005	19,979	0	0	12,368	6,874	6,660	13,810	24,735	23,937	29,778	29,778	24,950	192,868	0
2006	17,124	13,810	10,465	6,660	6,015	9,323	6,445	22,833	22,096	29,778	29,778	24,950	199,276	0
2007	19,027	13,810	15,222	17,124	15,467	24,735	23,937	25,782	24,950	29,778	29,778	24,950	264,561	0
2008	21,881	16,572	12,368	9,323	6,015	21,881	23,937	25,782	24,950	29,778	29,778	24,950	247,215	0
2009	19,979	14,731	17,124	17,124	6,015	6,660	23,937	25,782	24,950	29,778	29,778	23,937	239,795	0
Ave	19,174	11,586	10,056	13,763	9,761	16,390	19,886	24,296	23,512	29,490	29,185	24,138	231,238	

This section provides an entry for the diversions of the CCSF System to the San Joaquin Pipeline. Switch UI 4.10 directs the use of Test Case diversions (UI 4.10 = 0), or user-specified diversions (UI 4.10 = 1). If Test Case diversions are directed, a pre-processed time series of diversions is used. If directed to use user-specified diversions, the matrix table shown at UI 4.20 requires input values for each month of each simulation year, beginning October 1970 (water year 1971) through September 2009. Values are entered as monthly volumes (acre-feet), which will be parsed by the Model into an equal daily distribution each month.

5.2 WaterBankRel Workheet

This worksheet (WaterBankRel) provides for entry of daily supplemental releases from the CCSF System. Without any other manual intervention the Model will direct releases from the CCSF System under a "hold-unless-need-to-release" protocol. Additional releases greater than provided by the default protocol may be needed. An example of such a need is during periods when CCSF System operations would otherwise deplete the Water Bank Account to a point of a "negative" balance.

The manual adjustment to releases from the CCSF System is provided to allow the user to "pull" additional water from the CCSF System as supplemental inflow to Don Pedro Reservoir. A single entry is established that will first pull water from Lake Lloyd so that water supply is preserved in the Hetch Hetchy Reservoir system for diversion to the SJPL. At a point when such supplemental releases strain Lake Lloyd storage, the supplemental releases are directed to Hetch Hetchy Reservoir. The supplemental release is directed from a reservoir at a point in logic after the default protocol releases occur. Thus, the release occurs in addition to what operation is already occurring by default. Such a release can affect the following day's default operation or previous periods' operations, thus results require review to determine if the user's desired result occurs. This worksheet is employed when Switch UI 3.10 directs the use of this suggested method for defining daily supplemental releases (UI 3.10 = 1).

Shown below is a snapshot of the worksheet. The worksheet provides the daily accounting of the Water Bank Account Balance for the Model. Information ported from other worksheets of the Model into this worksheet is Don Pedro Reservoir inflow (Column E) and the unimpaired flow at La Grange (Column F). These data and the protocols associated with Fourth Agreement Water Bank Balance accounting (Columns G through Column O) derive the daily credit or debit of CCSF and then the daily balance of the Water Bank Account (Column M).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1			1		San Francisco Water Bank Account Balance Computation and Supplement Release																			
2	*Unit Title*		2		CFS	CFS	CFS	CFS	CFS	AF		AF	AF		AF		AF			AF				
3	*Parameter Title*		3		DP Inflow	La Grange	Fourth Ag	Districts' E	SF Credit/	SF Credit/Debit w/ C		SF WB Eva	SF Water Bank Balan		Max Water Bank Cap		Credit Adj fc			SF Supplemental Release				
4																	*Advice*							
5	*Acre-foot to CFS conversion*				*From*	*From*																		
6	*divide by :*	*1.983471*			*DonPedro*	*Hydrology*		*Warnings*																
7																								
8																								
9																	(UI 1.31)			(UI 3.10)	Yes, this method is being used			
10																	0			1	Min Lloyd Storage		Min	Min
11																	(0) N, (1) Y				for WB		103,852	84,135
12																	- Debit				Call (acre-feet)		Min	Min
13												*Max*	*740,000*				+ Credit				45,000		Non 76-77	Non 76-77
14												*Min*	*0*			*Sum:*	*0*		*Sum:*	*171,708*	*171,708*	*0*	103,852	114,720
15					SF Water Bank Account Balance Calculation												La Grange			Supplemental Release and Storage Check				
16							Fourth	Daily	SF	SF C/D	SF Gross	SF WB	SF Net	SF Share	SF Max		Credit Adj			WB	1st Call	2nd Call		
17	Month				DP	La Grange	Agree	Districts'	Credit/	w/	WB	Evap	WB	RFlood	WB	WB	in SF			Supp	Lloyd	HH	Lloyd	HH
18	Index	Date	Day	Days	Inflow	UF	Check	Entitle	Debit	Credit Adj	Balance	Losses	Balance	DP	Balance	Neg Flag	WB	Mark	Mark	Release	Release	Release	Storage	Storage
19					CFS	CFS	CFS	CFS	CFS	AF	AF	AF	570,000	AF	AF	AF	AF			AF	AF	AF	AF	AF
20	1970.10	10/1/1970	T	31	322	159	2,416	159	163	324	570,324	48	570,000	0	570,000	0	0			0	0	0	200,091	249,349
21	1970.10	10/2/1970	F	31	453	55	2,416	55	398	790	570,790	48	570,000	0	570,000	0	0			0	0	0	200,080	248,379
22	1970.10	10/3/1970	S	31	541	265	2,416	265	276	548	570,548	48	570,000	0	570,000	0	0			0	0	0	200,090	247,622
23	1970.10	10/4/1970	S	31	625	-166	2,416	-166	791	1,569	571,569	48	570,000	0	570,000	0	0			0	0	0	199,278	247,032
24	1970.10	10/5/1970	M	31	75	180	2,416	180	-105	-208	569,792	48	569,744	0	570,000	0	0			0	0	0	199,896	246,150
25	1970.10	10/6/1970	T	31	475	92	2,416	92	383	760	570,504	48	570,000	0	570,000	0	0			0	0	0	199,781	245,360
26	1970.10	10/7/1970	W	31	526	150	2,416	150	376	746	570,746	48	570,000	0	570,000	0	0			0	0	0	199,660	244,595
27	1970.10	10/8/1970	T	31	209	153	2,416	153	56	111	570,111	48	570,000	0	570,000	0	0			0	0	0	199,746	243,730
28	1970.10	10/9/1970	F	31	264	146	2,416	146	118	234	570,234	48	570,000	0	570,000	0	0			0	0	0	199,746	242,867
29	1970.10	10/10/1970	S	31	210	99	2,416	99	111	220	570,220	48	570,000	0	570,000	0	0			0	0	0	199,677	242,119
30	1970.10	10/11/1970	S	31	620	293	2,416	293	327	649	570,649	49	570,000	0	570,000	0	0			0	0	0	199,112	241,661
31	1970.10	10/12/1970	M	31	60	-285	2,416	-285	345	684	570,684	49	570,000	0	570,000	0	0			0	0	0	199,319	240,049
32	1970.10	10/13/1970	T	31	29	335	2,416	335	-306	-607	569,393	48	569,345	0	570,000	0	0			0	0	0	199,568	239,666
33	1970.10	10/14/1970	W	31	192	-15	2,416	-15	207	411	569,755	48	569,707	0	570,000	0	0			0	0	0	199,310	239,002
34	1970.10	10/15/1970	T	31	181	135	2,416	135	46	91	569,798	48	569,749	0	570,000	0	0			0	0	0	199,262	238,351
35	1970.10	10/16/1970	F	31	393	210	2,416	210	183	363	570,112	49	570,000	0	570,000	0	0			0	0	0	199,172	237,490
36	1970.10	10/17/1970	S	31	606	439	2,416	439	167	331	570,331	49	570,000	0	570,000	0	0			0	0	0	199,106	236,626
37	1970.10	10/18/1970	S	31	710	407	2,416	407	303	601	570,601	49	570,000	0	570,000	0	0			0	0	0	198,622	236,098
38	1970.10	10/19/1970	M	31	-115	20	2,416	20	-135	-268	569,732	49	569,684	0	570,000	0	0			0	0	0	199,115	235,023
39	1970.10	10/20/1970	T	31	318	130	2,416	130	188	373	570,057	49	570,000	0	570,000	0	0			0	0	0	199,014	234,169

For purposes of the FERC investigation, the protocols of Fourth Agreement Water Bank Accounting have been amended to incorporate a hypothetical implementation of “shared responsibility” for incremental increases in FERC-required flows for the Tuolumne River.[3] If running the option with shared responsibility has been selected (worksheet UserInput Switch UI 1.31 = 1), the incremental increase in FERC-required flows is determined by the daily difference between the current 1995 FERC Settlement requirements and scenario-required minimum flows. This computation occurs in worksheet LaGrangeSchedule with information regarding the scenario-required flows directed through worksheet UserInput. Approximately fifty-two percent (51.7121%) of the incremental difference between the flow schedules is assigned as CCSF’s responsibility and is ported into the worksheet in Column Q as a “debit”. This debit then enters the current protocols of Fourth Agreement Water Bank Accounting at Column J, and subsequently contributes to the determination of the daily Water Bank Account Balance (Column M).

Water Bank Account Balances which are less than zero (“negative”) are highlighted, and the minimum balance, whether negative or positive, is reported in Cell M14. When a negative balance occurs, the user is to enter into Column T (WB Supplemental Release) a volume of release needed to maintain the Water Bank Account Balance at, or greater than zero. The Model will first direct the supplemental release to Lake Lloyd,

[3] The “shared responsibility” assumption is presented for the purpose of evaluating alternative operations. The assumption shall not be used as evidence in any proceeding relating to and shall not act as precedence for any allocation of Tuolumne River water between CCSF and the Districts for any purpose under the Fourth Agreement.

and continue releases until storage at Lake Lloyd is drawn to a specified 45,000 acre-feet minimum level (shown in Cell Q10 and entered at worksheet CCSF Switch 3.00). Subsequent supplemental releases will be drawn from Hetch Hetchy Reservoir any time storage is less than the Lake Lloyd minimum. The result of entering the supplemental release will cause a recalculation of the entire Model with results refreshed in the worksheet. Lake Lloyd, Hetch Hetchy Reservoir and Don Pedro Reservoir storage is ported from other worksheets to provide the status of their storage as supplemental releases are entered.

Warnings and advice are provided in the worksheet when several conditions occur. The snapshots below illustrate the occurrence of these conditions.

Example 1: A Reservoir Empties and the Model Crashes

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1			1		San Francisco Water Bank Account Balance Computation and Supplement Release																				
2	Unit Title		2		CFS	CFS	CFS	CFS	CFS	AF		AF	AF		AF		AF			AF					
3	Parameter Title		3		DP Inflow	La Grange	Fourth Ag	Districts' E	SF Credit/	SF Credit/Debit w/ C		SF WB Eva	SF Water Bank Balan		Max Water Bank Cap		Credit Adj fc			SF Supplemental Release					
4																	Advice								
5	Acre-foot to CFS conversion				From	From											#N/A								
6	divide by :	1.983471			DonPedro	Hydrology		Warnings									#N/A								
7									Warning: Your have likely drained a reservoir, check reservoirs.								#N/A								
8									#N/A	#N/A															
9										#N/A							(UI 1.31)			(UI 3.10)	Yes, this method is being used				
10									#N/A	#N/A							1			1	Min Lloyd Storage		Min	Min	Min
11										#N/A							(0) N, (1) Y				WB Call (CCSF 3.00)		24,474	#N/A	#N/A
12																	- Debit				(acre-feet)		Min	Min	Min
13												Max	#N/A				+ Credit				45,000		Non76-77	Non76-77	Non76-77
14												Min	#N/A			Sum:	-5,922,391		Sum:	1,197,522	714,938	482,584	24,474	#N/A	#N/A
15					SF Water Bank Account Balance Calculation												La Grange			Supplemental Release and Storage Check					
16							Fourth	Daily	SF	SF C/D	SF Gross	SF WB	SF Net	SF Share	SF Max		Credit Adj			WB	1st Call	2nd Call			
17	Month				DP	La Grange	Agree	Districts'	Credit/	w/	WB	Evap	WB	RFlood	WB	WB	in SF			Supp	Lloyd	HH	Lloyd	HH	DP
18	Index	Date	Day	Days	Inflow	UF	Check	Entitle	Debit	Credit Adj	Balance	Losses	Balance	DP	Balance	Neg Flag	WB	Mark	Mark	Release	Release	Release	Storage	Storage	Storage
19					CFS	CFS	CFS	CFS	CFS	AF	AF	AF	570,000	AF	AF	AF	AF			AF	AF	AF	AF	AF	AF
8018	1992.08	8/24/1992	M	31	205	5	2,416	5	200	396	-122,421	0	-122,421	0	570,000	-396	0			0	0	0	30,461	1,488	528,302
8019	1992.08	8/25/1992	T	31	445	28	2,416	28	417	827	-121,594	0	-121,594	0	570,000	-827	0			0	0	0	30,065	262	526,440
8020	1992.08	8/26/1992	W	31	#N/A	201	2,416	201	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0			0	0	0	29,709	#N/A	#N/A
8021	1992.08	8/27/1992	T	31	#N/A	104	2,416	104	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0			0	0	0	29,370	#N/A	#N/A

A warning has been provided that a reservoir has likely been depleted by the current operation assumptions. In this particular example, Tuolumne River minimum flows were increased with responsibility shared with CCSF, and a set of supplemental releases were established. In this iteration of results it is discovered in Column X (Hetch Hetchy Reservoir storage) an error (reported as "#N/A") on August 26, 1992 has occurred in the Model. By review of the previous day's storage results for Lake Lloyd (Column W), Hetch Hetchy Reservoir (Column X) and Don Pedro Reservoir (Column Y), and the rate of depletion for each of these reservoirs, it is concluded that Hetch Hetchy Reservoir likely drained on August 26 and thus crashed the Model. Although noted, a negative Water Bank Account Balance (Column M) will not cause the Model to crash. To remedy the condition, the user uses worksheet UserInput to revise (lower) SJPL diversions from Hetch Hetchy Reservoir (UI 4.10 and UI 4.20) and retain water in Hetchy Hetchy Reservoir for release. If Don Pedro Reservoir storage was the culprit of causing the Model to crash, the user uses worksheet UserInput to revise (lower) MID and TID canal diversions (UI 2.10, UI 2.20 and UI 2.30 to retain water in Don Pedro Reservoir for release. Alternatively, the user could reduce the scenario's designated minimum flow requirement, which would change flow needed from the upstream systems.

Example 2: Water Bank is Negative

San Francisco Water Bank Account Balance Computation and Supplement Release

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1			1		San Francisco Water Bank Account Balance Computation and Supplement Release																				
2	*Unit Title*		2		CFS	CFS	CFS	CFS	CFS	AF		AF	AF		AF		AF			AF					
3	*Parameter Title*		3		DP Inflow	La Grange	Fourth Ag	Districts' E	SF Credit/	SF Credit/Debit w/ C		SF WB Eva	SF Water Bank Balan		Max Water Bank Cap		Credit Adj fc			SF Supplemental Release					
4																	*Advice*								
5	*Acre-foot to CFS conversion*				*From*	*From*											*If Water Bank Balance is negative (shown as highlighted value in*								
6	*divide by :*	*1.983471*			*DonPedro*	*Hydrology*		*Warnings*									*Column M) enter volume of supplemental release into Column T to*								
7																	*maintin balance at zero or greater. Use Column M and Column P for guidance.*								
8									*Warning: SF Water Bank is 'negative'. Add supplemental release*																
9									*(Column T) to maintain balance at least zero.*								(UI 1.31)			(UI 3.10)	Yes, this method is being used				
10																	0			1	Min Lloyd Storage		Min	Min	Min
11																	(0) N, (1) Y				WB Call (CCSF 3.00)		131,254	84,135	508,489
12																	- Debit				(acre-feet)		Min	Min	Min
13												*Max*	*740,000*				+ Credit				45,000		Non76-77	Non76-77	Non76-77
14												*Min*	*-150,778*			*Sum:*	*0*		*Sum:*	*0*	*0*	*0*	131,254	114,720	740,875
15					SF Water Bank Account Balance Calculation												La Grange			Supplemental Release and Storage Check					
16–19	Month Index	Date	Day	Days	DP Inflow CFS	La Grange UF CFS	Fourth Agree Check CFS	Daily Districts' Entitle CFS	SF Credit/ Debit CFS	SF C/D w/ Credit Adj AF	SF Gross WB Balance AF	SF WB Evap Losses AF	SF Net WB Balance 570,000	SF Share RFlood DP AF	SF Max WB Balance AF	WB Neg Flag AF	Credit Adj in SF WB AF	Mark	Mark	WB Supp Release AF	1st Call Lloyd Release AF	2nd Call HH Release AF	Lloyd Storage AF	HH Storage AF	DP Storage AF
7887	1992.04	4/15/1992	W	30	2138	4,322	4,066	4,066	-1,928	-3,824	4,011	0	4,011	0	570,000	0	0			0	0	0	256,353	262,227	969,641
7888	1992.04	4/16/1992	T	30	1628	3,150	4,066	3,150	-1,521	-3,017	994	0	994	0	570,000	0	0			0	0	0	257,148	263,740	969,822
7889	1992.04	4/17/1992	F	30	1925	4,267	4,066	4,066	-2,141	-4,247	-3,253	0	-3,253	0	570,000	4,247	0			0	0	0	259,037	265,786	970,196
7890	1992.04	4/18/1992	S	30	1980	5,507	4,066	4,066	-2,086	-4,137	-7,390	0	-7,390	0	570,000	4,137	0			0	0	0	260,795	270,314	970,897

A warning has been provided that the Water Bank Account Balance is negative for one or more days of the scenario. In this instance, all Model reservoirs are operating within a viable operation (the Model did not crash due an emptying reservoir); however, the objective to maintain a positive Water Bank Account Balance has been violated. Upon inspection of the results the user can find the first instance of violation and remedy the violation by entry into Column T an amount of release that maintains at least a zero balance in the Water Bank Account Balance. For the first day of violation the reported negative balance (e.g., -3,253 acre-feet) is needed as a supplemental release. The ensuing days of supplemental release are informed by Column P.

It is possible that within the remedy of Example 2 the error exemplified by Example 1 may occur as Hetchy Hetchy Reservoir may be drained through the efforts of maintaining a positive Water Bank Account Balance. At that point, the procedures of Example 1 will be required and the values already derived for supplemental releases may need to be revisited and possibly changed.

5.3 Control Workheet

This worksheet (Control) provides an interface for entering assumptions for reservoir operations and several facility characteristics of District and CCSF facilities. The worksheet is described below.

Contents Description and Study Name

Operation Control Parameters and Facility Characteristics Variables Affecting Case and Facility Operation
Contents: Section 1 - Don Pedro Reservoir and District Facilities Section 2 - CCSF Facilities Section 3 - Don Pedro Reservoir and CCSF Reservoir Elevation/Storage/Area and Evaporation Factors Section 4 - Don Pedro Reservoir Flood Control Reservation Space and Discretionary Target

This section provides an index to the contents of this worksheet (Control).

Section 1: Don Pedro Reservoir and District Facilities

Reservoir Management, Preferred Storage Target and Drawdown, Modesto Flood Control Objective, Snowmelt Runoff, and Storage Constraints

Section 1 - Don Pedro Reservoir and District Facilities

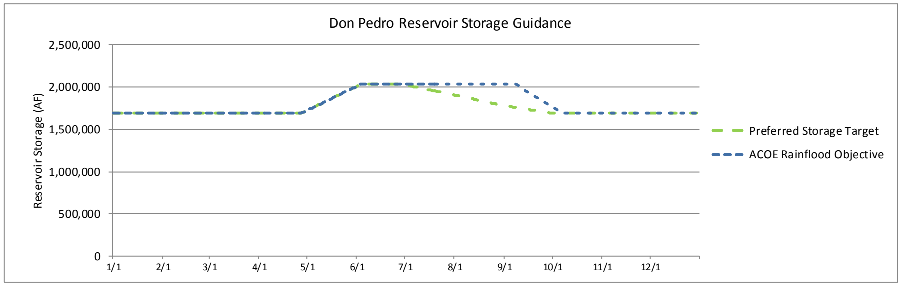
Reservoir Management

Rainflood reservoir reservation space according to ACOE manual.

"Flood control reservoir increases uniformly at a rate of 11,700 acre-feet per day from zero requirement on September 8 to the maximum reservation of 340,000 acre-feet by October 7. The reservation is maintained at 340,000 acre-feet through April 27 after which, unless additional reservation is indicated by the snowmelt parameters, it will decrease uniformaly at a rate of 9,200 acre-feet per day to zero requirement by June 3."

Preferred Storage Targets

ACOE through June 30. Target 1,906,000 acre-feet for July 31, 1,782,000 acre-feet August 31, and 1,692,000 acre-feet for September 30. UCOE thereafter.



Modesto flood control objective

(C 1.00)	*9,000*	*cfs. Target flow not to exceed in Tuolumne River below Modesto.*

Snowmelt release forecast parameters

90% exceedence DWR forecast of watershed runoff for April 1 and May 1
Historical watershed runoff for June 1

Release of forecasted excess runoff

(C 1.10)	*30*	*percent of April - June excess runoff during April*
(C 1.11)	*50*	*percent of May - June excess runoff during May*
(C 1.12)	*100*	*percent of June excess runoff during June*

Reservoir Storage Constraints/Objectives

	2,030,000	*acre-feet Maximum reservoir storage*
(C 1.20)	*308,960*	*acre-feet dead pool, cutoff of generation capability/no release**
(C 1.21)	*5,400*	*cfs maximum Don Pedro Powerhouse discharge*

** The Model will not crash upon simulating an operation below dead pool. However, to conform with operational limitations the user is to modify input assumptions to maintain reservoir storage at or above dead pool.*

This section describes the parameters that provide guidance to the management of Don Pedro Reservoir storage and provides entry of several parameters that advise reservoir operations. United States Army Corps of Engineers (ACOE) and preferred reservoir storage guidance is described. User specified values for specific storage targets are input in Section 4 of this worksheet. The maximum targeted flood flow in the Tuolumne River at Modesto (below Dry Creek) is entered at C 1.00. Releases to the Tuolumne River will be constrained to not exceed this flow level when reservoir space is available in Don Pedro Reservoir to defer releases. Guidance is also provided for the release of anticipated runoff during the snowmelt runoff season. Values entered at C 1.10, C 1.11 and C 1.12 advise the amount of projected excess runoff (from the date of forecast through June) to be released during April, May and June. For instance, the value entered at C 1.10 (30 percent) advises the Model to release 30 percent of the excess runoff volume forecasted to occur during April through June during April. The Model estimates the total excess runoff volume as being the projected inflow to Don Pedro Reservoir less projected canal diversions, reservoir evaporation and minimum Tuolumne River flow requirements, with an objective to fill Don Pedro Reservoir at the end of June. An entry at C 1.20 directs the Model to cease

the simulation of power generation at Don Pedro Powerhouse when reservoir storage is below the value. A warning occurs when Don Pedro Reservoir storage is less than the value. The warning informs the study that the reservoir is being simulated below dead pool. The study should be revised through inputs in worksheet UserInput to remedy reservoir storage that is less than dead pool. The entry at C 1.21 informs the Model of the maximum flow through the Don Pedro powerhouse. Releases from Don Pedro Dam in excess of this value is labeled spill or bypassed at the dam.

FERC Minimum Flow Requirements

FERC Minimum Flow Requirements

FERC Flow Schedules

(C 1.30)

Year Type	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Oct 1-15 (CFS)	*100*	*100*	*150*	*150*	*180*	*200*	*300*
Oct 16-31 (CFS)	*150*	*150*	*150*	*150*	*180*	*175*	*300*
Total Base (AF)	*7,736*	*7,736*	*9,223*	*9,223*	*11,068*	*11,504*	*18,447*
Attraction (AF)	*0*	*0*	*0*	*0*	*1,676*	*1,736*	*5,950*
Total Oct (AF)	*7,736*	*7,736*	*9,223*	*9,223*	*12,744*	*13,240*	*24,397*
Nov (CFS)	*150*	*150*	*150*	*150*	*180*	*175*	*300*
AF	*8,926*	*8,926*	*8,926*	*8,926*	*10,711*	*10,413*	*17,852*
Dec (CFS)	*150*	*150*	*150*	*150*	*180*	*175*	*300*
AF	*9,223*	*9,223*	*9,223*	*9,223*	*11,068*	*10,760*	*18,447*
Jan (CFS)	*150*	*150*	*150*	*150*	*180*	*175*	*300*
AF	*9,223*	*9,223*	*9,223*	*9,223*	*11,068*	*10,760*	*18,447*
Feb (CFS)	*150*	*150*	*150*	*150*	*180*	*175*	*300*
AF	*8,331*	*8,331*	*8,331*	*8,331*	*9,997*	*9,719*	*16,661*
Mar (CFS)	*150*	*150*	*150*	*150*	*180*	*175*	*300*
AF	*9,223*	*9,223*	*9,223*	*9,223*	*11,068*	*10,760*	*18,447*
Apr (CFS)	*150*	*150*	*150*	*150*	*180*	*175*	*300*
AF	*8,926*	*8,926*	*8,926*	*8,926*	*10,711*	*10,413*	*17,852*
May (CFS)	*150*	*150*	*150*	*150*	*180*	*175*	*300*
AF	*9,223*	*9,223*	*9,223*	*9,223*	*11,068*	*10,760*	*18,447*
Migration Flow							
AF	*11,091*	*20,091*	*32,619*	*37,060*	*35,920*	*60,027*	*89,882*
Jun (CFS)	*50*	*50*	*50*	*75*	*75*	*75*	*250*
AF	*2,975*	*2,975*	*2,975*	*4,463*	*4,463*	*4,463*	*14,876*
Jul (CFS)	*50*	*50*	*50*	*75*	*75*	*75*	*250*
AF	*3,074*	*3,074*	*3,074*	*4,612*	*4,612*	*4,612*	*15,372*
Aug (CFS)	*50*	*50*	*50*	*75*	*75*	*75*	*250*
AF	*3,074*	*3,074*	*3,074*	*4,612*	*4,612*	*4,612*	*15,372*
Sep (CFS)	*50*	*50*	*50*	*75*	*75*	*75*	*250*
AF	*2,975*	*2,975*	*2,975*	*4,463*	*4,463*	*4,463*	*14,876*
Total Annual	*94,001*	*103,001*	*117,017*	*127,508*	*142,503*	*165,004*	*300,926*

April - May distribution of spring migration volume

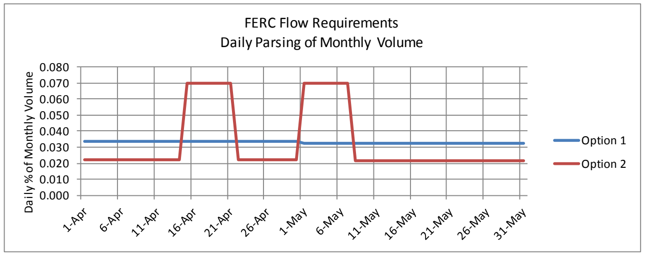
(C 1.40)	*16*	*parts (days) during April*
(C 1.41)	*15*	*parts (days) during May*
	31	*parts total during April and May*

Forecast of San Joaquin River Index

(C 1.50)	*1*	
	1	*Actual*
	2	*90% Exc.*
	3	*75% Exc.*
	4	*Med.*
	5	*10% Exc.*

April - May daily parsing of monthly volume of flow

(C 1.60)	*2*	
	1	*Even*
	2	*2-Pulse*



This section defines the 1995 FERC minimum flow requirements. Values are entered (C 1.30) for each defined flow period by year type, consistent with the FERC order issued July 31, 1996. Seven year types are defined based on the San Joaquin Basin 60-20-20 water supply index. The sequence year of the flow schedule begins in April and continues through the following March. The water supply index of each year of the simulation period is found in worksheet 602020, and the projection method of the index is defined at C 1.50. For the Test Case condition, the historical actual 60-20-20 index is used. The volume of water interpolated between annual schedules is distributed among April and May in proportion to the values provided at C 1.40 (April) and C 1.41 (May). The total volume of water designated for April and May is distributed daily during April and May is directed by C 1.60. If directed to use an equal distribution of the volume of flow during April and May, C 1.60 is set as 1. If C 1.60 is set as 2, two 7-day pulse flows will occur with the remaining volume evenly spread over the remaining days of the months. The pattern of these schedules can be modified in worksheet LaGrangeSchedule.

Test Case District Canal Demands

Test Case Canal Demands

Modesto Irrigation District

										Modesto Reservoir		
		Turnout Delivery Factor	Nominal Private GW Pumping	Canal Operation Spills Critical	Canal Operation Spills Non-crit	Canal Losses blw Modesto Reservoir	Intercptd Flows	Nominal MID GW Pumping	Mod Res & Upper Canal Losses	Municipal Delivery	Target Storage	Target Storage Change
	Month	%	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF
(C 1.70)	Jan	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	17.0	2.0
	Feb	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	18.0	1.0
	Mar	65.0	1.0	1.0	3.0	0.6	0.9	1.0	2.0	2.7	18.0	0.0
	Apr	70.0	2.0	3.0	6.0	0.6	0.9	2.3	2.9	2.7	19.0	1.0
	May	85.0	3.0	4.0	6.5	0.6	1.2	2.3	3.9	3.0	20.0	1.0
	Jun	85.0	4.0	3.5	6.5	0.6	1.0	2.3	4.3	3.2	20.0	0.0
	Jul	77.5	4.0	3.5	6.5	0.6	1.0	2.6	4.9	3.3	21.0	1.0
	Aug	70.0	4.0	4.9	7.0	0.6	1.4	2.4	4.9	3.3	22.0	1.0
	Sep	65.0	2.0	5.0	7.0	0.6	1.2	2.3	4.2	3.3	20.0	-2.0
	Oct	40.0	1.0	2.8	6.9	0.6	0.9	2.1	2.0	3.2	17.0	-3.0
	Nov	30.0	0.0	2.0	2.0	0.1	0.0	0.0	2.0	2.7	15.0	-2.0
	Dec	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.5	15.0	0.0
	Total		21.0	35.7	57.4	5.4	8.5	17.3	31.1	34.5		

March TO Factor

TO Del Fac Break Point	Factor %
0	65
9.9	65
13.2	65
20	65
9999	65

Turlock Irrigation District

										Turlock Lake		
		Turnout Delivery Factor	Nominal Private GW Pumping	Canal Operation Spills Critical	Canal Operation Spills Non-crit	Canal Losses blw Turlock Lake	Intercptd Flows	Nominal TID GW Pumping	Turlock Lk & Upper Canal Losses	Delivery	Target Storage	Target Storage Change
	Month	%	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF
(C 1.80)	Jan	30	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	18.0	5.0
	Feb	30	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	25.0	7.0
	Mar	65	1.2	3.0	3.0	4.5	0.0	4.1	1.0	0.0	30.0	5.0
	Apr	57.5	2.4	5.1	6.3	4.5	0.0	8.0	6.6	0.0	30.0	0.0
	May	85	3.6	4.6	6.7	4.5	0.0	10.3	7.7	0.0	32.0	2.0
	Jun	92.5	5.2	4.2	6.7	4.5	0.0	12.4	8.2	0.0	32.0	0.0
	Jul	72.5	6.4	4.2	6.7	4.5	0.0	14.6	8.7	0.0	32.0	0.0
	Aug	62.5	6.2	4.0	7.3	4.5	0.0	13.3	9.0	0.0	30.0	-2.0
	Sep	67.5	3.9	3.2	7.3	4.5	0.0	9.1	5.0	0.0	27.0	-3.0
	Oct	40	2.4	2.3	7.3	4.5	0.0	5.3	2.0	0.0	13.0	-14.0
	Nov	30	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0	0.0
	Dec	30	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0	0.0
	Total		31.3	38.6	59.3	39.2	0.0	77.1	52.2	0.0		

March TO Factor

TO Del Fac Break Point	Factor %
0	65
19.8	65
27.5	65
40	65
9999	65

This section of parameters contributes to the computation of District canal demands. The values entered at C 1.70 for Modesto Irrigation District and at C 1.80 for Turlock Irrigation District are utilized by worksheet DailyCanalsCompute in the projection of daily canal demands for the simulation period. These parameters represent various components of water supplies and disposition that result in the need for canal diversion. These components are combined with the projected demand for applied water associated with lands within the Districts. The projected demand for applied water is provided to the model in worksheet DailyCanalsCompute, and is adjusted by the turnout delivery factor entered in C 1.70 and C 1.80, which adjusts for applied water not associated with immediate consumptive use such as pre-irrigation and groundwater recharge. The computation of daily canal demand is processed by parsing the monthly values of C 1.70 and C 1.80 evenly across the days of a month and combining them with the monthly value of applied water that has been parsed daily in a pattern reflective of recent historical daily diversions for the canals.

Don Pedro Water Supply Factor

Don Pedro Water Supply Factor

	Don Pedro Stor + Infl Index	M/TID WS Factor
	TAF	%
(C 1.90)	0	0.60
	1,350	0.60
	1,600	0.85
	2,000	0.85
	2,001	1.00
	2,300	1.00
	9,999	1.00

The reservoir index method adds the end-of-March Don Pedro Reservoir storage to the projected April through July inflow to assess water availability for diversion.

The Don Pedro Water Supply Factor directs the reduction of District canal diversions during periods of anticipated limited water supply. The values at C 1.90 provide the model with a relationship between water availability at Don Pedro Reservoir and advised canal diversions. The parameters of the relationship is an index of water availability which is computed as the storage in Don Pedro Reservoir at the end of March plus the projected inflow into Don Pedro Reservoir for April through July, and the water supply factor which is applied to projected demand for applied water described above. A water supply factor of 1.00 will provide a diversion equal to projected canal demand (full demand). A water supply factor less than 1.00 will reduce the canal diversion to less than full canal demand.

Section 2: City and County of San Francisco Facilities
Hetch Hetchy Reservoir

This section provides parameters that direct or advise the operation of Hetch Hetchy Reservoir. Minimum flow releases below Hetch Hetchy Reservoir are directed by C 2.00, C 2.01 and C 2.02. These parameters and schedules are consistent with the stipulations for the Canyon Power Project and the modifications thereof for Kirkwood Powerhouse Unit No. 3. The application of these flow schedules and the addition of 64 cfs to the minimum flow schedule below Hetch Hetchy Reservoir are embedded in model logic in worksheet CCSF.

Section 2 - CCSF Facilities

Hetch Hetchy Reservoir Control

Minimum releases below reservoir

(C 2.00)

Schedule Index - Accum Inches or Storage			
CY Month	A (1)	B (2)	C (3)
1	8.80	6.10	
2	14.00	9.50	
3	18.60	14.20	
4	23.00	18.00	
5	26.60	19.50	
6	28.45	21.25	
7	575,000	390,000	
8	640,000	400,000	

(C 2.01)

Below Dam Flow Requirement - CFS			
CY Month	A (1)	B (2)	C (3)
1	50	40	35
2	60	50	35
3	60	50	35
4	75	65	35
5	100	80	50
6	125	110	75
7	125	110	75
8	125	72.5	75
9	90	65	62.5
10	60	50	35
11	60	50	35
12	50	40	35

(C 2.02)

	15,000	6,500	4,400
Discretionary Schedule - Acre-feet			
CY Month	A (1)	B (2)	C (3)
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0
7	0	0	0
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
12	0	0	0

Reservoir Management

(C 2.10)

Target Storage - Acre-feet		
CY Month	Soft Trgt EOM	Hard Limit EOM
1	320,000	360,360
2	320,000	360,360
3	320,000	360,360
4	320,000	360,360
5	360,360	360,360
6	360,360	360,360
7	360,360	360,360
8	360,360	360,360
9	360,360	360,360
10	330,000	360,360
11	320,000	360,360
12	320,000	360,360

Snowmelt release forecast parameters

Historical watershed runoff used for all forecasts of inflow (perfect foresight)

Release of forecasted excess runoff

(C 2.20)	10	*percent of Februay - June excess runoff during February*
(C 2.21)	10	*percent of March - June excess runoff during March*
(C 2.22)	10	*percent of April - June excess runoff during April*
(C 2.23)	100	*percent of May - June excess runoff during June*
(C 2.24)	100	*percent of June excess runoff during June*

Minimum storage of draw down for snowmelt release

(C 2.30) 100,000 *acre-feet*

Maximum advised release for snowmelt

(C 2.25)	1,200	*cfs - February*
(C 2.26)	1,150	*cfs - March*
(C 2.27)	1,200	*cfs - April*
(C 2.28)	100,000	*cfs - May*
(C 2.29)	100,000	*cfs - June*

Target storage for filling at end of June

(C 2.31) 360,360 *acre-feet*

Values entered at C 2.10 advise the management of reservoir storage throughout a year. The hard limit entered into C 2.10 directs the maximum allowed storage in Hetch Hetchy Reservoir at the end of each month. Model logic will not allow exceedence of these values and will release addition water from the facility if needed to not exceed the values. The soft target, also representing a value at the end of each month, when

exceeded advises the Model to make additional releases in order to not exceed that reservoir storage. Model logic computes the storage exceedence, if any, every seventh day and advises a release in addition to minimum releases. The rate of this additional release is equal to the exceedence volume spread over seven days. For transitional months when the soft target value at the end of a month differs from a previous month, the transition in storage target is parsed equally within the days of the month.

Entries at C 2.20 through C 2.24 advise the amount of projected excess runoff (from the date of forecast through June) to be released during February, March, April, May and June. For instance, the value entered at C 2.20 (10 percent) advises the Model to release 10 percent of the excess runoff volume forecasted to occur during the February through June during February. The Model estimates the total excess runoff volume as being the projected inflow to Hetch Hetchy Reservoir less projected San Joaquin Pipeline diversions, deliveries to Groveland and Moccasin Fish Hatchery, reservoir evaporation and minimum flow requirements below Hetch Hetchy Reservoir, with an objective to fill Hetch Hetchy Reservoir at the end of June.

Entries at C 2.25 through C 2.29 work in concert with the advised snowmelt runoff releases, and limit the rate at which those releases will be made. The functionality of the limit provides an ability to manage releases in recognition of downstream facility protection, the efficiency of releases through power generation facilities and reservoir storage goals. The example of C 2.25 being set as 1,200 cfs for February results in the advised snowmelt release being limited to no more than that value regardless of the rate of release advised by the projection of excess runoff. These releases are in addition to the already established minimum releases described previously. C 2.30 and C 2.31 also affect the advisement of snowmelt runoff releases. C 2.30 limits the drawdown of Hetch Hetchy Reservoir for snowmelt runoff, and its value will limit the release to not lower Hetch Hetchy reservoir storage below such value. C 2.31 directs the storage goal for Hetch Hetchy Reservoir at the assumed fill date of the end of June.

Lake Lloyd

The section of parameters that direct or advise the operation of Lake Lloyd (show below) is very similar in content and structure as the section just described for Hetch Hetchy Reservoir. Minimum flow releases below Lake Lloyd are directed by C 2.40 and C 2.41. A single schedule of flow requirements is provided for Lake Lloyd and is consistent with the stipulations for the Cherry River Project. The application of the flow schedule is embedded in Model logic in worksheet CCSF. Entry of a value at C 2.41 provides a release from Lake Lloyd through Holm Powerhouse during the months of May through August, established as 950 cfs for four hours per day. The entry at C 2.41 also advises the maximum flow rate through Holm Powerhouse.

Values entered at C 2.50 advise the management of reservoir storage throughout a year. The hard limit entered into C 2.50 directs the maximum allowed storage in Lake Lloyd at the end of each month. Model logic will not allow exceedence of these values and will release addition water from the facility if needed to not exceed the values. The soft target, also representing a value at the end of each month, when exceeded advises the Model to make additional releases in order to not exceed that reservoir storage. Model logic computes the storage exceedence, if any, every

seventh day and advises a release in addition to minimum releases. The rate of this additional release is equal to the exceedence volume spread over seven days. For transitional months when the soft target value at the end of a month differs from a previous month, the transition in storage target is parsed equally within the days of the month.

Entries at C 2.60 through C 2.64 advise the amount of projected excess runoff (from the date of forecast through June) to be released during February, March, April, May and June. The model estimates the total excess runoff volume as being the projected inflow to Lake Lloyd less reservoir evaporation, minimum flow requirements below Lake Lloyd and releases to Holm Powerhouse, with an objective to fill Lake Lloyd at the end of June.

Entries at C 2.65 through C 2.69 work in concert with the advised snowmelt runoff releases, and limit the rate at which those releases will be made. C 2.70 and C 2.71 also affect the advisement of snowmelt runoff releases. These releases are in addition to the already established minimum releases described previously. C 2.70 limits the drawdown of Lake Lloyd for snowmelt runoff, and its value will limit the release to not lower Lake Lloyd storage below such value. C 2.71 directs the storage goal for Lake Lloyd at the assumed fill date of the end of June.

Lake Lloyd Control

Minimum releases below reservoir

	Blw Lake Lloyd - CFS	
	CY Month	*Flow Req*
(C 2.40)	*1*	*5*
	2	*5*
	3	*5*
	4	*5*
	5	*5*
	6	*5*
	7	*15.5*
	8	*15.5*
	9	*15.5*
	10	*5*
	11	*5*
	12	*5*

Holm Target Releases

May (Memorial Day) thru	(C 2.41)	
August (Labor Day)		
Holm Capacity	*950*	*cfs*
Day	*1,884*	*acre-feet*
4-hours per day	*314*	*acre-feet*

Reservoir Management

	Target Storage - Acre-feet		
		Soft Trgt	*Hard Limit*
	CY Month	*EOM*	*EOM*
(C 2.50)	*1*	*238,000*	*273,300*
	2	*238,000*	*273,300*
	3	*238,000*	*273,300*
	4	*273,300*	*273,300*
	5	*273,300*	*273,300*
	6	*273,300*	*273,300*
	7	*268,000*	*273,300*
	8	*258,000*	*273,300*
	9	*248,000*	*273,300*
	10	*248,000*	*273,300*
	11	*238,000*	*273,300*
	12	*238,000*	*273,300*

Snowmelt release forecast parameters

Historical watershed runoff used for all forecasts of inflow (perfect foresight)

Release of forecasted excess runoff

(C 2.60)	*20*	*percent of Februay - June excess runoff during February*
(C 2.61)	*25*	*percent of March - June excess runoff during March*
(C 2.62)	*33*	*percent of April - June excess runoff during April*
(C 2.63)	*50*	*percent of May - June excess runoff during June*
(C 2.64)	*100*	*percent of June excess runoff during June*

Minimum storage of draw down for snowmelt release

(C 2.70) *100,000* *acre-feet*

Maximum advised release for snowmelt

(C 2.65)	*1,000*	*cfs - February*
(C 2.66)	*1,000*	*cfs - March*
(C 2.67)	*1,000*	*cfs - April*
(C 2.68)	*1,000*	*cfs - May*
(C 2.69)	*1,000*	*cfs - June*

Target storage for filling at end of June

(C 2.71) *273,300* *acre-feet*

Lake Eleanor

This section provides parameters that direct or advise the operation of Lake Eleanor. Minimum flow releases below Lake Eleanor are directed by C 2.80. These flow schedules are consistent with the stipulations for the Cherry-Eleanor Pumping Station. The application of these flow schedules are embedded in Model logic in worksheet CCSF, and always assume the schedule associated with pumping. An entry at C 2.81 directs the maximum flow rate through the Eleanor-Cherry Diversion Tunnel. This value may limit the rate at which water can be transferred from Lake Eleanor to Lake Lloyd.

Lake Eleanor Control

Minimum releases below reservoir

	Blw Lake Eleanor - CFS		
	CY Month	w/Pump Flow Req	w/o Flow Req
(C 2.80)	1	5	5
	2	5	5
	3	10	5
	4	15	5
	5	20	5
	6	20	5
	7	20	16
	8	20	16
	9	15	16
	10	10	5
	11	5	5
	12	5	5

Always uses w/Pump flow requirement

Eleanor to Lloyd tunnel capacity

(C 2.81) 400 *cfs*

Reservoir Management

	Target Storage - Acre-feet		
	CY Month	Soft Trgt EOM	Hard Limit EOM
(C 2.90)	1	21,495	27,100
	2	21,495	27,100
	3	21,495	27,100
	4	27,100	27,100
	5	27,100	27,100
	6	27,100	27,100
	7	27,100	27,100
	8	27,100	27,100
	9	15,000	27,100
	10	15,000	27,100
	11	15,000	27,100
	12	18,250	27,100

Snowmelt release forecast parameters

Historical watershed runoff used for all forecasts of inflow (perfect foresight)

Release of forecasted excess runoff

(C 2a.10)	20	*percent of Februay - June excess runoff during February*
(C 2a.11)	25	*percent of March - June excess runoff during March*
(C 2a.12)	33	*percent of April - June excess runoff during April*
(C 2a.13)	70	*percent of May - June excess runoff during June*
(C 2a.14)	100	*percent of June excess runoff during June*

Maximum advised release for snowmelt

(C 2a.15)	2,000	*cfs - February*
(C 2a.16)	2,000	*cfs - March*
(C 2a.17)	2,000	*cfs - April*
(C 2a.18)	2,000	*cfs - May*
(C 2a.19)	2,000	*cfs - June*

Minimum storage of draw down for snowmelt release

(C 2a.20) 1,000 *acre-feet*

Target storage for filling at end of June

(C 2a.21) 27,100 *acre-feet*

Values entered at C 2.90 advise the management of reservoir storage throughout a year. The hard limit entered into C 2.90 directs the maximum allowed storage in Lake Eleanor at the end of each month. Model logic will not allow exceedence of these values and will release addition water from the facility if needed to not exceed the values. The soft target, also representing a value at the end of each month, when exceeded advises the Model to make additional releases in order to not exceed that reservoir storage. Model logic computes the storage exceedence, if any, every seventh day and advises a release in addition to minimum releases. The rate of this additional release is equal to the exceedence volume spread

over seven days. For transitional months when the soft target value at the end of a month differs from a previous month, the transition in storage target is parsed equally within the days of the month.

Entries at C 2a.10 through C 2a.14 advise the amount of projected excess runoff (from the date of forecast through June) to be released during February, March, April, May and June. The model estimates the total excess runoff volume as being the projected inflow to Lake Eleanor less reservoir evaporation and minimum flow requirements below Lake Eleanor, with an objective to fill Lake Eleanor at the end of June.

Entries at C 2a.15 through C 2a.19 work in concert with the advised snowmelt runoff releases, and limit the rate at which those releases will be made. These releases are in addition to the already established minimum releases described previously. C 2a.20 and C 2a.21 also affect the advisement of snowmelt runoff releases. C 2a.20 limits the drawdown of Lake Eleanor for snowmelt runoff, and its value will limit the release to not lower Lake Eleanor storage below such value. C 2a.21 directs the storage goal for Lake Eleanor at the assumed fill date of the end of June.

CCSF Water Supply Parameters

The matrix describing the San Francisco water supply parameters provides the model information to report the state of Test Case condition water supply action levels and the potential changes in the occurrence of action level due to alternative operations.

CCSF Water Supply Parameters

	Actions		
	Level	*Trigger Tot Sys Stor*	*Action % Del Reduc*
(C 2a.30)	*0*		*0*
	1	*1,100,000*	*10*
	2	*1,100,000*	*10*
	3	*700,000*	*20*

Entries at C 2a.30 represent the relationship between CCSF total system storage (at the end of June each year) and the advisement of water supply actions. Total system storage includes CCSF's local watershed reservoirs, its Hetch Hetchy Project reservoirs, and also the Don Pedro Water Bank Account Balance. Local watershed storage is provided from CCSF's system operation model (HHLSM) as pre-processed values for the simulation period. These values are combined with the Model's depiction of CCSF reservoir storage for the Tuolumne River system to depict total system storage. A water supply action level for each year of each study is determined by the matrix, relating total system storage thresholds to advised action levels. For instance, if total system storage at the end of June of a year is greater than 700,000 acre-feet and less than 1,100,000 acre-feet, an action level of 10 percent rationing is advised. The CCSF Test Case condition SJPL diversions include the effect of occasional water delivery shortages due to these water supply parameters.

Section 3: Don Pedro Reservoir and CCSF Elevation/Storage/Area and Evaporation Factors

The section provides entry of the physical elevation/storage/area relationship for Don Pedro Reservoir and CCSF reservoirs. The values entered at C 3.00 for Hetch Hetchy Reservoir, Lake Lloyd, Lake Eleanor and Don Pedro Reservoir are currently being used by the Model. The Model employs a table lookup function to determine the area of a reservoir based on storage. The area is multiplied by a reservoir's evaporation factor for the estimation of reservoir evaporation. The monthly evaporation factor for CCSF reservoirs is entered at C 3.10 and Don Pedro Reservoir's evaporation factors are entered at C 3.20. These reservoir rating tables and evaporation factors are consistent with the daily accounting of Tuolumne River flows between the Districts and CCSF.

Section 3 - Don Pedro Reservoir and CCSF Reservoir Elevation/Storage/Area and Evaporation Factors

(C 3.00)

Hetch Hetchy Reservoir			Lake Lloyd			Lake Eleanor			Don Pedro Reservoir		
Elev - FT	Stor - AF	Area- Ac	Elev - FT	Stor - AF	Area- Ac	Elev - FT	Stor - AF	Area- Ac	Elev - FT	Stor - AF	Area- Ac
3520.0	410	124.0	4440.0	0.0	5.0	4605.0	0.0	0.0		0	0
3520.1	439	127.9	4440.1	1.0	5.1	4605.1	0.0	2.5		0	0
3520.2	468	131.8	4440.2	2.0	5.1	4605.2	0.0	5.0		0	0
3520.3	497	135.7	4440.3	2.0	5.2	4605.3	1.0	7.6		1	1
3520.4	526	139.6	4440.4	3.0	5.2	4605.4	1.0	10.1		1	1
3520.5	555	143.5	4440.5	4.0	5.3	4605.5	1.0	12.6		3	2
3520.6	583	147.4	4440.6	5.0	5.3	4605.6	2.0	15.1		5	3
3520.7	612	151.3	4440.7	5.0	5.4	4605.7	2.0	17.6		8	3
3520.8	641	155.2	4440.8	6.0	5.4	4605.8	2.0	20.2		12	4
3520.9	670	159.1	4440.9	7.0	5.5	4605.9	2.0	22.7		17	6
3521.0	699	163.0	4441.0	8.0	5.5	4606.0	2.0	25.2	300.0	35	7
3521.1	728	166.9	4441.1	8.0	5.6	4606.1	3.0	27.7		42	7
3521.2	757	170.8	4441.2	9.0	5.6	4606.2	3.0	30.2		50	8
3521.3	786	174.7	4441.3	10.0	5.7	4606.3	3.0	32.7		57	8
3521.4	815	178.6	4441.4	11.0	5.7	4606.4	3.0	35.3		65	8
3521.5	843	182.5	4441.5	11.0	5.8	4606.5	4.0	37.8		74	8
3521.6	872	186.4	4441.6	12.0	5.8	4606.6	4.0	40.3		82	9
3521.7	901	190.3	4441.7	13.0	5.9	4606.7	4.0	42.8		91	9
3521.8	930	194.2	4441.8	14.0	5.9	4606.8	4.0	45.3		100	9
3521.9	959	198.1	4441.9	14.0	6.0	4606.9	5.0	47.9		110	10
3522.0	988	202.0	4442.0	15.0	6.0	4607.0	5.0	50.4	310.0	120	10
3522.1	1017	205.9	4442.1	16.0	6.1	4607.1	5.0	52.9		130	10
3522.2	1046	209.8	4442.2	17.0	6.1	4607.2	5.0	55.4		140	10
3522.3	1075	213.7	4442.3	17.0	6.2	4607.3	6.0	57.9		150	11
3522.4	1104	217.6	4442.4	18.0	6.2	4607.4	6.0	60.4		161	11
3522.5	1133	221.5	4442.5	19.0	6.3	4607.5	6.0	63.0		172	11
3522.6	1161	225.4	4442.6	20.0	6.3	4607.6	6.0	65.5		183	11
3522.7	1190	229.3	4442.7	20.0	6.4	4607.7	7.0	68.0		194	11
3522.8	1219	233.2	4442.8	21.0	6.4	4607.8	7.0	70.5		206	12
3522.9	1248	237.1	4442.9	22.0	6.5	4607.9	7.0	73.0		218	12
3523.0	1277	241.0	4443.0	23.0	6.5	4608.0	7.0	75.6	320.0	229	12
3523.1	1306	244.9	4443.1	23.0	6.6	4608.1	8.0	78.1		242	13
3523.2	1335	248.8	4443.2	24.0	6.6	4608.2	8.0	80.6		255	13
3523.3	1364	252.7	4443.3	25.0	6.7	4608.3	8.0	83.1		268	14
3523.4	1393	256.6	4443.4	26.0	6.7	4608.4	8.0	85.6		283	15
3523.5	1422	260.5	4443.5	26.0	6.8	4608.5	9.0	88.2		297	15

Evaporation Factors

CCSF Reservoirs (C 3.10)

		CFS/Ac/Day
Jan	1 =	-0.00325
Feb	2 =	-0.0036
Mar	3 =	0
Apr	4 =	0
May	5 =	0.003253
Jun	6 =	0.006722
Jul	7 =	0.009758
Aug	8 =	0.009758
Sep	9 =	0.006722
Oct	10 =	0.003253
Nov	11 =	0
Dec	12 =	0

Evaporation Factors

Don Pedro Reservoir (C 3.20)

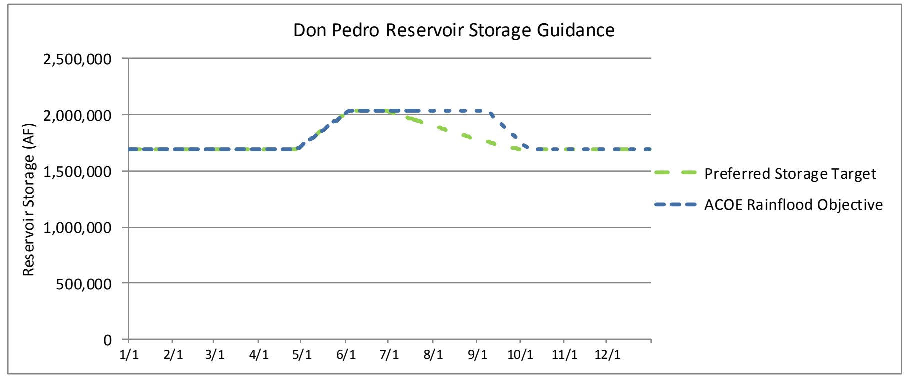
		CFS/Ac/Day
Jan	1 =	-0.00088
Feb	2 =	-0.00026
Mar	3 =	0.001135
Apr	4 =	0.003081
May	5 =	0.007968
Jun	6 =	0.010947
Jul	7 =	0.013976
Aug	8 =	0.014109
Sep	9 =	0.01072
Oct	10 =	0.006395
Nov	11 =	0.001781
Dec	12 =	-0.00013

Section 4: Don Pedro Reservoir Flood Control Reservation and Discretionary Target

The section provides for the entry of the preferred storage target for Don Pedro Reservoir.
Values entered at C 4.00 and C 4.01 advises the management of reservoir storage throughout a year. A hard limit of 2,030,000 acre-feet directs the maximum allowed storage in Don Pedro Reservoir at the end of each month. Model logic will not allow exceedence of these values and will release addition water from the facility if needed to not exceed the values. The soft target ("Final Target Storage" at C 4.00), also representing a value at the end of each day, when exceeded advises the model to make additional releases in order to not exceed that reservoir storage. Model logic computes the storage exceedence, if any, every seventh day and advises a release in addition to minimum releases. The rate of this additional release is equal to the exceedence volume spread over ten days. For transitional months when the soft target value at the end of a month differs from a previous month, the transition in storage target is parsed equally within the days of the month.

Section 4 - Don Pedro Reservoir Flood Control Reservation Space and Preferred Storage Target

	ACOE thru
	June
Full Res	*1,906,000*
(2,030,000)	*Jul 31*
Less	*1,782,000*
ACOE	*Aug 31*
RF Space	*1,692,000*
	Sep 30
	UCOE
	therefter



(C 4.00)

Don Pedro Reservoir FC/Discretionary/Drawdown Space							
Mo/Day	Mo/Day Index		ACOE RF Space AF	DP RF Storage AF	Add Descr Storage AF	Add Descr Modifier AF	Final Target Storage AF
1/1	1.01		340,000	1,690,000			1,690,000
1/2	1.02		340,000	1,690,000			1,690,000
1/3	1.03		340,000	1,690,000			1,690,000
1/4	1.04		340,000	1,690,000			1,690,000
1/5	1.05		340,000	1,690,000			1,690,000
1/6	1.06		340,000	1,690,000			1,690,000
1/7	1.07		340,000	1,690,000			1,690,000
1/8	1.08		340,000	1,690,000			1,690,000
1/9	1.09		340,000	1,690,000			1,690,000
1/10	1.10		340,000	1,690,000			1,690,000
1/11	1.11		340,000	1,690,000			1,690,000
1/12	1.12		340,000	1,690,000			1,690,000
1/13	1.13		340,000	1,690,000			1,690,000
1/14	1.14		340,000	1,690,000			1,690,000
1/15	1.15		340,000	1,690,000			1,690,000
1/16	1.16		340,000	1,690,000			1,690,000
1/17	1.17		340,000	1,690,000			1,690,000

ACOE Rainflood (AF) End-of-month

Jan	1,690,000	Jul	2,030,000
Feb	1,690,000	Aug	2,030,000
Mar	1,690,000	Sep	1,772,600
Apr	1,717,600	Oct	1,690,000
May	2,002,800	Nov	1,690,000
Jun	2,030,000	Dec	1,690,000

(C 4.01)

	Discretionar Guide AF
1 Jan	0
2 Feb	0
3 Mar	0
4 Apr	0
5 May	0
6 Jun	0
7 Jul	0
8 Aug	0
9 Sep	0
10 Oct	0
11 Nov	0
12 Dec	0

The guidance provided by this parameter manages Don Pedro Reservoir storage throughout the year for both ACOE objectives during the season of rainflood reservation space and additional discretionary reservoir storage space or targets to manage reservoir storage from one year to another.

5.4 Output Worksheet

This worksheet (Output) provides an interface between Model computations and data summary and analysis tools. It also provides a formatted set of information usable for exchange into an HEC-DSS database file, such as used to provide information to the temperature models used for this FERC investigation. Information concerning HEC-DSS can be found on the HEC web site at:

http://www.hec.usace.army.mil/software/hec-dss/hecdss-dss.html

The structure and contents of worksheet Output accommodates the use of the HEC-DSS Excel Data Exchange Add-in which is an application for retrieving and storing interval time series data, in this circumstance the daily results of the Model.

Results provided in worksheet Output are directly linked to the computational and input worksheets of the Model. For instance, the daily inflow to Don Pedro Reservoir listed in worksheet Output is the value provided to worksheet DonPedro for its computations, which is dependent upon several other computation worksheets. As such, any change to model assumptions or data which causes a recalculation by the model will automatically update the values in worksheet Output. To preserve or store the results of a particular model study a copy of the worksheet should be created with a unique tab name and its contents converted to values. The HEC-DSS Add-in could also be used to create a unique database file for later use. Alternatively, but storage consuming, the entire Model could be saved as a unique study. However, this approach is not recommended as the worksheet Output will continue to be dynamically linked to the model's computational worksheets and any subsequent change to model assumptions will overwrite the results previously provided in the worksheet.

More than 80 parameters are reported in the worksheet, representing salient information concerning the simulated operations and hydrology of the Tuolumne River and the Districts' and CCSF's facilities. Table 5.4-1 provides a listing of the parameters including their HEC-DSS name parts. Shown below is a snapshot of the content and format of the worksheet.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	1	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE
2	2	TUOLUMNEI	TUOLUMNEI	TUOLUMNEI	TUOLUMNEI	TUOLUMNEI	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO
3	3	FLOW-LAGRANGE UNIMP	FLOW-HHUNIMP	FLOW-LLOYDUNI MP	FLOW-ELEANORU NIMP	FLOW-UNREGUNI MP	FLOW-TOTINFLO W	FLOW-SUP1INFLO WLL	FLOW-SUP2INFLO WHH	FLOW-INFLOWHH	FLOW-INFLOWLL	FLOW-INFLOWEL	STORAGE	EVAP
4	4	2	3	4	5	6	7	8	9	10	11	12	13	14
5	5	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY
6	6	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base
7	7	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70
8	8	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400
9	9	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09
10	10	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400
11	11	CFS	CFS	CFS	CFS	CFS	CFS	AF	AF	CFS	CFS	CFS	AF	AF
12		PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER
13	10/1/1970	159	79	56	25	-1	322	0	0	90	223	10	1,666,767	143
14	10/2/1970	55	-82	5	2	130	453	0	0	90	223	10	1,664,567	141
15	10/3/1970	265	25	15	7	218	541	0	0	90	223	10	1,662,719	141
16	10/4/1970	-166	110	-399	-179	302	625	0	0	90	223	10	1,659,892	141
17	10/5/1970	180	-38	322	144	-248	75	0	0	90	223	10	1,656,745	141
18	10/6/1970	92	9	-48	-21	152	475	0	0	90	223	10	1,654,119	141
19	10/7/1970	150	21	-51	-23	203	526	0	0	90	223	10	1,652,009	140
20	10/8/1970	153	-29	54	24	104	209	0	0	90	5	10	1,650,525	140
21	10/9/1970	146	-28	10	5	159	264	0	0	90	5	10	1,648,926	140
22	10/10/1970	99	30	-25	-11	105	210	0	0	90	5	10	1,647,059	140
23	10/11/1970	293	176	-275	-123	515	620	0	0	90	5	10	1,645,737	140

Table 5.4-1 – Worksheet Output Parameters

Column	Col No	DSS - Part B	DSS - Part C	Units	Column	Col No	DSS - Part B	DSS - Part C	Units
B	2	TUOLUMNERIVER	FLOW-LAGRANGEUNIMP	CFS	BD	56	MIDCANAL	MIDFULLREQ	AF
C	3	TUOLUMNERIVER	FLOW-HHUNIMP	CFS	BE	57	TIDCANAL	TIDAGPDAW	AF
D	4	TUOLUMNERIVER	FLOW-LLOYDUNIMP	CFS	BF	58	TIDCANAL	TIDMI	AF
E	5	TUOLUMNERIVER	FLOW-ELEANORUNIMP	CFS	BG	59	TIDCANAL	TIDFACT	AF
F	6	TUOLUMNERIVER	FLOW-UNREGUNIMP	CFS	BH	60	TIDCANAL	TIDNOMGWPRVT	AF
G	7	DONPEDRO	FLOW-TOTINFLOW	CFS	BI	61	TIDCANAL	TIDOPSPLS	AF
H	8	DONPEDRO	FLOW-SUP1INFLOWLL	AF	BJ	62	TIDCANAL	TIDLOSS	AF
I	9	DONPEDRO	FLOW-SUP2INFLOWHH	AF	BK	63	TIDCANAL	TIDINTCP	AF
J	10	DONPEDRO	FLOW-INFLOWHH	CFS	BL	64	TIDCANAL	TIDNOMGWDIST	AF
K	11	DONPEDRO	FLOW-INFLOWLL	CFS	BM	65	TIDCANAL	TIDUPSYSLOSSDIV	AF
L	12	DONPEDRO	FLOW-INFLOWEL	CFS	BN	66	TIDCANAL	TIDLKDIV	AF
M	13	DONPEDRO	STORAGE	AF	BO	67	TIDCANAL	TIDLKSTORCHNG	AF
N	14	DONPEDRO	EVAP	AF	BP	68	TIDCANAL	TIDFULLREQ	AF
O	15	DONPEDRO	STORAGE-RFTRG	AF	BQ	69	DONPEDRO	DPFACT	UNIT
P	16	DONPEDRO	STORAGE-SOFTTRG	AF	BR	70	SANFRAN	SFSJPLBASE	AF
Q	17	DONPEDRO	RELEASE-7DAYENCRADVISE	CFS	BS	71	SANFRAN	SFLOCALSTOR	AF
R	18	DONPEDRO	RELEASE-SNOWADVISE	CFS	BT	72	SANFRAN	SFSJPL	AF
S	19	DONPEDRO	RELEASE-TOTAL	CFS	BU	73	SANFRAN	SFTOTSYSSTOR	AF
T	20	DONPEDRO	POWR-MW	MW	BV	74	SANFRAN	SFTOTTRSYSSTOR	AF
U	21	DONPEDRO	POWR-EFF	kWh/AF	BW	75	SANFRAN	SFSUPPREL	UNIT
V	22	DONPEDRO	POWR-MWh	MWh	BX	76	SANFRAN	SFSUPPTAB	UNIT
W	23	DONPEDRO	RELEASE-PH	AF	BY	77	SANFRAN	TRIGGER	UNIT
X	24	DONPEDRO	RELEASE-BYPASS	AF	BZ	78	SANFRAN	WBBAL	UNIT
Y	25	DONPEDRO	FLOW-TOTCANALS	AF	CA	79	HETCH	HATCH-GRVLND	CFS
Z	26	LAGRANGE	RELEASE-MINQ	CFS	CB	80	HETCH	HATCH-RTRN	CFS
AA	27	LAGRANGE	RELEASE-TOTAL	CFS	CC	81	HETCH	RELEASE-MINQ1	CFS
AB	28	LAGRANGE	RELEASE-MCANAL	CFS	CD	82	HETCH	RELEASE-TOTMINQ	CFS
AC	29	LAGRANGE	RELEASE-TCANAL	CFS	CE	83	HETCH	RELEASE-7DAYENCRADVISE	CFS
AD	30	LAGRANGE	FULLCANALREQ	AF	CF	84	HETCH	RELEASE-SNOWADVISE	CFS
AE	31	RIVER	FLOW-LTRACC1	CFS	CG	85	HETCH	RELEASE-TOTAL	CFS
AF	32	RIVER	FLOW-LTRACC2	CFS	CH	86	HETCH	STORAGE	AF
AG	33	RIVER	FLOW-LTRACC3	CFS	CI	87	HETCH	EVAP	AF
AH	34	RIVER	FLOW-LTRACC4	CFS	CJ	88	HETCH	STORAGE-SOFTTRG	AF
AI	35	RIVER	FLOW-DRYCK	CFS	CK	89	LLOYD	RELEASE-MINSTRMQ	CFS
AJ	36	RIVER	FLOW-LTRACC5	CFS	CL	90	LLOYD	RELEASE-MINHOLM	CFS
AK	37	RIVER	FLOW-TR1	CFS	CM	91	LLOYD	RELEASE-7DAYENCRADVISE	CFS
AL	38	RIVER	FLOW-TR2	CFS	CN	92	LLOYD	RELEASE-SNOWADVISE	CFS
AM	39	RIVER	FLOW-TR3	CFS	CO	93	LLOYD	RELEASE-LLOYDONLYHOLM	CFS
AN	40	RIVER	FLOW-TR4	CFS	CP	94	LLOYD	HOLMAVAILEL	CFS
AO	41	RIVER	FLOW-MODMAX	CFS	CQ	95	LLOYD	RELEASE-TOTHOLM	CFS
AP	42	RIVER	FLOW-MODMAXLG	CFS	CR	96	LLOYD	RELEASE-TOTLLOYD	CFS
AQ	43	RIVER	FLOW-MODESTO	CFS	CS	97	LLOYD	STORAGE	AF
AR	44	RIVER	FLOW-TR5	CFS	CT	98	LLOYD	EVAP	AF
AS	45	MIDCANAL	MIDAGPDAW	AF	CU	99	LLOYD	STORAGE-SOFTTRG	AF
AT	46	MIDCANAL	MIDMI	AF	CV	100	ELEANOR	RELEASE-MINSTRMQ	CFS
AU	47	MIDCANAL	MIDFACT	PERCENT	CW	101	ELEANOR	RELEASE-7DAYENCRADVISE	CFS
AV	48	MIDCANAL	MIDNOMGWPRVT	AF	CX	102	ELEANOR	RELEASE-SNOWADVISE	CFS
AW	49	MIDCANAL	MIDOPSPLS	AF	CY	103	ELEANOR	TUNTRNSFCAP	CFS
AX	50	MIDCANAL	MIDLOSS	AF	CZ	104	ELEANOR	FLOW-TUNNEL	CFS
AY	51	MIDCANAL	MIDINTCP	AF	DA	105	ELEANOR	RELEASE-STREAM	CFS
AZ	52	MIDCANAL	MIDNOMGWDIST	AF	DB	106	ELEANOR	RELEASE-TOTELEANOR	CFS
BA	53	MIDCANAL	MIDUPSYSLOSSDIV	AF	DC	107	ELEANOR	STORAGE	AF
BB	54	MIDCANAL	MIDLKDIV	AF	DD	108	ELEANOR	EVAP	AF
BC	55	MIDCANAL	MIDLKSTORCHNG	AF	DE	109	ELEANOR	STORAGE-SOFTTRG	AF

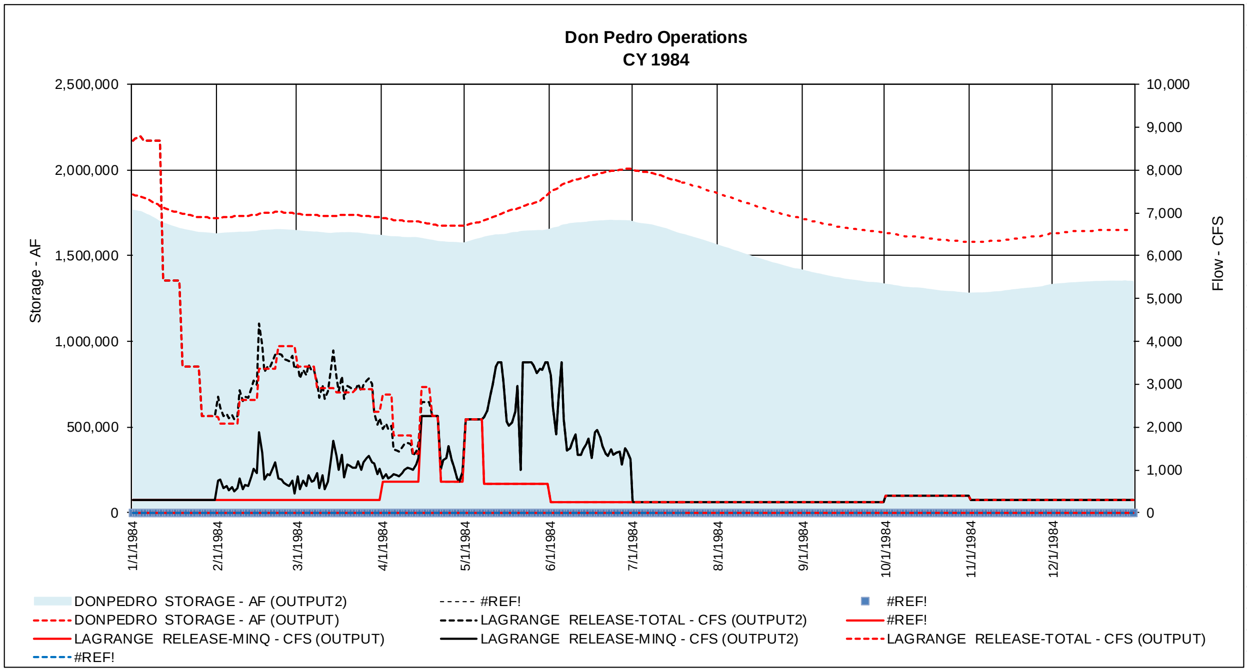
5.5 DSSAnyGroup Worksheet

This worksheet (DSSAnyGroup) provides plotting of up to ten parameters provided in worksheet Output or another equally formatted worksheet of results. One calendar year (the same year or different years) of data for a parameter can be plotted. The parameter(s) to be plotted are identified by reference worksheet name and column. A snapshot of the identification parameters and result values is shown below.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	DSSAnyGroup													
2	This sheet illustrates a CY of daily results from Model sheets in graphic format.													
3	Axis Reference	1		1		2		2		2		2		1
4	Enter CY Graph Year:	1984		1984		1984		1984		1984		1984		1984
5	Enter Sheet Name:	OUTPUT1		OUTPUT2		OUTPUT2		OUTPUT1		OUTPUT		OUTPUT2		OUTPUT
6	Column:	#N/A		13		27		#N/A		26		26		#N/A
7	Enter Column:			M		AA				Z		Z		
8	Data Reference:	#REF!	Date	DONPEDRO STORAGE - AF (OUTPUT2)	Date	LAGRANGE RELEASE- TOTAL - CFS (OUTPUT2)	Date	#REF!	Date	LAGRANGE RELEASE- MINQ - CFS (OUTPUT)	Date	LAGRANGE RELEASE- MINQ - CFS (OUTPUT2)	Date	#REF!
9	Enter Scaler:	1		1		1		1		1		1		1
10	1-Jan-84	#REF!	1-Jan-84	1,765,400	1-Jan-84	8,681	1-Jan-84	#REF!	1-Jan-84	300	1-Jan-84	300	1-Jan-84	#REF!
11	2-Jan-84	#REF!	2-Jan-84	1,762,808	2-Jan-84	8,732	2-Jan-84	#REF!	2-Jan-84	300	2-Jan-84	300	2-Jan-84	#REF!
12	3-Jan-84	#REF!	3-Jan-84	1,759,443	3-Jan-84	8,758	3-Jan-84	#REF!	3-Jan-84	300	3-Jan-84	300	3-Jan-84	#REF!
13	4-Jan-84	#REF!	4-Jan-84	1,757,150	4-Jan-84	8,773	4-Jan-84	#REF!	4-Jan-84	300	4-Jan-84	300	4-Jan-84	#REF!
14	5-Jan-84	#REF!	5-Jan-84	1,749,651	5-Jan-84	8,683	5-Jan-84	#REF!	5-Jan-84	300	5-Jan-84	300	5-Jan-84	#REF!
15	6-Jan-84	#REF!	6-Jan-84	1,741,186	6-Jan-84	8,683	6-Jan-84	#REF!	6-Jan-84	300	6-Jan-84	300	6-Jan-84	#REF!
16	7-Jan-84	#REF!	7-Jan-84	1,735,636	7-Jan-84	8,683	7-Jan-84	#REF!	7-Jan-84	300	7-Jan-84	300	7-Jan-84	#REF!
17	8-Jan-84	#REF!	8-Jan-84	1,726,314	8-Jan-84	8,683	8-Jan-84	#REF!	8-Jan-84	300	8-Jan-84	300	8-Jan-84	#REF!
18	9-Jan-84	#REF!	9-Jan-84	1,718,101	9-Jan-84	8,683	9-Jan-84	#REF!	9-Jan-84	300	9-Jan-84	300	9-Jan-84	#REF!
19	10-Jan-84	#REF!	10-Jan-84	1,708,161	10-Jan-84	8,683	10-Jan-84	#REF!	10-Jan-84	300	10-Jan-84	300	10-Jan-84	#REF!
20	11-Jan-84	#REF!	11-Jan-84	1,696,327	11-Jan-84	8,683	11-Jan-84	#REF!	11-Jan-84	300	11-Jan-84	300	11-Jan-84	#REF!
21	12-Jan-84	#REF!	12-Jan-84	1,691,421	12-Jan-84	5,421	12-Jan-84	#REF!	12-Jan-84	300	12-Jan-84	300	12-Jan-84	#REF!
22	13-Jan-84	#REF!	13-Jan-84	1,686,396	13-Jan-84	5,421	13-Jan-84	#REF!	13-Jan-84	300	13-Jan-84	300	13-Jan-84	#REF!
23	14-Jan-84	#REF!	14-Jan-84	1,680,358	14-Jan-84	5,421	14-Jan-84	#REF!	14-Jan-84	300	14-Jan-84	300	14-Jan-84	#REF!
24	15-Jan-84	#REF!	15-Jan-84	1,674,328	15-Jan-84	5,421	15-Jan-84	#REF!	15-Jan-84	300	15-Jan-84	300	15-Jan-84	#REF!
25	16-Jan-84	#REF!	16-Jan-84	1,669,263	16-Jan-84	5,421	16-Jan-84	#REF!	16-Jan-84	300	16-Jan-84	300	16-Jan-84	#REF!

Values are plotted to either the primary y-axis or secondary y-axis. The "axis reference" indicates to which axis the value will be plotted by default. The designation of y-axis assignment is not modified by this field, and the user must edit the series data within the plot to change the y-axis assignment, graph type or line or shape characteristics. The "enter graph year" is a user entry. The same year or different year of a parameter or multiple parameters can be plotted. "Sheet name" is a user entry, and identifies from which Output-formatted worksheet the parameter is to be acquired. The "enter column" entry identifies from which column the parameter occurs. Refer to Table 5.4-1 of the description for worksheet Output for the identification of the column associated with each parameter. Upon proper entry of a parameter a return of the parameter's label and source worksheet will occur in the "data reference" field. Values for the specified calendar year will also be returned in the data field. If a plotting position is not used, a "#VALUE!" or "#REF!" will be returned. The "scaler" field is provided to allow the conversion or scaling of the data returned from the result worksheet. For instance, if the daily data occurs in the result worksheet in units of daily average flow (cfs) it could be plotted in units of daily volume (acre-feet) by entering the conversion factor of 1.983471. The entry in the field acts as a multiplier to the value occurring in the result worksheet. This field can also be used to scale two different "order of magnitude" parameters to use the same y-axis.

The results of up to ten parameters will be plotted. An example of the several plotted parameters from two different studies is shown below.



Unused plotting positions will appear with values plotted at “zero” and will have legends of “#VALUE!” or “#REF!”. To create graphs without unused positions a copy of the plot can be made and positioned elsewhere in the worksheet. The unwanted positions can then be deleted from the plot.

5.6 DSSMonthTable Worksheet

This worksheet (DSSMonthTable) provides summation or averaging, and plotting of up to four parameters provided in worksheet Output or another equally formatted worksheet of results. The function of this worksheet is to provide a synthesis of the daily result data into monthly results thus reducing the handling and display of over 14,000 values for each parameter (39 years of days) to 468 values (39 years of months).

The parameter(s) to be plotted or tabled are identified by reference worksheet name and column, very similarly to the method identified for worksheet DSSAnyGroup. A snapshot of the identification parameters and result values is shown below.

5				Conversion Key:			
6				0	1 >> 1	Native	1
7				1	CFS >> AF	AF	1.9834700
8				2	AF >> CFS	CFS	0.5041669
9				3	CFS >> TAF	TAF	0.0019835
10				4	EOM Stor	AF	1
11				5	Ave Day	Native	1
12	Enter Conversion (0-5):			4	4	4	4
13	Enter Sheet Name:			Output	Output1	Output3c	Output2b
14	Enter Column Letter:			M	M	M	M
15	Column No:			13	13	13	13
16	Label:			O STORAG	D STORAGE	D STORAGE	D STORAGE
17	Native Unit:			AF	AF	AF	AF
18	Convert Unit:			AF	AF	AF	AF
19	Index	Date	Day	1	1	1	1
20	1970.10	10/1/1970	T	1,666,767	1,666,767	1,666,767	1,666,969
21	1970.10	10/2/1970	F	1,664,567	1,664,567	1,664,567	1,664,971
22	1970.10	10/3/1970	S	1,662,719	1,662,719	1,662,719	1,663,323
23	1970.10	10/4/1970	S	1,659,892	1,659,892	1,659,892	1,660,699
24	1970.10	10/5/1970	M	1,656,745	1,656,745	1,656,745	1,657,753
25	1970.10	10/6/1970	T	1,654,119	1,654,119	1,654,119	1,655,329

Each parameter is tabled and plotted separately for the entire 39-year simulation period. “Sheet name” is a user entry, and identifies from which Output-formatted worksheet the parameter is to be acquired. The “enter column letter” entry identifies from which column the parameter occurs. Refer to Table 5.4-1 of the description for worksheet Output for the identification of the column associated with each parameter. Upon proper entry of a parameter a return of the parameter’s label, source worksheet and the native unit of the parameter will occur. Depending on need, the “conversion” entry is provided. This entry, a keyed value of 0 to 5, directs the worksheet on the handling of the daily data. An entry of 1 will direct the worksheet to sum the daily data into monthly increments in the parameter’s native units (e.g., daily acre-feet into monthly volumes). An entry of 1 will convert the daily data from a native unit of flow (cfs) into monthly volumes of acre-feet. An entry of 2 will convert the daily data from a native unit of volume (acre-feet) into a monthly sum of daily flow in units of cfs. An entry of 3 will act as an entry of 1 except convert the result into monthly volumes with units of 1,000 acre-feet. An entry of 4 will table and plot the daily value associated with the last day of each month in its native unit, and is primarily intended to analyze reservoir storage. An entry of 5 will report the average of daily values within a month. Depending on the entry in the conversion field, the converted unit will be returned to “converted unit” field. Values for the each month of the simulation period will also be returned in the data field. If a plotting position is not used, a “#VALUE!” or “#REF!” will be returned.
A “scaler” field is also provided for each parameter (in the row above the data fields) to allow the conversion or scaling of the data returned from the result worksheet. The results of up to four parameters will be tabled and plotted. Examples of the formats of reports are shown below.

Standardized Tables

An example of a standardized table for the illustration of results is shown below (Table 1 Form). In this example the current minimum daily flow requirement at La Grange Bridge has been synthesized into monthly volumes for the simulation period, and water year totals and for the annual period February through January.

Conversion (0-5):	1
Sheet Name:	Output1
Column Letter:	Z
Column No:	26
Label:	ELEASE-MI
Native Unit:	CFS
Convert Unit:	AF

Table 1
LAGRANGE RELEASE-MINQ (Output1)
AF

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Feb-Jan
1971	24,397	17,851	18,447	18,447	16,661	18,447	66,685	63,515	4,463	4,612	4,612	4,463	262,598	228,631
1972	13,240	10,413	10,760	10,760	9,719	10,760	30,288	29,251	2,975	3,074	3,074	2,975	137,292	128,713
1973	9,223	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	240,823	283,369
1974	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1975	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1976	24,397	17,851	18,447	18,447	16,661	18,447	20,153	19,749	2,975	3,074	3,074	2,975	166,250	122,217
1977	7,736	8,926	9,223	9,223	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	94,000	94,000
1978	7,736	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	239,336	283,369
1979	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1980	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1981	24,397	17,851	18,447	18,447	16,661	18,447	29,339	28,532	4,463	4,612	4,612	4,463	190,269	156,718
1982	12,744	10,711	11,068	11,068	9,997	11,068	64,241	61,936	14,876	15,372	15,372	14,876	253,329	286,880
1983	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1984	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1985	24,397	17,851	18,447	18,447	16,661	18,447	34,656	33,346	4,463	4,612	4,612	4,463	200,400	157,854
1986	9,223	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	240,823	283,369
1987	24,397	17,851	18,447	18,447	16,661	18,447	24,481	23,806	2,975	3,074	3,074	2,975	174,636	130,603
1988	7,736	8,926	9,223	9,223	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	94,000	94,000
1989	7,736	8,926	9,223	9,223	8,331	9,223	25,991	25,222	2,975	3,074	3,074	2,975	115,975	115,975
1990	7,736	8,926	9,223	9,223	8,331	9,223	19,362	19,008	2,975	3,074	3,074	2,975	103,131	103,131
1991	7,736	8,926	9,223	9,223	8,331	9,223	25,870	25,109	2,975	3,074	3,074	2,975	115,740	115,740
1992	7,736	8,926	9,223	9,223	8,331	9,223	19,995	19,601	2,975	3,074	3,074	2,975	104,357	104,357
1993	7,736	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	239,336	283,369
1994	24,397	17,851	18,447	18,447	16,661	18,447	25,903	25,140	2,975	3,074	3,074	2,975	177,391	134,846
1995	9,223	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	240,823	283,369
1996	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1997	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1998	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1999	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
2000	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
2001	24,397	17,851	18,447	18,447	16,661	18,447	28,572	27,642	4,463	4,612	4,612	4,463	188,612	146,067
2002	9,223	8,926	9,223	9,223	8,331	9,223	32,729	31,539	4,463	4,612	4,612	4,463	136,567	136,567
2003	9,223	8,926	9,223	9,223	8,331	9,223	55,641	53,161	4,463	4,612	4,612	4,463	181,101	189,680
2004	13,240	10,413	10,760	10,760	9,719	10,760	28,696	27,758	4,463	4,612	4,612	4,463	140,257	131,678
2005	9,223	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	240,823	283,369
2006	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
2007	24,397	17,851	18,447	18,447	16,661	18,447	26,085	25,310	2,975	3,074	3,074	2,975	177,743	133,710
2008	7,736	8,926	9,223	9,223	8,331	9,223	27,470	26,609	2,975	3,074	3,074	2,975	118,840	120,328
2009	9,223	8,926	9,223	9,223	8,331	9,223	42,919	41,235	4,463	4,612	4,612	4,463	156,452	
Average	16,957	13,625	14,079	14,079	12,717	14,079	46,531	44,910	9,078	9,381	9,381	9,078	213,897	214,289
Min	7,736	8,926	9,223	9,223	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	94,000	94,000
Max	24,397	17,851	18,447	18,447	16,661	18,447	66,685	63,515	14,876	15,372	15,372	14,876	300,923	300,923

Conversion (0-5):	5
Sheet Name:	Output1
Column Letter:	Z
Column No:	26
Label:	ELEASE-MI
Native Unit:	CFS
Convert Unit:	Native

The values could also be tabled in the parameter's native unit of flow (cfs) representing the average daily flow requirement during each month. Annual totals are not included as the value is non-sensible.

Table 1
LAGRANGE RELEASE-MINQ (Output1)
CFS — Average Daily Value

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1971	397	300	300	300	300	300	1,121	1,033	75	75	75	75
1972	215	175	175	175	169	175	509	476	50	50	50	50
1973	150	150	150	150	150	150	1,080	1,007	250	250	250	250
1974	397	300	300	300	300	300	1,080	1,007	250	250	250	250
1975	397	300	300	300	300	300	1,080	1,007	250	250	250	250
1976	397	300	300	300	290	300	339	321	50	50	50	50
1977	126	150	150	150	150	150	246	237	50	50	50	50
1978	126	150	150	150	150	150	1,080	1,007	250	250	250	250
1979	397	300	300	300	300	300	1,080	1,007	250	250	250	250
1980	397	300	300	300	290	300	1,080	1,007	250	250	250	250
1981	397	300	300	300	300	300	493	464	75	75	75	75
1982	207	180	180	180	180	180	1,080	1,007	250	250	250	250
1983	397	300	300	300	300	300	1,080	1,007	250	250	250	250
1984	397	300	300	300	290	300	1,080	1,007	250	250	250	250
1985	397	300	300	300	300	300	582	542	75	75	75	75
1986	150	150	150	150	150	150	1,080	1,007	250	250	250	250
1987	397	300	300	300	300	300	411	387	50	50	50	50
1988	126	150	150	150	145	150	246	237	50	50	50	50
1989	126	150	150	150	150	150	437	410	50	50	50	50
1990	126	150	150	150	150	150	325	309	50	50	50	50
1991	126	150	150	150	150	150	435	408	50	50	50	50
1992	126	150	150	150	145	150	336	319	50	50	50	50
1993	126	150	150	150	150	150	1,080	1,007	250	250	250	250
1994	397	300	300	300	300	300	435	409	50	50	50	50
1995	150	150	150	150	150	150	1,080	1,007	250	250	250	250
1996	397	300	300	300	290	300	1,080	1,007	250	250	250	250
1997	397	300	300	300	300	300	1,080	1,007	250	250	250	250
1998	397	300	300	300	300	300	1,080	1,007	250	250	250	250
1999	397	300	300	300	300	300	1,080	1,007	250	250	250	250
2000	397	300	300	300	290	300	1,080	1,007	250	250	250	250
2001	397	300	300	300	300	300	480	450	75	75	75	75
2002	150	150	150	150	150	150	550	513	75	75	75	75
2003	150	150	150	150	150	150	935	865	75	75	75	75
2004	215	175	175	175	169	175	482	451	75	75	75	75
2005	150	150	150	150	150	150	1,080	1,007	250	250	250	250
2006	397	300	300	300	300	300	1,080	1,007	250	250	250	250
2007	397	300	300	300	300	300	438	412	50	50	50	50
2008	126	150	150	150	145	150	462	433	50	50	50	50
2009	150	150	150	150	150	150	721	671	75	75	75	75
Average	276	229	229	229	227	229	782	730	153	153	153	153
Min	126	150	150	150	145	150	246	237	50	50	50	50
Max	397	300	300	300	300	300	1,121	1,033	250	250	250	250

For each parameter the sequential, the chronological annual values and associated monthly values are also grouped by water type, in descending order of annual runoff. The rank ordering of the years within the simulation period is established by the naming of 6 year types, wet, above normal, normal, below normal, dry and critical. Using the water year runoff for the years 1921 through 2011 (91 years), the years were rank ordered from wettest to driest. The wettest 20 percent of the years (18 years) are designated the wet year type. The next wettest 18 years are designated the above normal year type.

And so on for the normal and below normal year types. The driest 20 percent of years are split between the dry and critical year types. After the demarcation occurs for each year the data set is reduced to only the 1971 through 2009 modeling period (39 years). A switch at cell X216 directs the monthly sequence of the year. For instance, if the year is to begin February 1 of the year and continue through January of the following year, the switch would be set to “Feb”. The switch can be set to any month February (Feb) through June (Jun). The first form of standardized table (Table 1a Form) for this information follows, which identifies the year type associated with each chronologically-based listed year. Averages for each year type follow the listing.

	Table 1a													
Prelim	LAGRANGE RELEASE-MINQ (Output1)													
Relicense	AF													
Yr-Type	Yr Begin	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Total
3	1971	16,661	18,447	66,685	63,515	4,463	4,612	4,612	4,463	13,240	10,413	10,760	10,760	228,631
4	1972	9,719	10,760	30,288	29,251	2,975	3,074	3,074	2,975	9,223	8,926	9,223	9,223	128,713
3	1973	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
2	1974	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
2	1975	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
6	1976	16,661	18,447	20,153	19,749	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	122,217
6	1977	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	94,000
1	1978	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
3	1979	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
1	1980	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
5	1981	16,661	18,447	29,339	28,532	4,463	4,612	4,612	4,463	12,744	10,711	11,068	11,068	156,718
1	1982	9,997	11,068	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	286,880
1	1983	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
2	1984	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
4	1985	16,661	18,447	34,656	33,346	4,463	4,612	4,612	4,463	9,223	8,926	9,223	9,223	157,854
1	1986	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
6	1987	16,661	18,447	24,481	23,806	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	130,603
6	1988	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	94,000
4	1989	8,331	9,223	25,991	25,222	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	115,975
5	1990	8,331	9,223	19,362	19,008	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	103,131
4	1991	8,331	9,223	25,870	25,109	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	115,740
6	1992	8,331	9,223	19,995	19,601	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	104,357
2	1993	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
5	1994	16,661	18,447	25,903	25,140	2,975	3,074	3,074	2,975	9,223	8,926	9,223	9,223	134,846
1	1995	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
2	1996	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
1	1997	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
1	1998	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
2	1999	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
3	2000	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
4	2001	16,661	18,447	28,572	27,642	4,463	4,612	4,612	4,463	9,223	8,926	9,223	9,223	146,067
3	2002	8,331	9,223	32,729	31,539	4,463	4,612	4,612	4,463	9,223	8,926	9,223	9,223	136,567
3	2003	8,331	9,223	55,641	53,161	4,463	4,612	4,612	4,463	13,240	10,413	10,760	10,760	189,680
4	2004	9,719	10,760	28,696	27,758	4,463	4,612	4,612	4,463	9,223	8,926	9,223	9,223	131,678
1	2005	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
1	2006	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
5	2007	16,661	18,447	26,085	25,310	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	133,710
4	2008	8,331	9,223	27,470	26,609	2,975	3,074	3,074	2,975	9,223	8,926	9,223	9,223	120,328
3	2009	8,331	9,223	42,919	41,235	4,463	4,612	4,612	4,463					

LAGRANGE RELEASE-MINQ (Output1) - AF														
Water Year Type		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Total
W	1	12,663	14,019	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	292,497
AN	2	15,273	16,909	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	297,997
N	3	11,901	13,176	55,814	53,608	8,926	9,223	9,223	8,926	18,149	13,884	14,347	14,347	240,016
BN	4	11,108	12,298	28,792	27,848	3,613	3,733	3,733	3,613	8,798	8,926	9,223	9,223	130,908
D	5	14,579	16,141	25,172	24,497	3,347	3,459	3,459	3,347	9,360	9,372	9,684	9,684	132,101
C	6	11,663	12,913	18,786	18,467	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	109,035
All		12,717	14,079	46,531	44,910	9,078	9,381	9,381	9,078	16,762	13,514	13,964	13,964	214,289

The second form of report (Table 1b Form) for the water year type based ranking is shown below. This form rank orders the years according to descending volume of watershed runoff, named by the convention described above. The same averaging results occur for this format of report.

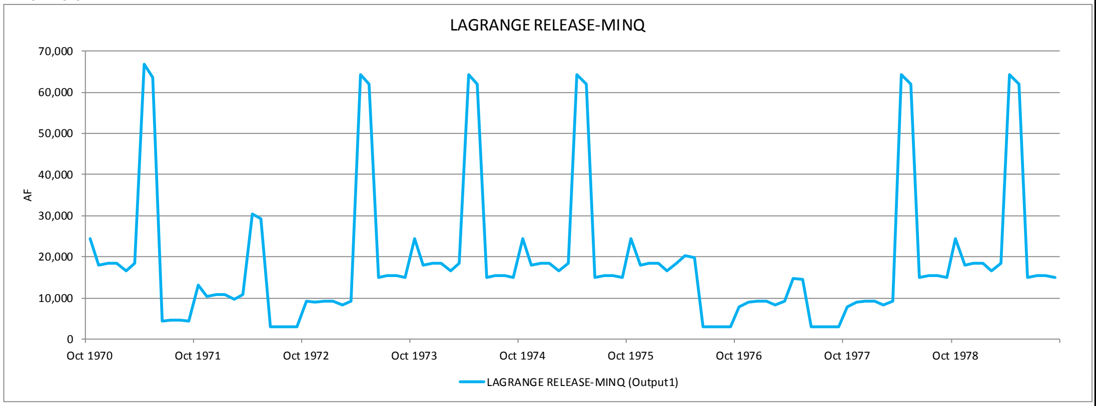
	Table 1b												
Prelim	LAGRANGE RELEASE-MINQ (Output1)												
Relicense	AF												
Yr-Type	Yr Begin	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Total
W	1983	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
W	1995	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
W	1982	9,997	11,068	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	286,880
W	1998	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
W	2006	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
W	1997	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
W	1980	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
W	1986	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
W	2005	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
W	1978	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
AN	1984	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
AN	1993	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
AN	1996	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
AN	1974	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
AN	1999	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
AN	1975	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
N	1973	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
N	2000	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
N	1979	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
N	1971	16,661	18,447	66,685	63,515	4,463	4,612	4,612	4,463	13,240	10,413	10,760	10,760	228,631
N	2009	8,331	9,223	42,919	41,235	4,463	4,612	4,612	4,463					
N	2003	8,331	9,223	55,641	53,161	4,463	4,612	4,612	4,463	13,240	10,413	10,760	10,760	189,680
N	2002	8,331	9,223	32,729	31,539	4,463	4,612	4,612	4,463	9,223	8,926	9,223	9,223	136,567
BN	1989	8,331	9,223	25,991	25,222	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	115,975
BN	2004	9,719	10,760	28,696	27,758	4,463	4,612	4,612	4,463	9,223	8,926	9,223	9,223	131,678
BN	1985	16,661	18,447	34,656	33,346	4,463	4,612	4,612	4,463	9,223	8,926	9,223	9,223	157,854
BN	1972	9,719	10,760	30,288	29,251	2,975	3,074	3,074	2,975	9,223	8,926	9,223	9,223	128,713
BN	2008	8,331	9,223	27,470	26,609	2,975	3,074	3,074	2,975	9,223	8,926	9,223	9,223	120,328
BN	1991	8,331	9,223	25,870	25,109	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	115,740
BN	2001	16,661	18,447	28,572	27,642	4,463	4,612	4,612	4,463	9,223	8,926	9,223	9,223	146,067
D	1981	16,661	18,447	29,339	28,532	4,463	4,612	4,612	4,463	12,744	10,711	11,068	11,068	156,718
D	2007	16,661	18,447	26,085	25,310	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	133,710
D	1990	8,331	9,223	19,362	19,008	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	103,131
D	1994	16,661	18,447	25,903	25,140	2,975	3,074	3,074	2,975	9,223	8,926	9,223	9,223	134,846
C	1992	8,331	9,223	19,995	19,601	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	104,357
C	1988	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	94,000
C	1976	16,661	18,447	20,153	19,749	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	122,217
C	1987	16,661	18,447	24,481	23,806	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	130,603
C	1977	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	94,000

LAGRANGE RELEASE-MINQ (Output1) - AF														
Water Year Type		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Total
W	1	12,663	14,019	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	292,497
AN	2	15,273	16,909	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	297,997
N	3	11,901	13,176	55,814	53,608	8,926	9,223	9,223	8,926	18,149	13,884	14,347	14,347	240,016
BN	4	11,108	12,298	28,792	27,848	3,613	3,733	3,733	3,613	8,798	8,926	9,223	9,223	130,908
D	5	14,579	16,141	25,172	24,497	3,347	3,459	3,459	3,347	9,360	9,372	9,684	9,684	132,101
C	6	11,663	12,913	18,786	18,467	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	109,035
All		12,717	14,079	46,531	44,910	9,078	9,381	9,381	9,078	16,762	13,514	13,964	13,964	214,289

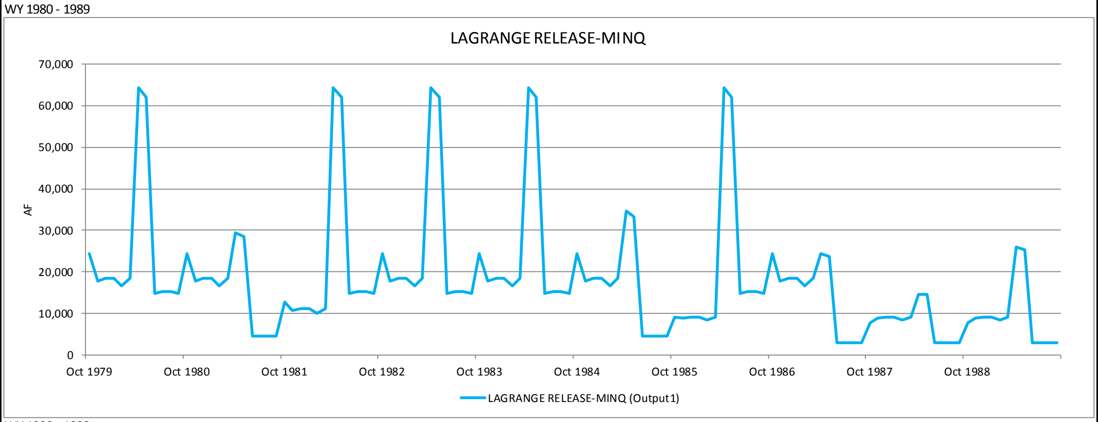
Standardized Graphs

Several standardized graphs are also provided for each parameter. The first graph provides a trace of the monthly sequence of data developed for the standardized chronological table. Following is the minimum flow requirement at La Grange Bridge synthesized as monthly volume during the simulation.

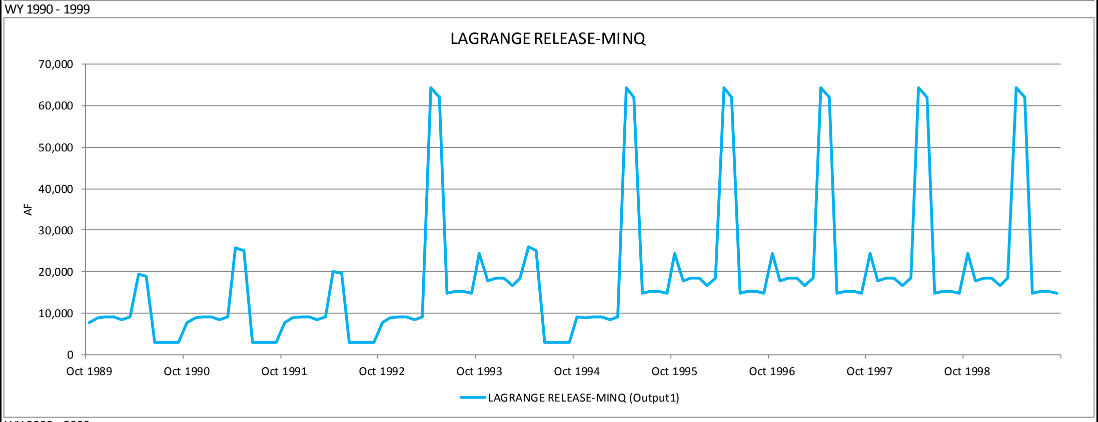
WY 1971-1979



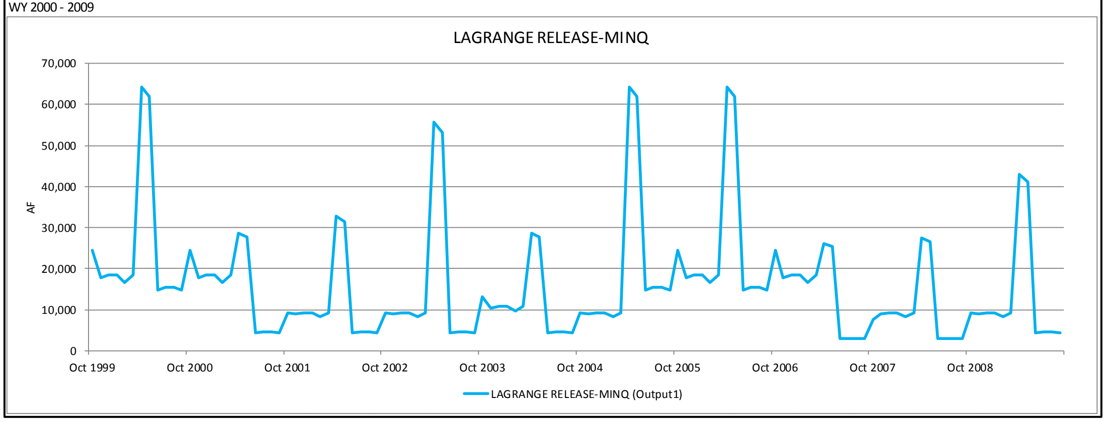
WY 1980 - 1989



WY 1990 - 1999



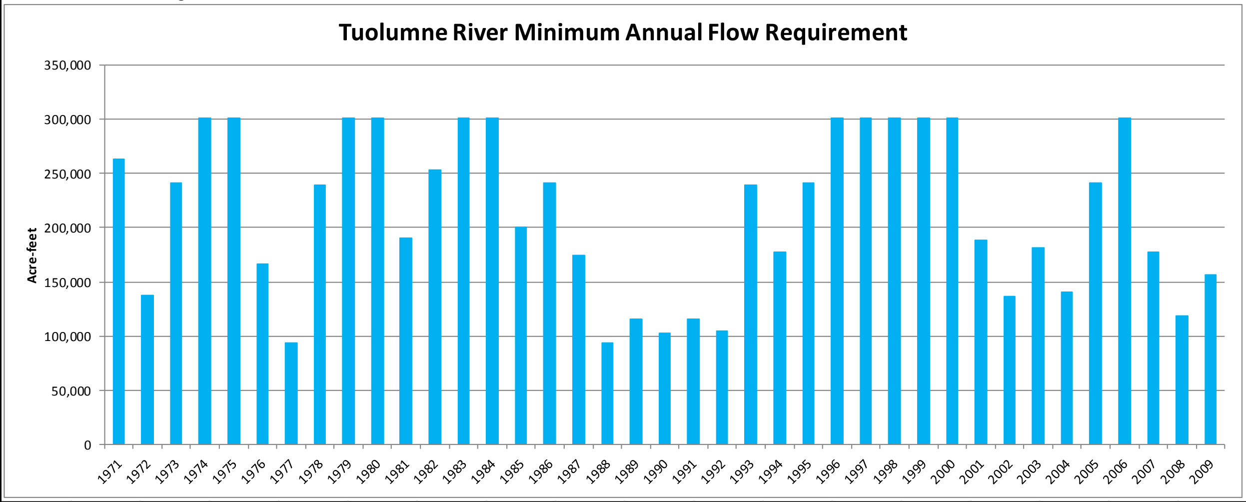
WY 2000 - 2009



A user-defined graph is also available to depict a particular column of data from the water year-based standardized table (Table 1) described above. A column of interest within the Table 1 standardized table is selected (such as column AI representing a water year total volume) in cell AN116 to display the 39 annual values.

Tab:	Output1					
Parmater:	LAGRANGE RELEASE-MINQ (Output1)			Table 1 Column Label:	Total	
Native:	CFS					
Convert:	AF	cell AN116				
Table 1 Plotted Col:		AI	Title:	Tuolumne River Minimum Annual Flow Requirement	Y-Axis:	Acre-feet

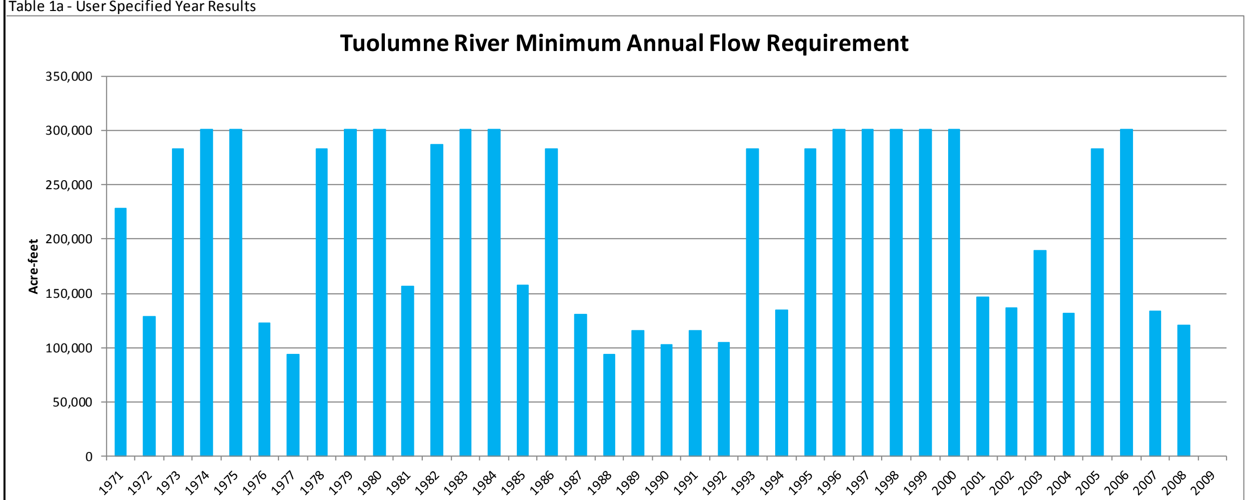
Table 1 - Water Year Arranged Results



A similar display of columnar results can be keyed to the chronological sequence year table described above. Entry of the desired column of information from the table (e.g., Table 1a) is done at cell AN143.

	cell AN143					
Table 1a Plotted Col:	AI	Table 1a Column Label:	Total	Year Beginning:	Feb	

Table 1a - User Specified Year Results

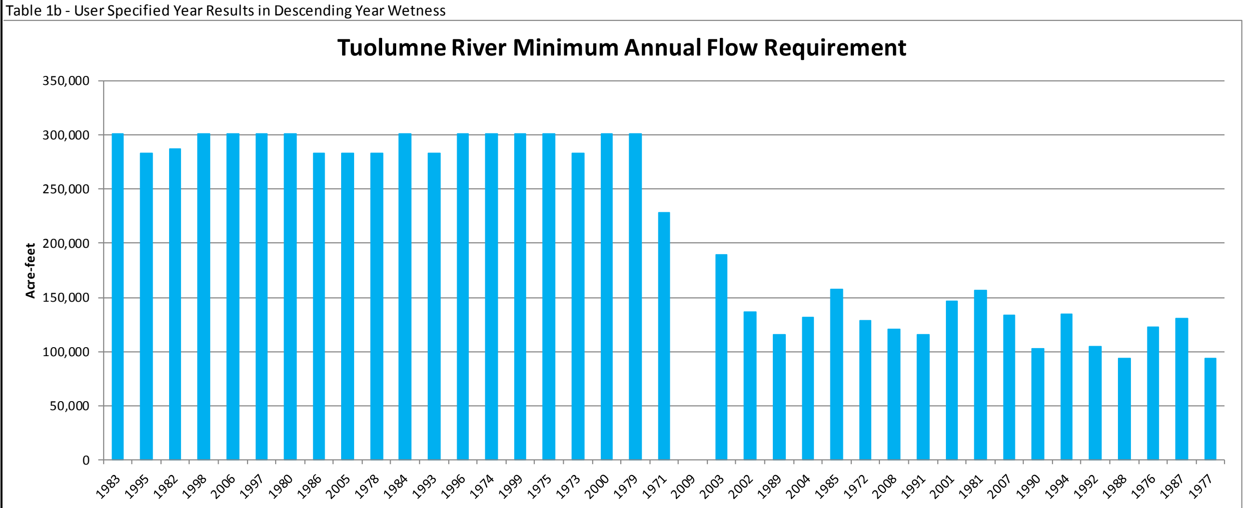


The third version of standardized graph for the same information displays results from a column of a table that rank-ordered the years of simulation according to descending runoff (e.g., Table 1b). Entry of

the desired column of information from that table is done at cell AN170, with results exemplified by the following graph.

	cell AN170			
Table 1b Plotted Col	AY	Table 1b Column Label:	Total	Year Beginning: Feb

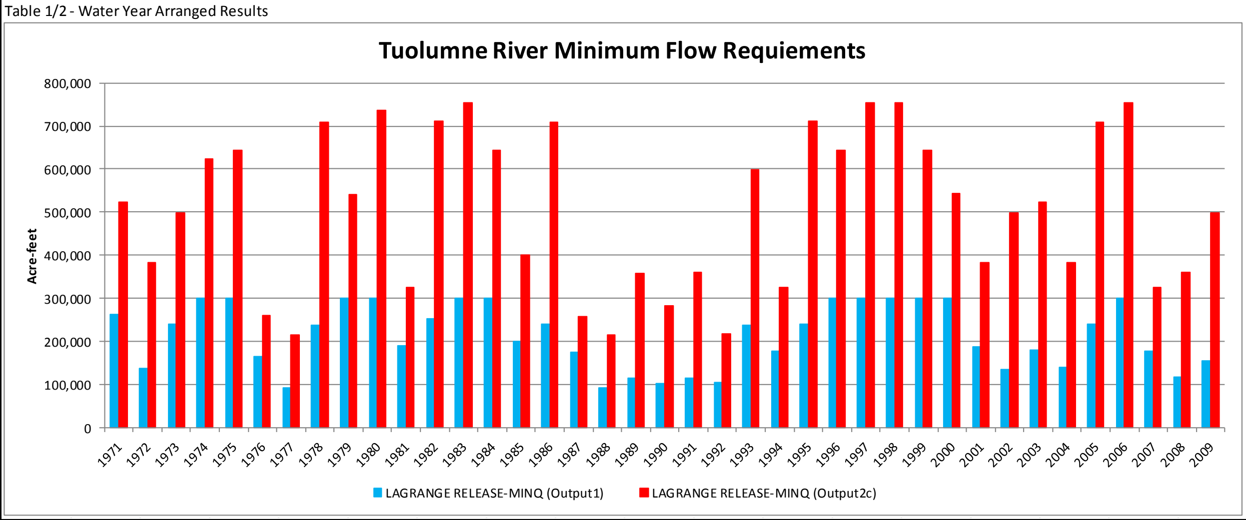
Table 1b - User Specified Year Results in Descending Year Wetness



The same tables and graphics are provided for each of the three other parameters. Additionally, standardized graphics are provided for a columnar comparison of Table 1 and Table 2 values. An example of those graphics is shown below, with the column(s) of interest defined by the Table 1-specific and Table 2-specific entries.

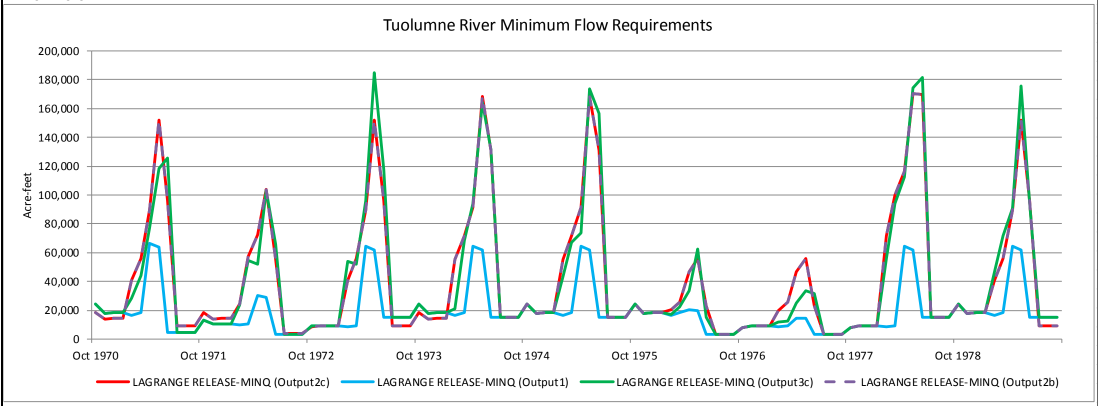
Tab:	Output1 & Output2c				
Parmater:	LAGRANGE RELEASE-MINQ (Output1) & LAGRANGE RELEASE-MINQ (Output2c)		Table 1 Column Label: Total		
Native:	CFS & CFS		Table 2 Column Label: Total		
Convert:	AF & AF				
Table 1 & Table 2 Plotted Col:	AI & AI	Title:	Tuolumne River Minimum Flow Requiements	Y-Axis:	Acre-feet

Table 1/2 - Water Year Arranged Results

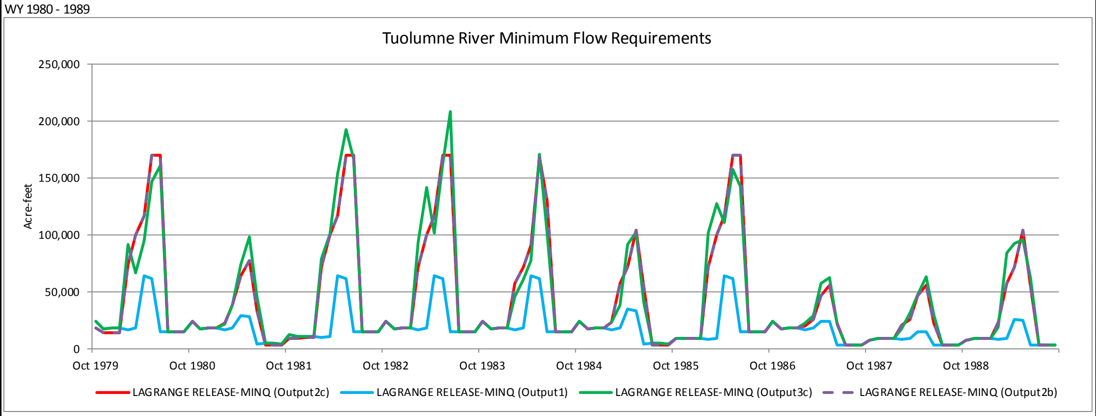


A standardized graphic comparison of Table 1, Table 2, Table 3 and Table 4 form monthly data is also provided. The four-way comparison graphs are shown below.

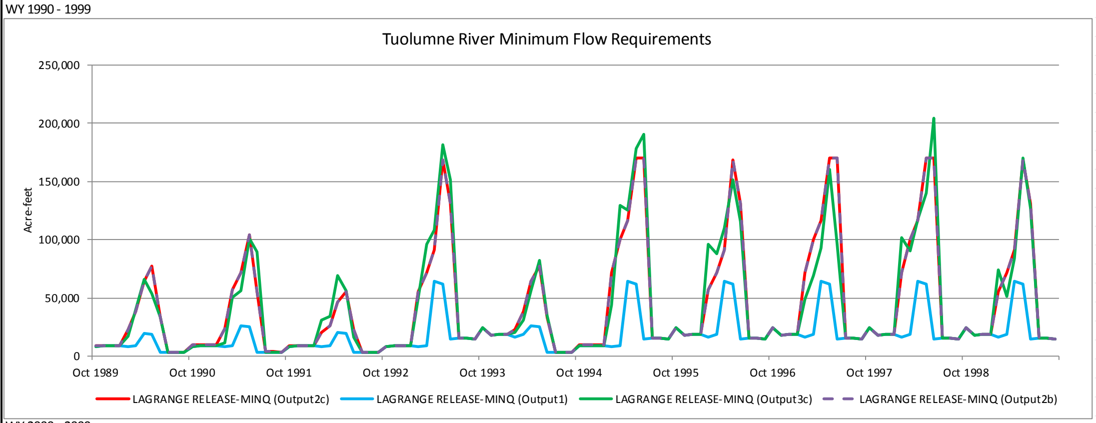
WY 1971-1979



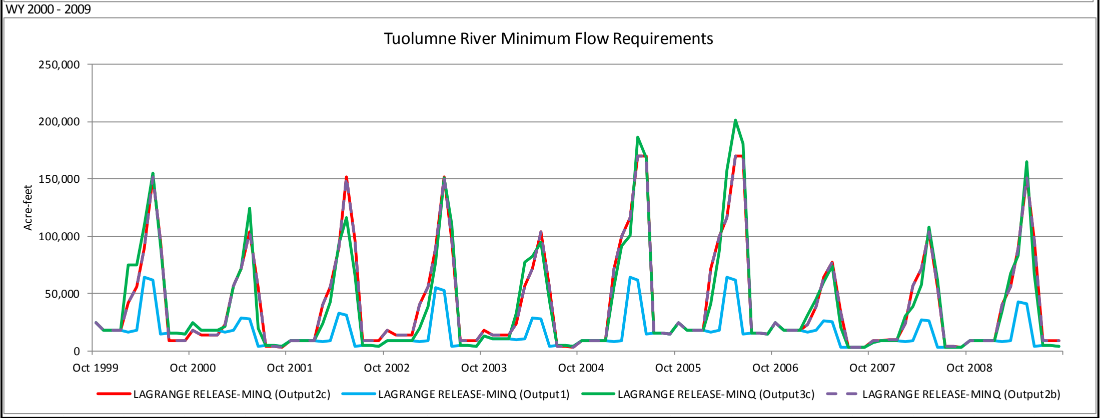
WY 1980 - 1989



WY 1990 - 1999



WY 2000 - 2009



5.7 XXGroup Worksheets

These worksheets provide graphical display of a single calendar year of operation for several model components. The model components represent groupings of physical features of the Tuolumne River system that make up logical components of operation. The model components are:

<u>Don Pedro Reservoir, the Distircts' facilities, and the Lower Tuolumne River</u>
Modeled with computational worksheet DonPedro and displayed by worksheet DPGroup

<u>Hetch Hetchy Reservoir, the San Joaquin Pipeline and downstream releases</u>
Modeled with computational worksheet SFHetchHetchy and displayed by worksheet HHGroup

<u>Lake Lloyd, Holm Powerhouse and its downstream releases</u>
Modeled with computational worksheet SFLloyd and displayed by worksheet LloydGroup

<u>Lake Eleanor, the Eleanor-Cherry Tunnel and its downstream releases</u>
Modeled with computational worksheet SFEleanor and displayed by worksheet ELGroup

<u>CCSF Water Bank and Supplemental Releases</u>
Modeled with computational worksheet SFWaterBank and displayed by worksheet WBGroup

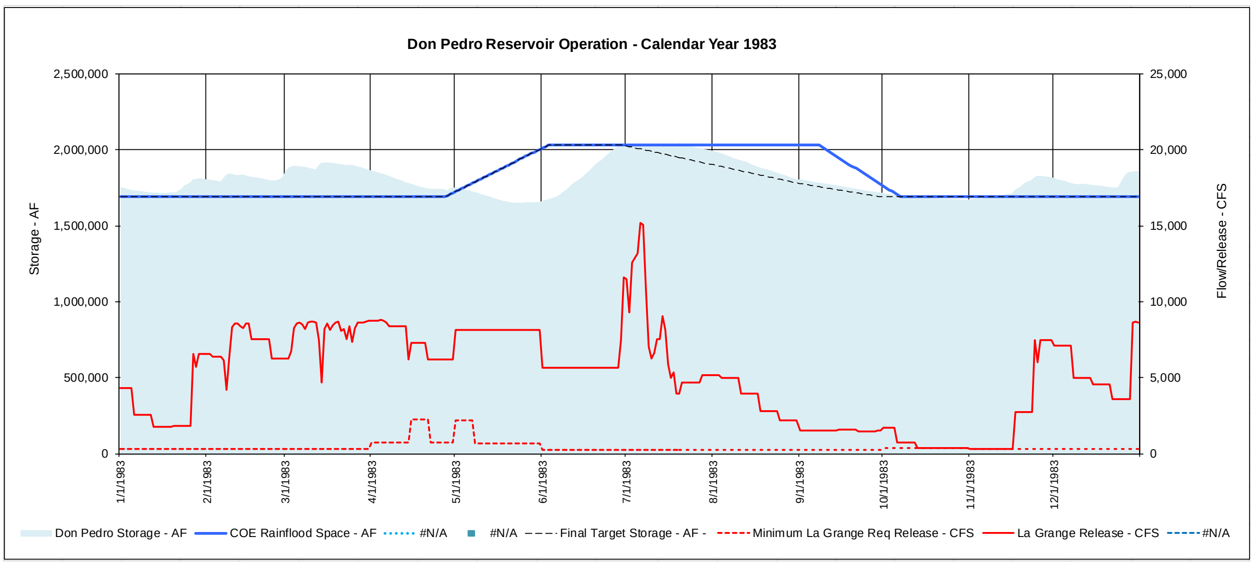
<u>CCSF System Storage</u> displayed by worksheet SFSysGroup.

Both the Districts' and CCSF's operations are additionally displayed for the 1986 through 1994 period by worksheets DPGroup86_94 and SFGroup86_94.

These component-specific display worksheets provide plotting of numerous parameters provided in the computation worksheets. One calendar year (the same year) of data for all parameters can be plotted. These display worksheets are similar to worksheet DSSAnyGroup except they rely upon the data being computed by the current study within the computational worksheets. A comparison between the same parameter from two different studies is not possible. Those comparisons are intended to be made through the worksheet Output and its tools. The parameter(s) to be plotted are identified by reference worksheet name and column. A snapshot of the identification parameters and result values is shown below for worksheet DPGroup.

	A	B	C	D	E	F	G	H
1	**DPGroup**							
2	This sheet illustrates a CY of daily results for Don Pedro operations in graphic format.							
3	Axis Reference	1	1	2	2	2	2	2
4	Enter CY Graph Year:	1983	1983	1983	1983	1983	1983	1983
5	Enter Sheet Name:	DonPedro	DonPedro	DonPedro	DonPedro	DonPedro	DonPedro	DonPedro
6	Column:	28	72	5	7	13	15	70
7	Enter Column:	AB	BT	E	G	M	O	BR
8	Data Reference:	COE Rainflood Space - AF	Don Pedro Storage - AF	Reservoir Inflow - CFS	Minimum La Grange Req Release - CFS	MID Canal - CFS	TID Canal - CFS	La Grange Release - CFS
9	Enter Scaler:	1	1	1	1	1	1	1
10	1-Jan-83	1,690,000	1,752,672	2,688	300	70	98	4,301
11	2-Jan-83	1,690,000	1,748,069	2,138	300	70	98	4,301
12	3-Jan-83	1,690,000	1,742,799	1,801	300	70	98	4,301
13	4-Jan-83	1,690,000	1,737,746	1,911	300	70	98	4,301
14	5-Jan-83	1,690,000	1,732,665	1,897	300	70	98	4,301
15	6-Jan-83	1,690,000	1,730,261	1,501	300	70	98	2,555
16	7-Jan-83	1,690,000	1,728,957	2,055	300	70	98	2,555
17	8-Jan-83	1,690,000	1,726,043	1,244	300	70	98	2,555
18	9-Jan-83	1,690,000	1,724,497	1,933	300	70	98	2,555

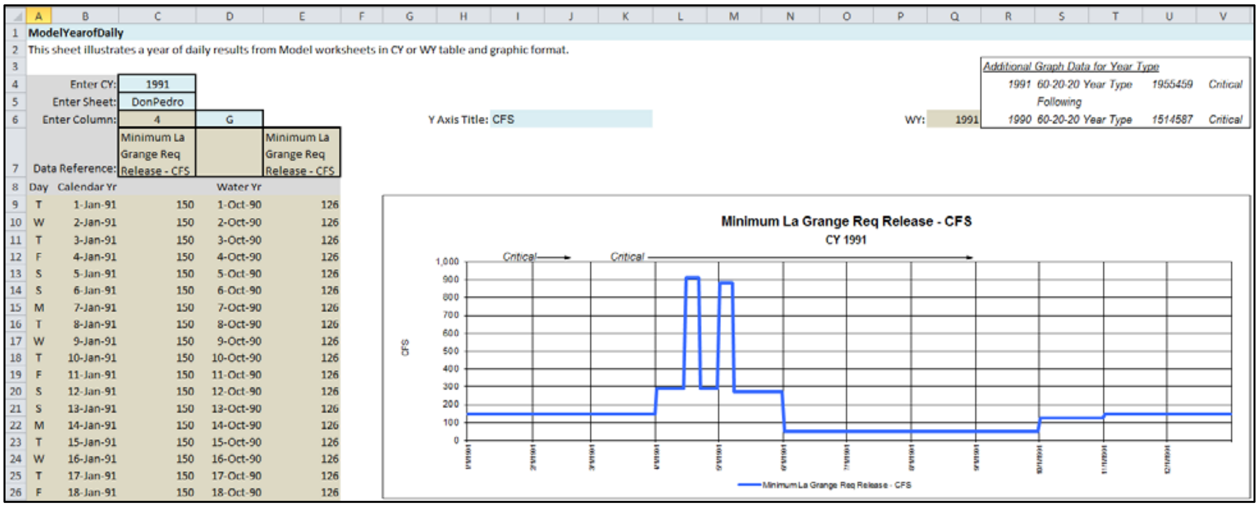
Values are plotted to either the primary y-axis or secondary y-axis. The "axis reference" indicates to which axis the value will be plotted by default. The designation of y-axis assignment is not modified by this field, and the user must edit the series data within the plot to change the y-axis assignment, graph type or line or shape characteristics. The "enter graph year" is a user entry. The same year or different year of a parameter or multiple parameters can be plotted. "Sheet name" is a user entry, and identifies from which Output-formatted worksheet the parameter is to be acquired. The "enter column" entry identifies from which column the parameter occurs. Upon proper entry of a parameter a return of the parameter's label and source worksheet will occur in the "data reference" field. Values for the specified calendar year will also be returned in the data field. If a plotting position is not used, a "#VALUE" or "#REF" will be returned. The "scaler" field is provided to allow the conversion or scaling of the data returned from the result worksheet. For instance, if the daily data occurs in the result worksheet in units of daily average flow (cfs) it could be plotted in units of daily volume (acre-feet) by entering the conversion factor of 1.983471. The entry in the field acts as a multiplier to the value occurring in the result worksheet. This field can also be used to scale two different "order of magnitude" parameters to use the same y-axis. An example of the several plotted parameters from an active scenario study is shown below.



Unused plotting positions will appear with values plotted at "zero" and will have legends of "#VALUE!", "#REF!" or "#N/A". To create graphs without unused positions a copy of the plot can be made and positioned elsewhere in the worksheet. The unwanted positions can then be deleted from the plot.

5.8 ModelYearofDaily Worksheet

This worksheet (ModelYearofDaily) provides graphical and table display of the daily result for a single calendar or water year for any parameter within a Model component worksheet (e.g., worksheet DonPedro). A snapshot of the data entry interface and a sample of graphical display are shown below.



The calendar year, Model worksheet, and column of interest are entered by the user. The result data are plotted by calendar year and water year. The result data are also tabled by calendar year (shown below) and water year.

Minimum La Grange Req Release - CFS

CY 1991	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	150	150	150	289	886	50	50	50	50	126	150	150
2	150	150	150	289	886	50	50	50	50	126	150	150
3	150	150	150	289	886	50	50	50	50	126	150	150
4	150	150	150	289	886	50	50	50	50	126	150	150
5	150	150	150	289	886	50	50	50	50	126	150	150
6	150	150	150	289	886	50	50	50	50	126	150	150
7	150	150	150	289	886	50	50	50	50	126	150	150
8	150	150	150	289	269	50	50	50	50	126	150	150
9	150	150	150	289	269	50	50	50	50	126	150	150
10	150	150	150	289	269	50	50	50	50	126	150	150
11	150	150	150	289	269	50	50	50	50	126	150	150
12	150	150	150	289	269	50	50	50	50	126	150	150
13	150	150	150	289	269	50	50	50	50	126	150	150
14	150	150	150	289	269	50	50	50	50	126	150	150
15	150	150	150	913	269	50	50	50	50	126	150	150
16	150	150	150	913	269	50	50	50	50	126	150	150
17	150	150	150	913	269	50	50	50	50	126	150	150
18	150	150	150	913	269	50	50	50	50	126	150	150
19	150	150	150	913	269	50	50	50	50	126	150	150
20	150	150	150	913	269	50	50	50	50	126	150	150
21	150	150	150	913	269	50	50	50	50	126	150	150
22	150	150	150	289	269	50	50	50	50	126	150	150
23	150	150	150	289	269	50	50	50	50	126	150	150
24	150	150	150	289	269	50	50	50	50	126	150	150
25	150	150	150	289	269	50	50	50	50	126	150	150
26	150	150	150	289	269	50	50	50	50	126	150	150
27	150	150	150	289	269	50	50	50	50	126	150	150
28	150	150	150	289	269	50	50	50	50	126	150	150
29	150	---	150	289	269	50	50	50	50	126	150	150
30	150	---	150	289	269	50	50	50	50	126	150	150
31	150	---	150	---	269	---	50	50	---	126	---	150
Ave	150	150	150	435	408	50	50	50	50	126	150	150
AF	9,223	8,331	9,223	25,871	25,109	2,975	3,074	3,074	2,975	7,736	8,926	9,223
Annual	115,742 AF		160 Ave CFS									

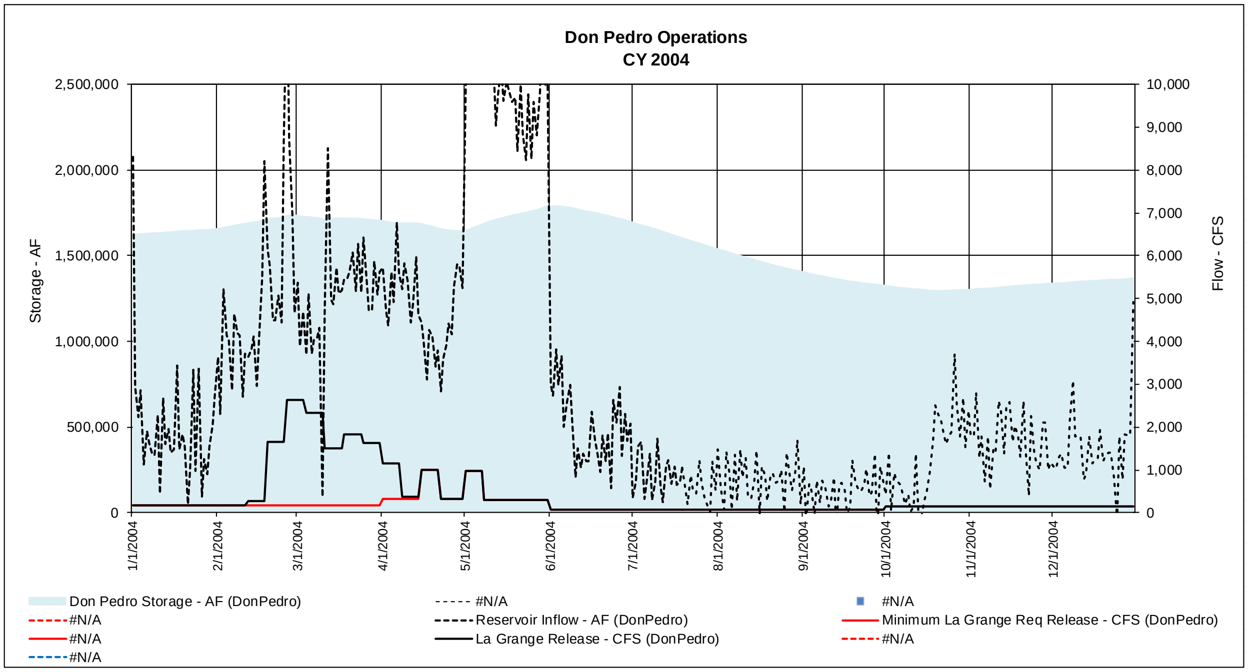
5.9 ModelAnyGroup Worksheet

This worksheet (ModelAnyGroup) provides plotting of up to ten parameters provided in any Model component worksheet (e.g., worksheet DonPedro). One calendar year (the same year or different years) of data for a parameter can be plotted. The parameter(s) to be plotted are identified by reference worksheet name and column. A snapshot of the identification parameters and result values is shown below. This worksheet performs the same function as the DSSAnyGroup worksheet except the source of its data are the Model component worksheets instead of DSS interface worksheets.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**ModelAnyGroup**													
2	This sheet illustrates a CY of daily results from Model worksheets in graphic format.													
3	Axis Reference	1		1		2		2		2		2		1
4	Enter CY Graph Year:	2004		2004		2004		2004		2004		2004		2004
5	Enter Sheet Name:	DonPedro		DonPedro		DonPedro		DonPedro		DonPedro		DonPedro		DonPedro
6	Column:	#N/A		72		6		7		#N/A		70		#N/A
7	Enter Column:			BT		F		G				BR		
8	Data Reference:	#N/A	Date	Don Pedro Storage - AF (DonPedro)	Date	Reservoir Inflow - AF (DonPedro)	Date	La Grange Req Release - CFS	Date	#N/A	Date	La Grange Release - CFS (DonPedro)	Date	#N/A
9	Enter Scaler:	1		1		1		1		1		1		1
10	1-Jan-04	#N/A	1-Jan-04	1,622,829	1-Jan-04	8,300	1-Jan-04	175	1-Jan-04	#N/A	1-Jan-04	175	1-Jan-04	#N/A
11	2-Jan-04	#N/A	2-Jan-04	1,625,102	2-Jan-04	2,934	2-Jan-04	175	2-Jan-04	#N/A	2-Jan-04	175	2-Jan-04	#N/A
12	3-Jan-04	#N/A	3-Jan-04	1,626,670	3-Jan-04	2,229	3-Jan-04	175	3-Jan-04	#N/A	3-Jan-04	175	3-Jan-04	#N/A
13	4-Jan-04	#N/A	4-Jan-04	1,628,860	4-Jan-04	2,850	4-Jan-04	175	4-Jan-04	#N/A	4-Jan-04	175	4-Jan-04	#N/A
14	5-Jan-04	#N/A	5-Jan-04	1,629,314	5-Jan-04	1,115	5-Jan-04	175	5-Jan-04	#N/A	5-Jan-04	175	5-Jan-04	#N/A
15	6-Jan-04	#N/A	6-Jan-04	1,630,546	6-Jan-04	1,892	6-Jan-04	175	6-Jan-04	#N/A	6-Jan-04	175	6-Jan-04	#N/A
16	7-Jan-04	#N/A	7-Jan-04	1,631,507	7-Jan-04	1,621	7-Jan-04	175	7-Jan-04	#N/A	7-Jan-04	175	7-Jan-04	#N/A
17	8-Jan-04	#N/A	8-Jan-04	1,632,196	8-Jan-04	1,349	8-Jan-04	175	8-Jan-04	#N/A	8-Jan-04	175	8-Jan-04	#N/A
18	9-Jan-04	#N/A	9-Jan-04	1,632,895	9-Jan-04	1,359	9-Jan-04	175	9-Jan-04	#N/A	9-Jan-04	175	9-Jan-04	#N/A
19	10-Jan-04	#N/A	10-Jan-04	1,634,514	10-Jan-04	2,279	10-Jan-04	175	10-Jan-04	#N/A	10-Jan-04	175	10-Jan-04	#N/A
20	11-Jan-04	#N/A	11-Jan-04	1,634,300	11-Jan-04	446	11-Jan-04	175	11-Jan-04	#N/A	11-Jan-04	175	11-Jan-04	#N/A
21	12-Jan-04	#N/A	12-Jan-04	1,636,320	12-Jan-04	2,680	12-Jan-04	175	12-Jan-04	#N/A	12-Jan-04	175	12-Jan-04	#N/A
22	13-Jan-04	#N/A	13-Jan-04	1,637,275	13-Jan-04	1,615	13-Jan-04	175	13-Jan-04	#N/A	13-Jan-04	175	13-Jan-04	#N/A
23	14-Jan-04	#N/A	14-Jan-04	1,638,581	14-Jan-04	1,967	14-Jan-04	175	14-Jan-04	#N/A	14-Jan-04	175	14-Jan-04	#N/A
24	15-Jan-04	#N/A	15-Jan-04	1,639,327	15-Jan-04	1,406	15-Jan-04	175	15-Jan-04	#N/A	15-Jan-04	175	15-Jan-04	#N/A
25	16-Jan-04	#N/A	16-Jan-04	1,640,134	16-Jan-04	1,466	16-Jan-04	175	16-Jan-04	#N/A	16-Jan-04	175	16-Jan-04	#N/A

Values are plotted to either the primary y-axis or secondary y-axis. The "axis reference" indicates to which axis the value will be plotted by default. The designation of y-axis assignment is not modified by this field, and the user must edit the series data within the plot to change the y-axis assignment, graph type or line or shape characteristics. The "enter CY graph year" is a user entry. The same year or different year of a parameter or multiple parameters can be plotted. "Sheet name" is a user entry, and identifies from which Model component worksheet the parameter is to be acquired. The "enter column" entry identifies from which column the parameter occurs. Upon proper entry of a parameter a return of the parameter's label and source worksheet will occur in the "data reference" field. Values for the specified calendar year will also be returned in the data field. If a plotting position is not used, a "#VALUE!" or "#REF!" will be returned. The "scaler" field is provided to allow the conversion or scaling of the data returned from the result worksheet. For instance, if the daily data occurs in the result worksheet in units of daily average flow (cfs) it could be plotted in units of daily volume (acre-feet) by entering the conversion factor of 1.983471. The entry in the field acts as a multiplier to the value occurring in the result worksheet. This field can also be used to scale two different "order of magnitude" parameters to use the same y-axis.

The results of up to ten parameters will be plotted. An example of the several plotted parameters from an active scenario is shown below.



Unused plotting positions will appear with values plotted at "zero" and will have legends of "#VALUE!" or "#REF!". To create graphs without unused positions a copy of the plot can be made and positioned elsewhere in the worksheet. The unwanted positions can then be deleted from the plot.

5.10 ModelMonthTable Worksheet

This worksheet (ModelMonthTable) provides summation or averaging, and plotting of up to four parameters provided in Model component worksheets (e.g., DonPedro worksheet). The function of this worksheet is to provide a synthesis of the daily result data into monthly results thus reducing the handling and display of over 14,000 values for each parameter (39 years of days) to 468 values (39 years of months). This worksheet and its functionality are identical to the DSSMonthTable worksheet except the source of its data are the Model component worksheets instead of DSS interface worksheets.

The parameter(s) to be plotted or tabled are identified by reference worksheet name and column, very similarly to the method identified for the ModelAnyGroup worksheet. A snapshot of the identification parameters and result values is shown below.

5				Conversion Key:			
6				0	1 >> 1	Native	1
7				1	CFS >> AF	AF	1.9834700
8				2	AF >> CFS	CFS	0.5041669
9				3	CFS >> TAF	TAF	0.0019835
10				4	EOM Stor	AF	1
11				5	Ave Day	Native	1
12	Enter Conversion (0-5):			4	1	1	1
13	Enter Sheet Name:			DonPedro	DonPedro	DonPedro	DonPedro
14	Enter Column Letter:			BT	F	BR	G
15	Column No:			72	6	70	7
16	Label:			ro Storage	oir Inflow (	ge Release	ange Req F
17	Native Unit:			AF	AF	CFS	CFS
18	Convert Unit:			AF	AF	AF	AF
19	Index	Date	Day	1	1	1	1
20	1970.10	10/1/1970	T	1,666,767	1,268	787	787
21	1970.10	10/2/1970	F	1,664,567	1,783	787	787
22	1970.10	10/3/1970	S	1,662,719	2,130	787	787
23	1970.10	10/4/1970	S	1,659,892	2,460	787	787
24	1970.10	10/5/1970	M	1,656,745	296	787	787
25	1970.10	10/6/1970	T	1,654,119	1,870	787	787

Each parameter is tabled and plotted separately for the entire 39-year simulation period. "Sheet name" is a user entry, and identifies from which Model component worksheet the parameter is to be acquired. The "enter column letter" entry identifies from which column the parameter occurs. Upon proper entry of a parameter a return of the parameter's label, source worksheet and the native unit of the parameter will occur. Depending on need, the "conversion" entry is provided. This entry, a keyed value of 0 to 5, directs the worksheet on the handling of the daily data. An entry of 1 will direct the worksheet to sum the daily data into monthly increments in the parameter's native units (e.g., daily acre-feet into monthly volumes). An entry of 1 will convert the daily data from a native unit of flow (cfs) into monthly volumes of acre-feet. An entry of 2 will convert the daily data from a native unit of volume (acre-feet) into a monthly sum of daily flow in units of cfs. An entry of 3 will act as an entry of 1 except convert the result into monthly volumes with units of 1,000 acre-feet. An entry of 4 will table and plot the daily value associated with the last day of each month in its native unit, and is primarily intended to analyze reservoir storage. An entry of 5 will report the average of daily values within a month. Depending on the entry in the conversion field, the converted unit will be returned to "converted unit" field. Values for the each month of the simulation period will also be returned in the data field. If a plotting position is not used, a "#VALUE!" or "#REF!" will be returned.

A “scaler” field is also provided for each parameter (in the row above the data fields) to allow the conversion or scaling of the data returned from the result worksheet.

The results of up to four parameters will be tabled and plotted. The content formats of reports are identified below. Refer to section 5.5 DSSMonthTable for illustrations of each format.

Standardized Tables

- Data synthesized into monthly volumes for the simulation period.

- Chronological annual values and associated monthly values are also grouped by water type, in descending order of annual runoff.

Standardized Graphs

- Graphs providing a trace of the monthly sequence of data developed for the standardized chronological table.

- Graphs depicting a particular column of data from the water year-based standardized table.

- Graphs for the same information displayed rank-ordered according to descending runoff.

- Standardized graphics are provided for a columnar comparison of the four parameters.

5.11 DonPedro Worksheet

This Model component worksheet (DonPedro) simulates the operation of Don Pedro Reservoir. Several sections of logic provide a systematic operation of the reservoir based on inflow and forecasted hydrology and water demands. As described earlier, the Model will direct releases from the Don Pedro Project under a "hold-unless-need-to-release" protocol, except as conditioned by minimum release requirements, diversions, preferred/maximum storage, and snowmelt management releases. The several sections of logic are illustrate and discussed below.

Don Pedro Release Demands

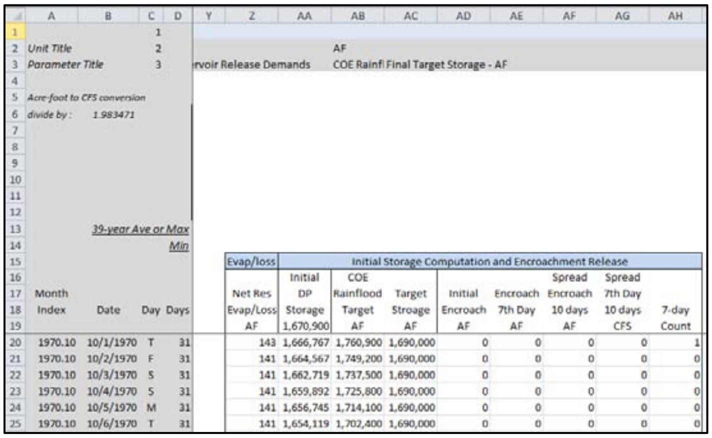
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1			1		**Don Pedro Model**																			
2	*Unit Title*		2		CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF					CFS	AF
3	*Parameter Title*		3		DP Reserv	DP Reserv	Minimum Li	Minimum	MID Full C	MID Full C	TID Full Di	TID Full Di	MID Canal	MID Canal	TID Canal	TID Canal	Total Cana	Total Canals					Total Rese	Total Rese
4																								
5	*Acre-foot to CFS conversion*				*This Scenario*													*Difference from Base*						
6	*divide by :*	*1.983471*			*Check Sums*		*Sum AF*	*39-ave*		*Other*	*39-ave*			*39-ave*	*39-ave*				*39-yr Ave*	*39-yr Ave*				
7						*Inflow*	*65,915,187*	*1,690,133*		*MID Canal*	*284,177*		*Inflow*	*1,690,133*	*284,177*	*MID Canal*		*Inflow*	*0*	*0*	*MID Canal*			
8						*Evap*	*1,740,362*	*44,625*		*TID Canal*	*559,697*		*Evap*	*44,625*	*559,697*	*TID Canal*		*Evap*	*0*	*0*	*TID Canal*			
9						*River*	*31,532,459*	*808,525*					*River*	*808,525*				*River*	*0*					
10						*Canals*	*32,911,098*	*843,874*		*Minimum River*	*213,897*		*Canals*	*843,874*	*213,897*	*Minimum River*		*Canals*	*0*	*0*	*Minimum River*			
11						*Net*	*-268,732*																	
12						*Chng Stor*	*-268,732*																	
13		*39-year Ave or Max*											*1,257*	*284,177*	*2,404*	*559,697*		*843,874*		*16,777*		*41,518*		*1,057,771*
14				*Min*					*Using WSF = 1.000 All Years*				*41*		*1*									
15					Inflow		La Grange Require		Existing Level Full Diversion Demand				Scenario Canal Diversions						Diversion Shortage from Full Demand				Total DP Demands	
16										*300,954*		*601,215*											Total	Total
17	Month				Reservoir	Reservoir	Minimum	Minimum	MID	MID	TID	TID	MID	MID	TID	TID	Total	Total	MID	MID	TID	TID	Res Rel	Res Rel
18	Index	Date	Day	Days	Inflow	Inflow	Req	Req	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canals	Canals	Canal	Canal	Canal	Canal	Demands	Demands
19					CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF
20	1970.10	10/1/1970	T	31	322	639	397	787	531	1,053	1,406	2,789	531	1,053	1,406	2,789	1,937	3,842	0	0	0	0	2,334	4,629
21	1970.10	10/2/1970	F	31	453	899	397	787	434	860	661	1,311	434	860	661	1,311	1,094	2,171	0	0	0	0	1,491	2,958
22	1970.10	10/3/1970	S	31	541	1,074	397	787	424	840	582	1,154	424	840	582	1,154	1,006	1,994	0	0	0	0	1,402	2,781
23	1970.10	10/4/1970	S	31	625	1,240	397	787	463	918	1,119	2,220	463	918	1,119	2,220	1,582	3,139	0	0	0	0	1,979	3,926
24	1970.10	10/5/1970	M	31	75	149	397	787	461	915	733	1,453	461	915	733	1,453	1,194	2,368	0	0	0	0	1,591	3,155
25	1970.10	10/6/1970	T	31	475	943	397	787	491	973	841	1,668	491	973	841	1,668	1,332	2,641	0	0	0	0	1,728	3,428

This section of logic assembles the underlying water demands placed for Don Pedro Reservoir releases. Reservoir inflow is derived from other Model component worksheets and is the sum of unregulated inflow to Don Pedro Reservoir (Hydrology worksheet) and regulated releases from the CCSF System (SFHetchHetchy worksheet, SFLLoyd worksheet and SFEleanor worksheet). The minimum flow requirement for the Tuolumne River is provided by worksheet LaGrangeSchedule as directed by worksheet UserInput. The "Existing Level Full Diversion Demand" is a projection of canal diversion requirements if no water supply shortages occurred and full demands are provided. "Scenario Canal Diversion Demand" is the canal diversions of MID and TID for the active scenario. These diversions are determined by either pre-processed computations of diversions (e.g, fixed Test Case diversions), user specified diversions, or dynamic computations. "Total DP Demands" are the summation of minimum release requirements for the river and canal diversions. Other information is developed in this section concerning the difference between scenario diversions and full diversion demand, and an overall summary of water disposition for the entire simulation period.

Reservoir Evaporation / Initial Storage Computation and Encroachment Release

This section performs an initial check of reservoir storage assuming the previously described minimum releases for the river and canals. A daily mass balance is performed: *change in reservoir storage = inflow, minus outflow (releases), minus reservoir losses*. The prior day's reservoir evaporation is included in the calculation. If the computation produces resulting Don Pedro Reservoir storage in excess (encroachment) of the preferred storage target, the encroachment is computed. Every 7th day the model checks for an encroachment, and if it exists a check release is computed. It is assumed that a constant supplemental release (in excess of minimum releases) will be initiated at a rate equal to the encroachment divided equally over the next 10 days. This protocol repeats itself every 7th day,

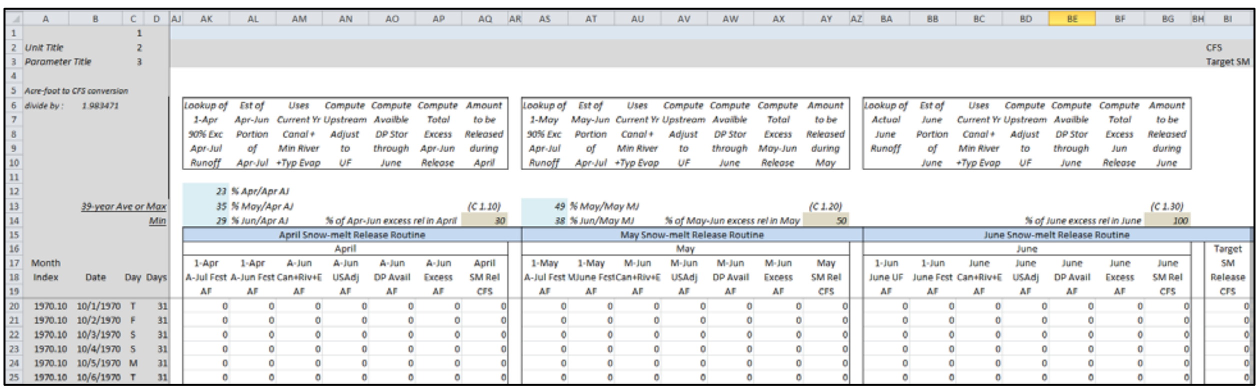
reestablishing the level of check release each time. The end result of this procedure will allow encroachment of storage space above the preferred storage target and not require unrealistic hard releases of water to exactly conform to the target.



Unit Title 2 — AF
Parameter Title 3 — rvoir Release Demands — COE Rainfl Final Target Storage - AF
Acre-foot to CFS conversion
divide by : 1.983471
39-year Ave or Max
Min

Month Index	Date	Day	Days	Evap/loss: Net Res Evap/Loss AF	Initial DP Storage 1,670,900	COE Rainflood Target AF	Target Stroage AF	Initial Encroach AF	Encroach 7th Day AF	Spread Encroach 10 days AF	Spread 7th Day 10 days CFS	7-day Count
					Initial Storage Computation and Encroachment Release							
1970.10	10/1/1970	T	31	143	1,666,767	1,760,900	1,690,000	0	0	0	0	1
1970.10	10/2/1970	F	31	141	1,664,567	1,749,200	1,690,000	0	0	0	0	0
1970.10	10/3/1970	S	31	141	1,662,719	1,737,500	1,690,000	0	0	0	0	0
1970.10	10/4/1970	S	31	141	1,659,892	1,725,800	1,690,000	0	0	0	0	0
1970.10	10/5/1970	M	31	141	1,656,745	1,714,100	1,690,000	0	0	0	0	0
1970.10	10/6/1970	T	31	141	1,654,119	1,702,400	1,690,000	0	0	0	0	0

Snow-melt Management



Unit Title 2
Parameter Title 3
Acre-foot to CFS conversion
divide by : 1.983471
39-year Ave or Max
Min
CFS
Target SM

April Snow-melt Release Routine (April): Lookup of 1-Apr 90% Exc Apr-Jul Runoff; Est of Apr-Jun Portion of Apr-Jul; Uses Current Yr Canal + Min River +Typ Evap; Compute Upstream Adjust to UF; Compute Availble DP Stor through June; Compute Total Excess Apr-Jun Release; Amount to be Released during April
23 % Apr/Apr AJ
35 % May/Apr AJ
29 % Jun/Apr AJ
% of Apr-Jun excess rel in April (C 1.10) 30

Month Index	Date	Day	Days	1-Apr A-Jul Fcst AF	1-Apr A-Jun Fcst AF	A-Jun Can+Riv+E AF	A-Jun USAdj AF	A-Jun DP Avail AF	A-Jun Excess AF	April SM Rel CFS
1970.10	10/1/1970	T	31	0	0	0	0	0	0	0
1970.10	10/2/1970	F	31	0	0	0	0	0	0	0
1970.10	10/3/1970	S	31	0	0	0	0	0	0	0
1970.10	10/4/1970	S	31	0	0	0	0	0	0	0
1970.10	10/5/1970	M	31	0	0	0	0	0	0	0
1970.10	10/6/1970	T	31	0	0	0	0	0	0	0

May Snow-melt Release Routine (May): Lookup of 1-May 90% Exc Apr-Jul Runoff; Est of May-Jun Portion of Apr-Jul; Uses Current Yr Canal + Min River +Typ Evap; Compute Upstream Adjust to UF; Compute Availble DP Stor through June; Compute Total Excess May-Jun Release; Amount to be Released during May
49 % May/May MJ
38 % Jun/May MJ
% of May-Jun excess rel in May (C 1.20) 50

Month Index	Date	1-May A-Jul Fcst AF	1-May MJune Fcst AF	M-Jun Can+Riv+E AF	M-Jun USAdj AF	M-Jun DP Avail AF	M-Jun Excess AF	May SM Rel CFS
1970.10	10/1/1970	0	0	0	0	0	0	0
1970.10	10/2/1970	0	0	0	0	0	0	0
1970.10	10/3/1970	0	0	0	0	0	0	0
1970.10	10/4/1970	0	0	0	0	0	0	0
1970.10	10/5/1970	0	0	0	0	0	0	0
1970.10	10/6/1970	0	0	0	0	0	0	0

June Snow-melt Release Routine (June): Lookup of Actual June Runoff; Est of June Portion of June; Uses Current Yr Canal + Min River +Typ Evap; Compute Upstream Adjust to UF; Compute Availble DP Stor through June; Compute Total Excess Jun Release; Amount to be Released during June
% of June excess rel in June (C 1.30) 100

Month Index	Date	1-Jun June UF AF	1-Jun June Fcst AF	June Can+Riv+E AF	June USAdj AF	June DP Avail AF	June Excess AF	June SM Rel CFS	Target SM Release CFS
1970.10	10/1/1970	0	0	0	0	0	0	0	0
1970.10	10/2/1970	0	0	0	0	0	0	0	0
1970.10	10/3/1970	0	0	0	0	0	0	0	0
1970.10	10/4/1970	0	0	0	0	0	0	0	0
1970.10	10/5/1970	0	0	0	0	0	0	0	0
1970.10	10/6/1970	0	0	0	0	0	0	0	0

A second check release is made during the April through June period for management of anticipated snowmelt runoff. On the first day of each of these months a forecast is made of anticipated runoff into the reservoir and minimum releases and losses from the reservoir from the date of forecast through the end of June (the assumed target date of reservoir filling). These forecasts determine the volume of water (if any) that will require release in excess of minimum releases and losses and storage gain by the end of June. For April and May, the DWR 90 percent exceedence forecast is used for anticipated runoff, along with known minimum releases and losses, and upstream impairment. The user defines the percentage of volume (of the total volume) to be additionally released during each month. For April, 30 percent of the 3-month volume is advised for release, and during May 50 percent of the 2-month volume is advised for released. For June, the historically reported UF flow is assumed for the runoff computation. This assumes pre-knowledge of the runoff volume for the month, and 100 percent of the excess is spread across the month. The snowmelt check release is evenly distributed across the days of the month. The release made in a day is the greater of the two check releases or the minimum release. At no time is the maximum capacity of the reservoir (2,030,000 acre-feet) allowed to be exceeded, and if necessary a release, regardless of magnitude, will be made by the model to not exceed maximum storage capacity.

Modesto Flood Control Objective, Don Pedro Reservoir, and Tuolumne River Release

	A	B	C	D	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY
1			1																	
2	Unit Title		2			CFS	CFS	CFS	CFS	CFS		AF	CFS		AF		Acres			AF
3	Parameter Title		3		Re	Dry Creek	LTR Accr	Tot Unreg	Trg Max L(	Modesto Flo		La Grange	La Grange Release		Don Pedro Storage		DP Surface Area			DP Total E
4																				
5	Acre-foot to CFS conversion																			
6	divide by :	1.983471																		
7																				
8																				
9																				
10																				
11																				
12																				
13		39-year Ave or Max							(C 1.00)			808,525			508,489	Min 1976-77				44,626
14		Min				Enter Modesto FC Target:			9,000	CFS					785,605	Min 1987-92				
15						Modesto Flood Control Flow Objective						Final La Grange River		Don Pedro Reservoir						
16						Report	Est	Total	Target	Calc		Final	Final	DP		Encroach	Net Don Pedro Loss Calculation			
17	Month					Dry Creek	LTR Acc	Unreg	Max	Modesto		La Grange	La Grange	Storage	DP	above	Area	Factor	CFS	AF
18	Index	Date	Day	Days		Flow	Flow	Blw LG	LaGrange	Flow		Release	Release	Change	Storage	2,030,000				
19						CFS	CFS	CFS	CFS	CFS		AF	CFS	AF	1,670,900		11,156			
20	1970.10	10/1/1970	T	31		30	99	129	8,871	526		787	397	-4,133	1,666,767	0	11,139	0.006395	71.2	141.3
21	1970.10	10/2/1970	F	31		30	99	129	8,871	526		787	397	-2,200	1,664,567	0	11,127	0.006395	71.2	141.1
22	1970.10	10/3/1970	S	31		30	99	129	8,871	526		787	397	-1,849	1,662,719	0	11,116	0.006395	71.1	141.0
23	1970.10	10/4/1970	S	31		30	100	130	8,870	526		787	397	-2,826	1,659,892	0	11,099	0.006395	71.0	140.8
24	1970.10	10/5/1970	M	31		30	100	130	8,870	527		787	397	-3,147	1,656,745	0	11,082	0.006395	70.9	140.6
25	1970.10	10/6/1970	T	31		30	100	130	8,870	527		787	397	-2,626	1,654,119	0	11,071	0.006395	70.8	140.4

A Modesto flood control objective is incorporated into the release logic. The objective is to maintain a flow at Modesto no greater than a user-specified flow rate (assumed as 9,000 cfs). The logic checks against an allowable river release that would not exceed the flood control objective after considering the lower Tuolumne River accretions and Dry Creek flow. Logic is applied to the previous check releases in comparison to the allowable release. The La Grange release is then reduced if necessary to not exceed the Modesto flow target objective, even if it results in an encroachment in Don Pedro Reservoir. The exception is when the reservoir reaches full (2,030,000 AF). Any computed encroachment above a full reservoir is passed and the Modesto flow objective will be exceeded.

The several advised releases, storage conditions and water demands all culminate in determining the "Final La Grange River" release. The "Don Pedro Reservoir" section of logic reports the final reservoir storage of a day and the computation of Don Pedro Reservoir losses. Reservoir losses are computed in accordance with procedures of the Fourth Agreement.

Don Pedro Project Generation, and River Flows

	A	B	C	D	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP
1			1																		
2	Unit Title		2					MW	kWh/AF	AF	AF	AF	MWh		CFS				CFS	CFS	
3	Parameter Title		3		vaporation			DP PH Cap	DP PH Eff	Total DP R	DP Power I	DP Spill / I	Don Pedro Er		La Grange Release				TR abv Mc	TR blw Dry Creek	
4																					
5	Acre-foot to CFS conversion																				
6	divide by :	1.983471																			
7																					
8																					
9																					
10																					
11											(C 1.22)										
12							39-yr Ave	191	392	1,652,399	1,488,570	163,829	607,705								
13		39-year Ave or Max					Max	198	440	154,471	10,711	143,760	4,710								
14		Min					Min	127	258	410	410	0	106								
15						Don Pedro Power Operations									River Flows						
16						Per Ave	Per Min	(C 1.20)		Total	Thru		Don						LTR abv	LTR blw	
17	Month					DPStor	DPStor	308,960		DP	PH (cfs)	Spill/	Pedro		La Grange	Waterford	Hickman	Santa Fe	Modesto	Modesto	Mouth
18	Index	Date	Day	Days		(for Eff)	(for Cap)	Capability	Efficiency	Release	5,400	Bypass	Energy		RM 51.8	RM 42.0	RM 31.0	RM 21.6	RM 16.2	RM	RM 0.0
19						AF	AF	MW	kWh/AF	AF	AF	AF	MWh		CFS	CFS	CFS	CFS	CFS	CFS	CFS
20	1970.10	10/1/1970	T	31		1,668,834	1,666,767	195	408	4,629	4,629	0	1,888		397				496	526	
21	1970.10	10/2/1970	F	31		1,665,667	1,664,567	195	408	2,958	2,958	0	1,205		397				496	526	
22	1970.10	10/3/1970	S	31		1,663,643	1,662,719	195	407	2,781	2,781	0	1,133		397				496	526	
23	1970.10	10/4/1970	S	31		1,661,305	1,659,892	195	407	3,926	3,926	0	1,598		397				496	526	
24	1970.10	10/5/1970	M	31		1,658,319	1,656,745	195	407	3,155	3,155	0	1,284		397				497	527	
25	1970.10	10/6/1970	T	31		1,655,432	1,654,119	195	407	3,428	3,428	0	1,394		397				497	527	

Based on the hydrologic operation of Don Pedro Reservoir in the Model, power characteristics of the scenario are computed. Equations of Don Pedro powerhouse generation characteristics define capacity (MW) and efficiency (kWh/AF), based on reservoir storage. Capacity potential uses minimum storage of

the day, while efficiency uses average storage of the day. The maximum water through plant is assumed to be 5,400 cfs. Water that does not appear as passing through the generators is computed to be “spilled-bypassed”. The power generation is “cutoff” at reservoir storage of 308,960 acre-feet, the top of the dead pool.

Flow in the river below La Grange diversion dam is computed and reported. The flow is a determined value by the Model. The same hydrologic information used within the Modesto flow objective logic is added to La Grange releases to estimate flow at downstream points in the river. Currently an estimate of total Tuolumne River accretion between La Grange Bridge and the confluence of Dry Creek is added to La Grange releases to provide an estimate of flow above the Dry Creek confluence. The estimated flow of Dry Creek is added to that estimate to provide an estimate of flow below the Dry Creek confluence at “Modesto”. Additional flow points can be added as information becomes available.

Don Pedro Inflow Components

	A	B	C	D	CT	CU	CV	CW	CX	CY	CZ	DA	DB	DC	DD
1			1												
2	*Unit Title*		2			AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS
3	*Parameter Title*		3			DP Inflow	DP Inflow	DP Inflow	DP Inflow	DP Inflow	DP Inflow	Unreg Infl	Unreg Infl	DP Inflow	DP Inflow
4															
5	*Acre-foot to CFS conversion*														
6	*divide by :*	*1.983471*				*Read*		*Read*		*Read*			*Read*		*Read by*
7						*from*		*from*		*from*			*from*		*Model*
8						*SFHetchHetchy*		*SFLloyd*		*SFEleanor*			*Hydrology*		
9						*Incl*									
10						*Return of*									
11						*Moc Hatch*									
12															
13		*39-year Ave or Max*				*39-year average*									
14				*Min*		*525,724*		*378,296*		*102,781*		*683,332*		*1,690,133*	
15						Inflow to Don Pedro Reservoir									
16						Inflow	Inflow	Inflow	Inflow	Inflow	Inflow				
17	Month					from	from	from	from	from	from	Unreg	Unreg	DP	DP
18	Index	Date	Day	Days		HH	HH	Lloyd	Lloyd	Eleanor	Eleanor	Inflow	Inflow	Inflow	Inflow
19						AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS
20	1970.10	10/1/1970	T	31		179	90	443	223	20	10	-2	-1	639	322
21	1970.10	10/2/1970	F	31		179	90	443	223	20	10	258	130	899	453
22	1970.10	10/3/1970	S	31		179	90	443	223	20	10	433	218	1,074	541
23	1970.10	10/4/1970	S	31		179	90	443	223	20	10	599	302	1,240	625
24	1970.10	10/5/1970	M	31		179	90	443	223	20	10	-492	-248	149	75
25	1970.10	10/6/1970	T	31		179	90	443	223	20	10	302	152	943	475

This section of logic assembles the Don Pedro Reservoir inflow components from other Model component worksheets.

5.12 SFHetchHetchy Worksheet

This Model component worksheet (SFHetchHetchy) simulates the operation of Hetch Hetchy Reservoir. Several sections of logic provide a systematic operation of the reservoir based on inflow and forecasted hydrology and water demands. As described earlier, the Model will direct releases from Hetch Hetchy Reservoir under a “hold-unless-need-to-release” protocol, except as conditioned by minimum release requirements, diversions, preferred/maximum storage, and snowmelt management releases. The several sections of logic are illustrate and discussed below.

<u>Hetch Hetchy Release Demands / Reservoir Evaporation / Initial Storage Computation and Encroachment Release</u>

This section of logic assembles the underlying water demands placed for Hetchy Hetchy Reservoir releases. Reservoir inflow is derived from worksheet Hydrology and is the unimpaired flow entering the reservoir. The initial releases are comprised of the minimum flow requirement below Hetch Hetchy Reservoir (from the worksheet CCSF) and represent requirements prior to consideration of Canyon Tunnel flows, Mountain Tunnel flows that consist of diversions for the SJPL (from the worksheet CCSF), Moccasin Fish Hatchery releases and diversions by Groveland CSD from Mountain Tunnel.

This section also performs an initial check of reservoir storage assuming the previously described minimum releases for the river and Mountain Tunnel. A daily mass balance is performed: *change in reservoir storage = inflow, minus outflow (releases), minus reservoir losses*. The prior day’s reservoir evaporation is included in the calculation. If the computation produces resulting Hetch Hetchy Reservoir storage in excess (encroachment) of the preferred storage target, the encroachment is computed. Every 7th day the model checks for an encroachment, and if it exists a check release is computed. For the preferred reservoir storage target encroachment it is assumed that a constant supplemental release (in excess of minimum releases) will be initiated at a rate equal to the encroachment divided equally over the next 7 days. This protocol repeats itself every 7th day, reestablishing the level of check release each time. The end result of this procedure will allow encroachment of storage space above the preferred storage target and not require unrealistic hard releases of water to exactly conform to the target.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1			1		**Hetch Hetchy Reservoir Model**																	
2	*Unit Title*		2		CFS	AF		CFS	AF	CFS	AF	CFS	AF	AF								
3	*Parameter Title*		3		Hetch Het	Hetch Het		SJPL + Mo	SJPL + Mo	SJPL	SJPL	HH Req St	HH Req St	HH Net Evap								
4																						
5	*Acre-foot to CFS conversion*				*This scenario*								*<u>Base</u>*				*<u>Difference from Base</u>*					
6	*divide by :*	*1.983471*			*<u>Check Sums</u>*		*<u>Sum AF</u>*	*<u>39-ave</u>*		*<u>Other Sums</u>*		*<u>Sum AF</u>*		*<u>39-ave</u>*		*<u>Sum AF</u>*		*<u>39-ave</u>*		*<u>Sum AF</u>*		
7						*Inflow*	*29,761,289*	*763,110*			*Supplmtl*	*0*	*Inflow*	*763,110*	*Supplmtl*	*0*	*Inflow*	*0*	*Supplmtl*	*0*		
8						*Evap*	*149,655*	*3,837*					*Evap*	*3,837*			*Evap*	*0*				
9						*SJPL+*	*9,922,420*	*254,421*					*SJPL+*	*254,421*			*SJPL+*	*0*				
10						*Non-SJPL*	*19,655,587*	*503,989*					*Non-SJPL*	*503,989*			*Non-SJPL*	*0*				
11						*Net*	*33,627*															
12						*Chng Stor*	*33,627*															
13				*<u>39-year Ave</u>*		*763,110*			*254,421*		*231,238*			*3,837*								
14								32	*Moc Hatch + Groveland (CFS)*													
15					Inflow			Initial Releases						Evap/loss	Initial Storage Computation and Encroachment Release							
16					HH	HH		SJPL	SJPL			w/o 64	w/o 64		Initial	Target	Hard			Spread	Spread	
17	Month				Reservoir	Reservoir		+ Moc Hat	+ Moc Hat			Req	Req	Net Res	HH	HH	Limit	Initial	Encroach	Encroach	7th Day	
18	Index	Date	Day	Days	Inflow	Inflow		Grove	Grove	SJPL	SJPL	Blw HH	Blw HH	Evap/Loss	Storage	Storage	Storage	Encroach	7th Day	over 7	Enc over 7	7-day
19					CFS	AF		CFS	AF	CFS	AF	CFS	AF	AF	250,000	360,360	AF	AF	AF	AF	CFS	Count
20	1970.10	10/1/1970	T	31	79	157		341	677	309	614	60	119	11	249,349	359,381	360,360	0	0	0	0	1
21	1970.10	10/2/1970	F	31	-82	-163		341	677	309	614	60	119	11	248,379	358,401	360,360	0	0	0	0	0
22	1970.10	10/3/1970	S	31	25	50		341	677	309	614	60	119	11	247,622	357,422	360,360	0	0	0	0	0
23	1970.10	10/4/1970	S	31	110	218		341	677	309	614	60	119	11	247,032	356,443	360,360	0	0	0	0	0
24	1970.10	10/5/1970	M	31	-38	-75		341	677	309	614	60	119	11	246,150	355,463	360,360	0	0	0	0	0
25	1970.10	10/6/1970	T	31	9	18		341	677	309	614	60	119	11	245,360	354,484	360,360	0	0	0	0	0

Supplemental Releases and Final Reservoir and Release Computation

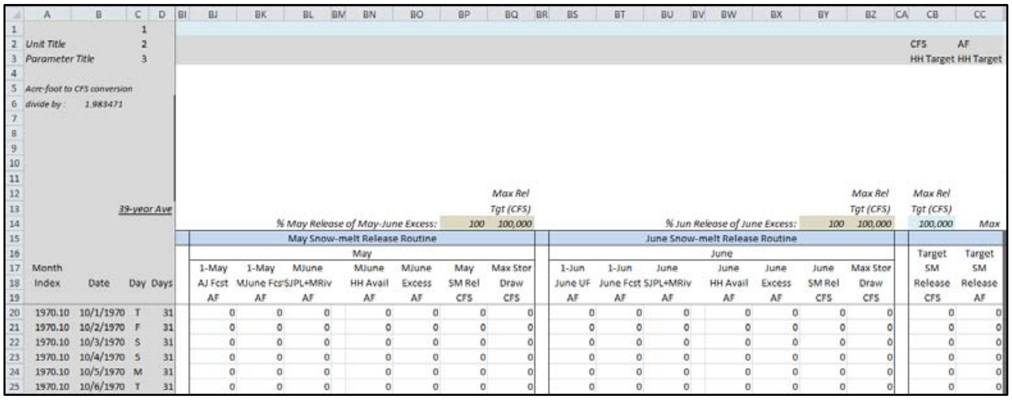
	A	B	C	D	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
1			1												
2	*Unit Title*		2			AF	CFS	AF	AF						CFS
3	*Parameter Title*		3			HH Supple	HH Releas	HH Releas	HH Storag						Total HH R
4															
5	*Acre-foot to CFS conversion*														
6	*divide by :*	*1.983471*													
7															
8															
9															
10															
11															
12															
13				*39-year Ave*				*503,989*							
14															
15					Final Release and Storage										
16							HH	HH		HH	Hetch Hetchy Reservoir Loss Calculation				HH
17	Month				Supplmtl	Supplmtl	Release	Release	HH	Storage	Area	Factor	CFS	AF	Total
18	Index	Date	Day	Days	Release	Release	abv Mnt	abv Mnt	Storage	Change					Release
19					CFS	AF	CFS	AF	250,000	AF					CFS
20	1970.10	10/1/1970	T	31	0	0	60	119	249,349	-651	1,722	0.003253	5.6	11.1	401
21	1970.10	10/2/1970	F	31	0	0	60	119	248,379	-970	1,721	0.003253	5.6	11.1	401
22	1970.10	10/3/1970	S	31	0	0	60	119	247,622	-758	1,718	0.003253	5.6	11.1	401
23	1970.10	10/4/1970	S	31	0	0	60	119	247,032	-589	1,716	0.003253	5.6	11.1	401
24	1970.10	10/5/1970	M	31	0	0	60	119	246,150	-883	1,714	0.003253	5.6	11.1	401
25	1970.10	10/6/1970	T	31	0	0	60	119	245,360	-789	1,711	0.003253	5.6	11.0	401

This section of logic performs the final computation of reservoir storage and releases. Incorporated into the logic is inclusion of user specified supplemental releases (from WaterBankRel or SFWaterBank worksheets) and snowmelt management releases (described later). Reservoir losses are computed in accordance with procedures of the Fourth Agreement.

Snow-melt Management

A second check release is made during the February through June period for management of anticipated snowmelt runoff. On the first day of each of these months a forecast is made of anticipated runoff into the reservoir and minimum releases and losses from the reservoir, from the date of forecast through the end of June (assumed target of reservoir filling). These forecasts determine the volume of water (if any) that will require release in excess of minimum releases and losses and storage gain by the end of June.

	A	B	C	D	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH
1			1																											
2	*Unit Title*		2																											
3	*Parameter Title*		3																											
4																														
5	*Acre-foot to CFS conversion*																													
6	*divide by :*	*1.983471*																												
7																														
8																														
9																														
10																														
11																														
12										*June Storage Target (AF):*	*360,360*	*Max Rel*									*Max Rel*									*Max Rel*
13				*39-year Ave*						*Minimum HH Storage for SM Drawdown (AF):*	*100,000*	*Tgt (CFS)*									*Tgt (CFS)*									*Tgt (CFS)*
14										*% Feb Release of Feb-June Excess:*	*10*	*1,200*							*% Mar Release of Mar-June Excess:*	*10*	*1,150*							*% Apr Release of Apr-June Excess:*	*10*	*1,200*
15					February Snow-melt Release Routine									March Snow-melt Release Routine									April Snow-melt Release Routine							
16					February									March									April							
17	Month				1-Feb	1-Feb	FJune		FJune	FJune	Feb	Max Stor		1-Mar	1-Mar	MJune		MJune	MJune	March	Max Stor		1-Apr	1-Apr	AJune		AJune	AJune	April	Max Stor
18	Index	Date	Day	Days	AJ Fcst	FJune Fcst	SJPL+MRiv		HH Avail	Excess	SM Rel	Draw		AJ Fcst	MJune Fcs	SJPL+MRiv		HH Avail	Excess	SM Rel	Draw		AJ Fcst	AJune Fcst	SJPL+MRiv		HH Avail	Excess	SM Rel	Draw
19					AF	AF	AF		AF	AF	CFS	CFS		AF	AF	AF		AF	AF	CFS	CFS		AF	AF	AF		AF	AF	CFS	CFS
20	1970.10	10/1/1970	T	31	0	0	0		0	0	0	0		0	0	0		0	0	0	0		0	0	0		0	0	0	0
21	1970.10	10/2/1970	F	31	0	0	0		0	0	0	0		0	0	0		0	0	0	0		0	0	0		0	0	0	0
22	1970.10	10/3/1970	S	31	0	0	0		0	0	0	0		0	0	0		0	0	0	0		0	0	0		0	0	0	0
23	1970.10	10/4/1970	S	31	0	0	0		0	0	0	0		0	0	0		0	0	0	0		0	0	0		0	0	0	0
24	1970.10	10/5/1970	M	31	0	0	0		0	0	0	0		0	0	0		0	0	0	0		0	0	0		0	0	0	0
25	1970.10	10/6/1970	T	31	0	0	0		0	0	0	0		0	0	0		0	0	0	0		0	0	0		0	0	0	0



Unit Title 2
Parameter Title 3
Acre-foot to CFS conversion
divide by : 1.983471
39-year Ave
% May Release of May-June Excess: 100 Max Rel Tgt (CFS) 100,000
% Jun Release of June Excess: 100 Max Rel Tgt (CFS) 100,000
Max Rel Tgt (CFS) 100,000 Max
CFS HH Target / AF HH Target

				May Snow-melt Release Routine (May)							June Snow-melt Release Routine (June)								
Month Index	Date	Day	Days	1-May AJ Fcst AF	1-May MJune Fcst AF	MJune SJPL+MRiv AF	MJune HH Avail AF	MJune Excess AF	May SM Rel CFS	Max Stor Draw CFS	1-Jun June UF AF	1-Jun June Fcst AF	June SJPL+MRiv AF	June HH Avail AF	June Excess AF	June SM Rel CFS	Max Stor Draw CFS	Target SM Release CFS	Target SM Release AF
1970.10	10/1/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/2/1970	F	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/3/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/4/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/5/1970	M	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/6/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Pre-knowledge is used for anticipated runoff, minimum releases and losses. The user defines the percentage of volume (of the total volume for the period) to be additionally released during each month. For February through April, 10 percent of the additional release volume is advised for release, and may be additionally capped. This approach tends to hold Hetch Hetchy Reservoir releases for later release during May. The snowmelt check release is evenly distributed across the days of the month and can be capped in terms of rate (cfs) or minimum volume of the reservoir to which it can be drawn during the month. The particular release made in a day is the greater of the two check releases or the minimum release. At no time is the maximum capacity of the reservoir allowed to be exceeded, and if necessary a release, regardless of magnitude, will be made by the model to not exceed maximum storage capacity.

5.13 SFLloyd Worksheet

This Model component worksheet (SFLloyd) simulates the operation of Lake Lloyd. Several sections of logic provide a systematic operation of the reservoir based on inflow and forecasted hydrology and water demands. The Model will direct releases from Lake Lloyd under a “hold-unless-need-to-release” protocol, except as conditioned by minimum release requirements, diversions, preferred/maximum storage, snowmelt management releases and target releases for Holm Powerhouse. The several sections of logic are illustrate and discussed below.

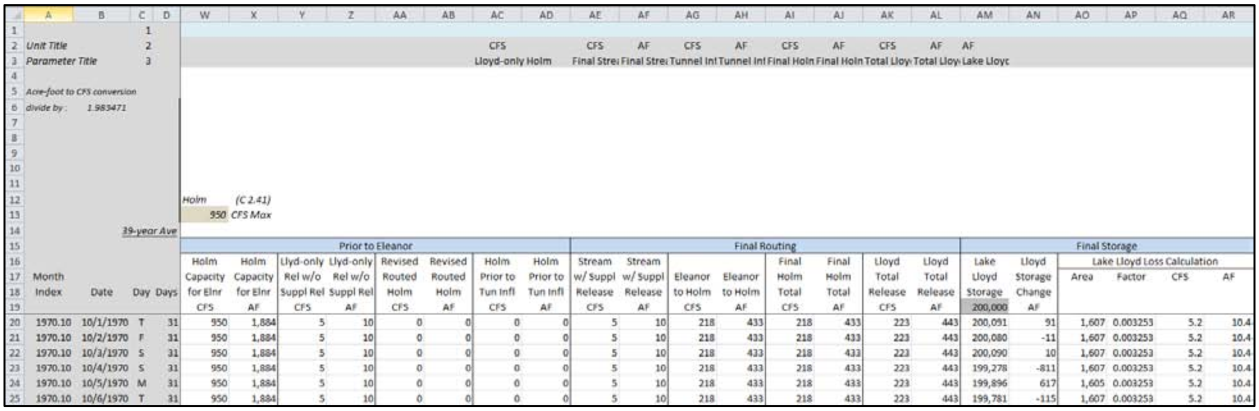
Lake Lloyd Release Demands, Initial Storage Computation and Encroachment Release

This section of logic assembles the underlying water demands placed for Lake Lloyd releases. Reservoir inflow is derived from the Hydrology worksheet and is the unimpaired flow entering the reservoir. The initial releases are comprised of the minimum flow requirement below Lake Lloyd (from worksheet CCSF) and target releases for Holm Powerhouse (from worksheet CCSF).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1			1		Lake Lloyd Model																
2	Unit Title		2		CFS	AF	CFS	AF		AF	CFS	AF		AF		AF	AF				
3	Parameter Title		3		Lake Lloyc	Lake Lloyc	Min Holm Ti	Min Holm		Suppleme	Lloyd Req	Lloyd Req		Lloyd Net Evap		Lloyd Targe	Lloyd Limi				
4																					
5	Acre-foot to CFS conversion				This scenario								Base				Difference from Base				
6	divide by :	1.983471			Check Sums		Sum AF	39-ave		Other Sums		Sum AF		39-ave		Sum AF		39-ave		Sum AF	
7						Inflow	11,743,646	301,119			Supplmtl	171,708	Inflow	301,119	Supplmtl	171,708	Inflow	0	Supplmtl	0	
8						Tun Inflow	3,196,266	81,956					Tun Inflow	81,956			Tun Inflow	0			
9						Evap	136,660	3,504					Evap	3,504			Evap	0			
10						Stream	1,298,823	33,303					Stream	33,303			Stream	0			
11						Holm	13,454,734	344,993					Holm	344,993			Holm	0			
12						Net	49,694														
13						Chng Stor	49,694														
14				39-year Ave		301,119		38,628		4,403		5,538		3,504							
15					Inflow		Initial Release			Suppl	Initial Release			Evap/loss	Initial Storage and Encroachment Release						
16					Lake	Lake	Min	Min		171,708	Stream	Stream			Initial	Lloyd				Spread	Spread
17	Month				Lloyd	Lloyd	Holm	Holm		Supplmtl	Req	Req		Net Res	Lloyd	Target	Limit	Initial	Encroach	Encroach	7th Day
18	Index	Date	Day	Days	Inflow	Inflow	Target	Target		Release	Blw Lloyd	Blw Lloyd		Evap/Loss	Storage	Storage	Storage	Encroach	7th Day	over 7	Enc over 7
19					CFS	AF	CFS	AF		AF	CFS	AF		AF	200,000	200,000	AF	AF	AF	AF	CFS
20	1970.10	10/1/1970	T	31	56	111	0	0		0	5	10		10	200,091	248,000	273,300	0	0	0	0
21	1970.10	10/2/1970	F	31	5	10	0	0		0	5	10		10	200,080	248,000	273,300	0	0	0	0
22	1970.10	10/3/1970	S	31	15	30	0	0		0	5	10		10	200,090	248,000	273,300	0	0	0	0
23	1970.10	10/4/1970	S	31	-399	-791	0	0		0	5	10		10	199,278	248,000	273,300	0	0	0	0
24	1970.10	10/5/1970	M	31	322	638	0	0		0	5	10		10	199,896	248,000	273,300	0	0	0	0
25	1970.10	10/6/1970	T	31	-48	-94	0	0		0	5	10		10	199,781	248,000	273,300	0	0	0	0

This section also performs an initial check of reservoir storage assuming the previously described minimum releases for the river and Holm Powerhouse. A daily mass balance is performed: *change in reservoir storage = inflow, minus outflow (releases), minus reservoir losses*. The prior day’s reservoir evaporation is included in the calculation. If the computation produces resulting Lake Lloyd storage in excess (encroachment) of the preferred storage target, the encroachment is computed. Every 7^{th} day the model checks for an encroachment, and if it exists a check release is computed. It is assumed that a constant supplemental release (in excess of minimum releases) will be initiated at a rate equal to the encroachment divided equally over the next 7 days. This protocol repeats itself every 7^{th} day, reestablishing the level of check release each time. The end result of this procedure will allow encroachment of storage space above the preferred storage target and not require unrealistic hard releases of water to exactly conform to the target. User specified supplemental releases are reported in this section but are not incorporated into the worksheet’s logic until later.

Supplemental Releases, Lake Eleanor Transfers and Final Reservoir and Release Computation



	A	B	C	D	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR
1			1																							
2	Unit Title		2								CFS		CFS	AF	CFS	AF	CFS	AF	CFS	AF	AF					
3	Parameter Title		3								Lloyd-only Holm		Final Stre	Final Stre	Tunnel Inf	Tunnel Inf	Final Holn	Final Holn	Total Lloy	Total Lloy	Lake Lloyc					
4																										
5	Acre-foot to CFS conversion																									
6	divide by :	1.983471																								
7																										
8																										
9																										
10																										
11																										
12					Holm	(C 2.41)																				
13					950	CFS Max																				
14				39-year Ave																						
15					Prior to Eleanor								Final Routing								Final Storage					
16					Holm	Holm	Llyd-only	Llyd-only	Revised	Revised	Holm	Holm	Stream	Stream			Final	Final	Lloyd	Lloyd	Lake	Lloyd	Lake Lloyd Loss Calculation			
17	Month				Capacity	Capacity	Rel w/o	Rel w/o	Routed	Routed	Prior to	Prior to	w/ Suppl	w/ Suppl	Eleanor	Eleanor	Holm	Holm	Total	Total	Lloyd	Storage	Area	Factor	CFS	AF
18	Index	Date	Day	Days	for Elnr	for Elnr	Suppl Rel	Suppl Rel	Holm	Holm	Tun Infl	Tun Infl	Release	Release	to Holm	to Holm	Total	Total	Release	Release	Storage	Change				
19					CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	200,000	AF				
20	1970.10	10/1/1970	T	31	950	1,884	5	10	0	0	0	0	5	10	218	433	218	433	223	443	200,091	91	1,607	0.003253	5.2	10.4
21	1970.10	10/2/1970	F	31	950	1,884	5	10	0	0	0	0	5	10	218	433	218	433	223	443	200,080	-11	1,607	0.003253	5.2	10.4
22	1970.10	10/3/1970	S	31	950	1,884	5	10	0	0	0	0	5	10	218	433	218	433	223	443	200,090	10	1,607	0.003253	5.2	10.4
23	1970.10	10/4/1970	S	31	950	1,884	5	10	0	0	0	0	5	10	218	433	218	433	223	443	199,278	-811	1,607	0.003253	5.2	10.4
24	1970.10	10/5/1970	M	31	950	1,884	5	10	0	0	0	0	5	10	218	433	218	433	223	443	199,896	617	1,605	0.003253	5.2	10.4
25	1970.10	10/6/1970	T	31	950	1,884	5	10	0	0	0	0	5	10	218	433	218	433	223	443	199,781	-115	1,607	0.003253	5.2	10.4

This section of logic performs the final computation of reservoir storage and releases, including consideration of snowmelt management releases (described later) and transfers from Lake Eleanor. Both the initial check release for preferred storage encroachment and the snowmelt check release are computed and advised for reservoir operations. If supplemental releases above minimum releases are computed the Model routes the additional release through Holm Powerhouse up to its available capacity. The remainder of the supplemental release is routed to the stream below Lake Lloyd. A comparison is made between "Lloyd-only" use of Holm Powerhouse capacity and maximum capacity for passage to the Lake Eleanor model component.

The operation goal linkage between Lake Lloyd and Lake Eleanor assumes that Lake Eleanor will transfer water from its watershed to Lake Lloyd for the purpose of enhancing power generation at Holm Powerhouse. Thus, any available capacity at Holm Powerhouse after the Lloyd-only operation is assumed available and desired for use of a Lake Eleanor transfer. If water is transferred from Lake Eleanor the Model assumes the water to be directly routed to Holm Powerhouse which then becomes additional release from Lake Lloyd.

Also incorporated into the logic is inclusion of user specified supplemental releases (from the WaterBankRel or SFWaterBank worksheets). Supplemental releases are added to any other release established for Lake Lloyd. Reservoir losses are compute in accordance with procedures of the Fourth Agreement.

Snow-melt Management

Unit Title 2
Parameter Title 3

Acre-foot to CFS conversion
divide by : 1.983471

June Storage Target (AF): 273,300
Minimum HH Storage for SM Drawdown (AF): 100,000

	Max Rel Tgt (CFS)
% Feb Release of Feb-June Excess: 20	1,000
% Mar Release of Mar-June Excess: 25	1,000
% Apr Release of Apr-June Excess: 33	1,000

39-year Ave

Month Index	Date	Day	Days	February Snow-melt Release Routine: 1-Feb AJ Fcst AF	1-Feb FJune Fcst AF	FJune Riv+Trg Holm AF	FJune Ch Avail AF	FJune Excess AF	Feb SM Rel CFS	Max Stor Draw CFS	March Snow-melt Release Routine: 1-Mar AJ Fcst AF	1-Mar MJune Fcst AF	MJune Riv+Trg Holm AF	MJune Ch Avail AF	MJune Excess AF	March SM Rel CFS	Max Stor Draw CFS	April Snow-melt Release Routine: 1-Apr AJ Fcst AF	1-Apr AJune Fcst AF	AJune Riv+Trg Holm AF	AJune Ch Avail AF	AJune Excess AF	April SM Rel CFS	Max Stor Draw CFS
1970.10	10/1/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/2/1970	F	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/3/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/4/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/5/1970	M	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/6/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Unit Title 2 — CFS / AF
Parameter Title 3 — Lloyd Targ / Lloyd Targ

Acre-foot to CFS conversion
divide by : 1.983471

	Max Rel Tgt (CFS)
% May Rleose of Ma y-June Excess: 50	1,000
% Jun Release of June Excess: 100	1,000
	1,000 Max

39-year Ave

Month Index	Date	Day	Days	May Snow-melt Release Routine: 1-May AJ Fcst AF	1-May MJune Fcst AF	MJune Riv+Trg Holm AF	MJune Ch Avail AF	MJune Excess AF	May SM Rel CFS	Max Stor Draw CFS	June Snow-melt Release Routine: 1-Jun June UF AF	1-Jun June Fcst AF	June Riv+Trg Holm AF	June Ch Avail AF	June Excess AF	June SM Rel CFS	Max Stor Draw CFS	Target SM Release CFS	Target SM Release AF
1970.10	10/1/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/2/1970	F	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/3/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/4/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/5/1970	M	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/6/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

A second check release is made during the February through June period for management of anticipated snowmelt runoff. On the first day of each of these months a forecast is made of anticipated runoff into the reservoir and minimum releases and losses from the reservoir, from the date of forecast through the end of June (assumed target of reservoir filling). These forecasts determine the volume of water (if any) that will require release in excess of minimum releases and losses and storage gain by the end of June. Pre-knowledge is used for anticipated runoff, minimum releases and losses. The user defines the percentage of volume (of the total volume for the period) to be additionally released during each month. For February through May, a varying percentage of the additional release volume is advised for release, and is capped in rate as a means to confine releases within the capacity of Holm Powerhouse. The snowmelt check release is evenly distributed across the days of the month. The release can also be capped in terms of minimum volume of the reservoir to which it can be drawn during the month.

5.14 SFEleanor Worksheet

This Model component worksheet (SFEleanor) simulates the operation of Lake Eleanor. Several sections of logic provide a systematic operation of the reservoir based on inflow and forecasted hydrology and water demands. The Model will direct releases from Lake Eleanor under a "hold-unless-need-to-release" protocol, except as conditioned by minimum release requirements, diversions, preferred/maximum storage, snowmelt management releases. When advised releases exceed the minimum Model logic attempts to transfer water to Lake Lloyd. The several sections of logic are illustrated and discussed below.

Lake Eleanor Release Demands, Initial Storage Computation and Encroachment Release

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1			1		**Lake Eleanor Model**																	
2	*Unit Title*		2		CFS	AF					CFS	AF				AF	AF					
3	*Parameter Title*		3		Lake Elear	Lake Eleanor Inflow					Eleanor R	Eleanor Req Stream Rel				Eleanor T	Eleanor Limit Storage					
4																						
5	*Acre-foot to CFS conversion*				*This scenario*								*Base*				*Difference from Base*					
6	*divide by :*	*1.983471*			*Check Sums*		*Sum AF*	*39-ave*		*Other Sums*		*39-yr Ave*		*39-ave*		*39-yr Ave*		*39-ave*			*39-yr Ave*	
7						*Inflow*	*7,276,607*	*186,580*			*Tunnel*	*81,956*	*Inflow*	*186,580*	*Tunnel*	*81,956*	*Inflow*	*0*	*Tunnel*		*0*	
8						*Evap*	*72,708*	*1,864*					*Evap*	*1,864*			*Evap*	*0*				
9						*Tun Out*	*3,196,266*	*81,956*					*Tun Out*	*81,956*			*Tun Out*	*0*				
10						*Stream*	*4,008,460*	*102,781*					*Stream*	*102,781*			*Stream*	*0*				
11						*Net*	*-826*															
12						*Chng Stor*	*-826*															
13																						
14				*39-year Ave*		*186,580*						*9,087*		*1,864*								
15					Inflow						Initial Release			Evap/loss	Initial Storage and Encroachment Release							
16					Lake	Lake					Stream	Stream			Initial	Eleanor	Hard			Spread	Spread	
17	Month				Eleanor	Eleanor					Req	Req		Net Res	Eleanor	Target	Limit	Initial	Encroach	Encroach	7th Day	
18	Index	Date	Day	Days	Inflow	Inflow					Bl Eleanor	Bl Eleanor		Evap/Loss	Storage	Storage	Storage	Encroach	7th Day	over 7	Enc over 7	7-day
19					CFS	AF					CFS	AF		AF	18,000	AF	AF	AF	AF	AF	CFS	Count
20	1970.10	10/1/1970	T	31	25	50					10	20		6	18,030	15,000	27,100	3,030	3,030	433	218	1
21	1970.10	10/2/1970	F	31	2	4					10	20		6	17,576	15,000	27,100	2,576	3,030	433	218	0
22	1970.10	10/3/1970	S	31	7	14					10	20		6	17,131	15,000	27,100	2,131	3,030	433	218	0
23	1970.10	10/4/1970	S	31	-179	-355					10	20		6	16,317	15,000	27,100	1,317	3,030	433	218	0
24	1970.10	10/5/1970	M	31	144	287					10	20		6	16,145	15,000	27,100	1,145	3,030	433	218	0
25	1970.10	10/6/1970	T	31	-21	-42					10	20		6	15,644	15,000	27,100	644	3,030	433	218	0

This section of logic assembles the underlying water demands placed for Lake Eleanor releases. Reservoir inflow is derived from the Hydrology worksheet and is the unimpaired flow entering the reservoir. The initial releases are comprised of the minimum flow requirement below Lake Eleanor (from the CCSF worksheet). An initial check of reservoir storage occurs assuming the minimum releases for the river. A daily mass balance is performed: *change in reservoir storage = inflow, minus outflow (releases), minus reservoir losses*. The prior day's reservoir evaporation is included in the calculation. If the computation produces resulting Lake Eleanor storage in excess (encroachment) of the preferred storage target, the encroachment is computed. Every 7th day the model checks for an encroachment, and if it exists a check release is computed. For the preferred reservoir storage target encroachment it is assumed that a constant supplemental release (in excess of minimum releases) will be initiated at a rate equal to the encroachment divided equally over the next 7 days. This protocol repeats itself every 7th day, reestablishing the level of check release each time. The end result of this procedure will allow encroachment of storage space above the preferred storage target and not require unrealistic hard releases of water to exactly conform to the target.

<u>Lake Eleanor Transfers and Final Reservoir and Release Computation</u>

	A	B	C	D	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR
1			1																							
2	Unit Title		2						CFS	AF	CFS	AF					CFS	AF	CFS	AF	AF					
3	Parameter Title		3						Tunnel	Tunnel	Eleanor St	Eleanor Stream Release					Tun Trans	Tun Trans	Total Elea	Total Elea	Lake Eleanor Storage					
4																										
5	Acre-foot to CFS conversion																									
6	divide by :	1.983471																								
7																										
8																										
9																										
10																										
11														Tunnel Capacity (C 2.81)												
12															400	CFS Max										
13																										
14				39-year Ave						81,956		102,781								184,737						
15												Revised and Final Routing												Final Storage		
16					Revised	Revised	Excess	Excess	Put	Put			Avail	Avail	Limit by	Limit by			Total	Total	Revised	Eleanor		Lake Eleanor Loss Calculation		
17	Month				Stream	Stream	abv Min	abv Min	to	to	Final	Final	Holm Cap	Holm Cap	Tunnel	Tunnel	Transfer	Transfer	Eleanor	Eleanor	Eleanor	Storage	Area	Factor		
18	Index	Date	Day	Days	Release	Release	Stream	Stream	Tunnel	Tunnel	Stream	Stream	for El	for El	Available	Available	Capacity	Capacity	Release	Release	Storage	Change				
19					CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	18,000	AF	Acres		CFS	AF
20	1970.10	10/1/1970	T	31	228	453	218	433	218	433	10	20	950	1,884	400	793	400	793	228	453	17,591	-409	896	0.003253	2.9	5.8
21	1970.10	10/2/1970	F	31	228	453	218	433	218	433	10	20	950	1,884	400	793	400	793	228	453	17,137	-454	893	0.003253	2.9	5.8
22	1970.10	10/3/1970	S	31	228	453	218	433	218	433	10	20	950	1,884	400	793	400	793	228	453	16,692	-445	890	0.003253	2.9	5.7
23	1970.10	10/4/1970	S	31	228	453	218	433	218	433	10	20	950	1,884	400	793	400	793	228	453	15,878	-814	885	0.003253	2.9	5.7
24	1970.10	10/5/1970	M	31	228	453	218	433	218	433	10	20	950	1,884	400	793	400	793	228	453	15,707	-172	876	0.003253	2.8	5.7
25	1970.10	10/6/1970	T	31	228	453	218	433	218	433	10	20	950	1,884	400	793	400	793	228	453	15,206	-501	874	0.003253	2.8	5.6

This section of logic performs the final computation of reservoir storage and releases, including consideration of snowmelt management releases (described later) and transfers from Lake Eleanor to Lake Lloyd.

Both the initial check release for preferred storage encroachment and the snowmelt check release are computed and advised for reservoir operations. If excess releases above minimum releases are computed the Model routes the additional release through the tunnel up to the limit of its available capacity or the capacity available at Holm Powerhouse. The remainder of the supplemental release is routed to the stream below Lake Eleanor. The Lake Eleanor operation protocol will transfer water that would otherwise be released in excess of minimum flow requirements (largely dependent upon the preferred target storage and snowmelt releases) but it will not allow water to be “pulled” from Lake Eleanor to Lake Lloyd.

The operation goal linkage between Lake Lloyd and Lake Eleanor assumes that Lake Eleanor will transfer water from its watershed to Lake Lloyd for the purpose of enhancing power generation at Holm Powerhouse. Thus, any available capacity at Holm Powerhouse <u>after</u> the Lloyd-only operation is assumed available and desired for use of a Lake Eleanor transfer. If water is transferred from Lake Eleanor the model assumes the water to be directly routed to Holm Powerhouse which then becomes additional release from Lake Lloyd. Reservoir losses are computed in accordance with procedures of the Fourth Agreement.

Snow-melt Management

	A	B	C	D	AS	AT	AU	AW	AX	AY	AZ	BB	BC	BD	BF	BG	BH	BI	BK	BL	BM	BO	BP	BQ	BR
1			1																						
2	*Unit Title*		2																						
3	*Parameter Title*		3																						
5	*Acre-foot to CFS conversion*																								
6	*divide by :*	*1.983471*																							
12									*June Storage Target (AF):*	*27,100*	*Max Rel*							*Max Rel*							*Max Rel*
13									*Minimum Eleanor Storage for SM Drawdown (AF):*	*1,000*	*Tgt (CFS)*							*Tgt (CFS)*							*Tgt (CFS)*
14				*39-year Ave*					*% Feb Release of Feb-June Excess:*	*20*	*2,000*					*% Mar Release of Mar-June Excess:*	*25*	*2,000*					*% Apr Release of Apr-June Excess:*	*33*	*2,000*
15					February Snow-melt Release Routine							March Snow-melt Release Routine							April Snow-melt Release Routine						
16					February							March							April						
17	Month				1-Feb	1-Feb	FJune	FJune	FJune	Feb	Max Stor	1-Mar	1-Mar	MJune	MJune	MJune	March	Max Stor	1-Apr	1-Apr	AJune	AJune	AJune	April	Max Stor
18	Index	Date	Day	Days	AJ Fcst	FJune Fcst	MinRiv+Tun	El Avail St	Excess	SM Rel	Draw	AJ Fcst	MJune Fcst	MinRiv+Evap	El Avail St	Excess	SM Rel	Draw	AJ Fcst	AJune Fcst	MinRiv+Evap	El Avail St	Excess	SM Rel	Draw
19					AF	AF	AF	AF	AF	CFS	CFS	AF	AF	AF	AF	AF	CFS	CFS	AF	AF	AF	AF	AF	CFS	CFS
20	1970.10	10/1/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	1970.10	10/2/1970	F	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	1970.10	10/3/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	1970.10	10/4/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	1970.10	10/5/1970	M	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	1970.10	10/6/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	A	B	C	D	BT	BU	BV	BX	BY	BZ	CA	CC	CD	CE	CG	CH	CI	CJ	CL	CM
1			1																	
2	*Unit Title*		2																	
3	*Parameter Title*		3																	
5	*Acre-foot to CFS conversion*																			
6	*divide by :*	*1.983471*																		
9																			*Max*	
10																			*1,385*	
12											*Max Rel*							*Max Rel*	*Max Rel*	
13											*Tgt (CFS)*							*Tgt (CFS)*	*Tgt (CFS)*	
14				*39-year Ave*					*% May Rlease of Ma y-June Excess:*	*70*	*2,000*					*% Jun Release of June Excess:*	*100*	*2,000*	*2,000*	*Max*
15					May Snow-melt Release Routine							June Snow-melt Release Routine								
16					May							June							Target	Target
17	Month				1-May	1-May	MJune	MJune	MJune	May	Max Stor	1-Jun	1-Jun	June	June	June	June	Max Stor	SM	SM
18	Index	Date	Day	Days	AJ Fcst	MJune Fcst	MinRiv+Evap	El Avail St	Excess	SM Rel	Draw	June UF	June Fcst	MinRiv+Evap	Ch Avail	Excess	SM Rel	Draw	Release	Release
19					AF	AF	AF	AF	AF	CFS	CFS	AF	AF	AF	AF	AF	CFS	CFS	CFS	AF
20	1970.10	10/1/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	1970.10	10/2/1970	F	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	1970.10	10/3/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	1970.10	10/4/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	1970.10	10/5/1970	M	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	1970.10	10/6/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

A second check release is made during the February through June period for management of anticipated snowmelt runoff. On the first day of each of these months a forecast is made of anticipated runoff into the reservoir and minimum releases and losses from the reservoir, from the date of forecast through the end of June (assumed target of reservoir filling). These forecasts determine the volume of water (if any) that will require release in excess of minimum releases and losses and storage gain by the end of June. Pre-knowledge is used for anticipated runoff, minimum releases and losses. The user defines the percentage of volume (of the total volume for the period) to be additionally released during each month. For February through May, a varying percentage of the additional release volume is advised for release. The snowmelt check release is evenly distributed across the days of the month. The release can also be capped in terms of minimum volume of the reservoir to which it can be drawn during the month.

5.15 SFWaterBank Workheet

This worksheet (SFWaterBank) provides for entry of daily supplemental releases from the CCSF System. The worksheet is comparable to worksheet WaterBankRel except that this worksheet provides alternative methods of identifying supplemental releases (UI 3.10 = 0). Employing this option, the user can identify year type table-based supplemental flow, without or without addition of the pre-processed Test Case supplemental release.

Without any other manual intervention the Model will direct releases from the CCSF System under a “hold-unless-need-to-release” protocol. Additional releases greater than provided by the default protocol may be needed. An example of such a need is during periods when CCSF System operations would otherwise deplete the Water Bank Account to a point of a “negative” balance.

The manual adjustment to releases from the CCSF System is provided to allow the user to “pull” additional water from the CCSF System as supplemental inflow to Don Pedro Reservoir. An entry of supplemental release is established that will first pull water from Lake Lloyd so that water supply is preserved in the Hetch Hetchy Reservoir system for diversion to the SJPL. At a point when such supplemental releases strain Lake Lloyd storage, the supplemental releases are directed to Hetch Hetchy Reservoir. The supplemental release is directed from a reservoir at a point in logic after the default protocol releases occur. Thus, the release occurs in addition to what operation is already occurring by default. Such a release can affect the following day’s default operation or previous periods’ operations, thus results require review to determine if the user’s desired result occurs.

<u>SF Water Bank Account Balance Accounting, CCSF La Grange Flow Responsibility and Test Case Supplemental Releases</u>

Shown below is a snapshot of the worksheet. The worksheet provides the daily accounting of the Water Bank Account Balance for the Model. Information ported from other worksheets of the Model into this worksheet is Don Pedro Reservoir inflow (Column E) and the unimpaired flow at La Grange (Column F). These data and the protocols associated with Fourth Agreement Water Bank Account Balance accounting (Columns G through Column O) derive the daily credit or debit of CCSF and then the daily balance of the Water Bank Account (Column M).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1			1		San Francisco Water Bank Account Credit Computation															SF Water Bank Release - Base				
2	Unit Title		2		CFS	CFS	CFS	CFS	CFS				AF		AF					AF				
3	Parameter Title		3		DP Inflow	La Grange	District Ra	Districts' E	SF Credit/Debit				SF Water Bank Balan	Max Water Bank Capacity						Water Bank Release				
4																	Advice							
5	Acre-foot to CFS conversion				From	From																		
6	divide by :	1.983471			DonPedro	Hydrology		Warnings																
7																								
8																								
9																	(UI 1.31)			(UI 3.10)	No, this method is not being used			
10																	0			1	Min Lloyd Storage			
11																	(0) N, (1) Y				WB Call (CCSF 3.00)			
12																	- Debit				(acre-feet)			
13												Max	740,000				+ Credit				45,000			
14												Min	0			Sum:	0		Sum:	171,708	171,708	0		
15					SF Water Bank Account Balance Calculation												La Grange			Direct Entry Only				
16							Fourth	Daily	SF	SF C/D	SF Gross	SF WB	SF Net	SF Share	SF Max		Credit Adj			WB	1st Call	2nd Call		
17	Month				DP	La Grange	Agree	Districts'	Credit/	w/	WB	Evap	WB	RFlood	WB	WB	in SF			Supp	Lloyd	HH		
18	Index	Date	Day	Days	Inflow	UF	Check	Entitle	Debit	Credit Adj	Balance	Losses	Balance	DP	Balance	Neg Flag	WB	Mark	Mark	Release	Release	Release		
19					CFS	CFS	CFS	CFS	CFS	AF	AF	AF	570,000	AF	AF	AF	AF			AF	AF	AF		
20	1970.10	10/1/1970	T	31	322	159	2,416	159	163	324	570,324	48	570,000	0	570,000	0	0			0	0	0		
21	1970.10	10/2/1970	F	31	453	55	2,416	55	398	790	570,790	48	570,000	0	570,000	0	0			0	0	0		
22	1970.10	10/3/1970	S	31	541	265	2,416	265	276	548	570,548	48	570,000	0	570,000	0	0			0	0	0		
23	1970.10	10/4/1970	S	31	625	-166	2,416	-166	791	1,569	571,569	48	570,000	0	570,000	0	0			0	0	0		
24	1970.10	10/5/1970	M	31	75	180	2,416	180	-105	-208	569,792	48	569,744	0	570,000	0	0			0	0	0		
25	1970.10	10/6/1970	T	31	475	92	2,416	92	383	760	570,504	48	570,000	0	570,000	0	0			0	0	0		

For purposes of the FERC investigation, the protocols of Fourth Agreement Water Bank Accounting have been amended to incorporate a hypothetical implementation of “shared responsibility” for incremental increases in FERC-required flows for the Tuolumne River.[4] If running the scenario with shared responsibility has been selected (worksheet UserInput Switch UI 1.31 = 1), the incremental increase in FERC-required flows is determined by the daily difference between the current 1995 FERC Settlement requirements and scenario-required minimum flows. This computation occurs in worksheet LaGrangeSchedule with information regarding the scenario-required flows directed through worksheet UserInput. Approximately fifty-two percent (51.7121%) of the incremental difference between the flow schedules is assigned as CCSF’s responsibility and is ported into the worksheet in Column Q as a “debit”. This debit then enters the current protocols of Fourth Agreement Water Bank Accounting at Column J, and subsequently contributes to the determination of the daily Water Bank Account Balance (Column M).

Water Bank Account Balances which are less than zero (“negative”) are highlighted, and the minimum balance, whether negative or positive, is reported in Cell M14. By default, the base supplemental releases to maintain a positive Water Bank Account Balance at or above zero have been entered into Column T (WB Supplemental Release). An alternative time series can be used. The Model will first direct the supplemental release to Lake Lloyd, and continue releases until storage at Lake Lloyd is drawn to a specified 45,000 acre-feet minimum level (shown in Cell Q10 and entered at worksheet CCSF Switch 3.00). Subsequent supplemental releases will be drawn from Hetch Hetchy Reservoir any time storage is less than the Lake Lloyd minimum.

<u>User Specified Table of Supplemental Releases and Reservoir Status Computation</u>

The snapshot below illustrates the section of logic that incorporates a user Specified table of supplemental releases (UI 3.40) into the Model. A daily time series (Column Y) of supplemental releases is developed from the user specified table in worksheet UserInput. By selection, the user identifies whether or not the year type table-based supplemental release is added the preprocessed Test Case supplemental releases (Column T previously described). The Model then uses the selected supplemental release in its computation of operations.

	A	B	C	D	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI
1			1		User-defined SF Upstream Supplemental Release										
2	*Unit Title*		2							AF					
3	*Parameter Title*		3							Total SF Suppl Release					
4															
5	*Acre-foot to CFS conversion*														
6	*divide by :*	*1.983471*								*(UI 3.10)*	1	No, this method is not being used			
7					*2,704,000*	*2,875,708*	*2,875,708*	*0*							
8						Add Base									
9						Supp				Final Supplimental Release from Other Method					
10						1	N/A			0	*(UI 3.20)*				
11						*(0) no*	*(UI 3.30)*			*(0) Base*			Min	Min	Min
12						*(1) yes*				*(1) User-defined*			103,852	84,135	508,489
13					Supplemental Table Entry								Min	Min	Min
14						Supp							Non 76-77	Non 76-77	Non 76-77
15					Supp	Table	1st Call	2nd Call					103,852	114,720	785,605
16					Table	Only, or	To	To	*Sum:*	*171,708*	*171,708*	*0*			
17	Month				Release	Table +	Lloyd	HH			Lloyd	HH	Lloyd	HH	DP
18	Index	Date	Day	Days	Only	Existing	Release	Release		Total	Release	Release	Storage	Storage	Storage
19					AF	AF	AF	AF		AF	AF	AF	AF	AF	AF
20	1970.10	10/1/1970	T	31	0	0	0	0		0	0	0	200,091	249,349	1,666,767
21	1970.10	10/2/1970	F	31	0	0	0	0		0	0	0	200,080	248,379	1,664,567
22	1970.10	10/3/1970	S	31	0	0	0	0		0	0	0	200,090	247,622	1,662,719
23	1970.10	10/4/1970	S	31	0	0	0	0		0	0	0	199,278	247,032	1,659,892
24	1970.10	10/5/1970	M	31	0	0	0	0		0	0	0	199,896	246,150	1,656,745
25	1970.10	10/6/1970	T	31	0	0	0	0		0	0	0	199,781	245,360	1,654,119

[4] The “shared responsibility” assumption is presented for the purpose of evaluating alternative operations. The assumption shall not be used as evidence in any proceeding relating to and shall not act as precedence for any allocation of Tuolumne River water between CCSF and the Districts for any purpose under the Fourth Agreement.

The result of entering the supplemental release will cause a recalculation of the entire Model with results refreshed in the worksheet. Lake Lloyd, Hetch Hetchy Reservoir and Don Pedro Reservoir storage is ported from other worksheets to provide the status of their storage as supplemental releases are entered.

Warnings and advice are provided in the worksheet when several conditions occur. The snapshots below illustrate the occurrence of these conditions.

Example 1: A Reservoir Empties and the Model Crashes

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1			1		San Francisco Water Bank Account Balance Computation and Supplement Release																				
2	*Unit Title*		2		CFS	CFS	CFS	CFS	CFS	AF		AF	AF		AF		AF			AF					
3	*Parameter Title*		3		DP Inflow	La Grange	Fourth Ag	Districts' E	SF Credit/	SF Credit/Debit w/ C		SF WB Eva	SF Water Bank Balan		Max Water Bank Cap		Credit Adj fc			SF Supplemental Release					
4																	*Advice*								
5	*Acre-foot to CFS conversion*				*From*	*From*											*#N/A*								
6	*divide by :*	*1.983471*			*DonPedro*	*Hydrology*		*Warnings*									*#N/A*								
7									***Warning: Your have likely drained a reservoir, check reservoirs.***								*#N/A*								
8									*#N/A*	*#N/A*															
9										*#N/A*							(UI 1.31)			(UI 3.10)	**Yes, this method is being used**				
10									*#N/A*	*#N/A*							1			1	Min Lloyd Storage		Min	Min	Min
11										*#N/A*							(0) N, (1) Y				WB Call (CCSF 3.00)		24,474	#N/A	#N/A
12																	- Debit				(acre-feet)		Min	Min	Min
13												*Max*	*#N/A*				+ Credit				45,000		Non76-77	Non76-77	Non76-77
14												*Min*	*#N/A*			*Sum:*	*-5,922,391*		*Sum:*	*1,197,522*	*714,938*	*482,584*	24,474	#N/A	#N/A
15					SF Water Bank Account Balance Calculation												La Grange			Supplemental Release and Storage Check					
16							Fourth	Daily	SF	SF C/D	SF Gross	SF WB	SF Net	SF Share	SF Max		Credit Adj			WB	1st Call	2nd Call			
17	Month				DP	La Grange	Agree	Districts'	Credit/	w/	WB	Evap	WB	RFlood	WB	WB	in SF			Supp	Lloyd	HH	Lloyd	HH	DP
18	Index	Date	Day	Days	Inflow	UF	Check	Entitle	Debit	Credit Adj	Balance	Losses	Balance	DP	Balance	Neg Flag	WB	Mark	Mark	Release	Release	Release	Storage	Storage	Storage
19					CFS	CFS	CFS	CFS	CFS	AF	AF	AF	570,000	AF	AF	AF	AF			AF	AF	AF	AF	AF	AF
8018	1992.08	8/24/1992	M	31	205	5	2,416	5	200	396	-122,421	0	-122,421	0	570,000	-396	0			0	0	0	30,461	1,488	528,302
8019	1992.08	8/25/1992	T	31	445	28	2,416	28	417	827	-121,594	0	-121,594	0	570,000	-827	0			0	0	0	30,065	262	526,440
8020	1992.08	8/26/1992	W	31	#N/A	201	2,416	201	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0			0	0	0	29,709	#N/A	#N/A
8021	1992.08	8/27/1992	T	31	#N/A	104	2,416	104	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0			0	0	0	29,370	#N/A	#N/A

Note: This screen save is from the worksheet WaterBankRel description. Identical warnings are included in worksheet SFWaterBank.

A warning has been provided that a reservoir has likely been depleted by the current operation assumptions. In this particular example, Tuolumne River minimum flows were increased with responsibility shared with CCSF, and a set of supplemental releases were established. In this iteration of results it is discovered in Column X (Hetch Hetchy Reservoir storage) an error (reported as "#N/A") on August 26, 1992 has occurred in the Model. By review of the previous day's storage results for Lake Lloyd (Column W), Hetch Hetchy Reservoir (Column X) and Don Pedro Reservoir (Column Y), and the rate of depletion for each of these reservoirs, it is concluded that Hetch Hetchy Reservir likely drained on August 26 and thus crashed the Model. Although noted, a negative Water Bank Account Balance (Column M) will not cause the Model to crash. To remedy the condition, the user uses worksheet UserInput to revise (lower) SJPL diversions from Hetch Hetchy Reservoir (UI 4.10 and UI 4.20) and retain water in Hetchy Hetchy Reservoir for release. If Don Pedro Reservoir storage was the culprit of causing the Model to crash, the user uses worksheet UserInput to revise (lower) MID and TID canal diversions (UI 2.10, UI 2.20 and UI 2.30 to retain water in Don Pedro Reservoir for release. Alternatively, the user could reduce the scenario's designated minimum flow requirement, which would change flow needed from the upstream systems.

Example 2: Water Bank is Negative.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1			1		San Francisco Water Bank Account Balance Computation and Supplement Release																				
2	Unit Title		2		CFS	CFS	CFS	CFS	CFS	AF		AF	AF		AF		AF			AF					
3	Parameter Title		3		DP Inflow	La Grange	Fourth Ag	Districts' E	SF Credit/	SF Credit/Debit w/ C		SF WB Eva	SF Water Bank Balan		Max Water Bank Cap		Credit Adj fc			SF Supplemental Release					
4																	Advice								
5	Acre-foot to CFS conversion				From	From											If Water Bank Balance is negative (shown as highlighted value in								
6	divide by :	1.983471			DonPedro	Hydrology		Warnings									Column M) enter volume of supplemental release into Column T to								
7																	maintin balance at zero or greater. Use Column M and Column P for guidance.								
8									Warning: SF Water Bank is 'negative'. Add supplemental release																
9										(Column T) to maintain balance at least zero.							(UI 1.31)			(UI 3.10)	Yes, this method is being used				
10																	0			1	Min Lloyd Storage		Min	Min	Min
11																	(0) N, (1) Y				WB Call (CCSF 3.00)		131,254	84,135	508,489
12																	- Debit				(acre-feet)		Min	Min	Min
13												Max	740,000				+ Credit				45,000		Non76-77	Non76-77	Non76-77
14												Min	-150,778			Sum:	0		Sum:	0	0	0	131,254	114,720	740,875
15					SF Water Bank Account Balance Calculation												La Grange			Supplemental Release and Storage Check					
16							Fourth	Daily	SF	SF C/D	SF Gross	SF WB	SF Net	SF Share	SF Max		Credit Adj			WB	1st Call	2nd Call			
17	Month				DP	La Grange	Agree	Districts'	Credit/	w/	WB	Evap	WB	RFlood	WB	WB	in SF			Supp	Lloyd	HH	Lloyd	HH	DP
18	Index	Date	Day	Days	Inflow	UF	Check	Entitle	Debit	Credit Adj	Balance	Losses	Balance	DP	Balance	Neg Flag	WB	Mark	Mark	Release	Release	Release	Storage	Storage	Storage
19					CFS	CFS	CFS	CFS	CFS	AF	AF	AF	570,000	AF	AF	AF	AF			AF	AF	AF	AF	AF	AF
7887	1992.04	4/15/1992	W	30	2138	4,322	4,066	4,066	-1,928	-3,824	4,011	0	4,011	0	570,000	0	0			0	0	0	256,353	262,227	969,641
7888	1992.04	4/16/1992	T	30	1628	3,150	4,066	3,150	-1,521	-3,017	994	0	994	0	570,000	0	0			0	0	0	257,148	263,740	969,822
7889	1992.04	4/17/1992	F	30	1925	4,267	4,066	4,066	-2,141	-4,247	-3,253	0	-3,253	0	570,000	4,247	0			0	0	0	259,037	265,786	970,196
7890	1992.04	4/18/1992	S	30	1980	5,507	4,066	4,066	-2,086	-4,137	-7,390	0	-7,390	0	570,000	4,137	0			0	0	0	260,795	270,314	970,897

Note: This screen save is from the worksheet WaterBankRel description. Identical warnings are included in worksheet SFWaterBank.

A warning has been provided that the Water Bank Account Balance is negative for one or more days of the scenario. In this instance, all Model reservoirs are operating within a viable operation (the Model did not crash due an emptying reservoir); however, the objective to maintain a positive Water Bank Account Balance has been violated. Upon inspection of the results the user can find the first instance of violation and remedy the violation by entry into Column T an amount of release that maintains at least a zero balance in the Water Bank Account Balance, and/or modify the year type table-based supplemental flows in worksheet UserInput. For the first day of violation the reported negative balance (e.g., -3,253 acre-feet) is needed as a supplemental release. The ensuing days of supplemental release are informed by Column P.

It is possible that within the remedy of Example 2 the error exemplified by Example 1 may occur as Hetchy Hetchy Reservoir may be drained through the efforts of maintaining a positive Water Bank Account Balance. At that point, the procedures of Example 1 will be required and the values already derived for supplemental releases may need to be revisited and possibly changed.

5.16 LaGrangeSchedule Workheet

This worksheet (LaGrangeSchedule) assembles the designation of the minimum flow requirement for the Tuolumne River. By user specification (UI 1.10) either the current 1995 FERC schedule is selected (UI 1.10 = 0) or the user defined minimum flow requirement is selected (UI 1.10 = 1). If the current 1995 FERC schedule is selected the computation of the schedule is computed in this worksheet (later described).

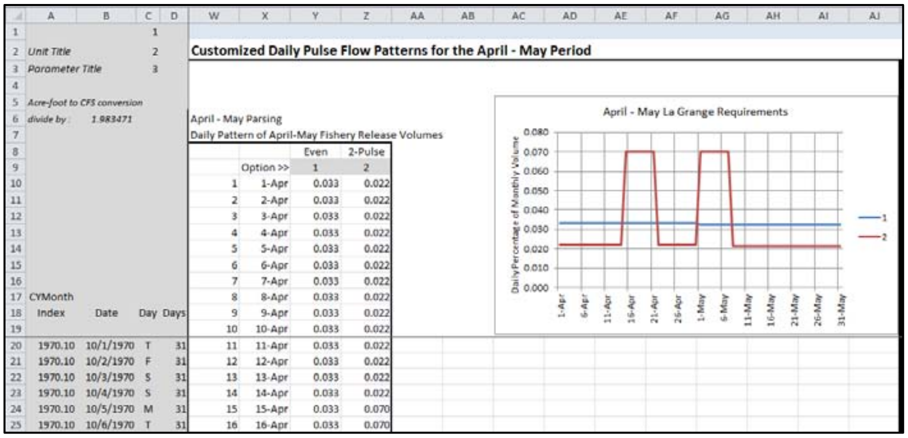
Minimum Flow Requirement Options

When using current 1995 FERC minimum flow requirements, the user can within worksheet Control (C 1.60) direct which shape of releases to assume for pulse flows during April and May. This section of the worksheet performs the parsing the monthly flow requirements into daily flow requirements. If using the user specified flow schedule (identified and processed in worksheet UserInput), this section prepares the use of that data for use by the Model. Upon selection of the flow requirement, Column F is used to provide the minimum flow requirement to the rest of the Model. Although not directly linked through user switches, this section of the worksheet illustrates an example of developing an alternative flow requirement for testing. Columns M through Column Q perform a synthesis of an alternative flow requirement as has been suggested by the SWRCB. This particular flow requirement currently serves as the example alternative requirement for this documentation. The specifics of this component of flow requirement (February through June) in combination with the current 1995 FERC minimum flow requirement has been provided to worksheet UserInput for illustration purposes.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1			1		La Grange Minimum Flow Calculation																	
2	Unit Title		2		CFS	AF					AF						AF		CFS	AF	CFS	AF
3	Parameter Title		3		La Grange	La Grange					1995 FERC I						Alt Test Fl		User-Defi	User-Defi	User-Defi	User-Defi
4																						
5	Acre-foot to CFS conversion																		Sample Alt			
6	divide by :	1.983471				Read by		Existing FERC Requirements											Greater of FERC or 30% UF Feb-Jun			
7						Model		See Cell AN1 for beginning of calculation					Alternative flow requirement (Column T or V)						Daily time series, or average of daily			
8						as AF			Required	Daily			Option within an option:			0			by year type average			
9						213,897			Monthly	Parsing	213,897			(0) if from UserInput Time Series						507,554		507,395
10					Input Option:				Volume	Monthly				(1) if from UserInput YT Table					Time Series		Table	
11						0							Greater of FERC or 30%UF Feb-Jun, with Bounds						1	1	0	0
12					0 - Current FERC (Column K)				April - May Parsing				Self-contained Computation of SWRCB Component						UserInput	UserInput	UserInput	UserInput
13					1 - Alternative (Column T or V)				Option >>	2			Alternative - SWRCB X% F-J						User	User	User	User
14									(1) Even daily distribution						200	3500			Defined	Defined	Defined	Defined
15					Model	Model			(2) 2-Pulse					X%	Min Cap	Max Cap			Time	Time	Yr-Type	Yr-Type
16					Input	Input					FERC Only			30	200	3500			Series	Series	Table	Table
17	CYMonth				La Grange	La Grange		Pulse	La Grange	Day	La Grange			Trial			X% Req		Flow	Flow	Flow	Flow
18	Index	Date	Day	Days	Daily	Daily		Day	Monthly	Percent	Daily		TR UF	Feb-Jun	Feb-Jun	Feb-Jun	Alone		Reqrmnt	Reqrmnt	Reqrmnt	Reqrmnt
19					CFS	AF			AF		AF		CFS	CFS	CFS	CFS	AF		CFS	AF	CFS	AF
20	1970.10	10/1/1970	T	31	397	787			24,397	0.03226	787		159	0	0	0	0		397	787	295	585
21	1970.10	10/2/1970	F	31	397	787			24,397	0.03226	787		55	0	0	0	0		397	787	295	585
22	1970.10	10/3/1970	S	31	397	787			24,397	0.03226	787		265	0	0	0	0		397	787	295	585
23	1970.10	10/4/1970	S	31	397	787			24,397	0.03226	787		-166	0	0	0	0		397	787	295	585
24	1970.10	10/5/1970	M	31	397	787			24,397	0.03226	787		180	0	0	0	0		397	787	295	585
25	1970.10	10/6/1970	T	31	397	787			24,397	0.03226	787		92	0	0	0	0		397	787	295	585

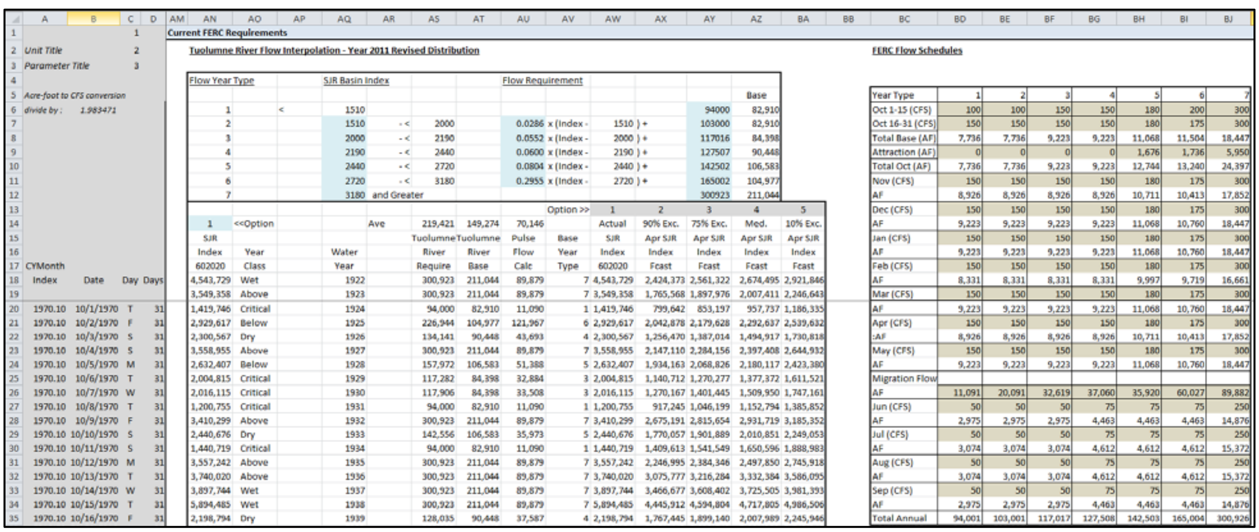
April – May Daily Parsing of Flow Requirements

This section of the worksheet provides information to parse monthly-designated minimum flow requirements into daily patterns during April and May. Worksheet Control designates which parsing pattern is to be used.



Computation of 1995 FERC Minimum Flow Requirement

This section of the worksheet computes the current 1995 FERC flow requirement. Several elements of information provided in this worksheet and from worksheet Control provide the computation of flow requirement based on 1995 FERC Settlement procedures and flow rates. The basis of the year type flow requirements is the SWRCB San Joaquin River Basin 60-20-20 index. The annual flow schedules are assumed to be apply on a April through March year, with the interpolation water of the schedules applied to April and May pulse flows. A snapshot of the worksheet's computation area is shown below.



San Francisco La Grange Responsibility

Also performed in this worksheet is the computation of the hypothetical responsibility of CCSF for Tuolumne River incremental flow requirements.[5] A snapshot of the computation area is shown below.

[5] The "shared responsibility" assumption is presented for the purpose of evaluating alternative operations. The assumption shall not be used as evidence in any proceeding relating to and shall not act as precedence for any allocation of Tuolumne River water between CCSF and the Districts for any purpose under the Fourth Agreement.

	A	B	C	D	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI
1			1			SF La Grange Responsibility Computation												
2	*Unit Title*		2															
3	*Parameter Title*		3															
4																		
5	*Acre-foot to CFS conversion*																	
6	*divide by :*	*1.983471*																
7																		
8																		
9																		
10						*Approach - SF 52% Responsibility Scenario*												
11																		
12						*Compute difference between existing FERC minimum flow requirement and test scenario*												
13						*Test scenario: SWRCB 30% UF February-June w/ 200/3,500 cfs bounds on SWRCB component, or existing FERC whichever is greater*												
14							213,897		213,897		0	0						
15											Total Diff							
16								Scenario	Scenario		Alt							
17	CYMonth					Exsiting	Exsiting	SWRCB	SWRCB		minus	51.7121						
18	Index	Date	Day	Days		FERC	FERC	30%	30%		FERC	SF Debit						
19						CFS	AF	CFS	AF		AF	AF						
20	1970.10	10/1/1970	T	31		397	787	397	787		0	0						
21	1970.10	10/2/1970	F	31		397	787	397	787		0	0						
22	1970.10	10/3/1970	S	31		397	787	397	787		0	0						
23	1970.10	10/4/1970	S	31		397	787	397	787		0	0						
24	1970.10	10/5/1970	M	31		397	787	397	787		0	0						
25	1970.10	10/6/1970	T	31		397	787	397	787		0	0						

The 1995 FERC flow requirement and the scenario flow requirement are compared on a daily basis to identify the difference between the two schedules. The CCSF 52% responsibility factor is applied to the total difference, which values are then provided to the WaterBankRel and SFWaterBank worksheets for use if selected.

5.17 DailyCanalsCompute Workheet

This worksheet (DailyCanalsCompute) performs the computation of the daily canal demands of the MID and TID. The computation of canal demands incorporate the PDAW and canal operations practices of the districts. This worksheet also incorporates the application of a Water Supply Factor (from worksheet DPWSF) that reduces canal diversions during limited water supply conditions. The results from this worksheet have been provided to the Model for the Test Case scenario.

Projected Demand for Applied Water and Don Pedro Water Supply Factor

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1			1		District Canal Diversion Computed by Canal Assumptions and Don Pedro Water Supply Factor									
2	Unit Title		2		Factor		Factor	Factor			AF	AF	AF	AF
3	Parameter Title		3		DP WSF Full		DP WSF	Dynamic WSF			MID Daily	TID Daily	MID Daily	TID Daily
4														
5	Acre-foot to CFS conversion													
6	divide by :	1.983471			Pre-Proc	Pre-Proc	Active	Read	Read	Read				
7					Full	Base	Factor	from	from	from				
8					Factor	Factor	Used in	DPWSF	BU20:487	BV20:487				
9					1		Scenario							
10				39-yr Ave							170,364	406,025	34,500	0
11				Max	1.0000	1.0000	1.0000	1.0000	36,100		1,822	4,116	110	0
12				Min	1.0000	0.6000	0.6000	0.6000	0		0	0	74	0
13					DP Water Supply Factor				District Projected Demand of Applied Water					
14						10-4-2012								
15					DP	DP								
16					WS Factor	WS Factor	Model	DP	MID	TID	MID	TID	MID	TID
17	Month				Full	Base	DP	WS Factor	PDAW	PDAW	Daily	Daily	Daily	Daily
18	Index	Date	Day	Days	Demand	Case	WS Factor	Dynamic	Monthly	Monthly	PDAW	PDAW	M&I	M&I
19									AF	AF	AF	AF	AF	AF
20	1970.10	10/1/1970	T	31	1.0000	1.0000	1.0000	1.0000	6,000	16,000	347	1,217	103	0
21	1970.10	10/2/1970	F	31	1.0000	1.0000	1.0000	1.0000	6,000	16,000	270	626	103	0
22	1970.10	10/3/1970	S	31	1.0000	1.0000	1.0000	1.0000	6,000	16,000	262	564	103	0
23	1970.10	10/4/1970	S	31	1.0000	1.0000	1.0000	1.0000	6,000	16,000	293	990	103	0
24	1970.10	10/5/1970	M	31	1.0000	1.0000	1.0000	1.0000	6,000	16,000	292	683	103	0
25	1970.10	10/6/1970	T	31	1.0000	1.0000	1.0000	1.0000	6,000	16,000	315	769	103	0

This section of logic incorporates two components of information into the computation of canal demands. The PDAW for each District is a pre-processed Model entry based on an estimate developed by the California Department of Water Resources Consumptive Use model. The monthly time series for PDAW for the simulation period is modified prior to use in the computation to refine the demand to recognize the local districts' delivery records. The second component of information is the Don Pedro Water Supply Factor (WSF). This fraction is computed in worksheet DPWSF and reflects limited water supplies during periods of drought. The factor is used to reduce canal diversions, based on antecedent reservoir storage and forecasted inflow to Don Pedro Reservoir. There are several versions of the WSF available for use in the Model if user access is allowed. The "full demand" WSF will produce a canal demand/diversion equal to full needs, as if the available water supply is sufficient to meet the full canal demands. The WSF table included in the Model represents canal demands including reductions from full diversions, and manages water supplies to produce a reservoir operation similar to that occurred during the 1987-1992 drought.

District Canal Demand Calculation

The sections of logic shown below illustrate the components of District canal operations that factor into the computation of daily canal demands/diversions. These components build on top of the PDAW to develop a daily canal demand from Don Pedro Reservoir. The PDAW is represented as a daily varying demand based on recent historical daily diversion shapes while the canal operation parameters are generally represented by an even distribution pattern within each month.

#	A	B	C	D	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE
1			1																		
2	Unit Title		2			AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF		AF		CFS	
3	Parameter Title		3		M&I	MID Turnc	MID Nom	MID Turnc	MID Canal	MID Canal	MID Canal	MID Lwr C	MID Nom	MID Lwr C	MID M&I [	MID Upper Sys Losse		MID La Grange Diver		MID La Grange Diver	
4																					
5	Acre-foot to CFS conversion				Override for DailyCanals			(UI 2.10)	0	(1) on, use user-defined table, (0) off, use Base Case canal diversion									Capacity Check	2,000	cfs
6	divide by :	1.983471				0			0	(0) off, use UserInput option (UI 2.10), or (2) use calculated canal diversion									Max	1,257	
7					If <> 2, use UserInput or Base				1	If using calculated canal diversion, (1) Base, (2) Full Demand, or (3) Dynamic											
8					If = 2, use calculated																Pre-Proc
9																					Factor
10				39-yr Ave		215,775	20,995	194,780	44,510	5,059	8,492	235,857	17,280	218,577	34,500	31,100	0	284,177			
11				Max		2,323	133	2,291	233	21	45	2,314	84	2,282	110	158	65	2,492			
12				Min		0	0	0	0	0	0	0	0	0	74	0	-97	81			
13					MID Canal Demand Calculation																
14															MID		MID				MID
15						MID					MID	MID			M&I Div	MID	Modesto		MID		7-day
16						Turnout	MID	MID	MID	MID	Canal	Lwr Canal		MID	frm	Upper	Lake	MID	Monthly	MID	3-yr Ave
17	Month				MID	w/o	Nom Prvt	Turnout	Canal	Canal	Intercpt	bfr MID	MID	Lwr Canal	Modesto	System	Daily	La Grange	Sum	La Grange	Day
18	Index	Date	Day	Days	Factor	Prvt Pmp	Pmp	Delivery	Op Spills	Losses	Flow	Nom Pmp	Nom Pmp	Diversion	Lake	Losses	Change	Diversion	Diversion	Diversion	Percent
19					%	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	CFS	% of Mo
20	1970.10	10/1/1970	T	31	40	869	32	836	223	20	29	1,050	68	982	103	65	-97	1,053	20,952	531	0.06
21	1970.10	10/2/1970	F	31	40	676	32	643	223	20	29	857	68	789	103	65	-97	860	20,952	434	0.05
22	1970.10	10/3/1970	S	31	40	656	32	623	223	20	29	837	68	769	103	65	-97	840	20,952	424	0.04
23	1970.10	10/4/1970	S	31	40	734	32	701	223	20	29	915	68	847	103	65	-97	918	20,952	463	0.05
24	1970.10	10/5/1970	M	31	40	730	32	698	223	20	29	911	68	844	103	65	-97	915	20,952	461	0.05
25	1970.10	10/6/1970	T	31	40	789	32	756	223	20	29	970	68	902	103	65	-97	973	20,952	491	0.05

#	A	B	C	D	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV
1			1																		
2	Unit Title		2			AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF		AF		CFS	
3	Parameter Title		3		sion	TID Turnoı	TID Nom F	TID Turnoı	TID Canal	MID Canal	TID Canal	TID Lwr Ca	TID Nom F	TID Lwr Ca	TID M&I D	TID Upper Sys Losse		TID La Grange Divers		TID La Grange Divers	
4																					
5	Acre-foot to CFS conversion																		Capacity Check	3,400	cfs
6	divide by :	1.983471																	Max	2,404	
7																					
8																					Pre-Proc
9																					Factor
10				39-yr Ave		532,337	31,298	501,039	46,871	36,555	0	584,465	77,066	507,399	0	52,200	0	559,697			
11				Max		4,535	206	4,455	243	150	0	4,815	471	4,548	0	290	250	4,768			
12				Min		0	0	0	0	0	0	0	0	0	0	32	-452	1			
13					TID Canal Demand Calculation																
14															TID						TID
15						TID					TID	TID			M&I Div	TID	Turlock		TID		7-day
16						Turnout	TID	TID	TID	TID	Canal	Lwr Canal		TID	frm	Upper	Lake	TID	Monthly	TID	3-yr Ave
17	Month				TID	w/o	Nom Prvt	Turnout	Canal	Canal	Intercpt	bfr TID	TID	Lwr Canal	Turlock	System	Daily	La Grange	Sum	La Grange	Day
18	Index	Date	Day	Days	Factor	Prvt Pmp	Pmp	Delivery	Op Spills	Losses	Flow	Nom Pmp	Nom Pmp	Diversion	Lake	Losses	Change	Diversion	Diversion	Diversion	Percent
19					%	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	CFS	% of Mo
20	1970.10	10/1/1970	T	31	40	3,044	77	2,966	235	145	0	3,347	171	3,176	0	65	-452	2,789	31,487	1,406	0.08
21	1970.10	10/2/1970	F	31	40	1,565	77	1,488	235	145	0	1,869	171	1,698	0	65	-452	1,311	31,487	661	0.04
22	1970.10	10/3/1970	S	31	40	1,409	77	1,332	235	145	0	1,712	171	1,541	0	65	-452	1,154	31,487	582	0.04
23	1970.10	10/4/1970	S	31	40	2,475	77	2,398	235	145	0	2,779	171	2,608	0	65	-452	2,220	31,487	1,119	0.06
24	1970.10	10/5/1970	M	31	40	1,708	77	1,631	235	145	0	2,011	171	1,841	0	65	-452	1,453	31,487	733	0.04
25	1970.10	10/6/1970	T	31	40	1,923	77	1,845	235	145	0	2,226	171	2,055	0	65	-452	1,668	31,487	841	0.05

District Canal Operation Assumptions

The canal operation assumptions, e.g., seepage and losses and canal operation spills, are identified in this worksheet (entered into worksheet Control). These parameters are provided to the computations shown above. The canal operation assumptions for each District are shown below.

Modesto Irrigation District											
	Turnout Delivery Factor	Nominal Private GW Pumping	Canal Operational Spills Critical	Canal Operational Spills Non-crit	System Losses below Modesto Res	Intercepted Flows	Nominal MID GW Pumping	Modesto Res and Upper Canal Losses/Div	Municipal Delivery from Modesto Res	Modesto Res Target Storage	Modesto Res Target Storage Change
Month	%	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF
January	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	17.0	2.0
February	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	18.0	1.0
March	65.0	1.0	1.0	3.0	0.6	0.9	1.0	2.0	2.7	18.0	0.0
April	70.0	2.0	3.0	6.0	0.6	0.9	2.3	2.9	2.7	19.0	1.0
May	85.0	3.0	4.0	6.5	0.6	1.2	2.3	3.9	3.0	20.0	1.0
June	85.0	4.0	3.5	6.5	0.6	1.0	2.3	4.3	3.2	20.0	0.0
July	77.5	4.0	3.5	6.5	0.6	1.0	2.6	4.9	3.3	21.0	1.0
August	70.0	4.0	4.9	7.0	0.6	1.4	2.4	4.9	3.3	22.0	1.0
September	65.0	2.0	5.0	7.0	0.6	1.2	2.3	4.2	3.3	20.0	-2.0
October	40.0	1.0	2.8	6.9	0.6	0.9	2.1	2.0	3.2	17.0	-3.0
November	30.0	0.0	2.0	2.0	0.1	0.0	0.0	2.0	2.7	15.0	-2.0
December	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.5	15.0	0.0
Total		21.0	35.7	57.4	5.4	8.5	17.3	31.1	34.5		

Turlock Irrigation District											
	Turnout Delivery Factor	Nominal Private GW Pumping	Canal Operational Spills Critical	Canal Operational Spills Non-crit	System Losses below Turlock Lk	Intercepted Flows	Nominal TID GW Pumping	Turlock Lk and Upper Canal Losses	Other Delivery from Turlock Lk	Turlock Lk Target Storage	Turlock Lk Target Storage Change
Month	%	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF
January	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	18.0	5.0
February	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	25.0	7.0
March	65.0	1.2	3.0	3.0	4.5	0.0	4.1	1.0	0.0	30.0	5.0
April	57.5	2.4	5.1	6.3	4.5	0.0	8.0	6.6	0.0	30.0	0.0
May	85.0	3.6	4.6	6.7	4.5	0.0	10.3	7.7	0.0	32.0	2.0
June	92.5	5.2	4.2	6.7	4.5	0.0	12.4	8.2	0.0	32.0	0.0
July	72.5	6.4	4.2	6.7	4.5	0.0	14.6	8.7	0.0	32.0	0.0
August	62.5	6.2	4.0	7.3	4.5	0.0	13.3	9.0	0.0	30.0	-2.0
September	67.5	3.9	3.2	7.3	4.5	0.0	9.1	5.0	0.0	27.0	-3.0
October	40.0	2.4	2.3	7.3	4.5	0.0	5.3	2.0	0.0	13.0	-14.0
November	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0	0.0
December	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0	0.0
Total		31.3	38.6	59.3	39.2	0.0	77.1	52.2	0.0		

5.18 DailyCanals Workheet

This worksheet (DailyCanals) assembles the appropriate canal demands for the scenario. While worksheet DailyCanalsCompute is capable of providing several versions of canal demands, worksheet DailyCanals readies either those selected demands or alternatively defined demands for the Model.

Model (scenario) Canal Demands

	A	B	C	D	E	F	G	H	I	J
1			1		District Canal Diversion Read by Model					
2	Unit Title		2							
3	Parameter Title		3							
4										
5	Acre-foot to CFS conversion									
6	divide by :	1.983471			MID and TID Canal Diversion Assumption					
7					Read		Read			
8					by		by			
9					DP Model		DP Model		Sum	
10			39-yr Ave		284,177		559,697		843,874	
11					Option (0) is using Base Case Canal Diversion					
12					Option (1) is using Alt from UserInput Canal Diversion					
13					Option>>	0	Switch 2.10 or Override			
14					Option (2) is using Calculated Canal Diversion					
15					Model	Model	Model	Model	Model	Model
16					MID	MID	TID	TID	Total	Total
17	Month				Canal	Canal	Canal	Canal	Canal	Canal
18	Index	Date	Day	Days	Diversion	Diversion	Diversion	Diversion	Diversion	Diversion
19					AF	CFS	AF	CFS	AF	CFS
20	1970.10	10/1/1970	T	31	1,053	531	2,789	1,406	3,842	1,937
21	1970.10	10/2/1970	F	31	860	434	1,311	661	2,171	1,094
22	1970.10	10/3/1970	S	31	840	424	1,154	582	1,994	1,006
23	1970.10	10/4/1970	S	31	918	463	2,220	1,119	3,139	1,582
24	1970.10	10/5/1970	M	31	915	461	1,453	733	2,368	1,194
25	1970.10	10/6/1970	T	31	973	491	1,668	841	2,641	1,332

The section of logic shown above illustrates the two columns of data used by the Model (worksheet DonPedro) for canal diversions by MID and TID. The data version of demand used is user specified. If using the worksheet UserInput interface, UI 2.10 selects whether pre-processed Test Case diversions are used or a user specified table of diversions are used. If access to worksheet DailyCanalsCompute is granted, a time series of canal diversions from worksheet DailyCanalsCompute is used.

Test Case and Alternative Canal Diversions

This section of logic provides the Model either a pre-processed time series of canal diversions (Test Case) or a time series of canal diversions that has been specified by the user in worksheet UserInput (UI 2.20 and UI 2.30) as monthly canal demands for the simulation period. A snapshot of the worksheet is shown below. This section of logic also parses the user specified monthly table of canal diversions into a daily diversion pattern based on the Test Case scenario's daily pattern of diversions.

	A	B	C	D	L	M	N	O	P	Q
1			1							
2	Unit Title		2							
3	Parameter Title		3							
4										
5	Acre-foot to CFS conversion									
6	divide by :	1.983471			Enter		Enter		Pre-Processed	
7					Time		Time		as base scenario	
8					Series		Series			
9					Here		Here		Sum	
10			39-yr Ave		284,177		559,697		843,874	
11						1,257		2,404		
12						41		1		
13					0	0	0	0	0	0
14					Values of Base Case - October 4, 2012					
15					Base	Base	Base	Base	Base	Base
16					MID	MID	TID	TID	Total	Total
17	Month				Canal	Canal	Canal	Canal	Canal	Canal
18	Index	Date	Day	Days	Diversion	Diversion	Diversion	Diversion	Diversion	Diversion
19					AF	CFS	AF	CFS	AF	CFS
20	1970.10	10/1/1970	T	31	1,053	531	2,789	1,406	3,842	1,937
21	1970.10	10/2/1970	F	31	860	434	1,311	661	2,171	1,094
22	1970.10	10/3/1970	S	31	840	424	1,154	582	1,994	1,006
23	1970.10	10/4/1970	S	31	918	463	2,220	1,119	3,139	1,582
24	1970.10	10/5/1970	M	31	915	461	1,453	733	2,368	1,194
25	1970.10	10/6/1970	T	31	973	491	1,668	841	2,641	1,332

	R	S	T	U	V	W	X	Y	Z	AA
6	Alternative Canal Diversion				Enter		Enter		Derived from	
7					Data in		Data in		UserInput	
8	Daily Distribution of User Supplied				Matrix		Matrix			
9	Monthly Alternative District Canal				AI66:AU103		AX66:BJ103		Sum	
10	Diversion				284,177		559,697		843,874	
11	Distributed as Daily Percentage of					1,257		2,404		
12	Monthly Total District Base Diversion					41		1		
13				Option>>	1	1	1	1	1	1
15	Base	MID %	Base	TID %	Alt	Alt	Alt	Alt	Alt	Alt
16	MID Mon	Day of	TID Mon	Day of	MID	MID	TID	TID	Total	Total
17	Canal	Month	Canal	Month	Canal	Canal	Canal	Canal	Canal	Canal
18	Diversion	Diversion	Diversion	Diversion	Diversion	Diversion	Diversion	Diversion	Diversion	Diversion
19	AF		AF		AF	CFS	AF	CFS	AF	CFS
20	20,952	0.05	31,487	0.09	1,053	531	2,789	1,406	3,842	1,937
21	20,952	0.04	31,487	0.04	860	434	1,311	661	2,171	1,094
22	20,952	0.04	31,487	0.04	840	424	1,154	582	1,994	1,006
23	20,952	0.04	31,487	0.07	918	463	2,220	1,119	3,139	1,582
24	20,952	0.04	31,487	0.05	915	461	1,453	733	2,368	1,194
25	20,952	0.05	31,487	0.05	973	491	1,668	841	2,641	1,332

Adjacent to the above illustrated area of computations are several components of data assemblage. The monthly time series columns serve to summarize daily Test Case diversions assumptions and provide user specified monthly diversions for daily parsing. The chronological matrices provide an alternative listing of the monthly data.

	A	B	C	D
1			1	
2	*Unit Title*		2	
3	*Parameter Title*		3	
4				
5	*Acre-foot to CFS conversion*			
6	*divide by :*	*1.983471*		
7				
8				
9				
10				*39-yr Ave*
11				
12				
13				
14				
15				
16				
17	Month			
18	Index	Date	Day	Days
19				
20	1970.10	10/1/1970	T	31
21	1970.10	10/2/1970	F	31
22	1970.10	10/3/1970	S	31
23	1970.10	10/4/1970	S	31
24	1970.10	10/5/1970	M	31
25	1970.10	10/6/1970	T	31

Monthly Time Series Data

AC	AD	AE	AF	AG
	Monthly from Daily Input Pre-Proc	*Enter Data in Matrix AI66:AU103 UserInput*	*Monthly from Daily Input Pre-Proc*	*Enter Data in Matrix AX66:BJ103 UserInput*
39-yr Ave	*284,177*	*284,177*	*559,697*	*559,697*
	1	2	1	2
Yr-Month	MID Base Assumpt Monthly Volume AF	MID Alt Assumpt Monthly Volume AF	TID Base Assumpt Monthly Volume AF	TID Alt Assumpt Monthly Volume AF
1970.10	20,952	20,952	31,487	31,487
1970.11	2,700	2,700	1,000	1,000
1970.12	2,500	2,500	1,000	1,000
1971.01	4,300	4,300	6,000	6,000
1971.02	3,300	3,300	8,000	8,000
1971.03	14,746	14,746	42,220	42,220

Monthly Matrix Time Series Data

User-defined District Canal Diversions at AI66:AU103 and AX66:BJ103

Test_Base MID Canal Assumption - Read from Time Series in Column AD
Acre-feet

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total WY
1971	20,952	2,700	2,500	4,300	3,300	14,746	30,656	42,917	47,253	54,987	49,086	32,192	305,589
1972	20,952	5,130	2,500	4,300	5,679	24,844	46,800	46,544	46,542	54,987	49,086	30,637	338,001
1973	20,952	2,700	2,500	4,300	3,300	14,746	23,737	45,374	47,016	54,987	49,086	32,658	301,356
1974	20,952	2,700	2,500	4,300	3,300	14,746	18,115	42,917	45,239	49,733	49,086	32,658	286,246
1975	20,952	5,460	2,500	4,300	3,300	14,746	28,782	44,672	47,253	54,859	43,423	32,658	302,906
1976	20,952	6,451	2,500	4,300	6,350	30,232	34,676	38,540	38,163	44,939	35,682	24,524	287,308

5.19 DPWSF Workheet

This worksheet (DPSWF) computes the Don Pedro Water Supply Factor (WSF). The premise of the WSF factor is to reduce the amount of water diverted to the canals during years when lack of carryover storage at Don Pedro Reservoir becomes a concern. The modeling mechanism used to reduce canal diversions is a factor applied to the PDAW of the canal demand. This mechanism results in a reduction to the amount of water "turned out" to the customers while still recognizing the relatively constant efficiencies of canal operations.

The WSF is established by forecasting upcoming water supply, based on antecedent storage and anticipated inflow to Don Pedro Reservoir. The forecasting procedure begins in February and ends in April. The Factor Table is based on April forecast results. The February and March Forecasts act as adjustments to get to the April 1 state. The forecasts have the following protocol:

February Forecast (forecasting April 1 state):
End of January storage + Feb-Jul UF - Feb-Jul US adjustment - Feb-Mar minimum river
March Forecast (forecasting April 1 state):
End of February storage + Mar-Jul UF - Mar-Jul US adjustment - Mar minimum river
April Forecast: (final)
End of March storage + Apr-Jul UF - Apr-July US adjustment

Pre-knowledge of unimpaired runoff for each forecast period is assumed, as well as knowledge of upcoming upstream impairment of the runoff.

The WSF factor / Don Pedro Storage + Inflow relationship is developed through iterations of multi-year system operation simulations. The WSF depicts actions that may be implemented during times of drought, and the projected canal diversions and reservoir storage operation during drought periods. The factors and index triggers were developed reviewing reservoir storage levels that occurred during the 1987-1992 drought.

A snapshot of the worksheet is shown below.

Don Pedro Reservoir Inflow Forecast for Diversion of Water Supply

Unit Title 2
Parameter Title 3

Acre-foot to CFS conversion
divide by: 1.983471

(W)ater (S)upply (F)actor is established by forecasting upcoming water supply, based on antecedent storage and anticipated inflow to Don Pedro Reservoir.

Forecast begins for February:
EO-January storage + Feb-July UF - Feb-July US adj - Feb-Mar minimum river
March Forecast:
EO-February storage + Mar-July UF - Mar-July US adj - Mar minimum river
April Forecast: (final)
EO-March storage + Apr-July UF - Apr-July US adj

Factor Table is April Forecast based
February and March Forecasts act as adjustments to estimate April 1 state.

Read by Daily Canals Compute

Reservoir Index Method - Active Matrix

	M/T NDP Stor + Infl Index	M/TID WS Factor	+1	+1
	kaf	%		
Enter Values	0	0.6	1350	0.6
	1350	0.6	1600	0.85
	1600	0.85	2000	0.85
	2000	0.85	2001	1
	2001	1	2300	1
	2300	1	9999	1
	9999	1		

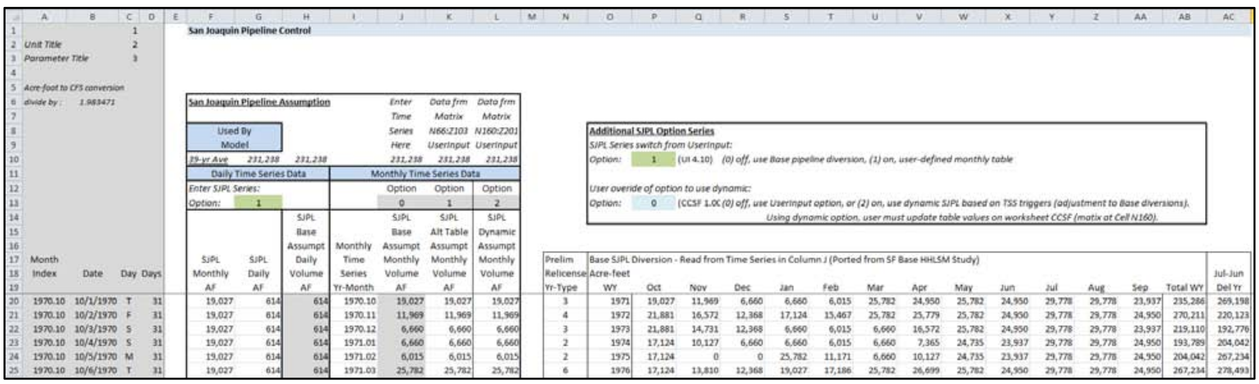
							Unimpaired Flow - Actual Used									Upstream Adjustement to UF			River		Storage	Forecast	WSF				
Month Index	Date	Day	Days	Month	Model DP Storage	Feb UF	Mar UF	Apr UF	May UF	Jun UF	Jul UF	F-Jul UF	M-Jul UF	A-Jul UF	F-Jul US	M-Jul US	A-Jul US	Feb River	Mar River	Prev Stor	Forecast	Lower WSP Factor	Upper WSP Factor	Lower Break Point	Upper Break Point	WSF
					AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	Unit	Unit	Unit	Unit	Unit
1970.10	10/1/1970	T	31	10	1666767	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,500,000	1.0000	1.0000	2300	9999	1.0000
1970.10	10/2/1970	F	31	10	1664567	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,500,000	1.0000	1.0000	2300	9999	1.0000
1970.10	10/3/1970	S	31	10	1662719	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,500,000	1.0000	1.0000	2300	9999	1.0000
1970.10	10/4/1970	S	31	10	1659892	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,500,000	1.0000	1.0000	2300	9999	1.0000
1970.10	10/5/1970	M	31	10	1656745	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,500,000	1.0000	1.0000	2300	9999	1.0000
1970.10	10/6/1970	T	31	10	1654119	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,500,000	1.0000	1.0000	2300	9999	1.0000

5.20 CCSF Workheet

This worksheet (CCSF) identifies, assembles and directs several elements of CCSF System operations, and provides input to other Model component worksheets.

San Joaquin Pipeline Diversions

The first section of logic concerns the identification of SJPL diversions. A snapshot of this section is shown below. By user selection (UI 4.10) either pre-processed Test Case SJPL diversions are used, or a user specified table of monthly diversions for the simulation period are used. This section assembles the user selected version of diversions for use by the Model. These two versions of SJPL diversions are available for selection through worksheet UserInput. If access is granted, a third version of SJPL diversions is provided which revises Test Case diversions based on circumstances of the scenario that changes CCSF's operation. Procedures are described below the monthly diversion matrix describing how to employ this third version of SJPL diversions.



Month Index	Date	Day	Days	SJPL Monthly AF	SJPL Daily AF	SJPL Base Assumpt Daily Volume AF	Monthly Time Series Yr-Month	SJPL Base Assumpt Monthly Volume AF	SJPL Alt Table Assumpt Monthly Volume AF	SJPL Dynamic Assumpt Monthly Volume AF
1970.10	10/1/1970	T	31	19,027	614	614	1970.10	19,027	19,027	19,027
1970.10	10/2/1970	F	31	19,027	614	614	1970.11	11,969	11,969	11,969
1970.10	10/3/1970	S	31	19,027	614	614	1970.12	6,660	6,660	6,660
1970.10	10/4/1970	S	31	19,027	614	614	1971.01	6,660	6,660	6,660
1970.10	10/5/1970	M	31	19,027	614	614	1971.02	6,015	6,015	6,015
1970.10	10/6/1970	T	31	19,027	614	614	1971.03	25,782	25,782	25,782

Prelim Relicense Yr-Type	WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total WY	Jul-Jun Del Yr
3	1971	19,027	11,969	6,660	6,660	6,015	25,782	24,950	25,782	24,950	29,778	29,778	23,937	235,286	269,198
4	1972	21,881	16,572	12,368	17,124	15,467	25,782	25,779	25,782	24,950	29,778	29,778	24,950	270,211	220,123
3	1973	21,881	14,731	12,368	6,660	6,015	6,660	16,572	25,782	24,950	29,778	29,778	23,937	219,110	192,776
2	1974	17,124	10,127	6,660	6,660	6,015	6,660	7,365	24,735	23,937	29,778	29,778	24,950	193,789	204,042
2	1975	17,124	0	0	25,782	11,171	6,660	10,127	24,735	23,937	29,778	29,778	24,950	204,042	267,234
6	1976	17,124	13,810	12,368	19,027	17,186	25,782	26,699	25,782	24,950	29,778	29,778	24,950	267,234	278,493

CCSF System Storage and Action Levels

This section of logic provides reporting and computational functions. The CCSF System action level computation analyzes scenario results concerning CCSF's reservoir storage and extrapolates that information into advised action levels within the CCSF System. Germane to the FERC investigation is the potential effect that flow responsibility placed upon CCSF may have upon its water system and deliveries. The relationship between CCSF System reservoir storage and action levels (translated to increased delivery rationing) is incorporated into this worksheet. Upon changed conditions within a scenario (as compared to Test Case conditions), the change in action levels is identified. This change is also provided the SJPL diversion logic described above, and if allowed to be selected this worksheet will perform an adjustment to SJPL diversions.

Row	A	B	C
1			1
2	*Unit Title*		2
3	*Parameter Title*		3
5	*Acre-foot to CFS conversion*		
6	*divide by :*	*1.983471*	

San Franciso System Storage and Action Levels

	AE	AF	AG	AH	AI	AJ	AK	AL	AM
2	Level	AF	AF	AF	AF	AF	AF	AF	AF
3	Plng Mod	Hetch Het	Lake Lloyd	Lake Eleanor Storage			Total HH S	Local Stor	Total Syst	Model Action Level

SF System Storage and Action Level Status - Daily Time Series Data

Linked to SF Base HHLSM Study "Hydrology" — *Use Only Last Day of Month Plotting*

Scenario Model Results plus SF Base HHLSM Study Local System Storage

Month Index	Date	Day	Days	Base Action Level	Scenario Hetch Hetchy Storage AF	Scenario Lake Lloyd Storage AF	Scenario Lake Eleanor Storage AF	Scenario Water Bank Balance AF	Scenario Total Upcountry Storage AF	Scenario Total HH System Storage AF	Base Local Storage Incl GW EOM AF	Total System Storage Incl GW EOM AF	Scenario Action Level
1970.10	10/1/1970	T	31	0	249,349	200,091	17,591	570,000	467,031	1,037,031	211,136	3,000,000	0
1970.10	10/2/1970	F	31	0	248,379	200,080	17,137	570,000	465,596	1,035,596	211,136	3,000,000	0
1970.10	10/3/1970	S	31	0	247,622	200,090	16,692	570,000	464,404	1,034,404	211,136	3,000,000	0
1970.10	10/4/1970	S	31	0	247,032	199,278	15,878	570,000	462,189	1,032,189	211,136	3,000,000	0
1970.10	10/5/1970	M	31	0	246,150	199,896	15,707	569,744	461,752	1,031,496	211,136	3,000,000	0
1970.10	10/6/1970	T	31	0	245,360	199,781	15,206	570,000	460,347	1,030,347	211,136	3,000,000	0

SF System Action Level Computation

Actions	C2a.30	C2a.30			
Level	BaseTrigger	BaseAction	ScenarioT	ScenarioA	
0		0			
1	1,100,000	10	1,100,000	10	CCSF 2.00
2	1,100,000	10	1,100,000	10	
3	700,000	20	700,000	20	

Action Level Count	Base	Scenario
Level	Count	Count
0	33	33
1	0	0
2	6	6
3	0	0
Total	39	39

SF Action Level & SJPL Adjustment

EO-Jun	Year	SF Base June 30 TSS AF ("Hydrology")	SF Base Action Level (0-3)	Scenario June 30 TSS AF	Scenario Action Level (0-3)

Hetch Hetchy Reservoir Control

This section of logic identifies several underlying operation constraints for Hetch Hetchy Reservoir. Snapshots of this section are shown below. The minimum stream release below Hetch Hetchy Reservoir is computed in this section. Also identified in this section are reservoir storage targets and limits. This information is used in worksheet SFHetchHetchy for several operational constraints and objectives.

Hetch Hetchy Reservoir Control

Schedule Index - Accum Inches or Storage: Cal Mon	A (1)	B (2)	C (3)
1	8.80	6.1	
2	14	9.5	
3	18.6	14.2	
4	23	18	
5	26.6	19.5	
6	28.45	21.25	
7	575,000	390,000	
8	640,000	400,000	

Below Hetch Hetchy Requirement - CFS: Cal Mon	A (1)	B (2)	C (3)	Discretionary Schedule - Acre-feet: Cal Mon	A (1) 15,000	B (2) 6,500	C (3) 4,400
1	50	40	35	1	0	0	0
2	60	50	35	2	0	0	0
3	60	50	35	3	0	0	0
4	75	65	35	4	0	0	0
5	100	80	50	5	0	0	0
6	125	110	75	6	0	0	0
7	125	110	75	7	0	0	0
8	125	72.5	75	8	0	0	0
9	90	65	62.5	9	0	0	0
10	60	50	35	10	0	0	0
11	60	50	35	11	0	0	0
12	50	40	35	12	0	0	0

Month Index	Date	Day	Days	HH Accum Precip beginning Oct 1 Inches	Sum of WY HH Inflow To Date AF	Trigger Due to Inflow Jul-Dec AF	Schedule Due to Inflow Jul	Schedule Due to Inflow Aug - Dec	Jan Schedule	Feb Schedule	Mar Schedule	Apr Schedule	May Schedule	Jun Schedule	10 Oct Schedule CFS	11 Nov Schedule CFS	12 Dec Schedule CFS
						709,538		1									
1970.10	10/1/1970	T	31	0.73	157	709,538	0	1	0	0	0	0	0	0	60	0	0
1970.10	10/2/1970	F	31	0.73	-6	709,538	0	1	0	0	0	0	0	0	60	0	0
1970.10	10/3/1970	S	31	0.73	44	709,538	0	1	0	0	0	0	0	0	60	0	0
1970.10	10/4/1970	S	31	0.73	262	709,538	0	1	0	0	0	0	0	0	60	0	0
1970.10	10/5/1970	M	31	0.73	186	709,538	0	1	0	0	0	0	0	0	60	0	0
1970.10	10/6/1970	T	31	0.73	204	709,538	0	1	0	0	0	0	0	0	60	0	0

Target Storage - Acre-feet: Cal Mon	Target EOM	Limit EOM
0	320000	
1	320,000	360,360
2	320,000	360,360
3	320,000	360,360
4	320,000	360,360
5	360,360	360,360
6	360,360	360,360
7	360,360	360,360
8	360,360	360,360
9	360,360	360,360
10	330,000	360,360
11	320,000	360,360
12	320,000	360,360

Month on 5. *Does not include offramp of Discret "C" Sch due to HH Stor* / *Does not include Canyon 64 cfs* / *Lagged by 1 day to avoid circular reference*

Month Index	Date	Day	Days	1 Jan Schedule CFS	2 Feb Schedule CFS	3 Mar Schedule CFS	4 Apr Schedule CFS	5 May Schedule CFS	6 Jun Schedule CFS	7 Jul Schedule CFS	8 Aug Schedule CFS	9 Sep Schedule CFS	Basic Schedule AF	Discret Schedule AF	Min HH Basic + Discret Schedule AF	Canyon 64 cfs Schedule AF	w/ 64 cfs Total Min HH Schedule AF (Total Mini)	w/ 64 cfs Total Min HH Schedule CFS (Total Mini)	Day Chg Target	Target 360,360
1970.10	10/1/1970	T	31	0	0	0	0	0	0	0	0	0	119	0	119		119	60	-979	359,381
1970.10	10/2/1970	F	31	0	0	0	0	0	0	0	0	0	119	0	119	0	119	60	-979	358,401
1970.10	10/3/1970	S	31	0	0	0	0	0	0	0	0	0	119	0	119	0	119	60	-979	357,422
1970.10	10/4/1970	S	31	0	0	0	0	0	0	0	0	0	119	0	119	0	119	60	-979	356,443
1970.10	10/5/1970	M	31	0	0	0	0	0	0	0	0	0	119	0	119	0	119	60	-979	355,463
1970.10	10/6/1970	T	31	0	0	0	0	0	0	0	0	0	119	0	119	0	119	60	-979	354,484

Lake Lloyd Control

This section of logic identifies several underlying operation constraints for Lake Lloyd. A snapshot of this section is shown below. The minimum stream release below Lake LLoyd is computed in this section. Also identified in this section are reservoir storage targets and limits, and the target release objective for Holm Powerhouse. The maximum drawdown of Lake Lloyd due to supplemental releases is identified. This information is used in worksheet SFLloyd for several operational constraints and objectives.

	A	B	C	D	CE	CF	CG	CH
1			1			Lake Lloyd and Lake Eleanor Control		
2	*Unit Title*		2			Lloyd Target Storage - Acre-feet		
3	*Parameter Title*		3				Soft Trgt	Hard Limit
4						Cal Mon	EOM	EOM
5	*Acre-foot to CFS conversion*					0	238,000	
6	*divide by :*	*1.983471*				1	238,000	273,300
7						2	238,000	273,300
8						3	238,000	273,300
9						4	273,300	273,300
10						5	273,300	273,300
11						6	273,300	273,300
12						7	268,000	273,300
13						8	258,000	273,300
14						9	248,000	273,300
15						10	248,000	273,300
16						11	238,000	273,300
17	Month					12	238,000	273,300
18	Index	Date	Day	Days		Day Chg	Target	
19						Target	248,000	
20	1970.10	10/1/1970	T	31		0	248,000	
21	1970.10	10/2/1970	F	31		0	248,000	
22	1970.10	10/3/1970	S	31		0	248,000	
23	1970.10	10/4/1970	S	31		0	248,000	
24	1970.10	10/5/1970	M	31		0	248,000	
25	1970.10	10/6/1970	T	31		0	248,000	

	CI	CJ	CK	CL	CM	CN
1						
2		Lake Lloyd/Lake Eleanor Split of Combined Inflow				
3			Lloyd	Eleanor		
4		Cal Mon	%	%	*Note:*	
5		1	53	47	*Watershed*	
6		2	52	48	*proportions*	
7		3	52	48	*were developed*	
8		4	57	43	*from the record*	
9		5	65	35	*of runoff each basin*	
10		6	72	28	*basin prior to 1960.*	
11		7	72	28		
12		8	56	44		
13		9	52	48		
14		10	69	31		
15		11	58	42		
16		12	57	43		
17		Total	Lloyd	Lloyd	Eleanor	Eleanor
18		Inflow	Inflow	Inflow	Inflow	Inflow
19		CFS	CFS	AF	CFS	AF
20		81	56	111	25	50
21		7	5	10	2	4
22		22	15	30	7	14
23		-578	-399	-791	-179	-355
24		466	322	638	144	287
25		-69	-48	-94	-21	-42

	CO	CP	CQ	CR	CS	CT	CU	CV
1								
2		Blw Lake Lloyd - CFS			Holm Target Releases			
3		Cal Mon	Req					
4		1	5		May (Memorial Day) thru			
5		2	5		August (Labor Day)			
6		3	5		Holm Capacity		950	cfs
7		4	5			Day	1,884	acre-feet
8		5	5			4-hours per day	314	acre-feet
9		6	5					
10		7	15.5		Minimum Lloyd Storage to Draw			
11		8	15.5		for Water Bank/Supplemental Release			
12		9	15.5		Release:	45,000	acre-feet	CCSF 3.00
13		10	5					
14		11	5			May-Aug		
15		12	5			Min		
16						Holm		
17		Min Req	Min Req			Target		
18		Release	Release			Release		
19		CFS	AF		CFS	AF		
20		5	10		0	0		
21		5	10		0	0		
22		5	10		0	0		
23		5	10		0	0		
24		5	10		0	0		
25		5	10		0	0		

Lake Eleanor Control

This section of logic identifies several underlying operation constraints for Lake Eleanor. A snapshot of this section is shown below. The minimum stream release below Lake LLoyd is computed in this section. Also identified in this section are reservoir storage targets and limits. This information is used in worksheet SFEleanor for several operational constraints and objectives.

	A	B	C	D	CW	CX	CY	CZ	DA	DB	DC	DD
1			1									
2	*Unit Title*		2			Blw Lake Eleanor - CFS				Eleanor Target Storage - Acre-f		
3	*Parameter Title*		3				w/Pump	w/o			Soft Trgt	Hard Limit
4						Cal Mon	Req	Req		Cal Mon	EOM	EOM
5	*Acre-foot to CFS conversion*					1	5	5		0	18,250	
6	*divide by :*	*1.983471*				2	5	5		1	21,495	27,100
7						3	10	5		2	21,495	27,100
8						4	15	5		3	21,495	27,100
9						5	20	5		4	27,100	27,100
10						6	20	5		5	27,100	27,100
11						7	20	16		6	27,100	27,100
12						8	20	16		7	27,100	27,100
13						9	15	16		8	27,100	27,100
14						10	10	5		9	15,000	27,100
15						11	5	5		10	15,000	27,100
16						12	5	5		11	15,000	27,100
17	Month					Min Req	Min Req	*Always*		12	18,250	27,100
18	Index	Date	Day	Days		Release	Release	*Assume*		Day Chg	Target	
19						CFS	AF	*Pump*		Target	15,000	
20	1970.10	10/1/1970	T	31		10	20			0	15,000	
21	1970.10	10/2/1970	F	31		10	20			0	15,000	
22	1970.10	10/3/1970	S	31		10	20			0	15,000	
23	1970.10	10/4/1970	S	31		10	20			0	15,000	
24	1970.10	10/5/1970	M	31		10	20			0	15,000	
25	1970.10	10/6/1970	T	31		10	20			0	15,000	

5.21 Hydrology Workheet

This worksheet (Hydrology) identifies and assembles underlying watershed hydrologic data necessary for Model operation. Required elements of historical hydrology include inflows to CCSF System reservoirs and the unregulated inflow to Don Pedro Reservoir. Also necessary are certain Test Case conditions for the CCSF System, namely Test Case SJPL diversions and water delivery (action levels) associated with Test Case conditions. Also needed is the status of local watershed reservoir storage associated with the Test Case condition.

5.22 602020 Workheet

This worksheet (602020) identifies and assembles underlying watershed hydrologic data necessary for Model operation. Included is the computation of the San Joaquin River Index. Also included are published results of DWR runoff forecasts.

From: Staples, Rose
Sent: Friday, October 19, 2012 10:55 AM
To: Alves, Jim; Anderson, Craig; Asay, Lynette; Barnes, James; Barnes, Peter; Beniamine Beronia; Blake, Martin; Bond, Jack; Borovansky, Jenna; Boucher, Allison; Bowes, Stephen; Bowman, Art; Brenneman, Beth; Brewer, Doug; Buckley, John; Buckley, Mark; Burt, Charles; Byrd, Tim; Cadagan, Jerry; Carlin, Michael; Charles, Cindy; Colvin, Tim; Costa, Jan; Cowan, Jeffrey; Cox, Stanley Rob; Cranston, Peggy; Cremeen, Rebecca; Damin Nicole; Day, Kevin; Day, P; Denean; Derwin, Maryann Moise; Devine, John; Donaldson, Milford Wayne; Dowd, Maggie; Drekmeier, Peter; Edmondson, Steve; Eicher, James; Fargo, James; Ferranti, Annee; Ferrari, Chandra; Fety, Lauren; Findley, Timothy; Fuller, Reba; Furman, Donn W; Ganteinbein, Julie; Giglio, Deborah; Gorman, Elaine; Grader, Zeke; Gutierrez, Monica; Hackamack, Robert; Hastreiter, James; Hatch, Jenny; Hayat, Zahra; Hayden, Ann; Hellam, Anita; Heyne, Tim; Holley, Thomas; Holm, Lisa; Horn, Jeff; Horn, Timi; Hudelson, Bill; Hughes, Noah; Hughes, Robert; Hume, Noah; Jackman, Jerry; Jackson, Zac; Jauregui, Julia; Jennings, William; Jensen, Art; Jensen, Laura; Johannis, Mary; Johnson, Brian; Justin; Keating, Janice; Kempton, Kathryn; Kinney, Teresa; Koepele, Patrick; Kordella, Lesley; Lein, Joseph; Levin, Ellen; Lewis, Reggie; Linkard, David; Loy, Carin; Lwenya, Roselynn; Lyons, Bill; Madden, Dan; Manji, Annie; Marko, Paul; Marshall, Mike; Martin, Michael; Martin, Ramon; Mathiesen, Lloyd; McDaniel, Dan; McDevitt, Ray; McDonnell, Marty; McLain, Jeffrey; Mein Janis; Mills, John; Minami Amber; Monheit, Susan; Morningstar Pope, Rhonda; Motola, Mary; Murphey, Gretchen; O'Brien, Jennifer; Orvis, Tom; Ott, Bob; Ott, Chris; Paul, Duane; Pavich, Steve; Pinhey, Nick; Pool, Richard; Porter, Ruth; Powell, Melissa; Puccini, Stephen; Raeder, Jessie; Ramirez, Tim; Rea, Maria; Reed, Rhonda; Richardson, Kevin; Ridenour, Jim; Robbins, Royal; Romano, David O; Roos-Collins, Richard; Roseman, Jesse; Rothert, Steve; Sandkulla, Nicole; Saunders, Jenan; Schutte, Allison; Sears, William; Shakal, Sarah; Shipley, Robert; Shumway, Vern; Shutes, Chris; Sill, Todd; Slay, Ron; Smith, Jim; Staples, Rose; Steindorf, Dave; Steiner, Dan; Stone, Vicki; Stork, Ron; Stratton, Susan; Taylor, Mary Jane; Terpstra, Thomas; TeVelde, George; Thompson, Larry; Vasquez, Sandy; Verkuil, Colette; Vierra, Chris; Wantuck, Richard; Welch, Steve; Wesselman, Eric; Wheeler, Dan; Wheeler, Dave; Wheeler, Douglas; Wilcox, Scott; Williamson, Harry; Willy, Allison; Wilson, Bryan; Winchell, Frank; Wooster, John; Workman, Michelle; Yoshiyama, Ron; Zipser, Wayne
Subject: LIVE MEETING LINK-AUDIO INFO for Don Pedro Relicensing Operations Model Training-Validation Meeting October 23 2012
Attachments: OpsModelTraining-ValidationMtg-Oct 23 2012_W-AR-02_AGENDA_Update 20121019.doc

Please find below (and attached) a copy of the AGENDA (as previously released) together with the addition of the Audio call-in number—and a link to LIVE MEETING for those who want to participate but are unable to attend in person. This is also a reminder to bring your computer to the meeting, so that the Model can be loaded on it.

Operations Model Training / Validation Meeting
Don Pedro Relicensing Study W&AR-2
October 23, 2012 – 9:00 a.m. to 4:00 p.m. - MID Offices

Audio Call-In Number: 866-994-6437, Conference Code 5424697994
To LINK to LIVE Meeting, please see below

LINK to LIVE MEETING:
TO JOIN THE DISCUSSION VIA "LIVE MEETING":

....

[Join online meeting](https://meet.hdrinc.com/jenna.borovansky/3D64F0F5)
https://meet.hdrinc.com/jenna.borovansky/3D64F0F5

First online meeting?

....

AGENDA

9:00 a.m. to 9:10 a.m.	**Introductions**
9:10 a.m. to 9:20 a.m.	**Review of Agenda**
9:20 a.m. to 9:30 a.m.	**Purpose of Meeting**
9:30 a.m. to 9:45 a.m.	**Overview of FERC-Approved Study Plan**
9:45 a.m. to 10:00 a.m.	**Summary of Prior Workshops**
10:00 a.m. to 12:30 p.m.	**Presentation of Model Architecture, Model Description, and User's Guide**
12:30 p.m. to 1:15 p.m.	**Lunch: On Your Own**
1:15 p.m. to 1:30 p.m.	**Load Model on Computers** *Note to Participants: Bring Your Computer!*
1:30 p.m. to 4:00 p.m.	**Model Operation and Introduction to Running the Model**

ROSE STAPLES
CAP-OM

HDR Engineering, Inc.
Executive Assistant, Hydropower Services

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Operations Model Training / Validation Meeting
Don Pedro Relicensing Study W&AR-2
October 23, 2012 – 9:00 a.m. to 4:00 p.m. - MID Offices

Audio Call-In Number: 866-994-6437, Conference Code 5424697994
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AGENDA

9:00 a.m. to 9:10 a.m.	Introductions
9:10 a.m. to 9:20 a.m.	Review of Agenda
9:20 a.m. to 9:30 a.m.	Purpose of Meeting
9:30 a.m. to 9:45 a.m.	Overview of FERC-Approved Study Plan
9:45 a.m. to 10:00 a.m.	Summary of Prior Workshops
10:00 a.m. to 12:30 p.m.	Presentation of Model Architecture, Model Description, and User's Guide
12:30 p.m. to 1:15 p.m.	Lunch: On Your Own
1:15 p.m. to 1:30 p.m.	Load Model on Computers *Note to Participants: Bring Your Computer!*
1:30 p.m. to 4:00 p.m.	Model Operation and Introduction to Running the Model

LINK to LIVE MEETING:
TO JOIN THE DISCUSSION VIA "LIVE MEETING":

....

Join online meeting
https://meet.hdrinc.com/jenna.borovansky/3D64F0F5

First online meeting?

....

From: Staples, Rose
Sent: Monday, March 18, 2013 1:09 PM
To: Alves, Jim; Amerine, Bill; Anderson, Craig; Asay, Lynette; Barnes, James; Barnes, Peter; Barrera, Linda; Beniamine Beronia; Blake, Martin; Bond, Jack; Borovansky, Jenna; Boucher, Allison; Bowes, Stephen; Bowman, Art; Brenneman, Beth; Brewer, Doug; Buckley, John; Buckley, Mark; Burke, Steve; Burt, Charles; Byrd, Tim; Cadagan, Jerry; Carlin, Michael; Charles, Cindy; Colvin, Tim; Costa, Jan; Cowan, Jeffrey; Cox, Stanley Rob; Cranston, Peggy; Cremeen, Rebecca; Damin Nicole; Day, Kevin; Day, P; Denean; Derwin, Maryann Moise; Devine, John; Donaldson, Milford Wayne; Dowd, Maggie; Drake, Emerson; Drekmeier, Peter; Edmondson, Steve; Eicher, James; Fargo, James; Ferranti, Annee; Ferrari, Chandra; Fety, Lauren; Findley, Timothy; Fleming, Mike; Fuller, Reba; Furman, Donn W; Ganteinbein, Julie; Giglio, Deborah; Gorman, Elaine; Grader, Zeke; Gutierrez, Monica; Hackamack, Robert; Hastreiter, James; Hatch, Jenny; Hayat, Zahra; Hayden, Ann; Hellam, Anita; Heyne, Tim; Holley, Thomas; Holm, Lisa; Horn, Jeff; Horn, Timi; Hudelson, Bill; Hughes, Noah; Hughes, Robert; Hume, Noah; Jackson, Zac; Jauregui, Julia; Jennings, William; Jensen, Art; Jensen, Laura; Johannis, Mary; Johnson, Brian; Jones, Christy; Jsansley; Justin; Keating, Janice; Kempton, Kathryn; Kinney, Teresa; Koepele, Patrick; Kordella, Lesley; Le, Bao; Lein, Joseph; Levin, Ellen; Lewis, Reggie; Linkard, David; Loy, Carin; Lwenya, Roselynn; Lyons, Bill; Madden, Dan; Manji, Annie; Marko, Paul; Marshall, Mike; Martin, Michael; Martin, Ramon; Mathiesen, Lloyd; McDaniel, Dan; McDevitt, Ray; McDonnell, Marty; Mein Janis; Mills, John; Monheit, Susan; Morningstar Pope, Rhonda; Motola, Mary; Murphey, Gretchen; Murray, Shana; O'Brien, Jennifer; Orvis, Tom; Ott, Bob; Ott, Chris; Paul, Duane; Pavich, Steve; Pool, Richard; Porter, Ruth; Powell, Melissa; Puccini, Stephen; Raeder, Jessie; Ramirez, Tim; Rea, Maria; Reed, Rhonda; Richardson, Daniel; Richardson, Kevin; Ridenour, Jim; Riggs T; Robbins, Royal; Romano, David O; Roos-Collins, Richard; Rosekrans, Spreck; Roseman, Jesse; Rothert, Steve; Sandkulla, Nicole; Saunders, Jenan; Schutte, Allison; Sears, William; Shakal, Sarah; Shipley, Robert; Shumway, Vern; Shutes, Chris; Sill, Todd; Slay, Ron; Smith, Jim; Staples, Rose; Stapley, Garth; Steindorf, Dave; Steiner, Dan; Stender, John; Stone, Vicki; Stork, Ron; Stratton, Susan; Taylor, Mary Jane; Terpstra, Thomas; TeVelde, George; Thompson, Larry; Tmberliner; Ulibarri, Nicola; Ulm, Richard; Vasquez, Sandy; Verkuil, Colette; Vierra, Chris; Wantuck, Richard; Welch, Steve; Wenger, Jack; Wesselman, Eric; Wheeler, Dan; Wheeler, Dave; Wheeler, Douglas; White, David K; Wilcox, Scott; Williamson, Harry; Willy, Allison; Wilson, Bryan; Winchell, Frank; Wooster, John; Workman, Michelle; Yoshiyama, Ron; Zipser, Wayne
Subject: Don Pedro Ops Model Workshop/Training Sessions Oct 23 and Dec 7 DRAFT NOTES for Review
Attachments: P-2299 Don Pedro W-AR-02 Dec 7 2012 Workshop Notes_DRAFT_130316.docx; P-2299 Don Pedro W-AR-02 Oct 23 2012 Workshop Notes_DRAFT_130316.doc

Please find attached the DRAFT Meeting Notes for the Don Pedro Operations Model Workshop and Training Sessions held on October 23, 2012 and December 7, 2012. These draft notes are being forwarded to you for your review before being filed with FERC. Please send any comments to me at rose.staples@hdrinc.com by Thursday, April 18, 2013. Thank you.

ROSE STAPLES
CAP-OM

HDR Engineering, Inc.
Executive Assistant, Hydropower Services

970 Baxter Boulevard, Suite 301 | Portland, ME 04103
207.239.3857 | f: 207.775.1742
rose.staples@hdrinc.com| hdrinc.com

Don Pedro Project Relicensing
Operations Model Workshop and Training Session (W&AR-02)
DRAFT Meeting Notes
October 23, 2012
Location: Modesto Irrigation District

Attendees:

Ron Stork, Friends of the River	Tim Findley, Bay Area Water Users	Bob Hughes, CDFG
Zac Jackson, USFWS	Robert Nees, TID	Rob Sherrick, HDR
Peter Barnes, SWRCB	Chris Shutes, CSPA	Bill Sears, CCSF
Bob Hughes, CDFG	Nicola Ulibarri, Stanford University	Ellen Levin, CCSF
Dan Steiner	Art Goodwin, TID	Donn Furman, CCSF
Bill Paris, MID	Joy Warren, MID	John Wooster, NMFS
Bill Johnston, MID	Greg Dias, MID	Dale Stanton, CDFG
Spreck Rosekrans, Restore Hetch Hetchy	John Devine, HDR	Patrick Koepele (by phone)
Bob Hackamack	Jenna Borovansky, HDR	Jim Fargo, FERC (by phone)
Daniel McDaniels, Central Delta Water Agency (by	Chandra Ferrari, Trout Unlimited (by phone)	Dave Boucher (by phone)
Jim Alves, City of Modesto (by phone)	Annie Manji (by phone)	
Ramon Martin, USFWS (by phone)	Allison Boucher (by phone)	

Meeting Materials

Materials will be attached to the final meeting notes filed with FERC.

Meeting materials provided were:

- Agenda (attached)
- PowerPoint Presentation (attached)
- Draft User's Guide (attached)

Meeting Summary

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The schematic showing existing nodes in the Operations Model was reviewed with RPs. Additional nodes can be added as needed where there is a change in hydrology.

Mr. Steiner then presented and discussed with RPs a series of PowerPoint slides covering key elements of the Operations Model user's manual. Questions from RPs and responses during this discussion are summarized below.

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Response: Mr. Steiner explained that for supplemental releases, water first comes from Cherry/Eleanor, then Hetch Hetchy.

Comment: Mr. Shutes inquired whether the user-adjustable "knob" that controls CCSF water withdraws from Hetch Hetchy and Cherry-Eleanor separately.
Response: Mr. Steiner indicated that the "knob" controls total CCSF water, with the model specifying flows must come from Cherry-Eleanor first, then Hetch Hetchy.

Mr. Steiner explained that inflow to Don Pedro is about 60% from the regulated portion of the watershed and about 40% from the unregulated portion. He noted that this does not change between scenarios. Mr. Steiner demonstrated in the model where to find the CCSF Water Bank Account information.

Comment: Mr. Koepele inquired if there is tabulation for flood storage space.
Response: Mr. Steiner replied that use of flood storage space can be derived by viewing model outputs because flood storage all occurs about elev 801.9 ft.

Comment: Mr. Rosekrans inquired if water necessarily comes through the Holm powerhouse and do user-specified releases have to go through Holm, or Cherry releases.
Response: Mr. Steiner replied that the model does not differentiate between flows through Holm Powerhouse or simply released at the dam because generation at Holm is not part of the model.

Reservoir Operation Goals and Model Algorithms

Mr. Steiner then reviewed information on each of the following areas within the model. RP comments and responses are recorded below.

- Minimum releases
  - Instream flows
  - Diversion demand (MID/TID canals & CCSF San Joaquin Pipeline)
  - Other
- Reservoir Guidance Curves / storage targets
  - Rainfall flood control

- □ Snowmelt allocation and management
- □ Other storage goals

Comment: Mr. Koepele inquired if the flood control rule curves can be modified in the model (dates and volumes)?
Response: Mr. Steiner replied that because of the open Excel format all parameters are "customizable"; however, the reservoir guidance curves are currently fixed because a change in the guidance curve could fundamentally change the operation of the project. The model could be modified to allow it, if necessary.

Comment: Mr. Hughes noted he thought that the flood control guidance curves were more complicated for the snowmelt period.
Response: Mr. Steiner replied that the ACOE curves for the snowmelt portion of the year have different target levels at times of the year depending on the projected runoff and the month.

Comment: Mr. Stork asked how the Districts' canal diversion demand was estimated.
Response: Mr. Steiner replied that the sample demands are pre-determined (processed) using a district-level water demand procedure and water supply forecasting technique beginning in February that is based on an annual-varying water need.

Comment: Mr. Stork asked about the process for estimating spillway operations.
Response: Mr. Steiner explained that Don Pedro releases come through the powerhouse first, then the hollow-jet valve, then the outlet works, and "spill" only occurs if water levels exceed 830 ft with all these various outflows already operating. Consistent with the ACOE manual, releases are attempted to be held to under 9,000 cfs at the Modesto gage (including Dry Creek and accretion) until they cannot be any longer due to inflow flood conditions. As far as the model is concerned, all releases in excess of the powerhouse capability are considered as "spill" whether it would be physically made through outlets or the spillway.

Comment: A question was asked regarding whether the model routes the Reservoir Design Flood.
Response: Mr. Steiner explained that the model has not routed the flood. The current hydrology is historical, including 1997.

Comment: Mr. Shutes asked how canal diversions were adjusted through the seasons. Are they hardwired as a time series, or calculated on a month-to-month basis?
Response: Mr. Steiner replied that diversion demand is currently locked in as a fixed time series, which is based on month-to-month varying demand. In order to change the diversion, one must change the time series with the "knob."

Comment: Mr. Rosekrans asked when does the CCSF water bank account drive operations.
Response: Mr. Steiner explained that only when it's depleted would the water bank account influence operations; and except for the '87 through '92 drought, the water bank is never really very low. The model does not automatically react to a state of depletion; the user must adjust CCSF releases.

Comment: A follow-up question was asked: could there be alternative scenarios that would empty the water bank more often?
Responses: Mr. Steiner stated that, yes, if more water is called for in the lower Tuolumne and CCSF is assigned responsibility, it's possible that the water bank could empty more often.

Comment: Mr. Stork inquired if there been a PMF [probable maximum flood] completed for Don Pedro.
Response: Mr. Devine replied that yes, it has been done separate from relicensing, and is not part of this model. The results are probably CEII (Critical Energy Infrastructure Information) and thus protected from public inspection on FERC's website. If requested, the Districts could set-up a conference call to provide the PMF information on Don Pedro. The Project safely passes the PMF.

Comment: Mr. Hughes asked for additional explanation of how demands from the San Joaquin Pipeline and Districts canals are established. Were they current use levels or a 'projected level of development?
Response: Mr. Steiner replied that the Districts' demand models are land use based using 2005 data, adjusted to more recent conditions, and applied to the 39 years of hydrology. Mr. Steiner also noted that the CCSF SJPL demand comes from a planning study, and is based on recent levels of water demand.

Comment: RPs requested that this information be documented in the user guide.
Response: Mr. Steiner noted that additional information should be in final model report, which will include more discussion of assumptions and inputs. The Draft User's Guide provided today is focused on the actual model and how it operates.

Comment: Mr. Hughes noted that the "Base Case" should reflect current operations, not future or past. He read from a January 31, 2012 YBDS letter from FERC which stated the "Base Case" / No Action alternative should not include future levels of irrigation demand.
Response: Mr. Devine noted the study plan states that "Base Case" condition will be defined in March, after ISR submittal. Mr. Steiner reminded participants that today's discussion uses a "test case" which is strictly for purposes of model training.

Comment: Mr. Rosekrans asked why CCSF power production was not part of the model. While FERC has no jurisdiction over those facilities, they may inform the impacts of lower Tuolumne instream flows. Mr. Shutes added that it may be important or useful to include San Francisco's generation in model output for comprehensive impact analysis, and balancing beneficial uses. Mr. Shutes also requested that there be nodes at each of the upper Tuolumne tributaries.
Response: Mr. Devine, then Mr. Fargo both stated that those issues were covered in the Scoping Document and the Study Plan Determination, and would not be included in the model.

Comment: Rosekrans requested clarification on which of the CCSF water flow constraints are required by regulations and which are operationally determined by CCSF.
Response: Mr. Furman noted that CCSF operations are fully outlined in the WSIP that is available on-line.

The afternoon session was dedicated to hands-on demonstration of the model and RP training.

Summary of Action Items

- An additional model training session was scheduled for RPs for December 7, 2012.
- RPs requested additional information on what factors Mr. Steiner referred to as "switches." ***Mr. Steiner provided a glossary of the codes used for switches at the follow-up workshop in December.***

July 12, 2013 | Don Pedro Project
E-Filed | FERC No. 2299-075

Honorable Kimberly D Bose
Secretary
Federal Energy Regulatory Commission
Mail Code: DHAC, PJ-12.3
888 First Street NE
Washington DC 20426

RE: Turlock Irrigation District and Modesto Irrigation District
Don Pedro Project - FERC Project No. 2299
Final Meeting Notes for the October 23, 2012 and December 7, 2012 Operations Model Workshop and Training Sessions for W&AR-02

In October 2012 and December 2012, as part of the ongoing studies under the Integrated Licensing Process ("ILP") for the Don Pedro Project ("Project"), the Turlock Irrigation District and the Modesto Irrigation District (collectively, the "Districts"), co-licensees of the Project, held two relicensing participant meetings to discuss the Project Operations/Water Balance Model (W&AR-02).

October 23, 2012: Operations Model Workshop and Training Session (W&AR-02)

The Districts held Consultation Workshop No. 3 on October 23, 2012 as proposed in the Project Operations/Water Balance Model Study Plan ("Operations Model"; W&AR-02) and approved by FERC in its December 22, 2011 Study Plan Determination ("SPD"). The meeting was held to present and discuss key elements of the Operation Model user's manual and review reservoir operation goals and model algorithms. The Districts also provided an update on the accretion flow field data collection and presented a schematic of existing nodes in the Operations Model.

On March 18, 2013, the Districts circulated draft meeting notes along with responses to requests for additional information received at the meeting. Within the 30-day review period, the Districts did not receive any comments on the draft notes or the additional information; therefore, the content of the final meeting notes are the same as the draft notes distributed to relicensing participants. In accordance with Appendix B of the SPD and the Final Workshop Consultation Protocols filed with FERC on May 18, 2012, Attachment A of this filing provides the final October 23, 2012 Workshop meeting notes, which also include the meeting agenda, PowerPoint presentation, and draft model user's guide.

HDR Engineering, Inc.
970 Baxter Boulevard
Suite 301
Portland, ME 04103-5346
Phone: (207) 775-4495
Fax: (207) 775-1742
www.hdrinc.com

<u>December 7, 2012: Operations Model Workshop and Training Session (W&AR-02)</u>

The Districts held Consultation Workshop No. 4 on December 7, 2012. The purpose of the meeting was to illustrate validation of the Operations Model and to provide an additional hands-on model training opportunity for relicensing participants on use of the Operations Model. As part of the model training, Mr. Steiner walked relicensing participants through an example modeling scenario and addressed questions from participants regarding model assumptions, inputs, and outputs.

On March 18, 2013, the Districts circulated draft meeting notes. Within the 30-day review period, the Districts did not receive any comments on the draft notes; therefore, the content of the final Workshop meeting notes is the same as the draft notes distributed to relicensing participants. In accordance with Appendix B of the SPD and the Final Workshop Consultation Protocols filed with FERC on May 18, 2012, Attachment B of this filing provides the final December 7, 2012 meeting notes, which include the meeting agenda and PowerPoint presentation.

Sincerely,

John Devine, P.E.
Project Manager

Enclosures:
Attachment A – October 23, 2012 Operations Model (W&AR-02) Workshop Notes
Attachment B – December 7, 2012 Operations Model (W&AR-02) Workshop Notes

Attachment A

October 23, 2012 Operations Model (W&AR-02) Workshop Notes

Don Pedro Project Relicensing
Operations Model Workshop and Training Session (W&AR-02)
Final Meeting Notes
October 23, 2012
Location: Modesto Irrigation District

Attendees:

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Zac Jackson, USFWS	Robert Nees, TID	Rob Sherrick, HDR
Peter Barnes, SWRCB	Chris Shutes, CSPA	Bill Sears, CCSF
Bob Hughes, CDFG	Nicola Ulibarri, Stanford University	Ellen Levin, CCSF
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Operations Model Training / Validation Meeting
Don Pedro Relicensing Study W&AR-2
October 23, 2012 – 9:00 a.m. to 4:00 p.m. - MID Offices

Audio Call-In Number: 866-994-6437, Conference Code 5424697994
To LINK to LIVE Meeting, please see below

AGENDA

9:00 a.m. to 9:10 a.m.	Introductions
9:10 a.m. to 9:20 a.m.	Review of Agenda
9:20 a.m. to 9:30 a.m.	Purpose of Meeting
9:30 a.m. to 9:45 a.m.	Overview of FERC-Approved Study Plan
9:45 a.m. to 10:00 a.m.	Summary of Prior Workshops
10:00 a.m. to 12:30 p.m.	Presentation of Model Architecture, Model Description, and User's Guide
12:30 p.m. to 1:15 p.m.	Lunch: On Your Own
1:15 p.m. to 1:30 p.m.	Load Model on Computers *Note to Participants: Bring Your Computer!*
1:30 p.m. to 4:00 p.m.	Model Operation and Introduction to Running the Model

LINK to LIVE MEETING:
TO JOIN THE DISCUSSION VIA "LIVE MEETING":

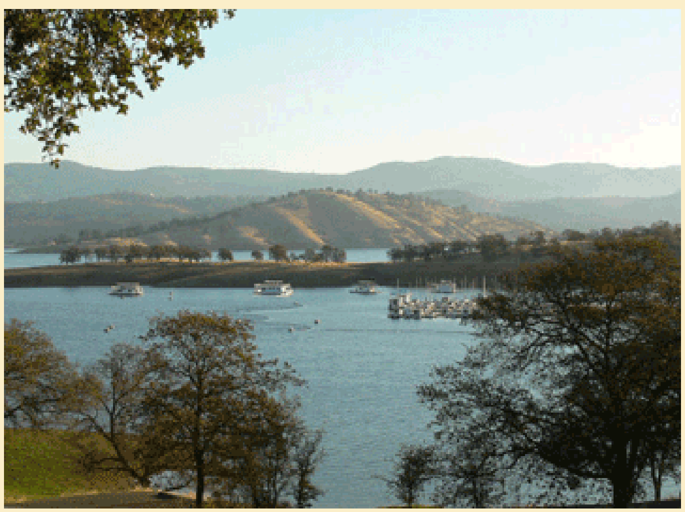
Join online meeting
https://meet.hdrinc.com/jenna.borovansky/3D64F0F5

First online meeting?

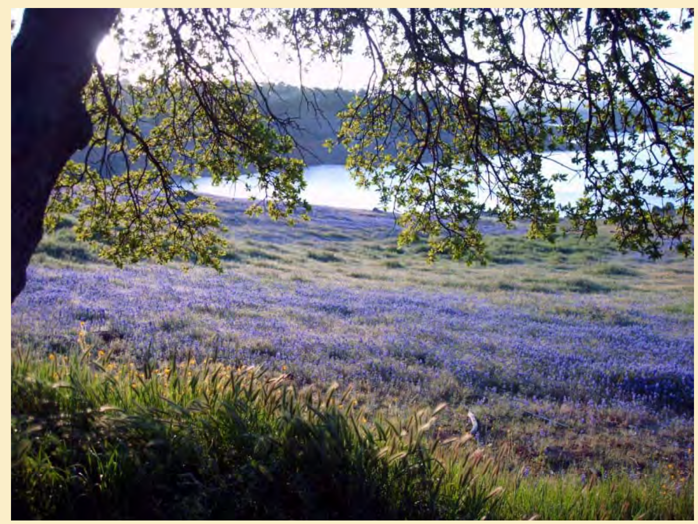
Don Pedro Project Relicensing

W&AR-2: Project Operations Model Workshop #3

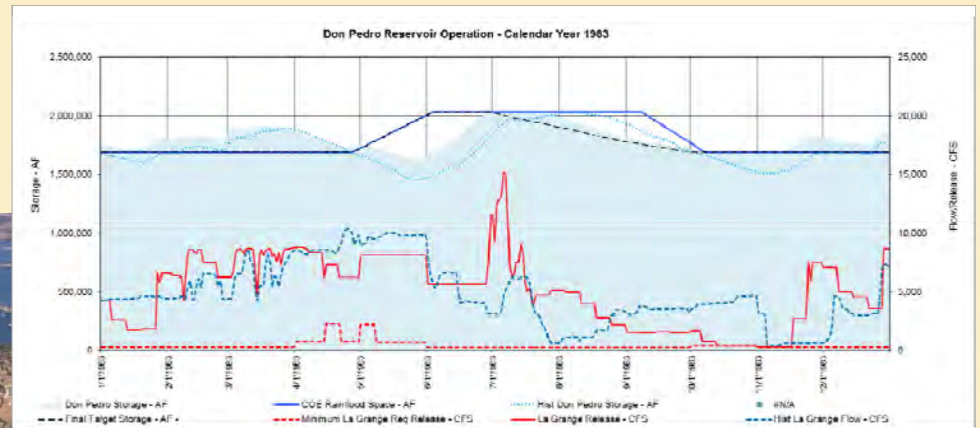
MODESTO IRRIGATION DISTRICT | TURLOCK IRRIGATION DISTRICT



FERC
PROJECT
No. 2299



Tuolumne River
Daily Operations Model



W&AR-2 Workshop No. 3
Model Description and User's Guide
October 23, 2012

Agenda and Topics

- Introductions
- Review of Agenda
- Purpose of Meeting
- Overview of FERC-approved Study Plan
- Summary of Prior Workshops
- Presentation of Model Architecture, Model Description, and User's Guide
  - Model overview
  - Model operations
  - Model outputs
- Model Operation

Purpose

- Present the Model Architecture
- Discuss Model Description and User's Guide Document
- Review Path Forward
- Provide Initial Training on Model Use

Study Status Overview

- Develop Project Operations Model *("Tuolumne River Operations Model")* --- through June 2012
- Prepare Preliminary Report on Model Description –-- July 2012
- Present Model to Relicensing Participants –-- October 2012
- Issue Final Model Report: (1) Model description, (2) Model validation, (3) User's Guide --- January 2013

FERC Study Plan Determination

- Districts' Plan Approved Without Material Modification
- Discuss Participant Preferences for Model Output (graphs, tables, statistics) in Workshops
- Include Agreements Not Part of FERC License (4^{th} Agreement/Water Bank)
- After Accretion Measurements, Extend Model to Confluence

Prior Workshops

Workshop #1 --- April 9, 2012

- Hydrology Workshop – Model Overview and Development of Don Pedro Unimpaired Flow Data Set
- All RP Comments Submitted by End of May
- Districts' Filed Responses and Meeting Notes with FERC on August 1

Prior Workshops

Workshop #2 -- September 21, 2012

- Accretion Flow Measurement Results and Proposed Hydrologic Investigations
- Draft Meeting Notes in Final Review
- RP Comments Due Circa November 21
- Responses and FERC Filing by Districts Circa December 20

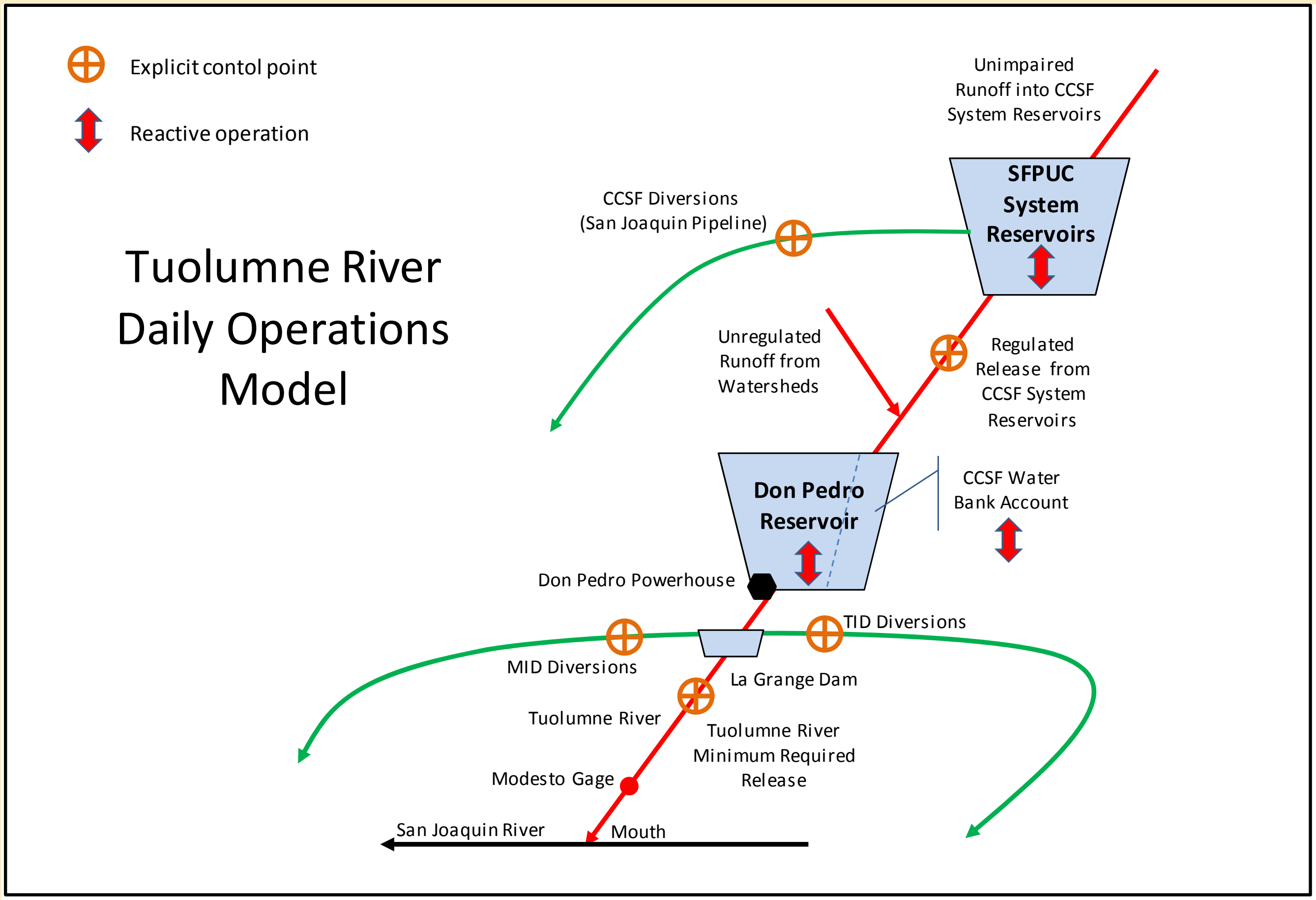
Future Workshop(s)

- Model Validation Report Presentation
- Intensive User Training

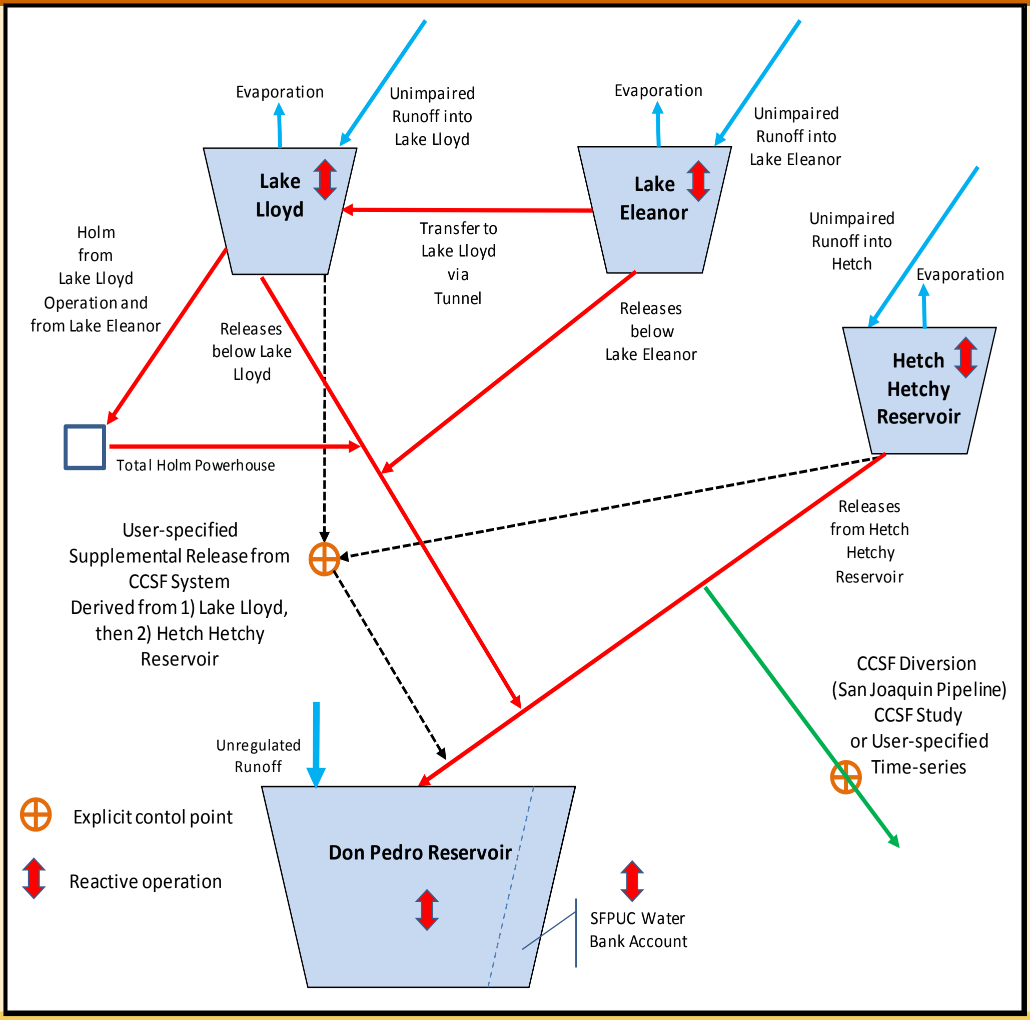
Model Overview

- Microsoft Excel 2010 worksheet
- Physical boundaries of the model
  - Upstream CCSF facilities
  - Downstream to confluence with San Joaquin River
- Simulation period
  - Daily time step of water year 1971 through 2009

Model Overview
General Schematic and Geographical Range



Model Overview
Schematic of Upstream CCSF Facilities



Model Operations

- Four reservoirs
  - Don Pedro Reservoir
  - Hetch Hetchy Reservoir
  - Lake Lloyd
  - Lake Eleanor
- Reservoir operation goals/algorithms
  - Minimum releases from reservoirs
    - Instream flow requirements
    - Diversion demand (MID/TID Canals & CCSF SJPL)
    - Other releases
  - Additional releases for reservoir and release management
    - Flood control
    - Snowmelt release management
    - Other storage goals
- Water Bank Account

Model Operations

- Diversion demand – Test Case
  - MID/TID Canals diversions reflective of current land use and operation, including reduced deliveries during drought
  - CCSF San Joaquin Pipeline diversion reflective of current water deliveries and system operation, including delivery shortages during drought
- Instream flow requirements – Test Case
  - Don Pedro Project – current FERC minimum flow requirements
  - CCSF facilities – current requirements for Hetch Hetchy Reservoir, Lake Lloyd and Lake Eleanor
- Don Pedro Project Hydropower Generation
  - Uses simulated releases and reservoir storage (head) limited to power plant constraints

Model Operations

- Model performs sequential operation for entire simulation period
- User can modify parameters to develop alternative operations
  - Minimum flow requirement for lower Tuolumne River
  - MID/TID Canals diversions
  - CCSF supplemental releases
  - CCSF SJPL diversions

Model Outputs

- Daily results
- Don Pedro Reservoir and District facilities
  - Reservoir inflow, release, storage and generation
  - MID/TID Canals diversions
  - Release to Tuolumne River
- CCSF facilities
  - Reservoir inflow, release, and storage
  - SJPL diversions
- Additional flow information
  - Lower Tuolumne River flow locations
- Result review tools
  - Time series data
  - Tables and graphs
- Data interface with temperature models

Model Operation

Load your computers

DRAFT
Tuolumne River Daily Operations Model
Model Description and User's Guide

Modesto Irrigation District
Turlock Irrigation District

Don Pedro Project Relicensing
FERC No. 2299

DRAFT Working Document
October, 2012

Tuolumne River Daily Operations Model
Model Description and User's Guide

Contents

1.0 Introduction

The Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) have developed a computerized Project Operations Model (Model) to assist in evaluating the relicensing of the Don Pedro Project (Project) (FERC Project 2299). On November 22, 2011, in accordance with the Integrated Licensing Process schedule for the relicensing of the Don Pedro Project, the Districts filed their Revised Study Plan containing 35 proposed studies with the Federal Energy Regulatory Commission (FERC) and relicensing participants. On December 22, 2011, FERC issued its Study Plan Determination approving, with modifications, the proposed studies, including Study Plan W&AR-2: Project Operations /Water Balance Model Study Plan. Consistent with the FERC-approved study plan, the objective of the Model is to provide a tool to compare current and potential future operations of the Project. Due to the fact that the geographic scope of the Model extends from the City and County of San Francisco's (CCSF) Hetch Hetchy system in the upper part of the watershed to the confluence of the Tuolumne and San Joaquin rivers, the Model is now entitled the Tuolumne River Daily Operations Model.

In accordance with the study plan, the Districts are preparing a Model Development Report due to be filed with FERC in January 2013 (W&AR-2 Study Plan, page 7). The Model Development Report will contain three components: (1) this Model Description and User's Guide (User's Guide), (2) a Validation Report, and (3) an executable version of the Model. Also in accordance with the FERC-approved study plan, the Districts are organizing and conducting a number of workshops with relicensing participants associated with the development of the Model. The first Workshop, held on April 9, 2012, was focused on the development of the hydrologic dataset; the second Workshop, held on September 21, dealt with accretion flows, Dry Creek flows, downstream nodes, and other related hydrologic investigations. The third Workshop, scheduled for October 23, will focus on Model architecture, logic, and functionality and provide an initial training opportunity for potential Model users. This Model Description and User's Guide provides information to be covered in the Workshop No. 3.

As fully described in this User's Guide, and consistent with the FERC-approved study plan, the Model includes numerous user-controlled parameters that allow the simulation of alternative Project operations, such as alternative flow regimes for the lower Tuolumne River. The Model performs a simulation of Project operations for a sequential period of years that covers a range of historical hydrologic conditions. The period of hydrologic record selected for the Model is Water Year 1971 through Water Year 2009, which includes extreme years of hydrology (1977 dry and 1983 wet) and multi-year periods of challenging water supply conditions such as 1976-1977, 1987-1992, and 2001-2004. The purpose of this User's Guide is to describe the structure of the Model, the interfaces available for operation of the Model, and methods available for the reviewing Model results. Procedures for development of input files for running alternative future operations are also described and illustrated. The data presented in this document are referenced to a "Test-Case" simulation of operations and are being incorporated for illustrative purposes of the Workshop.

As is the case with any model, the Tuolumne River Daily Operations Model is only a depiction of project operations, and is limited to representing CCSF and District operations to the extent that their operations can be described systematically by various equations and algorithms. Actual project operations may vary from those depicted by the Model due to circumstantial conditions of hydrology and weather,

facility operation, and human intervention. The FERC-approved study plan has identified a number of user-controlled variables for running alternatives. The fact that the Model provides these user-controlled inputs is not an indication that either the Districts or CCSF endorse or support any specific alternative developed by manipulating these inputs.

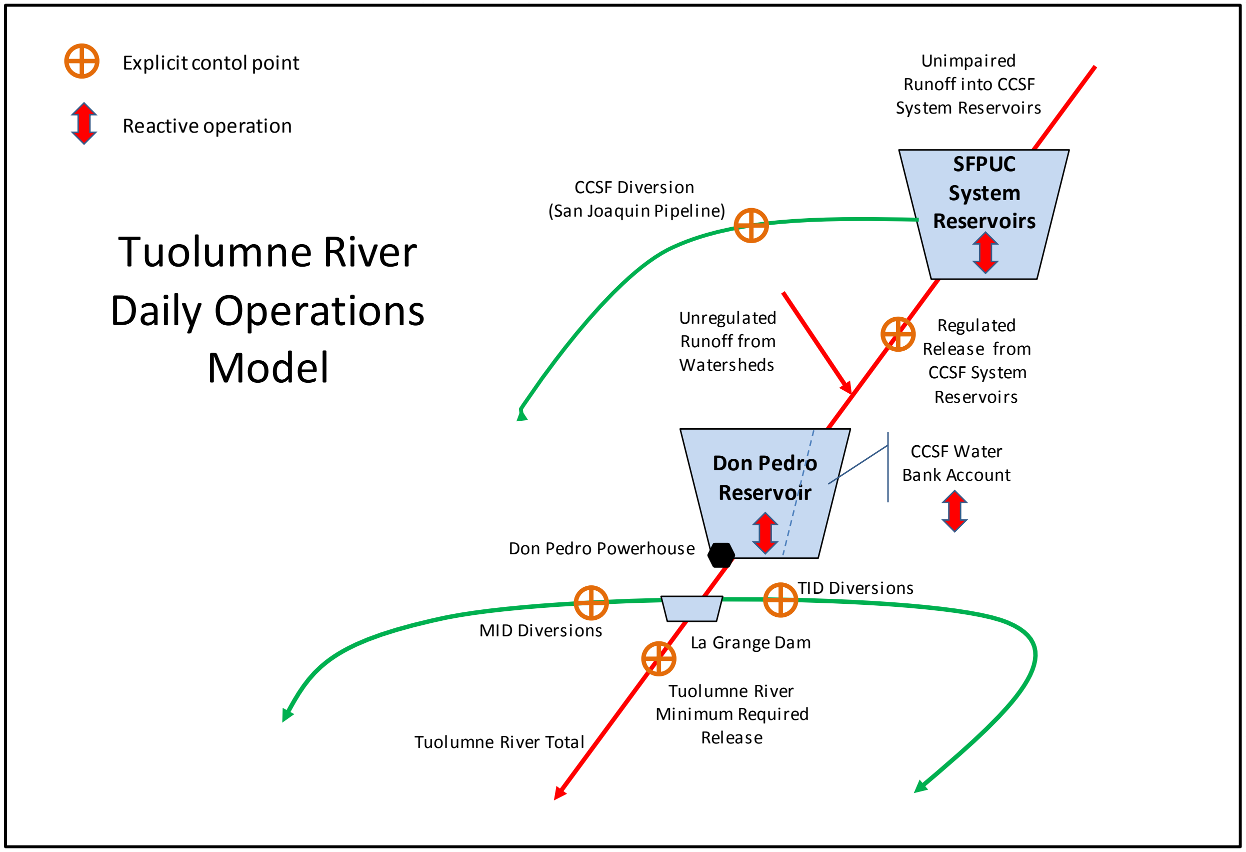
2.0 Geographical Range of Model and Underlying System Operation

As mentioned above, the geographic scope of the Model extends for CCSF's Hetch Hetchy system to the confluence of the Tuolumne and San Joaquin Rivers, as generally depicted in Figure 2.0-1. The Model comprises two primary subsystems -- the Districts' Don Pedro Project and CCSF's Hetch Hetchy Project, which are independently owned and operated by the respective parties. The Don Pedro Project includes the Don Pedro Reservoir and powerhouse. It provides water storage and flood control benefits. Water that flows into Don Pedro Reservoir is either stored or passed through to the lower Tuolumne River. Included in the model is the projected diversion of water at La Grange to serve irrigation and M&I customers of MID and TID. A model "node" (calculation point) is provided at the Districts' La Grange diversion dam, where the Model simulates flows to the Modesto Canal, the Turlock Canal, and the Tuolumne River below the La Grange diversion dam. The CCSF System is modeled as three physical reservoirs (Hetch Hetchy Reservoir, Lake Lloyd and Lake Eleanor), the San Joaquin Pipeline (SJPL), and an accounting for the Don Pedro Water Bank Account. All releases from the CCSF System, except those diverted to the SJPL enter Don Pedro Reservoir. A node is also provided to represent the location of the existing USGS stream flow gage entitled "Tuolumne River at Modesto" (Modesto). Additional nodes may be established above and/or below the Modesto gage node depending on the results of ongoing lower Tuolumne River accretion flow measurements.

The Model components operate with systematic algorithms that attempt to mimic operational decisions for reservoir and facility operations. For each subsystem, certain operation constraints can be user-controlled consistent with the FERC-approved study plan. Within each subsystem, each reservoir has the same underlying operation protocol. A daily mass balance is performed: *change in reservoir storage = inflow, minus outflow (releases), minus reservoir losses*. If the calculation results in a reservoir storage that is in excess of preferred/maximum capacity, an additional release is made.

Minimum releases for each modeled reservoir are in accordance with current stream flow requirements and diversion requirements. Each reservoir assumes a common "hold-unless-need-to-release" protocol, except as conditioned by minimum stream release requirements, diversions, preferred/maximum storage, snowmelt management releases, or other specified releases. In essence, each reservoir operates for its own "reservoir conservation" goal and retains storage as much as possible, only drawn down as needed to meet release requirements, diversions, or to achieve reservoir or flow management goals such as flood control or, in some cases hydropower.

Figure 2.0-1 - Tuolumne River Daily Operations Model



3.0 Don Pedro Project and La Grange Diversion Dam

The Don Pedro Project and the La Grange diversion dam operations are modeled to represent current operations for irrigation and municipal water deliveries, fishery and instream flow requirements and flood control. Hydropower production is a function of the releases made for these other purposes. The following elements of hydrology and objectives guide the modeled operation.

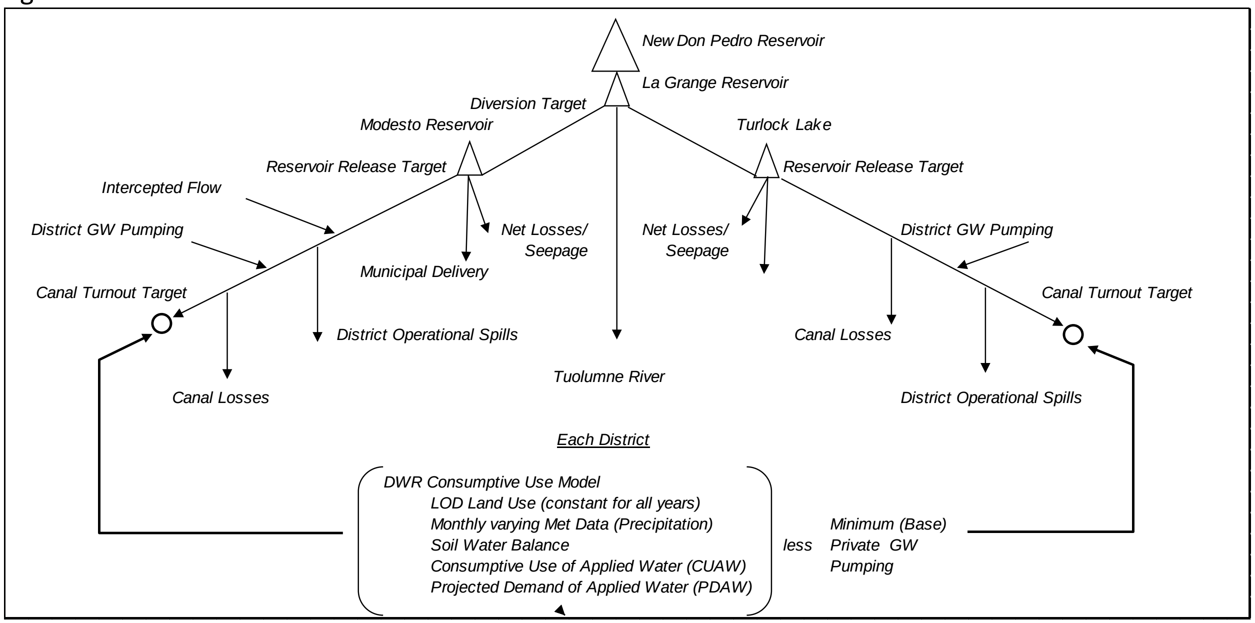
3.1 Reservoir Inflow

Inflow to Don Pedro Reservoir is modeled as two components: 1) a fluctuating unregulated inflow to Don Pedro Reservoir, and 2) the regulated releases (regulated Don Pedro Reservoir inflow) from the CCSF System. The inflow will reflect a daily fluctuating pattern which is mostly associated with the unregulated component of runoff in the basin, which is approximately 40 percent of the total runoff in the basin. The unregulated component of inflow to Don Pedro Reservoir remains the same among all operation simulations. The regulated inflow to Don Pedro is based on a projected level of development and operation for the CCSF System. This component of Don Pedro Reservoir inflow may change among operation simulations due to changed assumptions for CCSF System demands and level of development, or due to user-controlled parameters.

3.2 MID and TID Canal Demand

Figure 3.2-1 is a schematic of the parameters used by modeling to create each District's diversion demand at La Grange diversion dam.

Figure 3.2-1 - District Canal Demand Parameters



Due to changing land use and cropping patterns, groundwater use and irrigation and canal management practices throughout history, the historical record of recorded diversions does not provide a consistent definition of water diversion needs. Similar to depicting inflow, the Model uses a projected level of development for establishing irrigation and canal diversion demand.

The canal diversions are assumed to be driven by three components: 1) a fluctuating customer component, the (P)rojected (D)emand of (A)pplied (W)ater (PDAW), 2) a relatively constant depiction of operational system losses/efficiencies, and 3) a water supply availability factor based on Don Pedro Reservoir storage and inflow.

The PDAW is developed through use of DWR's consumptive use model, and considers precipitation, ET rates, soil moisture criteria, rooting depth, irrigation indicators, and other factors along with land use to estimate the CUAW on a monthly basis. Monthly water use varies based on input ET rates, which are constant each year. CUAW will only vary each year based on variation in precipitation. The PDAW has been adjusted to

reflect other routine irrigation practices not identifiable with strict ET, such as pre-irrigation. The estimate of monthly PDAW is distributed daily based on the historical (2009-2011) distribution of canal diversions within months.

In addition to the PDAW requirement, several canal operation and management components are incorporated into the projected diversion demand. The following tables provide the monthly estimates used for each component, Table 3.2-1 for MID and Table 3.2-2 for TID.

Table 3.2-1 – Canal Demand and Operation Components for MID

Modesto Irrigation District

	Turnout Delivery Factor	Nominal Private GW Pumping	Canal Operational Spills Critical	Canal Operational Spills Non-crit	System Losses below Modesto Res	Intercepted Flows	Nominal MID GW Pumping	Modesto Res and Upper Canal Losses/Div	Municipal Delivery from Modesto Res	Modesto Res Target Storage
Month	%	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF
January	35	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	17.0
February	35	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	18.0
March	65	1.0	1.0	3.0	0.6	0.9	1.0	2.0	2.7	18.0
April	70	2.0	3.0	6.0	0.6	0.9	2.3	2.9	2.7	19.0
May	85	3.0	4.0	6.5	0.6	1.2	2.3	3.9	3.0	20.0
June	85	4.0	3.5	6.5	0.6	1.0	2.3	4.3	3.2	20.0
July	77.5	4.0	3.5	6.5	0.6	1.0	2.6	4.9	3.3	21.0
August	70	4.0	4.9	7.0	0.6	1.4	2.4	4.9	3.3	22.0
September	65	2.0	5.0	7.0	0.6	1.2	2.3	4.2	3.3	20.0
October	40	1.0	2.8	6.9	0.6	0.9	2.1	2.0	3.2	17.0
November	30	0.0	2.0	2.0	0.1	0.0	0.0	2.0	2.7	15.0
December	35	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.5	15.0
Total		21.0	35.7	57.4	5.4	8.5	17.3	31.1	34.5	

Table 3.2-2 – Canal Demand and Operation Components for TID

Turlock Irrigation District

Month	Turnout Delivery Factor %	Nominal Private GW Pumping TAF	Canal Operational Spills Critical TAF	Canal Operational Spills Non-crit TAF	System Losses below Turlock Lk TAF	Intercepted Flows TAF	Nominal TID GW Pumping TAF	Turlock Lk and Upper Canal Losses TAF	Other Delivery from Turlock Lk TAF	Turlock Lk Target Storage TAF
January	30	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	18.0
February	30	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	25.0
March	65	1.2	3.0	3.0	4.5	0.0	4.1	1.0	0.0	30.0
April	57.5	2.4	5.1	6.3	4.5	0.0	8.0	6.6	0.0	30.0
May	85	3.6	4.6	6.7	4.5	0.0	10.3	7.7	0.0	32.0
June	92.5	5.2	4.2	6.7	4.5	0.0	12.4	8.2	0.0	32.0
July	72.5	6.4	4.2	6.7	4.5	0.0	14.6	8.7	0.0	32.0
August	62.5	6.2	4.0	7.3	4.5	0.0	13.3	9.0	0.0	30.0
September	67.5	3.9	3.2	7.3	4.5	0.0	9.1	5.0	0.0	27.0
October	40	2.4	2.3	7.3	4.5	0.0	5.3	2.0	0.0	13.0
November	30	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0
December	30	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0
Total		31.3	38.6	59.3	39.2	0.0	77.1	52.2	0.0	

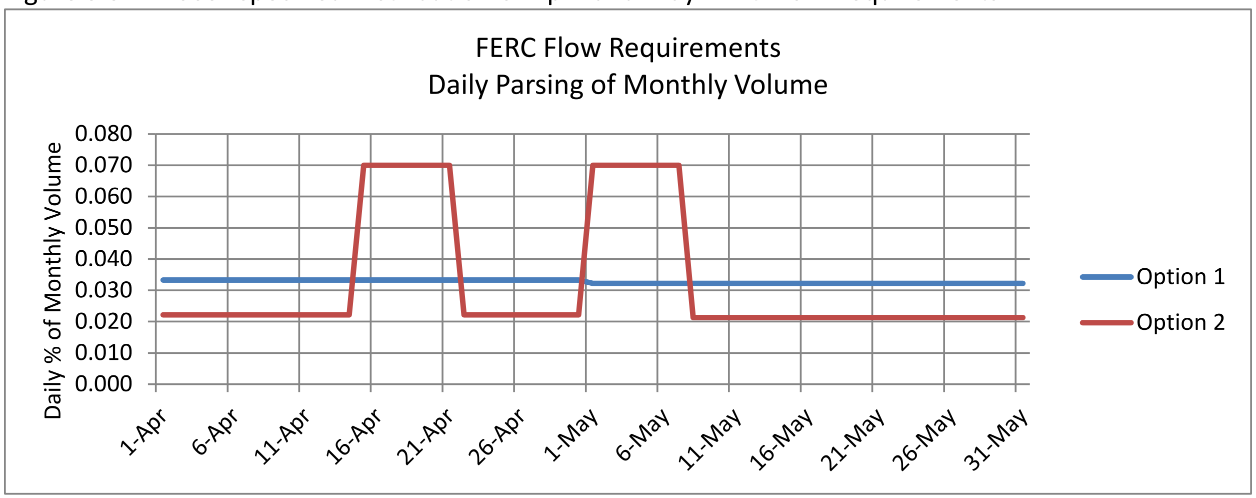
The turnout delivery factor is unique to each District and represents a modeling mechanism to adjust the PDAW for irrigation practices that are not included in the estimation of the CUAW, such as irrigation that provides for groundwater recharge.

3.3 Required FERC flows at La Grange Bridge

The current FERC minimum flow requirements at La Grange Bridge are included in the Model. In the Model the terms "La Grange releases", "flows at La Grange Bridge" or "releases at La Grange diversion dam" are used interchangeably to mean the minimum flow requirements under the Project's current FERC license as measured at the USGS gage "Tuolumne River at La Grange, CA". The annual flow requirement is established for the April-March flow year beginning April based on pre-knowledge of the final San Joaquin River Index (60-20-20) for the year. The annual volume including "interpolation water" is computed using the FERC Settlement Agreement procedures, which includes a revised year type distribution using a 1906-2011 population of historical years. The interpolation water is assumed to be spread among April and May volumes.

The Model assumes each month's volume of the annual volume is spread evenly across the days of the months, except during April and May where the user can define the distribution of daily flows. The user can define the distribution as: 1) total monthly volume spread evenly across all days of a month, or 2) a user-specified daily distribution of monthly volume during April and May. Figure 3.3-1 illustrates the outcome of the two assumed flow distributions during April and May. The pulsing pattern option shown in Figure 3.3-1 is being used by the Model.

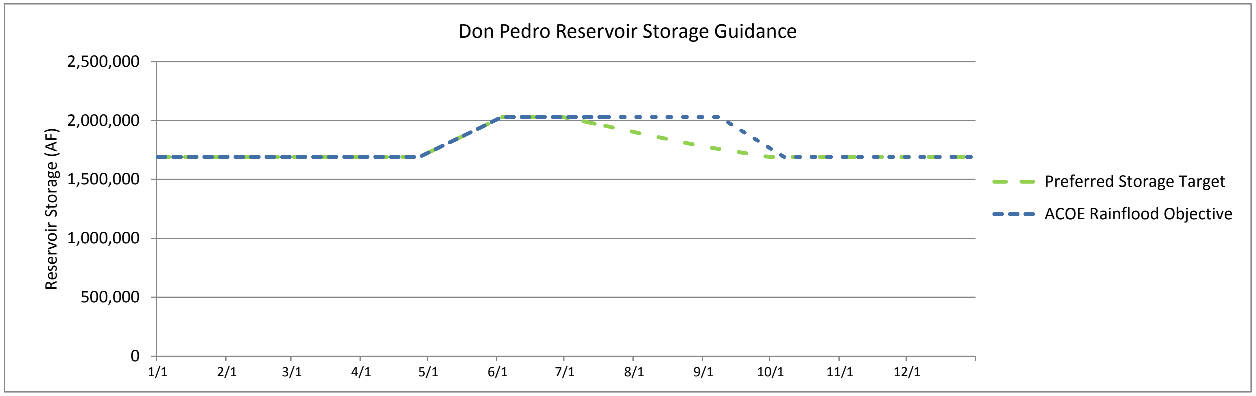
Figure 3.3-1 – User-specified Distribution of April and May FERC Flow Requirements



3.4 Reservoir and Release Management

Don Pedro Reservoir storage is initially checked against a preferred storage target. The Model allows the user to establish the preferred storage target. The preferred storage target is the ACOE rainflood reservation objective, except after July 1, when there is no required reservation space. The preferred storage target reflects a drawdown to evacuate storage during the summer in late and wet runoff years. The preferred target storage is again equal to the ACOE objective on October 7. Figure 3.4-1 illustrates the reservoir storage target used in the Model.

Figure 3.4-1 –Reservoir Storage Guidance



For a day of Don Pedro Reservoir operation, the day's inflow is a computed amount from upstream CCSF System operations and unregulated inflow. The stream flow requirements contained in the FERC license at La Grange Bridge and the MID and TID canal diversions are the release from Don Pedro Reservoir. The prior day's reservoir evaporation is included in the calculation. If the computation produces resulting Don Pedro Reservoir storage in excess (encroachment) of the preferred storage target, the encroachment is computed. Every 7th day the model checks for an encroachment, and if it exists a "check" release is computed. It is assumed that a constant supplemental release (in excess of minimum releases) will be initiated at a rate equal to the encroachment divided equally over the next 10 days. This protocol repeats itself every 7th day, reestablishing the level of check release each time. The end result of this procedure will allow encroachment of storage space above the preferred storage target and not require unrealistic "hard" releases of water to exactly conform to the target.

A second check release is made during the April through June period for management of anticipated snowmelt runoff. On the first day of each of these months a forecast is made of anticipated runoff into the reservoir and minimum releases and losses from the reservoir from the date of forecast through the end of June (the assumed target date of reservoir filling). These forecasts determine the volume of water (if any) that will require release in excess of minimum releases and losses and storage gain by the end of June. For April and May, the DWR "90 percent exceedence forecast" is used for anticipated runoff, along with known minimum releases and losses, and upstream impairment. The user defines

the percentage of volume (of the total volume) to be additionally released during each month. For April, 30 percent of the 3-month volume is advised for release, and during May 50 percent of the 2-month volume is advised for released. For June, the historically reported unimpaired flow (UF) flow is assumed for the runoff computation. This assumes pre-knowledge of the runoff volume for the month, and 100 percent of the excess is spread across the month. The snowmelt check release is evenly distributed across the days of the month. The release made in a day is the greater of the two check releases or the minimum release. At no time is the maximum capacity of the reservoir (2,030,000 acre-feet) allowed to be exceeded, and if necessary a release, regardless of magnitude, will be made by the Model to not exceed maximum storage capacity.

A Modesto flood control objective is incorporated into the release logic. The objective is to maintain a flow at Modesto no greater than a user specified flow rate (assumed as 9,000 cfs). The logic checks against an "allowable" La Grange release considering the lower Tuolumne River accretions and Dry Creek flow. Model logic compares the La Grange allowable release to the other check releases. The La Grange release is then reduced if necessary to not exceed the Modesto flow target objective, even if it results in an encroachment in Don Pedro Reservoir. The exception is when the reservoir reaches full (2,030,000 AF). Any computed encroachment above a full reservoir is passed and the Modesto flow objective will be exceeded.

Consistent with the original FERC license filings for the new Don Pedro Project, the minimum operating reservoir level is established at elevation 600 feet, corresponding to a storage volume of 308,960 AF. Below this elevation is referred to as the "dead pool" storage.

3.5 Water Supply Factor

A constraint to the Districts' canal diversions is recognized when there is a reduced water supply at Don Pedro Reservoir. The premise of the (W)ater (S)upply (F)actor (WSF) is to reduce the amount of water diverted to the canals during years when lack of carryover storage at Don Pedro Reservoir becomes a concern.

The modeling mechanism used to reduce canal diversions is a factor applied to the PDAW of the canal demand. This mechanism results in a reduction to the amount of water "turned out" to the customers while still recognizing the relatively constant efficiencies of canal operations.

The WSF is established by forecasting upcoming water supply, based on antecedent storage and anticipated inflow to Don Pedro Reservoir. The forecasting procedure begins in February and ends in April. The Factor Table is based on April forecast results. The February and March Forecasts act as adjustments to get to the April 1 state. The forecasts have the following protocol:

February Forecast (forecasting April 1 state):

End of January storage + Feb-Jul UF - Feb-Jul Upstream adjustment - Feb-Mar minimum river

March Forecast (forecasting April 1 state):

End of February storage + Mar-Jul UF - Mar-Jul Upstream adjustment - Mar minimum river

April Forecast: (final)

End of March storage + Apr-Jul UF - Apr-Jul Upstream adjustment

Pre-knowledge of unimpaired runoff for each forecast period is assumed, as well as knowledge of upcoming upstream impairment of the runoff.

The WSF factor / Don Pedro Storage + Inflow relationship is developed through iterations of multi-year system operation simulations. The WSF depicts actions that may be implemented during times of drought, and the projected canal diversions and reservoir storage operation during drought periods. The factors and index triggers were developed reviewing reservoir storage levels that occurred during the 1987-1992 drought.

3.6 Power Generation

Equations of Don Pedro powerhouse generation characteristics define capacity (MW) and efficiency (kWh/AF), based on reservoir storage. Capacity potential uses minimum storage of the day, while efficiency uses average storage of the day. The maximum flow through plant is assumed to be 5,400 cfs. Water that does not appear as passing through the generators is computed to be “spilled-bypassed”. The power generation “cutoff” also occurs at the reservoir storage of 308,960 acre-feet or the top of dead pool.

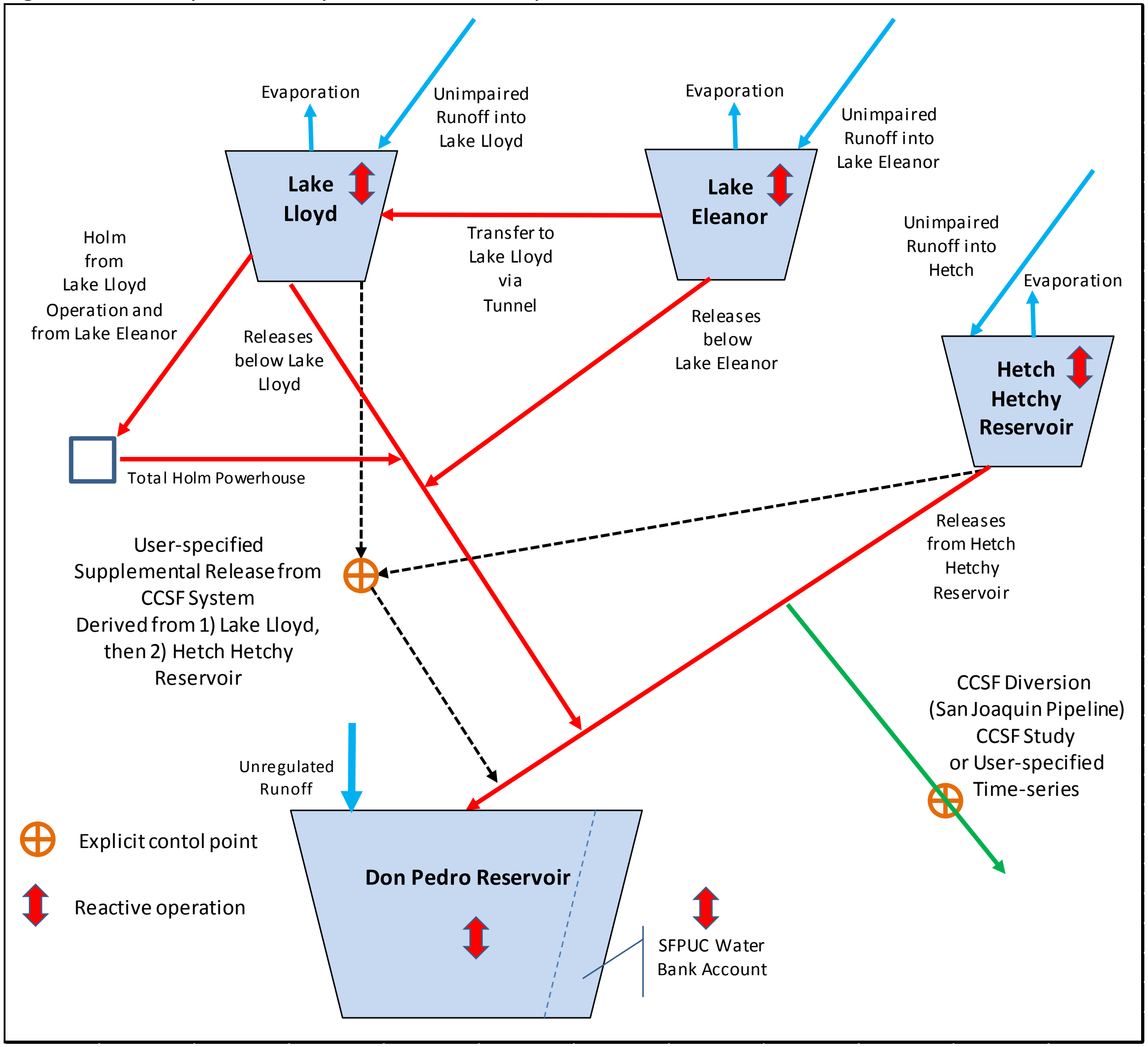
3.7 User-Interface Adjustments

The Model allows alternative user-specified data for two components of District operations: 1) user-specified assumptions for the La Grange Bridge minimum flow requirements, and 2) a user-specified diversion for the Districts' canals. An alternative La Grange Bridge flow requirement can be incorporated by definition of required flows by periods within a year, based on year type. Entered in this protocol the input will result as a daily time series for the Model. Alternatively, a flow requirement can be entered as a daily time series. For an alternative canal diversion, an array has been provided to input a monthly by 39-year matrix of alternative canal diversions. The monthly array of data is parsed by the Model into daily distributions reflecting the current depicted daily distribution of canal diversions.

4.0 City and County of San Francisco System

The Model representation of the CCSF System on the Tuolumne River includes the three physical reservoirs (Hetch Hetchy Reservoir, Lake Lloyd and Lake Eleanor), diversions to the Bay Area through the San Joaquin Pipeline, and an accounting for the Don Pedro Water Bank Account. The CCSF System is illustrated in Figure 4.0-1, with detail provided for the components of explicitly modeled hydrologic parameters.

Figure 4.0-1 – City and County of San Francisco System



Each CCSF System reservoir has the same underlying operation protocol. A daily mass balance is performed: *change in reservoir storage = inflow, minus outflow (releases), minus reservoir losses*. If the calculation results in reservoir storage exceeding preferred/maximum capacity, an additional release of water is made.

Minimum releases from each reservoir are in accordance with current requirements for Hetch Hetchy Reservoir, Lake Lloyd and Lake Eleanor.

Each reservoir assumes a common “hold-unless-need-to-release” protocol, except as conditioned by minimum release requirements, diversions, preferred/maximum storage, snowmelt management releases, hydropower, or other flow or management objectives. In essence, each reservoir operates for its own “reservoir conservation” goal of retaining storage unless drawn down by demands or reservoir management objectives. CCSF is required by State law and its Charter to operate its system for “water first”.

4.1 Hetch Hetchy Reservoir

Hetch Hetchy Reservoir storage is initially checked against a preferred storage target. The day's inflow is a given amount, and the SJPL diversion and minimum stream flow requirements below Hetch Hetchy Reservoir determine the release. The prior day's reservoir evaporation is included in the calculation. If the computation produces storage in excess (encroachment) of the preferred storage target, the encroachment is computed. Every 7th day the model checks for the encroachment, and if it exists a check release is computed. It is assumed that a constant supplemental release (in excess of minimum releases) will be initiated at a rate equal to the encroachment divided equally over the next 7 days. This protocol repeats itself every 7th day, reestablishing the level of check release each time. The end result of this procedure will allow encroachment of storage space above the preferred target storage and not require unrealistic releases of water to exactly conform to the target.

A second check release is made during the February through June period for management of anticipated snowmelt runoff. On the first day of each of these months a forecast is made of anticipated runoff into the reservoir and minimum releases and losses from the reservoir from the date of forecast through the end of June (assumed target of reservoir filling). These forecasts determine the volume of water (if any) that will require release in excess of minimum releases and losses and storage gain by the end of June. Pre-knowledge is used for anticipated runoff, minimum releases and losses. The user defines the percentage of volume (of the total volume for the period) to be additionally released during each month. For February through April, 10 percent of the additional release volume is advised for release, and may be additionally capped. This approach tends to hold Hetch Hetchy Reservoir releases for later release during May. The snowmelt check release is evenly distributed across the days of the month and can be capped in terms of rate (cfs) or minimum volume of the reservoir to which it can be drawn during the month. The particular release made in a day is the greater of the two check releases or the minimum release. At no time is the maximum capacity of the reservoir allowed to be exceeded, and if necessary a release, regardless of magnitude, will be made by the Model to not exceed maximum storage capacity.

For Hetch Hetchy Reservoir these two check releases typically guide the operation of the reservoir during the winter and spring. After reservoir filling, summer-time stream release requirements and the SJPL demand typically draw the reservoir down below the preferred storage targets.

Canyon Tunnel, Kirkwood Powerhouse, Mountain Tunnel and Moccasin Powerhouse are not explicitly modeled. The structure of the Model depicts the component of inflow to Don Pedro Reservoir that originates from the Hetch Hetchy Reservoir watershed. The detail of flow reaches below Hetch Hetchy Reservoir is not needed. Therefore, the simple gradation of flow between flow removed from the stream system by the SJPL and the remaining flow that will eventually reach Don Pedro Reservoir is sufficient for purposes related to the relicensing of the Districts' Don Pedro Project.

4.2 Lake Lloyd

The same underlying reservoir operation protocols of Hetch Hetchy Reservoir apply to Lake Lloyd, with a couple of modifications. Instead of the SJPL demand being assumed as an initial release requirement, a minimum Holm Powerhouse release during May through August is assumed from Lake Lloyd.

Both the initial check release for preferred storage encroachment and the snowmelt check release are computed and advised for reservoir operations. If supplemental releases above minimum releases are computed the Model routes the additional release through Holm Powerhouse up to its available capacity. The remainder of the supplemental release is routed to the stream below Lake Lloyd. A comparison is made between "Lloyd-only" use of Holm Powerhouse capacity and maximum capacity for passage to the Lake Eleanor model component.

The operation goal linkage between Lake Lloyd and Lake Eleanor assumes that Lake Eleanor will transfer water from its watershed to Lake Lloyd for the purpose of enhancing power generation at Holm Powerhouse. Thus, any available capacity at Holm Powerhouse after the Lloyd-only operation is assumed available and desired for use of a Lake Eleanor transfer. If water is transferred from Lake Eleanor the Model assumes the water to be directly routed to Holm Powerhouse which then becomes additional release from Lake Lloyd. The inclusion of the Holm Powerhouse logic in the Lloyd/Eleanor watershed logic is only done to facilitate the interaction between the two watersheds.

4.3 Lake Eleanor

Both the initial check release for preferred storage encroachment and the snowmelt check release are computed and employed into reservoir operations. In this instance of Lake Eleanor operations, the transfer “desire” for Holm Powerhouse generation is considered a disposition of the Lake Eleanor releases determined to be in excess of minimum stream requirements. To the extent that check (stream) releases are available from Lake Eleanor, they will be transferred. The amount transferred is limited by available Holm Powerhouse capacity and the assumed capacity of the Eleanor-Cherry Diversion Tunnel. The Lake Eleanor operation protocol will transfer water that would otherwise be released in excess of minimum flow requirements (largely dependent upon the preferred storage target and snowmelt releases) but it will not allow water to be “pulled” from Lake Eleanor to Lake Lloyd.

4.4 Don Pedro Inflow

The three components of regulated releases from Hetch Hetchy Reservoir (not including the SJPL), Lake Lloyd and Lake Eleanor are combined with the unregulated runoff below CCSF System reservoirs to provide the inflow data set for Don Pedro Reservoir.

4.5 Water Bank Account

A Water Bank Account calculation procedure is included in the Model. A running account of the Water Bank Account balance is computed daily, as limited by the Fourth Agreement and implementing agreement. The Model allows the computation of a "negative" balance. The accounting of the balance is incidental to model operations, and there is no auto-default feedback linkage to upstream operations if the balance is negative. To be consistent with current operations in the watershed, the user must employ the user-specified adjustment mechanism for supplemental CCSF System releases to remedy any negative balances.

For purposes of the FERC investigation, the protocols of Fourth Agreement Water Bank Accounting have been amended to incorporate a hypothetical implementation of "shared responsibility" for incremental increases in FERC-required flows for the Tuolumne River.[1] The incremental increase in FERC-required flows is determined by the daily difference between the current FERC requirements and scenario-required minimum flows. Approximately fifty-two percent (51.7121%) of the incremental difference between the flow schedules is assigned as CCSF's responsibility and counted as a debit within Water Bank Accounting.

[1] The "shared responsibility" assumption is presented for the purpose of evaluating alternative operations. The assumption shall not be used as evidence in any proceeding relating to and shall not act as precedence for any allocation of Tuolumne River water between CCSF and the Districts for any purpose under the Fourth Agreement.

4.6 User Interface Adjustments

The Model allows alternative user-specified data for two components of CCSF operations: 1) user-specified supplemental releases from the CCSF System, and 2) user-specified SJPL diversions.

The user-specified release from the CCSF System is to allow the user to “pull” additional water from the CCSF System as supplemental inflow to Don Pedro Reservoir. A single entry is established that will first pull water from Lake Lloyd so that water supply is preserved in the Hetch Hetchy Reservoir system for diversion to the SJPL. At a point when such supplemental releases strain Lake Lloyd storage, the supplemental releases are directed to Hetch Hetchy Reservoir. When employed, a daily flow release is directed from a reservoir at a point in logic after most of the previously described logic occurs. Thus, this release occurs in addition to what operation is already occurring by default. Such a release can affect the following day’s default operation or previous periods’ operations, thus results require review to determine if the user’s desired result occurs. It is also necessary to determine at the end of each simulation whether the operations depicted are consistent with the keeping of the Water Bank Account Balance from being negative.

This adjustment capability is used to maintain the Water Bank Account Balance greater than zero. There is no auto-default logic to keep the Water Bank Account Balance from going negative. In a typical scenario of normal CCSF System operations during most years, for this level of modeling, the Water Bank Account would not affect CCSF upstream operations. The exception is during prolonged drought when the default reservoir operation of CCSF System reservoirs attempts to hold stream releases to a minimum. In the modeled WY 1971 to 2009, the period 1987 through 1992, and possibly other periods may drive the Water Bank Account to a negative condition. The release adjustment is used to provide additional releases from the CCSF System to avoid driving the Water Bank Account negative.

The second adjustment to SF System hydrology can be made to the pre-specified time series of monthly SJPL diversion. The user is provided a tool to enter an alternative time series of data. This capability can be used to adjust CCSF System diversions from the Tuolumne River.

5.0 General Model Structure

The Model was constructed within the platform of a Microsoft Excel 2010 workbook. All Model logic is contained within cells of the workbook with no macros or calls to other forms of programming such as Visual Basic for Applications. Numerous worksheets within the workbook represent logical groupings of either sub-system facilities and operations, or input/output functionality. The worksheets of the Model are briefly described in Table 5.0-1. Some of the worksheets in the Model are fixed to prevent inadvertent changes to certain facility functions and operations. These aspects of the Model are consistent with the FERC-approved study plan.

Table 5.0-1 – Model Worksheets

Purpose	Worksheet Name	Description
Model Operations	UserInput*	Contains user inputs for La Grange Requirements, Canal Diversions, CCSF SJPL and CCSF Supplemental Releases
	Control	Contains inputs for facility characteristics and Test Case configuration
	DonPedro	Contains model logic for Don Pedro Reservoir operation
	SFHetchHetchy	Contains model logic for Hetch Hetchy Reservoir operation
	SFLloyd	Contains model logic for Lake Lloyd operation
	SFEleanor	Contains model logic for Lake Eleanor operation
	SFWaterBank	Contains model logic for Water Bank operation
	WaterBankRel*	Contains mode logic and user input for CCSF Supplemental Releases
View Model Results	DPGroup*	Plots simulation of Don Pedro Reservoir operations and River flows
	HHGroup*	Plots simulation of Hetch Hetchy Reservoir operation
	LloydGroup*	Plots simulation of Lake Lloyd operation
	ELGroup*	Plots simulation of Lake Eleanor operation
	WBGroup*	Plots simulation of Water Bank Balance computation
	SFSysGroup*	Plots simulation of CCSF System reservoirs
	DPGroup86_94*	Plots simulation of Don Pedro Reservoir operation during 1986-1994
	SFGroup86_94*	Plots simulation of CCSF System operation during 1986-1994
	ModelYearofDaily*	Plots and tables any single parameter for a calendar or water year
	ModelAnyGroup*	Plots any group of parameters for a calendar year
	ModelMonthTable*	Plots and tables up to four parameters, summarizing daily data by month
Model Operations	LaGrangeSchedule	Contains model logic for 1995 FERC minimum flow requirements
	DailyCanalsCompute	Contains model logic for computation of daily District canal demand
	DailyCanals	Contains model logic for computation of user-defined canal demand
	DPWSF	Contains model logic for computation of Don Pedro water supply factor
	CCSF	Contains model logic for CCSF release and diversion requirements
Model Inputs	Hydrology	Contains input data for hydrology
	602020	Contains input data for forecasting hydrology
View Output	Output*	Results of scenario specific simulation in HEC-DSS format
	DSSAnyGroup*	Plots any group of parameters for a calendar year from HEC-DSS format
	DSSMonthTable*	Plots and tables up to four parameters, summarizing daily data by month from HEC-DSS format
"*" Identifies worksheets accessible as user interfaces.		

5.1 UserInput Worksheet

This worksheet (UserInput) provides the interface for entering assumptions for minimum flow schedules for the lower Tuolumne River at La Grange Bridge, canal diversions by the Modesto Irrigation District and Turlock Irrigation District, supplemental releases to Don Pedro Reservoir from the CCSF System, and diversions by CCSF through the San Joaquin Pipeline. The worksheet is described below.

Contents Description and Study Name

User Defined Input
Variables Affected by User Entered in Blue Shaded Cells

Contents:
Section 1 - Alternative Flow Requirements at La Grange Bridge
Section 2 - Alternative Modesto and Turlock Canal Diversions
Section 3 - Supplemental Release from CCSF Upstream Reservoirs
Section 4 - Alternative CCSF San Joaquin Pipeline

(UI 1.00)	Enter Study Reference:	Test_Case	*For Part 6 of DSS file (minimize length of name)*

This section provides an index of the contents included in the worksheet, and identifies a named label for the particular study. An alpha numeric entry is entered (UI 1.00) for the study name, which is then incorporated into the DSS output interface tab (see worksheet Output description).

Section 1: Minimum Flow Requirements at La Grange Bridge

Section 1 - Alternative Flow Requirements La Grange Bridge

This table is used to enter a user-specified minimum flow schedule at La Grange Bridge. Twenty-four time periods are available to define a flow rate. Six different water year types can be established.
The year types correspond to the Preliminary Relicensing Year Type which is based on Tuolumne River unimpaired flow.

(UI 1.10) Turn alterantive flow requirement on: 0 *(1) on, and use alternative flow requirement, or (0) off, use current FERC flow requirement*

(UI 1.20) Use year type table below, or time series: 0 *(1) for table below, or (0) for time series (Column BM)* N/A

(UI 1.30)

Alternative Flow Requirements
Enter values in CFS

CYMo Day MM.DD	W 1	AN 2	N 3	BN 4	D 5	C 6
1.01	300	300	233	150	157	150
1.16	300	300	233	150	157	150
2.01	1,287	994	729	419	409	359
2.15	1,287	994	729	419	409	359
3.01	1,627	1,172	912	931	627	421
3.16	1,627	1,172	912	931	627	421
4.01	1,960	1,533	1,508	1,211	1,075	785
4.16	1,960	1,533	1,508	1,211	1,075	785
5.01	2,767	2,744	2,476	1,696	1,258	905
5.16	2,767	2,744	2,476	1,696	1,258	905
6.01	2,857	2,200	1,619	924	566	382
6.16	2,857	2,200	1,619	924	566	382
7.01	250	250	150	61	56	50
7.16	250	250	150	61	56	50
8.01	250	250	150	61	56	50
8.16	250	250	150	61	56	50
9.01	250	250	150	61	56	50
9.16	250	250	150	61	56	50
10.01	397	397	295	143	152	126
10.16	397	397	295	143	152	126
11.01	300	300	233	150	158	150
11.16	300	300	233	150	158	150
12.01	300	300	233	150	157	150
12.16	300	300	233	150	157	150

(UI 1.40) Enter beginning month of annual flow requirement schedule: Feb-Jun / Feb / 2

Preliminary Relicensing Year Type is based on a rank-ordering of the water-year runoff for the years 1921-2011. Each water year type W, AN, N, and BN represent 20% of the years of ranking. D and C year types each represent 10% of the years.

CCSF Responsibility* for La Grange Minimum Flows

CCSF responsibility is applied as a daily debit in the computation of CCSF debit or credit in the Water Bank Account.

0 *(0) not responsible, or*
(UI 1.31) *(1) responsible for 51.7121% of difference between 1995 FERC and scenario requirement.*

If responsibility option is selected, user should go to Section 3 of UserInput and use supplemental CCSF releases to maintain Water Bank Account > zero.

Existing FERC Flow Requirements at La Grange Bridge
Values in CFS

CYMo Day MM.DD	W 1	AN 2	N 3	BN 4	D 5	C 6
1.01	300	300	225	150	157	150
1.16	300	300	225	150	157	150
2.01	300	300	225	150	158	150
2.15	300	300	225	150	158	150
3.01	300	300	225	150	157	150
3.16	300	300	225	150	157	150
4.01	300	300	225	150	158	150
4.15	1,762	1,762	1,562	776	655	461
5.01	1,762	1,762	1,562	776	655	461
5.16	300	300	225	150	157	150
6.01	250	250	150	61	56	50
6.16	250	250	150	61	56	50
7.01	250	250	150	61	56	50
7.16	250	250	150	61	56	50
8.01	250	250	150	61	56	50
8.16	250	250	150	61	56	50
9.01	250	250	150	61	56	50
9.16	250	250	150	61	56	50
10.01	397	397	284	143	152	126
10.16	397	397	284	143	152	126
11.01	300	300	225	150	158	150
11.16	300	300	225	150	158	150
12.01	300	300	225	150	157	150
12.16	300	300	225	150	157	150

Existing FERC flow requirements averaged within Preliminary Relicensing Year Type designations. Existing annual FERC schedules are assumed to begin April 1. Values shown for comparison purposes.

*The “shared responsibility” assumption is presented for the purpose of evaluating alternative operations. The assumption shall not be used as evidence in any proceeding relating to and shall not act as precedence for any allocation of Tuolumne River water between CCSF and the Districts for any purpose under the Fourth Agreement.

This section provides an entry of the minimum flow schedule for the lower Tuolumne River. Switch UI 1.10 directs the use of the current 1995 FERC schedule (UI 1.10 = 0) or an alternative schedule (UI 1.10 = 1). If an alternative schedule is directed, Switch UI 1.20 directs the use of a user-defined daily times series (UI 1.20 = 0) or the use of a user-specified year type schedule (UI 1.20 = 1).

Daily Time Series

If the daily time series is directed, a flow value (expressed in average daily flow – cfs) must be entered in Column BM of this worksheet for each day beginning October 1, 1970 through September 30, 2009.

Year Type Schedule

If the year type schedule is directed, values must be entered into the matrix provided at UI 1.30. Values are entered as average daily flow (cfs) for 6 year types, for up to 24 discrete periods during the year. The periods are identified in MM.DD format. For instance, for a flow to be provided for January 1 through January 15 the flow would be identified with a period starting 01.01 (January [01], day 1) and ending

with a different flow identified with a starting period of 01.16 (January [01], day 16). The year type has been established by the naming of 6 year types, wet, above normal, normal, below normal, dry and critical. Using the water year runoff for the years 1921 through 2011 (91 years), the years were rank ordered from wettest to driest. The wettest 20 percent of the years (18 years) are designated the wet year type. The next wettest 18 years are designated the above normal year type. And so on for the normal and below normal year types. The driest 20 percent of years are split between the dry and critical year types. After the demarcation occurs for each year the data set is reduced to only the 1971 through 2009 modeling period (39 years). The reduced set of years of the modeling period maintains a year type frequency distribution similar to the larger data set's 20/20/20/20/10/10 percent frequency. Switch UI 1.40 directs the monthly sequence of the flow requirement year. For instance, if the flow schedule is to be established for a year beginning February 1 of the year, UI 1.40 would be set to "Feb". The applicable year type schedule would be applied beginning February 1 of the year and continue through January 31 of the following year. Switch UI 1.40 can be set to any month February (Feb) through June (Jun).

The current 1995 FERC minimum flows to the lower Tuolumne River at La Grange Bridge are illustrated in this section for comparison purposes only, and the values are arranged in the context of the year type designations described above. The values reflect an assumption of two equal periods of flow requirements during each month. If Switch UI 1.10 directs the use of the current schedule, the 1995 FERC schedule as defined by the 1995 FERC Settlement Agreement is implemented including the use of its definition of year types and discrete periods of flow requirements during the year. The 1995 FERC schedule is computed in worksheet LaGrangeSchedule.

Shared responsibility for incremental increases in FERC-required flows for the Tuolumne River is enabled with Switch 1.31.[2] The incremental increase in FERC-required flows is determined by the daily difference between the current FERC requirements and scenario-required minimum flows. Approximately fifty-two percent (51.7121%) of the incremental difference between the flow schedules is assigned as CCSF's responsibility and counted as a debit within Water Bank Accounting. If enabled, shared responsibility will cause an effect in the CCSF Water Bank Account which requires review and possible revision to CCSF supplemental releases.

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[2] The "shared responsibility" assumption is presented for the purpose of evaluating alternative operations. The assumption shall not be used as evidence in any proceeding relating to and shall not act as precedence for any allocation of Tuolumne River water between CCSF and the Districts for any purpose under the Fourth Agreement.

Section 2: Canal Diversions of Modesto Irrigation District and Turlock Irrigation District

Section 2 - Alternative Modesto and Turlock Canal Diversions

These tables are used to enter user-specified canal diversions for Modesto ID and Turlock ID. Enter a value for each month of each year.
The monthly volumes of canal diversions are distributed daily within a month based on the daily distribution used for the Base case.

(UI 2.10) Turn alterantive canal diversion on: 0 *(1) on, and use table below, or (0) off, use Test Case canal diversion*

(UI 2.20)

Alternative MID Canal Diversion

Enter values in acre-feet

Prelim Relicense Yr-Type	WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total WY
N	1971	20,952	2,700	2,500	4,300	3,300	14,746	30,656	42,917	47,253	54,987	49,086	32,192	305,589
BN	1972	20,952	5,130	2,500	4,300	5,679	24,844	46,800	46,544	46,542	54,987	49,086	30,637	338,001
N	1973	20,952	2,700	2,500	4,300	3,300	14,746	23,737	45,374	47,016	54,987	49,086	32,658	301,356
AN	1974	20,952	2,700	2,500	4,300	3,300	14,746	18,115	42,917	45,239	49,733	49,086	32,658	286,246
AN	1975	20,952	5,460	2,500	4,300	3,300	14,746	28,782	44,672	47,253	54,859	43,423	32,658	302,906
C	1976	20,952	6,451	2,500	4,300	6,350	30,232	34,676	38,540	38,163	44,939	35,682	24,524	287,308
C	1977	14,568	5,081	2,500	4,300	6,379	17,127	30,279	23,572	28,282	33,405	30,961	19,432	215,886
W	1978	10,761	2,700	2,500	4,300	3,300	14,746	10,143	39,642	47,253	54,987	49,086	25,506	264,924
N	1979	23,490	2,700	2,500	4,300	3,300	14,746	27,340	45,140	47,253	53,962	49,086	32,658	306,475
W	1980	20,952	2,700	2,500	4,300	3,300	14,746	24,602	43,034	47,253	50,758	49,086	32,658	295,889
D	1981	23,236	7,441	2,500	4,300	3,300	14,746	33,395	45,608	47,253	54,987	49,086	32,658	318,510
W	1982	20,952	2,700	2,500	4,300	3,300	14,746	12,687	42,917	45,476	54,987	49,086	17,265	270,916
W	1983	20,952	2,700	2,500	4,300	3,300	14,746	11,058	40,110	47,253	54,987	47,529	15,866	265,301
AN	1984	20,952	2,700	2,500	4,300	3,300	14,746	37,719	46,777	47,253	54,859	49,086	32,502	316,695
BN	1985	20,952	2,700	2,500	4,300	3,300	14,746	33,106	46,193	45,950	54,987	49,086	31,881	309,700
W	1986	20,952	2,700	2,500	4,300	3,300	14,746	19,701	42,215	47,253	54,987	49,086	32,192	293,932
C	1987	20,952	7,441	2,500	4,300	3,300	11,348	33,450	38,540	38,264	45,048	40,977	26,903	273,023
C	1988	14,568	5,081	2,500	4,300	3,300	10,522	20,959	28,485	29,064	35,631	32,822	21,807	209,039
BN	1989	13,109	2,700	2,500	4,300	5,631	11,348	37,004	38,341	38,264	45,048	40,375	15,537	254,156
D	1990	14,568	5,361	2,500	4,300	5,590	15,190	29,936	21,644	29,236	34,588	31,919	20,952	215,784
BN	1991	11,125	6,242	2,500	4,300	5,812	10,324	26,779	32,222	30,198	37,899	33,900	23,035	224,335
C	1992	12,215	6,407	2,500	4,300	3,300	9,811	16,590	29,752	29,193	35,255	32,639	21,693	203,656
AN	1993	11,399	2,700	2,500	4,300	3,300	14,746	23,160	36,951	44,528	54,987	49,086	32,658	280,315
D	1994	20,952	2,700	2,500	4,300	3,300	17,718	28,427	26,707	38,264	45,048	40,977	26,639	257,531
W	1995	14,568	2,700	2,500	4,300	3,300	14,746	15,953	32,974	43,936	54,987	49,086	32,658	271,707
AN	1996	23,490	7,441	2,500	4,300	3,300	14,746	24,746	30,868	47,134	54,987	49,086	32,658	295,257
W	1997	20,952	2,700	2,500	4,300	3,300	14,746	45,935	45,491	46,542	54,987	49,086	32,658	323,197
W	1998	21,967	2,700	2,500	4,300	3,300	14,746	20,421	19,404	43,462	54,987	49,086	32,502	269,376
AN	1999	20,952	2,700	2,500	4,300	3,300	14,746	31,232	43,619	47,134	54,987	49,086	32,347	306,904
N	2000	23,236	6,781	2,500	4,300	3,300	14,746	19,989	29,347	38,722	54,987	49,086	32,192	279,187
BN	2001	20,952	5,790	2,500	4,300	3,300	14,746	21,863	44,204	46,898	54,987	49,086	31,414	300,040
N	2002	21,713	2,700	2,500	4,300	3,300	14,746	36,133	45,959	47,253	54,987	49,086	32,658	315,335
N	2003	23,490	2,700	2,500	4,300	3,300	14,746	27,196	44,087	47,253	54,987	47,670	32,658	304,888
BN	2004	23,490	6,781	2,500	4,300	5,959	25,777	51,269	46,777	47,253	54,987	49,086	32,192	350,369
W	2005	20,952	2,700	2,500	4,300	3,300	14,746	36,422	46,193	47,134	54,987	49,086	30,792	313,112
W	2006	22,982	6,121	2,500	4,300	3,300	14,746	13,115	41,747	47,253	54,987	49,086	32,502	292,640
D	2007	20,952	2,700	2,500	4,300	5,672	22,068	36,391	38,142	38,264	45,048	40,977	25,317	282,330
BN	2008	14,568	5,923	2,500	4,300	3,300	11,348	31,368	38,540	38,264	45,048	40,977	26,903	263,037
N	2009	14,568	5,361	2,500	4,300	3,300	14,746	47,088	44,204	46,661	54,987	49,086	31,259	318,060
	Ave	19,262	4,197	2,500	4,300	3,830	15,412	28,160	38,984	42,875	50,662	45,333	28,663	284,177

Test Case MID Canal Diversion

Values in acre-feet

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total WY	Full Dem Total WY
1971	20,952	2,700	2,500	4,300	3,300	14,746	30,656	42,917	47,253	54,987	49,086	32,192	305,589	305,589
1972	20,952	5,130	2,500	4,300	5,679	24,844	46,800	46,544	46,542	54,987	49,086	30,637	338,001	338,001
1973	20,952	2,700	2,500	4,300	3,300	14,746	23,737	45,374	47,016	54,987	49,086	32,658	301,356	301,356
1974	20,952	2,700	2,500	4,300	3,300	14,746	18,115	42,917	45,239	49,733	49,086	32,658	286,246	286,246
1975	20,952	5,460	2,500	4,300	3,300	14,746	28,782	44,672	47,253	54,859	43,423	32,658	302,906	302,906
1976	20,952	6,451	2,500	4,300	6,350	30,232	34,676	38,540	38,163	44,939	35,682	24,524	287,308	324,478
1977	14,568	5,081	2,500	4,300	6,379	17,127	30,279	23,572	28,282	33,405	30,961	19,432	215,886	316,195
1978	10,761	2,700	2,500	4,300	3,300	14,746	10,143	39,642	47,253	54,987	49,086	25,506	264,924	271,015
1979	23,490	2,700	2,500	4,300	3,300	14,746	27,340	45,140	47,253	53,962	49,086	32,658	306,475	306,475
1980	20,952	2,700	2,500	4,300	3,300	14,746	24,602	43,034	47,253	50,758	49,086	32,658	295,889	295,889
1981	23,236	7,441	2,500	4,300	3,300	14,746	33,395	45,608	47,253	54,987	49,086	32,658	318,510	318,510
1982	20,952	2,700	2,500	4,300	3,300	14,746	12,687	42,917	45,476	54,987	49,086	17,265	270,916	270,916
1983	20,952	2,700	2,500	4,300	3,300	14,746	11,058	40,110	47,253	54,987	47,529	15,866	265,301	265,301
1984	20,952	2,700	2,500	4,300	3,300	14,746	37,719	46,777	47,253	54,859	49,086	32,502	316,695	316,695
1985	20,952	2,700	2,500	4,300	3,300	14,746	33,106	46,193	45,950	54,987	49,086	31,881	309,700	309,700
1986	20,952	2,700	2,500	4,300	3,300	14,746	19,701	42,215	47,253	54,987	49,086	32,192	293,932	293,932
1987	20,952	7,441	2,500	4,300	3,300	11,348	33,450	38,540	38,264	45,048	40,977	26,903	273,023	307,868
1988	14,568	5,081	2,500	4,300	3,300	10,522	20,959	28,485	29,064	35,631	32,822	21,807	209,039	288,428
1989	13,109	2,700	2,500	4,300	5,631	11,348	37,004	38,341	38,264	45,048	40,375	15,537	254,156	293,803
1990	14,568	5,361	2,500	4,300	5,590	15,190	29,936	21,644	29,236	34,588	31,919	20,952	215,784	304,883
1991	11,125	6,242	2,500	4,300	5,812	10,324	26,779	32,222	30,198	37,899	33,900	23,035	224,335	299,335
1992	12,215	6,407	2,500	4,300	3,300	9,811	16,590	29,752	29,193	35,255	32,639	21,693	203,656	285,286
1993	11,399	2,700	2,500	4,300	3,300	14,746	23,160	36,951	44,528	54,987	49,086	32,658	280,315	285,768
1994	20,952	2,700	2,500	4,300	3,300	17,718	28,427	26,707	38,264	45,048	40,977	26,639	257,531	287,956
1995	14,568	2,700	2,500	4,300	3,300	14,746	15,953	32,974	43,936	54,987	49,086	32,658	271,707	273,991
1996	23,490	7,441	2,500	4,300	3,300	14,746	24,746	30,868	47,134	54,987	49,086	32,658	295,257	295,257
1997	20,952	2,700	2,500	4,300	3,300	14,746	45,935	45,491	46,542	54,987	49,086	32,658	323,197	323,197
1998	21,967	2,700	2,500	4,300	3,300	14,746	20,421	19,404	43,462	54,987	49,086	32,502	269,376	269,376
1999	20,952	2,700	2,500	4,300	3,300	14,746	31,232	43,619	47,134	54,987	49,086	32,347	306,904	306,904
2000	23,236	6,781	2,500	4,300	3,300	14,746	19,989	29,347	38,722	54,987	49,086	32,192	279,187	279,187
2001	20,952	5,790	2,500	4,300	3,300	14,746	21,863	44,204	46,898	54,987	49,086	31,414	300,040	300,040
2002	21,713	2,700	2,500	4,300	3,300	14,746	36,133	45,959	47,253	54,987	49,086	32,658	315,335	315,335
2003	23,490	2,700	2,500	4,300	3,300	14,746	27,196	44,087	47,253	54,987	47,670	32,658	304,888	304,888
2004	23,490	6,781	2,500	4,300	5,959	25,777	51,269	46,777	47,253	54,987	49,086	32,192	350,369	350,369
2005	20,952	2,700	2,500	4,300	3,300	14,746	36,422	46,193	47,134	54,987	49,086	30,792	313,112	313,112
2006	22,982	6,121	2,500	4,300	3,300	14,746	13,115	41,747	47,253	54,987	49,086	32,502	292,640	292,640
2007	20,952	2,700	2,500	4,300	5,672	22,068	36,391	38,142	38,264	45,048	40,977	25,317	282,330	315,945
2008	14,568	5,923	2,500	4,300	3,300	11,348	31,368	38,540	38,264	45,048	40,977	26,903	263,037	299,996
2009	14,568	5,361	2,500	4,300	3,300	14,746	47,088	44,204	46,661	54,987	49,086	31,259	318,060	320,443
Ave	19,262	4,197	2,500	4,300	3,830	15,412	28,160	38,984	42,875	50,662	45,333	28,663	284,177	300,954

This section provides an entry of the diversions of the Modesto Irrigation District and Turlock Irrigation District. Switch UI 2.10 directs the use of Test Case diversions (UI 2.10 = 0) or user specified canal diversions (UI 2.10 = 1). If Test Case diversions are directed, a pre-processed daily time series of canal diversions is used. If directed to use user-specified canal diversions, the matrix tables shown at UI 2.30 (above for Modesto Irrigation District) and at UI 2.40 (below for Turlock Irrigation District) require input values for each month of each simulation year, beginning October 1970 (water year 1971) through September 2009. Values are entered as monthly volumes (acre-feet), which will be parsed by the Model into a daily distribution each month represented by the distribution pattern of the Test Case diversions. The Test Case diversions to the Modesto Canal and Turlock Canal are illustrated in this section for comparison purposes.

(UI 2.30)

Alternative TID Canal Diversion

Enter values in acre-feet

Prelim Relicense Yr-Type	WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total WY
N	1971	31,487	1,000	1,000	6,000	8,000	42,220	71,385	79,506	96,454	118,397	101,372	51,350	608,171
BN	1972	31,487	4,120	1,000	6,000	12,542	70,210	104,879	92,357	95,639	118,397	101,372	50,168	688,170
N	1973	31,487	1,000	1,000	6,000	8,000	42,220	44,833	89,056	96,105	118,397	101,372	52,681	592,149
AN	1974	31,487	1,000	1,000	6,000	8,000	42,220	39,626	82,689	92,845	106,930	101,372	52,681	565,851
AN	1975	31,487	4,761	1,000	6,000	8,000	42,220	59,410	85,755	96,454	117,430	92,559	52,681	597,756
C	1976	31,487	6,684	1,000	6,000	13,169	81,414	79,704	77,553	79,063	97,737	72,955	32,004	578,770
C	1977	20,773	1,000	1,000	6,000	13,371	50,509	72,025	45,645	54,416	68,098	57,243	26,675	416,755
W	1978	11,340	4,569	1,000	6,000	8,000	42,220	9,548	72,786	96,454	118,397	101,372	37,013	508,698
N	1979	31,487	1,000	1,000	6,000	8,000	42,220	53,683	87,405	96,454	115,219	101,372	52,681	596,521
W	1980	31,487	1,000	1,000	6,000	8,000	42,220	49,345	81,864	96,454	112,318	101,372	52,681	583,741
D	1981	31,487	7,966	1,000	6,000	11,130	42,220	78,153	90,235	96,454	118,397	101,372	52,681	637,093
W	1982	31,487	1,000	1,000	6,000	8,000	42,220	18,801	79,506	93,427	118,397	101,372	26,075	527,285
W	1983	31,487	1,000	1,000	6,000	8,000	42,220	14,289	73,376	96,454	118,397	97,046	25,780	515,047
AN	1984	31,487	1,000	1,000	6,000	8,000	42,220	89,260	92,475	95,173	118,120	101,372	51,794	637,901
BN	1985	31,487	1,000	1,000	6,000	8,000	42,220	80,930	92,003	92,845	118,397	101,372	51,942	627,195
W	1986	31,487	1,000	1,000	6,000	8,000	42,220	36,155	80,567	96,454	118,397	101,372	50,168	572,820
C	1987	31,487	7,645	1,000	6,000	11,080	37,117	80,884	77,453	79,756	97,972	82,761	40,798	553,954
C	1988	20,773	4,345	1,000	6,000	8,000	34,416	44,841	54,744	59,435	73,648	61,984	30,238	399,424
BN	1989	13,087	1,000	1,000	6,000	11,360	37,117	89,292	76,551	79,756	97,972	80,991	19,063	513,190
D	1990	20,773	4,889	1,000	6,000	11,491	42,592	67,733	41,090	58,355	70,954	59,683	28,700	413,261
BN	1991	12,239	5,799	1,000	6,000	12,548	33,362	63,975	63,689	62,376	79,506	64,759	32,781	438,033
C	1992	14,931	5,806	1,000	6,000	8,000	31,457	37,881	58,023	58,785	71,771	61,517	30,001	385,173
AN	1993	12,915	5,034	1,000	6,000	8,000	42,220	43,271	70,428	88,770	118,397	101,372	52,681	550,087
D	1994	31,487	4,441	1,000	6,000	8,000	42,220	67,460	54,104	79,756	97,972	82,761	39,040	514,241
W	1995	20,773	1,000	1,000	6,000	8,000	42,220	25,049	58,874	87,023	118,120	101,372	52,681	522,113
AN	1996	31,487	7,966	1,000	6,000	8,000	42,220	46,047	59,228	96,454	118,397	101,372	52,681	570,851
W	1997	31,487	1,000	1,000	6,000	8,000	42,220	107,135	91,532	95,173	118,397	101,372	52,089	655,405
W	1998	31,487	1,000	1,000	6,000	8,000	42,220	31,470	38,950	81,784	118,397	101,372	52,681	514,360
AN	1999	31,487	1,000	1,000	6,000	8,000	42,220	75,897	88,702	96,454	118,397	101,372	52,681	623,209
N	2000	31,487	5,723	1,000	6,000	8,000	42,220	36,503	56,634	83,065	118,397	101,372	52,681	543,081
BN	2001	31,487	4,761	1,000	6,000	8,000	42,220	49,518	83,515	96,105	118,397	101,372	50,168	592,542
N	2002	31,487	1,000	1,000	6,000	8,000	42,220	84,748	81,510	96,454	118,397	101,372	52,681	624,868
N	2003	31,487	1,000	1,000	6,000	8,000	42,220	66,179	82,454	96,454	118,397	99,129	52,681	604,999
BN	2004	31,487	6,363	1,000	6,000	8,000	42,220	111,474	89,763	91,215	112,042	96,725	52,681	648,970
W	2005	31,487	1,000	1,000	6,000	8,000	42,220	54,725	81,275	96,454	118,397	100,731	48,099	589,386
W	2006	31,487	6,363	1,000	6,000	8,000	42,220	29,387	71,607	96,454	118,397	101,372	52,681	564,968
D	2007	31,487	1,000	1,000	6,000	12,448	70,365	85,162	76,852	79,756	97,972	82,761	36,904	581,706
BN	2008	20,773	5,707	1,000	6,000	8,000	37,117	76,901	76,952	79,756	97,972	82,761	40,798	533,738
N	2009	20,773	4,617	1,000	6,000	8,000	42,220	103,144	85,047	95,522	118,397	101,372	50,611	636,704
	Ave	27,456	3,271	1,000	6,000	8,952	43,791	61,044	74,917	87,340	108,669	92,511	44,747	559,697

Test Case TID Canal Diversion

Values in acre-feet

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total WY	Full Dem Total
1971	31,487	1,000	1,000	6,000	8,000	42,220	71,385	79,506	96,454	118,397	101,372	51,350	608,171	608,171
1972	31,487	4,120	1,000	6,000	12,542	70,210	104,879	92,357	95,639	118,397	101,372	50,168	688,170	688,170
1973	31,487	1,000	1,000	6,000	8,000	42,220	44,833	89,056	96,105	118,397	101,372	52,681	592,149	592,149
1974	31,487	1,000	1,000	6,000	8,000	42,220	39,626	82,689	92,845	106,930	101,372	52,681	565,851	565,851
1975	31,487	4,761	1,000	6,000	8,000	42,220	59,410	85,755	96,454	117,430	92,559	52,681	597,756	597,756
1976	31,487	6,684	1,000	6,000	13,169	81,414	79,704	77,553	79,063	97,737	72,955	32,004	578,770	669,740
1977	20,773	1,000	1,000	6,000	13,371	50,509	72,025	45,645	54,416	68,098	57,243	26,675	416,755	669,171
1978	11,340	4,569	1,000	6,000	8,000	42,220	9,548	72,786	96,454	118,397	101,372	37,013	508,698	524,472
1979	31,487	1,000	1,000	6,000	8,000	42,220	53,683	87,405	96,454	115,219	101,372	52,681	596,521	596,521
1980	31,487	1,000	1,000	6,000	8,000	42,220	49,345	81,864	96,454	112,318	101,372	52,681	583,741	583,741
1981	31,487	7,966	1,000	6,000	11,130	42,220	78,153	90,235	96,454	118,397	101,372	52,681	637,093	637,093
1982	31,487	1,000	1,000	6,000	8,000	42,220	18,801	79,506	93,427	118,397	101,372	26,075	527,285	527,285
1983	31,487	1,000	1,000	6,000	8,000	42,220	14,289	73,376	96,454	118,397	97,046	25,780	515,047	515,047
1984	31,487	1,000	1,000	6,000	8,000	42,220	89,260	92,475	95,173	118,120	101,372	51,794	637,901	637,901
1985	31,487	1,000	1,000	6,000	8,000	42,220	80,930	92,003	92,845	118,397	101,372	51,942	627,195	627,195
1986	31,487	1,000	1,000	6,000	8,000	42,220	36,155	80,567	96,454	118,397	101,372	50,168	572,820	572,820
1987	31,487	7,645	1,000	6,000	11,080	37,117	80,884	77,453	79,756	97,972	82,761	40,798	553,954	640,376
1988	20,773	4,345	1,000	6,000	8,000	34,416	44,841	54,744	59,435	73,648	61,984	30,238	399,424	595,199
1989	13,087	1,000	1,000	6,000	11,360	37,117	89,292	76,551	79,756	97,972	80,991	19,063	513,190	610,352
1990	20,773	4,889	1,000	6,000	11,491	42,592	67,733	41,090	58,355	70,954	59,683	28,700	413,261	632,968
1991	12,239	5,799	1,000	6,000	12,548	33,362	63,975	63,689	62,376	79,506	64,759	32,781	438,033	624,153
1992	14,931	5,806	1,000	6,000	8,000	31,457	37,881	58,023	58,785	71,771	61,517	30,001	385,173	586,401
1993	12,915	5,034	1,000	6,000	8,000	42,220	43,271	70,428	88,770	118,397	101,372	52,681	550,087	564,462
1994	31,487	4,441	1,000	6,000	8,000	42,220	67,460	54,104	79,756	97,972	82,761	39,040	514,241	588,710
1995	20,773	1,000	1,000	6,000	8,000	42,220	25,049	58,874	87,023	118,120	101,372	52,681	522,113	527,941
1996	31,487	7,966	1,000	6,000	8,000	42,220	46,047	59,228	96,454	118,397	101,372	52,681	570,851	570,851
1997	31,487	1,000	1,000	6,000	8,000	42,220	107,135	91,532	95,173	118,397	101,372	52,089	655,405	655,405
1998	31,487	1,000	1,000	6,000	8,000	42,220	31,470	38,950	81,784	118,397	101,372	52,681	514,360	514,360
1999	31,487	1,000	1,000	6,000	8,000	42,220	75,897	88,702	96,454	118,397	101,372	52,681	623,209	623,209
2000	31,487	5,723	1,000	6,000	8,000	42,220	36,503	56,634	83,065	118,397	101,372	52,681	543,081	543,081
2001	31,487	4,761	1,000	6,000	8,000	42,220	49,518	83,515	96,105	118,397	101,372	50,168	592,542	592,542
2002	31,487	1,000	1,000	6,000	8,000	42,220	84,748	81,510	96,454	118,397	101,372	52,681	624,868	624,868
2003	31,487	1,000	1,000	6,000	8,000	42,220	66,179	82,454	96,454	118,397	99,129	52,681	604,999	604,999
2004	31,487	6,363	1,000	6,000	8,000	42,220	111,474	89,763	91,215	112,042	96,725	52,681	648,970	648,970
2005	31,487	1,000	1,000	6,000	8,000	42,220	54,725	81,275	96,454	118,397	100,731	48,099	589,386	589,386
2006	31,487	6,363	1,000	6,000	8,000	42,220	29,387	71,607	96,454	118,397	101,372	52,681	564,968	564,968
2007	31,487	1,000	1,000	6,000	12,448	70,365	85,162	76,852	79,756	97,972	82,761	36,904	581,706	662,937
2008	20,773	5,707	1,000	6,000	8,000	37,117	76,901	76,952	79,756	97,972	82,761	40,798	533,738	625,483
2009	20,773	4,617	1,000	6,000	8,000	42,220	103,144	85,047	95,522	118,397	101,372	50,611	636,704	642,676
Ave	27,456	3,271	1,000	6,000	8,952	43,791	61,044	74,917	87,340	108,669	92,511	44,747	559,697	601,215

Section 3: Supplemental Releases of City and County of San Francisco

This section provides entry of supplemental releases from CCSF upstream facilities. Switch UI 3.10 directs the use of a suggested method for defining daily supplemental releases (UI 3.10 = 1) or the use of a user-specified table of supplemental releases with or without consideration of Test Case supplemental releases (UI 3.10 = 0), other methods. If the suggested daily supplemental releases method is selected (UI 3.10 = 1) the user must go to worksheet WaterBankRel to complete Model input (see worksheet WaterBankRel description). If the "other methods" path is selected (UI 3.10 = 0) the user must provide additional direction. Switch UI 3.20 directs the use of Test Case supplemental releases (UI 3.20 = 0) or the use of a user-specified table of supplemental releases (UI 3.20 = 1). The user must also direct the consideration of Test Case supplemental releases. To only use the user-specified table of supplement releases, Switch UI 3.30 is set to 0. To add Test Case supplemental releases to the user-specified table of supplemental releases, Switch UI 3.30 is set to 1. The format and application of the user-specified table is the same as described for the entry of alternative flow requirements in Section 1. Values must be entered into the matrix provided at UI 3.40. Values are entered as a daily volume (acre-feet) for 6 year types, for up to 24 discrete periods during the year. The periods are identified in MM.DD format. The year type has been established by the naming of 6 year types, wet, above normal, normal, below normal, dry and critical. Switch UI 3.50 directs the monthly sequence of the supplemental release year. For instance, if the schedule is to be established for a year beginning February 1 of the year, UI 3.50 would be set to "Feb". The applicable year type schedule would be applied beginning February 1 of the year and continue through January 31 of the following year. Switch UI 3.50 can be set to any month February (Feb) through June (Jun). The Test Case supplemental release schedule is illustrated in this section for information purposes.

Section 3 - Supplemental Release from CCSF Upstream Reservoirs

This table is used to enter a user-specified supplemental release from CCSF upstream reservoirs. Twenty-four time periods are available to define the period and flow rate. Six different water year types can be established.
The year types correspond to the Preliminary Relicensing Year Type which is based on Tuolumne River unimpaired flow.
The supplemental release will be directed to Lake Lloyd until the reservoir storage reaches a defined limit, then the supplemental release is directed to Hetch Hetchy Reservoir.
User specifies whether or not Table supplemental releases are added to Test Case supplemental releases.
Alternatively, user can define a daily supplemental release from CCSF facilities. This option is the same method used to define Test Base supplemental releases to maintain the Water Bank Balance at or above zero. (Suggested method)

(UI 3.10) Use daily supplemental release option: 1 *(1) on, use daily defined option - go to worksheet WaterBankRel, or (0) off, use other supplemental release options*

If using other supplement release options, Switch UI 3.10 = 0, enter choices below.
(UI 3.20) Turn other user-specified supplemental releases on: 0 *(1) on, and use table below, or (0) off, use existing Test Case supplemental releases* N/A
(UI 3.30) If using table below, add to existing supplemental releases: 1 *(1) yes, add table to existing releases, or (0) no use table only*

Alternative Supplemental Releases
Enter values in acre-feet per day

(UI 3.40)

CYMo Day MM.DD	W 1	AN 2	N 3	BN 4	D 5	C 6
1.01	0	0	0	0	0	0
1.16	0	0	0	0	0	0
2.01	0	0	0	0	2,000	2,000
2.15	0	0	0	0	2,000	2,000
3.01	0	0	0	0	2,000	2,000
3.16	0	0	0	0	2,000	2,000
4.01	0	0	0	0	2,000	2,000
4.16	0	0	0	0	2,000	2,000
5.01	0	0	0	0	2,000	2,000
5.16	0	0	0	0	2,000	2,000
6.01	0	0	0	0	2,000	2,000
6.16	0	0	0	0	2,000	2,000
7.01	0	0	0	0	0	0
7.16	0	0	0	0	0	0
8.01	0	0	0	0	0	0
8.16	0	0	0	0	0	0
9.01	0	0	0	0	0	0
9.16	0	0	0	0	0	0
10.01	0	0	0	0	0	0
10.16	0	0	0	0	0	0
11.01	0	0	0	0	0	0
11.16	0	0	0	0	0	0
12.01	0	0	0	0	0	0
12.16	0	0	0	0	0	0

Preliminary Relicensing Year Type is based on a rank-ordering of the water-year runoff for the years 1921-2011. Each water year type W, AN, N, and BN represent 20% of the years of ranking. D and C year types each represent 10% of the years.

(UI 3.50) Enter beginning month of annual supplemental release schedule: Feb-Jun / Jun / 6

Test Case Supplemental Releases (made to retain WB Balance above zero)

Prelim Relicense Yr-Type	WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
	Monthly Acre-feet													
N	1971	0	0	0	0	0	0	0	0	0	0	0	0	0
BN	1972	0	0	0	0	0	0	0	0	0	0	0	0	0
N	1973	0	0	0	0	0	0	0	0	0	0	0	0	0
AN	1974	0	0	0	0	0	0	0	0	0	0	0	0	0
AN	1975	0	0	0	0	0	0	0	0	0	0	0	0	0
C	1976	0	0	0	0	0	0	0	0	0	0	0	0	0
C	1977	0	0	0	0	0	0	0	0	0	0	0	0	0
W	1978	0	0	0	0	0	0	0	0	0	0	0	0	0
N	1979	0	0	0	0	0	0	0	0	0	0	0	0	0
W	1980	0	0	0	0	0	0	0	0	0	0	0	0	0
D	1981	0	0	0	0	0	0	0	0	0	0	0	0	0
W	1982	0	0	0	0	0	0	0	0	0	0	0	0	0
W	1983	0	0	0	0	0	0	0	0	0	0	0	0	0
AN	1984	0	0	0	0	0	0	0	0	0	0	0	0	0
BN	1985	0	0	0	0	0	0	0	0	0	0	0	0	0
W	1986	0	0	0	0	0	0	0	0	0	0	0	0	0
C	1987	0	0	0	0	0	0	0	0	0	0	0	0	0
C	1988	0	0	0	0	0	0	0	0	0	0	0	0	0
BN	1989	0	0	0	0	0	0	0	0	0	0	0	0	0
D	1990	0	0	0	0	0	0	0	0	0	0	0	0	0
BN	1991	0	0	0	0	0	0	0	0	0	0	0	0	0
C	1992	0	0	0	0	0	0	59,864	70,684	19,366	21,794	0	0	171,708
AN	1993	0	0	0	0	0	0	0	0	0	0	0	0	0
D	1994	0	0	0	0	0	0	0	0	0	0	0	0	0
W	1995	0	0	0	0	0	0	0	0	0	0	0	0	0
AN	1996	0	0	0	0	0	0	0	0	0	0	0	0	0
W	1997	0	0	0	0	0	0	0	0	0	0	0	0	0
W	1998	0	0	0	0	0	0	0	0	0	0	0	0	0
AN	1999	0	0	0	0	0	0	0	0	0	0	0	0	0
N	2000	0	0	0	0	0	0	0	0	0	0	0	0	0
BN	2001	0	0	0	0	0	0	0	0	0	0	0	0	0
N	2002	0	0	0	0	0	0	0	0	0	0	0	0	0
N	2003	0	0	0	0	0	0	0	0	0	0	0	0	0
BN	2004	0	0	0	0	0	0	0	0	0	0	0	0	0
W	2005	0	0	0	0	0	0	0	0	0	0	0	0	0
W	2006	0	0	0	0	0	0	0	0	0	0	0	0	0
D	2007	0	0	0	0	0	0	0	0	0	0	0	0	0
BN	2008	0	0	0	0	0	0	0	0	0	0	0	0	0
N	2009	0	0	0	0	0	0	0	0	0	0	0	0	0

Values are associated with Test Case scenario and are equal to daily supplemental releases made from CCSF facilities to maintain the Water Bank Account Balance at or above zero. Values are shown for comparison purposes.

Section 4: San Joaquin Pipeline Diversions of City and County of San Francisco

Section 4 - Alternative CCSF San Joaquin Pipeline

This section specifies the CCSF San Joaquin Pipeline diversion. Use Test Case diversions, or user-specified values by entering a value for each month of each year.
The monthly volumes of pipeline diversions will be distributed daily within a month equally.

(UI 4.10) Turn alterantive pipeline diversion on: 0 *(0) off, use Test Case pipeline diversion, (1) on, use table below*

(UI 4.20)

Alternative SJPL Diversion — Enter values in acre-feet

Prelim Relicense Yr-Type	WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total WY
N	1971	19,027	11,969	6,660	6,660	6,015	25,782	24,950	25,782	24,950	29,778	29,778	23,937	235,286
BN	1972	21,881	16,572	12,368	17,124	15,467	25,782	25,779	25,782	24,950	29,778	29,778	24,950	270,211
N	1973	21,881	14,731	12,368	6,660	6,015	6,660	16,572	25,782	24,950	29,778	29,778	23,937	219,110
AN	1974	17,124	10,127	6,660	6,660	6,015	6,660	7,365	24,735	23,937	29,778	29,778	24,950	193,789
AN	1975	17,124	0	0	25,782	11,171	6,660	10,127	24,735	23,937	29,778	29,778	24,950	204,042
C	1976	17,124	13,810	12,368	19,027	17,186	25,782	26,699	25,782	24,950	29,778	29,778	24,950	267,234
C	1977	21,881	16,572	17,124	17,124	15,467	25,782	27,620	26,638	25,779	27,589	25,782	21,175	268,535
W	1978	19,027	16,572	12,368	6,660	6,015	6,660	9,023	22,833	22,096	29,778	29,778	23,937	204,745
N	1979	17,124	13,810	17,124	15,222	6,015	17,124	22,096	25,782	24,950	29,778	29,778	23,937	242,741
W	1980	17,124	0	0	14,270	6,015	6,660	19,334	25,782	24,950	29,778	29,778	23,937	197,628
D	1981	17,124	13,810	12,891	12,368	11,171	22,833	23,937	25,782	24,950	29,778	29,778	23,937	248,358
W	1982	17,124	11,969	9,323	6,660	6,015	6,660	6,445	19,979	19,334	29,778	29,778	26,239	189,302
W	1983	19,979	11,969	6,660	6,660	6,015	6,660	7,365	12,368	11,969	29,778	29,778	28,817	178,015
AN	1984	22,833	9,023	6,660	6,660	6,015	25,782	24,950	24,735	23,937	29,778	29,778	24,950	235,099
BN	1985	21,881	0	0	25,782	20,623	25,782	28,817	25,782	24,950	29,778	29,778	23,937	257,109
W	1986	21,881	18,413	12,368	19,027	6,015	6,660	14,731	25,782	24,950	29,778	29,778	23,937	233,319
C	1987	17,124	13,810	17,124	17,124	15,467	25,782	26,239	25,782	24,950	29,778	29,778	24,950	267,909
C	1988	21,881	16,572	12,368	19,027	17,186	25,782	27,620	25,782	24,950	27,589	26,638	21,175	266,571
BN	1989	19,027	16,572	15,222	15,222	13,749	25,782	23,937	22,833	22,096	28,541	25,782	21,175	249,937
D	1990	19,027	0	0	25,782	20,623	25,782	28,817	22,833	22,096	28,541	25,782	21,175	240,458
BN	1991	19,027	16,572	12,891	17,124	15,467	19,979	22,096	22,833	22,096	27,589	25,782	21,175	242,632
C	1992	19,027	16,572	15,222	15,222	6,015	21,881	21,175	22,833	22,096	27,589	25,782	21,175	234,590
AN	1993	19,027	16,572	12,368	6,660	6,015	6,660	16,572	21,881	21,175	29,778	29,778	24,950	211,435
D	1994	17,124	13,810	17,124	17,124	13,749	24,735	24,950	25,782	24,950	29,778	29,778	24,950	263,855
W	1995	19,979	0	0	12,368	6,874	6,660	13,810	22,833	22,096	29,778	29,778	24,950	189,124
AN	1996	17,124	13,810	12,891	6,660	6,015	6,660	18,413	24,735	23,937	29,778	29,778	24,950	214,751
W	1997	17,124	7,365	6,660	6,660	6,015	19,979	23,937	25,782	24,950	29,778	29,778	23,937	221,964
W	1998	21,881	11,969	12,368	6,660	6,015	6,660	6,445	19,979	19,334	29,778	29,778	24,950	195,814
AN	1999	17,124	13,810	15,222	14,270	6,015	12,368	13,810	24,735	23,937	29,778	29,778	23,937	224,785
N	2000	17,124	0	0	25,782	11,171	6,660	23,937	25,782	24,950	29,778	29,778	23,937	218,898
BN	2001	19,027	13,810	12,368	19,027	12,889	17,124	22,096	25,782	24,950	29,778	29,778	23,937	250,566
N	2002	17,124	13,810	9,323	15,222	13,749	24,735	23,937	25,782	24,950	29,778	29,778	24,950	253,138
N	2003	19,979	14,731	6,660	6,660	6,015	25,782	24,950	22,833	22,096	29,778	29,778	24,950	234,209
BN	2004	21,881	13,810	14,270	15,222	6,015	19,027	24,950	25,782	24,950	29,778	29,778	23,937	249,400
W	2005	19,979	0	0	12,368	6,874	6,660	13,810	24,735	23,937	29,778	29,778	24,950	192,868
W	2006	17,124	13,810	10,465	6,660	6,015	9,323	6,445	22,833	22,096	29,778	29,778	24,950	199,276
D	2007	19,027	13,810	15,222	17,124	15,467	24,735	23,937	25,782	24,950	29,778	29,778	24,950	264,561
BN	2008	21,881	16,572	12,368	9,323	6,015	21,881	23,937	25,782	24,950	29,778	29,778	24,950	247,215
N	2009	19,979	14,731	17,124	17,124	6,015	6,660	23,937	25,782	24,950	29,778	29,778	23,937	239,795
	Ave	19,174	11,586	10,056	13,763	9,761	16,390	19,886	24,296	23,512	29,490	29,185	24,138	231,238

Test Case SJPL Diversion — Values in acre-feet

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total WY	CCSF Sys Action
1971	19,027	11,969	6,660	6,660	6,015	25,782	24,950	25,782	24,950	29,778	29,778	23,937	235,286	0
1972	21,881	16,572	12,368	17,124	15,467	25,782	25,779	25,782	24,950	29,778	29,778	24,950	270,211	0
1973	21,881	14,731	12,368	6,660	6,015	6,660	16,572	25,782	24,950	29,778	29,778	23,937	219,110	0
1974	17,124	10,127	6,660	6,660	6,015	6,660	7,365	24,735	23,937	29,778	29,778	24,950	193,789	0
1975	17,124	0	0	25,782	11,171	6,660	10,127	24,735	23,937	29,778	29,778	24,950	204,042	0
1976	17,124	13,810	12,368	19,027	17,186	25,782	26,699	25,782	24,950	29,778	29,778	24,950	267,234	0
1977	21,881	16,572	17,124	17,124	15,467	25,782	27,620	26,638	25,779	27,589	25,782	21,175	268,535	1
1978	19,027	16,572	12,368	6,660	6,015	6,660	9,023	22,833	22,096	29,778	29,778	23,937	204,745	0
1979	17,124	13,810	17,124	15,222	6,015	17,124	22,096	25,782	24,950	29,778	29,778	23,937	242,741	0
1980	17,124	0	0	14,270	6,015	6,660	19,334	25,782	24,950	29,778	29,778	23,937	197,628	0
1981	17,124	13,810	12,891	12,368	11,171	22,833	23,937	25,782	24,950	29,778	29,778	23,937	248,358	0
1982	17,124	11,969	9,323	6,660	6,015	6,660	6,445	19,979	19,334	29,778	29,778	26,239	189,302	0
1983	19,979	11,969	6,660	6,660	6,015	6,660	7,365	12,368	11,969	29,778	29,778	28,817	178,015	0
1984	22,833	9,023	6,660	6,660	6,015	25,782	24,950	24,735	23,937	29,778	29,778	24,950	235,099	0
1985	21,881	0	0	25,782	20,623	25,782	28,817	25,782	24,950	29,778	29,778	23,937	257,109	0
1986	21,881	18,413	12,368	19,027	6,015	6,660	14,731	25,782	24,950	29,778	29,778	23,937	233,319	0
1987	17,124	13,810	17,124	17,124	15,467	25,782	26,239	25,782	24,950	29,778	29,778	24,950	267,909	0
1988	21,881	16,572	12,368	19,027	17,186	25,782	27,620	25,782	24,950	27,589	26,638	21,175	266,571	1
1989	19,027	16,572	15,222	15,222	13,749	25,782	23,937	22,833	22,096	28,541	25,782	21,175	249,937	1
1990	19,027	0	0	25,782	20,623	25,782	28,817	22,833	22,096	28,541	25,782	21,175	240,458	1
1991	19,027	16,572	12,891	17,124	15,467	19,979	22,096	22,833	22,096	27,589	25,782	21,175	242,632	1
1992	19,027	16,572	15,222	15,222	6,015	21,881	21,175	22,833	22,096	27,589	25,782	21,175	234,590	1
1993	19,027	16,572	12,368	6,660	6,015	6,660	16,572	21,881	21,175	29,778	29,778	24,950	211,435	0
1994	17,124	13,810	17,124	17,124	13,749	24,735	24,950	25,782	24,950	29,778	29,778	24,950	263,855	0
1995	19,979	0	0	12,368	6,874	6,660	13,810	22,833	22,096	29,778	29,778	24,950	189,124	0
1996	17,124	13,810	12,891	6,660	6,015	6,660	18,413	24,735	23,937	29,778	29,778	24,950	214,751	0
1997	17,124	7,365	6,660	6,660	6,015	19,979	23,937	25,782	24,950	29,778	29,778	23,937	221,964	0
1998	21,881	11,969	12,368	6,660	6,015	6,660	6,445	19,979	19,334	29,778	29,778	24,950	195,814	0
1999	17,124	13,810	15,222	14,270	6,015	12,368	13,810	24,735	23,937	29,778	29,778	23,937	224,785	0
2000	17,124	0	0	25,782	11,171	6,660	23,937	25,782	24,950	29,778	29,778	23,937	218,898	0
2001	19,027	13,810	12,368	19,027	12,889	17,124	22,096	25,782	24,950	29,778	29,778	23,937	250,566	0
2002	17,124	13,810	9,323	15,222	13,749	24,735	23,937	25,782	24,950	29,778	29,778	24,950	253,138	0
2003	19,979	14,731	6,660	6,660	6,015	25,782	24,950	22,833	22,096	29,778	29,778	24,950	234,209	0
2004	21,881	13,810	14,270	15,222	6,015	19,027	24,950	25,782	24,950	29,778	29,778	23,937	249,400	0
2005	19,979	0	0	12,368	6,874	6,660	13,810	24,735	23,937	29,778	29,778	24,950	192,868	0
2006	17,124	13,810	10,465	6,660	6,015	9,323	6,445	22,833	22,096	29,778	29,778	24,950	199,276	0
2007	19,027	13,810	15,222	17,124	15,467	24,735	23,937	25,782	24,950	29,778	29,778	24,950	264,561	0
2008	21,881	16,572	12,368	9,323	6,015	21,881	23,937	25,782	24,950	29,778	29,778	24,950	247,215	0
2009	19,979	14,731	17,124	17,124	6,015	6,660	23,937	25,782	24,950	29,778	29,778	23,937	239,795	0
Ave	19,174	11,586	10,056	13,763	9,761	16,390	19,886	24,296	23,512	29,490	29,185	24,138	231,238	

This section provides an entry for the diversions of the CCSF System to the San Joaquin Pipeline. Switch UI 4.10 directs the use of Test Case diversions (UI 4.10 = 0), or user-specified diversions (UI 4.10 = 1). If Test Case diversions are directed, a pre-processed time series of diversions is used. If directed to use user-specified diversions, the matrix table shown at UI 4.20 requires input values for each month of each simulation year, beginning October 1970 (water year 1971) through September 2009. Values are entered as monthly volumes (acre-feet), which will be parsed by the Model into an equal daily distribution each month.

5.2 WaterBankRel Workheet

This worksheet (WaterBankRel) provides for entry of daily supplemental releases from the CCSF System. Without any other manual intervention the Model will direct releases from the CCSF System under a "hold-unless-need-to-release" protocol. Additional releases greater than provided by the default protocol may be needed. An example of such a need is during periods when CCSF System operations would otherwise deplete the Water Bank Account to a point of a "negative" balance.

The manual adjustment to releases from the CCSF System is provided to allow the user to "pull" additional water from the CCSF System as supplemental inflow to Don Pedro Reservoir. A single entry is established that will first pull water from Lake Lloyd so that water supply is preserved in the Hetch Hetchy Reservoir system for diversion to the SJPL. At a point when such supplemental releases strain Lake Lloyd storage, the supplemental releases are directed to Hetch Hetchy Reservoir. The supplemental release is directed from a reservoir at a point in logic after the default protocol releases occur. Thus, the release occurs in addition to what operation is already occurring by default. Such a release can affect the following day's default operation or previous periods' operations, thus results require review to determine if the user's desired result occurs. This worksheet is employed when Switch UI 3.10 directs the use of this suggested method for defining daily supplemental releases (UI 3.10 = 1).

Shown below is a snapshot of the worksheet. The worksheet provides the daily accounting of the Water Bank Account Balance for the Model. Information ported from other worksheets of the Model into this worksheet is Don Pedro Reservoir inflow (Column E) and the unimpaired flow at La Grange (Column F). These data and the protocols associated with Fourth Agreement Water Bank Balance accounting (Columns G through Column O) derive the daily credit or debit of CCSF and then the daily balance of the Water Bank Account (Column M).

San Francisco Water Bank Account Balance Computation and Supplement Release

Row	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1			1		San Francisco Water Bank Account Balance Computation and Supplement Release																			
2	Unit Title		2		CFS	CFS	CFS	CFS	CFS	AF		AF	AF		AF		AF			AF				
3	Parameter Title		3		DP Inflow	La Grange	Fourth Ag	Districts' E	SF Credit/	SF Credit/Debit w/ C		SF WB Eva	SF Water Bank Balan		Max Water Bank Cap		Credit Adj fc			SF Supplemental Release				
4																	Advice							
5	Acre-foot to CFS conversion				From	From																		
6	divide by :	1.983471			DonPedro	Hydrology		Warnings																
9																	(UI 1.31)			(UI 3.10)	Yes, this method is being used			
10																	0			1	Min Lloyd Storage		Min	Min
11																	(0) N, (1) Y				for WB		103,852	84,135
12																	- Debit				Call (acre-feet)		Min	Min
13												Max	740,000				+ Credit				45,000		Non 76-77	Non 76-77
14												Min	0			Sum:	0		Sum:	171,708	171,708	0	103,852	114,720
15					SF Water Bank Account Balance Calculation												La Grange			Supplemental Release and Storage Check				
16–19	Month Index	Date	Day	Days	DP Inflow CFS	La Grange UF CFS	Fourth Agree Check CFS	Daily Districts' Entitle CFS	SF Credit/ Debit CFS	SF C/D w/ Credit Adj AF	SF Gross WB Balance AF	SF WB Evap Losses AF	SF Net WB Balance 570,000	SF Share RFlood DP AF	SF Max WB Balance AF	WB Neg Flag AF	Credit Adj in SF WB AF	Mark	Mark	WB Supp Release AF	1st Call Lloyd Release AF	2nd Call HH Release AF	Lloyd Storage AF	HH Storage AF
20	1970.10	10/1/1970	T	31	322	159	2,416	159	163	324	570,324	48	570,000	0	570,000	0	0			0	0	0	200,091	249,349
21	1970.10	10/2/1970	F	31	453	55	2,416	55	398	790	570,790	48	570,000	0	570,000	0	0			0	0	0	200,080	248,379
22	1970.10	10/3/1970	S	31	541	265	2,416	265	276	548	570,548	48	570,000	0	570,000	0	0			0	0	0	200,090	247,622
23	1970.10	10/4/1970	S	31	625	-166	2,416	-166	791	1,569	571,569	48	570,000	0	570,000	0	0			0	0	0	199,278	247,032
24	1970.10	10/5/1970	M	31	75	180	2,416	180	-105	-208	569,792	48	569,744	0	570,000	0	0			0	0	0	199,896	246,150
25	1970.10	10/6/1970	T	31	475	92	2,416	92	383	760	570,504	48	570,000	0	570,000	0	0			0	0	0	199,781	245,360
26	1970.10	10/7/1970	W	31	526	150	2,416	150	376	746	570,746	48	570,000	0	570,000	0	0			0	0	0	199,660	244,595
27	1970.10	10/8/1970	T	31	209	153	2,416	153	56	111	570,111	48	570,000	0	570,000	0	0			0	0	0	199,746	243,730
28	1970.10	10/9/1970	F	31	264	146	2,416	146	118	234	570,234	48	570,000	0	570,000	0	0			0	0	0	199,746	242,867
29	1970.10	10/10/1970	S	31	210	99	2,416	99	111	220	570,220	48	570,000	0	570,000	0	0			0	0	0	199,677	242,119
30	1970.10	10/11/1970	S	31	620	293	2,416	293	327	649	570,649	49	570,000	0	570,000	0	0			0	0	0	199,112	241,661
31	1970.10	10/12/1970	M	31	60	-285	2,416	-285	345	684	570,684	49	570,000	0	570,000	0	0			0	0	0	199,319	240,049
32	1970.10	10/13/1970	T	31	29	335	2,416	335	-306	-607	569,393	48	569,345	0	570,000	0	0			0	0	0	199,568	239,666
33	1970.10	10/14/1970	W	31	192	-15	2,416	-15	207	411	569,755	48	569,707	0	570,000	0	0			0	0	0	199,310	239,002
34	1970.10	10/15/1970	T	31	181	135	2,416	135	46	91	569,798	48	569,749	0	570,000	0	0			0	0	0	199,262	238,351
35	1970.10	10/16/1970	F	31	393	210	2,416	210	183	363	570,112	49	570,000	0	570,000	0	0			0	0	0	199,172	237,490
36	1970.10	10/17/1970	S	31	606	439	2,416	439	167	331	570,331	49	570,000	0	570,000	0	0			0	0	0	199,106	236,626
37	1970.10	10/18/1970	S	31	710	407	2,416	407	303	601	570,601	49	570,000	0	570,000	0	0			0	0	0	198,622	236,098
38	1970.10	10/19/1970	M	31	-115	20	2,416	20	-135	-268	569,732	49	569,684	0	570,000	0	0			0	0	0	199,115	235,023
39	1970.10	10/20/1970	T	31	318	130	2,416	130	188	373	570,057	49	570,000	0	570,000	0	0			0	0	0	199,014	234,169

For purposes of the FERC investigation, the protocols of Fourth Agreement Water Bank Accounting have been amended to incorporate a hypothetical implementation of "shared responsibility" for incremental increases in FERC-required flows for the Tuolumne River.[3] If running the option with shared responsibility has been selected (worksheet UserInput Switch UI 1.31 = 1), the incremental increase in FERC-required flows is determined by the daily difference between the current 1995 FERC Settlement requirements and scenario-required minimum flows. This computation occurs in worksheet LaGrangeSchedule with information regarding the scenario-required flows directed through worksheet UserInput. Approximately fifty-two percent (51.7121%) of the incremental difference between the flow schedules is assigned as CCSF's responsibility and is ported into the worksheet in Column Q as a "debit". This debit then enters the current protocols of Fourth Agreement Water Bank Accounting at Column J, and subsequently contributes to the determination of the daily Water Bank Account Balance (Column M).

Water Bank Account Balances which are less than zero ("negative") are highlighted, and the minimum balance, whether negative or positive, is reported in Cell M14. When a negative balance occurs, the user is to enter into Column T (WB Supplemental Release) a volume of release needed to maintain the Water Bank Account Balance at, or greater than zero. The Model will first direct the supplemental release to Lake Lloyd,

[3] The "shared responsibility" assumption is presented for the purpose of evaluating alternative operations. The assumption shall not be used as evidence in any proceeding relating to and shall not act as precedence for any allocation of Tuolumne River water between CCSF and the Districts for any purpose under the Fourth Agreement.

and continue releases until storage at Lake Lloyd is drawn to a specified 45,000 acre-feet minimum level (shown in Cell Q10 and entered at worksheet CCSF Switch 3.00). Subsequent supplemental releases will be drawn from Hetch Hetchy Reservoir any time storage is less than the Lake Lloyd minimum. The result of entering the supplemental release will cause a recalculation of the entire Model with results refreshed in the worksheet. Lake Lloyd, Hetch Hetchy Reservoir and Don Pedro Reservoir storage is ported from other worksheets to provide the status of their storage as supplemental releases are entered.

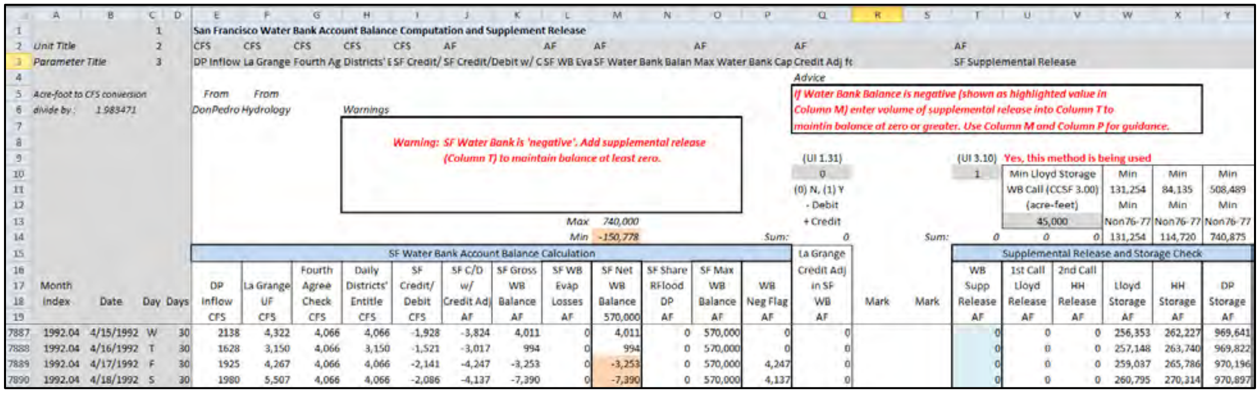
Warnings and advice are provided in the worksheet when several conditions occur. The snapshots below illustrate the occurrence of these conditions.

Example 1: A Reservoir Empties and the Model Crashes

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1			1		San Francisco Water Bank Account Balance Computation and Supplement Release																				
2	Unit Title		2		CFS	CFS	CFS	CFS	CFS	AF		AF	AF		AF		AF			AF					
3	Parameter Title		3		DP Inflow	La Grange	Fourth Ag	Districts' F	SF Credit/	SF Credit/Debit w/ C		SF WB Eva	SF Water Bank Balan		Max Water Bank Cap		Credit Adj fc			SF Supplemental Release					
4																	Advice								
5	Acre-foot to CFS conversion				From	From											#N/A								
6	divide by :	1.983471			DonPedro	Hydrology		Warnings									#N/A								
7									Warning: Your have likely drained a reservoir, check reservoirs.								#N/A								
8									#N/A	#N/A															
9										#N/A							(UI 1.31)			(UI 3.10)	Yes, this method is being used				
10									#N/A	#N/A							1			1	Min Lloyd Storage		Min	Min	Min
11										#N/A							(0) N, (1) Y				WB Call (CCSF 3.00)		24,474	#N/A	#N/A
12																	- Debit				(acre-feet)		Min	Min	Min
13												Max	#N/A				+ Credit				45,000		Non76-77	Non76-77	Non76-77
14												Min	#N/A			Sum:	-5,922,391		Sum:	1,197,522	714,938	482,584	24,474	#N/A	#N/A
15					SF Water Bank Account Balance Calculation												La Grange			Supplemental Release and Storage Check					
16							Fourth	Daily	SF	SF C/D	SF Gross	SF WB	SF Net	SF Share	SF Max		Credit Adj			WB	1st Call	2nd Call			
17	Month				DP	La Grange	Agree	Districts'	Credit/	w/	WB	Evap	WB	RFlood	WB	WB	in SF			Supp	Lloyd	HH	Lloyd	HH	DP
18	Index	Date	Day	Days	Inflow	UF	Check	Entitle	Debit	Credit Adj	Balance	Losses	Balance	DP	Balance	Neg Flag	WB	Mark	Mark	Release	Release	Release	Storage	Storage	Storage
19					CFS	CFS	CFS	CFS	CFS	AF	AF	AF	570,000	AF	AF	AF	AF			AF	AF	AF	AF	AF	AF
8018	1992.08	8/24/1992	M	31	205	5	2,416	5	200	396	-122,421	0	-122,421	0	570,000	-396	0			0	0	0	30,461	1,488	528,302
8019	1992.08	8/25/1992	T	31	445	28	2,416	28	417	827	-121,594	0	-121,594	0	570,000	-827	0			0	0	0	30,065	262	526,440
8020	1992.08	8/26/1992	W	31	#N/A	201	2,416	201	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0			0	0	0	29,709	#N/A	#N/A
8021	1992.08	8/27/1992	T	31	#N/A	104	2,416	104	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0			0	0	0	29,370	#N/A	#N/A

A warning has been provided that a reservoir has likely been depleted by the current operation assumptions. In this particular example, Tuolumne River minimum flows were increased with responsibility shared with CCSF, and a set of supplemental releases were established. In this iteration of results it is discovered in Column X (Hetch Hetchy Reservoir storage) an error (reported as "#N/A") on August 26, 1992 has occurred in the Model. By review of the previous day's storage results for Lake Lloyd (Column W), Hetch Hetchy Reservoir (Column X) and Don Pedro Reservoir (Column Y), and the rate of depletion for each of these reservoirs, it is concluded that Hetch Hetchy Reservoir likely drained on August 26 and thus crashed the Model. Although noted, a negative Water Bank Account Balance (Column M) will not cause the Model to crash. To remedy the condition, the user uses worksheet UserInput to revise (lower) SJPL diversions from Hetch Hetchy Reservoir (UI 4.10 and UI 4.20) and retain water in Hetchy Hetchy Reservoir for release. If Don Pedro Reservoir storage was the culprit of causing the Model to crash, the user uses worksheet UserInput to revise (lower) MID and TID canal diversions (UI 2.10, UI 2.20 and UI 2.30 to retain water in Don Pedro Reservoir for release. Alternatively, the user could reduce the scenario's designated minimum flow requirement, which would change flow needed from the upstream systems.

Example 2: Water Bank is Negative



San Francisco Water Bank Account Balance Computation and Supplement Release

Acre-foot to CFS conversion divide by: 1.983471

From DonPedro Hydrology

Warnings

Warning: SF Water Bank is 'negative'. Add supplemental release (Column T) to maintain balance at least zero.

Advice

If Water Bank Balance is negative (shown as highlighted value in Column M) enter volume of supplemental release into Column T to maintin balance at zero or greater. Use Column M and Column P for guidance.

(UI 1.31) 0 (0) N, (1) Y - Debit + Credit

(UI 3.10) 1 Yes, this method is being used

Max 740,000; Min -150,778; Sum: 0; Sum: 0 0 0

Min Lloyd Storage WB Call (CCSF 3.00) (acre-feet)	Min	Min	Min
45,000	131,254	84,135	508,489
	Min Non76-77	Min Non76-77	Min Non76-77
	131,254	114,720	740,875

SF Water Bank Account Balance Calculation

Row	Month Index	Date	Day	Days	DP Inflow CFS	La Grange UF CFS	Fourth Agree Check CFS	Daily Districts' Entitle CFS	SF Credit/ Debit CFS	SF C/D w/ Credit Adj AF	SF Gross WB Balance AF	SF WB Evap Losses AF	SF Net WB Balance 570,000
7887	1992.04	4/15/1992	W	30	2138	4,322	4,066	4,066	-1,928	-3,824	4,011	0	4,011
7888	1992.04	4/16/1992	T	30	1628	3,150	4,066	3,150	-1,521	-3,017	994	0	994
7889	1992.04	4/17/1992	F	30	1925	4,267	4,066	4,066	-2,141	-4,247	-3,253	0	-3,253
7890	1992.04	4/18/1992	S	30	1980	5,507	4,066	4,066	-2,086	-4,137	-7,390	0	-7,390

Supplemental Release and Storage Check

Row	SF Share RFlood DP AF	SF Max WB Balance AF	WB Neg Flag AF	La Grange Credit Adj in SF WB AF	Mark	Mark	WB Supp Release AF	1st Call Lloyd Release AF	2nd Call HH Release AF	Lloyd Storage AF	HH Storage AF	DP Storage AF
7887	0	570,000	0	0			0	0	0	256,353	262,227	969,641
7888	0	570,000	0	0			0	0	0	257,148	263,740	969,822
7889	0	570,000	4,247	0			0	0	0	259,037	265,786	970,196
7890	0	570,000	4,137	0			0	0	0	260,795	270,314	970,897

A warning has been provided that the Water Bank Account Balance is negative for one or more days of the scenario. In this instance, all Model reservoirs are operating within a viable operation (the Model did not crash due an emptying reservoir); however, the objective to maintain a positive Water Bank Account Balance has been violated. Upon inspection of the results the user can find the first instance of violation and remedy the violation by entry into Column T an amount of release that maintains at least a zero balance in the Water Bank Account Balance. For the first day of violation the reported negative balance (e.g., -3,253 acre-feet) is needed as a supplemental release. The ensuing days of supplemental release are informed by Column P.

It is possible that within the remedy of Example 2 the error exemplified by Example 1 may occur as Hetchy Hetchy Reservoir may be drained through the efforts of maintaining a positive Water Bank Account Balance. At that point, the procedures of Example 1 will be required and the values already derived for supplemental releases may need to be revisited and possibly changed.

5.3 Control Workheet

This worksheet (Control) provides an interface for entering assumptions for reservoir operations and several facility characteristics of District and CCSF facilities. The worksheet is described below.

Contents Description and Study Name

Operation Control Parameters and Facility Characteristics Variables Affecting Case and Facility Operation
Contents: Section 1 - Don Pedro Reservoir and District Facilities Section 2 - CCSF Facilities Section 3 - Don Pedro Reservoir and CCSF Reservoir Elevation/Storage/Area and Evaporation Factors Section 4 - Don Pedro Reservoir Flood Control Reservation Space and Discretionary Target

This section provides an index to the contents of this worksheet (Control).

Section 1: Don Pedro Reservoir and District Facilities

Reservoir Management, Preferred Storage Target and Drawdown, Modesto Flood Control Objective, Snowmelt Runoff, and Storage Constraints

Section 1 - Don Pedro Reservoir and District Facilities

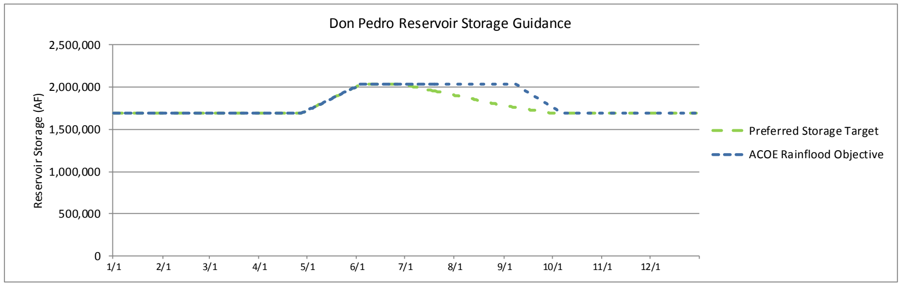
Reservoir Management

Rainflood reservoir reservation space according to ACOE manual.

"Flood control reservoir increases uniformly at a rate of 11,700 acre-feet per day from zero requirement on September 8 to the maximum reservation of 340,000 acre-feet by October 7. The reservation is maintained at 340,000 acre-feet through April 27 after which, unless additional reservation is indicated by the snowmelt parameters, it will decrease uniformaly at a rate of 9,200 acre-feet per day to zero requirement by June 3."

Preferred Storage Targets

ACOE through June 30. Target 1,906,000 acre-feet for July 31, 1,782,000 acre-feet August 31, and 1,692,000 acre-feet for September 30. UCOE thereafter.



Modesto flood control objective

(C 1.00) 9,000 *cfs. Target flow not to exceed in Tuolumne River below Modesto.*

Snowmelt release forecast parameters

90% exceedence DWR forecast of watershed runoff for April 1 and May 1
Historical watershed runoff for June 1

Release of forecasted excess runoff

(C 1.10)	*30*	*percent of April - June excess runoff during April*
(C 1.11)	*50*	*percent of May - June excess runoff during May*
(C 1.12)	*100*	*percent of June excess runoff during June*

Reservoir Storage Constraints/Objectives

	2,030,000	*acre-feet Maximum reservoir storage*
(C 1.20)	*308,960*	*acre-feet dead pool, cutoff of generation capability/no release**
(C 1.21)	*5,400*	*cfs maximum Don Pedro Powerhouse discharge*

** The Model will not crash upon simulating an operation below dead pool. However, to conform with operational limitations the user is to modify input assumptions to maintain reservoir storage at or above dead pool.*

This section describes the parameters that provide guidance to the management of Don Pedro Reservoir storage and provides entry of several parameters that advise reservoir operations. United States Army Corps of Engineers (ACOE) and preferred reservoir storage guidance is described. User specified values for specific storage targets are input in Section 4 of this worksheet. The maximum targeted flood flow in the Tuolumne River at Modesto (below Dry Creek) is entered at C 1.00. Releases to the Tuolumne River will be constrained to not exceed this flow level when reservoir space is available in Don Pedro Reservoir to defer releases. Guidance is also provided for the release of anticipated runoff during the snowmelt runoff season. Values entered at C 1.10, C 1.11 and C 1.12 advise the amount of projected excess runoff (from the date of forecast through June) to be released during April, May and June. For instance, the value entered at C 1.10 (30 percent) advises the Model to release 30 percent of the excess runoff volume forecasted to occur during April through June during April. The Model estimates the total excess runoff volume as being the projected inflow to Don Pedro Reservoir less projected canal diversions, reservoir evaporation and minimum Tuolumne River flow requirements, with an objective to fill Don Pedro Reservoir at the end of June. An entry at C 1.20 directs the Model to cease

the simulation of power generation at Don Pedro Powerhouse when reservoir storage is below the value. A warning occurs when Don Pedro Reservoir storage is less than the value. The warning informs the study that the reservoir is being simulated below dead pool. The study should be revised through inputs in worksheet UserInput to remedy reservoir storage that is less than dead pool. The entry at C 1.21 informs the Model of the maximum flow through the Don Pedro powerhouse. Releases from Don Pedro Dam in excess of this value is labeled spill or bypassed at the dam.

FERC Minimum Flow Requirements

FERC Minimum Flow Requirements

FERC Flow Schedules

(C 1.30)	Year Type	1	2	3	4	5	6	7
	Oct 1-15 (CFS)	100	100	150	150	180	200	300
	Oct 16-31 (CFS)	150	150	150	150	180	175	300
	Total Base (AF)	7,736	7,736	9,223	9,223	11,068	11,504	18,447
	Attraction (AF)	0	0	0	0	1,676	1,736	5,950
	Total Oct (AF)	7,736	7,736	9,223	9,223	12,744	13,240	24,397
	Nov (CFS)	150	150	150	150	180	175	300
	AF	8,926	8,926	8,926	8,926	10,711	10,413	17,852
	Dec (CFS)	150	150	150	150	180	175	300
	AF	9,223	9,223	9,223	9,223	11,068	10,760	18,447
	Jan (CFS)	150	150	150	150	180	175	300
	AF	9,223	9,223	9,223	9,223	11,068	10,760	18,447
	Feb (CFS)	150	150	150	150	180	175	300
	AF	8,331	8,331	8,331	8,331	9,997	9,719	16,661
	Mar (CFS)	150	150	150	150	180	175	300
	AF	9,223	9,223	9,223	9,223	11,068	10,760	18,447
	Apr (CFS)	150	150	150	150	180	175	300
	AF	8,926	8,926	8,926	8,926	10,711	10,413	17,852
	May (CFS)	150	150	150	150	180	175	300
	AF	9,223	9,223	9,223	9,223	11,068	10,760	18,447
	Migration Flow							
	AF	11,091	20,091	32,619	37,060	35,920	60,027	89,882
	Jun (CFS)	50	50	50	75	75	75	250
	AF	2,975	2,975	2,975	4,463	4,463	4,463	14,876
	Jul (CFS)	50	50	50	75	75	75	250
	AF	3,074	3,074	3,074	4,612	4,612	4,612	15,372
	Aug (CFS)	50	50	50	75	75	75	250
	AF	3,074	3,074	3,074	4,612	4,612	4,612	15,372
	Sep (CFS)	50	50	50	75	75	75	250
	AF	2,975	2,975	2,975	4,463	4,463	4,463	14,876
	Total Annual	94,001	103,001	117,017	127,508	142,503	165,004	300,926

April - May distribution of spring migration volume

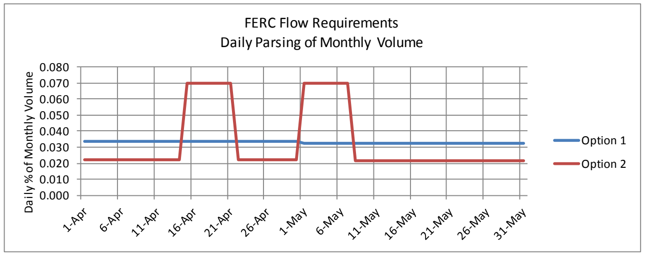
(C 1.40)	16	*parts (days) during April*
(C 1.41)	15	*parts (days) during May*
	31	*parts total during April and May*

Forecast of San Joaquin River Index

(C 1.50)	1	
	1	Actual
	2	90% Exc.
	3	75% Exc.
	4	Med.
	5	10% Exc.

April - May daily parsing of monthly volume of flow

(C 1.60)	2	
	1	Even
	2	2-Pulse



This section defines the 1995 FERC minimum flow requirements. Values are entered (C 1.30) for each defined flow period by year type, consistent with the FERC order issued July 31, 1996. Seven year types are defined based on the San Joaquin Basin 60-20-20 water supply index. The sequence year of the flow schedule begins in April and continues through the following March. The water supply index of each year of the simulation period is found in worksheet 602020, and the projection method of the index is defined at C 1.50. For the Test Case condition, the historical actual 60-20-20 index is used. The volume of water interpolated between annual schedules is distributed among April and May in proportion to the values provided at C 1.40 (April) and C 1.41 (May). The total volume of water designated for April and May is distributed daily during April and May is directed by C 1.60. If directed to use an equal distribution of the volume of flow during April and May, C 1.60 is set as 1. If C 1.60 is set as 2, two 7-day pulse flows will occur with the remaining volume evenly spread over the remaining days of the months. The pattern of these schedules can be modified in worksheet LaGrangeSchedule.

Test Case District Canal Demands

Test Case Canal Demands

Modesto Irrigation District (C 1.70)

Month	Turnout Delivery Factor %	Nominal Private GW Pumping TAF	Canal Operation Spills Critical TAF	Canal Operation Spills Non-crit TAF	Canal Losses blw Modesto Reservoir TAF	Intercptd Flows TAF	Nominal MID GW Pumping TAF	Mod Res & Upper Canal Losses TAF	Modesto Reservoir: Municipal Delivery TAF	Modesto Reservoir: Target Storage TAF	Modesto Reservoir: Target Storage Change TAF
Jan	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	17.0	2.0
Feb	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	18.0	1.0
Mar	65.0	1.0	1.0	3.0	0.6	0.9	1.0	2.0	2.7	18.0	0.0
Apr	70.0	2.0	3.0	6.0	0.6	0.9	2.3	2.9	2.7	19.0	1.0
May	85.0	3.0	4.0	6.5	0.6	1.2	2.3	3.9	3.0	20.0	1.0
Jun	85.0	4.0	3.5	6.5	0.6	1.0	2.3	4.3	3.2	20.0	0.0
Jul	77.5	4.0	3.5	6.5	0.6	1.0	2.6	4.9	3.3	21.0	1.0
Aug	70.0	4.0	4.9	7.0	0.6	1.4	2.4	4.9	3.3	22.0	1.0
Sep	65.0	2.0	5.0	7.0	0.6	1.2	2.3	4.2	3.3	20.0	-2.0
Oct	40.0	1.0	2.8	6.9	0.6	0.9	2.1	2.0	3.2	17.0	-3.0
Nov	30.0	0.0	2.0	2.0	0.1	0.0	0.0	2.0	2.7	15.0	-2.0
Dec	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.5	15.0	0.0
Total		21.0	35.7	57.4	5.4	8.5	17.3	31.1	34.5		

March TO Factor

TO Del Fac Break Point	Factor %
0	65
9.9	65
13.2	65
20	65
9999	65

Turlock Irrigation District (C 1.80)

Month	Turnout Delivery Factor %	Nominal Private GW Pumping TAF	Canal Operation Spills Critical TAF	Canal Operation Spills Non-crit TAF	Canal Losses blw Turlock Lake TAF	Intercptd Flows TAF	Nominal TID GW Pumping TAF	Turlock Lk & Upper Canal Losses TAF	Turlock Lake: Delivery TAF	Turlock Lake: Target Storage TAF	Turlock Lake: Target Storage Change TAF
Jan	30	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	18.0	5.0
Feb	30	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	25.0	7.0
Mar	65	1.2	3.0	3.0	4.5	0.0	4.1	1.0	0.0	30.0	5.0
Apr	57.5	2.4	5.1	6.3	4.5	0.0	8.0	6.6	0.0	30.0	0.0
May	85	3.6	4.6	6.7	4.5	0.0	10.3	7.7	0.0	32.0	2.0
Jun	92.5	5.2	4.2	6.7	4.5	0.0	12.4	8.2	0.0	32.0	0.0
Jul	72.5	6.4	4.2	6.7	4.5	0.0	14.6	8.7	0.0	32.0	0.0
Aug	62.5	6.2	4.0	7.3	4.5	0.0	13.3	9.0	0.0	30.0	-2.0
Sep	67.5	3.9	3.2	7.3	4.5	0.0	9.1	5.0	0.0	27.0	-3.0
Oct	40	2.4	2.3	7.3	4.5	0.0	5.3	2.0	0.0	13.0	-14.0
Nov	30	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0	0.0
Dec	30	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0	0.0
Total		31.3	38.6	59.3	39.2	0.0	77.1	52.2	0.0		

March TO Factor

TO Del Fac Break Point	Factor %
0	65
19.8	65
27.5	65
40	65
9999	65

This section of parameters contributes to the computation of District canal demands. The values entered at C 1.70 for Modesto Irrigation District and at C 1.80 for Turlock Irrigation District are utilized by worksheet DailyCanalsCompute in the projection of daily canal demands for the simulation period. These parameters represent various components of water supplies and disposition that result in the need for canal diversion. These components are combined with the projected demand for applied water associated with lands within the Districts. The projected demand for applied water is provided to the model in worksheet DailyCanalsCompute, and is adjusted by the turnout delivery factor entered in C 1.70 and C 1.80, which adjusts for applied water not associated with immediate consumptive use such as pre-irrigation and groundwater recharge. The computation of daily canal demand is processed by parsing the monthly values of C 1.70 and C 1.80 evenly across the days of a month and combining them with the monthly value of applied water that has been parsed daily in a pattern reflective of recent historical daily diversions for the canals.

Don Pedro Water Supply Factor

Don Pedro Water Supply Factor

The reservoir index method adds the end-of-March Don Pedro Reservoir storage to the projected April through July inflow to assess water availability for diversion.

	Don Pedro Stor + Infl Index	M/TID WS Factor
	TAF	%
(C 1.90)	0	0.60
	1,350	0.60
	1,600	0.85
	2,000	0.85
	2,001	1.00
	2,300	1.00
	9,999	1.00

The Don Pedro Water Supply Factor directs the reduction of District canal diversions during periods of anticipated limited water supply. The values at C 1.90 provide the model with a relationship between water availability at Don Pedro Reservoir and advised canal diversions. The parameters of the relationship is an index of water availability which is computed as the storage in Don Pedro Reservoir at the end of March plus the projected inflow into Don Pedro Reservoir for April through July, and the water supply factor which is applied to projected demand for applied water described above. A water supply factor of 1.00 will provide a diversion equal to projected canal demand (full demand). A water supply factor less than 1.00 will reduce the canal diversion to less than full canal demand.

Section 2: City and County of San Francisco Facilities
Hetch Hetchy Reservoir

This section provides parameters that direct or advise the operation of Hetch Hetchy Reservoir. Minimum flow releases below Hetch Hetchy Reservoir are directed by C 2.00, C 2.01 and C 2.02. These parameters and schedules are consistent with the stipulations for the Canyon Power Project and the modifications thereof for Kirkwood Powerhouse Unit No. 3. The application of these flow schedules and the addition of 64 cfs to the minimum flow schedule below Hetch Hetchy Reservoir are embedded in model logic in worksheet CCSF.

Section 2 - CCSF Facilities

Hetch Hetchy Reservoir Control

Minimum releases below reservoir

(C 2.00)

Schedule Index - Accum Inches or Storage			
CY Month	A (1)	B (2)	C (3)
1	8.80	6.10	
2	14.00	9.50	
3	18.60	14.20	
4	23.00	18.00	
5	26.60	19.50	
6	28.45	21.25	
7	575,000	390,000	
8	640,000	400,000	

(C 2.01)

Below Dam Flow Requirement - CFS			
CY Month	A (1)	B (2)	C (3)
1	50	40	35
2	60	50	35
3	60	50	35
4	75	65	35
5	100	80	50
6	125	110	75
7	125	110	75
8	125	72.5	75
9	90	65	62.5
10	60	50	35
11	60	50	35
12	50	40	35

(C 2.02)

	15,000	6,500	4,400
Discretionary Schedule - Acre-feet			
CY Month	A (1)	B (2)	C (3)
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0
7	0	0	0
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
12	0	0	0

Reservoir Management

(C 2.10)

Target Storage - Acre-feet		
CY Month	Soft Trgt EOM	Hard Limit EOM
1	320,000	360,360
2	320,000	360,360
3	320,000	360,360
4	320,000	360,360
5	360,360	360,360
6	360,360	360,360
7	360,360	360,360
8	360,360	360,360
9	360,360	360,360
10	330,000	360,360
11	320,000	360,360
12	320,000	360,360

Snowmelt release forecast parameters

Historical watershed runoff used for all forecasts of inflow (perfect foresight)

Release of forecasted excess runoff

(C 2.20)	10	percent of Februay - June excess runoff during February
(C 2.21)	10	percent of March - June excess runoff during March
(C 2.22)	10	percent of April - June excess runoff during April
(C 2.23)	100	percent of May - June excess runoff during June
(C 2.24)	100	percent of June excess runoff during June

Minimum storage of draw down for snowmelt release

(C 2.30) 100,000 acre-feet

Maximum advised release for snowmelt

(C 2.25)	1,200	cfs - February
(C 2.26)	1,150	cfs - March
(C 2.27)	1,200	cfs - April
(C 2.28)	100,000	cfs - May
(C 2.29)	100,000	cfs - June

Target storage for filling at end of June

(C 2.31) 360,360 acre-feet

Values entered at C 2.10 advise the management of reservoir storage throughout a year. The hard limit entered into C 2.10 directs the maximum allowed storage in Hetch Hetchy Reservoir at the end of each month. Model logic will not allow exceedence of these values and will release addition water from the facility if needed to not exceed the values. The soft target, also representing a value at the end of each month, when

exceeded advises the Model to make additional releases in order to not exceed that reservoir storage. Model logic computes the storage exceedence, if any, every seventh day and advises a release in addition to minimum releases. The rate of this additional release is equal to the exceedence volume spread over seven days. For transitional months when the soft target value at the end of a month differs from a previous month, the transition in storage target is parsed equally within the days of the month.

Entries at C 2.20 through C 2.24 advise the amount of projected excess runoff (from the date of forecast through June) to be released during February, March, April, May and June. For instance, the value entered at C 2.20 (10 percent) advises the Model to release 10 percent of the excess runoff volume forecasted to occur during the February through June during February. The Model estimates the total excess runoff volume as being the projected inflow to Hetch Hetchy Reservoir less projected San Joaquin Pipeline diversions, deliveries to Groveland and Moccasin Fish Hatchery, reservoir evaporation and minimum flow requirements below Hetch Hetchy Reservoir, with an objective to fill Hetch Hetchy Reservoir at the end of June.

Entries at C 2.25 through C 2.29 work in concert with the advised snowmelt runoff releases, and limit the rate at which those releases will be made. The functionality of the limit provides an ability to manage releases in recognition of downstream facility protection, the efficiency of releases through power generation facilities and reservoir storage goals. The example of C 2.25 being set as 1,200 cfs for February results in the advised snowmelt release being limited to no more than that value regardless of the rate of release advised by the projection of excess runoff. These releases are in addition to the already established minimum releases described previously. C 2.30 and C 2.31 also affect the advisement of snowmelt runoff releases. C 2.30 limits the drawdown of Hetch Hetchy Reservoir for snowmelt runoff, and its value will limit the release to not lower Hetch Hetchy reservoir storage below such value. C 2.31 directs the storage goal for Hetch Hetchy Reservoir at the assumed fill date of the end of June.

Lake Lloyd

The section of parameters that direct or advise the operation of Lake Lloyd (show below) is very similar in content and structure as the section just described for Hetch Hetchy Reservoir. Minimum flow releases below Lake Lloyd are directed by C 2.40 and C 2.41. A single schedule of flow requirements is provided for Lake Lloyd and is consistent with the stipulations for the Cherry River Project. The application of the flow schedule is embedded in Model logic in worksheet CCSF. Entry of a value at C 2.41 provides a release from Lake Lloyd through Holm Powerhouse during the months of May through August, established as 950 cfs for four hours per day. The entry at C 2.41 also advises the maximum flow rate through Holm Powerhouse.

Values entered at C 2.50 advise the management of reservoir storage throughout a year. The hard limit entered into C 2.50 directs the maximum allowed storage in Lake Lloyd at the end of each month. Model logic will not allow exceedence of these values and will release addition water from the facility if needed to not exceed the values. The soft target, also representing a value at the end of each month, when exceeded advises the Model to make additional releases in order to not exceed that reservoir storage. Model logic computes the storage exceedence, if any, every

seventh day and advises a release in addition to minimum releases. The rate of this additional release is equal to the exceedence volume spread over seven days. For transitional months when the soft target value at the end of a month differs from a previous month, the transition in storage target is parsed equally within the days of the month.

Entries at C 2.60 through C 2.64 advise the amount of projected excess runoff (from the date of forecast through June) to be released during February, March, April, May and June. The model estimates the total excess runoff volume as being the projected inflow to Lake Lloyd less reservoir evaporation, minimum flow requirements below Lake Lloyd and releases to Holm Powerhouse, with an objective to fill Lake Lloyd at the end of June.

Entries at C 2.65 through C 2.69 work in concert with the advised snowmelt runoff releases, and limit the rate at which those releases will be made. C 2.70 and C 2.71 also affect the advisement of snowmelt runoff releases. These releases are in addition to the already established minimum releases described previously. C 2.70 limits the drawdown of Lake Lloyd for snowmelt runoff, and its value will limit the release to not lower Lake Lloyd storage below such value. C 2.71 directs the storage goal for Lake Lloyd at the assumed fill date of the end of June.

Lake Lloyd Control

Minimum releases below reservoir

Blw Lake Lloyd - CFS

	CY Month	Flow Req
(C 2.40)	1	5
	2	5
	3	5
	4	5
	5	5
	6	5
	7	15.5
	8	15.5
	9	15.5
	10	5
	11	5
	12	5

Holm Target Releases

May (Memorial Day) thru	(C 2.41)	
August (Labor Day)		
Holm Capacity	950	*cfs*
Day	1,884	*acre-feet*
4-hours per day	314	*acre-feet*

Reservoir Management

Target Storage - Acre-feet

	CY Month	Soft Trgt EOM	Hard Limit EOM
(C 2.50)	1	238,000	273,300
	2	238,000	273,300
	3	238,000	273,300
	4	273,300	273,300
	5	273,300	273,300
	6	273,300	273,300
	7	268,000	273,300
	8	258,000	273,300
	9	248,000	273,300
	10	248,000	273,300
	11	238,000	273,300
	12	238,000	273,300

Snowmelt release forecast parameters

Historical watershed runoff used for all forecasts of inflow (perfect foresight)

Release of forecasted excess runoff

(C 2.60)	20	*percent of Februay - June excess runoff during February*
(C 2.61)	25	*percent of March - June excess runoff during March*
(C 2.62)	33	*percent of April - June excess runoff during April*
(C 2.63)	50	*percent of May - June excess runoff during June*
(C 2.64)	100	*percent of June excess runoff during June*

Minimum storage of draw down for snowmelt release

(C 2.70) 100,000 *acre-feet*

Maximum advised release for snowmelt

(C 2.65)	1,000	*cfs - February*
(C 2.66)	1,000	*cfs - March*
(C 2.67)	1,000	*cfs - April*
(C 2.68)	1,000	*cfs - May*
(C 2.69)	1,000	*cfs - June*

Target storage for filling at end of June

(C 2.71) 273,300 *acre-feet*

Lake Eleanor

This section provides parameters that direct or advise the operation of Lake Eleanor. Minimum flow releases below Lake Eleanor are directed by C 2.80. These flow schedules are consistent with the stipulations for the Cherry-Eleanor Pumping Station. The application of these flow schedules are embedded in Model logic in worksheet CCSF, and always assume the schedule associated with pumping. An entry at C 2.81 directs the maximum flow rate through the Eleanor-Cherry Diversion Tunnel. This value may limit the rate at which water can be transferred from Lake Eleanor to Lake Lloyd.

Lake Eleanor Control

Minimum releases below reservoir

Blw Lake Eleanor - CFS

	CY Month	w/Pump Flow Req	w/o Flow Req
(C 2.80)	1	5	5
	2	5	5
	3	10	5
	4	15	5
	5	20	5
	6	20	5
	7	20	16
	8	20	16
	9	15	16
	10	10	5
	11	5	5
	12	5	5

Always uses w/Pump flow requirement

Eleanor to Lloyd tunnel capacity

(C 2.81) 400 *cfs*

Reservoir Management

Target Storage - Acre-feet

	CY Month	Soft Trgt EOM	Hard Limit EOM
(C 2.90)	1	21,495	27,100
	2	21,495	27,100
	3	21,495	27,100
	4	27,100	27,100
	5	27,100	27,100
	6	27,100	27,100
	7	27,100	27,100
	8	27,100	27,100
	9	15,000	27,100
	10	15,000	27,100
	11	15,000	27,100
	12	18,250	27,100

Snowmelt release forecast parameters

Historical watershed runoff used for all forecasts of inflow (perfect foresight)

Release of forecasted excess runoff

(C 2a.10)	20	*percent of Februay - June excess runoff during February*
(C 2a.11)	25	*percent of March - June excess runoff during March*
(C 2a.12)	33	*percent of April - June excess runoff during April*
(C 2a.13)	70	*percent of May - June excess runoff during June*
(C 2a.14)	100	*percent of June excess runoff during June*

Maximum advised release for snowmelt

(C 2a.15)	2,000	*cfs - February*
(C 2a.16)	2,000	*cfs - March*
(C 2a.17)	2,000	*cfs - April*
(C 2a.18)	2,000	*cfs - May*
(C 2a.19)	2,000	*cfs - June*

Minimum storage of draw down for snowmelt release

(C 2a.20) 1,000 *acre-feet*

Target storage for filling at end of June

(C 2a.21) 27,100 *acre-feet*

Values entered at C 2.90 advise the management of reservoir storage throughout a year. The hard limit entered into C 2.90 directs the maximum allowed storage in Lake Eleanor at the end of each month. Model logic will not allow exceedence of these values and will release addition water from the facility if needed to not exceed the values. The soft target, also representing a value at the end of each month, when exceeded advises the Model to make additional releases in order to not exceed that reservoir storage. Model logic computes the storage exceedence, if any, every seventh day and advises a release in addition to minimum releases. The rate of this additional release is equal to the exceedence volume spread

over seven days. For transitional months when the soft target value at the end of a month differs from a previous month, the transition in storage target is parsed equally within the days of the month.

Entries at C 2a.10 through C 2a.14 advise the amount of projected excess runoff (from the date of forecast through June) to be released during February, March, April, May and June. The model estimates the total excess runoff volume as being the projected inflow to Lake Eleanor less reservoir evaporation and minimum flow requirements below Lake Eleanor, with an objective to fill Lake Eleanor at the end of June.

Entries at C 2a.15 through C 2a.19 work in concert with the advised snowmelt runoff releases, and limit the rate at which those releases will be made. These releases are in addition to the already established minimum releases described previously. C 2a.20 and C 2a.21 also affect the advisement of snowmelt runoff releases. C 2a.20 limits the drawdown of Lake Eleanor for snowmelt runoff, and its value will limit the release to not lower Lake Eleanor storage below such value. C 2a.21 directs the storage goal for Lake Eleanor at the assumed fill date of the end of June.

CCSF Water Supply Parameters

The matrix describing the San Francisco water supply parameters provides the model information to report the state of Test Case condition water supply action levels and the potential changes in the occurrence of action level due to alternative operations.

CCSF Water Supply Parameters

	Actions		
	Level	*Trigger Tot Sys Stor*	*Action % Del Reduc*
(C 2a.30)	*0*		*0*
	1	*1,100,000*	*10*
	2	*1,100,000*	*10*
	3	*700,000*	*20*

Entries at C 2a.30 represent the relationship between CCSF total system storage (at the end of June each year) and the advisement of water supply actions. Total system storage includes CCSF's local watershed reservoirs, its Hetch Hetchy Project reservoirs, and also the Don Pedro Water Bank Account Balance. Local watershed storage is provided from CCSF's system operation model (HHLSM) as pre-processed values for the simulation period. These values are combined with the Model's depiction of CCSF reservoir storage for the Tuolumne River system to depict total system storage. A water supply action level for each year of each study is determined by the matrix, relating total system storage thresholds to advised action levels. For instance, if total system storage at the end of June of a year is greater than 700,000 acre-feet and less than 1,100,000 acre-feet, an action level of 10 percent rationing is advised. The CCSF Test Case condition SJPL diversions include the effect of occasional water delivery shortages due to these water supply parameters.

Section 3: Don Pedro Reservoir and CCSF Elevation/Storage/Area and Evaporation Factors

The section provides entry of the physical elevation/storage/area relationship for Don Pedro Reservoir and CCSF reservoirs. The values entered at C 3.00 for Hetch Hetchy Reservoir, Lake Lloyd, Lake Eleanor and Don Pedro Reservoir are currently being used by the Model. The Model employs a table lookup function to determine the area of a reservoir based on storage. The area is multiplied by a reservoir's evaporation factor for the estimation of reservoir evaporation. The monthly evaporation factor for CCSF reservoirs is entered at C 3.10 and Don Pedro Reservoir's evaporation factors are entered at C 3.20. These reservoir rating tables and evaporation factors are consistent with the daily accounting of Tuolumne River flows between the Districts and CCSF.

Section 3 - Don Pedro Reservoir and CCSF Reservoir Elevation/Storage/Area and Evaporation Factors

(C 3.00)

Hetch Hetchy Reservoir			Lake Lloyd			Lake Eleanor			Don Pedro Reservoir		
Elev - FT	Stor - AF	Area- Ac	Elev - FT	Stor - AF	Area- Ac	Elev - FT	Stor - AF	Area- Ac	Elev - FT	Stor - AF	Area- Ac
3520.0	410	124.0	4440.0	0.0	5.0	4605.0	0.0	0.0		0	0
3520.1	439	127.9	4440.1	1.0	5.1	4605.1	0.0	2.5		0	0
3520.2	468	131.8	4440.2	2.0	5.1	4605.2	0.0	5.0		0	0
3520.3	497	135.7	4440.3	2.0	5.2	4605.3	1.0	7.6		1	1
3520.4	526	139.6	4440.4	3.0	5.2	4605.4	1.0	10.1		1	1
3520.5	555	143.5	4440.5	4.0	5.3	4605.5	1.0	12.6		3	2
3520.6	583	147.4	4440.6	5.0	5.3	4605.6	2.0	15.1		5	3
3520.7	612	151.3	4440.7	5.0	5.4	4605.7	2.0	17.6		8	3
3520.8	641	155.2	4440.8	6.0	5.4	4605.8	2.0	20.2		12	4
3520.9	670	159.1	4440.9	7.0	5.5	4605.9	2.0	22.7		17	6
3521.0	699	163.0	4441.0	8.0	5.5	4606.0	2.0	25.2	300.0	35	7
3521.1	728	166.9	4441.1	8.0	5.6	4606.1	3.0	27.7		42	7
3521.2	757	170.8	4441.2	9.0	5.6	4606.2	3.0	30.2		50	8
3521.3	786	174.7	4441.3	10.0	5.7	4606.3	3.0	32.7		57	8
3521.4	815	178.6	4441.4	11.0	5.7	4606.4	3.0	35.3		65	8
3521.5	843	182.5	4441.5	11.0	5.8	4606.5	4.0	37.8		74	8
3521.6	872	186.4	4441.6	12.0	5.8	4606.6	4.0	40.3		82	9
3521.7	901	190.3	4441.7	13.0	5.9	4606.7	4.0	42.8		91	9
3521.8	930	194.2	4441.8	14.0	5.9	4606.8	4.0	45.3		100	9
3521.9	959	198.1	4441.9	14.0	6.0	4606.9	5.0	47.9		110	10
3522.0	988	202.0	4442.0	15.0	6.0	4607.0	5.0	50.4	310.0	120	10
3522.1	1017	205.9	4442.1	16.0	6.1	4607.1	5.0	52.9		130	10
3522.2	1046	209.8	4442.2	17.0	6.1	4607.2	5.0	55.4		140	10
3522.3	1075	213.7	4442.3	17.0	6.2	4607.3	6.0	57.9		150	11
3522.4	1104	217.6	4442.4	18.0	6.2	4607.4	6.0	60.4		161	11
3522.5	1133	221.5	4442.5	19.0	6.3	4607.5	6.0	63.0		172	11
3522.6	1161	225.4	4442.6	20.0	6.3	4607.6	6.0	65.5		183	11
3522.7	1190	229.3	4442.7	20.0	6.4	4607.7	7.0	68.0		194	11
3522.8	1219	233.2	4442.8	21.0	6.4	4607.8	7.0	70.5		206	12
3522.9	1248	237.1	4442.9	22.0	6.5	4607.9	7.0	73.0		218	12
3523.0	1277	241.0	4443.0	23.0	6.5	4608.0	7.0	75.6	320.0	229	12
3523.1	1306	244.9	4443.1	23.0	6.6	4608.1	8.0	78.1		242	13
3523.2	1335	248.8	4443.2	24.0	6.6	4608.2	8.0	80.6		255	13
3523.3	1364	252.7	4443.3	25.0	6.7	4608.3	8.0	83.1		268	14
3523.4	1393	256.6	4443.4	26.0	6.7	4608.4	8.0	85.6		283	15
3523.5	1422	260.5	4443.5	26.0	6.8	4608.5	9.0	88.2		297	15

Evaporation Factors

CCSF Reservoirs (C 3.10)

		CFS/Ac/Day
Jan	1 =	-0.00325
Feb	2 =	-0.0036
Mar	3 =	0
Apr	4 =	0
May	5 =	0.003253
Jun	6 =	0.006722
Jul	7 =	0.009758
Aug	8 =	0.009758
Sep	9 =	0.006722
Oct	10 =	0.003253
Nov	11 =	0
Dec	12 =	0

Evaporation Factors

Don Pedro Reservoir (C 3.20)

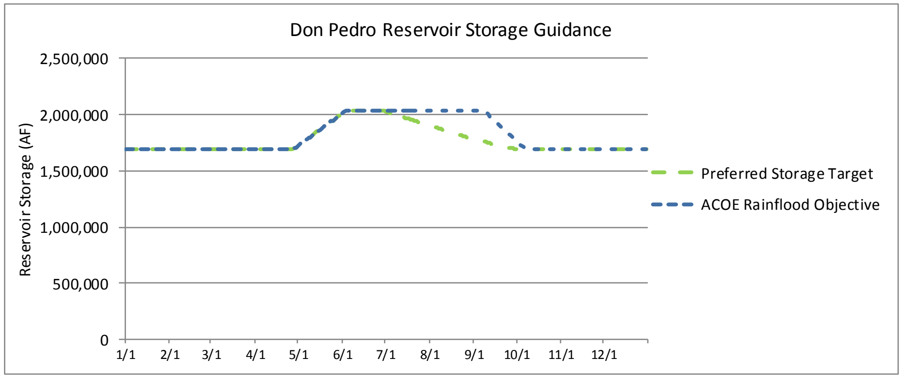
		CFS/Ac/Day
Jan	1 =	-0.00088
Feb	2 =	-0.00026
Mar	3 =	0.001135
Apr	4 =	0.003081
May	5 =	0.007968
Jun	6 =	0.010947
Jul	7 =	0.013976
Aug	8 =	0.014109
Sep	9 =	0.01072
Oct	10 =	0.006395
Nov	11 =	0.001781
Dec	12 =	-0.00013

Section 4: Don Pedro Reservoir Flood Control Reservation and Discretionary Target

The section provides for the entry of the preferred storage target for Don Pedro Reservoir.
Values entered at C 4.00 and C 4.01 advises the management of reservoir storage throughout a year. A hard limit of 2,030,000 acre-feet directs the maximum allowed storage in Don Pedro Reservoir at the end of each month. Model logic will not allow exceedence of these values and will release addition water from the facility if needed to not exceed the values. The soft target ("Final Target Storage" at C 4.00), also representing a value at the end of each day, when exceeded advises the model to make additional releases in order to not exceed that reservoir storage. Model logic computes the storage exceedence, if any, every seventh day and advises a release in addition to minimum releases. The rate of this additional release is equal to the exceedence volume spread over ten days. For transitional months when the soft target value at the end of a month differs from a previous month, the transition in storage target is parsed equally within the days of the month.

Section 4 - Don Pedro Reservoir Flood Control Reservation Space and Preferred Storage Target

	ACOE thru June
Full Res	*1,906,000*
(2,030,000)	*Jul 31*
Less	*1,782,000*
ACOE	*Aug 31*
RF Space	*1,692,000*
	Sep 30
	UCOE
	therefter



(C 4.00)

Don Pedro Reservoir FC/Discretionary/Drawdown Space

Mo/Day	Mo/Day Index		ACOE RF Space AF	DP RF Storage AF	Add Descr Storage AF	Add Descr Modifier AF	Final Target Storage AF
1/1	1.01		340,000	1,690,000			1,690,000
1/2	1.02		340,000	1,690,000			1,690,000
1/3	1.03		340,000	1,690,000			1,690,000
1/4	1.04		340,000	1,690,000			1,690,000
1/5	1.05		340,000	1,690,000			1,690,000
1/6	1.06		340,000	1,690,000			1,690,000
1/7	1.07		340,000	1,690,000			1,690,000
1/8	1.08		340,000	1,690,000			1,690,000
1/9	1.09		340,000	1,690,000			1,690,000
1/10	1.10		340,000	1,690,000			1,690,000
1/11	1.11		340,000	1,690,000			1,690,000
1/12	1.12		340,000	1,690,000			1,690,000
1/13	1.13		340,000	1,690,000			1,690,000
1/14	1.14		340,000	1,690,000			1,690,000
1/15	1.15		340,000	1,690,000			1,690,000
1/16	1.16		340,000	1,690,000			1,690,000
1/17	1.17		340,000	1,690,000			1,690,000

ACOE Rainflood (AF) End-of-month

Jan	1,690,000	Jul	2,030,000
Feb	1,690,000	Aug	2,030,000
Mar	1,690,000	Sep	1,772,600
Apr	1,717,600	Oct	1,690,000
May	2,002,800	Nov	1,690,000
Jun	2,030,000	Dec	1,690,000

(C 4.01)

	Discretionar Guide AF
1 Jan	0
2 Feb	0
3 Mar	0
4 Apr	0
5 May	0
6 Jun	0
7 Jul	0
8 Aug	0
9 Sep	0
10 Oct	0
11 Nov	0
12 Dec	0

The guidance provided by this parameter manages Don Pedro Reservoir storage throughout the year for both ACOE objectives during the season of rainflood reservation space and additional discretionary reservoir storage space or targets to manage reservoir storage from one year to another.

5.4 Output Worksheet

This worksheet (Output) provides an interface between Model computations and data summary and analysis tools. It also provides a formatted set of information usable for exchange into an HEC-DSS database file, such as used to provide information to the temperature models used for this FERC investigation. Information concerning HEC-DSS can be found on the HEC web site at:

http://www.hec.usace.army.mil/software/hec-dss/hecdss-dss.html

The structure and contents of worksheet Output accommodates the use of the HEC-DSS Excel Data Exchange Add-in which is an application for retrieving and storing interval time series data, in this circumstance the daily results of the Model.

Results provided in worksheet Output are directly linked to the computational and input worksheets of the Model. For instance, the daily inflow to Don Pedro Reservoir listed in worksheet Output is the value provided to worksheet DonPedro for its computations, which is dependent upon several other computation worksheets. As such, any change to model assumptions or data which causes a recalculation by the model will automatically update the values in worksheet Output. To preserve or store the results of a particular model study a copy of the worksheet should be created with a unique tab name and its contents converted to values. The HEC-DSS Add-in could also be used to create a unique database file for later use. Alternatively, but storage consuming, the entire Model could be saved as a unique study. However, this approach is not recommended as the worksheet Output will continue to be dynamically linked to the model's computational worksheets and any subsequent change to model assumptions will overwrite the results previously provided in the worksheet.

More than 80 parameters are reported in the worksheet, representing salient information concerning the simulated operations and hydrology of the Tuolumne River and the Districts' and CCSF's facilities. Table 5.4-1 provides a listing of the parameters including their HEC-DSS name parts. Shown below is a snapshot of the content and format of the worksheet.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	1	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE
2	2	TUOLUMNEI	TUOLUMNEI	TUOLUMNEI	TUOLUMNEI	TUOLUMNEI	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO
3	3	FLOW-LAGRANGE UNIMP	FLOW-HHUNIMP	FLOW-LLOYDUNI MP	FLOW-ELEANORU NIMP	FLOW-UNREGUNI MP	FLOW-TOTINFLO W	FLOW-SUP1INFLO WLL	FLOW-SUP2INFLO WHH	FLOW-INFLOWHH	FLOW-INFLOWLL	FLOW-INFLOWEL	STORAGE	EVAP
4	4	2	3	4	5	6	7	8	9	10	11	12	13	14
5	5	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY
6	6	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base
7	7	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70
8	8	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400
9	9	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09
10	10	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400
11	11	CFS	CFS	CFS	CFS	CFS	CFS	AF	AF	CFS	CFS	CFS	AF	AF
12		PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER
13	10/1/1970	159	79	56	25	-1	322	0	0	90	223	10	1,666,767	143
14	10/2/1970	55	-82	5	2	130	453	0	0	90	223	10	1,664,567	141
15	10/3/1970	265	25	15	7	218	541	0	0	90	223	10	1,662,719	141
16	10/4/1970	-166	110	-399	-179	302	625	0	0	90	223	10	1,659,892	141
17	10/5/1970	180	-38	322	144	-248	75	0	0	90	223	10	1,656,745	141
18	10/6/1970	92	9	-48	-21	152	475	0	0	90	223	10	1,654,119	141
19	10/7/1970	150	21	-51	-23	203	526	0	0	90	223	10	1,652,009	140
20	10/8/1970	153	-29	54	24	104	209	0	0	90	5	10	1,650,525	140
21	10/9/1970	146	-28	10	5	159	264	0	0	90	5	10	1,648,926	140
22	10/10/1970	99	30	-25	-11	105	210	0	0	90	5	10	1,647,059	140
23	10/11/1970	293	176	-275	-123	515	620	0	0	90	5	10	1,645,737	140

Table 5.4-1 – Worksheet Output Parameters

Column	Col No	DSS - Part B	DSS - Part C	Units	Column	Col No	DSS - Part B	DSS - Part C	Units
B	2	TUOLUMNERIVER	FLOW-LAGRANGEUNIMP	CFS	BD	56	MIDCANAL	MIDFULLREQ	AF
C	3	TUOLUMNERIVER	FLOW-HHUNIMP	CFS	BE	57	TIDCANAL	TIDAGPDAW	AF
D	4	TUOLUMNERIVER	FLOW-LLOYDUNIMP	CFS	BF	58	TIDCANAL	TIDMI	AF
E	5	TUOLUMNERIVER	FLOW-ELEANORUNIMP	CFS	BG	59	TIDCANAL	TIDFACT	AF
F	6	TUOLUMNERIVER	FLOW-UNREGUNIMP	CFS	BH	60	TIDCANAL	TIDNOMGWPRVT	AF
G	7	DONPEDRO	FLOW-TOTINFLOW	CFS	BI	61	TIDCANAL	TIDOPSPLS	AF
H	8	DONPEDRO	FLOW-SUP1INFLOWLL	AF	BJ	62	TIDCANAL	TIDLOSS	AF
I	9	DONPEDRO	FLOW-SUP2INFLOWHH	AF	BK	63	TIDCANAL	TIDINTCP	AF
J	10	DONPEDRO	FLOW-INFLOWHH	CFS	BL	64	TIDCANAL	TIDNOMGWDIST	AF
K	11	DONPEDRO	FLOW-INFLOWLL	CFS	BM	65	TIDCANAL	TIDUPSYSLOSSDIV	AF
L	12	DONPEDRO	FLOW-INFLOWEL	CFS	BN	66	TIDCANAL	TIDLKDIV	AF
M	13	DONPEDRO	STORAGE	AF	BO	67	TIDCANAL	TIDLKSTORCHNG	AF
N	14	DONPEDRO	EVAP	AF	BP	68	TIDCANAL	TIDFULLREQ	AF
O	15	DONPEDRO	STORAGE-RFTRG	AF	BQ	69	DONPEDRO	DPFACT	UNIT
P	16	DONPEDRO	STORAGE-SOFTTRG	AF	BR	70	SANFRAN	SFSJPLBASE	AF
Q	17	DONPEDRO	RELEASE-7DAYENCRADVISE	CFS	BS	71	SANFRAN	SFLOCALSTOR	AF
R	18	DONPEDRO	RELEASE-SNOWADVISE	CFS	BT	72	SANFRAN	SFSJPL	AF
S	19	DONPEDRO	RELEASE-TOTAL	CFS	BU	73	SANFRAN	SFTOTSYSSTOR	AF
T	20	DONPEDRO	POWR-MW	MW	BV	74	SANFRAN	SFTOTTRSYSSTOR	AF
U	21	DONPEDRO	POWR-EFF	kWh/AF	BW	75	SANFRAN	SFSUPPREL	UNIT
V	22	DONPEDRO	POWR-MWh	MWh	BX	76	SANFRAN	SFSUPPTAB	UNIT
W	23	DONPEDRO	RELEASE-PH	AF	BY	77	SANFRAN	TRIGGER	UNIT
X	24	DONPEDRO	RELEASE-BYPASS	AF	BZ	78	SANFRAN	WBBAL	UNIT
Y	25	DONPEDRO	FLOW-TOTCANALS	AF	CA	79	HETCH	HATCH-GRVLND	CFS
Z	26	LAGRANGE	RELEASE-MINQ	CFS	CB	80	HETCH	HATCH-RTRN	CFS
AA	27	LAGRANGE	RELEASE-TOTAL	CFS	CC	81	HETCH	RELEASE-MINQ1	CFS
AB	28	LAGRANGE	RELEASE-MCANAL	CFS	CD	82	HETCH	RELEASE-TOTMINQ	CFS
AC	29	LAGRANGE	RELEASE-TCANAL	CFS	CE	83	HETCH	RELEASE-7DAYENCRADVISE	CFS
AD	30	LAGRANGE	FULLCANALREQ	AF	CF	84	HETCH	RELEASE-SNOWADVISE	CFS
AE	31	RIVER	FLOW-LTRACC1	CFS	CG	85	HETCH	RELEASE-TOTAL	CFS
AF	32	RIVER	FLOW-LTRACC2	CFS	CH	86	HETCH	STORAGE	AF
AG	33	RIVER	FLOW-LTRACC3	CFS	CI	87	HETCH	EVAP	AF
AH	34	RIVER	FLOW-LTRACC4	CFS	CJ	88	HETCH	STORAGE-SOFTTRG	AF
AI	35	RIVER	FLOW-DRYCK	CFS	CK	89	LLOYD	RELEASE-MINSTRMQ	CFS
AJ	36	RIVER	FLOW-LTRACC5	CFS	CL	90	LLOYD	RELEASE-MINHOLM	CFS
AK	37	RIVER	FLOW-TR1	CFS	CM	91	LLOYD	RELEASE-7DAYENCRADVISE	CFS
AL	38	RIVER	FLOW-TR2	CFS	CN	92	LLOYD	RELEASE-SNOWADVISE	CFS
AM	39	RIVER	FLOW-TR3	CFS	CO	93	LLOYD	RELEASE-LLOYDONLYHOLM	CFS
AN	40	RIVER	FLOW-TR4	CFS	CP	94	LLOYD	HOLMAVAILEL	CFS
AO	41	RIVER	FLOW-MODMAX	CFS	CQ	95	LLOYD	RELEASE-TOTHOLM	CFS
AP	42	RIVER	FLOW-MODMAXLG	CFS	CR	96	LLOYD	RELEASE-TOTLLOYD	CFS
AQ	43	RIVER	FLOW-MODESTO	CFS	CS	97	LLOYD	STORAGE	AF
AR	44	RIVER	FLOW-TR5	CFS	CT	98	LLOYD	EVAP	AF
AS	45	MIDCANAL	MIDAGPDAW	AF	CU	99	LLOYD	STORAGE-SOFTTRG	AF
AT	46	MIDCANAL	MIDMI	AF	CV	100	ELEANOR	RELEASE-MINSTRMQ	CFS
AU	47	MIDCANAL	MIDFACT	PERCENT	CW	101	ELEANOR	RELEASE-7DAYENCRADVISE	CFS
AV	48	MIDCANAL	MIDNOMGWPRVT	AF	CX	102	ELEANOR	RELEASE-SNOWADVISE	CFS
AW	49	MIDCANAL	MIDOPSPLS	AF	CY	103	ELEANOR	TUNTRNSFCAP	CFS
AX	50	MIDCANAL	MIDLOSS	AF	CZ	104	ELEANOR	FLOW-TUNNEL	CFS
AY	51	MIDCANAL	MIDINTCP	AF	DA	105	ELEANOR	RELEASE-STREAM	CFS
AZ	52	MIDCANAL	MIDNOMGWDIST	AF	DB	106	ELEANOR	RELEASE-TOTELEANOR	CFS
BA	53	MIDCANAL	MIDUPSYSLOSSDIV	AF	DC	107	ELEANOR	STORAGE	AF
BB	54	MIDCANAL	MIDLKDIV	AF	DD	108	ELEANOR	EVAP	AF
BC	55	MIDCANAL	MIDLKSTORCHNG	AF	DE	109	ELEANOR	STORAGE-SOFTTRG	AF

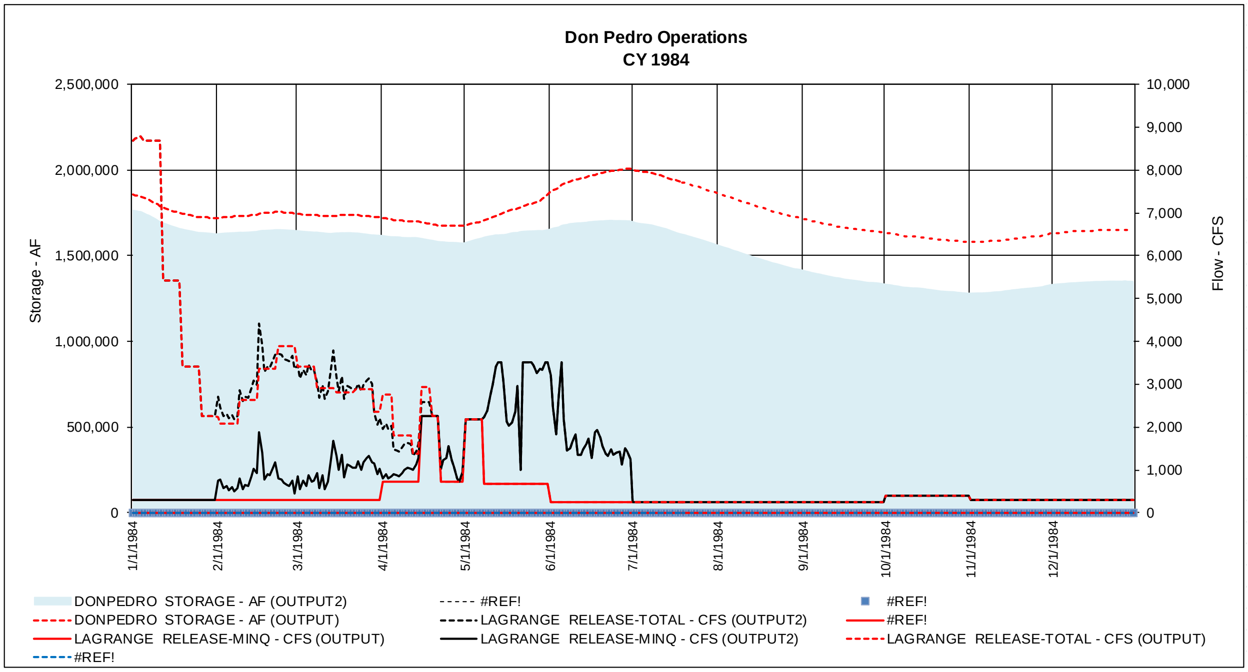
5.5 DSSAnyGroup Worksheet

This worksheet (DSSAnyGroup) provides plotting of up to ten parameters provided in worksheet Output or another equally formatted worksheet of results. One calendar year (the same year or different years) of data for a parameter can be plotted. The parameter(s) to be plotted are identified by reference worksheet name and column. A snapshot of the identification parameters and result values is shown below.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	DSSAnyGroup													
2	This sheet illustrates a CY of daily results from Model sheets in graphic format.													
3	Axis Reference	1		1		2		2		2		2		1
4	Enter CY Graph Year:	1984		1984		1984		1984		1984		1984		1984
5	Enter Sheet Name:	OUTPUT1		OUTPUT2		OUTPUT2		OUTPUT1		OUTPUT		OUTPUT2		OUTPUT
6	Column:	#N/A		13		27		#N/A		26		26		#N/A
7	Enter Column:			M		AA				Z		Z		
8	Data Reference:	#REF!	Date	DONPEDRO STORAGE - AF (OUTPUT2)	Date	LAGRANGE RELEASE- TOTAL - CFS (OUTPUT2)	Date	#REF!	Date	LAGRANGE RELEASE- MINQ - CFS (OUTPUT)	Date	LAGRANGE RELEASE- MINQ - CFS (OUTPUT2)	Date	#REF!
9	Enter Scaler:	1		1		1		1		1		1		1
10	1-Jan-84	#REF!	1-Jan-84	1,765,400	1-Jan-84	8,681	1-Jan-84	#REF!	1-Jan-84	300	1-Jan-84	300	1-Jan-84	#REF!
11	2-Jan-84	#REF!	2-Jan-84	1,762,808	2-Jan-84	8,732	2-Jan-84	#REF!	2-Jan-84	300	2-Jan-84	300	2-Jan-84	#REF!
12	3-Jan-84	#REF!	3-Jan-84	1,759,443	3-Jan-84	8,758	3-Jan-84	#REF!	3-Jan-84	300	3-Jan-84	300	3-Jan-84	#REF!
13	4-Jan-84	#REF!	4-Jan-84	1,757,150	4-Jan-84	8,773	4-Jan-84	#REF!	4-Jan-84	300	4-Jan-84	300	4-Jan-84	#REF!
14	5-Jan-84	#REF!	5-Jan-84	1,749,651	5-Jan-84	8,683	5-Jan-84	#REF!	5-Jan-84	300	5-Jan-84	300	5-Jan-84	#REF!
15	6-Jan-84	#REF!	6-Jan-84	1,741,186	6-Jan-84	8,683	6-Jan-84	#REF!	6-Jan-84	300	6-Jan-84	300	6-Jan-84	#REF!
16	7-Jan-84	#REF!	7-Jan-84	1,735,636	7-Jan-84	8,683	7-Jan-84	#REF!	7-Jan-84	300	7-Jan-84	300	7-Jan-84	#REF!
17	8-Jan-84	#REF!	8-Jan-84	1,726,314	8-Jan-84	8,683	8-Jan-84	#REF!	8-Jan-84	300	8-Jan-84	300	8-Jan-84	#REF!
18	9-Jan-84	#REF!	9-Jan-84	1,718,101	9-Jan-84	8,683	9-Jan-84	#REF!	9-Jan-84	300	9-Jan-84	300	9-Jan-84	#REF!
19	10-Jan-84	#REF!	10-Jan-84	1,708,161	10-Jan-84	8,683	10-Jan-84	#REF!	10-Jan-84	300	10-Jan-84	300	10-Jan-84	#REF!
20	11-Jan-84	#REF!	11-Jan-84	1,696,327	11-Jan-84	8,683	11-Jan-84	#REF!	11-Jan-84	300	11-Jan-84	300	11-Jan-84	#REF!
21	12-Jan-84	#REF!	12-Jan-84	1,691,421	12-Jan-84	5,421	12-Jan-84	#REF!	12-Jan-84	300	12-Jan-84	300	12-Jan-84	#REF!
22	13-Jan-84	#REF!	13-Jan-84	1,686,396	13-Jan-84	5,421	13-Jan-84	#REF!	13-Jan-84	300	13-Jan-84	300	13-Jan-84	#REF!
23	14-Jan-84	#REF!	14-Jan-84	1,680,358	14-Jan-84	5,421	14-Jan-84	#REF!	14-Jan-84	300	14-Jan-84	300	14-Jan-84	#REF!
24	15-Jan-84	#REF!	15-Jan-84	1,674,328	15-Jan-84	5,421	15-Jan-84	#REF!	15-Jan-84	300	15-Jan-84	300	15-Jan-84	#REF!
25	16-Jan-84	#REF!	16-Jan-84	1,669,263	16-Jan-84	5,421	16-Jan-84	#REF!	16-Jan-84	300	16-Jan-84	300	16-Jan-84	#REF!

Values are plotted to either the primary y-axis or secondary y-axis. The “axis reference” indicates to which axis the value will be plotted by default. The designation of y-axis assignment is not modified by this field, and the user must edit the series data within the plot to change the y-axis assignment, graph type or line or shape characteristics. The “enter graph year” is a user entry. The same year or different year of a parameter or multiple parameters can be plotted. “Sheet name” is a user entry, and identifies from which Output-formatted worksheet the parameter is to be acquired. The “enter column” entry identifies from which column the parameter occurs. Refer to Table 5.4-1 of the description for worksheet Output for the identification of the column associated with each parameter. Upon proper entry of a parameter a return of the parameter’s label and source worksheet will occur in the “data reference” field. Values for the specified calendar year will also be returned in the data field. If a plotting position is not used, a “#VALUE!” or “#REF!” will be returned. The “scaler” field is provided to allow the conversion or scaling of the data returned from the result worksheet. For instance, if the daily data occurs in the result worksheet in units of daily average flow (cfs) it could be plotted in units of daily volume (acre-feet) by entering the conversion factor of 1.983471. The entry in the field acts as a multiplier to the value occurring in the result worksheet. This field can also be used to scale two different “order of magnitude” parameters to use the same y-axis.

The results of up to ten parameters will be plotted. An example of the several plotted parameters from two different studies is shown below.



Unused plotting positions will appear with values plotted at "zero" and will have legends of "#VALUE!" or "#REF!". To create graphs without unused positions a copy of the plot can be made and positioned elsewhere in the worksheet. The unwanted positions can then be deleted from the plot.

5.6 DSSMonthTable Worksheet

This worksheet (DSSMonthTable) provides summation or averaging, and plotting of up to four parameters provided in worksheet Output or another equally formatted worksheet of results. The function of this worksheet is to provide a synthesis of the daily result data into monthly results thus reducing the handling and display of over 14,000 values for each parameter (39 years of days) to 468 values (39 years of months).

The parameter(s) to be plotted or tabled are identified by reference worksheet name and column, very similarly to the method identified for worksheet DSSAnyGroup. A snapshot of the identification parameters and result values is shown below.

5				Conversion Key:			
6				0	1 >> 1	Native	1
7				1	CFS >> AF	AF	1.9834700
8				2	AF >> CFS	CFS	0.5041669
9				3	CFS >> TAF	TAF	0.0019835
10				4	EOM Stor	AF	1
11				5	Ave Day	Native	1
12			Enter Conversion (0-5):	4	4	4	4
13			Enter Sheet Name:	Output	Output1	Output3c	Output2b
14			Enter Column Letter:	M	M	M	M
15			Column No:	13	13	13	13
16			Label:	O STORAG	D STORAGE	D STORAGE	) STORAGE
17			Native Unit:	AF	AF	AF	AF
18			Convert Unit:	AF	AF	AF	AF
19	Index	Date	Day	1	1	1	1
20	1970.10	10/1/1970	T	1,666,767	1,666,767	1,666,767	1,666,969
21	1970.10	10/2/1970	F	1,664,567	1,664,567	1,664,567	1,664,971
22	1970.10	10/3/1970	S	1,662,719	1,662,719	1,662,719	1,663,323
23	1970.10	10/4/1970	S	1,659,892	1,659,892	1,659,892	1,660,699
24	1970.10	10/5/1970	M	1,656,745	1,656,745	1,656,745	1,657,753
25	1970.10	10/6/1970	T	1,654,119	1,654,119	1,654,119	1,655,329

Each parameter is tabled and plotted separately for the entire 39-year simulation period. “Sheet name” is a user entry, and identifies from which Output-formatted worksheet the parameter is to be acquired. The “enter column letter” entry identifies from which column the parameter occurs. Refer to Table 5.4-1 of the description for worksheet Output for the identification of the column associated with each parameter. Upon proper entry of a parameter a return of the parameter’s label, source worksheet and the native unit of the parameter will occur. Depending on need, the “conversion” entry is provided. This entry, a keyed value of 0 to 5, directs the worksheet on the handling of the daily data. An entry of 1 will direct the worksheet to sum the daily data into monthly increments in the parameter’s native units (e.g., daily acre-feet into monthly volumes). An entry of 1 will convert the daily data from a native unit of flow (cfs) into monthly volumes of acre-feet. An entry of 2 will convert the daily data from a native unit of volume (acre-feet) into a monthly sum of daily flow in units of cfs. An entry of 3 will act as an entry of 1 except convert the result into monthly volumes with units of 1,000 acre-feet. An entry of 4 will table and plot the daily value associated with the last day of each month in its native unit, and is primarily intended to analyze reservoir storage. An entry of 5 will report the average of daily values within a month. Depending on the entry in the conversion field, the converted unit will be returned to “converted unit” field. Values for the each month of the simulation period will also be returned in the data field. If a plotting position is not used, a “#VALUE!” or “#REF!” will be returned.
A “scaler” field is also provided for each parameter (in the row above the data fields) to allow the conversion or scaling of the data returned from the result worksheet. The results of up to four parameters will be tabled and plotted. Examples of the formats of reports are shown below.

Standardized Tables

An example of a standardized table for the illustration of results is shown below (Table 1 Form). In this example the current minimum daily flow requirement at La Grange Bridge has been synthesized into monthly volumes for the simulation period, and water year totals and for the annual period February through January.

Conversion (0-5):	1
Sheet Name:	Output1
Column Letter:	Z
Column No:	26
Label:	ELEASE-MI
Native Unit:	CFS
Convert Unit:	AF

Table 1
LAGRANGE RELEASE-MINQ (Output1)
AF

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Feb-Jan
1971	24,397	17,851	18,447	18,447	16,661	18,447	66,685	63,515	4,463	4,612	4,612	4,463	262,598	228,631
1972	13,240	10,413	10,760	10,760	9,719	10,760	30,288	29,251	2,975	3,074	3,074	2,975	137,292	128,713
1973	9,223	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	240,823	283,369
1974	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1975	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1976	24,397	17,851	18,447	18,447	16,661	18,447	20,153	19,749	2,975	3,074	3,074	2,975	166,250	122,217
1977	7,736	8,926	9,223	9,223	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	94,000	94,000
1978	7,736	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	239,336	283,369
1979	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1980	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1981	24,397	17,851	18,447	18,447	16,661	18,447	29,339	28,532	4,463	4,612	4,612	4,463	190,269	156,718
1982	12,744	10,711	11,068	11,068	9,997	11,068	64,241	61,936	14,876	15,372	15,372	14,876	253,329	286,880
1983	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1984	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1985	24,397	17,851	18,447	18,447	16,661	18,447	34,656	33,346	4,463	4,612	4,612	4,463	200,400	157,854
1986	9,223	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	240,823	283,369
1987	24,397	17,851	18,447	18,447	16,661	18,447	24,481	23,806	2,975	3,074	3,074	2,975	174,636	130,603
1988	7,736	8,926	9,223	9,223	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	94,000	94,000
1989	7,736	8,926	9,223	9,223	8,331	9,223	25,991	25,222	2,975	3,074	3,074	2,975	115,975	115,975
1990	7,736	8,926	9,223	9,223	8,331	9,223	19,362	19,008	2,975	3,074	3,074	2,975	103,131	103,131
1991	7,736	8,926	9,223	9,223	8,331	9,223	25,870	25,109	2,975	3,074	3,074	2,975	115,740	115,740
1992	7,736	8,926	9,223	9,223	8,331	9,223	19,995	19,601	2,975	3,074	3,074	2,975	104,357	104,357
1993	7,736	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	239,336	283,369
1994	24,397	17,851	18,447	18,447	16,661	18,447	25,903	25,140	2,975	3,074	3,074	2,975	177,391	134,846
1995	9,223	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	240,823	283,369
1996	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1997	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1998	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1999	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
2000	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
2001	24,397	17,851	18,447	18,447	16,661	18,447	28,572	27,642	4,463	4,612	4,612	4,463	188,612	146,067
2002	9,223	8,926	9,223	9,223	8,331	9,223	32,729	31,539	4,463	4,612	4,612	4,463	136,567	136,567
2003	9,223	8,926	9,223	9,223	8,331	9,223	55,641	53,161	4,463	4,612	4,612	4,463	181,101	189,680
2004	13,240	10,413	10,760	10,760	9,719	10,760	28,696	27,758	4,463	4,612	4,612	4,463	140,257	131,678
2005	9,223	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	240,823	283,369
2006	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
2007	24,397	17,851	18,447	18,447	16,661	18,447	26,085	25,310	2,975	3,074	3,074	2,975	177,743	133,710
2008	7,736	8,926	9,223	9,223	8,331	9,223	27,470	26,609	2,975	3,074	3,074	2,975	118,840	120,328
2009	9,223	8,926	9,223	9,223	8,331	9,223	42,919	41,235	4,463	4,612	4,612	4,463	156,452	
Average	16,957	13,625	14,079	14,079	12,717	14,079	46,531	44,910	9,078	9,381	9,381	9,078	213,897	214,289
Min	7,736	8,926	9,223	9,223	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	94,000	94,000
Max	24,397	17,851	18,447	18,447	16,661	18,447	66,685	63,515	14,876	15,372	15,372	14,876	300,923	300,923

Conversion (0-5):	5
Sheet Name:	Output1
Column Letter:	Z
Column No:	26
Label:	ELEASE-MI
Native Unit:	CFS
Convert Unit:	Native

The values could also be tabled in the parameter's native unit of flow (cfs) representing the average daily flow requirement during each month. Annual totals are not included as the value is non-sensible.

Table 1
LAGRANGE RELEASE-MINQ (Output1)
CFS — Average Daily Value

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1971	397	300	300	300	300	300	1,121	1,033	75	75	75	75
1972	215	175	175	175	169	175	509	476	50	50	50	50
1973	150	150	150	150	150	150	1,080	1,007	250	250	250	250
1974	397	300	300	300	300	300	1,080	1,007	250	250	250	250
1975	397	300	300	300	300	300	1,080	1,007	250	250	250	250
1976	397	300	300	300	290	300	339	321	50	50	50	50
1977	126	150	150	150	150	150	246	237	50	50	50	50
1978	126	150	150	150	150	150	1,080	1,007	250	250	250	250
1979	397	300	300	300	300	300	1,080	1,007	250	250	250	250
1980	397	300	300	300	290	300	1,080	1,007	250	250	250	250
1981	397	300	300	300	300	300	493	464	75	75	75	75
1982	207	180	180	180	180	180	1,080	1,007	250	250	250	250
1983	397	300	300	300	300	300	1,080	1,007	250	250	250	250
1984	397	300	300	300	290	300	1,080	1,007	250	250	250	250
1985	397	300	300	300	300	300	582	542	75	75	75	75
1986	150	150	150	150	150	150	1,080	1,007	250	250	250	250
1987	397	300	300	300	300	300	411	387	50	50	50	50
1988	126	150	150	150	145	150	246	237	50	50	50	50
1989	126	150	150	150	150	150	437	410	50	50	50	50
1990	126	150	150	150	150	150	325	309	50	50	50	50
1991	126	150	150	150	150	150	435	408	50	50	50	50
1992	126	150	150	150	145	150	336	319	50	50	50	50
1993	126	150	150	150	150	150	1,080	1,007	250	250	250	250
1994	397	300	300	300	300	300	435	409	50	50	50	50
1995	150	150	150	150	150	150	1,080	1,007	250	250	250	250
1996	397	300	300	300	290	300	1,080	1,007	250	250	250	250
1997	397	300	300	300	300	300	1,080	1,007	250	250	250	250
1998	397	300	300	300	300	300	1,080	1,007	250	250	250	250
1999	397	300	300	300	300	300	1,080	1,007	250	250	250	250
2000	397	300	300	300	290	300	1,080	1,007	250	250	250	250
2001	397	300	300	300	300	300	480	450	75	75	75	75
2002	150	150	150	150	150	150	550	513	75	75	75	75
2003	150	150	150	150	150	150	935	865	75	75	75	75
2004	215	175	175	175	169	175	482	451	75	75	75	75
2005	150	150	150	150	150	150	1,080	1,007	250	250	250	250
2006	397	300	300	300	300	300	1,080	1,007	250	250	250	250
2007	397	300	300	300	300	300	438	412	50	50	50	50
2008	126	150	150	150	145	150	462	433	50	50	50	50
2009	150	150	150	150	150	150	721	671	75	75	75	75
Average	276	229	229	229	227	229	782	730	153	153	153	153
Min	126	150	150	150	145	150	246	237	50	50	50	50
Max	397	300	300	300	300	300	1,121	1,033	250	250	250	250

For each parameter the sequential, the chronological annual values and associated monthly values are also grouped by water type, in descending order of annual runoff. The rank ordering of the years within the simulation period is established by the naming of 6 year types, wet, above normal, normal, below normal, dry and critical. Using the water year runoff for the years 1921 through 2011 (91 years), the years were rank ordered from wettest to driest. The wettest 20 percent of the years (18 years) are designated the wet year type. The next wettest 18 years are designated the above normal year type.

And so on for the normal and below normal year types. The driest 20 percent of years are split between the dry and critical year types. After the demarcation occurs for each year the data set is reduced to only the 1971 through 2009 modeling period (39 years). A switch at cell X216 directs the monthly sequence of the year. For instance, if the year is to begin February 1 of the year and continue through January of the following year, the switch would be set to “Feb”. The switch can be set to any month February (Feb) through June (Jun). The first form of standardized table (Table 1a Form) for this information follows, which identifies the year type associated with each chronologically-based listed year. Averages for each year type follow the listing.

Table 1a

LAGRANGE RELEASE-MINQ (Output1)

AF

Prelim Relicense Yr-Type	Yr Begin	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Total
3	1971	16,661	18,447	66,685	63,515	4,463	4,612	4,612	4,463	13,240	10,413	10,760	10,760	228,631
4	1972	9,719	10,760	30,288	29,251	2,975	3,074	3,074	2,975	9,223	8,926	9,223	9,223	128,713
3	1973	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
2	1974	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
2	1975	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
6	1976	16,661	18,447	20,153	19,749	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	122,217
6	1977	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	94,000
1	1978	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
3	1979	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
1	1980	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
5	1981	16,661	18,447	29,339	28,532	4,463	4,612	4,612	4,463	12,744	10,711	11,068	11,068	156,718
1	1982	9,997	11,068	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	286,880
1	1983	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
2	1984	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
4	1985	16,661	18,447	34,656	33,346	4,463	4,612	4,612	4,463	9,223	8,926	9,223	9,223	157,854
1	1986	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
6	1987	16,661	18,447	24,481	23,806	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	130,603
6	1988	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	94,000
4	1989	8,331	9,223	25,991	25,222	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	115,975
5	1990	8,331	9,223	19,362	19,008	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	103,131
4	1991	8,331	9,223	25,870	25,109	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	115,740
6	1992	8,331	9,223	19,995	19,601	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	104,357
2	1993	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
5	1994	16,661	18,447	25,903	25,140	2,975	3,074	3,074	2,975	9,223	8,926	9,223	9,223	134,846
1	1995	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
2	1996	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
1	1997	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
1	1998	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
2	1999	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
3	2000	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
4	2001	16,661	18,447	28,572	27,642	4,463	4,612	4,612	4,463	9,223	8,926	9,223	9,223	146,067
3	2002	8,331	9,223	32,729	31,539	4,463	4,612	4,612	4,463	9,223	8,926	9,223	9,223	136,567
3	2003	8,331	9,223	55,641	53,161	4,463	4,612	4,612	4,463	13,240	10,413	10,760	10,760	189,680
4	2004	9,719	10,760	28,696	27,758	4,463	4,612	4,612	4,463	9,223	8,926	9,223	9,223	131,678
1	2005	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
1	2006	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
5	2007	16,661	18,447	26,085	25,310	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	133,710
4	2008	8,331	9,223	27,470	26,609	2,975	3,074	3,074	2,975	9,223	8,926	9,223	9,223	120,328
3	2009	8,331	9,223	42,919	41,235	4,463	4,612	4,612	4,463					

LAGRANGE RELEASE-MINQ (Output1) - AF

Water Year Type		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Total
W	1	12,663	14,019	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	292,497
AN	2	15,273	16,909	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	297,997
N	3	11,901	13,176	55,814	53,608	8,926	9,223	9,223	8,926	18,149	13,884	14,347	14,347	240,016
BN	4	11,108	12,298	28,792	27,848	3,613	3,733	3,733	3,613	8,798	8,926	9,223	9,223	130,908
D	5	14,579	16,141	25,172	24,497	3,347	3,459	3,459	3,347	9,360	9,372	9,684	9,684	132,101
C	6	11,663	12,913	18,786	18,467	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	109,035
All		12,717	14,079	46,531	44,910	9,078	9,381	9,381	9,078	16,762	13,514	13,964	13,964	214,289

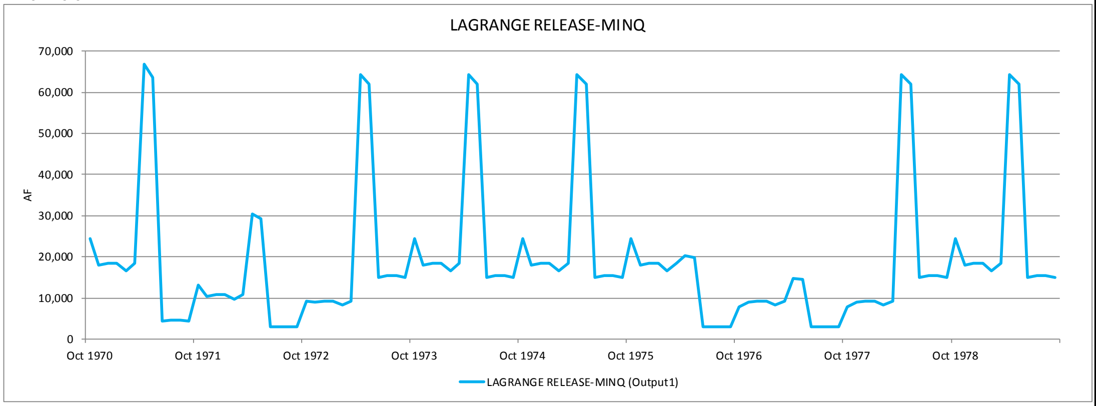
The second form of report (Table 1b Form) for the water year type based ranking is shown below. This form rank orders the years according to descending volume of watershed runoff, named by the convention described above. The same averaging results occur for this format of report.

	Table 1b													
Prelim	LAGRANGE RELEASE-MINQ (Output1)													
Relicense	AF													
Yr-Type	Yr Begin	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Total
W	1983	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
W	1995	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
W	1982	9,997	11,068	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	286,880
W	1998	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
W	2006	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
W	1997	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
W	1980	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
W	1986	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
W	2005	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
W	1978	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
AN	1984	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
AN	1993	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
AN	1996	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
AN	1974	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
AN	1999	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
AN	1975	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
N	1973	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
N	2000	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
N	1979	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
N	1971	16,661	18,447	66,685	63,515	4,463	4,612	4,612	4,463	13,240	10,413	10,760	10,760	228,631
N	2009	8,331	9,223	42,919	41,235	4,463	4,612	4,612	4,463					
N	2003	8,331	9,223	55,641	53,161	4,463	4,612	4,612	4,463	13,240	10,413	10,760	10,760	189,680
N	2002	8,331	9,223	32,729	31,539	4,463	4,612	4,612	4,463	9,223	8,926	9,223	9,223	136,567
BN	1989	8,331	9,223	25,991	25,222	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	115,975
BN	2004	9,719	10,760	28,696	27,758	4,463	4,612	4,612	4,463	9,223	8,926	9,223	9,223	131,678
BN	1985	16,661	18,447	34,656	33,346	4,463	4,612	4,612	4,463	9,223	8,926	9,223	9,223	157,854
BN	1972	9,719	10,760	30,288	29,251	2,975	3,074	3,074	2,975	9,223	8,926	9,223	9,223	128,713
BN	2008	8,331	9,223	27,470	26,609	2,975	3,074	3,074	2,975	9,223	8,926	9,223	9,223	120,328
BN	1991	8,331	9,223	25,870	25,109	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	115,740
BN	2001	16,661	18,447	28,572	27,642	4,463	4,612	4,612	4,463	9,223	8,926	9,223	9,223	146,067
D	1981	16,661	18,447	29,339	28,532	4,463	4,612	4,612	4,463	12,744	10,711	11,068	11,068	156,718
D	2007	16,661	18,447	26,085	25,310	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	133,710
D	1990	8,331	9,223	19,362	19,008	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	103,131
D	1994	16,661	18,447	25,903	25,140	2,975	3,074	3,074	2,975	9,223	8,926	9,223	9,223	134,846
C	1992	8,331	9,223	19,995	19,601	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	104,357
C	1988	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	94,000
C	1976	16,661	18,447	20,153	19,749	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	122,217
C	1987	16,661	18,447	24,481	23,806	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	130,603
C	1977	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	94,000
LAGRANGE RELEASE-MINQ (Output1) - AF														
Water Year Type		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Total
W	1	12,663	14,019	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	292,497
AN	2	15,273	16,909	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	297,997
N	3	11,901	13,176	55,814	53,608	8,926	9,223	9,223	8,926	18,149	13,884	14,347	14,347	240,016
BN	4	11,108	12,298	28,792	27,848	3,613	3,733	3,733	3,613	8,798	8,926	9,223	9,223	130,908
D	5	14,579	16,141	25,172	24,497	3,347	3,459	3,459	3,347	9,360	9,372	9,684	9,684	132,101
C	6	11,663	12,913	18,786	18,467	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	109,035
All		12,717	14,079	46,531	44,910	9,078	9,381	9,381	9,078	16,762	13,514	13,964	13,964	214,289

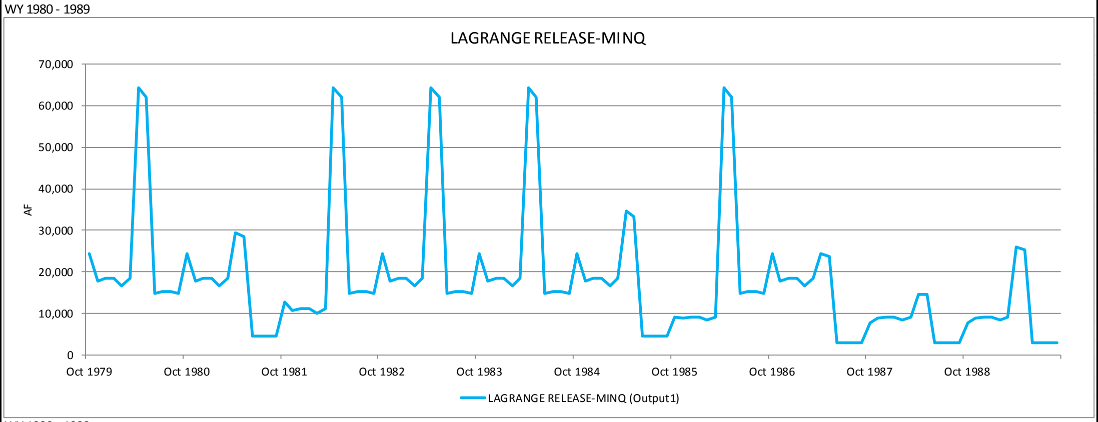
Standardized Graphs

Several standardized graphs are also provided for each parameter. The first graph provides a trace of the monthly sequence of data developed for the standardized chronological table. Following is the minimum flow requirement at La Grange Bridge synthesized as monthly volume during the simulation.

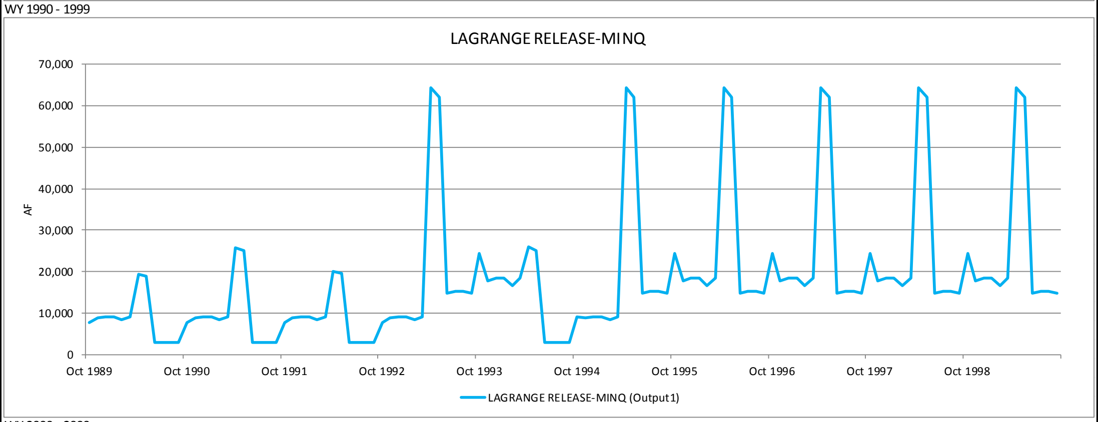
WY 1971-1979



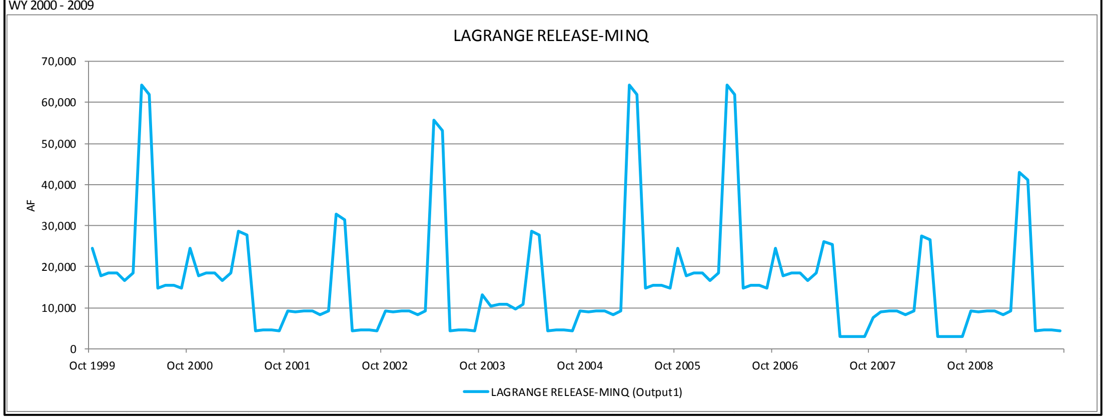
WY 1980 - 1989



WY 1990 - 1999



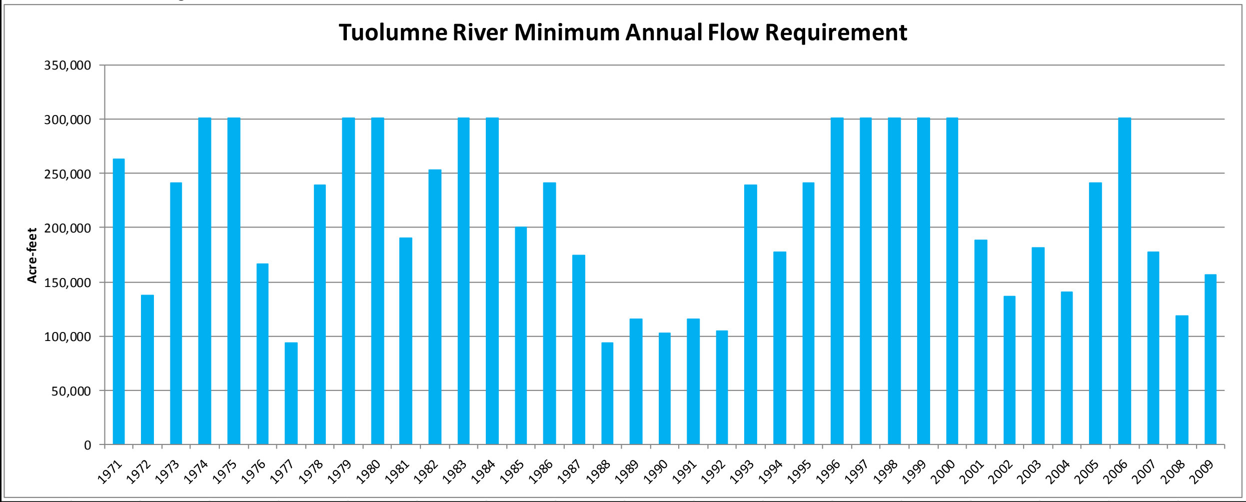
WY 2000 - 2009



A user-defined graph is also available to depict a particular column of data from the water year-based standardized table (Table 1) described above. A column of interest within the Table 1 standardized table is selected (such as column AI representing a water year total volume) in cell AN116 to display the 39 annual values.

Tab: Output1
Parmater: LAGRANGE RELEASE-MINQ (Output1) Table 1 Column Label: Total
Native: CFS
Convert: AF cell AN116
Table 1 Plotted Col: AI Title: Tuolumne River Minimum Annual Flow Requirement Y-Axis: Acre-feet

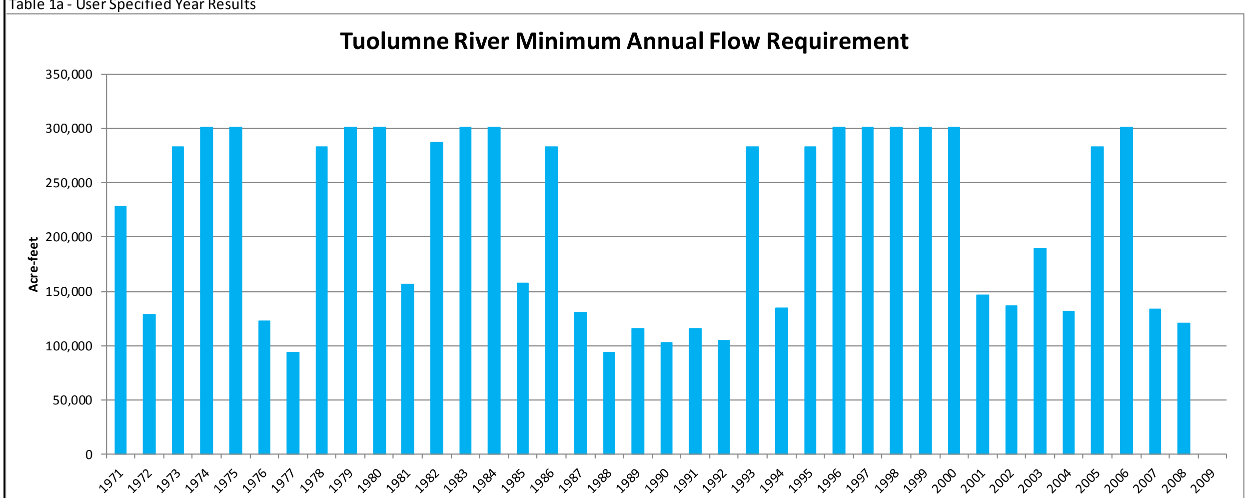
Table 1 - Water Year Arranged Results



A similar display of columnar results can be keyed to the chronological sequence year table described above. Entry of the desired column of information from the table (e.g., Table 1a) is done at cell AN143.

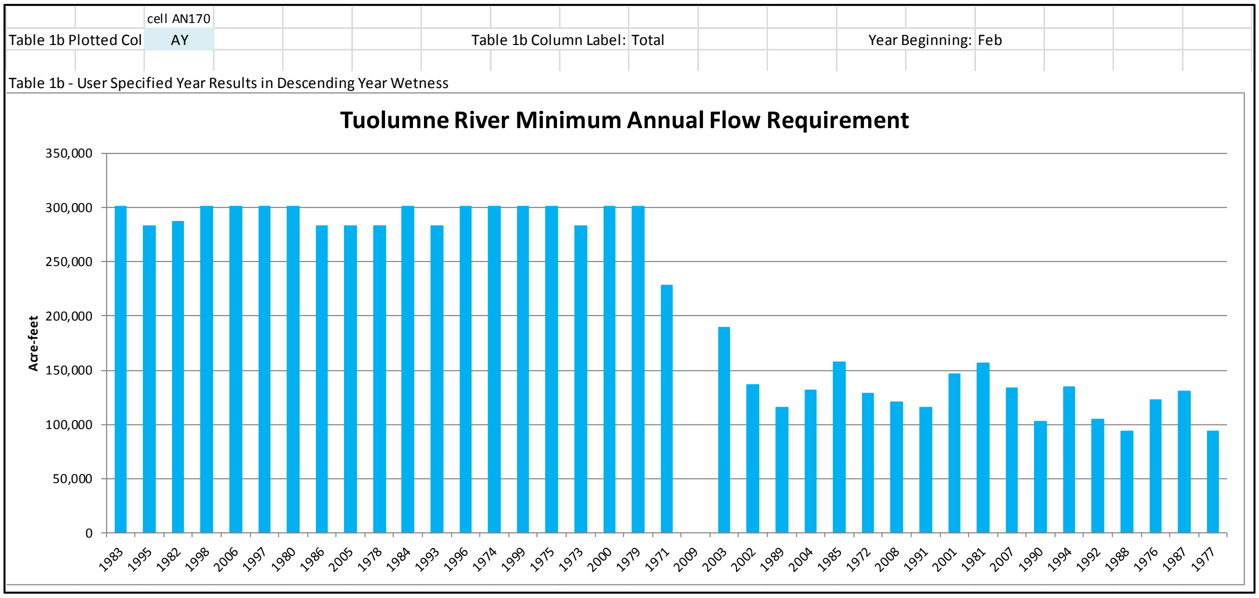
cell AN143
Table 1a Plotted Col: AI Table 1a Column Label: Total Year Beginning: Feb

Table 1a - User Specified Year Results

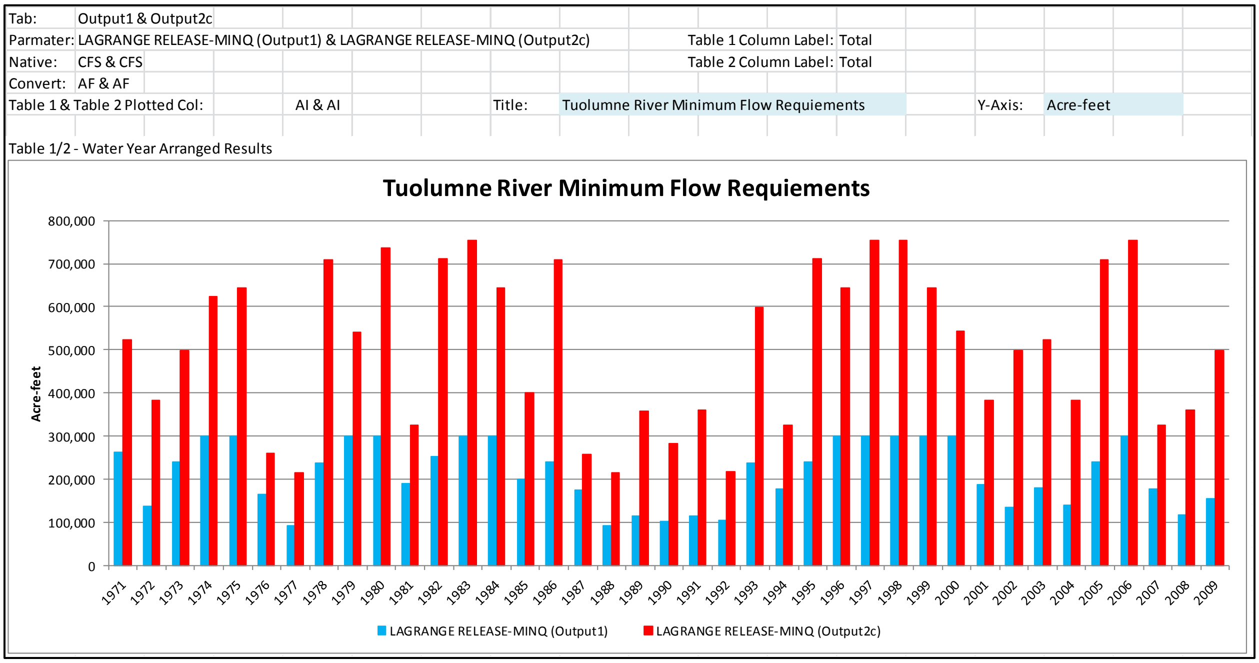


The third version of standardized graph for the same information displays results from a column of a table that rank-ordered the years of simulation according to descending runoff (e.g., Table 1b). Entry of

the desired column of information from that table is done at cell AN170, with results exemplified by the following graph.

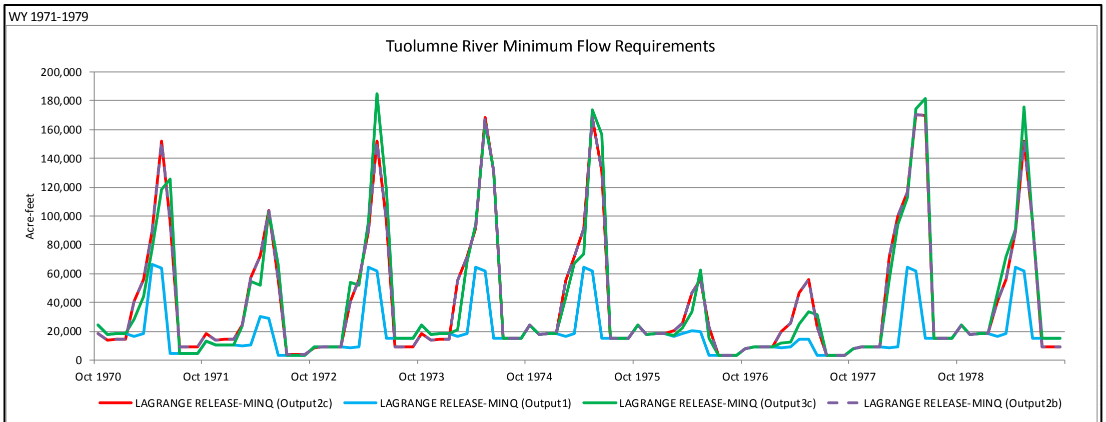


The same tables and graphics are provided for each of the three other parameters. Additionally, standardized graphics are provided for a columnar comparison of Table 1 and Table 2 values. An example of those graphics is shown below, with the column(s) of interest defined by the Table 1-specific and Table 2-specific entries.

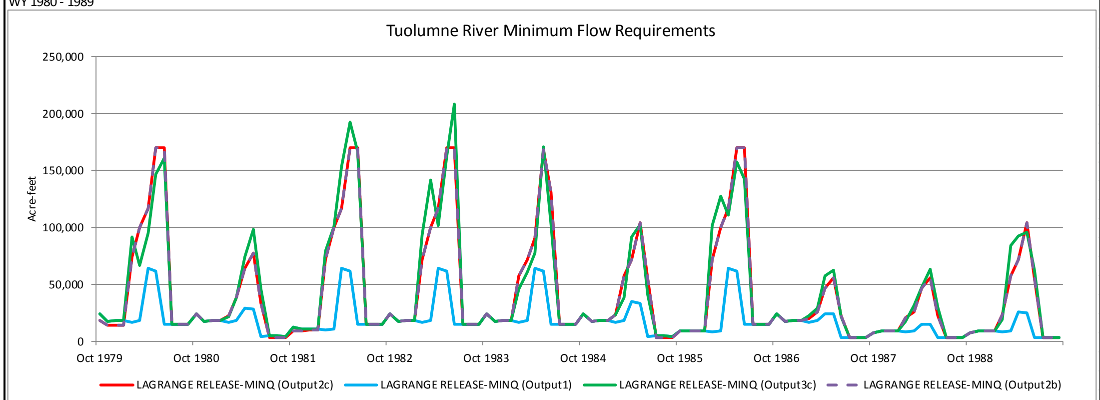


A standardized graphic comparison of Table 1, Table 2, Table 3 and Table 4 form monthly data is also provided. The four-way comparison graphs are shown below.

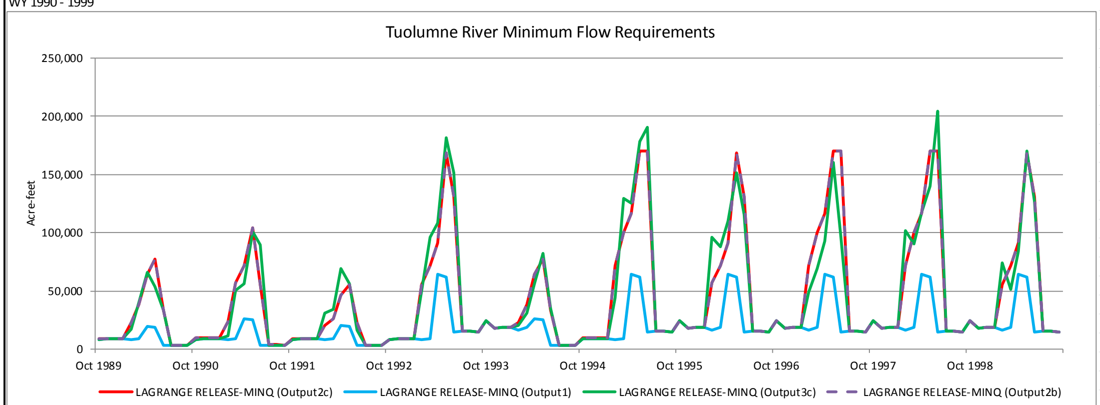
WY 1971-1979



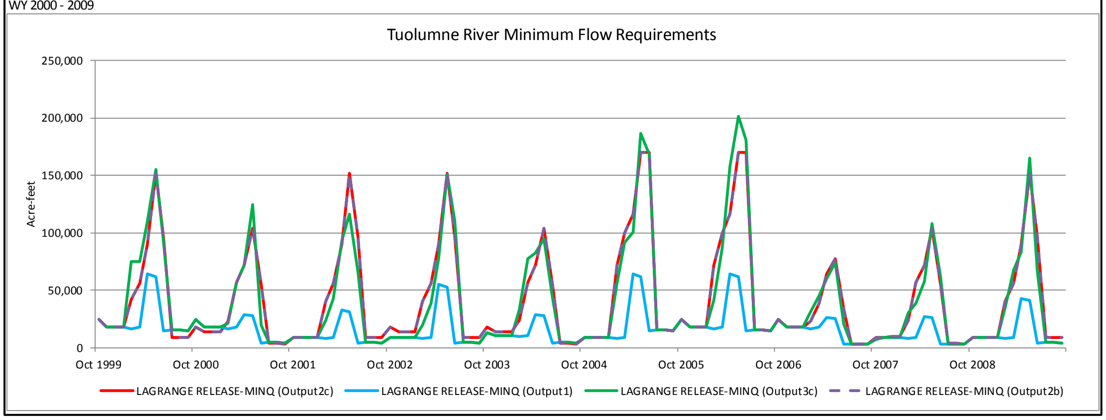
WY 1980 - 1989



WY 1990 - 1999



WY 2000 - 2009



5.7 XXGroup Worksheets

These worksheets provide graphical display of a single calendar year of operation for several model components. The model components represent groupings of physical features of the Tuolumne River system that make up logical components of operation. The model components are:

<u>Don Pedro Reservoir, the Distircts' facilities, and the Lower Tuolumne River</u>
Modeled with computational worksheet DonPedro and displayed by worksheet DPGroup

<u>Hetch Hetchy Reservoir, the San Joaquin Pipeline and downstream releases</u>
Modeled with computational worksheet SFHetchHetchy and displayed by worksheet HHGroup

<u>Lake Lloyd, Holm Powerhouse and its downstream releases</u>
Modeled with computational worksheet SFLloyd and displayed by worksheet LloydGroup

<u>Lake Eleanor, the Eleanor-Cherry Tunnel and its downstream releases</u>
Modeled with computational worksheet SFEleanor and displayed by worksheet ELGroup

<u>CCSF Water Bank and Supplemental Releases</u>
Modeled with computational worksheet SFWaterBank and displayed by worksheet WBGroup

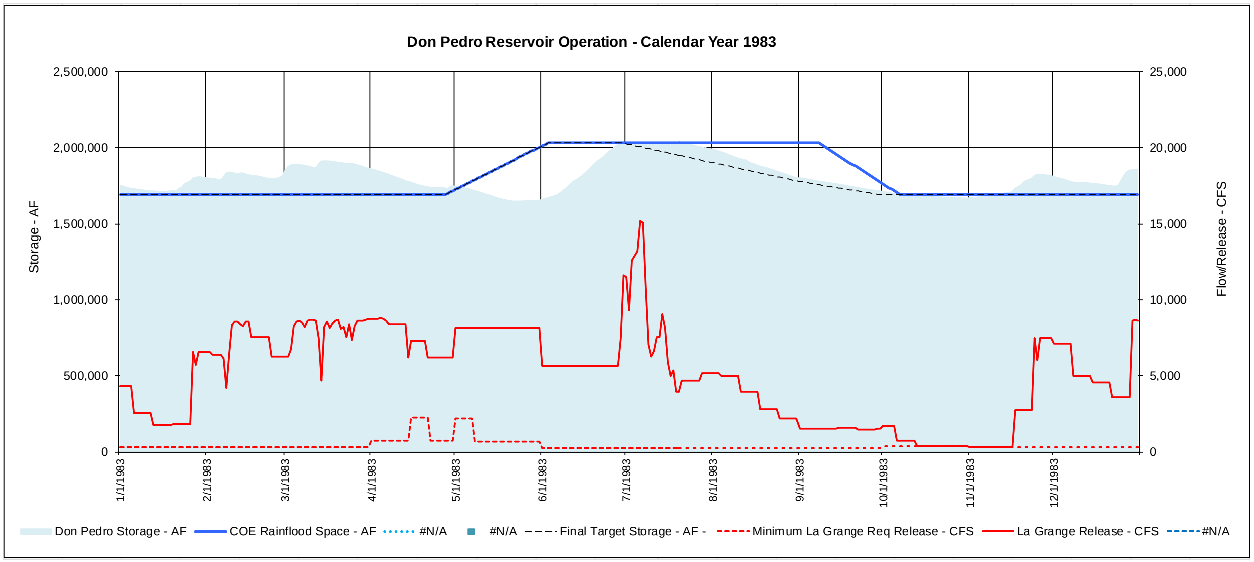
<u>CCSF System Storage</u> displayed by worksheet SFSysGroup.

Both the Districts' and CCSF's operations are additionally displayed for the 1986 through 1994 period by worksheets DPGroup86_94 and SFGroup86_94.

These component-specific display worksheets provide plotting of numerous parameters provided in the computation worksheets. One calendar year (the same year) of data for all parameters can be plotted. These display worksheets are similar to worksheet DSSAnyGroup except they rely upon the data being computed by the current study within the computational worksheets. A comparison between the same parameter from two different studies is not possible. Those comparisons are intended to be made through the worksheet Output and its tools. The parameter(s) to be plotted are identified by reference worksheet name and column. A snapshot of the identification parameters and result values is shown below for worksheet DPGroup.

	A	B	C	D	E	F	G	H
1	**DPGroup**							
2	This sheet illustrates a CY of daily results for Don Pedro operations in graphic format.							
3	Axis Reference	1	1	2	2	2	2	2
4	Enter CY Graph Year:	1983	1983	1983	1983	1983	1983	1983
5	Enter Sheet Name:	DonPedro	DonPedro	DonPedro	DonPedro	DonPedro	DonPedro	DonPedro
6	Column:	28	72	5	7	13	15	70
7	Enter Column:	AB	BT	E	G	M	O	BR
8	Data Reference:	COE Rainflood Space - AF	Don Pedro Storage - AF	Reservoir Inflow - CFS	Minimum La Grange Req Release - CFS	MID Canal - CFS	TID Canal - CFS	La Grange Release - CFS
9	Enter Scaler:	1	1	1	1	1	1	1
10	1-Jan-83	1,690,000	1,752,672	2,688	300	70	98	4,301
11	2-Jan-83	1,690,000	1,748,069	2,138	300	70	98	4,301
12	3-Jan-83	1,690,000	1,742,799	1,801	300	70	98	4,301
13	4-Jan-83	1,690,000	1,737,746	1,911	300	70	98	4,301
14	5-Jan-83	1,690,000	1,732,665	1,897	300	70	98	4,301
15	6-Jan-83	1,690,000	1,730,261	1,501	300	70	98	2,555
16	7-Jan-83	1,690,000	1,728,957	2,055	300	70	98	2,555
17	8-Jan-83	1,690,000	1,726,043	1,244	300	70	98	2,555
18	9-Jan-83	1,690,000	1,724,497	1,933	300	70	98	2,555

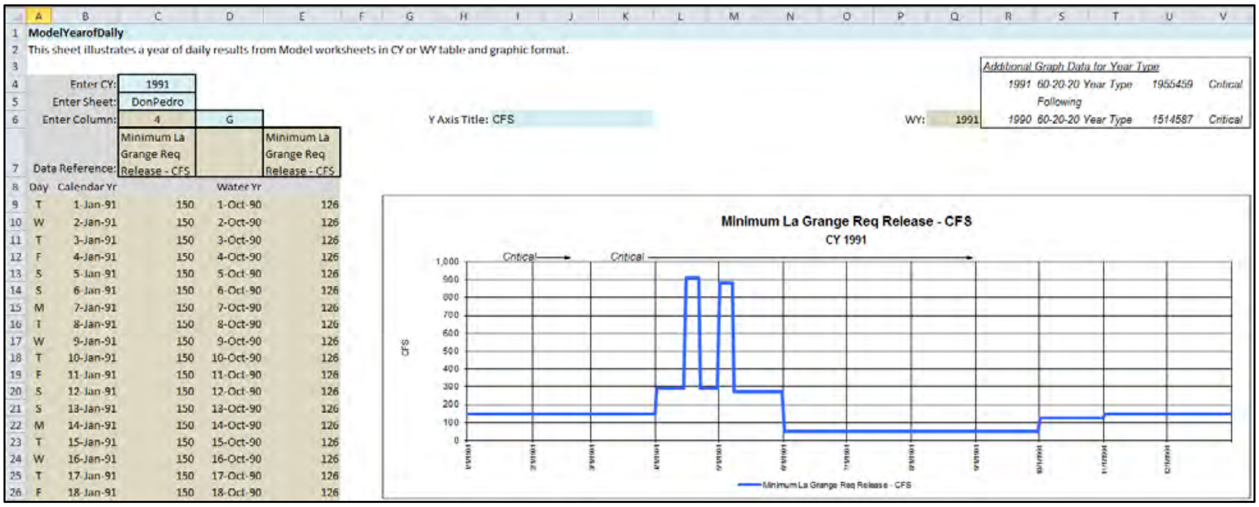
Values are plotted to either the primary y-axis or secondary y-axis. The “axis reference” indicates to which axis the value will be plotted by default. The designation of y-axis assignment is not modified by this field, and the user must edit the series data within the plot to change the y-axis assignment, graph type or line or shape characteristics. The “enter graph year” is a user entry. The same year or different year of a parameter or multiple parameters can be plotted. “Sheet name” is a user entry, and identifies from which Output-formatted worksheet the parameter is to be acquired. The “enter column” entry identifies from which column the parameter occurs. Upon proper entry of a parameter a return of the parameter’s label and source worksheet will occur in the “data reference” field. Values for the specified calendar year will also be returned in the data field. If a plotting position is not used, a “#VALUE” or “#REF” will be returned. The “scaler” field is provided to allow the conversion or scaling of the data returned from the result worksheet. For instance, if the daily data occurs in the result worksheet in units of daily average flow (cfs) it could be plotted in units of daily volume (acre-feet) by entering the conversion factor of 1.983471. The entry in the field acts as a multiplier to the value occurring in the result worksheet. This field can also be used to scale two different “order of magnitude” parameters to use the same y-axis. An example of the several plotted parameters from an active scenario study is shown below.



Unused plotting positions will appear with values plotted at “zero” and will have legends of “#VALUE!”, “#REF!” or “#N/A”. To create graphs without unused positions a copy of the plot can be made and positioned elsewhere in the worksheet. The unwanted positions can then be deleted from the plot.

5.8 ModelYearofDaily Worksheet

This worksheet (ModelYearofDaily) provides graphical and table display of the daily result for a single calendar or water year for any parameter within a Model component worksheet (e.g., worksheet DonPedro). A snapshot of the data entry interface and a sample of graphical display are shown below.



The calendar year, Model worksheet, and column of interest are entered by the user. The result data are plotted by calendar year and water year. The result data are also tabled by calendar year (shown below) and water year.

Minimum La Grange Req Release - CFS												
CY 1991	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	150	150	150	289	886	50	50	50	50	126	150	150
2	150	150	150	289	886	50	50	50	50	126	150	150
3	150	150	150	289	886	50	50	50	50	126	150	150
4	150	150	150	289	886	50	50	50	50	126	150	150
5	150	150	150	289	886	50	50	50	50	126	150	150
6	150	150	150	289	886	50	50	50	50	126	150	150
7	150	150	150	289	886	50	50	50	50	126	150	150
8	150	150	150	289	269	50	50	50	50	126	150	150
9	150	150	150	289	269	50	50	50	50	126	150	150
10	150	150	150	289	269	50	50	50	50	126	150	150
11	150	150	150	289	269	50	50	50	50	126	150	150
12	150	150	150	289	269	50	50	50	50	126	150	150
13	150	150	150	289	269	50	50	50	50	126	150	150
14	150	150	150	289	269	50	50	50	50	126	150	150
15	150	150	150	913	269	50	50	50	50	126	150	150
16	150	150	150	913	269	50	50	50	50	126	150	150
17	150	150	150	913	269	50	50	50	50	126	150	150
18	150	150	150	913	269	50	50	50	50	126	150	150
19	150	150	150	913	269	50	50	50	50	126	150	150
20	150	150	150	913	269	50	50	50	50	126	150	150
21	150	150	150	913	269	50	50	50	50	126	150	150
22	150	150	150	289	269	50	50	50	50	126	150	150
23	150	150	150	289	269	50	50	50	50	126	150	150
24	150	150	150	289	269	50	50	50	50	126	150	150
25	150	150	150	289	269	50	50	50	50	126	150	150
26	150	150	150	289	269	50	50	50	50	126	150	150
27	150	150	150	289	269	50	50	50	50	126	150	150
28	150	150	150	289	269	50	50	50	50	126	150	150
29	150	---	150	289	269	50	50	50	50	126	150	150
30	150	---	150	289	269	50	50	50	50	126	150	150
31	150	---	150	---	269	---	50	50	---	126	---	150
Ave	150	150	150	435	408	50	50	50	50	126	150	150
AF	9,223	8,331	9,223	25,871	25,109	2,975	3,074	3,074	2,975	7,736	8,926	9,223
Annual	115,742 AF		160 Ave CFS									

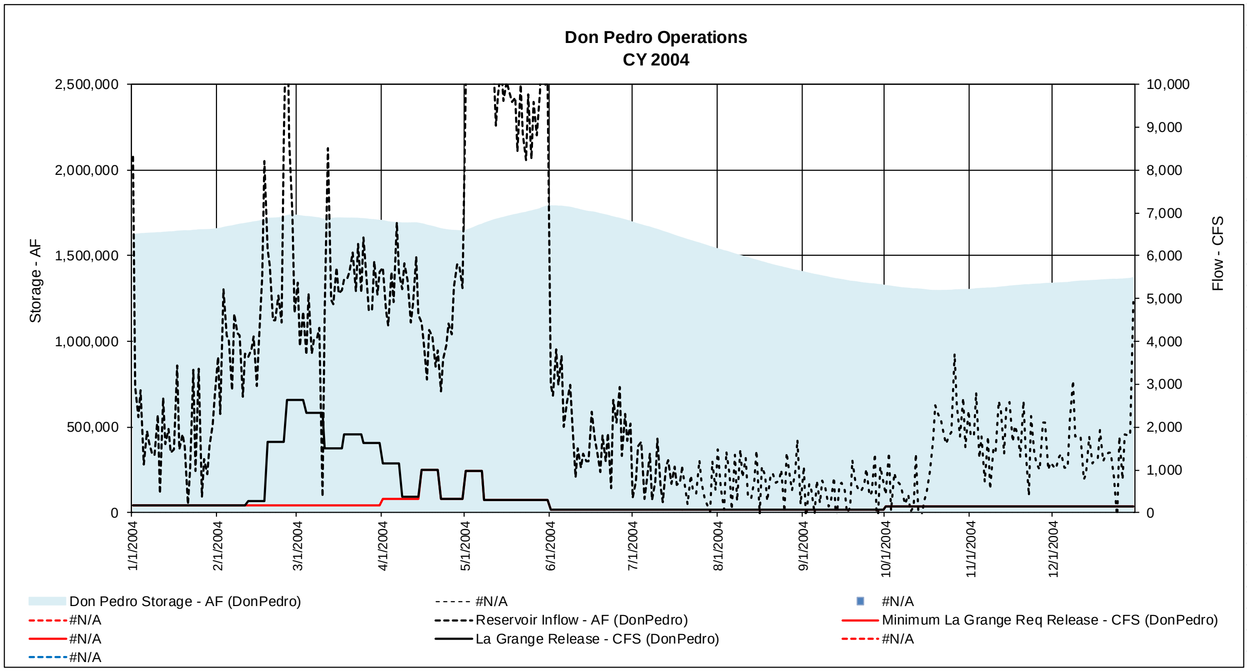
5.9 ModelAnyGroup Worksheet

This worksheet (ModelAnyGroup) provides plotting of up to ten parameters provided in any Model component worksheet (e.g., worksheet DonPedro). One calendar year (the same year or different years) of data for a parameter can be plotted. The parameter(s) to be plotted are identified by reference worksheet name and column. A snapshot of the identification parameters and result values is shown below. This worksheet performs the same function as the DSSAnyGroup worksheet except the source of its data are the Model component worksheets instead of DSS interface worksheets.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**ModelAnyGroup**													
2	This sheet illustrates a CY of daily results from Model worksheets in graphic format.													
3	Axis Reference	1		1		2		2		2		2		1
4	Enter CY Graph Year:	2004		2004		2004		2004		2004		2004		2004
5	Enter Sheet Name:	DonPedro		DonPedro		DonPedro		DonPedro		DonPedro		DonPedro		DonPedro
6	Column:	#N/A		72		6		7		#N/A		70		#N/A
7	Enter Column:			BT		F		G				BR		
8	Data Reference:	#N/A	Date	Don Pedro Storage - AF (DonPedro)	Date	Reservoir Inflow - AF (DonPedro)	Date	La Grange Req Release - CFS	Date	#N/A	Date	La Grange Release - CFS (DonPedro)	Date	#N/A
9	Enter Scaler:	1		1		1		1		1		1		1
10	1-Jan-04	#N/A	1-Jan-04	1,622,829	1-Jan-04	8,300	1-Jan-04	175	1-Jan-04	#N/A	1-Jan-04	175	1-Jan-04	#N/A
11	2-Jan-04	#N/A	2-Jan-04	1,625,102	2-Jan-04	2,934	2-Jan-04	175	2-Jan-04	#N/A	2-Jan-04	175	2-Jan-04	#N/A
12	3-Jan-04	#N/A	3-Jan-04	1,626,670	3-Jan-04	2,229	3-Jan-04	175	3-Jan-04	#N/A	3-Jan-04	175	3-Jan-04	#N/A
13	4-Jan-04	#N/A	4-Jan-04	1,628,860	4-Jan-04	2,850	4-Jan-04	175	4-Jan-04	#N/A	4-Jan-04	175	4-Jan-04	#N/A
14	5-Jan-04	#N/A	5-Jan-04	1,629,314	5-Jan-04	1,115	5-Jan-04	175	5-Jan-04	#N/A	5-Jan-04	175	5-Jan-04	#N/A
15	6-Jan-04	#N/A	6-Jan-04	1,630,546	6-Jan-04	1,892	6-Jan-04	175	6-Jan-04	#N/A	6-Jan-04	175	6-Jan-04	#N/A
16	7-Jan-04	#N/A	7-Jan-04	1,631,507	7-Jan-04	1,621	7-Jan-04	175	7-Jan-04	#N/A	7-Jan-04	175	7-Jan-04	#N/A
17	8-Jan-04	#N/A	8-Jan-04	1,632,196	8-Jan-04	1,349	8-Jan-04	175	8-Jan-04	#N/A	8-Jan-04	175	8-Jan-04	#N/A
18	9-Jan-04	#N/A	9-Jan-04	1,632,895	9-Jan-04	1,359	9-Jan-04	175	9-Jan-04	#N/A	9-Jan-04	175	9-Jan-04	#N/A
19	10-Jan-04	#N/A	10-Jan-04	1,634,514	10-Jan-04	2,279	10-Jan-04	175	10-Jan-04	#N/A	10-Jan-04	175	10-Jan-04	#N/A
20	11-Jan-04	#N/A	11-Jan-04	1,634,300	11-Jan-04	446	11-Jan-04	175	11-Jan-04	#N/A	11-Jan-04	175	11-Jan-04	#N/A
21	12-Jan-04	#N/A	12-Jan-04	1,636,320	12-Jan-04	2,680	12-Jan-04	175	12-Jan-04	#N/A	12-Jan-04	175	12-Jan-04	#N/A
22	13-Jan-04	#N/A	13-Jan-04	1,637,275	13-Jan-04	1,615	13-Jan-04	175	13-Jan-04	#N/A	13-Jan-04	175	13-Jan-04	#N/A
23	14-Jan-04	#N/A	14-Jan-04	1,638,581	14-Jan-04	1,967	14-Jan-04	175	14-Jan-04	#N/A	14-Jan-04	175	14-Jan-04	#N/A
24	15-Jan-04	#N/A	15-Jan-04	1,639,327	15-Jan-04	1,406	15-Jan-04	175	15-Jan-04	#N/A	15-Jan-04	175	15-Jan-04	#N/A
25	16-Jan-04	#N/A	16-Jan-04	1,640,134	16-Jan-04	1,466	16-Jan-04	175	16-Jan-04	#N/A	16-Jan-04	175	16-Jan-04	#N/A

Values are plotted to either the primary y-axis or secondary y-axis. The “axis reference” indicates to which axis the value will be plotted by default. The designation of y-axis assignment is not modified by this field, and the user must edit the series data within the plot to change the y-axis assignment, graph type or line or shape characteristics. The “enter CY graph year” is a user entry. The same year or different year of a parameter or multiple parameters can be plotted. “Sheet name” is a user entry, and identifies from which Model component worksheet the parameter is to be acquired. The “enter column” entry identifies from which column the parameter occurs. Upon proper entry of a parameter a return of the parameter’s label and source worksheet will occur in the “data reference” field. Values for the specified calendar year will also be returned in the data field. If a plotting position is not used, a “#VALUE!” or “#REF!” will be returned. The “scaler” field is provided to allow the conversion or scaling of the data returned from the result worksheet. For instance, if the daily data occurs in the result worksheet in units of daily average flow (cfs) it could be plotted in units of daily volume (acre-feet) by entering the conversion factor of 1.983471. The entry in the field acts as a multiplier to the value occurring in the result worksheet. This field can also be used to scale two different “order of magnitude” parameters to use the same y-axis.

The results of up to ten parameters will be plotted. An example of the several plotted parameters from an active scenario is shown below.



Unused plotting positions will appear with values plotted at “zero” and will have legends of “#VALUE!” or “#REF!”. To create graphs without unused positions a copy of the plot can be made and positioned elsewhere in the worksheet. The unwanted positions can then be deleted from the plot.

5.10 ModelMonthTable Worksheet

This worksheet (ModelMonthTable) provides summation or averaging, and plotting of up to four parameters provided in Model component worksheets (e.g., DonPedro worksheet). The function of this worksheet is to provide a synthesis of the daily result data into monthly results thus reducing the handling and display of over 14,000 values for each parameter (39 years of days) to 468 values (39 years of months). This worksheet and its functionality are identical to the DSSMonthTable worksheet except the source of its data are the Model component worksheets instead of DSS interface worksheets.

The parameter(s) to be plotted or tabled are identified by reference worksheet name and column, very similarly to the method identified for the ModelAnyGroup worksheet. A snapshot of the identification parameters and result values is shown below.

	Index	Date	Day				
5				Conversion Key:			
6				0	1 >> 1	Native	1
7				1	CFS >> AF	AF	1.9834700
8				2	AF >> CFS	CFS	0.5041669
9				3	CFS >> TAF	TAF	0.0019835
10				4	EOM Stor	AF	1
11				5	Ave Day	Native	1
12			Enter Conversion (0-5):	4	1	1	1
13			Enter Sheet Name:	DonPedro	DonPedro	DonPedro	DonPedro
14			Enter Column Letter:	BT	F	BR	G
15			Column No:	72	6	70	7
16			Label:	ro Storage	oir Inflow (	ge Release	ange Req F
17			Native Unit:	AF	AF	CFS	CFS
18			Convert Unit:	AF	AF	AF	AF
19	Index	Date	Day	1	1	1	1
20	1970.10	10/1/1970	T	1,666,767	1,268	787	787
21	1970.10	10/2/1970	F	1,664,567	1,783	787	787
22	1970.10	10/3/1970	S	1,662,719	2,130	787	787
23	1970.10	10/4/1970	S	1,659,892	2,460	787	787
24	1970.10	10/5/1970	M	1,656,745	296	787	787
25	1970.10	10/6/1970	T	1,654,119	1,870	787	787

Each parameter is tabled and plotted separately for the entire 39-year simulation period. “Sheet name” is a user entry, and identifies from which Model component worksheet the parameter is to be acquired. The “enter column letter” entry identifies from which column the parameter occurs. Upon proper entry of a parameter a return of the parameter’s label, source worksheet and the native unit of the parameter will occur. Depending on need, the “conversion” entry is provided. This entry, a keyed value of 0 to 5, directs the worksheet on the handling of the daily data. An entry of 1 will direct the worksheet to sum the daily data into monthly increments in the parameter’s native units (e.g., daily acre-feet into monthly volumes). An entry of 1 will convert the daily data from a native unit of flow (cfs) into monthly volumes of acre-feet. An entry of 2 will convert the daily data from a native unit of volume (acre-feet) into a monthly sum of daily flow in units of cfs. An entry of 3 will act as an entry of 1 except convert the result into monthly volumes with units of 1,000 acre-feet. An entry of 4 will table and plot the daily value associated with the last day of each month in its native unit, and is primarily intended to analyze reservoir storage. An entry of 5 will report the average of daily values within a month. Depending on the entry in the conversion field, the converted unit will be returned to “converted unit” field. Values for the each month of the simulation period will also be returned in the data field. If a plotting position is not used, a “#VALUE!” or “#REF!” will be returned.

A “scaler” field is also provided for each parameter (in the row above the data fields) to allow the conversion or scaling of the data returned from the result worksheet.

The results of up to four parameters will be tabled and plotted. The content formats of reports are identified below. Refer to section 5.5 DSSMonthTable for illustrations of each format.

Standardized Tables

- Data synthesized into monthly volumes for the simulation period.

- Chronological annual values and associated monthly values are also grouped by water type, in descending order of annual runoff.

Standardized Graphs

- Graphs providing a trace of the monthly sequence of data developed for the standardized chronological table.

- Graphs depicting a particular column of data from the water year-based standardized table.

- Graphs for the same information displayed rank-ordered according to descending runoff.

- Standardized graphics are provided for a columnar comparison of the four parameters.

5.11 DonPedro Worksheet

This Model component worksheet (DonPedro) simulates the operation of Don Pedro Reservoir. Several sections of logic provide a systematic operation of the reservoir based on inflow and forecasted hydrology and water demands. As described earlier, the Model will direct releases from the Don Pedro Project under a "hold-unless-need-to-release" protocol, except as conditioned by minimum release requirements, diversions, preferred/maximum storage, and snowmelt management releases. The several sections of logic are illustrate and discussed below.

Don Pedro Release Demands

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1			1		Don Pedro Model																			
2	Unit Title		2		CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF					CFS	AF
3	Parameter Title		3		DP Reserv	DP Reserv	Minimum L	Minimum	MID Full D	MID Full D	TID Full Di	TID Full Di	MID Canal	MID Canal	TID Canal	TID Canal	Total Cana	Total Canals					Total Rese	Total Rese
4																								
5	Acre-foot to CFS conversion				This Scenario													Difference from Base						
6	divide by	1.983471			Check Sums		Sum AF	39-ave		Other	39-ave			39-ave	39-ave				39-yr Ave	39-yr Ave				
7						Inflow	65,915,187	1,690,133		MID Canal	284,177		Inflow	1,690,133	284,177	MID Canal		Inflow	0	0	MID Canal			
8						Evap	1,740,362	44,625		TID Canal	559,697		Evap	44,625	559,697	TID Canal		Evap	0	0	TID Canal			
9						River	31,532,459	808,525					River	808,525				River	0					
10						Canals	32,911,098	843,874		Minimum River	213,897		Canals	843,874	213,897	Minimum River		Canals	0	0	Minimum River			
11						Net	-268,732																	
12						Chng Stor	-268,732																	
13		39-year Ave or Max											1,257	284,177	2,404	559,697		843,874		16,777		41,518		1,057,771
14				Min					Using WSF = 1.000 All Years				41		1									
15					Inflow		La Grange Require		Existing Level Full Diversion Demand				Scenario Canal Diversions						Diversion Shortage from Full Demand				Total DP Demands	
16										300,954		601,215											Total	Total
17	Month				Reservoir	Reservoir	Minimum	Minimum	MID	MID	TID	TID	MID	MID	TID	TID	Total	Total	MID	MID	TID	TID	Res Rel	Res Rel
18	Index	Date	Day	Days	Inflow	Inflow	Req	Req	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canals	Canals	Canal	Canal	Canal	Canal	Demands	Demands
19					CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF
20	1970.10	10/1/1970	T	31	322	639	397	787	531	1,053	1,406	2,789	531	1,053	1,406	2,789	1,937	3,842	0	0	0	0	2,334	4,629
21	1970.10	10/2/1970	F	31	453	899	397	787	434	860	661	1,311	434	860	661	1,311	1,094	2,171	0	0	0	0	1,491	2,958
22	1970.10	10/3/1970	S	31	541	1,074	397	787	424	840	582	1,154	424	840	582	1,154	1,006	1,994	0	0	0	0	1,402	2,781
23	1970.10	10/4/1970	S	31	625	1,240	397	787	463	918	1,119	2,220	463	918	1,119	2,220	1,582	3,139	0	0	0	0	1,979	3,926
24	1970.10	10/5/1970	M	31	75	149	397	787	461	915	733	1,453	461	915	733	1,453	1,194	2,368	0	0	0	0	1,591	3,155
25	1970.10	10/6/1970	T	31	475	943	397	787	491	973	841	1,668	491	973	841	1,668	1,332	2,641	0	0	0	0	1,728	3,428

This section of logic assembles the underlying water demands placed for Don Pedro Reservoir releases. Reservoir inflow is derived from other Model component worksheets and is the sum of unregulated inflow to Don Pedro Reservoir (Hydrology worksheet) and regulated releases from the CCSF System (SFHetchHetchy worksheet, SFLLoyd worksheet and SFEleanor worksheet). The minimum flow requirement for the Tuolumne River is provided by worksheet LaGrangeSchedule as directed by worksheet UserInput. The "Existing Level Full Diversion Demand" is a projection of canal diversion requirements if no water supply shortages occurred and full demands are provided. "Scenario Canal Diversion Demand" is the canal diversions of MID and TID for the active scenario. These diversions are determined by either pre-processed computations of diversions (e.g, fixed Test Case diversions), user specified diversions, or dynamic computations. "Total DP Demands" are the summation of minimum release requirements for the river and canal diversions. Other information is developed in this section concerning the difference between scenario diversions and full diversion demand, and an overall summary of water disposition for the entire simulation period.

Reservoir Evaporation / Initial Storage Computation and Encroachment Release

This section performs an initial check of reservoir storage assuming the previously described minimum releases for the river and canals. A daily mass balance is performed: *change in reservoir storage = inflow, minus outflow (releases), minus reservoir losses*. The prior day's reservoir evaporation is included in the calculation. If the computation produces resulting Don Pedro Reservoir storage in excess (encroachment) of the preferred storage target, the encroachment is computed. Every 7th day the model checks for an encroachment, and if it exists a check release is computed. It is assumed that a constant supplemental release (in excess of minimum releases) will be initiated at a rate equal to the encroachment divided equally over the next 10 days. This protocol repeats itself every 7th day,

reestablishing the level of check release each time. The end result of this procedure will allow encroachment of storage space above the preferred storage target and not require unrealistic hard releases of water to exactly conform to the target.

	A	B	C	D	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1			1											
2	Unit Title		2					AF						
3	Parameter Title		3		rvoir Release Demands			COE Rainfl Final Target Storage - AF						
4														
5	Acre-foot to CFS conversion													
6	divide by:	1.983471												
7–12														
13		39-year Ave or Max												
14				Min										
15						Evap/loss	Initial Storage Computation and Encroachment Release							
16–19	Month Index	Date	Day	Days		Net Res Evap/Loss AF	Initial DP Storage 1,670,900	COE Rainflood Target AF	Target Stroage AF	Initial Encroach AF	Encroach 7th Day AF	Spread Encroach 10 days AF	Spread 7th Day 10 days CFS	7-day Count
20	1970.10	10/1/1970	T	31		143	1,666,767	1,760,900	1,690,000	0	0	0	0	1
21	1970.10	10/2/1970	F	31		141	1,664,567	1,749,200	1,690,000	0	0	0	0	0
22	1970.10	10/3/1970	S	31		141	1,662,719	1,737,500	1,690,000	0	0	0	0	0
23	1970.10	10/4/1970	S	31		141	1,659,892	1,725,800	1,690,000	0	0	0	0	0
24	1970.10	10/5/1970	M	31		141	1,656,745	1,714,100	1,690,000	0	0	0	0	0
25	1970.10	10/6/1970	T	31		141	1,654,119	1,702,400	1,690,000	0	0	0	0	0

Snow-melt Management

	A	B	C	D
1			1	
2	Unit Title		2	
3	Parameter Title		3	
5	Acre-foot to CFS conversion			
6	divide by:	1.983471		
13		39-year Ave or Max		
14				Min
17–19	Month Index	Date	Day	Days
20	1970.10	10/1/1970	T	31
21	1970.10	10/2/1970	F	31
22	1970.10	10/3/1970	S	31
23	1970.10	10/4/1970	S	31
24	1970.10	10/5/1970	M	31
25	1970.10	10/6/1970	T	31

	AK	AL	AM	AN	AO	AP	AQ
6–10	Lookup of 1-Apr 90% Exc Apr-Jul Runoff	Est of Apr-Jun Portion of Apr-Jul	Uses Current Yr Canal + Min River +Typ Evap	Compute Upstream Adjust to UF	Compute Availble DP Stor through June	Compute Total Excess Apr-Jun Release	Amount to be Released during April
12	23 % Apr/Apr AJ						
13	35 % May/Apr AJ						(C 1.10)
14	29 % Jun/Apr AJ		% of Apr-Jun excess rel in April				30
15	April Snow-melt Release Routine						
16	April						
17–19	1-Apr A-Jul Fcst AF	1-Apr A-Jun Fcst AF	A-Jun Can+Riv+E AF	A-Jun USAdj AF	A-Jun DP Avail AF	A-Jun Excess AF	April SM Rel CFS
20	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0

	AS	AT	AU	AV	AW	AX	AY
6–10	Lookup of 1-May 90% Exc Apr-Jul Runoff	Est of May-Jun Portion of Apr-Jul	Uses Current Yr Canal + Min River +Typ Evap	Compute Upstream Adjust to UF	Compute Availble DP Stor through June	Compute Total Excess May-Jun Release	Amount to be Released during May
13	49 % May/May MJ						(C 1.20)
14	38 % Jun/May MJ		% of May-Jun excess rel in May				50
15	May Snow-melt Release Routine						
16	May						
17–19	1-May A-Jul Fcst AF	1-May MJune Fcst AF	M-Jun Can+Riv+E AF	M-Jun USAdj AF	M-Jun DP Avail AF	M-Jun Excess AF	May SM Rel CFS
20	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0

	BA	BB	BC	BD	BE	BF	BG	BI
2								CFS
3								Target SM
6–10	Lookup of Actual June Runoff	Est of June Portion of June	Uses Current Yr Canal + Min River +Typ Evap	Compute Upstream Adjust to UF	Compute Availble DP Stor through June	Compute Total Excess Jun Release	Amount to be Released during June	
13							(C 1.30)	
14					% of June excess rel in June		100	
15	June Snow-melt Release Routine							
16	June							Target
17–19	1-Jun June UF AF	1-Jun June Fcst AF	June Can+Riv+E AF	June USAdj AF	June DP Avail AF	June Excess AF	June SM Rel CFS	SM Release CFS
20	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0

A second check release is made during the April through June period for management of anticipated snowmelt runoff. On the first day of each of these months a forecast is made of anticipated runoff into the reservoir and minimum releases and losses from the reservoir from the date of forecast through the end of June (the assumed target date of reservoir filling). These forecasts determine the volume of water (if any) that will require release in excess of minimum releases and losses and storage gain by the end of June. For April and May, the DWR 90 percent exceedence forecast is used for anticipated runoff, along with known minimum releases and losses, and upstream impairment. The user defines the percentage of volume (of the total volume) to be additionally released during each month. For April, 30 percent of the 3-month volume is advised for release, and during May 50 percent of the 2-month volume is advised for released. For June, the historically reported UF flow is assumed for the runoff computation. This assumes pre-knowledge of the runoff volume for the month, and 100 percent of the excess is spread across the month. The snowmelt check release is evenly distributed across the days of the month. The release made in a day is the greater of the two check releases or the minimum release. At no time is the maximum capacity of the reservoir (2,030,000 acre-feet) allowed to be exceeded, and if necessary a release, regardless of magnitude, will be made by the model to not exceed maximum storage capacity.

Modesto Flood Control Objective, Don Pedro Reservoir, and Tuolumne River Release

	A	B	C	D	BK	BL	BM	BN	BO	BQ	BR	BS	BT	BU	BV	BW	BX	BY
1			1															
2	Unit Title		2		CFS	CFS	CFS	CFS	CFS	AF	CFS	AF			Acres			AF
3	Parameter Title		3		Re Dry Creek	LTR Accr	Tot Unreg	Trg Max LC	Modesto Flo	La Grange	La Grange Release	Don Pedro Storage			DP Surface Area			DP Total E
4																		
5	Acre-foot to CFS conversion																	
6	divide by :	1.983471																
7																		
8																		
9																		
10																		
11																		
12																		
13		39-year Ave or Max						(C 1.00)		808,525			508,489	Min 1976-77				44,626
14				Min		Enter Modesto FC Target:		9,000	CFS				785,605	Min 1987-92				
15					Modesto Flood Control Flow Objective					Final La Grange River		Don Pedro Reservoir						
16					Report	Est	Total	Target	Calc	Final	Final	DP		Encroach	Net Don Pedro Loss Calculation			
17	Month				Dry Creek	LTR Acc	Unreg	Max	Modesto	La Grange	La Grange	Storage	DP	above	Area	Factor	CFS	AF
18	Index	Date	Day	Days	Flow	Flow	Blw LG	LaGrange	Flow	Release	Release	Change	Storage	2,030,000				
19					CFS	CFS	CFS	CFS	CFS	AF	CFS	AF	1,670,900		11,156			
20	1970.10	10/1/1970	T	31	30	99	129	8,871	526	787	397	-4,133	1,666,767	0	11,139	0.006395	71.2	141.3
21	1970.10	10/2/1970	F	31	30	99	129	8,871	526	787	397	-2,200	1,664,567	0	11,127	0.006395	71.2	141.1
22	1970.10	10/3/1970	S	31	30	99	129	8,871	526	787	397	-1,849	1,662,719	0	11,116	0.006395	71.1	141.0
23	1970.10	10/4/1970	S	31	30	100	130	8,870	526	787	397	-2,826	1,659,892	0	11,099	0.006395	71.0	140.8
24	1970.10	10/5/1970	M	31	30	100	130	8,870	527	787	397	-3,147	1,656,745	0	11,082	0.006395	70.9	140.6
25	1970.10	10/6/1970	T	31	30	100	130	8,870	527	787	397	-2,626	1,654,119	0	11,071	0.006395	70.8	140.4

A Modesto flood control objective is incorporated into the release logic. The objective is to maintain a flow at Modesto no greater than a user-specified flow rate (assumed as 9,000 cfs). The logic checks against an allowable river release that would not exceed the flood control objective after considering the lower Tuolumne River accretions and Dry Creek flow. Logic is applied to the previous check releases in comparison to the allowable release. The La Grange release is then reduced if necessary to not exceed the Modesto flow target objective, even if it results in an encroachment in Don Pedro Reservoir. The exception is when the reservoir reaches full (2,030,000 AF). Any computed encroachment above a full reservoir is passed and the Modesto flow objective will be exceeded.

The several advised releases, storage conditions and water demands all culminate in determining the "Final La Grange River" release. The "Don Pedro Reservoir" section of logic reports the final reservoir storage of a day and the computation of Don Pedro Reservoir losses. Reservoir losses are computed in accordance with procedures of the Fourth Agreement.

Don Pedro Project Generation, and River Flows

	A	B	C	D	CA	CB	CC	CD	CE	CF	CG	CH	CJ	CK	CL	CM	CN	CO	CP
1			1																
2	Unit Title		2				MW	kWh/AF	AF	AF	AF	MWh	CFS				CFS	CFS	
3	Parameter Title		3		vaporation		DP PH Cap	DP PH Eff	Total DP R	DP Power	DP Spill /	Don Pedro Er	La Grange Release				TR abv Mc	TR blw Dry Creek	
4																			
5	Acre-foot to CFS conversion																		
6	divide by	1.983471																	
7																			
8																			
9																			
10																			
11										(C 1.22)									
12						39-yr Ave	191	392	1,652,399	1,488,570	163,829	607,705							
13		39-year Ave or Max				Max	198	440	154,471	10,711	143,760	4,710							
14				Min		Min	127	258	410	410	0	106							
15					Don Pedro Power Operations								River Flows						
16					Per Ave	Per Min	(C 1.20)		Total	Thru		Don					LTR abv	LTR blw	
17	Month				DPStor	DPStor	308,960		DP	PH (cfs)	Spill/	Pedro	La Grange	Waterford	Hickman	Santa Fe	Modesto	Modesto	Mouth
18	Index	Date	Day	Days	(for Eff)	(for Cap)	Capability	Efficiency	Release	5,400	Bypass	Energy	RM 51.8	RM 42.0	RM 31.0	RM 21.6	RM 16.2	RM	RM 0.0
19					AF	AF	MW	kWh/AF	AF	AF	AF	MWh	CFS	CFS	CFS	CFS	CFS	CFS	CFS
20	1970.10	10/1/1970	T	31	1,668,834	1,666,767	195	408	4,629	4,629	0	1,888	397				496	526	
21	1970.10	10/2/1970	F	31	1,665,667	1,664,567	195	408	2,958	2,958	0	1,205	397				496	526	
22	1970.10	10/3/1970	S	31	1,663,643	1,662,719	195	407	2,781	2,781	0	1,133	397				496	526	
23	1970.10	10/4/1970	S	31	1,661,305	1,659,892	195	407	3,926	3,926	0	1,598	397				496	526	
24	1970.10	10/5/1970	M	31	1,658,319	1,656,745	195	407	3,155	3,155	0	1,284	397				497	527	
25	1970.10	10/6/1970	T	31	1,655,432	1,654,119	195	407	3,428	3,428	0	1,394	397				497	527	

Based on the hydrologic operation of Don Pedro Reservoir in the Model, power characteristics of the scenario are computed. Equations of Don Pedro powerhouse generation characteristics define capacity (MW) and efficiency (kWh/AF), based on reservoir storage. Capacity potential uses minimum storage of

the day, while efficiency uses average storage of the day. The maximum water through plant is assumed to be 5,400 cfs. Water that does not appear as passing through the generators is computed to be “spilled-bypassed”. The power generation is “cutoff” at reservoir storage of 308,960 acre-feet, the top of the dead pool.

Flow in the river below La Grange diversion dam is computed and reported. The flow is a determined value by the Model. The same hydrologic information used within the Modesto flow objective logic is added to La Grange releases to estimate flow at downstream points in the river. Currently an estimate of total Tuolumne River accretion between La Grange Bridge and the confluence of Dry Creek is added to La Grange releases to provide an estimate of flow above the Dry Creek confluence. The estimated flow of Dry Creek is added to that estimate to provide an estimate of flow below the Dry Creek confluence at “Modesto”. Additional flow points can be added as information becomes available.

<u>Don Pedro Inflow Components</u>

	A	B	C	D	CT	CU	CV	CW	CX	CY	CZ	DA	DB	DC	DD
1			1												
2	*Unit Title*		2			AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS
3	*Parameter Title*		3			DP Inflow	DP Inflow	DP Inflow	DP Inflow	DP Inflow	DP Inflow	Unreg Infl	Unreg Infl	DP Inflow	DP Inflow
4															
5	*Acre-foot to CFS conversion*														
6	*divide by :*	*1.983471*				*Read*		*Read*		*Read*			*Read*		*Read by*
7						*from*		*from*		*from*			*from*		*Model*
8						*SFHetchHetchy*		*SFLloyd*		*SFEleanor*			*Hydrology*		
9						*incl*									
10						*Return of*									
11						*Moc Hatch*									
12															
13		*39-year Ave or Max*				*39-year average*									
14				*Min*		*525,724*		*378,296*		*102,781*		*683,332*		*1,690,133*	
15						Inflow to Don Pedro Reservoir									
16						Inflow	Inflow	Inflow	Inflow	Inflow	Inflow				
17	Month					from	from	from	from	from	from	Unreg	Unreg	DP	DP
18	Index	Date	Day	Days		HH	HH	Lloyd	Lloyd	Eleanor	Eleanor	Inflow	Inflow	Inflow	Inflow
19						AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS
20	1970.10	10/1/1970	T	31		179	90	443	223	20	10	-2	-1	639	322
21	1970.10	10/2/1970	F	31		179	90	443	223	20	10	258	130	899	453
22	1970.10	10/3/1970	S	31		179	90	443	223	20	10	433	218	1,074	541
23	1970.10	10/4/1970	S	31		179	90	443	223	20	10	599	302	1,240	625
24	1970.10	10/5/1970	M	31		179	90	443	223	20	10	-492	-248	149	75
25	1970.10	10/6/1970	T	31		179	90	443	223	20	10	302	152	943	475

This section of logic assembles the Don Pedro Reservoir inflow components from other Model component worksheets.

5.12 SFHetchHetchy Worksheet

This Model component worksheet (SFHetchHetchy) simulates the operation of Hetch Hetchy Reservoir. Several sections of logic provide a systematic operation of the reservoir based on inflow and forecasted hydrology and water demands. As described earlier, the Model will direct releases from Hetch Hetchy Reservoir under a "hold-unless-need-to-release" protocol, except as conditioned by minimum release requirements, diversions, preferred/maximum storage, and snowmelt management releases. The several sections of logic are illustrate and discussed below.

Hetch Hetchy Release Demands / Reservoir Evaporation / Initial Storage Computation and Encroachment Release

This section of logic assembles the underlying water demands placed for Hetchy Hetchy Reservoir releases. Reservoir inflow is derived from worksheet Hydrology and is the unimpaired flow entering the reservoir. The initial releases are comprised of the minimum flow requirement below Hetch Hetchy Reservoir (from the worksheet CCSF) and represent requirements prior to consideration of Canyon Tunnel flows, Mountain Tunnel flows that consist of diversions for the SJPL (from the worksheet CCSF), Moccasin Fish Hatchery releases and diversions by Groveland CSD from Mountain Tunnel.

This section also performs an initial check of reservoir storage assuming the previously described minimum releases for the river and Mountain Tunnel. A daily mass balance is performed: *change in reservoir storage = inflow, minus outflow (releases), minus reservoir losses*. The prior day's reservoir evaporation is included in the calculation. If the computation produces resulting Hetch Hetchy Reservoir storage in excess (encroachment) of the preferred storage target, the encroachment is computed. Every 7th day the model checks for an encroachment, and if it exists a check release is computed. For the preferred reservoir storage target encroachment it is assumed that a constant supplemental release (in excess of minimum releases) will be initiated at a rate equal to the encroachment divided equally over the next 7 days. This protocol repeats itself every 7th day, reestablishing the level of check release each time. The end result of this procedure will allow encroachment of storage space above the preferred storage target and not require unrealistic hard releases of water to exactly conform to the target.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1			1		Hetch Hetchy Reservoir Model																	
2	Unit Title		2		CFS	AF		CFS	AF	CFS	AF	CFS	AF	AF								
3	Parameter Title		3		Hetch Het	Hetch Het		SJPL + Mo	SJPL + Mo	SJPL	SJPL	HH Req St	HH Req St	HH Net Evap								
4																						
5	Acre-foot to CFS conversion				This scenario								Base				Difference from Base					
6	divide by :	1.983471			Check Sums		Sum AF	39-ave		Other Sums		Sum AF		39-ave		Sum AF		39-ave		Sum AF		
7						Inflow	29,761,289	763,110			Supplmtl	0	Inflow	763,110	Supplmtl	0	Inflow	0	Supplmtl	0		
8						Evap	149,655	3,837					Evap	3,837			Evap	0				
9						SJPL+	9,922,420	254,421					SJPL+	254,421			SJPL+	0				
10						Non-SJPL	19,655,587	503,989					Non-SJPL	503,989			Non-SJPL	0				
11						Net	33,627															
12						Chng Stor	33,627															
13		39-year Ave				763,110			254,421		231,238			3,837								
14								32	Moc Hatch + Groveland (CFS)													
15					Inflow			Initial Releases						Evap/loss	Initial Storage Computation and Encroachment Release							
16					HH	HH		SJPL	SJPL			w/o 64	w/o 64		Initial	Target	Hard			Spread	Spread	
17	Month				Reservoir	Reservoir		+ Moc Hat	+ Moc Hat			Req	Req	Net Res	HH	HH	Limit	Initial	Encroach	Encroach	7th Day	
18	Index	Date	Day	Days	Inflow	Inflow		Grove	Grove	SJPL	SJPL	Blw HH	Blw HH	Evap/Loss	Storage	Storage	Storage	Encroach	7th Day	over 7	Enc over 7	7-day
19					CFS	AF		CFS	AF	CFS	AF	CFS	AF	AF	250,000	360,360	AF	AF	AF	AF	CFS	Count
20	1970.10	10/1/1970	T	31	79	157		341	677	309	614	60	119	11	249,349	359,381	360,360	0	0	0	0	1
21	1970.10	10/2/1970	F	31	-82	-163		341	677	309	614	60	119	11	248,379	358,401	360,360	0	0	0	0	0
22	1970.10	10/3/1970	S	31	25	50		341	677	309	614	60	119	11	247,622	357,422	360,360	0	0	0	0	0
23	1970.10	10/4/1970	S	31	110	218		341	677	309	614	60	119	11	247,032	356,443	360,360	0	0	0	0	0
24	1970.10	10/5/1970	M	31	-38	-75		341	677	309	614	60	119	11	246,150	355,463	360,360	0	0	0	0	0
25	1970.10	10/6/1970	T	31	9	18		341	677	309	614	60	119	11	245,360	354,484	360,360	0	0	0	0	0

<u>Supplemental Releases and Final Reservoir and Release Computation</u>

	A	B	C	D	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
1			1												
2	Unit Title		2			AF	CFS	AF	AF						CFS
3	Parameter Title		3			HH Supple	HH Releas	HH Releas	HH Storag						Total HH R
4															
5	Acre-foot to CFS conversion														
6	divide by:	1.983471													
7															
8															
9															
10															
11															
12															
13			39-year Ave					503,989							
14															
15					Final Release and Storage										
16							HH	HH		HH	Hetch Hetchy Reservoir Loss Calculation				HH
17	Month				Supplmtl	Supplmtl	Release	Release	HH	Storage	Area	Factor	CFS	AF	Total
18	Index	Date	Day	Days	Release	Release	abv Mnt	abv Mnt	Storage	Change					Release
19					CFS	AF	CFS	AF	250,000	AF					CFS
20	1970.10	10/1/1970	T	31	0	0	60	119	249,349	-651	1,722	0.003253	5.6	11.1	401
21	1970.10	10/2/1970	F	31	0	0	60	119	248,379	-970	1,721	0.003253	5.6	11.1	401
22	1970.10	10/3/1970	S	31	0	0	60	119	247,622	-758	1,718	0.003253	5.6	11.1	401
23	1970.10	10/4/1970	S	31	0	0	60	119	247,032	-589	1,716	0.003253	5.6	11.1	401
24	1970.10	10/5/1970	M	31	0	0	60	119	246,150	-883	1,714	0.003253	5.6	11.1	401
25	1970.10	10/6/1970	T	31	0	0	60	119	245,360	-789	1,711	0.003253	5.6	11.0	401

This section of logic performs the final computation of reservoir storage and releases. Incorporated into the logic is inclusion of user specified supplemental releases (from WaterBankRel or SFWaterBank worksheets) and snowmelt management releases (described later). Reservoir losses are computed in accordance with procedures of the Fourth Agreement.

<u>Snow-melt Management</u>

A second check release is made during the February through June period for management of anticipated snowmelt runoff. On the first day of each of these months a forecast is made of anticipated runoff into the reservoir and minimum releases and losses from the reservoir, from the date of forecast through the end of June (assumed target of reservoir filling). These forecasts determine the volume of water (if any) that will require release in excess of minimum releases and losses and storage gain by the end of June.

	A	B	C	D	AI	AJ	AK	AL	AM	AN	AO	AP	AQ
1			1										
2	Unit Title		2										
3	Parameter Title		3										
4													
5	Acre-foot to CFS conversion												
6	divide by:	1.983471											
7													
8													
9													
10													
11													
12										June Storage Target (AF):	360,360	Max Rel	
13			39-year Ave							Minimum HH Storage for SM Drawdown (AF):	100,000	Tgt (CFS)	
14										% Feb Release of Feb-June Excess:	10	1,200	
15					February Snow-melt Release Routine								
16					February								
17	Month				1-Feb	1-Feb	FJune		FJune	FJune	Feb	Max Stor	
18	Index	Date	Day	Days	AJ Fcst	FJune Fcst	SJPL+MRiv		HH Avail	Excess	SM Rel	Draw	
19					AF	AF	AF		AF	AF	CFS	CFS	
20	1970.10	10/1/1970	T	31	0	0	0		0	0	0	0	
21	1970.10	10/2/1970	F	31	0	0	0		0	0	0	0	
22	1970.10	10/3/1970	S	31	0	0	0		0	0	0	0	
23	1970.10	10/4/1970	S	31	0	0	0		0	0	0	0	
24	1970.10	10/5/1970	M	31	0	0	0		0	0	0	0	
25	1970.10	10/6/1970	T	31	0	0	0		0	0	0	0	

	AR	AS	AT	AU	AV	AW	AX	AY	AZ
12								Max Rel	
13								Tgt (CFS)	
14						% Mar Release of Mar-June Excess:	10	1,150	
15	March Snow-melt Release Routine								
16	March								
17	1-Mar	1-Mar	MJune		MJune	MJune	March	Max Stor	
18	AJ Fcst	MJune Fcst	SJPL+MRiv		HH Avail	Excess	SM Rel	Draw	
19	AF	AF	AF		AF	AF	CFS	CFS	
20	0	0	0		0	0	0	0	
21	0	0	0		0	0	0	0	
22	0	0	0		0	0	0	0	
23	0	0	0		0	0	0	0	
24	0	0	0		0	0	0	0	
25	0	0	0		0	0	0	0	

	BA	BB	BC	BD	BE	BF	BG	BH
12								Max Rel
13								Tgt (CFS)
14						% Apr Release of Apr-June Excess:	10	1,200
15	April Snow-melt Release Routine							
16	April							
17	1-Apr	1-Apr	AJune		AJune	AJune	April	Max Stor
18	AJ Fcst	AJune Fcst	SJPL+MRiv		HH Avail	Excess	SM Rel	Draw
19	AF	AF	AF		AF	AF	CFS	CFS
20	0	0	0		0	0	0	0
21	0	0	0		0	0	0	0
22	0	0	0		0	0	0	0
23	0	0	0		0	0	0	0
24	0	0	0		0	0	0	0
25	0	0	0		0	0	0	0

Unit Title 2
Parameter Title 3

Acre-foot to CFS conversion
divide by 1.983471

19-year Ave

CFS HH Target | AF HH Target

% May Release of May-June Excess: 100 | Max Rel Tgt (CFS) 100,000

% Jun Release of June Excess: 100 | Max Rel Tgt (CFS) 100,000

Max Rel Tgt (CFS) 100,000 | Max

				May Snow-melt Release Routine (May)							June Snow-melt Release Routine (June)								
Month Index	Date	Day	Days	1-May AJ Fcst AF	1-May MJune Fcs AF	MJune SJPL+MRiv AF	MJune HH Avail AF	MJune Excess AF	May SM Rel CFS	Max Stor Draw CFS	1-Jun June UF AF	1-Jun June Fcst AF	June SJPL+MRiv AF	June HH Avail AF	June Excess AF	June SM Rel CFS	Max Stor Draw CFS	Target SM Release CFS	Target SM Release AF
1970.10	10/1/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/2/1970	F	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/3/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/4/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/5/1970	M	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/6/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Pre-knowledge is used for anticipated runoff, minimum releases and losses. The user defines the percentage of volume (of the total volume for the period) to be additionally released during each month. For February through April, 10 percent of the additional release volume is advised for release, and may be additionally capped. This approach tends to hold Hetch Hetchy Reservoir releases for later release during May. The snowmelt check release is evenly distributed across the days of the month and can be capped in terms of rate (cfs) or minimum volume of the reservoir to which it can be drawn during the month. The particular release made in a day is the greater of the two check releases or the minimum release. At no time is the maximum capacity of the reservoir allowed to be exceeded, and if necessary a release, regardless of magnitude, will be made by the model to not exceed maximum storage capacity.

5.13 SFLloyd Worksheet

This Model component worksheet (SFLloyd) simulates the operation of Lake Lloyd. Several sections of logic provide a systematic operation of the reservoir based on inflow and forecasted hydrology and water demands. The Model will direct releases from Lake Lloyd under a "hold-unless-need-to-release" protocol, except as conditioned by minimum release requirements, diversions, preferred/maximum storage, snowmelt management releases and target releases for Holm Powerhouse. The several sections of logic are illustrate and discussed below.

Lake Lloyd Release Demands, Initial Storage Computation and Encroachment Release

This section of logic assembles the underlying water demands placed for Lake Lloyd releases. Reservoir inflow is derived from the Hydrology worksheet and is the unimpaired flow entering the reservoir. The initial releases are comprised of the minimum flow requirement below Lake Lloyd (from worksheet CCSF) and target releases for Holm Powerhouse (from worksheet CCSF).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1			1		Lake Lloyd Model																
2	Unit Title		2		CFS	AF	CFS	AF		AF	CFS	AF		AF		AF	AF				
3	Parameter Title		3		Lake Lloyc	Lake Lloyc	Min Holm Ti	Min Holm		Suppleme	Lloyd Req	Lloyd Req		Lloyd Net Evap		Lloyd Targe	Lloyd Limi				
4																					
5	Acre-foot to CFS conversion				This scenario								Base				Difference from Base				
6	divide by :	1.983471			Check Sums		Sum AF	39-ave		Other Sums		Sum AF		39-ave		Sum AF		39-ave		Sum AF	
7						Inflow	11,743,646	301,119			Supplmtl	171,708	Inflow	301,119	Supplmtl	171,708	Inflow	0	Supplmtl	0	
8						Tun Inflow	3,196,266	81,956					Tun Inflow	81,956			Tun Inflow	0			
9						Evap	136,660	3,504					Evap	3,504			Evap	0			
10						Stream	1,298,823	33,303					Stream	33,303			Stream	0			
11						Holm	13,454,734	344,993					Holm	344,993			Holm	0			
12						Net	49,694														
13						Chng Stor	49,694														
14				39-year Ave		301,119		38,628		4,403		5,538		3,504							
15					Inflow		Initial Release			Suppl	Initial Release			Evap/loss	Initial Storage and Encroachment Release						
16					Lake	Lake	Min	Min		171,708	Stream	Stream			Initial	Lloyd				Spread	Spread
17	Month				Lloyd	Lloyd	Holm	Holm		Supplmtl	Req	Req		Net Res	Lloyd	Target	Limit	Initial	Encroach	Encroach	7th Day
18	Index	Date	Day	Days	Inflow	Inflow	Target	Target		Release	Blw Lloyd	Blw Lloyd		Evap/Loss	Storage	Storage	Storage	Encroach	7th Day	over 7	Enc over 7'
19					CFS	AF	CFS	AF		AF	CFS	AF		AF	200,000	200,000	AF	AF	AF	AF	CFS
20	1970.10	10/1/1970	T	31	56	111	0	0		0	5	10		10	200,091	248,000	273,300	0	0	0	0
21	1970.10	10/2/1970	F	31	5	10	0	0		0	5	10		10	200,080	248,000	273,300	0	0	0	0
22	1970.10	10/3/1970	S	31	15	30	0	0		0	5	10		10	200,090	248,000	273,300	0	0	0	0
23	1970.10	10/4/1970	S	31	-399	-791	0	0		0	5	10		10	199,278	248,000	273,300	0	0	0	0
24	1970.10	10/5/1970	M	31	322	638	0	0		0	5	10		10	199,896	248,000	273,300	0	0	0	0
25	1970.10	10/6/1970	T	31	-48	-94	0	0		0	5	10		10	199,781	248,000	273,300	0	0	0	0

This section also performs an initial check of reservoir storage assuming the previously described minimum releases for the river and Holm Powerhouse. A daily mass balance is performed: *change in reservoir storage = inflow, minus outflow (releases), minus reservoir losses*. The prior day's reservoir evaporation is included in the calculation. If the computation produces resulting Lake Lloyd storage in excess (encroachment) of the preferred storage target, the encroachment is computed. Every 7th day the model checks for an encroachment, and if it exists a check release is computed. It is assumed that a constant supplemental release (in excess of minimum releases) will be initiated at a rate equal to the encroachment divided equally over the next 7 days. This protocol repeats itself every 7th day, reestablishing the level of check release each time. The end result of this procedure will allow encroachment of storage space above the preferred storage target and not require unrealistic hard releases of water to exactly conform to the target. User specified supplemental releases are reported in this section but are not incorporated into the worksheet's logic until later.

Supplemental Releases, Lake Eleanor Transfers and Final Reservoir and Release Computation

	A	B	C	D	W	X	Y	Z	AA	AB	AC	AD
1			1									
2	Unit Title		2								CFS	
3	Parameter Title		3								Lloyd-only Holm	
5	Acre-foot to CFS conversion											
6	divide by:	1.983471										
12					Holm	(C 2.41)						
13					950	CFS Max						
14			39-year Ave									
15					Prior to Eleanor							
16–19	Month Index	Date	Day	Days	Holm Capacity for Elnr CFS	Holm Capacity for Elnr AF	Llyd-only Rel w/o Suppl Rel CFS	Llyd-only Rel w/o Suppl Rel AF	Revised Routed Holm CFS	Revised Routed Holm AF	Holm Prior to Tun Infl CFS	Holm Prior to Tun Infl AF
20	1970.10	10/1/1970	T	31	950	1,884	5	10	0	0	0	0
21	1970.10	10/2/1970	F	31	950	1,884	5	10	0	0	0	0
22	1970.10	10/3/1970	S	31	950	1,884	5	10	0	0	0	0
23	1970.10	10/4/1970	S	31	950	1,884	5	10	0	0	0	0
24	1970.10	10/5/1970	M	31	950	1,884	5	10	0	0	0	0
25	1970.10	10/6/1970	T	31	950	1,884	5	10	0	0	0	0

	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR
2	CFS	AF	CFS	AF	CFS	AF	CFS	AF	AF					
3	Final Stre	Final Stre	Tunnel Inf	Tunnel Inf	Final Holn	Final Holn	Total Lloy	Total Lloy	Lake Lloyc					
15	Final Routing								Final Storage					
16											Lake Lloyd Loss Calculation			
17–19	Stream w/ Suppl Release CFS	Stream w/ Suppl Release AF	Eleanor to Holm CFS	Eleanor to Holm AF	Final Holm Total CFS	Final Holm Total AF	Lloyd Total Release CFS	Lloyd Total Release AF	Lake Lloyd Storage 200,000	Lloyd Storage Change AF	Area	Factor	CFS	AF
20	5	10	218	433	218	433	223	443	200,091	91	1,607	0.003253	5.2	10.4
21	5	10	218	433	218	433	223	443	200,080	-11	1,607	0.003253	5.2	10.4
22	5	10	218	433	218	433	223	443	200,090	10	1,607	0.003253	5.2	10.4
23	5	10	218	433	218	433	223	443	199,278	-811	1,607	0.003253	5.2	10.4
24	5	10	218	433	218	433	223	443	199,896	617	1,605	0.003253	5.2	10.4
25	5	10	218	433	218	433	223	443	199,781	-115	1,607	0.003253	5.2	10.4

This section of logic performs the final computation of reservoir storage and releases, including consideration of snowmelt management releases (described later) and transfers from Lake Eleanor. Both the initial check release for preferred storage encroachment and the snowmelt check release are computed and advised for reservoir operations. If supplemental releases above minimum releases are computed the Model routes the additional release through Holm Powerhouse up to its available capacity. The remainder of the supplemental release is routed to the stream below Lake Lloyd. A comparison is made between "Lloyd-only" use of Holm Powerhouse capacity and maximum capacity for passage to the Lake Eleanor model component.

The operation goal linkage between Lake Lloyd and Lake Eleanor assumes that Lake Eleanor will transfer water from its watershed to Lake Lloyd for the purpose of enhancing power generation at Holm Powerhouse. Thus, any available capacity at Holm Powerhouse after the Lloyd-only operation is assumed available and desired for use of a Lake Eleanor transfer. If water is transferred from Lake Eleanor the Model assumes the water to be directly routed to Holm Powerhouse which then becomes additional release from Lake Lloyd.

Also incorporated into the logic is inclusion of user specified supplemental releases (from the WaterBankRel or SFWaterBank worksheets). Supplemental releases are added to any other release established for Lake Lloyd. Reservoir losses are compute in accordance with procedures of the Fourth Agreement.

Snow-melt Management

Unit Title 2
Parameter Title 3
Acre-foot to CFS conversion
divide by: 1.983471

June Storage Target (AF): 273,300 — Max Rel Tgt (CFS)
Minimum HH Storage for SM Drawdown (AF): 100,000
29-year Ave — % Feb Release of Feb-June Excess: 20 — 1,000
% Mar Release of Mar-June Excess: 25 — Max Rel Tgt (CFS) 1,000
% Apr Release of Apr-June Excess: 33 — Max Rel Tgt (CFS) 1,000

					February Snow-melt Release Routine (February)							March Snow-melt Release Routine (March)							April Snow-melt Release Routine (April)						
Row	Month Index	Date	Day	Days	1-Feb AJ Fcst AF	1-Feb FJune Fcst AF	FJune Riv+Trg Holm AF	FJune Ch Avail AF	FJune Excess AF	Feb SM Rel CFS	Max Stor Draw CFS	1-Mar AJ Fcst AF	1-Mar MJune Fcst AF	MJune Riv+Trg Holm AF	MJune Ch Avail AF	MJune Excess AF	March SM Rel CFS	Max Stor Draw CFS	1-Apr AJ Fcst AF	1-Apr AJune Fcst AF	AJune Riv+Trg Holm AF	AJune Ch Avail AF	AJune Excess AF	April SM Rel CFS	Max Stor Draw CFS
20	1970.10	10/1/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	1970.10	10/2/1970	F	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	1970.10	10/3/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	1970.10	10/4/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	1970.10	10/5/1970	M	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	1970.10	10/6/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Unit Title 2
Parameter Title 3 — CFS Lloyd Targ — AF Lloyd Targ
Acre-foot to CFS conversion
divide by: 1.983471

29-year Ave — % May Rlease of Ma y-June Excess: 50 — Max Rel Tgt (CFS) 1,000
% Jun Release of June Excess: 100 — Max Rel Tgt (CFS) 1,000
Max Rel Tgt (CFS) 1,000 — Max

					May Snow-melt Release Routine (May)							June Snow-melt Release Routine (June)								
Row	Month Index	Date	Day	Days	1-May AJ Fcst AF	1-May MJune Fcst AF	MJune Riv+Trg Holm AF	MJune Ch Avail AF	MJune Excess AF	May SM Rel CFS	Max Stor Draw CFS	1-Jun June UF AF	1-Jun June Fcst AF	June Riv+Trg Holm AF	June Ch Avail AF	June Excess AF	June SM Rel CFS	Max Stor Draw CFS	Target SM Release CFS	Target SM Release AF
20	1970.10	10/1/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	1970.10	10/2/1970	F	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	1970.10	10/3/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	1970.10	10/4/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	1970.10	10/5/1970	M	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	1970.10	10/6/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

A second check release is made during the February through June period for management of anticipated snowmelt runoff. On the first day of each of these months a forecast is made of anticipated runoff into the reservoir and minimum releases and losses from the reservoir, from the date of forecast through the end of June (assumed target of reservoir filling). These forecasts determine the volume of water (if any) that will require release in excess of minimum releases and losses and storage gain by the end of June. Pre-knowledge is used for anticipated runoff, minimum releases and losses. The user defines the percentage of volume (of the total volume for the period) to be additionally released during each month. For February through May, a varying percentage of the additional release volume is advised for release, and is capped in rate as a means to confine releases within the capacity of Holm Powerhouse. The snowmelt check release is evenly distributed across the days of the month. The release can also be capped in terms of minimum volume of the reservoir to which it can be drawn during the month.

5.14 SFEleanor Worksheet

This Model component worksheet (SFEleanor) simulates the operation of Lake Eleanor. Several sections of logic provide a systematic operation of the reservoir based on inflow and forecasted hydrology and water demands. The Model will direct releases from Lake Eleanor under a “hold-unless-need-to-release” protocol, except as conditioned by minimum release requirements, diversions, preferred/maximum storage, snowmelt management releases. When advised releases exceed the minimum Model logic attempts to transfer water to Lake Lloyd. The several sections of logic are illustrated and discussed below.

<u>Lake Eleanor Release Demands, Initial Storage Computation and Encroachment Release</u>

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1			1		Lake Eleanor Model																	
2	Unit Title		2		CFS	AF					CFS	AF				AF	AF					
3	Parameter Title		3		Lake Elear	Lake Eleanor Inflow					Eleanor R	Eleanor Req Stream Rel				Eleanor T	Eleanor Limit Storage					
4																						
5	Acre-foot to CFS conversion				This scenario								Base				Difference from Base					
6	divide by :	1.983471			Check Sums		Sum AF	39-ave		Other Sums		39-yr Ave		39-ave		39-yr Ave		39-ave		39-yr Ave		
7						Inflow	7,276,607	186,580			Tunnel	81,956	Inflow	186,580	Tunnel	81,956	Inflow	0	Tunnel	0		
8						Evap	72,708	1,864					Evap	1,864			Evap	0				
9						Tun Out	3,196,266	81,956					Tun Out	81,956			Tun Out	0				
10						Stream	4,008,460	102,781					Stream	102,781			Stream	0				
11						Net	-826															
12						Chng Stor	-826															
13																						
14				39-year Ave		186,580						9,087		1,864								
15					Inflow						Initial Release			Evap/loss	Initial Storage and Encroachment Release							
16					Lake	Lake					Stream	Stream			Initial	Eleanor	Hard			Spread	Spread	
17	Month				Eleanor	Eleanor					Req	Req		Net Res	Eleanor	Target	Limit	Initial	Encroach	Encroach	7th Day	
18	Index	Date	Day	Days	Inflow	Inflow					Bl Eleanor	Bl Eleanor		Evap/Loss	Storage	Storage	Storage	Encroach	7th Day	over 7	Enc over 7	7-day
19					CFS	AF					CFS	AF		AF	18,000	AF	AF	AF	AF	AF	CFS	Count
20	1970.10	10/1/1970	T	31	25	50					10	20		6	18,030	15,000	27,100	3,030	3,030	433	218	1
21	1970.10	10/2/1970	F	31	2	4					10	20		6	17,576	15,000	27,100	2,576	3,030	433	218	0
22	1970.10	10/3/1970	S	31	7	14					10	20		6	17,131	15,000	27,100	2,131	3,030	433	218	0
23	1970.10	10/4/1970	S	31	-179	-355					10	20		6	16,317	15,000	27,100	1,317	3,030	433	218	0
24	1970.10	10/5/1970	M	31	144	287					10	20		6	16,145	15,000	27,100	1,145	3,030	433	218	0
25	1970.10	10/6/1970	T	31	-21	-42					10	20		6	15,644	15,000	27,100	644	3,030	433	218	0

This section of logic assembles the underlying water demands placed for Lake Eleanor releases. Reservoir inflow is derived from the Hydrology worksheet and is the unimpaired flow entering the reservoir. The initial releases are comprised of the minimum flow requirement below Lake Eleanor (from the CCSF worksheet). An initial check of reservoir storage occurs assuming the minimum releases for the river. A daily mass balance is performed: *change in reservoir storage = inflow, minus outflow (releases), minus reservoir losses*. The prior day’s reservoir evaporation is included in the calculation. If the computation produces resulting Lake Eleanor storage in excess (encroachment) of the preferred storage target, the encroachment is computed. Every 7th day the model checks for an encroachment, and if it exists a check release is computed. For the preferred reservoir storage target encroachment it is assumed that a constant supplemental release (in excess of minimum releases) will be initiated at a rate equal to the encroachment divided equally over the next 7 days. This protocol repeats itself every 7th day, reestablishing the level of check release each time. The end result of this procedure will allow encroachment of storage space above the preferred storage target and not require unrealistic hard releases of water to exactly conform to the target.

<u>Lake Eleanor Transfers and Final Reservoir and Release Computation</u>

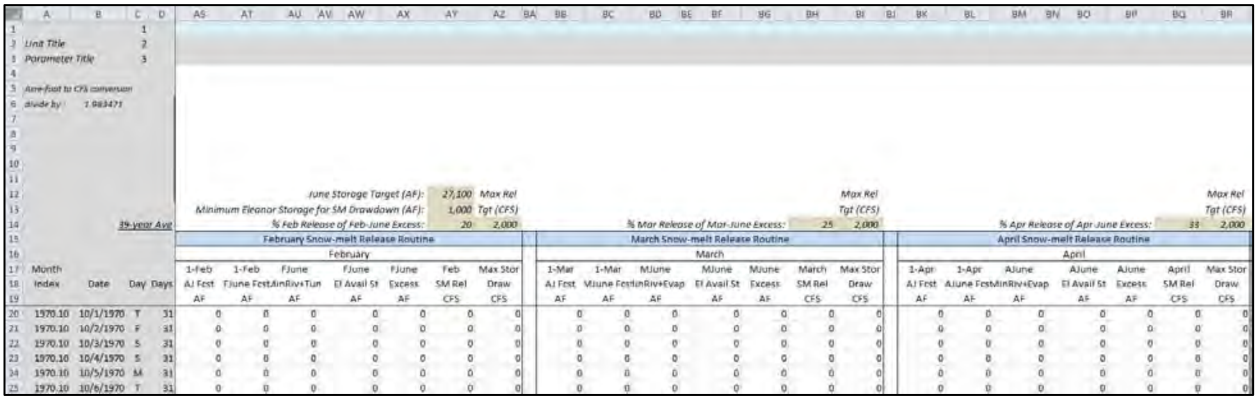
	A	B	C	D	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR
1			1																							
2	Unit Title		2						CFS	AF	CFS	AF					CFS	AF	CFS	AF	AF					
3	Parameter Title		3						Tunnel	Tunnel	Eleanor St	Eleanor Stream Release					Tun Trans	Tun Trans	Total Elea	Total Elea	Lake Eleanor Storage					
4																										
5	Acre-foot to CFS conversion																									
6	divide by	1.983471																								
7																										
8																										
9																										
10																										
11															Tunnel Capacity (C 2.81)											
12															400	CFS Max										
13																										
14				19-year Ave						81,956		102,781								184,737						
15												Revised and Final Routing												Final Storage		
16					Revised	Revised	Excess	Excess	Put	Put			Avail	Avail	Limit by	Limit by			Total	Total	Revised	Eleanor	Lake Eleanor Loss Calculation			
17	Month				Stream	Stream	abv Min	abv Min	to	to	Final	Final	Holm Cap	Holm Cap	Tunnel	Tunnel	Transfer	Transfer	Eleanor	Eleanor	Eleanor	Storage	Area	Factor		
18	Index	Date	Day	Days	Release	Release	Stream	Stream	Tunnel	Tunnel	Stream	Stream	for El	for El	Available	Available	Capacity	Capacity	Release	Release	Storage	Change				
19					CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	18,000	AF	Acres		CFS	AF
20	1970.10	10/1/1970	T	31	228	453	218	433	218	433	10	20	950	1,884	400	793	400	793	228	453	17,591	-409	896	0.003253	2.9	5.8
21	1970.10	10/2/1970	F	31	228	453	218	433	218	433	10	20	950	1,884	400	793	400	793	228	453	17,137	-454	893	0.003253	2.9	5.8
22	1970.10	10/3/1970	S	31	228	453	218	433	218	433	10	20	950	1,884	400	793	400	793	228	453	16,692	-445	890	0.003253	2.9	5.7
23	1970.10	10/4/1970	S	31	228	453	218	433	218	433	10	20	950	1,884	400	793	400	793	228	453	15,878	-814	885	0.003253	2.9	5.7
24	1970.10	10/5/1970	M	31	228	453	218	433	218	433	10	20	950	1,884	400	793	400	793	228	453	15,707	-172	876	0.003253	2.8	5.7
25	1970.10	10/6/1970	T	31	228	453	218	433	218	433	10	20	950	1,884	400	793	400	793	228	453	15,206	-501	874	0.003253	2.8	5.6

This section of logic performs the final computation of reservoir storage and releases, including consideration of snowmelt management releases (described later) and transfers from Lake Eleanor to Lake Lloyd.

Both the initial check release for preferred storage encroachment and the snowmelt check release are computed and advised for reservoir operations. If excess releases above minimum releases are computed the Model routes the additional release through the tunnel up to the limit of its available capacity or the capacity available at Holm Powerhouse. The remainder of the supplemental release is routed to the stream below Lake Eleanor. The Lake Eleanor operation protocol will transfer water that would otherwise be released in excess of minimum flow requirements (largely dependent upon the preferred target storage and snowmelt releases) but it will not allow water to be "pulled" from Lake Eleanor to Lake Lloyd.

The operation goal linkage between Lake Lloyd and Lake Eleanor assumes that Lake Eleanor will transfer water from its watershed to Lake Lloyd for the purpose of enhancing power generation at Holm Powerhouse. Thus, any available capacity at Holm Powerhouse <u>after</u> the Lloyd-only operation is assumed available and desired for use of a Lake Eleanor transfer. If water is transferred from Lake Eleanor the model assumes the water to be directly routed to Holm Powerhouse which then becomes additional release from Lake Lloyd. Reservoir losses are computed in accordance with procedures of the Fourth Agreement.

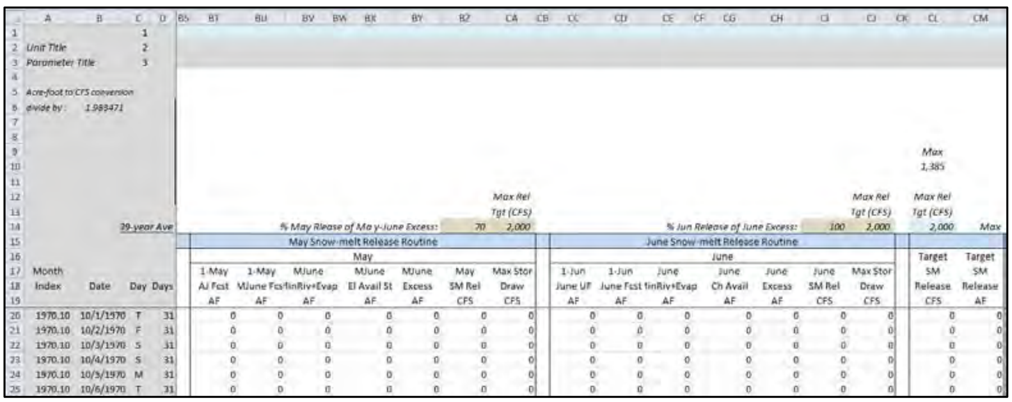
Snow-melt Management



Unit Title 2
Parameter Title 3
Acre-foot to CFS conversion
divide by : 1.983471

June Storage Target (AF): 27,100 | Max Rel Tgt (CFS)
Minimum Eleanor Storage for SM Drawdown (AF): 1,000
% Feb Release of Feb-June Excess: 20 | 2,000
% Mar Release of Mar-June Excess: 25 | 2,000 (Max Rel Tgt (CFS))
% Apr Release of Apr June Excess: 33 | 2,000 (Max Rel Tgt (CFS))
39-year Ave

				February Snow-melt Release Routine — February							March Snow-melt Release Routine — March							April Snow-melt Release Routine — April						
Month Index	Date	Day	Days	1-Feb AJ Fcst AF	1-Feb FJune Fcst AF	FJune MinRiv+Tun AF	FJune El Avail St AF	FJune Excess AF	Feb SM Rel CFS	Max Stor Draw CFS	1-Mar AJ Fcst AF	1-Mar MJune Fcst AF	MJune MinRiv+Evap AF	MJune El Avail St AF	MJune Excess AF	March SM Rel CFS	Max Stor Draw CFS	1-Apr AJ Fcst AF	1-Apr AJune Fcst AF	AJune MinRiv+Evap AF	AJune El Avail St AF	AJune Excess AF	April SM Rel CFS	Max Stor Draw CFS
1970.10	10/1/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/2/1970	F	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/3/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/4/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/5/1970	M	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/6/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



Unit Title 2
Parameter Title 3
Acre-foot to CFS conversion
divide by : 1.983471

Max 1,385
% May Rlease of Ma y-June Excess: 70 | 2,000 (Max Rel Tgt (CFS))
% Jun Release of June Excess: 100 | 2,000 (Max Rel Tgt (CFS))
Max Rel Tgt (CFS) 2,000 | Max
39-year Ave

				May Snow-melt Release Routine — May							June Snow-melt Release Routine — June								
Month Index	Date	Day	Days	1-May AJ Fcst AF	1-May MJune Fcst AF	MJune MinRiv+Evap AF	MJune El Avail St AF	MJune Excess AF	May SM Rel CFS	Max Stor Draw CFS	1-Jun June UF AF	1-Jun June Fcst AF	June MinRiv+Evap AF	June Ch Avail AF	June Excess AF	June SM Rel CFS	Max Stor Draw CFS	Target SM Release CFS	Target SM Release AF
1970.10	10/1/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/2/1970	F	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/3/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/4/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/5/1970	M	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/6/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

A second check release is made during the February through June period for management of anticipated snowmelt runoff. On the first day of each of these months a forecast is made of anticipated runoff into the reservoir and minimum releases and losses from the reservoir, from the date of forecast through the end of June (assumed target of reservoir filling). These forecasts determine the volume of water (if any) that will require release in excess of minimum releases and losses and storage gain by the end of June. Pre-knowledge is used for anticipated runoff, minimum releases and losses. The user defines the percentage of volume (of the total volume for the period) to be additionally released during each month. For February through May, a varying percentage of the additional release volume is advised for release. The snowmelt check release is evenly distributed across the days of the month. The release can also be capped in terms of minimum volume of the reservoir to which it can be drawn during the month.

5.15 SFWaterBank Workheet

This worksheet (SFWaterBank) provides for entry of daily supplemental releases from the CCSF System. The worksheet is comparable to worksheet WaterBankRel except that this worksheet provides alternative methods of identifying supplemental releases (UI 3.10 = 0). Employing this option, the user can identify year type table-based supplemental flow, without or without addition of the pre-processed Test Case supplemental release.

Without any other manual intervention the Model will direct releases from the CCSF System under a "hold-unless-need-to-release" protocol. Additional releases greater than provided by the default protocol may be needed. An example of such a need is during periods when CCSF System operations would otherwise deplete the Water Bank Account to a point of a "negative" balance.

The manual adjustment to releases from the CCSF System is provided to allow the user to "pull" additional water from the CCSF System as supplemental inflow to Don Pedro Reservoir. An entry of supplemental release is established that will first pull water from Lake Lloyd so that water supply is preserved in the Hetch Hetchy Reservoir system for diversion to the SJPL. At a point when such supplemental releases strain Lake Lloyd storage, the supplemental releases are directed to Hetch Hetchy Reservoir. The supplemental release is directed from a reservoir at a point in logic after the default protocol releases occur. Thus, the release occurs in addition to what operation is already occurring by default. Such a release can affect the following day's default operation or previous periods' operations, thus results require review to determine if the user's desired result occurs.

<u>*SF Water Bank Account Balance Accounting, CCSF La Grange Flow Responsibility and Test Case Supplemental Releases*</u>

Shown below is a snapshot of the worksheet. The worksheet provides the daily accounting of the Water Bank Account Balance for the Model. Information ported from other worksheets of the Model into this worksheet is Don Pedro Reservoir inflow (Column E) and the unimpaired flow at La Grange (Column F). These data and the protocols associated with Fourth Agreement Water Bank Account Balance accounting (Columns G through Column O) derive the daily credit or debit of CCSF and then the daily balance of the Water Bank Account (Column M).

San Francisco Water Bank Account Credit Computation — SF Water Bank Release - Base

Unit Title: CFS, CFS, CFS, CFS, CFS, AF, AF, AF

Parameter Title: DP Inflow, La Grange, District Ra, Districts' E, SF Credit/Debit, SF Water Bank Balan, Max Water Bank Capacity, Water Bank Release

Acre-foot to CFS conversion divide by: 1.983471

From DonPedro / From Hydrology

Warnings

Advice

(UI 1.31) 0 — (0) N, (1) Y; - Debit; + Credit

(UI 3.10) 1 — No, this method is not being used

Min Lloyd Storage WB Call (CCSF 3.00) (acre-feet): 45,000

Max 740,000 — Min 0 — Sum: 0 — Sum: 171,708 171,708 0

				SF Water Bank Account Balance Calculation												La Grange			Direct Entry Only		
Month Index	Date	Day	Days	DP Inflow CFS	La Grange UF CFS	Fourth Agree Check CFS	Daily Districts' Entitle CFS	SF Credit/ Debit CFS	SF C/D w/ Credit Adj AF	SF Gross WB Balance AF	SF WB Evap Losses AF	SF Net WB Balance 570,000	SF Share RFlood DP AF	SF Max WB Balance AF	WB Neg Flag AF	Credit Adj in SF WB AF	Mark	Mark	WB Supp Release AF	1st Call Lloyd Release AF	2nd Call HH Release AF
1970.10	10/1/1970	T	31	322	159	2,416	159	163	324	570,324	48	570,000	0	570,000	0	0			0	0	0
1970.10	10/2/1970	F	31	453	55	2,416	55	398	790	570,790	48	570,000	0	570,000	0	0			0	0	0
1970.10	10/3/1970	S	31	541	265	2,416	265	276	548	570,548	48	570,000	0	570,000	0	0			0	0	0
1970.10	10/4/1970	S	31	625	-166	2,416	-166	791	1,569	571,569	48	570,000	0	570,000	0	0			0	0	0
1970.10	10/5/1970	M	31	75	180	2,416	180	-105	-208	569,792	48	569,744	0	570,000	0	0			0	0	0
1970.10	10/6/1970	T	31	475	92	2,416	92	383	760	570,504	48	570,000	0	570,000	0	0			0	0	0

For purposes of the FERC investigation, the protocols of Fourth Agreement Water Bank Accounting have been amended to incorporate a hypothetical implementation of "shared responsibility" for incremental increases in FERC-required flows for the Tuolumne River.[4] If running the scenario with shared responsibility has been selected (worksheet UserInput Switch UI 1.31 = 1), the incremental increase in FERC-required flows is determined by the daily difference between the current 1995 FERC Settlement requirements and scenario-required minimum flows. This computation occurs in worksheet LaGrangeSchedule with information regarding the scenario-required flows directed through worksheet UserInput. Approximately fifty-two percent (51.7121%) of the incremental difference between the flow schedules is assigned as CCSF's responsibility and is ported into the worksheet in Column Q as a "debit". This debit then enters the current protocols of Fourth Agreement Water Bank Accounting at Column J, and subsequently contributes to the determination of the daily Water Bank Account Balance (Column M).

Water Bank Account Balances which are less than zero ("negative") are highlighted, and the minimum balance, whether negative or positive, is reported in Cell M14. By default, the base supplemental releases to maintain a positive Water Bank Account Balance at or above zero have been entered into Column T (WB Supplemental Release). An alternative time series can be used. The Model will first direct the supplemental release to Lake Lloyd, and continue releases until storage at Lake Lloyd is drawn to a specified 45,000 acre-feet minimum level (shown in Cell Q10 and entered at worksheet CCSF Switch 3.00). Subsequent supplemental releases will be drawn from Hetch Hetchy Reservoir any time storage is less than the Lake Lloyd minimum.

User Specified Table of Supplemental Releases and Reservoir Status Computation

The snapshot below illustrates the section of logic that incorporates a user Specified table of supplemental releases (UI 3.40) into the Model. A daily time series (Column Y) of supplemental releases is developed from the user specified table in worksheet UserInput. By selection, the user identifies whether or not the year type table-based supplemental release is added the preprocessed Test Case supplemental releases (Column T previously described). The Model then uses the selected supplemental release in its computation of operations.

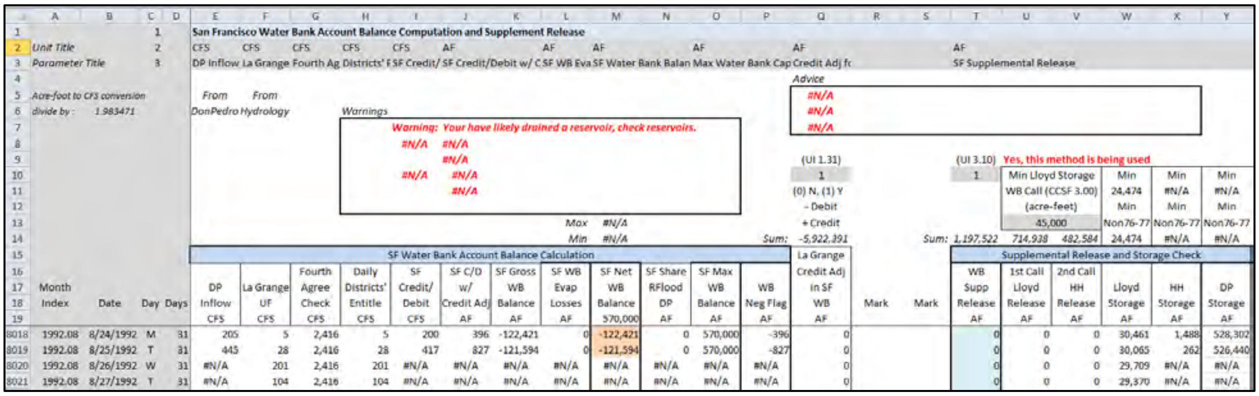
	A	B	C	D	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI
1			1			User-defined SF Upstream Supplemental Release									
2	*Unit Title*		2							AF					
3	*Parameter Title*		3							Total SF Suppl Release					
4															
5	*Acre-foot to CFS conversion*														
6	*divide by :*	*1.983471*								*(UI 3.10)*	1	No, this method is not being used			
7					*2,704,000*	*2,875,708*	*2,875,708*	*0*							
8						Add Base									
9						Supp				Final Supplimental Release from Other Method					
10						1	N/A			0	*(UI 3.20)*				
11						*(0) no*	*(UI 3.30)*			*(0) Base*			Min	Min	Min
12						*(1) yes*				*(1) User-defined*			103,852	84,135	508,489
13					Supplemental Table Entry								Min	Min	Min
14						Supp							Non 76-77	Non 76-77	Non 76-77
15					Supp	Table	1st Call	2nd Call					103,852	114,720	785,605
16					Table	Only, or	To	To	*Sum:*	*171,708*	*171,708*	*0*			
17	Month				Release	Table +	Lloyd	HH			Lloyd	HH	Lloyd	HH	DP
18	Index	Date	Day	Days	Only	Existing	Release	Release		Total	Release	Release	Storage	Storage	Storage
19					AF	AF	AF	AF		AF	AF	AF	AF	AF	AF
20	1970.10	10/1/1970	T	31	0	0	0	0		0	0	0	200,091	249,349	1,666,767
21	1970.10	10/2/1970	F	31	0	0	0	0		0	0	0	200,080	248,379	1,664,567
22	1970.10	10/3/1970	S	31	0	0	0	0		0	0	0	200,090	247,622	1,662,719
23	1970.10	10/4/1970	S	31	0	0	0	0		0	0	0	199,278	247,032	1,659,892
24	1970.10	10/5/1970	M	31	0	0	0	0		0	0	0	199,896	246,150	1,656,745
25	1970.10	10/6/1970	T	31	0	0	0	0		0	0	0	199,781	245,360	1,654,119

[4] The "shared responsibility" assumption is presented for the purpose of evaluating alternative operations. The assumption shall not be used as evidence in any proceeding relating to and shall not act as precedence for any allocation of Tuolumne River water between CCSF and the Districts for any purpose under the Fourth Agreement.

The result of entering the supplemental release will cause a recalculation of the entire Model with results refreshed in the worksheet. Lake Lloyd, Hetch Hetchy Reservoir and Don Pedro Reservoir storage is ported from other worksheets to provide the status of their storage as supplemental releases are entered.

Warnings and advice are provided in the worksheet when several conditions occur. The snapshots below illustrate the occurrence of these conditions.

Example 1: A Reservoir Empties and the Model Crashes



Row	Month Index	Date	Day	Days	DP Inflow CFS	La Grange UF CFS	Fourth Agree Check CFS	Daily Districts' Entitle CFS	SF Credit/ Debit CFS	SF C/D w/ Credit Adj AF	SF Gross WB Balance AF	SF WB Evap Losses AF	SF Net WB Balance 570,000	SF Share RFlood DP AF	SF Max WB Balance AF	WB Neg Flag AF	La Grange Credit Adj in SF WB AF	Mark	Mark	WB Supp Release AF	1st Call Lloyd Release AF	2nd Call HH Release AF	Lloyd Storage AF	HH Storage AF	DP Storage AF
8018	1992.08	8/24/1992	M	31	205	5	2,416	5	200	396	-122,421	0	-122,421	0	570,000	-396	0			0	0	0	30,461	1,488	528,302
8019	1992.08	8/25/1992	T	31	445	28	2,416	28	417	827	-121,594	0	-121,594	0	570,000	-827	0			0	0	0	30,065	262	526,440
8020	1992.08	8/26/1992	W	31	#N/A	201	2,416	201	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0			0	0	0	29,709	#N/A	#N/A
8021	1992.08	8/27/1992	T	31	#N/A	104	2,416	104	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0			0	0	0	29,370	#N/A	#N/A

Note: This screen save is from the worksheet WaterBankRel description. Identical warnings are included in worksheet SFWaterBank.

A warning has been provided that a reservoir has likely been depleted by the current operation assumptions. In this particular example, Tuolumne River minimum flows were increased with responsibility shared with CCSF, and a set of supplemental releases were established. In this iteration of results it is discovered in Column X (Hetch Hetchy Reservoir storage) an error (reported as "#N/A") on August 26, 1992 has occurred in the Model. By review of the previous day's storage results for Lake Lloyd (Column W), Hetch Hetchy Reservoir (Column X) and Don Pedro Reservoir (Column Y), and the rate of depletion for each of these reservoirs, it is concluded that Hetch Hetchy Reservir likely drained on August 26 and thus crashed the Model. Although noted, a negative Water Bank Account Balance (Column M) will not cause the Model to crash. To remedy the condition, the user uses worksheet UserInput to revise (lower) SJPL diversions from Hetch Hetchy Reservoir (UI 4.10 and UI 4.20) and retain water in Hetchy Hetchy Reservoir for release. If Don Pedro Reservoir storage was the culprit of causing the Model to crash, the user uses worksheet UserInput to revise (lower) MID and TID canal diversions (UI 2.10, UI 2.20 and UI 2.30 to retain water in Don Pedro Reservoir for release. Alternatively, the user could reduce the scenario's designated minimum flow requirement, which would change flow needed from the upstream systems.

Example 2: Water Bank is Negative.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1			1		San Francisco Water Bank Account Balance Computation and Supplement Release																				
2	Unit Title		2		CFS	CFS	CFS	CFS	CFS	AF		AF	AF		AF		AF			AF					
3	Parameter Title		3		DP Inflow	La Grange	Fourth Ag	Districts' E	SF Credit/	SF Credit/Debit w/ C		SF WB Eva	SF Water Bank Balan		Max Water Bank Cap		Credit Adj fc			SF Supplemental Release					
4																	Advice								
5	Acre-foot to CFS conversion				From	From											If Water Bank Balance is negative (shown as highlighted value in								
6	divide by :	1.983471			DonPedro	Hydrology		Warnings									Column M) enter volume of supplemental release into Column T to								
7																	maintin balance at zero or greater. Use Column M and Column P for guidance.								
8									Warning: SF Water Bank is 'negative'. Add supplemental release																
9									(Column T) to maintain balance at least zero.								(UI 1.31)			(UI 3.10)	Yes, this method is being used				
10																	0			1	Min Lloyd Storage		Min	Min	Min
11																	(0) N, (1) Y				WB Call (CCSF 3.00)		131,254	84,135	508,489
12																	- Debit				(acre-feet)		Min	Min	Min
13												Max	740,000				+ Credit				45,000		Non76-77	Non76-77	Non76-77
14												Min	-150,778			Sum:	0		Sum:	0	0	0	131,254	114,720	740,875
15					SF Water Bank Account Balance Calculation												La Grange			Supplemental Release and Storage Check					
16							Fourth	Daily	SF	SF C/D	SF Gross	SF WB	SF Net	SF Share	SF Max		Credit Adj			WB	1st Call	2nd Call			
17	Month				DP	La Grange	Agree	Districts'	Credit/	w/	WB	Evap	WB	RFlood	WB	WB	in SF			Supp	Lloyd	HH	Lloyd	HH	DP
18	Index	Date	Day	Days	Inflow	UF	Check	Entitle	Debit	Credit Adj	Balance	Losses	Balance	DP	Balance	Neg Flag	WB	Mark	Mark	Release	Release	Release	Storage	Storage	Storage
19					CFS	CFS	CFS	CFS	CFS	AF	AF	AF	570,000	AF	AF	AF	AF			AF	AF	AF	AF	AF	AF
7887	1992.04	4/15/1992	W	30	2138	4,322	4,066	4,066	-1,928	-3,824	4,011	0	4,011	0	570,000	0	0			0	0	0	256,353	262,227	969,641
7888	1992.04	4/16/1992	T	30	1628	3,150	4,066	3,150	-1,521	-3,017	994	0	994	0	570,000	0	0			0	0	0	257,148	263,740	969,822
7889	1992.04	4/17/1992	F	30	1925	4,267	4,066	4,066	-2,141	-4,247	-3,253	0	-3,253	0	570,000	4,247	0			0	0	0	259,037	265,786	970,196
7890	1992.04	4/18/1992	S	30	1980	5,507	4,066	4,066	-2,086	-4,137	-7,390	0	-7,390	0	570,000	4,137	0			0	0	0	260,795	270,314	970,897

Note: This screen save is from the worksheet WaterBankRel description. Identical warnings are included in worksheet SFWaterBank.

A warning has been provided that the Water Bank Account Balance is negative for one or more days of the scenario. In this instance, all Model reservoirs are operating within a viable operation (the Model did not crash due an emptying reservoir); however, the objective to maintain a positive Water Bank Account Balance has been violated. Upon inspection of the results the user can find the first instance of violation and remedy the violation by entry into Column T an amount of release that maintains at least a zero balance in the Water Bank Account Balance, and/or modify the year type table-based supplemental flows in worksheet UserInput. For the first day of violation the reported negative balance (e.g., -3,253 acre-feet) is needed as a supplemental release. The ensuing days of supplemental release are informed by Column P.

It is possible that within the remedy of Example 2 the error exemplified by Example 1 may occur as Hetchy Hetchy Reservoir may be drained through the efforts of maintaining a positive Water Bank Account Balance. At that point, the procedures of Example 1 will be required and the values already derived for supplemental releases may need to be revisited and possibly changed.

5.16 LaGrangeSchedule Workheet

This worksheet (LaGrangeSchedule) assembles the designation of the minimum flow requirement for the Tuolumne River. By user specification (UI 1.10) either the current 1995 FERC schedule is selected (UI 1.10 = 0) or the user defined minimum flow requirement is selected (UI 1.10 = 1). If the current 1995 FERC schedule is selected the computation of the schedule is computed in this worksheet (later described).

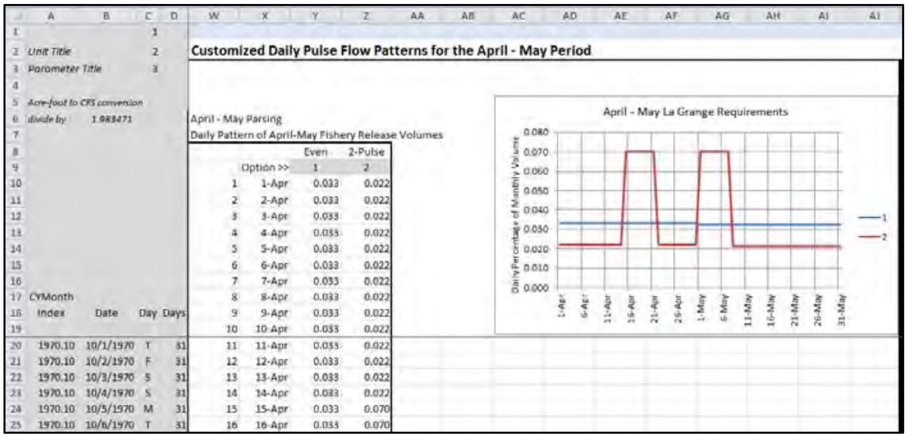
Minimum Flow Requirement Options

When using current 1995 FERC minimum flow requirements, the user can within worksheet Control (C 1.60) direct which shape of releases to assume for pulse flows during April and May. This section of the worksheet performs the parsing the monthly flow requirements into daily flow requirements. If using the user specified flow schedule (identified and processed in worksheet UserInput), this section prepares the use of that data for use by the Model. Upon selection of the flow requirement, Column F is used to provide the minimum flow requirement to the rest of the Model. Although not directly linked through user switches, this section of the worksheet illustrates an example of developing an alternative flow requirement for testing. Columns M through Column Q perform a synthesis of an alternative flow requirement as has been suggested by the SWRCB. This particular flow requirement currently serves as the example alternative requirement for this documentation. The specifics of this component of flow requirement (February through June) in combination with the current 1995 FERC minimum flow requirement has been provided to worksheet UserInput for illustration purposes.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1			1		La Grange Minimum Flow Calculation																	
2	Unit Title		2		CFS	AF					AF						AF		CFS	AF	CFS	AF
3	Parameter Title		3		La Grange	La Grange					1995 FERC I						Alt Test Fl		User-Defi	User-Defi	User-Defi	User-Defi
4																						
5	Acre-foot to CFS conversion																		Sample Alt			
6	divide by :	1.983471				Read by		Existing FERC Requirements											Greater of FERC or 30% UF Feb-Jun			
7						Model		See Cell AN1 for beginning of calculation					Alternative flow requirement (Column T or V)						Daily time series, or average of daily			
8						as AF			Required	Daily			Option within an option:			0			by year type average			
9						213,897			Monthly	Parsing	213,897			(0) if from UserInput Time Series						507,554		507,395
10					Input Option:				Volume	Monthly				(1) if from UserInput YT Table					Time Series		Table	
11						0							Greater of FERC or 30%UF Feb-Jun, with Bounds						1	1	0	0
12					0 - Current FERC (Column K)				April - May Parsing				Self-contained Computation of SWRCB Component						UserInput	UserInput	UserInput	UserInput
13					1 - Alternative (Column T or V)				Option >>	2			Alternative - SWRCB X% F-J						User	User	User	User
14									(1) Even daily distribution						200	3500			Defined	Defined	Defined	Defined
15					Model	Model			(2) 2-Pulse					X%	Min Cap	Max Cap			Time	Time	Yr-Type	Yr-Type
16					Input	Input					FERC Only			30	200	3500			Series	Series	Table	Table
17	CYMonth				La Grange	La Grange		Pulse	La Grange	Day	La Grange			Trial			X% Req		Flow	Flow	Flow	Flow
18	Index	Date	Day	Days	Daily	Daily		Day	Monthly	Percent	Daily		TR UF	Feb-Jun	Feb-Jun	Feb-Jun	Alone		Reqrmnt	Reqrmnt	Reqrmnt	Reqrmnt
19					CFS	AF			AF		AF		CFS	CFS	CFS	CFS	AF		CFS	AF	CFS	AF
20	1970.10	10/1/1970	T	31	397	787			24,397	0.03226	787		159	0	0	0	0		397	787	295	585
21	1970.10	10/2/1970	F	31	397	787			24,397	0.03226	787		55	0	0	0	0		397	787	295	585
22	1970.10	10/3/1970	S	31	397	787			24,397	0.03226	787		265	0	0	0	0		397	787	295	585
23	1970.10	10/4/1970	S	31	397	787			24,397	0.03226	787		-166	0	0	0	0		397	787	295	585
24	1970.10	10/5/1970	M	31	397	787			24,397	0.03226	787		180	0	0	0	0		397	787	295	585
25	1970.10	10/6/1970	T	31	397	787			24,397	0.03226	787		92	0	0	0	0		397	787	295	585

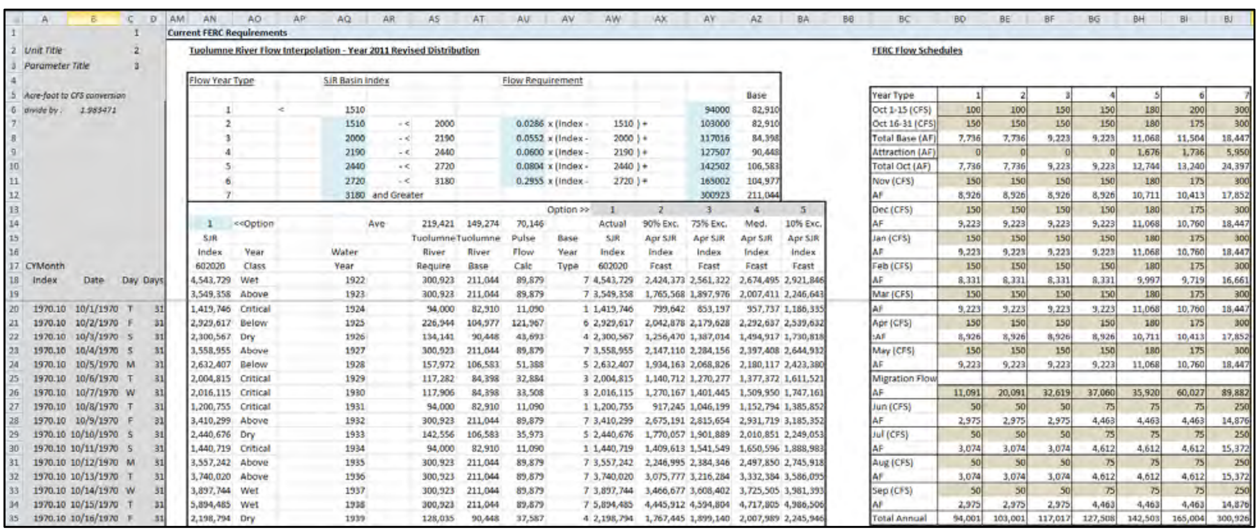
April – May Daily Parsing of Flow Requirements

This section of the worksheet provides information to parse monthly-designated minimum flow requirements into daily patterns during April and May. Worksheet Control designates which parsing pattern is to be used.



Computation of 1995 FERC Minimum Flow Requirement

This section of the worksheet computes the current 1995 FERC flow requirement. Several elements of information provided in this worksheet and from worksheet Control provide the computation of flow requirement based on 1995 FERC Settlement procedures and flow rates. The basis of the year type flow requirements is the SWRCB San Joaquin River Basin 60-20-20 index. The annual flow schedules are assumed to be apply on a April through March year, with the interpolation water of the schedules applied to April and May pulse flows. A snapshot of the worksheet's computation area is shown below.



San Francisco La Grange Responsibility

Also performed in this worksheet is the computation of the hypothetical responsibility of CCSF for Tuolumne River incremental flow requirements.[5] A snapshot of the computation area is shown below.

[5] The "shared responsibility" assumption is presented for the purpose of evaluating alternative operations. The assumption shall not be used as evidence in any proceeding relating to and shall not act as precedence for any allocation of Tuolumne River water between CCSF and the Districts for any purpose under the Fourth Agreement.

	A	B	C	D	BV	BW	BX	BY	BZ	CA	CB	CC
1			1			SF La Grange Responsibility Computation						
2	*Unit Title*		2									
3	*Parameter Title*		3									
4												
5	*Acre-foot to CFS conversion*											
6	*divide by :*	*1.983471*										
7												
8												
9												
10						*Approach - SF 52% Responsibility Scenario*						
11												
12						*Compute difference between existing FERC minimum flow requirement and test scenario*						
13						*Test scenario: SWRCB 30% UF February-June w/ 200/3,500 cfs bounds on SWRCB component, or existing FERC whichever is greater*						
14							213,897		213,897		0	0
15											Total Diff	
16								Scenario	Scenario		Alt	
17	CYMonth					Exsiting	Exsiting	SWRCB	SWRCB		minus	51.7121
18	Index	Date	Day	Days		FERC	FERC	30%	30%		FERC	SF Debit
19						CFS	AF	CFS	AF		AF	AF
20	1970.10	10/1/1970	T	31		397	787	397	787		0	0
21	1970.10	10/2/1970	F	31		397	787	397	787		0	0
22	1970.10	10/3/1970	S	31		397	787	397	787		0	0
23	1970.10	10/4/1970	S	31		397	787	397	787		0	0
24	1970.10	10/5/1970	M	31		397	787	397	787		0	0
25	1970.10	10/6/1970	T	31		397	787	397	787		0	0

The 1995 FERC flow requirement and the scenario flow requirement are compared on a daily basis to identify the difference between the two schedules. The CCSF 52% responsibility factor is applied to the total difference, which values are then provided to the WaterBankRel and SFWaterBank worksheets for use if selected.

5.17 DailyCanalsCompute Workheet

This worksheet (DailyCanalsCompute) performs the computation of the daily canal demands of the MID and TID. The computation of canal demands incorporate the PDAW and canal operations practices of the districts. This worksheet also incorporates the application of a Water Supply Factor (from worksheet DPWSF) that reduces canal diversions during limited water supply conditions. The results from this worksheet have been provided to the Model for the Test Case scenario.

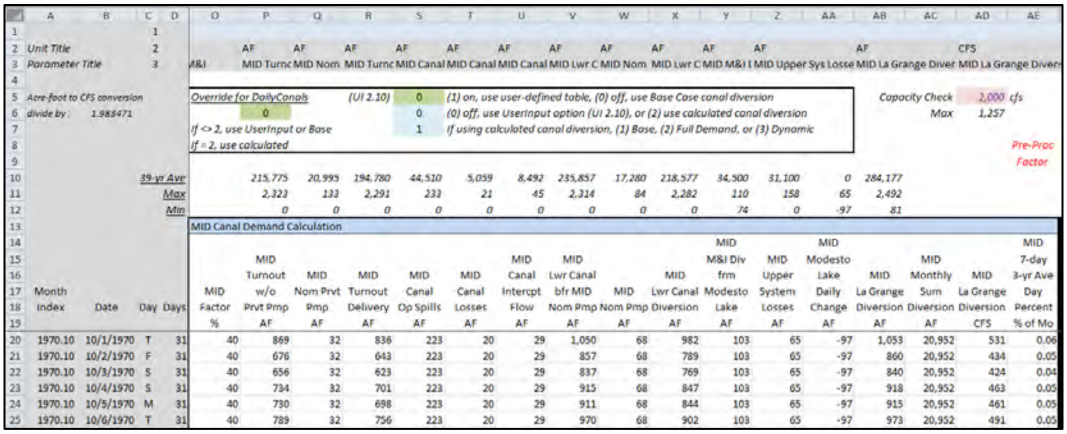
Projected Demand for Applied Water and Don Pedro Water Supply Factor

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1			1		District Canal Diversion Computed by Canal Assumptions and Don Pedro Water Supply Factor									
2	Unit Title		2		Factor		Factor	Factor			AF	AF	AF	AF
3	Parameter Title		3		DP WSF Full		DP WSF	Dynamic WSF			MID Daily	TID Daily /	MID Daily	TID Daily
4														
5	Acre-foot to CFS conversion													
6	divide by :	1.983471			Pre-Proc	Pre-Proc	Active	Read	Read	Read				
7					Full	Base	Factor	from	from	from				
8					Factor	Factor	Used in	DPWSF	BU20:487	BV20:487				
9					1		Scenario							
10				39-yr Ave							170,364	406,025	34,500	0
11				Max	1.0000	1.0000	1.0000	1.0000	36,100		1,822	4,116	110	0
12				Min	1.0000	0.6000	0.6000	0.6000	0		0	0	74	0
13					DP Water Supply Factor				District Projected Demand of Applied Water					
14						10-4-2012								
15					DP	DP								
16					WS Factor	WS Factor	Model	DP	MID	TID	MID	TID	MID	TID
17	Month				Full	Base	DP	WS Factor	PDAW	PDAW	Daily	Daily	Daily	Daily
18	Index	Date	Day	Days	Demand	Case	WS Factor	Dynamic	Monthly	Monthly	PDAW	PDAW	M&I	M&I
19									AF	AF	AF	AF	AF	AF
20	1970.10	10/1/1970	T	31	1.0000	1.0000	1.0000	1.0000	6,000	16,000	347	1,217	103	0
21	1970.10	10/2/1970	F	31	1.0000	1.0000	1.0000	1.0000	6,000	16,000	270	626	103	0
22	1970.10	10/3/1970	S	31	1.0000	1.0000	1.0000	1.0000	6,000	16,000	262	564	103	0
23	1970.10	10/4/1970	S	31	1.0000	1.0000	1.0000	1.0000	6,000	16,000	293	990	103	0
24	1970.10	10/5/1970	M	31	1.0000	1.0000	1.0000	1.0000	6,000	16,000	292	683	103	0
25	1970.10	10/6/1970	T	31	1.0000	1.0000	1.0000	1.0000	6,000	16,000	315	769	103	0

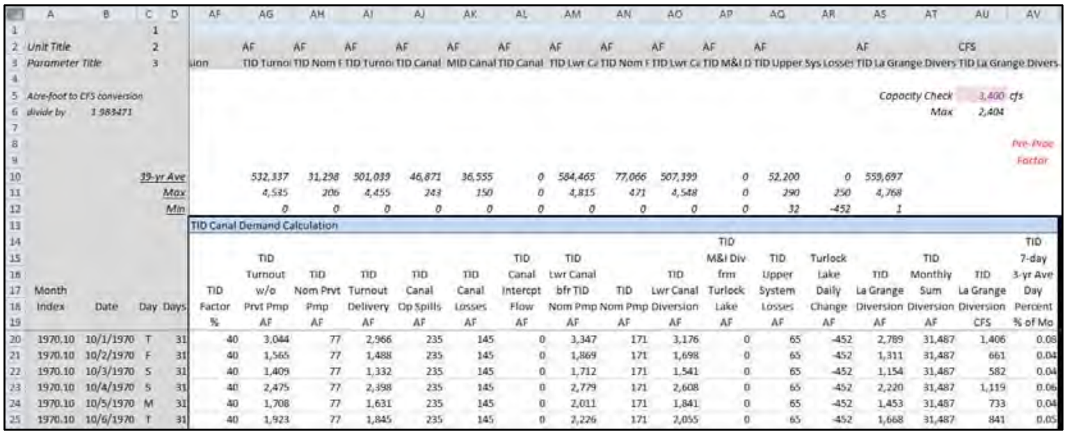
This section of logic incorporates two components of information into the computation of canal demands. The PDAW for each District is a pre-processed Model entry based on an estimate developed by the California Department of Water Resources Consumptive Use model. The monthly time series for PDAW for the simulation period is modified prior to use in the computation to refine the demand to recognize the local districts' delivery records. The second component of information is the Don Pedro Water Supply Factor (WSF). This fraction is computed in worksheet DPWSF and reflects limited water supplies during periods of drought. The factor is used to reduce canal diversions, based on antecedent reservoir storage and forecasted inflow to Don Pedro Reservoir. There are several versions of the WSF available for use in the Model if user access is allowed. The "full demand" WSF will produce a canal demand/diversion equal to full needs, as if the available water supply is sufficient to meet the full canal demands. The WSF table included in the Model represents canal demands including reductions from full diversions, and manages water supplies to produce a reservoir operation similar to that occurred during the 1987-1992 drought.

District Canal Demand Calculation

The sections of logic shown below illustrate the components of District canal operations that factor into the computation of daily canal demands/diversions. These components build on top of the PDAW to develop a daily canal demand from Don Pedro Reservoir. The PDAW is represented as a daily varying demand based on recent historical daily diversion shapes while the canal operation parameters are generally represented by an even distribution pattern within each month.



	A	B	C	D	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE
1			1																		
2	Unit Title		2			AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF		AF		CFS	
3	Parameter Title		3		M&I	MID Turnc	MID Nom	MID Turnc	MID Canal	MID Canal	MID Canal	MID Lwr C	MID Nom	MID Lwr C	MID M&I I	MID Upper Sys Losse		MID La Grange Diver		MID La Grange Diver	
4																					
5	Acre-foot to CFS conversion				Override for DailyCanals			(UI 2.10)	0	(1) on, use user-defined table, (0) off, use Base Case canal diversion									Capacity Check	2,000	cfs
6	divide by :	1.983471				0			0	(0) off, use UserInput option (UI 2.10), or (2) use calculated canal diversion									Max	1,257	
7					If <> 2, use UserInput or Base				1	If using calculated canal diversion, (1) Base, (2) Full Demand, or (3) Dynamic											
8					If = 2, use calculated																Pre-Proc
9																					Factor
10			39-yr Ave			215,775	20,995	194,780	44,510	5,059	8,492	235,857	17,280	218,577	34,500	31,100	0	284,177			
11			Max			2,323	133	2,291	233	21	45	2,314	84	2,282	110	158	65	2,492			
12			Min			0	0	0	0	0	0	0	0	0	74	0	-97	81			
13					MID Canal Demand Calculation																
14-19	Month Index	Date	Day	Days	MID Factor %	MID Turnout w/o Prvt Pmp AF	MID Nom Prvt Pmp AF	MID Turnout Delivery AF	MID Canal Op Spills AF	MID Canal Losses AF	MID Canal Intercpt Flow AF	MID Lwr Canal bfr MID Nom Pmp AF	MID Nom Pmp AF	MID Lwr Canal Diversion AF	MID M&I Div frm Modesto Lake AF	MID Upper System Losses AF	MID Modesto Lake Daily Change AF	MID La Grange Diversion AF	MID Monthly Sum Diversion AF	MID La Grange Diversion CFS	MID 7-day 3-yr Ave Day Percent % of Mo
20	1970.10	10/1/1970	T	31	40	869	32	836	223	20	29	1,050	68	982	103	65	-97	1,053	20,952	531	0.06
21	1970.10	10/2/1970	F	31	40	676	32	643	223	20	29	857	68	789	103	65	-97	860	20,952	434	0.05
22	1970.10	10/3/1970	S	31	40	656	32	623	223	20	29	837	68	769	103	65	-97	840	20,952	424	0.04
23	1970.10	10/4/1970	S	31	40	734	32	701	223	20	29	915	68	847	103	65	-97	918	20,952	463	0.05
24	1970.10	10/5/1970	M	31	40	730	32	698	223	20	29	911	68	844	103	65	-97	915	20,952	461	0.05
25	1970.10	10/6/1970	T	31	40	789	32	756	223	20	29	970	68	902	103	65	-97	973	20,952	491	0.05



	A	B	C	D	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV
1			1																		
2	Unit Title		2			AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF		AF		CFS	
3	Parameter Title		3		sion	TID Turnoi	TID Nom F	TID Turnoi	TID Canal	MID Canal	TID Canal	TID Lwr Ca	TID Nom F	TID Lwr Ca	TID M&I D	TID Upper Sys Losse		TID La Grange Divers		TID La Grange Divers	
4																					
5	Acre-foot to CFS conversion																		Capacity Check	3,400	cfs
6	divide by	1.983471																	Max	2,404	
7																					
8																					Pre-Proc
9																					Factor
10			39-yr Ave			532,337	31,298	501,039	46,871	36,555	0	584,465	77,066	507,399	0	52,200	0	559,697			
11			Max			4,535	206	4,455	243	150	0	4,815	471	4,548	0	290	250	4,768			
12			Min			0	0	0	0	0	0	0	0	0	0	32	-452	1			
13					TID Canal Demand Calculation																
14-19	Month Index	Date	Day	Days	TID Factor %	TID Turnout w/o Prvt Pmp AF	TID Nom Prvt Pmp AF	TID Turnout Delivery AF	TID Canal Op Spills AF	TID Canal Losses AF	TID Canal Intercpt Flow AF	TID Lwr Canal bfr TID Nom Pmp AF	TID Nom Pmp AF	TID Lwr Canal Diversion AF	TID M&I Div frm Turlock Lake AF	TID Upper System Losses AF	Turlock Lake Daily Change AF	TID La Grange Diversion AF	TID Monthly Sum Diversion AF	TID La Grange Diversion CFS	TID 7-day 3-yr Ave Day Percent % of Mo
20	1970.10	10/1/1970	T	31	40	3,044	77	2,966	235	145	0	3,347	171	3,176	0	65	-452	2,789	31,487	1,406	0.08
21	1970.10	10/2/1970	F	31	40	1,565	77	1,488	235	145	0	1,869	171	1,698	0	65	-452	1,311	31,487	661	0.04
22	1970.10	10/3/1970	S	31	40	1,409	77	1,332	235	145	0	1,712	171	1,541	0	65	-452	1,154	31,487	582	0.04
23	1970.10	10/4/1970	S	31	40	2,475	77	2,398	235	145	0	2,779	171	2,608	0	65	-452	2,220	31,487	1,119	0.06
24	1970.10	10/5/1970	M	31	40	1,708	77	1,631	235	145	0	2,011	171	1,841	0	65	-452	1,453	31,487	733	0.04
25	1970.10	10/6/1970	T	31	40	1,923	77	1,845	235	145	0	2,226	171	2,055	0	65	-452	1,668	31,487	841	0.05

District Canal Operation Assumptions

The canal operation assumptions, e.g., seepage and losses and canal operation spills, are identified in this worksheet (entered into worksheet Control). These parameters are provided to the computations shown above. The canal operation assumptions for each District are shown below.

Modesto Irrigation District											
	Turnout Delivery Factor	Nominal Private GW Pumping	Canal Operational Spills Critical	Canal Operational Spills Non-crit	System Losses below Modesto Res	Intercepted Flows	Nominal MID GW Pumping	Modesto Res and Upper Canal Losses/Div	Municipal Delivery from Modesto Res	Modesto Res Target Storage	Modesto Res Target Storage Change
Month	%	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF
January	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	17.0	2.0
February	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	18.0	1.0
March	65.0	1.0	1.0	3.0	0.6	0.9	1.0	2.0	2.7	18.0	0.0
April	70.0	2.0	3.0	6.0	0.6	0.9	2.3	2.9	2.7	19.0	1.0
May	85.0	3.0	4.0	6.5	0.6	1.2	2.3	3.9	3.0	20.0	1.0
June	85.0	4.0	3.5	6.5	0.6	1.0	2.3	4.3	3.2	20.0	0.0
July	77.5	4.0	3.5	6.5	0.6	1.0	2.6	4.9	3.3	21.0	1.0
August	70.0	4.0	4.9	7.0	0.6	1.4	2.4	4.9	3.3	22.0	1.0
September	65.0	2.0	5.0	7.0	0.6	1.2	2.3	4.2	3.3	20.0	-2.0
October	40.0	1.0	2.8	6.9	0.6	0.9	2.1	2.0	3.2	17.0	-3.0
November	30.0	0.0	2.0	2.0	0.1	0.0	0.0	2.0	2.7	15.0	-2.0
December	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.5	15.0	0.0
Total		21.0	35.7	57.4	5.4	8.5	17.3	31.1	34.5		

Turlock Irrigation District											
	Turnout Delivery Factor	Nominal Private GW Pumping	Canal Operational Spills Critical	Canal Operational Spills Non-crit	System Losses below Turlock Lk	Intercepted Flows	Nominal TID GW Pumping	Turlock Lk and Upper Canal Losses	Other Delivery from Turlock Lk	Turlock Lk Target Storage	Turlock Lk Target Storage Change
Month	%	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF
January	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	18.0	5.0
February	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	25.0	7.0
March	65.0	1.2	3.0	3.0	4.5	0.0	4.1	1.0	0.0	30.0	5.0
April	57.5	2.4	5.1	6.3	4.5	0.0	8.0	6.6	0.0	30.0	0.0
May	85.0	3.6	4.6	6.7	4.5	0.0	10.3	7.7	0.0	32.0	2.0
June	92.5	5.2	4.2	6.7	4.5	0.0	12.4	8.2	0.0	32.0	0.0
July	72.5	6.4	4.2	6.7	4.5	0.0	14.6	8.7	0.0	32.0	0.0
August	62.5	6.2	4.0	7.3	4.5	0.0	13.3	9.0	0.0	30.0	-2.0
September	67.5	3.9	3.2	7.3	4.5	0.0	9.1	5.0	0.0	27.0	-3.0
October	40.0	2.4	2.3	7.3	4.5	0.0	5.3	2.0	0.0	13.0	-14.0
November	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0	0.0
December	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0	0.0
Total		31.3	38.6	59.3	39.2	0.0	77.1	52.2	0.0		

5.18 DailyCanals Workheet

This worksheet (DailyCanals) assembles the appropriate canal demands for the scenario. While worksheet DailyCanalsCompute is capable of providing several versions of canal demands, worksheet DailyCanals readies either those selected demands or alternatively defined demands for the Model.

Model (scenario) Canal Demands

	A	B	C	D	E	F	G	H	I	J
1			1		District Canal Diversion Read by Model					
2	Unit Title		2							
3	Parameter Title		3							
4										
5	Acre-foot to CFS conversion									
6	divide by :	1.983471			MID and TID Canal Diversion Assumption					
7					Read		Read			
8					by		by			
9					DP Model		DP Model		Sum	
10			39-yr Ave		284,177		559,697		843,874	
11					Option (0) is using Base Case Canal Diversion					
12					Option (1) is using Alt from UserInput Canal Diversion					
13					Option>>	0	Switch 2.10 or Override			
14					Option (2) is using Calculated Canal Diversion					
15–19	Month Index	Date	Day	Days	Model MID Canal Diversion AF	Model MID Canal Diversion CFS	Model TID Canal Diversion AF	Model TID Canal Diversion CFS	Model Total Canal Diversion AF	Model Total Canal Diversion CFS
20	1970.10	10/1/1970	T	31	1,053	531	2,789	1,406	3,842	1,937
21	1970.10	10/2/1970	F	31	860	434	1,311	661	2,171	1,094
22	1970.10	10/3/1970	S	31	840	424	1,154	582	1,994	1,006
23	1970.10	10/4/1970	S	31	918	463	2,220	1,119	3,139	1,582
24	1970.10	10/5/1970	M	31	915	461	1,453	733	2,368	1,194
25	1970.10	10/6/1970	T	31	973	491	1,668	841	2,641	1,332

The section of logic shown above illustrates the two columns of data used by the Model (worksheet DonPedro) for canal diversions by MID and TID. The data version of demand used is user specified. If using the worksheet UserInput interface, UI 2.10 selects whether pre-processed Test Case diversions are used or a user specified table of diversions are used. If access to worksheet DailyCanalsCompute is granted, a time series of canal diversions from worksheet DailyCanalsCompute is used.

Test Case and Alternative Canal Diversions

This section of logic provides the Model either a pre-processed time series of canal diversions (Test Case) or a time series of canal diversions that has been specified by the user in worksheet UserInput (UI 2.20 and UI 2.30) as monthly canal demands for the simulation period. A snapshot of the worksheet is shown below. This section of logic also parses the user specified monthly table of canal diversions into a daily diversion pattern based on the Test Case scenario's daily pattern of diversions.

	A	B	C	D	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA
1			1																	
2	Unit Title		2																	
3	Parameter Title		3																	
4																				
5	Acre-foot to CFS conversion																			
6	divide by :	1.983471			Enter		Enter		Pre-Processed		Alternative Canal Diversion				Enter		Enter		Derived from	
7					Time		Time		as base scenario						Data in		Data in		UserInput	
8					Series		Series				Daily Distribution of User Supplied				Matrix		Matrix			
9					Here		Here		Sum		Monthly Alternative District Canal				AI66:AU103		AX66:BJ103		Sum	
10			39-yr Ave		284,177		559,697		843,874		Diversion				284,177		559,697		843,874	
11						1,257		2,404			Distributed as Daily Percentage of					1,257		2,404		
12						41		1			Monthly Total District Base Diversion					41		1		
13					0	0	0	0	0	0				Option>>	1	1	1	1	1	1
14					Values of Base Case - October 4, 2012															
15–19	Month Index	Date	Day	Days	Base MID Canal Diversion AF	Base MID Canal Diversion CFS	Base TID Canal Diversion AF	Base TID Canal Diversion CFS	Base Total Canal Diversion AF	Base Total Canal Diversion CFS	Base MID Mon Canal Diversion AF	MID % Day of Month Diversion	Base TID Mon Canal Diversion AF	TID % Day of Month Diversion	Alt MID Canal Diversion AF	Alt MID Canal Diversion CFS	Alt TID Canal Diversion AF	Alt TID Canal Diversion CFS	Alt Total Canal Diversion AF	Alt Total Canal Diversion CFS
20	1970.10	10/1/1970	T	31	1,053	531	2,789	1,406	3,842	1,937	20,952	0.05	31,487	0.09	1,053	531	2,789	1,406	3,842	1,937
21	1970.10	10/2/1970	F	31	860	434	1,311	661	2,171	1,094	20,952	0.04	31,487	0.04	860	434	1,311	661	2,171	1,094
22	1970.10	10/3/1970	S	31	840	424	1,154	582	1,994	1,006	20,952	0.04	31,487	0.04	840	424	1,154	582	1,994	1,006
23	1970.10	10/4/1970	S	31	918	463	2,220	1,119	3,139	1,582	20,952	0.04	31,487	0.07	918	463	2,220	1,119	3,139	1,582
24	1970.10	10/5/1970	M	31	915	461	1,453	733	2,368	1,194	20,952	0.04	31,487	0.05	915	461	1,453	733	2,368	1,194
25	1970.10	10/6/1970	T	31	973	491	1,668	841	2,641	1,332	20,952	0.05	31,487	0.05	973	491	1,668	841	2,641	1,332

Adjacent to the above illustrated area of computations are several components of data assemblage. The monthly time series columns serve to summarize daily Test Case diversions assumptions and provide user specified monthly diversions for daily parsing. The chronological matrices provide an alternative listing of the monthly data.

	A	B	C	D	AB	AC	AD	AE	AF	AG
1			1							
2	*Unit Title*		2							
3	*Parameter Title*		3							
4										
5	*Acre-foot to CFS conversion*					Monthly Time Series Data				
6	*divide by :*	*1.983471*					*Monthly*	*Enter*	*Monthly*	*Enter*
7							*from*	*Data in*	*from*	*Data in*
8							*Daily*	*Matrix*	*Daily*	*Matrix*
9							*Input*	*AI66:AU103*	*Input*	*AX66:BJ103*
10			*39-yr Ave*				*Pre-Proc*	*UserInput*	*Pre-Proc*	*UserInput*
11										
12						*39-yr Ave*	*284,177*	*284,177*	*559,697*	*559,697*
13							1	2	1	2
14							MID	MID	TID	TID
15							Base	Alt	Base	Alt
16							Assumpt	Assumpt	Assumpt	Assumpt
17	Month						Monthly	Monthly	Monthly	Monthly
18	Index	Date	Day	Days			Volume	Volume	Volume	Volume
19						Yr-Month	AF	AF	AF	AF
20	1970.10	10/1/1970	T	31		1970.10	20,952	20,952	31,487	31,487
21	1970.10	10/2/1970	F	31		1970.11	2,700	2,700	1,000	1,000
22	1970.10	10/3/1970	S	31		1970.12	2,500	2,500	1,000	1,000
23	1970.10	10/4/1970	S	31		1971.01	4,300	4,300	6,000	6,000
24	1970.10	10/5/1970	M	31		1971.02	3,300	3,300	8,000	8,000
25	1970.10	10/6/1970	T	31		1971.03	14,746	14,746	42,220	42,220

Monthly Matrix Time Series Data

User-defined District Canal Diversions at AI66:AU103 and AX66:BJ103

Test_Base MID Canal Assumption - Read from Time Series in Column AD

Acre-feet

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total WY
1971	20,952	2,700	2,500	4,300	3,300	14,746	30,656	42,917	47,253	54,987	49,086	32,192	305,589
1972	20,952	5,130	2,500	4,300	5,679	24,844	46,800	46,544	46,542	54,987	49,086	30,637	338,001
1973	20,952	2,700	2,500	4,300	3,300	14,746	23,737	45,374	47,016	54,987	49,086	32,658	301,356
1974	20,952	2,700	2,500	4,300	3,300	14,746	18,115	42,917	45,239	49,733	49,086	32,658	286,246
1975	20,952	5,460	2,500	4,300	3,300	14,746	28,782	44,672	47,253	54,859	43,423	32,658	302,906
1976	20,952	6,451	2,500	4,300	6,350	30,232	34,676	38,540	38,163	44,939	35,682	24,524	287,308

5.19 DPWSF Workheet

This worksheet (DPSWF) computes the Don Pedro Water Supply Factor (WSF). The premise of the WSF factor is to reduce the amount of water diverted to the canals during years when lack of carryover storage at Don Pedro Reservoir becomes a concern. The modeling mechanism used to reduce canal diversions is a factor applied to the PDAW of the canal demand. This mechanism results in a reduction to the amount of water "turned out" to the customers while still recognizing the relatively constant efficiencies of canal operations.

The WSF is established by forecasting upcoming water supply, based on antecedent storage and anticipated inflow to Don Pedro Reservoir. The forecasting procedure begins in February and ends in April. The Factor Table is based on April forecast results. The February and March Forecasts act as adjustments to get to the April 1 state. The forecasts have the following protocol:

February Forecast (forecasting April 1 state):

End of January storage + Feb-Jul UF - Feb-Jul US adjustment - Feb-Mar minimum river

March Forecast (forecasting April 1 state):

End of February storage + Mar-Jul UF - Mar-Jul US adjustment - Mar minimum river

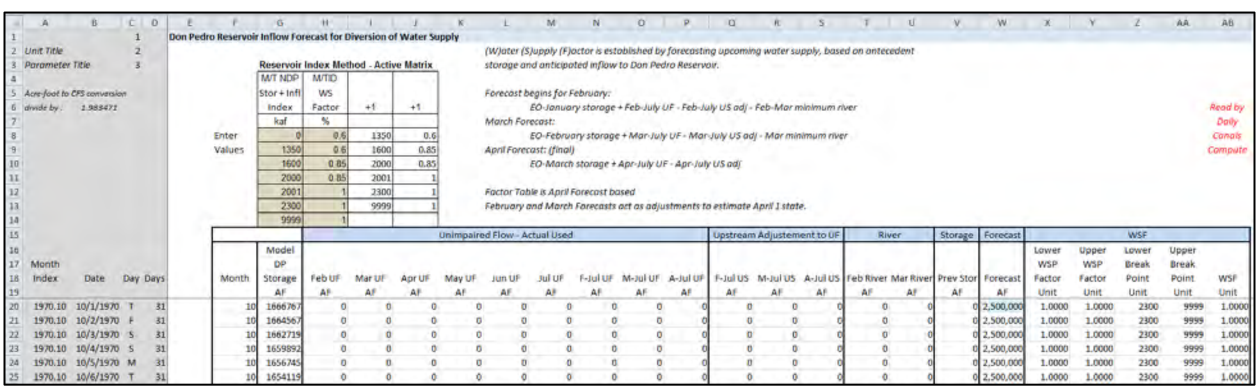
April Forecast: (final)

End of March storage + Apr-Jul UF - Apr-July US adjustment

Pre-knowledge of unimpaired runoff for each forecast period is assumed, as well as knowledge of upcoming upstream impairment of the runoff.

The WSF factor / Don Pedro Storage + Inflow relationship is developed through iterations of multi-year system operation simulations. The WSF depicts actions that may be implemented during times of drought, and the projected canal diversions and reservoir storage operation during drought periods. The factors and index triggers were developed reviewing reservoir storage levels that occurred during the 1987-1992 drought.

A snapshot of the worksheet is shown below.



Don Pedro Reservoir Inflow Forecast for Diversion of Water Supply

Unit Title 2
Parameter Title 3
Acre-foot to CFS conversion
divide by : 1.983471

Reservoir Index Method - Active Matrix

	M/T NDP Stor + Infl Index	M/TID WS Factor	+1	+1
	kaf	%		
Enter	0	0.6	1350	0.6
Values	1350	0.6	1600	0.85
	1600	0.85	2000	0.85
	2000	0.85	2001	1
	2001	1	2300	1
	2300	1	9999	1
	9999	1		

(W)ater (S)upply (F)actor is established by forecasting upcoming water supply, based on antecedent storage and anticipated inflow to Don Pedro Reservoir.

Forecast begins for February:
EO-January storage + Feb-July UF - Feb-July US adj - Feb-Mar minimum river
March Forecast:
EO-February storage + Mar-July UF - Mar-July US adj - Mar minimum river
April Forecast: (final)
EO-March storage + Apr-July UF - Apr-July US adj

Factor Table is April Forecast based
February and March Forecasts act as adjustments to estimate April 1 state.

Read by Daily Canals Compute

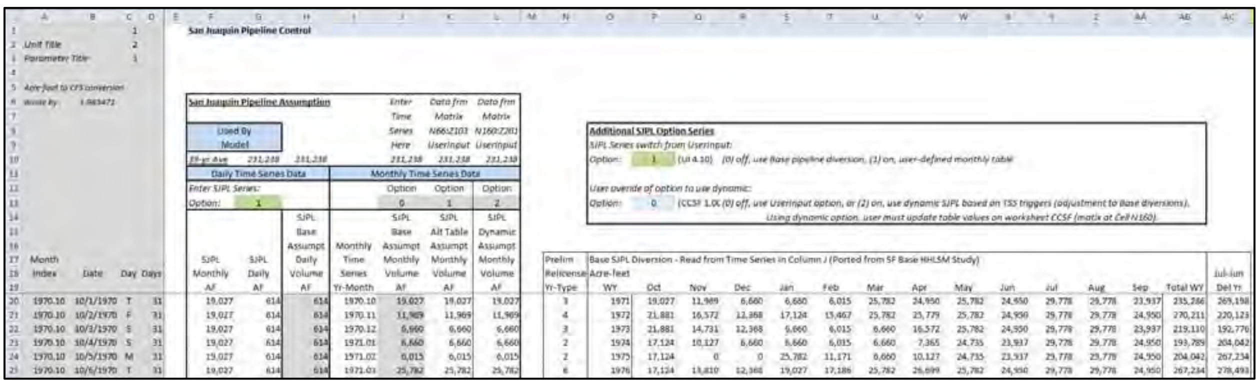
Month Index	Date	Day	Days	Month	Model DP Storage AF	Unimpaired Flow - Actual Used: Feb UF AF	Mar UF AF	Apr UF AF	May UF AF	Jun UF AF	Jul UF AF	F-Jul UF AF	M-Jul UF AF	A-Jul UF AF	Upstream Adjustement to UF: F-Jul US AF	M-Jul US AF	A-Jul US AF	River: Feb River AF	Mar River AF	Storage: Prev Stor AF	Forecast: Forecast AF	WSF: Lower WSP Factor Unit	Upper WSP Factor Unit	Lower Break Point Unit	Upper Break Point Unit	WSF Unit
1970.10	10/1/1970	T	31	10	1666767	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,500,000	1.0000	1.0000	2300	9999	1.0000
1970.10	10/2/1970	F	31	10	1664567	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,500,000	1.0000	1.0000	2300	9999	1.0000
1970.10	10/3/1970	S	31	10	1662719	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,500,000	1.0000	1.0000	2300	9999	1.0000
1970.10	10/4/1970	S	31	10	1659892	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,500,000	1.0000	1.0000	2300	9999	1.0000
1970.10	10/5/1970	M	31	10	1656745	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,500,000	1.0000	1.0000	2300	9999	1.0000
1970.10	10/6/1970	T	31	10	1654119	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,500,000	1.0000	1.0000	2300	9999	1.0000

5.20 CCSF Workheet

This worksheet (CCSF) identifies, assembles and directs several elements of CCSF System operations, and provides input to other Model component worksheets.

San Joaquin Pipeline Diversions

The first section of logic concerns the identification of SJPL diversions. A snapshot of this section is shown below. By user selection (UI 4.10) either pre-processed Test Case SJPL diversions are used, or a user specified table of monthly diversions for the simulation period are used. This section assembles the user selected version of diversions for use by the Model. These two versions of SJPL diversions are available for selection through worksheet UserInput. If access is granted, a third version of SJPL diversions is provided which revises Test Case diversions based on circumstances of the scenario that changes CCSF's operation. Procedures are described below the monthly diversion matrix describing how to employ this third version of SJPL diversions.


San Joaquin Pipeline Control

San Joaquin Pipeline Assumption

Used By Model

Additional SJPL Option Series
SJPL Series switch from UserInput:
Option: 1 (UI 4.10) (0) off, use Base pipeline diversion, (1) on, user-defined monthly table
User override of option to use dynamic:
Option: 0 (CCSF 1.0((0) off, use UserInput option, or (2) on, use dynamic SJPL based on TSS triggers (adjustment to Base diversions).
Using dynamic option, user must update table values on worksheet CCSF (matix at Cell N160).

Month Index	Date	Day	Days	SJPL Monthly AF	SJPL Daily AF	SJPL Base Assumpt Daily Volume AF	Monthly Time Series Yr-Month	SJPL Base Assumpt Monthly Volume AF (Option 0)	SJPL Alt Table Assumpt Monthly Volume AF (Option 1)	SJPL Dynamic Assumpt Monthly Volume AF (Option 2)
							Enter Time Series Here	Data frm Matrix N66:Z103 UserInput	Data frm Matrix N160:Z201 UserInput	
39-yr Ave				231,238	231,238			231,238	231,238	231,238
1970.10	10/1/1970	T	31	19,027	614	614	1970.10	19,027	19,027	19,027
1970.10	10/2/1970	F	31	19,027	614	614	1970.11	11,969	11,969	11,969
1970.10	10/3/1970	S	31	19,027	614	614	1970.12	6,660	6,660	6,660
1970.10	10/4/1970	S	31	19,027	614	614	1971.01	6,660	6,660	6,660
1970.10	10/5/1970	M	31	19,027	614	614	1971.02	6,015	6,015	6,015
1970.10	10/6/1970	T	31	19,027	614	614	1971.03	25,782	25,782	25,782

Base SJPL Diversion - Read from Time Series in Column J (Ported from SF Base HHLSM Study)
Acre-feet

Prelim Relicense Yr-Type	WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total WY	Jul-Jun Del Yr
3	1971	19,027	11,969	6,660	6,660	6,015	25,782	24,950	25,782	24,950	29,778	29,778	23,937	235,266	269,198
4	1972	21,881	16,572	12,368	17,124	15,467	25,782	25,779	25,782	24,950	29,778	29,778	24,950	270,211	220,123
3	1973	21,881	14,731	12,368	6,660	6,015	6,660	16,572	25,782	24,950	29,778	29,778	23,937	219,110	192,776
2	1974	17,124	10,127	6,660	6,660	6,015	6,660	7,365	24,735	23,937	29,778	29,778	24,950	193,789	204,042
2	1975	17,124	0	0	25,782	11,171	6,660	10,127	24,735	23,937	29,778	29,778	24,950	204,042	267,234
6	1976	17,124	13,810	12,368	19,027	17,186	25,782	26,699	25,782	24,950	29,778	29,778	24,950	267,234	278,493

CCSF System Storage and Action Levels

This section of logic provides reporting and computational functions. The CCSF System action level computation analyzes scenario results concerning CCSF's reservoir storage and extrapolates that information into advised action levels within the CCSF System. Germane to the FERC investigation is the potential effect that flow responsibility placed upon CCSF may have upon its water system and deliveries. The relationship between CCSF System reservoir storage and action levels (translated to increased delivery rationing) is incorporated into this worksheet. Upon changed conditions within a scenario (as compared to Test Case conditions), the change in action levels is identified. This change is also provided the SJPL diversion logic described above, and if allowed to be selected this worksheet will perform an adjustment to SJPL diversions.

San Francisco System Storage and Action Levels

	A	B	C	D
1			1	
2	Unit Title		2	
3	Parameter Title		3	
5	Acre-foot to CFS conversion			
6	divide by :	1.983471		

	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN
2	Level	AF	AF	AF	AF	AF	AF	AF	AF	
3	Plng Mod	Hetch Het	Lake Lloyd	Lake Eleanor	Storage		Total HH S	Local Stor	Total Syst	Model Action Level

SF System Storage and Action Level Status - Daily Time Series Data

Linked to SF Base HHLSM Study "Hydrology" — *Use Only Last Day of Month Plotting*

Scenario Model Results plus SF Base HHLSM Study Local System Storage

Row	Month Index	Date	Day	Days	Base Action Level	Scenario Hetch Hetchy Storage AF	Scenario Lake Lloyd Storage AF	Scenario Lake Eleanor Storage AF	Scenario Water Bank Balance AF	Scenario Total Upcountry Storage AF	Scenario Total HH System Storage AF	Base Local Storage Incl GW EOM AF	Total System Storage Incl GW EOM AF	Scenario Action Level
20	1970.10	10/1/1970	T	31	0	249,349	200,091	17,591	570,000	467,031	1,037,031	211,136	3,000,000	0
21	1970.10	10/2/1970	F	31	0	248,379	200,080	17,137	570,000	465,596	1,035,596	211,136	3,000,000	0
22	1970.10	10/3/1970	S	31	0	247,622	200,090	16,692	570,000	464,404	1,034,404	211,136	3,000,000	0
23	1970.10	10/4/1970	S	31	0	247,032	199,278	15,878	570,000	462,189	1,032,189	211,136	3,000,000	0
24	1970.10	10/5/1970	M	31	0	246,150	199,896	15,707	569,744	461,752	1,031,496	211,136	3,000,000	0
25	1970.10	10/6/1970	T	31	0	245,360	199,781	15,206	570,000	460,347	1,030,347	211,136	3,000,000	0

SF System Action Level Computation

Actions Level	BaseTrigger C2a.30	BaseAction C2a.30	ScenarioT	ScenarioA	
0		0			
1	1,100,000	10	1,100,000	10	CCSF 2.00
2	1,100,000	10	1,100,000	10	
3	700,000	20	700,000	20	

Action Level Count

Level	Base Count	Scenario Count
0	33	33
1	0	0
2	6	6
3	0	0
Total	39	39

SF Action Level & SJPL Adjustment

EO-Jun	Year	SF Base June 30 TSS AF ("Hydrology")	SF Base Action Level (0-3)	Scenario June 30 TSS AF	Scenario Action Level (0-3)

Hetch Hetchy Reservoir Control

This section of logic identifies several underlying operation constraints for Hetch Hetchy Reservoir. Snapshots of this section are shown below. The minimum stream release below Hetch Hetchy Reservoir is computed in this section. Also identified in this section are reservoir storage targets and limits. This information is used in worksheet SFHetchHetchy for several operational constraints and objectives.

Hetch Hetchy Reservoir Control (BH1: 15,000; BI1: 6,500; BJ1: 4,400)

Schedule Index - Accum Inches or Storage

Cal Mon	A (1)	B (2)	C (3)
1	8.80	6.1	
2	14	9.5	
3	18.6	14.2	
4	23	18	
5	26.6	19.5	
6	28.45	21.25	
7	575,000	390,000	
8	640,000	400,000	

Below Hetch Hetchy Requirement - CFS

Cal Mon	A (1)	B (2)	C (3)
1	50	40	35
2	60	50	35
3	60	50	35
4	75	65	35
5	100	80	50
6	125	110	75
7	125	110	75
8	125	72.5	75
9	90	65	62.5
10	60	50	35
11	60	50	35
12	50	40	35

Discretionary Schedule - Acre-feet

Cal Mon	A (1)	B (2)	C (3)
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0
7	0	0	0
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
12	0	0	0

Row	Month Index	Date	Day	Days	HH Accum Precip beginning Oct 1 Inches	Sum of WY HH Inflow To Date AF	Trigger Due to Inflow Jul-Dec AF	Schedule Due to Inflow Jul	Schedule Due to Inflow Aug - Dec	Jan Schedule	Feb Schedule	Mar Schedule	Apr Schedule	May Schedule	Jun Schedule	10 Oct Schedule CFS	11 Nov Schedule CFS	12 Dec Schedule CFS
19							709,538		1									
20	1970.10	10/1/1970	T	31	0.73	157	709,538	0	1	0	0	0	0	0	0	60	0	0
21	1970.10	10/2/1970	F	31	0.73	-6	709,538	0	1	0	0	0	0	0	0	60	0	0
22	1970.10	10/3/1970	S	31	0.73	44	709,538	0	1	0	0	0	0	0	0	60	0	0
23	1970.10	10/4/1970	S	31	0.73	262	709,538	0	1	0	0	0	0	0	0	60	0	0
24	1970.10	10/5/1970	M	31	0.73	186	709,538	0	1	0	0	0	0	0	0	60	0	0
25	1970.10	10/6/1970	T	31	0.73	204	709,538	0	1	0	0	0	0	0	0	60	0	0

Row	Month Index	Date	Day	Days	1 Jan Schedule CFS (BK)	2 Feb Schedule CFS (BL)	3 Mar Schedule CFS (BM)	4 Apr Schedule CFS (BN)	5 May Schedule CFS (BO)	6 Jun Schedule CFS (BP)	7 Jul Schedule CFS (BQ)	8 Aug Schedule CFS (BR)	9 Sep Schedule CFS (BS)	Basic Schedule AF (BT)	Discret Schedule AF (BU)	Min HH Basic + Discret Schedule AF (BV)	Canyon 64 cfs Schedule AF (BW)	w/ 64 cfs Total Min HH Schedule AF (BX)	w/ 64 cfs Total Min HH Schedule CFS (BY)	Day Chg Target (CA)	Target (CB)
19																					360,360
20	1970.10	10/1/1970	T	31	0	0	0	0	0	0	0	0	0	119	0	119		119	60	-979	359,381
21	1970.10	10/2/1970	F	31	0	0	0	0	0	0	0	0	0	119	0	119	0	119	60	-979	358,401
22	1970.10	10/3/1970	S	31	0	0	0	0	0	0	0	0	0	119	0	119	0	119	60	-979	357,422
23	1970.10	10/4/1970	S	31	0	0	0	0	0	0	0	0	0	119	0	119	0	119	60	-979	356,443
24	1970.10	10/5/1970	M	31	0	0	0	0	0	0	0	0	0	119	0	119	0	119	60	-979	355,463
25	1970.10	10/6/1970	T	31	0	0	0	0	0	0	0	0	0	119	0	119	0	119	60	-979	354,484

Notes in the sheet: BU — "Month on 5 — Does not include offramp of Discret "C" Sch due to HH Stor"; BV — "Does not include Canyon 64 cfs"; BW — "Lagged by 1 day to avoid circular reference". BX2/BY2: AF / CFS; BX3/BY3: Total Mini / Total Mini.

Target Storage - Acre-feet

Cal Mon	Target EOM	Limit EOM
0	320000	
1	320,000	360,360
2	320,000	360,360
3	320,000	360,360
4	320,000	360,360
5	360,360	360,360
6	360,360	360,360
7	360,360	360,360
8	360,360	360,360
9	360,360	360,360
10	330,000	360,360
11	320,000	360,360
12	320,000	360,360

Lake Lloyd Control

This section of logic identifies several underlying operation constraints for Lake Lloyd. A snapshot of this section is shown below. The minimum stream release below Lake LLoyd is computed in this section. Also identified in this section are reservoir storage targets and limits, and the target release objective for Holm Powerhouse. The maximum drawdown of Lake Lloyd due to supplemental releases is identified. This information is used in worksheet SFLloyd for several operational constraints and objectives.

	A	B	C	D	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CQ	CR	CS	CT	CU	CV
1			1			Lake Lloyd and Lake Eleanor Control																
2	Unit Title		2			Lloyd Target Storage - Acre-feet				Lake Lloyd/Lake Eleanor Split of Combined Inflow						Blw Lake Lloyd - CFS			Holm Target Releases			
3	Parameter Title		3				Soft Trgt	Hard Limit			Lloyd	Eleanor				Cal Mon	Req					
4						Cal Mon	EOM	EOM		Cal Mon	%	%	Note:			1	5		May (Memorial Day) thru			
5	Acre-foot to CFS conversion					0	238,000			1	53	47	Watershed			2	5		August (Labor Day)			
6	divide by	1.983471				1	238,000	273,300		2	52	48	proportions			3	5		Holm Capacity		950	cfs
7						2	238,000	273,300		3	52	48	were developed			4	5			Day	1,884	acre-feet
8						3	238,000	273,300		4	57	43	from the record			5	5			4-hours per day	314	acre-feet
9						4	273,300	273,300		5	65	35	of runoff each basin			6	5					
10						5	273,300	273,300		6	72	28	basin prior to 1960.			7	15.5		Minimum Lloyd Storage to Draw			
11						6	273,300	273,300		7	72	28				8	15.5		for Water Bank/Supplemental Release			
12						7	268,000	273,300		8	56	44				9	15.5		Release:	45,000	acre-feet	CCSF 3.00
13						8	258,000	273,300		9	52	48				10	5					
14						9	248,000	273,300		10	69	31				11	5			May-Aug		
15						10	248,000	273,300		11	58	42				12	5			Min		
16						11	238,000	273,300		12	57	43								Holm		
17	Month					12	238,000	273,300		Total	Lloyd	Lloyd	Eleanor	Eleanor		Min Req	Min Req			Target		
18	Index	Date	Day	Days		Day Chg	Target			Inflow	Inflow	Inflow	Inflow	Inflow		Release	Release			Release		
19						Target	248,000			CFS	CFS	AF	CFS	AF		CFS	AF		CFS	AF		
20	1970.10	10/1/1970	T	31		0	248,000			81	56	111	25	50		5	10		0	0		
21	1970.10	10/2/1970	F	31		0	248,000			7	5	10	2	4		5	10		0	0		
22	1970.10	10/3/1970	S	31		0	248,000			22	15	30	7	14		5	10		0	0		
23	1970.10	10/4/1970	S	31		0	248,000			-578	-399	-791	-179	-355		5	10		0	0		
24	1970.10	10/5/1970	M	31		0	248,000			466	322	638	144	287		5	10		0	0		
25	1970.10	10/6/1970	T	31		0	248,000			-69	-48	-94	-21	-42		5	10		0	0		

Lake Eleanor Control

This section of logic identifies several underlying operation constraints for Lake Eleanor. A snapshot of this section is shown below. The minimum stream release below Lake LLoyd is computed in this section. Also identified in this section are reservoir storage targets and limits. This information is used in worksheet SFEleanor for several operational constraints and objectives.

	A	B	C	D	CW	CX	CY	CZ	DA	DB	DC	DD
1			1									
2	Unit Title		2			Blw Lake Eleanor - CFS				Eleanor Target Storage - Acre-f		
3	Parameter Title		3				w/Pump	w/o			Soft Trgt	Hard Limit
4						Cal Mon	Req	Req		Cal Mon	EOM	EOM
5	Acre-foot to CFS conversion					1	5	5		0	18,250	
6	divide by	1.983471				2	5	5		1	21,495	27,100
7						3	10	5		2	21,495	27,100
8						4	15	5		3	21,495	27,100
9						5	20	5		4	27,100	27,100
10						6	20	5		5	27,100	27,100
11						7	20	16		6	27,100	27,100
12						8	20	16		7	27,100	27,100
13						9	15	16		8	27,100	27,100
14						10	10	5		9	15,000	27,100
15						11	5	5		10	15,000	27,100
16						12	5	5		11	15,000	27,100
17	Month					Min Req	Min Req	Always		12	18,250	27,100
18	Index	Date	Day	Days		Release	Release	Assume		Day Chg	Target	
19						CFS	AF	Pump		Target	15,000	
20	1970.10	10/1/1970	T	31		10	20			0	15,000	
21	1970.10	10/2/1970	F	31		10	20			0	15,000	
22	1970.10	10/3/1970	S	31		10	20			0	15,000	
23	1970.10	10/4/1970	S	31		10	20			0	15,000	
24	1970.10	10/5/1970	M	31		10	20			0	15,000	
25	1970.10	10/6/1970	T	31		10	20			0	15,000	

5.21 Hydrology Workheet

This worksheet (Hydrology) identifies and assembles underlying watershed hydrologic data necessary for Model operation. Required elements of historical hydrology include inflows to CCSF System reservoirs and the unregulated inflow to Don Pedro Reservoir. Also necessary are certain Test Case conditions for the CCSF System, namely Test Case SJPL diversions and water delivery (action levels) associated with Test Case conditions. Also needed is the status of local watershed reservoir storage associated with the Test Case condition.

5.22 602020 Workheet

This worksheet (602020) identifies and assembles underlying watershed hydrologic data necessary for Model operation. Included is the computation of the San Joaquin River Index. Also included are published results of DWR runoff forecasts.

Attachment B

December 7, 2012 Operations Model (W&AR-02) Workshop Notes

Don Pedro Project Relicensing
Operations Model Workshop and Training Session (W&AR-02)
Final Meeting Notes
December 7, 2012
HDR Office, Sacramento

Attendees

Bob Hackamack	Donn Furman, CCSF
Patrick Koepele, Tuolumne River Trust	Bob Hughes, CDFG
Chris Shutes, CSPA	Jenna Borovansky, HDR
Annie Manji, CDFG	Dan Steiner, consultant to TID/MID
Larry Thompson, NMFS	Rob Sherrick, HDR
Ramon Martin, USFWS	Rick Jones, HDR
Carin Loy, HDR	Monica Gutierrez, NMFS (by phone)
Ellen Levin, CCSF	Tim Heyne, CDFG (by phone)
Tim Findley, Bay Area Water Users (by phone)	Chandra Ferrari, Trout Unlimited (by phone)

Meeting Materials

Meeting materials are attached to the Final Notes filed with FERC.

Meeting materials provided were:

- Agenda (attached)
- PowerPoint Presentation (attached)
- Model Version 1.01 (provided at the meeting—and available by request to the Districts)

Meeting Summary

Mr. Steiner illustrated validation of the operations model and reviewed validation information. The meeting PowerPoint presentation is attached. Mr. Steiner explained the validation approach.

Mr. Hughes noted that synthesized unimpaired hydrology reflecting CDFG comments was not in the validation. Mr. Steiner replied that the validation used historical hydrology when appropriate to illustrate the validity of model logic; Mr. Steiner noted that the Districts will be replying to CDFG's recent letter to the SWRCB regarding CDFG's suggested approach to the unimpaired hydrology dataset.

Mr. Steiner reviewed validation materials with the group comparing historical to modeled information. Discussion regarding the modeling logic of accounting for snowmelt, flood control rules, and other factors previously covered in the October 23, 2012 Workshop also occurred during the demonstration and training.

Mr. Martin asked if pulse flows are provided for in the model. Mr. Steiner noted that flows are modeled at a daily level based on the monthly FERC required minimum flows. Mr. Steiner confirmed that VAMP flow is not shown in the current "test case" of the model. However, definition of a pulse flow during April and May is available within the model. October currently does not include a daily pulse flow capability.

Ms. Manji asked if there was any point at which high flows downstream in the SJR would trump the minimum flows in the Tuolumne River. Mr. Furman replied that no, this is not the case.

Mr. Steiner noted that the model validation for generation is still underway and that the Districts will provide this to Relicensing Participants for review when available in early 2013. A question was asked whether the model will include value of generation. Mr. Steiner noted that the value of generation is not a model component, but the Districts will be including this information in the license application (Exhibit D).

As part of the model training, Mr. Steiner walked Relicensing Participants through an example modeling scenario and addressed questions from participants regarding model assumptions, inputs, and outputs. There were questions regarding which elements of the model can be user-specified (i.e, "knobs") and which do not. Mr. Steiner noted that the model includes all the variables and "knobs" identified in the FERC-approved study plan.

Don Pedro Project Relicensing
W&AR-02: Tuolumne River Operations Model
Model Validation and User Training
December 7, 2012
10:00 a.m. to 4:00 p.m.

TRAINING LOCATION
HDR's Sacramento Office, located at 2379 Gateway Oaks Drive, Suite 200

CONFERENCE CALL-IN NUMBER
Conference Call-In Number 866-994-6437; Conference Code 542 469 7994

ON-LINE MEETING LINK

Join online meeting
https://meet.hdrinc.com/jenna.borovansky/3D64F0F5

First online meeting?

NOTE: If this is your first time attending an ONLINE MEETING, you will need to click on the "First online meeting?" link to load the ONLINE MEETING program. It is best that you do this step PRIOR to the meeting start.

EQUIPMENT NEEDS
Please bring your computer to this training session

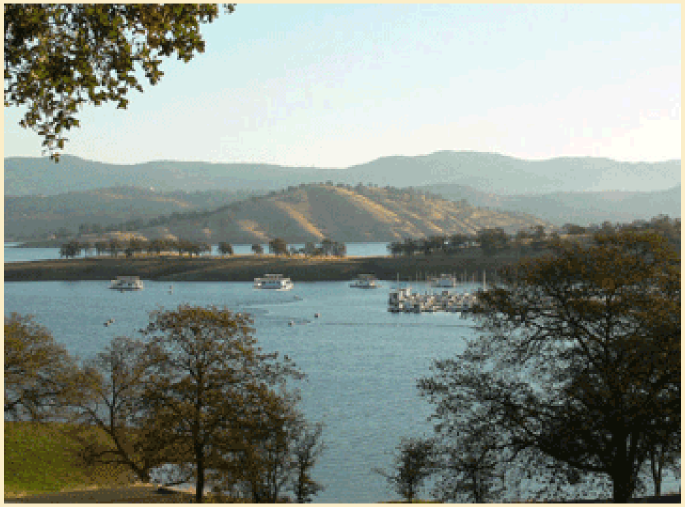
AGENDA

10:00 a.m. - 10:15 a.m.	Introductions and Meeting Purpose
10:15 a.m. - 11:30 a.m.	Operations Model Validation
11:30 a.m. - 12:00 p.m.	Lunch break (pizza to be provided)
12:00 p.m. - 4:00 p.m.	Operations Model User Training

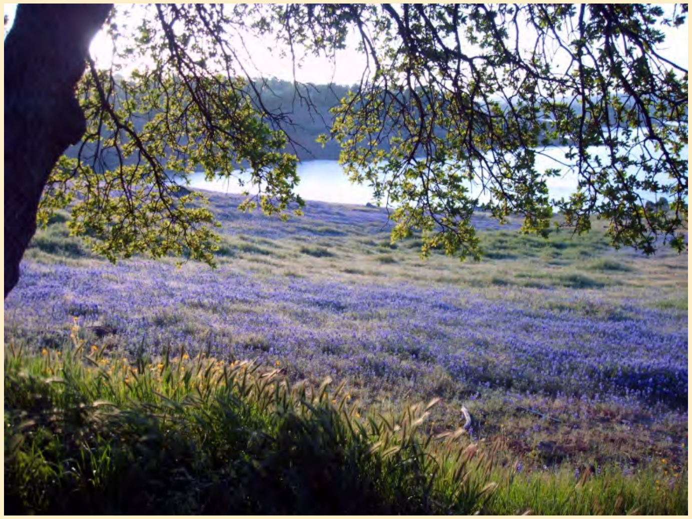
Don Pedro Project Relicensing

W&AR-2: Project Operations Model Training Session and Model Validation

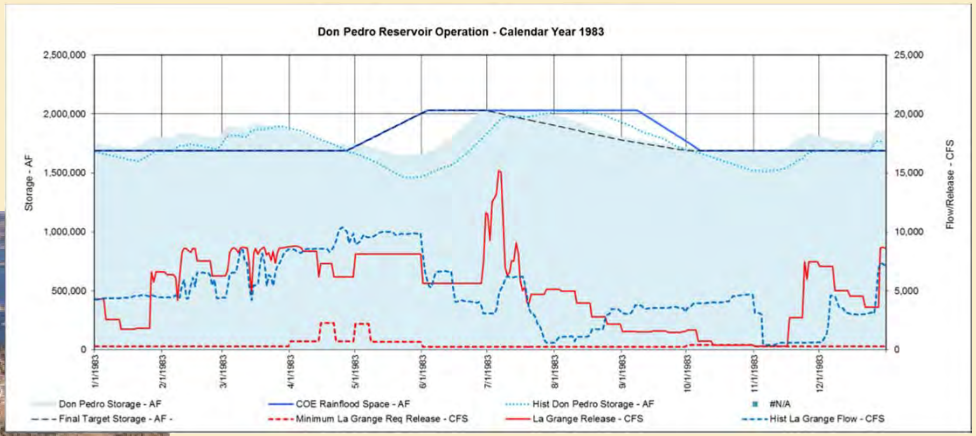
MODESTO IRRIGATION DISTRICT | TURLOCK IRRIGATION DISTRICT



FERC PROJECT No. 2299



Tuolumne River
Daily Operations Model



W&AR-2 Training Session and Model Validation
December 7, 2012

Agenda and Topics

- Introductions and Meeting Purpose
- Operations Model Validation
- Operations Model User Training

Purpose

- Review Path Forward
- Illustrate Model Validation
- Receive Feedback on Model
- Provide Additional Training on Model Use

Prior Workshops

- **Workshop #1 --- April 9, 2012**
  - Model Overview and Development of Don Pedro Unimpaired Flow Data Set
- **Workshop #2 -- September 21, 2012**
  - Accretion Flow Measurement Results and Proposed Hydrologic Investigations
- **Workshop #3 -- October 23, 2012**
  - Model Description and Users' Guide, and Initial Training to Model Use

Future Path

- Today – Illustration of Model Validation / User Training
- January – ISR Submittal on January 17, 2013; ISR Meeting on January 30/31, 2013
- March 20, 2013 (Preliminary) – Training on Integrating the Use of all Three Project Models (Ops Model, Two Temp Models)

Model Validation

- Validation is used to illustrate the "wellness" of the Model to assist in evaluating alternative Project operations as part of the relicensing process
- The Model is only a depiction of project operations, and is limited to representing CCSF and District operations to the extent that their operations can be described numerically and consistently by various equations and algorithms
- Model results are used to compare scenarios

Model Validation

- The historical operation of the two systems serve as the Model's validation comparison
- Actual operations of the two independently operated systems may vary from those depicted by the Model due to circumstantial conditions of hydrology and weather, facility operation, and complicated and sometimes inconsistent human decisions

Model Validation

- The tuning of the Model is intended to provide a depiction that represents a "here and now" Tuolumne River, a contemporary model for the operations of the two systems
- The historical record of operations represents real-time decision making about facilities, water use and operations

Model Validation

Elements of Validation

- Don Pedro Reservoir Storage and Stream Release
- Consideration of Modesto Flood Management Objective
- Don Pedro Reservoir Inflow and CCSF Upstream Operation
- District Canal Diversions
- Don Pedro Project Hydroelectric Generation

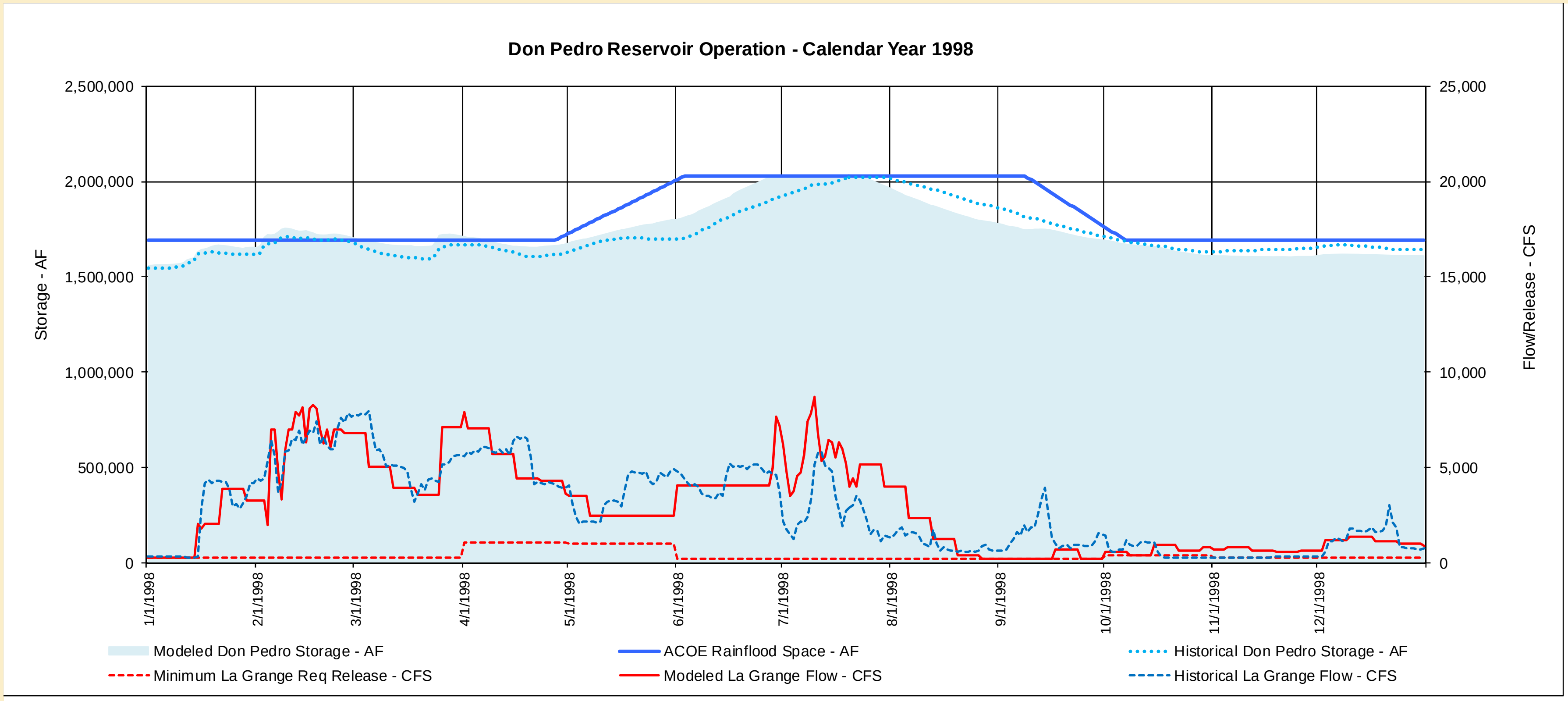
Model Validation

Don Pedro Reservoir Storage and Stream Release

- At previous workshop we discussed reservoir operation goals/algorithms
  - Minimum releases from reservoir
    - Instream flow requirements
    - Diversion demand - MID/TID Canals
  - Additional releases for reservoir and release management
    - Flood control
    - Snowmelt release management
    - Other storage goals

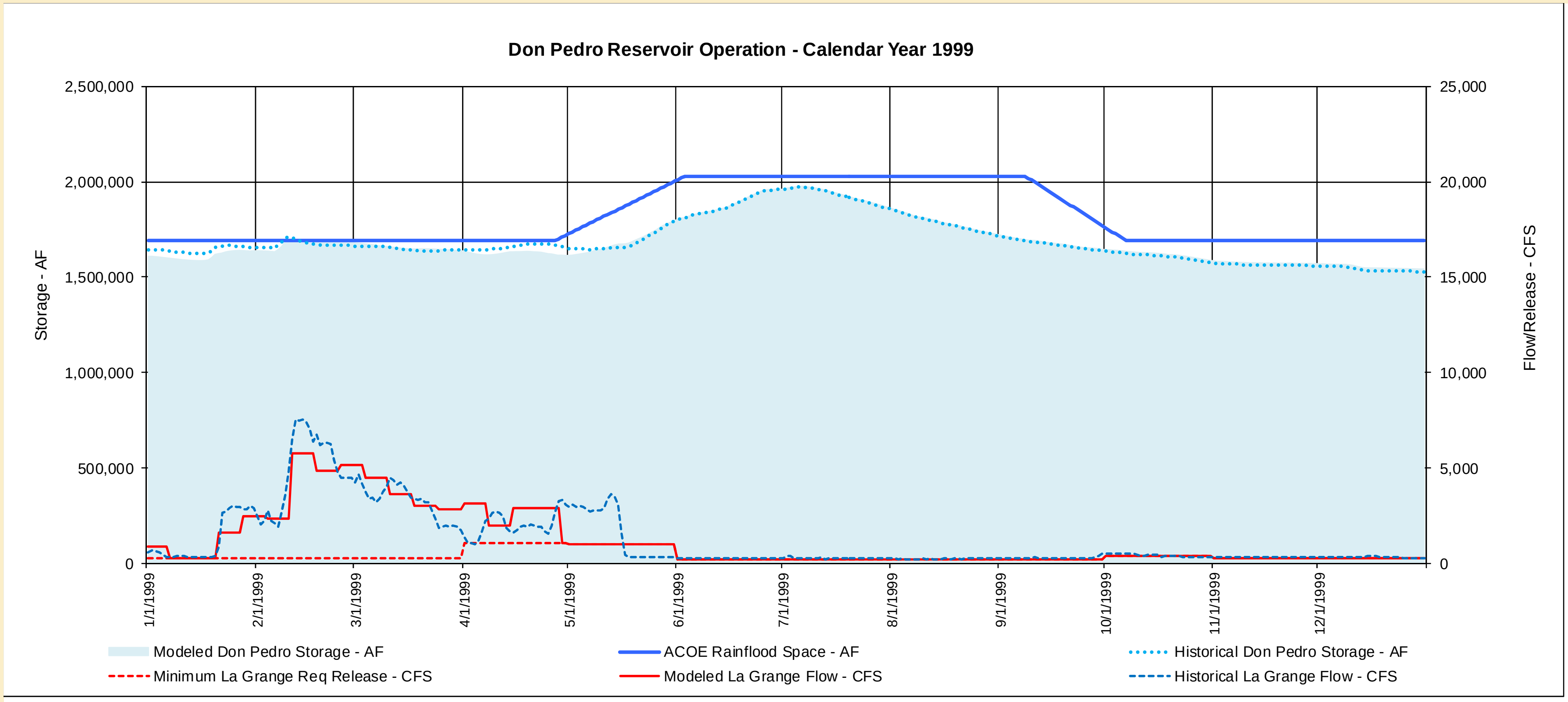
Model Validation

Don Pedro Reservoir Storage and Stream Release



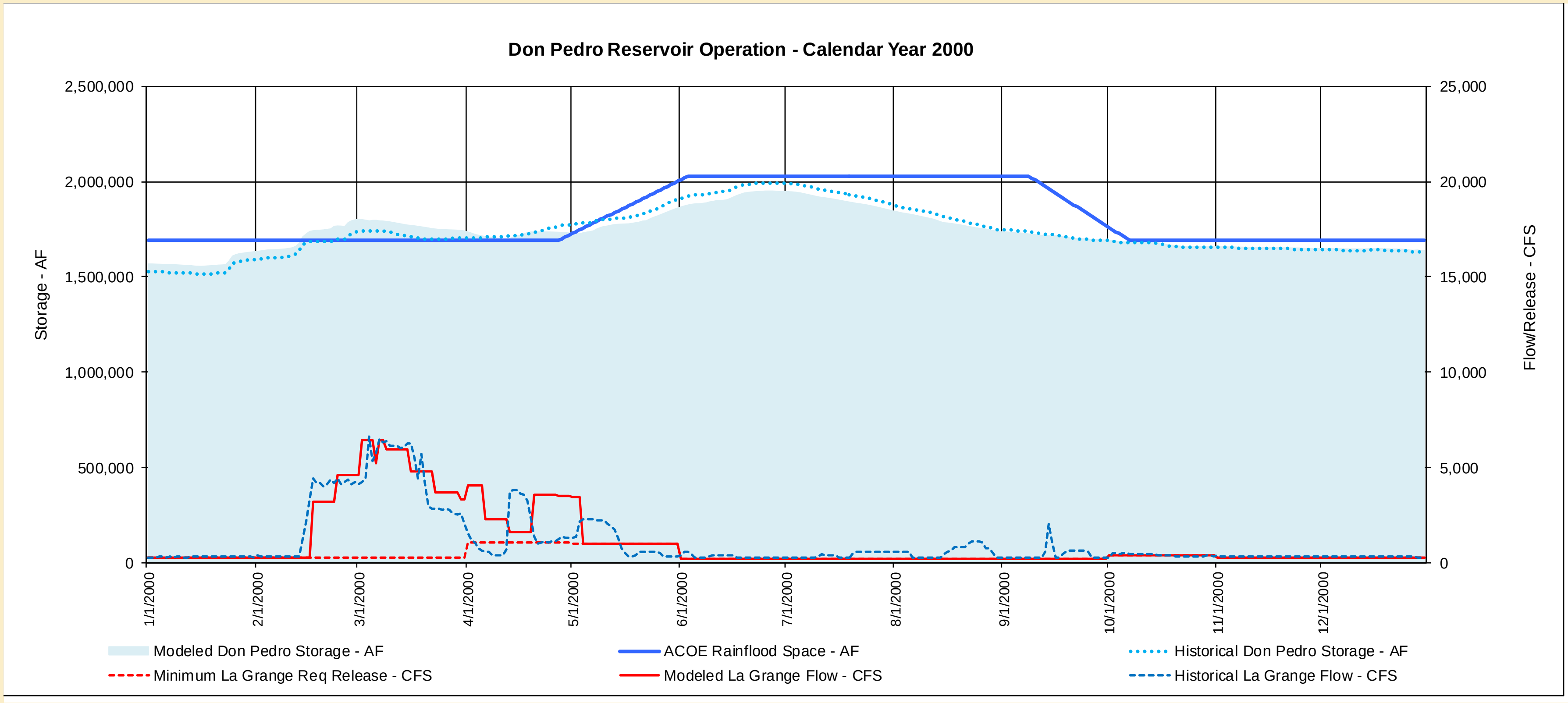
Model Validation

Don Pedro Reservoir Storage and Stream Release



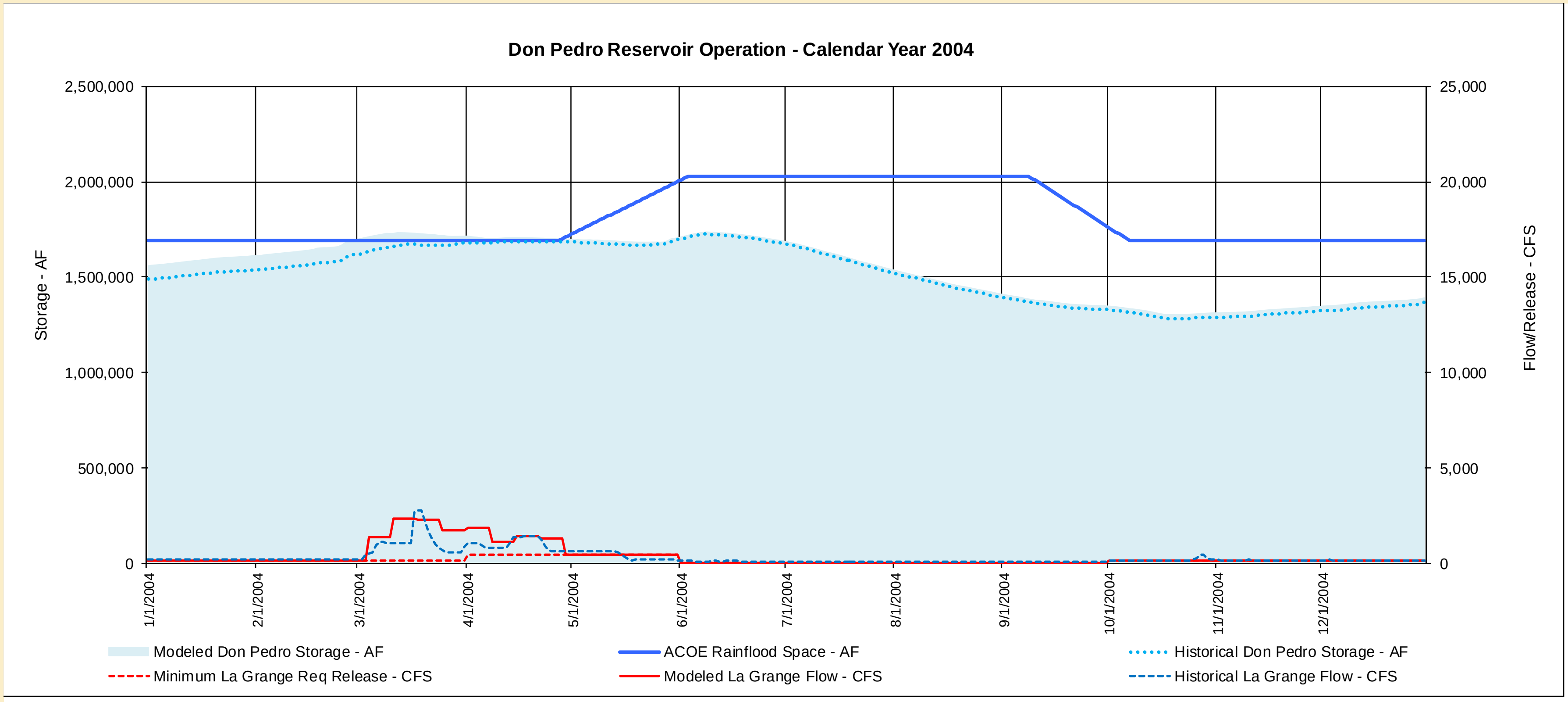
Model Validation

Don Pedro Reservoir Storage and Stream Release



Model Validation

Don Pedro Reservoir Storage and Stream Release



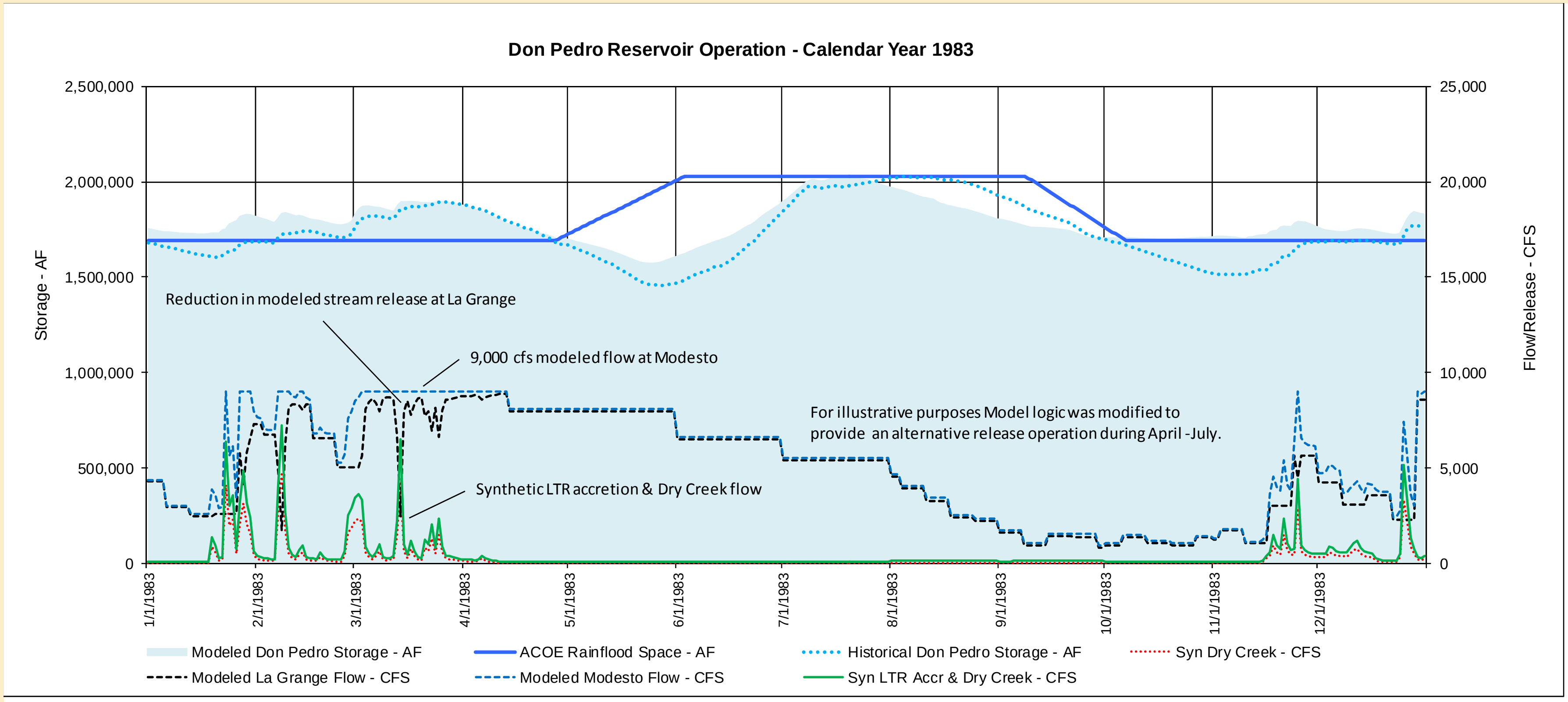
Model Validation

Consideration of Modesto Flood Management Objective

- Flood management operations are constrained due to flood flow guidelines at the Modesto 9th Street Bridge location
  - ACOE flood flow guideline at the Modesto location is to not exceed 9,000 cfs
  - Accretion flow in Lower Tuolumne River and flow from Dry Creek
- Model will decrease the release from Don Pedro Reservoir in order to maintain the flow objective

Model Validation

Consideration of Modesto Flood Management Objective



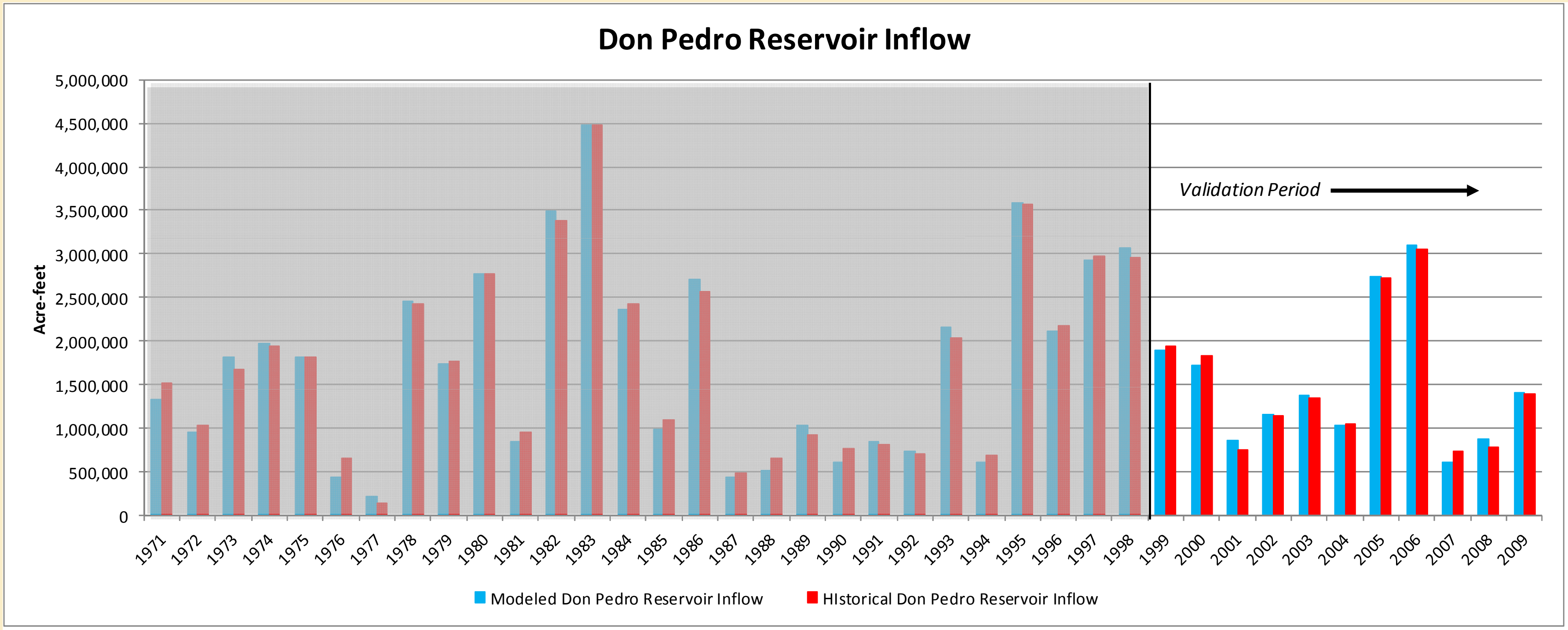
Model Validation

Don Pedro Reservoir Inflow and CCSF Upstream Operation

- The operation of CCSF's facilities upstream of Don Pedro Reservoir has changed throughout the modeling period
  - Model incorporates a contemporary operation of CCSF's system layered on top of the underlying hydrology of the basin
  - Incorporates the diversion demand of the San Joaquin Pipeline (SJPL) which is developed by the CCSF planning model
- The upstream operation leads to the depiction of inflow to Don Pedro Reservoir
  - The inflow to Don Pedro Reservoir is constructed of two components, regulated and unregulated inflow

Model Validation

Don Pedro Reservoir Inflow and CCSF Upstream Operation



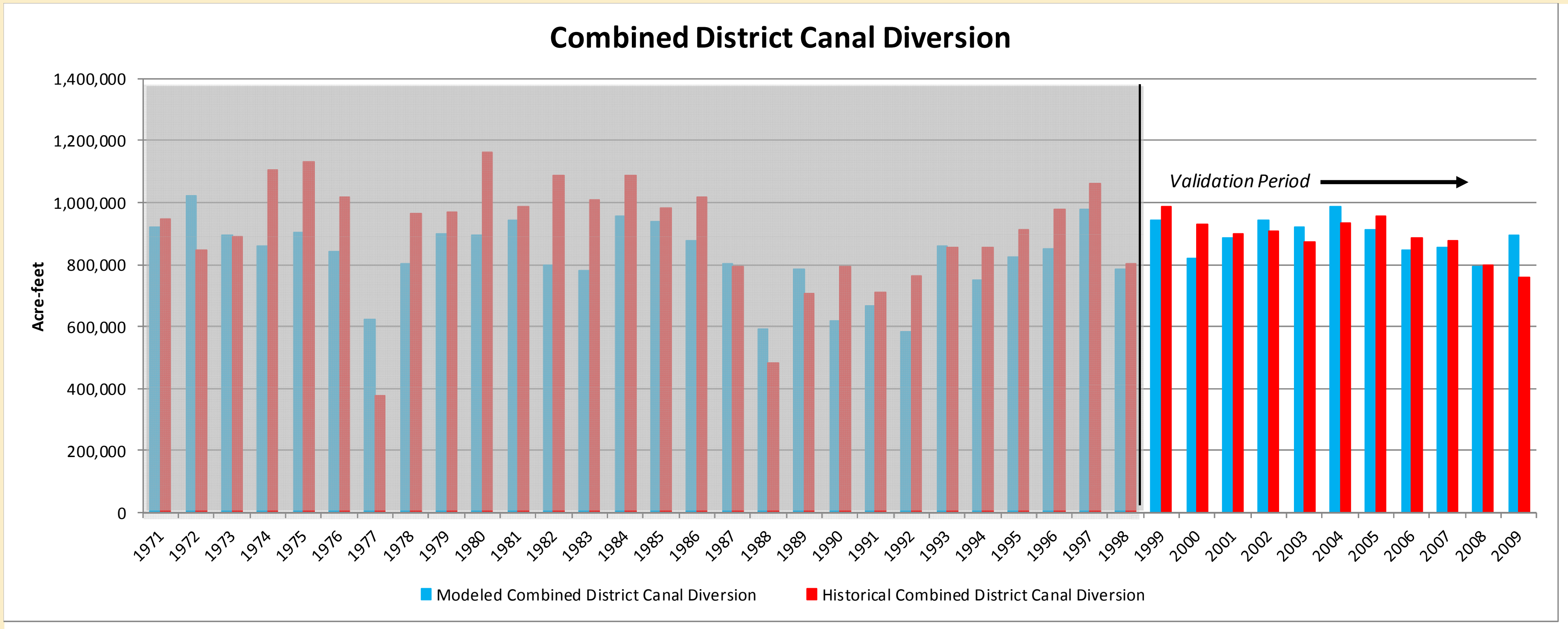
Model Validation

District Canal Diversions

- Due to annual changes in land use (crops planted), groundwater use, rainfall, and changing District and land owner practices the historical record of diversions varies from year-to-year
  - Model uses a projected canal diversion demand based on a planning model approach
- Projected canal diversions are assumed to be driven by three components
  - Fluctuating customer component, called the projected demand of applied water (PDAW), that varies year to year and month to month
  - Relatively constant depiction of District and land owner system operation efficiencies
  - Overriding water supply availability factor based on Don Pedro Reservoir storage and inflow

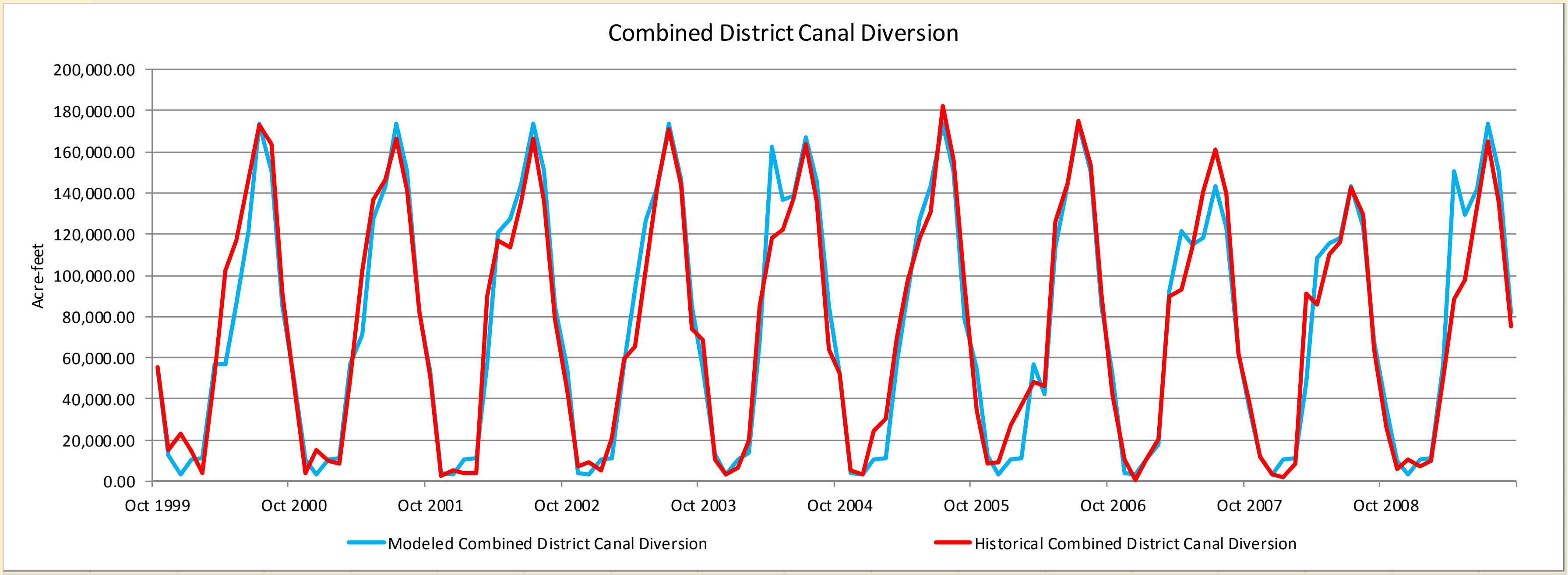
Model Validation

District Canal Diversions



Model Validation

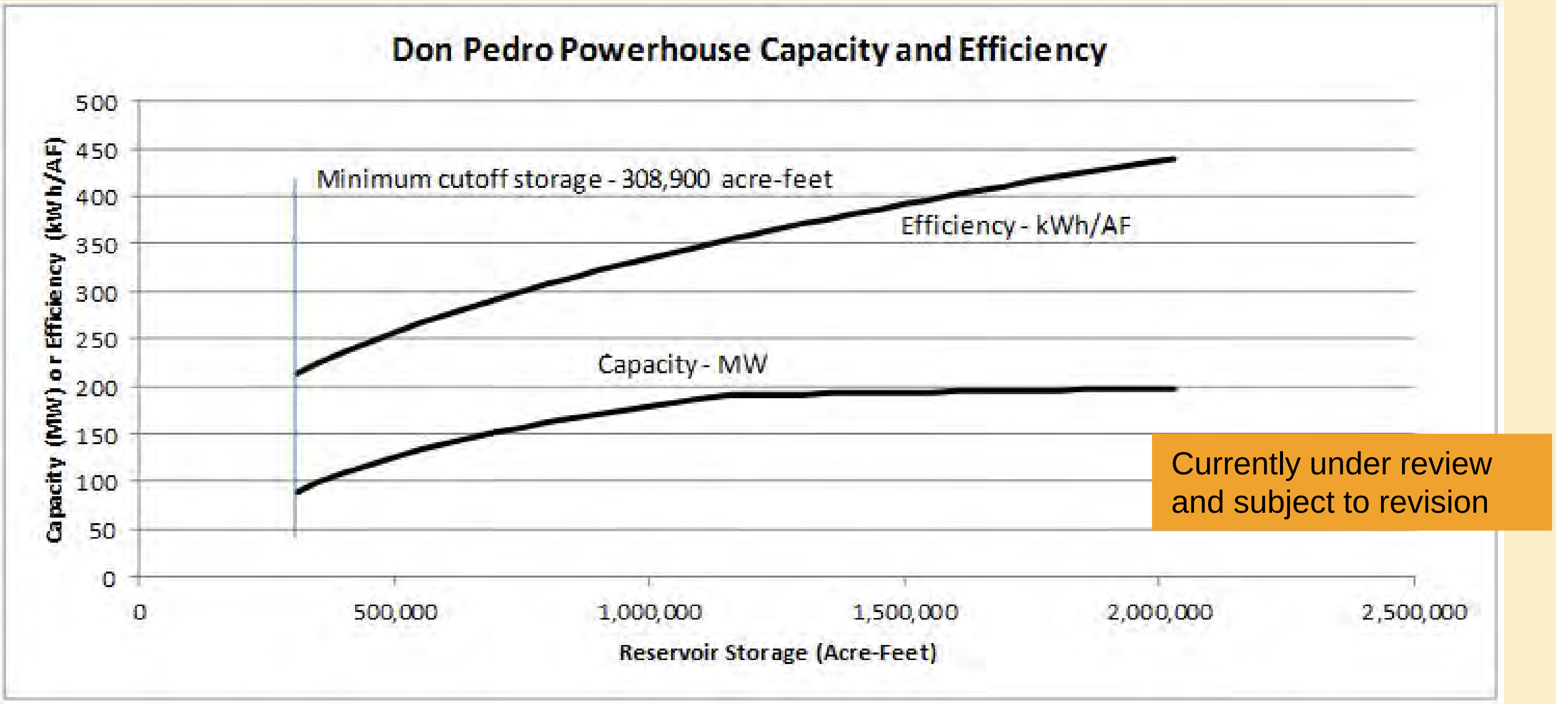
District Canal Diversions



Model Validation

Don Pedro Project Hydroelectric Generation

- Hydroelectric generation capability of the Don Pedro powerhouse has been depicted in the Model by mathematical equations relating station electrical output to Don Pedro Reservoir storage



Model Use Training

- Model has been revised
  - TuolumneDailyModel(Version1.01).xlsx

- Minor hydrology revisions
  - Lower Tuolumne River accretions and Dry Creek flow – synthetic data
  - Unregulated component of Don Pedro Reservoir inflow – adjusted

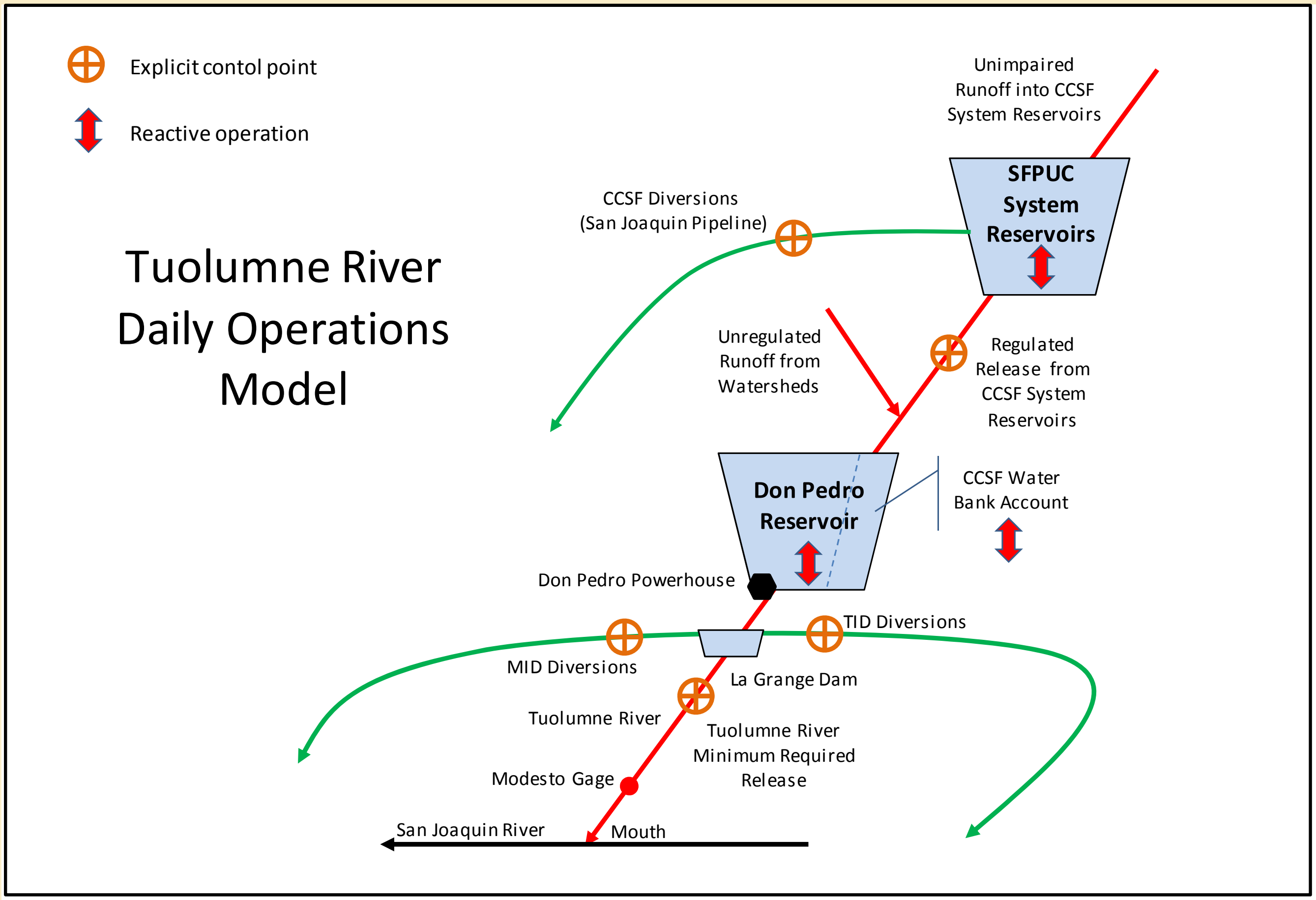
- Worksheet revisions
  - Incorporated columnar description of Output worksheet
  - Added "Switches" worksheet to provide documentation of input parameters

Load your computers

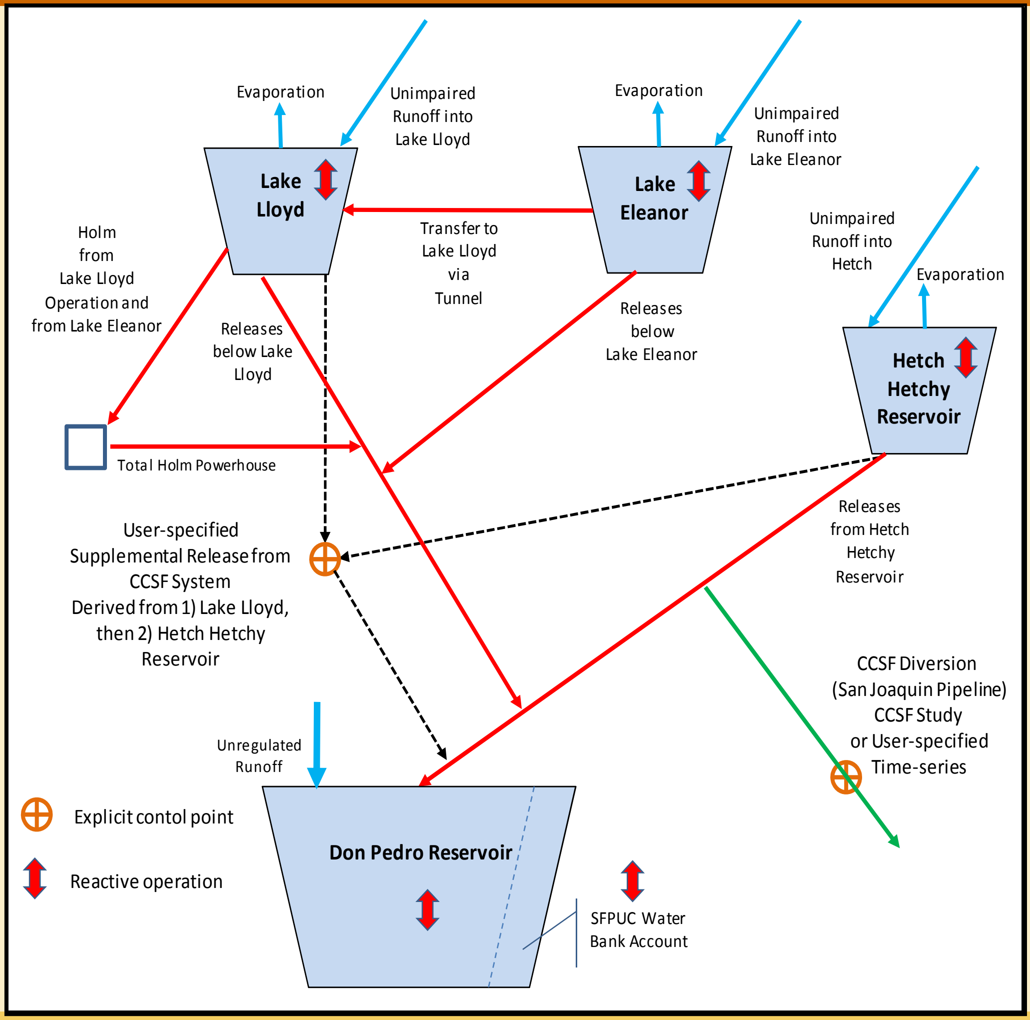
Model Overview

General Schematic and Geographical Range

Supplemental Slide from October 23, 2012 Workshop



Model Overview
Schematic of Upstream CCSF Facilities
Supplemental Slide from October 23, 2012 Workshop



Model Operations

Supplemental Slide from October 23, 2012 Workshop

- Model performs sequential operation for entire simulation period
- User can modify parameters to develop alternative operations
  - Minimum flow requirement for lower Tuolumne River
  - MID/TID Canals diversions
  - CCSF supplemental releases
  - CCSF SJPL diversions

Model Outputs

Supplemental Slide from October 23, 2012 Workshop

- Daily results
- Don Pedro Reservoir and District facilities
  - Reservoir inflow, release, storage and generation
  - MID/TID Canals diversions
  - Release to Tuolumne River
- CCSF facilities
  - Reservoir inflow, release, and storage
  - SJPL diversions
- Additional flow information
  - Lower Tuolumne River flow locations
- Result review tools
  - Time series data
  - Tables and graphs
- Data interface with temperature models

Operations Model Validation & Training

No. --

December 7, 2012

Doody, Andrew

Sent: Monday, October 29, 2012 4:56 PM
To: Alves, Jim; Anderson, Craig; Asay, Lynette; Barnes, James; Barnes, Peter; Beniamine Beronia; Blake, Martin; Bond, Jack; Borovansky, Jenna; Boucher, Allison; Bowes, Stephen; Bowman, Art; Brenneman, Beth; Brewer, Doug; Buckley, John; Buckley, Mark; Burt, Charles; Byrd, Tim; Cadagan, Jerry; Carlin, Michael; Charles, Cindy; Colvin, Tim; Costa, Jan; Cowan, Jeffrey; Cox, Stanley Rob; Cranston, Peggy; Cremeen, Rebecca; Damin Nicole; Day, Kevin; Day, P; Denean; Derwin, Maryann Moise; Devine, John; Donaldson, Milford Wayne; Dowd, Maggie; Drekmeier, Peter; Edmondson, Steve; Eicher, James; Fargo, James; Ferranti, Annee; Ferrari, Chandra; Fety, Lauren; Findley, Timothy; Fuller, Reba; Furman, Donn W; Ganteinbein, Julie; Giglio, Deborah; Gorman, Elaine; Grader, Zeke; Gutierrez, Monica; Hackamack, Robert; Hastreiter, James; Hatch, Jenny; Hayat, Zahra; Hayden, Ann; Hellam, Anita; Heyne, Tim; Holley, Thomas; Holm, Lisa; Horn, Jeff; Horn, Timi; Hudelson, Bill; Hughes, Noah; Hughes, Robert; Hume, Noah; Jackman, Jerry; Jackson, Zac; Jauregui, Julia; Jennings, William; Jensen, Art; Jensen, Laura; Johannis, Mary; Johnson, Brian; Justin; Keating, Janice; Kempton, Kathryn; Kinney, Teresa; Koepele, Patrick; Kordella, Lesley; Lein, Joseph; Levin, Ellen; Lewis, Reggie; Linkard, David; Loy, Carin; Lwenya, Roselynn; Lyons, Bill; Madden, Dan; Manji, Annie; Marko, Paul; Marshall, Mike; Martin, Michael; Martin, Ramon; Mathiesen, Lloyd; McDaniel, Dan; McDevitt, Ray; McDonnell, Marty; McLain, Jeffrey; Mein Janis; Mills, John; Minami Amber; Monheit, Susan; Morningstar Pope, Rhonda; Motola, Mary; Murphey, Gretchen; O'Brien, Jennifer; Orvis, Tom; Ott, Bob; Ott, Chris; Paul, Duane; Pavich, Steve; Pinhey, Nick; Pool, Richard; Porter, Ruth; Powell, Melissa; Puccini, Stephen; Raeder, Jessie; Ramirez, Tim; Rea, Maria; Reed, Rhonda; Richardson, Kevin; Ridenour, Jim; Robbins, Royal; Romano, David O; Roos-Collins, Richard; Roseman, Jesse; Rothert, Steve; Sandkulla, Nicole; Saunders, Jenan; Schutte, Allison; Sears, William; Shakal, Sarah; Shipley, Robert; Shumway, Vern; Shutes, Chris; Sill, Todd; Slay, Ron; Smith, Jim; Staples, Rose; Stapley, Garth; Steindorf, Dave; Steiner, Dan; Stender, John; Stone, Vicki; Stork, Ron; Stratton, Susan; Taylor, Mary Jane; Terpstra, Thomas; TeVelde, George; Thompson, Larry; Vasquez, Sandy; Verkuil, Colette; Vierra, Chris; Wantuck, Richard; Welch, Steve; Wesselman, Eric; Wheeler, Dan; Wheeler, Dave; Wheeler, Douglas; Wilcox, Scott; Williamson, Harry; Willy, Allison; Wilson, Bryan; Winchell, Frank; Wooster, John; Workman, Michelle; Yoshiyama, Ron; Zipser, Wayne
Subject: Don Pedro Relicensing - Tuolumne River Ops Model Training Session-Survey of Date Preference

AMServiceURLStr: https://Slingshot.hdrinc.com:443/CFSS/control?view=services/FTService

The Districts have offered to hold an additional full-day training session for the Tuolumne River Operations Model on either Thursday, December 6 or Friday, December 7th, depending on which of the two dates are preferred by the majority of relicensing participants. Location would be the HDR Office in Sacramento, at 2379 Gateway Oaks Drive.

Could you please advise me, by Friday, November 2nd, of the following:

(1) Do you plan to attend?
(2) Which of the two dates do you prefer: Dec 6 or Dec 7?

Thank you.

ROSE STAPLES
CAP-OM

HDR Engineering, Inc.
Executive Assistant, Hydropower Services

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From: Staples, Rose
Sent: Monday, November 05, 2012 5:48 PM
To: 'Asay, Lynette'; 'Barnes, James'; 'Barnes, Peter'; 'Beniamine Beronia'; 'Blake, Martin'; 'Bond, Jack'; Borovansky, Jenna; 'Boucher, Allison'; 'Bowes, Stephen'; 'Bowman, Art'; 'Brenneman, Beth'; 'Brewer, Doug'; 'Buckley, John'; 'Buckley, Mark'; 'Burt, Charles'; 'Byrd, Tim'; 'Cadagan, Jerry'; 'Carlin, Michael'; 'Charles, Cindy'; 'Colvin, Tim'; 'Costa, Jan'; 'Cowan, Jeffrey'; 'Cox, Stanley Rob'; 'Cranston, Peggy'; 'Cremeen, Rebecca'; 'Damin Nicole'; 'Day, Kevin'; 'Day, P'; 'Denean'; 'Derwin, Maryann Moise'; Devine, John; 'Donaldson, Milford Wayne'; 'Dowd, Maggie'; 'Drekmeier, Peter'; 'Edmondson, Steve'; 'Eicher, James'; 'Fargo, James'; 'Ferranti, Annee'; 'Ferrari, Chandra'; 'Fety, Lauren'; 'Findley, Timothy'; 'Fuller, Reba'; 'Furman, Donn W'; 'Ganteinbein, Julie'; 'Giglio, Deborah'; 'Gorman, Elaine'; 'Grader, Zeke'; 'Gutierrez, Monica'; 'Hackamack, Robert'; 'Hastreiter, James'; 'Hatch, Jenny'; 'Hayat, Zahra'; 'Hayden, Ann'; 'Hellam, Anita'; 'Heyne, Tim'; 'Holley, Thomas'; 'Holm, Lisa'; 'Horn, Jeff'; 'Horn, Timi'; 'Hudelson, Bill'; 'Hughes, Noah'; 'Hughes, Robert'; 'Hume, Noah'; 'Jackson, Zac'; 'Jauregui, Julia'; 'Jennings, William'; 'Jensen, Art'; 'Jensen, Laura'; 'Johannis, Mary'; 'Johnson, Brian'; 'Justin'; 'Keating, Janice'; 'Kempton, Kathryn'; 'Kinney, Teresa'; 'Koepele, Patrick'; 'Kordella, Lesley'; 'Lein, Joseph'; 'Levin, Ellen'; 'Lewis, Reggie'; 'Linkard, David'; Loy, Carin; 'Lwenya, Roselynn'; 'Lyons, Bill'; 'Madden, Dan'; 'Manji, Annie'; 'Marko, Paul'; 'Marshall, Mike'; 'Martin, Michael'; 'Martin, Ramon'; 'Mathiesen, Lloyd'; 'McDaniel, Dan'; 'McDevitt, Ray'; 'McDonnell, Marty'; 'McLain, Jeffrey'; 'Mein Janis'; 'Mills, John'; 'Minami Amber'; 'Monheit, Susan'; 'Morningstar Pope, Rhonda'; 'Motola, Mary'; 'Murphey, Gretchen'; 'Murray, Shana'; 'O'Brien, Jennifer'; 'Orvis, Tom'; 'Ott, Bob'; 'Ott, Chris'; 'Paul, Duane'; 'Pavich, Steve'; 'Pinhey, Nick'; 'Pool, Richard'; 'Porter, Ruth'; 'Powell, Melissa'; 'Puccini, Stephen'; 'Raeder, Jessie'; 'Ramirez, Tim'; 'Rea, Maria'; 'Reed, Rhonda'; 'Richardson, Kevin'; 'Ridenour, Jim'; 'Robbins, Royal'; 'Romano, David O'; 'Roos-Collins, Richard'; 'Roseman, Jesse'; 'Rothert, Steve'; 'Sandkulla, Nicole'; 'Saunders, Jenan'; 'Schutte, Allison'; 'Sears, William'; 'Shakal, Sarah'; 'Shipley, Robert'; 'Shumway, Vern'; 'Shutes, Chris'; 'Sill, Todd'; 'Slay, Ron'; 'Smith, Jim'; Staples, Rose; 'Stapley, Garth'; 'Steindorf, Dave'; 'Steiner, Dan'; 'Stender, John'; 'Stone, Vicki'; 'Stork, Ron'; 'Stratton, Susan'; 'Taylor, Mary Jane'; 'Terpstra, Thomas'; 'TeVelde, George'; 'Thompson, Larry'; 'Vasquez, Sandy'; 'Verkuil, Colette'; 'Vierra, Chris'; 'Wantuck, Richard'; 'Welch, Steve'; 'Wesselman, Eric'; 'Wheeler, Dan'; 'Wheeler, Dave'; 'Wheeler, Douglas'; 'Wilcox, Scott'; 'Williamson, Harry'; 'Willy, Allison'; 'Wilson, Bryan'; 'Winchell, Frank'; 'Wooster, John'; 'Workman, Michelle'; 'Yoshiyama, Ron'; 'Zipser, Wayne'
Subject: Don Pedro Relicensing-Additional Tuolumne River Operations Model Training Session - Friday, December 7, 2012

On October 29th we asked for your date preference of December 6 or December 7th for an additional full-day training session for the Tuolumne River Operations Model. Of those who advised they would like to attend this session, most preferred Friday, December 7th. Therefore, the training session will be held as follows:

SESSION: Additional Full-Day Training for Tuolumne River Operations Model

DATE: Friday, December 7, 2012

TIME: 9:00 a.m. to 4:00 p.m.

LOCATION: HDR Office in Sacramento, at 2379 Gateway Oaks Drive

Thank you!

ROSE STAPLES
CAP-OM

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Executive Assistant, Hydropower Services

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From: Staples, Rose
Sent: Thursday, November 29, 2012 5:22 PM
To: Amerine, Bill; Asay, Lynette; Barnes, James; Barnes, Peter; Beniamine Beronia; Blake, Martin; Bond, Jack; Borovansky, Jenna; Boucher, Allison; Bowes, Stephen; Bowman, Art; Brenneman, Beth; Brewer, Doug; Buckley, John; Buckley, Mark; Burt, Charles; Byrd, Tim; Cadagan, Jerry; Carlin, Michael; Charles, Cindy; Colvin, Tim; Costa, Jan; Cowan, Jeffrey; Cox, Stanley Rob; Cranston, Peggy; Cremeen, Rebecca; Damin Nicole; Day, Kevin; Day, P; Denean; Derwin, Maryann Moise; Devine, John; Donaldson, Milford Wayne; Dowd, Maggie; Drekmeier, Peter; Edmondson, Steve; Eicher, James; Fargo, James; Ferranti, Annee; Ferrari, Chandra; Fety, Lauren; Findley, Timothy; Fleming, Mike; Fuller, Reba; Furman, Donn W; Ganteinbein, Julie; Giglio, Deborah; Gorman, Elaine; Grader, Zeke; Gutierrez, Monica; Hackamack, Robert; Hastreiter, James; Hatch, Jenny; Hayat, Zahra; Hayden, Ann; Hellam, Anita; Heyne, Tim; Holley, Thomas; Holm, Lisa; Horn, Jeff; Horn, Timi; Hudelson, Bill; Hughes, Noah; Hughes, Robert; Hume, Noah; Jackson, Zac; Jauregui, Julia; Jennings, William; Jensen, Art; Jensen, Laura; Johannis, Mary; Johnson, Brian; Justin; Keating, Janice; Kempton, Kathryn; Kinney, Teresa; Koepele, Patrick; Kordella, Lesley; Le, Bao; Lein, Joseph; Levin, Ellen; Lewis, Reggie; Linkard, David; Loy, Carin; Lwenya, Roselynn; Lyons, Bill; Madden, Dan; Manji, Annie; Marko, Paul; Marshall, Mike; Martin, Michael; Martin, Ramon; Mathiesen, Lloyd; McDaniel, Dan; McDevitt, Ray; McDonnell, Marty; Mein Janis; Mills, John; Minami Amber; Monheit, Susan; Morningstar Pope, Rhonda; Motola, Mary; Murphey, Gretchen; Murray, Shana; O'Brien, Jennifer; Orvis, Tom; Ott, Bob; Ott, Chris; Paul, Duane; Pavich, Steve; Pinhey, Nick; Pool, Richard; Porter, Ruth; Powell, Melissa; Puccini, Stephen; Raeder, Jessie; Ramirez, Tim; Rea, Maria; Reed, Rhonda; Richardson, Kevin; Ridenour, Jim; Riggs T; Robbins, Royal; Romano, David O; Roos-Collins, Richard; Roseman, Jesse; Rothert, Steve; Sandkulla, Nicole; Saunders, Jenan; Schutte, Allison; Sears, William; Shakal, Sarah; Shipley, Robert; Shumway, Vern; Shutes, Chris; Sill, Todd; Slay, Ron; Smith, Jim; Staples, Rose; Stapley, Garth; Steindorf, Dave; Steiner, Dan; Stender, John; Stone, Vicki; Stork, Ron; Stratton, Susan; Taylor, Mary Jane; Terpstra, Thomas; TeVelde, George; Thompson, Larry; Ulibarri, Nicola; Vasquez, Sandy; Verkuil, Colette; Vierra, Chris; Wantuck, Richard; Welch, Steve; Wesselman, Eric; Wheeler, Dan; Wheeler, Dave; Wheeler, Douglas; White, David K; Wilcox, Scott; Williamson, Harry; Willy, Allison; Wilson, Bryan; Winchell, Frank; Wooster, John; Workman, Michelle; Yoshiyama, Ron; Zipser, Wayne
Subject: AGENDA - Don Pedro Tuolumne River Operations Model Validation - User Training December 7 Sacramento

Don Pedro Project Relicensing
W&AR-02: Tuolumne River Operations Model
Model Validation and User Training
December 7, 2012
10:00 a.m. to 4:00 p.m.

TRAINING LOCATION

HDR's Sacramento Office, located at 2379 Gateway Oaks Drive, Suite 200

CONFERENCE CALL-IN NUMBER

Conference Call-In Number 866-994-6437; Conference Code 542 469 7994

ON-LINE MEETING LINK

[Join online meeting](https://meet.hdrinc.com/jenna.borovansky/3D64F0F5)

https://meet.hdrinc.com/jenna.borovansky/3D64F0F5

First online meeting?

NOTE: If this is your first time attending an ONLINE MEETING, you will need to click on the "First online meeting?" link to load the ONLINE MEETING program. It is best that you do this step PRIOR to the meeting start.

EQUIPMENT NEEDS

Please bring your computer to this training session

AGENDA

10:00 a.m. - 10:15 a.m. Introductions and Meeting Purpose

10:15 a.m. - 11:30 a.m. Operations Model Validation

11:30 a.m. - 12:00 p.m. Lunch break (pizza to be provided)

12:00 p.m. - 4:00 p.m. Operations Model User Training

ROSE STAPLES
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Doody, Andrew

From: Staples, Rose
Sent: Monday, March 18, 2013 1:09 PM
To: Alves, Jim; Amerine, Bill; Anderson, Craig; Asay, Lynette; Barnes, James; Barnes, Peter; Barrera, Linda; Beniamine Beronia; Blake, Martin; Bond, Jack; Borovansky, Jenna; Boucher, Allison; Bowes, Stephen; Bowman, Art; Brenneman, Beth; Brewer, Doug; Buckley, John; Buckley, Mark; Burke, Steve; Burt, Charles; Byrd, Tim; Cadagan, Jerry; Carlin, Michael; Charles, Cindy; Colvin, Tim; Costa, Jan; Cowan, Jeffrey; Cox, Stanley Rob; Cranston, Peggy; Cremeen, Rebecca; Damin Nicole; Day, Kevin; Day, P; Denean; Derwin, Maryann Moise; Devine, John; Donaldson, Milford Wayne; Dowd, Maggie; Drake, Emerson; Drekmeier, Peter; Edmondson, Steve; Eicher, James; Fargo, James; Ferranti, Annee; Ferrari, Chandra; Fety, Lauren; Findley, Timothy; Fleming, Mike; Fuller, Reba; Furman, Donn W; Ganteinbein, Julie; Giglio, Deborah; Gorman, Elaine; Grader, Zeke; Gutierrez, Monica; Hackamack, Robert; Hastreiter, James; Hatch, Jenny; Hayat, Zahra; Hayden, Ann; Hellam, Anita; Heyne, Tim; Holley, Thomas; Holm, Lisa; Horn, Jeff; Horn, Timi; Hudelson, Bill; Hughes, Noah; Hughes, Robert; Hume, Noah; Jackson, Zac; Jauregui, Julia; Jennings, William; Jensen, Art; Jensen, Laura; Johannis, Mary; Johnson, Brian; Jones, Christy; Jsansley; Justin; Keating, Janice; Kempton, Kathryn; Kinney, Teresa; Koepele, Patrick; Kordella, Lesley; Le, Bao; Lein, Joseph; Levin, Ellen; Lewis, Reggie; Linkard, David; Loy, Carin; Lwenya, Roselynn; Lyons, Bill; Madden, Dan; Manji, Annie; Marko, Paul; Marshall, Mike; Martin, Michael; Martin, Ramon; Mathiesen, Lloyd; McDaniel, Dan; McDevitt, Ray; McDonnell, Marty; Mein Janis; Mills, John; Monheit, Susan; Morningstar Pope, Rhonda; Motola, Mary; Murphey, Gretchen; Murray, Shana; O'Brien, Jennifer; Orvis, Tom; Ott, Bob; Ott, Chris; Paul, Duane; Pavich, Steve; Pool, Richard; Porter, Ruth; Powell, Melissa; Puccini, Stephen; Raeder, Jessie; Ramirez, Tim; Rea, Maria; Reed, Rhonda; Richardson, Daniel; Richardson, Kevin; Ridenour, Jim; Riggs T; Robbins, Royal; Romano, David O; Roos-Collins, Richard; Rosekrans, Spreck; Roseman, Jesse; Rothert, Steve; Sandkulla, Nicole; Saunders, Jenan; Schutte, Allison; Sears, William; Shakal, Sarah; Shipley, Robert; Shumway, Vern; Shutes, Chris; Sill, Todd; Slay, Ron; Smith, Jim; Staples, Rose; Stapley, Garth; Steindorf, Dave; Steiner, Dan; Stender, John; Stone, Vicki; Stork, Ron; Stratton, Susan; Taylor, Mary Jane; Terpstra, Thomas; TeVelde, George; Thompson, Larry; Tmberliner; Ulibarri, Nicola; Ulm, Richard; Vasquez, Sandy; Verkuil, Colette; Vierra, Chris; Wantuck, Richard; Welch, Steve; Wenger, Jack; Wesselman, Eric; Wheeler, Dan; Wheeler, Dave; Wheeler, Douglas; White, David K; Wilcox, Scott; Williamson, Harry; Willy, Allison; Wilson, Bryan; Winchell, Frank; Wooster, John; Workman, Michelle; Yoshiyama, Ron; Zipser, Wayne
Subject: Don Pedro Ops Model Workshop/Training Sessions Oct 23 and Dec 7 DRAFT NOTES for Review
Attachments: P-2299 Don Pedro W-AR-02 Dec 7 2012 Workshop Notes_DRAFT_130316.docx; P-2299 Don Pedro W-AR-02 Oct 23 2012 Workshop Notes_DRAFT_130316.doc

Please find attached the DRAFT Meeting Notes for the Don Pedro Operations Model Workshop and Training Sessions held on October 23, 2012 and December 7, 2012. These draft notes are being forwarded to you for your review before being filed with FERC. Please send any comments to me at rose.staples@hdrinc.com by Thursday, April 18, 2013. Thank you.

ROSE STAPLES
CAP-OM

HDR Engineering, Inc.
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Don Pedro Project Relicensing
Operations Model Workshop and Training Session (W&AR-02)
DRAFT Meeting Notes
December 7, 2012
HDR Office, Sacramento

Attendees

Bob Hackamack	Donn Furman, CCSF
Patrick Koepele, Tuolumne River Trust	Bob Hughes, CDFG
Chris Shutes, CSPA	Jenna Borovansky, HDR
Annie Manji, CDFG	Dan Steiner, consultant to TID/MID
Larry Thompson, NMFS	Rob Sherrick, HDR
Ramon Martin, USFWS	Rick Jones, HDR
Carin Loy, HDR	Monica Gutierrez, NMFS (by phone)
Ellen Levin, CCSF	Tim Heyne, CDFG (by phone)
Tim Findley, Bay Area Water Users (by phone)	Chandra Ferrari, Trout Unlimited (by phone)

Meeting Materials

Meeting materials will be attached to the Final Notes when filed with FERC.

Meeting materials provided were:

- Agenda (attached)
- PowerPoint Presentation (attached)
- Model Version 1.01 (provided at the meeting—and available by request to the Districts)

Meeting Summary

Mr. Steiner illustrated validation of the operations model and reviewed validation information. The meeting PowerPoint presentation is attached. Mr. Steiner explained the validation approach.

Mr. Hughes noted that synthesized unimpaired hydrology reflecting CDFG comments was not in the validation. Mr. Steiner replied that the validation used historical hydrology when appropriate to illustrate the validity of model logic; Mr. Steiner noted that the Districts will be replying to CDFG's recent letter to the SWRCB regarding CDFG's suggested approach to the unimpaired hydrology dataset.

Mr. Steiner reviewed validation materials with the group comparing historical to modeled information. Discussion regarding the modeling logic of accounting for snowmelt, flood control rules, and other factors previously covered in the October 23, 2012 Workshop also occurred during the demonstration and training.

Mr. Martin asked if pulse flows are provided for in the model. Mr. Steiner noted that flows are modeled at a daily level based on the monthly FERC required minimum flows. Mr. Steiner confirmed that VAMP flow is not shown in the current "test case" of the model. However, definition of a pulse flow during April and May is available within the model. October currently does not include a daily pulse flow capability.

Ms. Manji asked if there was any point at which high flows downstream in the SJR would trump the minimum flows in the Tuolumne River. Mr. Furman replied that no, this is not the case.

Mr. Steiner noted that the model validation for generation is still underway and that the Districts will provide this to Relicensing Participants for review when available in early 2013. A question was asked whether the model will include value of generation. Mr. Steiner noted that the value of generation is not a model component, but the Districts will be including this information in the license application (Exhibit D).

As part of the model training, Mr. Steiner walked Relicensing Participants through an example modeling scenario and addressed questions from participants regarding model assumptions, inputs, and outputs. There were questions regarding which elements of the model can be user-specified (i.e, "knobs") and which do not. Mr. Steiner noted that the model includes all the variables and "knobs" identified in the FERC-approved study plan.

July 12, 2013 | Don Pedro Project
E-Filed | FERC No. 2299-075

Honorable Kimberly D Bose
Secretary
Federal Energy Regulatory Commission
Mail Code: DHAC, PJ-12.3
888 First Street NE
Washington DC 20426

RE: Turlock Irrigation District and Modesto Irrigation District
Don Pedro Project - FERC Project No. 2299
Final Meeting Notes for the October 23, 2012 and December 7, 2012 Operations Model Workshop and Training Sessions for W&AR-02

In October 2012 and December 2012, as part of the ongoing studies under the Integrated Licensing Process ("ILP") for the Don Pedro Project ("Project"), the Turlock Irrigation District and the Modesto Irrigation District (collectively, the "Districts"), co-licensees of the Project, held two relicensing participant meetings to discuss the Project Operations/Water Balance Model (W&AR-02).

<u>October 23, 2012: Operations Model Workshop and Training Session (W&AR-02)</u>

The Districts held Consultation Workshop No. 3 on October 23, 2012 as proposed in the Project Operations/Water Balance Model Study Plan ("Operations Model"; W&AR-02) and approved by FERC in its December 22, 2011 Study Plan Determination ("SPD"). The meeting was held to present and discuss key elements of the Operation Model user's manual and review reservoir operation goals and model algorithms. The Districts also provided an update on the accretion flow field data collection and presented a schematic of existing nodes in the Operations Model.

On March 18, 2013, the Districts circulated draft meeting notes along with responses to requests for additional information received at the meeting. Within the 30-day review period, the Districts did not receive any comments on the draft notes or the additional information; therefore, the content of the final meeting notes are the same as the draft notes distributed to relicensing participants. In accordance with Appendix B of the SPD and the Final Workshop Consultation Protocols filed with FERC on May 18, 2012, Attachment A of this filing provides the final October 23, 2012 Workshop meeting notes, which also include the meeting agenda, PowerPoint presentation, and draft model user's guide.

December 7, 2012: Operations Model Workshop and Training Session (W&AR-02)

The Districts held Consultation Workshop No. 4 on December 7, 2012. The purpose of the meeting was to illustrate validation of the Operations Model and to provide an additional hands-on model training opportunity for relicensing participants on use of the Operations Model. As part of the model training, Mr. Steiner walked relicensing participants through an example modeling scenario and addressed questions from participants regarding model assumptions, inputs, and outputs.

On March 18, 2013, the Districts circulated draft meeting notes. Within the 30-day review period, the Districts did not receive any comments on the draft notes; therefore, the content of the final Workshop meeting notes is the same as the draft notes distributed to relicensing participants. In accordance with Appendix B of the SPD and the Final Workshop Consultation Protocols filed with FERC on May 18, 2012, Attachment B of this filing provides the final December 7, 2012 meeting notes, which include the meeting agenda and PowerPoint presentation.

Sincerely,

John Devine, P.E.
Project Manager

Enclosures:
Attachment A – October 23, 2012 Operations Model (W&AR-02) Workshop Notes
Attachment B – December 7, 2012 Operations Model (W&AR-02) Workshop Notes

Attachment A

October 23, 2012 Operations Model (W&AR-02) Workshop Notes

Don Pedro Project Relicensing
Operations Model Workshop and Training Session (W&AR-02)
Final Meeting Notes
October 23, 2012
Location: Modesto Irrigation District

Attendees:

Ron Stork, Friends of the River	Tim Findley, Bay Area Water Users	Bob Hughes, CDFG
Zac Jackson, USFWS	Robert Nees, TID	Rob Sherrick, HDR
Peter Barnes, SWRCB	Chris Shutes, CSPA	Bill Sears, CCSF
Bob Hughes, CDFG	Nicola Ulibarri, Stanford University	Ellen Levin, CCSF
Dan Steiner	Art Goodwin, TID	Donn Furman, CCSF
Bill Paris, MID	Joy Warren, MID	John Wooster, NMFS
Bill Johnston, MID	Greg Dias, MID	Dale Stanton, CDFG
Spreck Rosekrans, Restore Hetch Hetchy	John Devine, HDR	Patrick Koepele (by phone)
Bob Hackamack	Jenna Borovansky, HDR	Jim Fargo, FERC (by phone)
Daniel McDaniels, Central Delta Water Agency (by	Chandra Ferrari, Trout Unlimited (by phone)	Dave Boucher (by phone)
Jim Alves, City of Modesto (by phone)	Annie Manji (by phone)	
Ramon Martin, USFWS (by phone)	Allison Boucher (by phone)	

Meeting Materials

Materials are attached to the final meeting notes filed with FERC.

Meeting materials provided were:

- Agenda (attached)
- PowerPoint Presentation (attached)
- Draft User's Guide (attached)

Meeting Summary

Mr. Devine reviewed the agenda with relicensing participants (RPs). No additional agenda items were added.

Mr. Devine summarized the previous two Workshops for study W&AR-02. He noted that the January 2013 Model Report will contain a full description of the model, model validation, unimpaired flow hydrology, and the model user's guide.

Comment: Mr. Rosekrans inquired whether there is a period of time for comments on the two prior Workshops.
Response: The Consultation Workshop protocol calls for a 30-day comment period on meeting notes and materials provided for the meeting.

Comment: Mr. Shutes requested a version of the model user's guide in a larger font size, or as a MS Word document.
Response: The Districts will look into providing the manual in a different format that will allow RPs to enlarge text if desired.

Mr. Devine provided an update on the accretion flow field data collection. A second set of accretion measurements were completed on October 3 - 4 under favorable flow conditions; results are under review and will be provided to relicensing participants (RPs). The number of measurement sites was expanded based on feedback from RPs at the September Workshop, and the results of the June accretion measurements. One more measurement may be taken in January/February time frame if conditions allow. Measurements are intended to supplement gage records to provide a more complete picture of accretion in the lower Tuolumne River, and may help determine the location of model *nodes*.

The schematic showing existing nodes in the Operations Model was reviewed with RPs. Additional nodes can be added as needed where there is a change in hydrology.

Mr. Steiner then presented and discussed with RPs a series of PowerPoint slides covering key elements of the Operations Model user's manual. Questions from RPs and responses during this discussion are summarized below.

Comment: RPs inquired about supplemental release flows to the Tuolumne River from the CCSF system.
Response: Mr. Steiner explained that for supplemental releases, water first comes from Cherry/Eleanor, then Hetch Hetchy.

Comment: Mr. Shutes inquired whether the user-adjustable "knob" that controls CCSF water withdraws from Hetch Hetchy and Cherry-Eleanor separately.
Response: Mr. Steiner indicated that the "knob" controls total CCSF water, with the model specifying flows must come from Cherry-Eleanor first, then Hetch Hetchy.

Mr. Steiner explained that inflow to Don Pedro is about 60% from the regulated portion of the watershed and about 40% from the unregulated portion. He noted that this does not change between scenarios. Mr. Steiner demonstrated in the model where to find the CCSF Water Bank Account information.

Comment: Mr. Koepele inquired if there is tabulation for flood storage space.
Response: Mr. Steiner replied that use of flood storage space can be derived by viewing model outputs because flood storage all occurs about elev 801.9 ft.

Comment: Mr. Rosekrans inquired if water necessarily comes through the Holm powerhouse and do user-specified releases have to go through Holm, or Cherry releases.
Response: Mr. Steiner replied that the model does not differentiate between flows through Holm Powerhouse or simply released at the dam because generation at Holm is not part of the model.

Reservoir Operation Goals and Model Algorithms

Mr. Steiner then reviewed information on each of the following areas within the model. RP comments and responses are recorded below.

- Minimum releases
  - Instream flows
  - Diversion demand (MID/TID canals & CCSF San Joaquin Pipeline)
  - Other
- Reservoir Guidance Curves / storage targets
  - Rainfall flood control

- Snowmelt allocation and management
- Other storage goals

Comment: Mr. Koepele inquired if the flood control rule curves can be modified in the model (dates and volumes)?
Response: Mr. Steiner replied that because of the open Excel format all parameters are "customizable"; however, the reservoir guidance curves are currently fixed because a change in the guidance curve could fundamentally change the operation of the project. The model could be modified to allow it, if necessary.

Comment: Mr. Hughes noted he thought that the flood control guidance curves were more complicated for the snowmelt period.
Response: Mr. Steiner replied that the ACOE curves for the snowmelt portion of the year have different target levels at times of the year depending on the projected runoff and the month.

Comment: Mr. Stork asked how the Districts' canal diversion demand was estimated.
Response: Mr. Steiner replied that the sample demands are pre-determined (processed) using a district-level water demand procedure and water supply forecasting technique beginning in February that is based on an annual-varying water need.

Comment: Mr. Stork asked about the process for estimating spillway operations.
Response: Mr. Steiner explained that Don Pedro releases come through the powerhouse first, then the hollow-jet valve, then the outlet works, and "spill" only occurs if water levels exceed 830 ft with all these various outflows already operating. Consistent with the ACOE manual, releases are attempted to be held to under 9,000 cfs at the Modesto gage (including Dry Creek and accretion) until they cannot be any longer due to inflow flood conditions. As far as the model is concerned, all releases in excess of the powerhouse capability are considered as "spill" whether it would be physically made through outlets or the spillway.

Comment: A question was asked regarding whether the model routes the Reservoir Design Flood.
Response: Mr. Steiner explained that the model has not routed the flood. The current hydrology is historical, including 1997.

Comment: Mr. Shutes asked how canal diversions were adjusted through the seasons. Are they hardwired as a time series, or calculated on a month-to-month basis?
Response: Mr. Steiner replied that diversion demand is currently locked in as a fixed time series, which is based on month-to-month varying demand. In order to change the diversion, one must change the time series with the "knob."

Comment: Mr. Rosekrans asked when does the CCSF water bank account drive operations.
Response: Mr. Steiner explained that only when it's depleted would the water bank account influence operations; and except for the '87 through '92 drought, the water bank is never really very low. The model does not automatically react to a state of depletion; the user must adjust CCSF releases.

Comment: A follow-up question was asked: could there be alternative scenarios that would empty the water bank more often?
Responses: Mr. Steiner stated that, yes, if more water is called for in the lower Tuolumne and CCSF is assigned responsibility, it's possible that the water bank could empty more often.

Comment: Mr. Stork inquired if there been a PMF [probable maximum flood] completed for Don Pedro.
Response: Mr. Devine replied that yes, it has been done separate from relicensing, and is not part of this model. The results are probably CEII (Critical Energy Infrastructure Information) and thus protected from public inspection on FERC's website. If requested, the Districts could set-up a conference call to provide the PMF information on Don Pedro. The Project safely passes the PMF.

Comment: Mr. Hughes asked for additional explanation of how demands from the San Joaquin Pipeline and Districts canals are established. Were they current use levels or a 'projected level of development?
Response: Mr. Steiner replied that the Districts' demand models are land use based using 2005 data, adjusted to more recent conditions, and applied to the 39 years of hydrology. Mr. Steiner also noted that the CCSF SJPL demand comes from a planning study, and is based on recent levels of water demand.

Comment: RPs requested that this information be documented in the user guide.
Response: Mr. Steiner noted that additional information should be in final model report, which will include more discussion of assumptions and inputs. The Draft User's Guide provided today is focused on the actual model and how it operates.

Comment: Mr. Hughes noted that the "Base Case" should reflect current operations, not future or past. He read from a January 31, 2012 YBDS letter from FERC which stated the "Base Case" / No Action alternative should not include future levels of irrigation demand.
Response: Mr. Devine noted the study plan states that "Base Case" condition will be defined in March, after ISR submittal. Mr. Steiner reminded participants that today's discussion uses a "test case" which is strictly for purposes of model training.

Comment: Mr. Rosekrans asked why CCSF power production was not part of the model. While FERC has no jurisdiction over those facilities, they may inform the impacts of lower Tuolumne instream flows. Mr. Shutes added that it may be important or useful to include San Francisco's generation in model output for comprehensive impact analysis, and balancing beneficial uses. Mr. Shutes also requested that there be nodes at each of the upper Tuolumne tributaries.
Response: Mr. Devine, then Mr. Fargo both stated that those issues were covered in the Scoping Document and the Study Plan Determination, and would not be included in the model.

Comment: Rosekrans requested clarification on which of the CCSF water flow constraints are required by regulations and which are operationally determined by CCSF.
Response: Mr. Furman noted that CCSF operations are fully outlined in the WSIP that is available on-line.

The afternoon session was dedicated to hands-on demonstration of the model and RP training.

Summary of Action Items

- An additional model training session was scheduled for RPs for December 7, 2012.
- RPs requested additional information on what factors Mr. Steiner referred to as "switches." ***Mr. Steiner provided a glossary of the codes used for switches at the follow-up workshop in December.***

Operations Model Training / Validation Meeting
Don Pedro Relicensing Study W&AR-2
October 23, 2012 – 9:00 a.m. to 4:00 p.m. - MID Offices

Audio Call-In Number: 866-994-6437, Conference Code 5424697994
To LINK to LIVE Meeting, please see below

AGENDA

9:00 a.m. to 9:10 a.m.	Introductions
9:10 a.m. to 9:20 a.m.	Review of Agenda
9:20 a.m. to 9:30 a.m.	Purpose of Meeting
9:30 a.m. to 9:45 a.m.	Overview of FERC-Approved Study Plan
9:45 a.m. to 10:00 a.m.	Summary of Prior Workshops
10:00 a.m. to 12:30 p.m.	Presentation of Model Architecture, Model Description, and User's Guide
12:30 p.m. to 1:15 p.m.	Lunch: On Your Own
1:15 p.m. to 1:30 p.m.	Load Model on Computers *Note to Participants: Bring Your Computer!*
1:30 p.m. to 4:00 p.m.	Model Operation and Introduction to Running the Model

LINK to LIVE MEETING:
TO JOIN THE DISCUSSION VIA "LIVE MEETING":

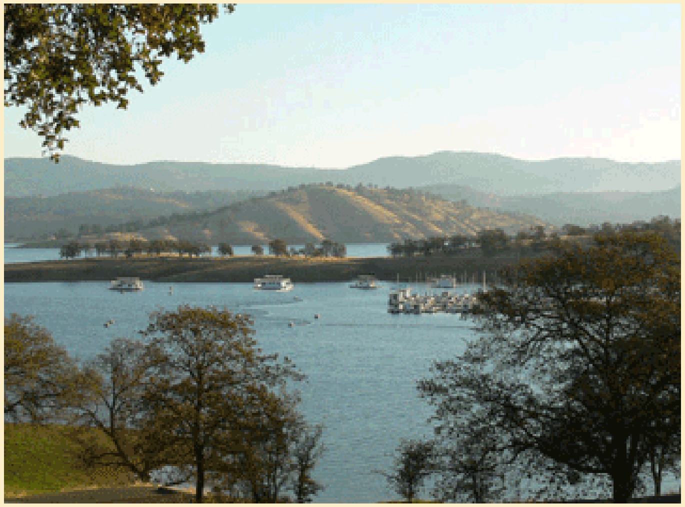
Join online meeting
https://meet.hdrinc.com/jenna.borovansky/3D64F0F5

First online meeting?

Don Pedro Project Relicensing

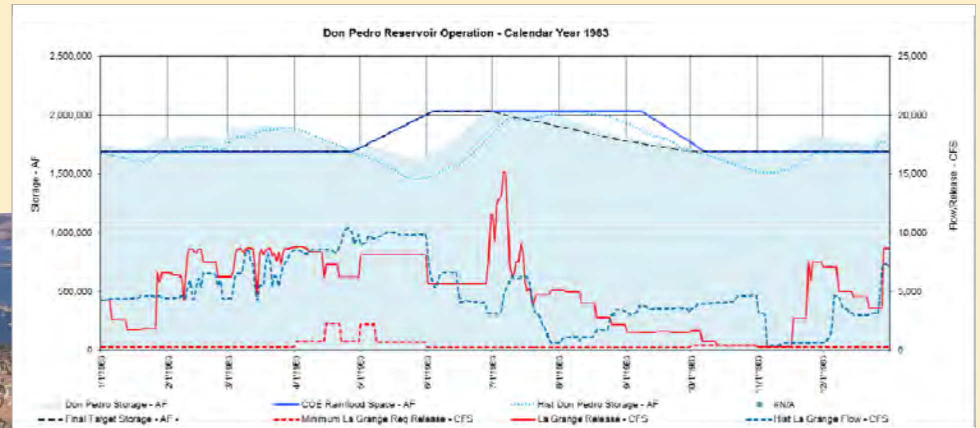
W&AR-2: Project Operations Model Workshop #3

MODESTO IRRIGATION DISTRICT | TURLOCK IRRIGATION DISTRICT



FERC
PROJECT
No. 2299

Tuolumne River
Daily Operations Model



W&AR-2 Workshop No. 3
Model Description and User's Guide
October 23, 2012

Agenda and Topics

- Introductions
- Review of Agenda
- Purpose of Meeting
- Overview of FERC-approved Study Plan
- Summary of Prior Workshops
- Presentation of Model Architecture, Model Description, and User's Guide
  - Model overview
  - Model operations
  - Model outputs
- Model Operation

Purpose

- Present the Model Architecture
- Discuss Model Description and User's Guide Document
- Review Path Forward
- Provide Initial Training on Model Use

Study Status Overview

- Develop Project Operations Model *(“Tuolumne River Operations Model”)* --- through June 2012
- Prepare Preliminary Report on Model Description –-- July 2012
- Present Model to Relicensing Participants –-- October 2012
- Issue Final Model Report: (1) Model description, (2) Model validation, (3) User’s Guide --- January 2013

FERC Study Plan Determination

- Districts' Plan Approved Without Material Modification
- Discuss Participant Preferences for Model Output (graphs, tables, statistics) in Workshops
- Include Agreements Not Part of FERC License (4th Agreement/Water Bank)
- After Accretion Measurements, Extend Model to Confluence

Prior Workshops

Workshop #1 --- April 9, 2012

- Hydrology Workshop – Model Overview and Development of Don Pedro Unimpaired Flow Data Set
- All RP Comments Submitted by End of May
- Districts' Filed Responses and Meeting Notes with FERC on August 1

Prior Workshops

Workshop #2 -- September 21, 2012

- Accretion Flow Measurement Results and Proposed Hydrologic Investigations
- Draft Meeting Notes in Final Review
- RP Comments Due Circa November 21
- Responses and FERC Filing by Districts Circa December 20

Future Workshop(s)

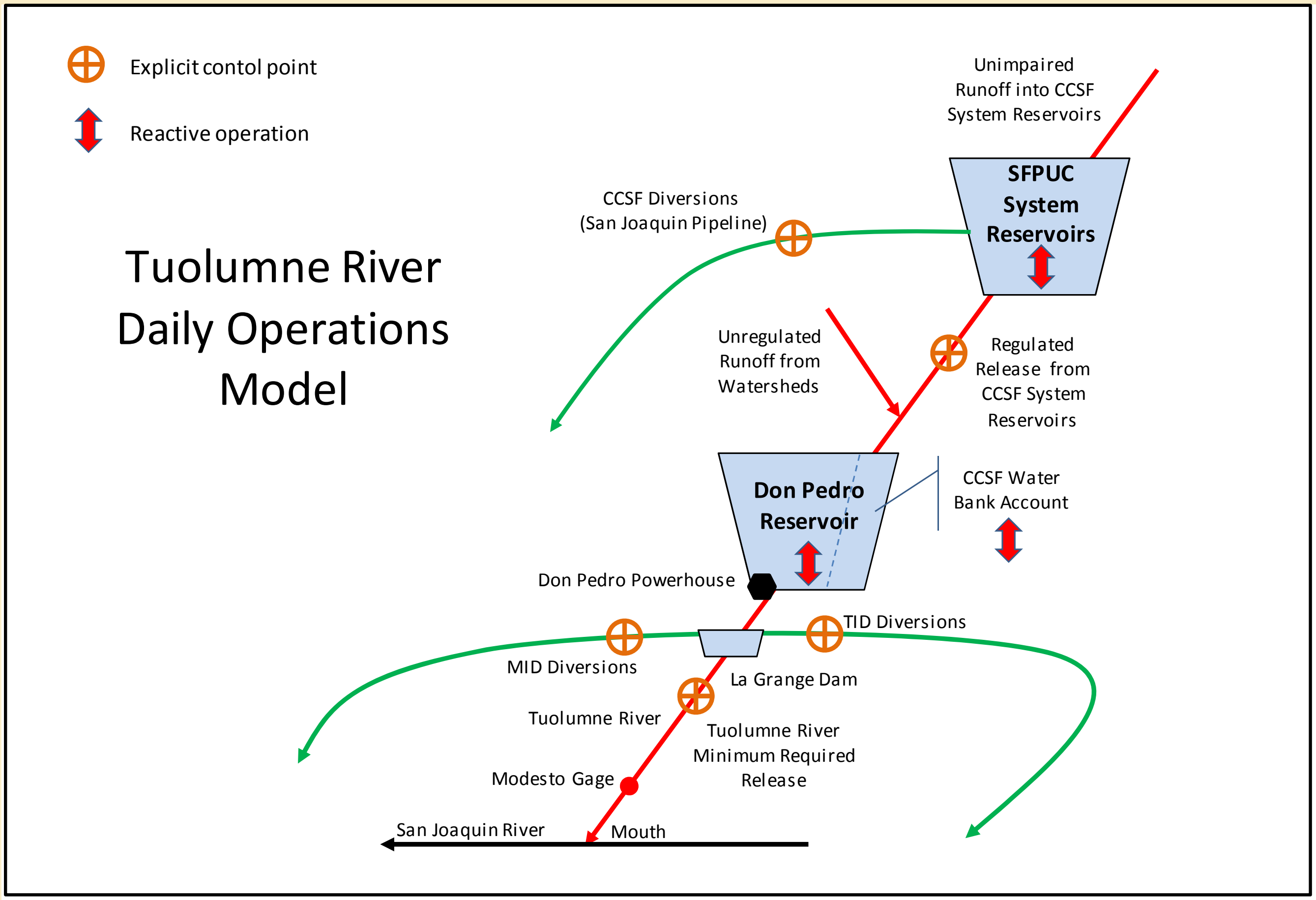
- Model Validation Report Presentation
- Intensive User Training

Model Overview

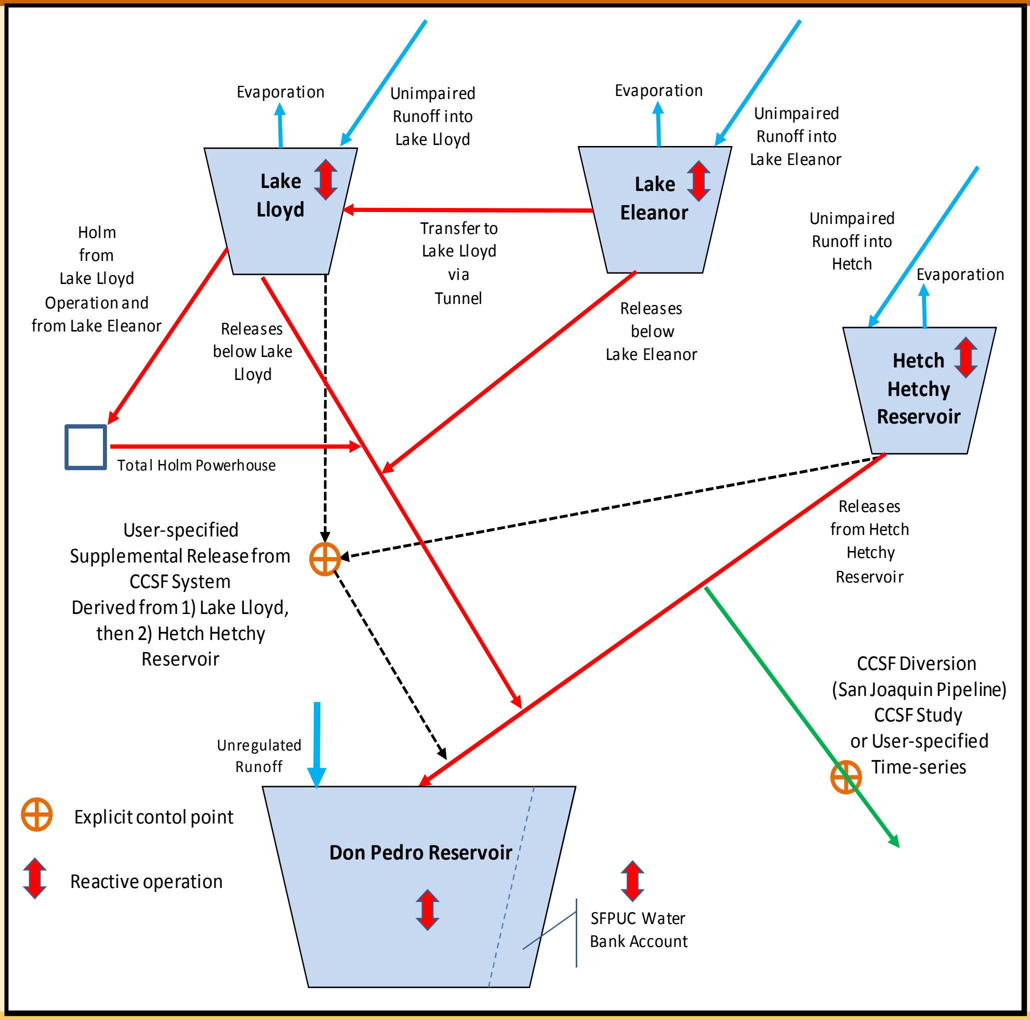
- Microsoft Excel 2010 worksheet
- Physical boundaries of the model
  - Upstream CCSF facilities
  - Downstream to confluence with San Joaquin River
- Simulation period
  - Daily time step of water year 1971 through 2009

Model Overview

General Schematic and Geographical Range



Model Overview
Schematic of Upstream CCSF Facilities



Model Operations

- Four reservoirs
  - Don Pedro Reservoir
  - Hetch Hetchy Reservoir
  - Lake Lloyd
  - Lake Eleanor
- Reservoir operation goals/algorithms
  - Minimum releases from reservoirs
    - Instream flow requirements
    - Diversion demand (MID/TID Canals & CCSF SJPL)
    - Other releases
  - Additional releases for reservoir and release management
    - Flood control
    - Snowmelt release management
    - Other storage goals
- Water Bank Account

Model Operations

- Diversion demand – Test Case
  - MID/TID Canals diversions reflective of current land use and operation, including reduced deliveries during drought
  - CCSF San Joaquin Pipeline diversion reflective of current water deliveries and system operation, including delivery shortages during drought
- Instream flow requirements – Test Case
  - Don Pedro Project – current FERC minimum flow requirements
  - CCSF facilities – current requirements for Hetch Hetchy Reservoir, Lake Lloyd and Lake Eleanor
- Don Pedro Project Hydropower Generation
  - Uses simulated releases and reservoir storage (head) limited to power plant constraints

Model Operations

- Model performs sequential operation for entire simulation period
- User can modify parameters to develop alternative operations
  - Minimum flow requirement for lower Tuolumne River
  - MID/TID Canals diversions
  - CCSF supplemental releases
  - CCSF SJPL diversions

Model Outputs

- Daily results
- Don Pedro Reservoir and District facilities
  - Reservoir inflow, release, storage and generation
  - MID/TID Canals diversions
  - Release to Tuolumne River
- CCSF facilities
  - Reservoir inflow, release, and storage
  - SJPL diversions
- Additional flow information
  - Lower Tuolumne River flow locations
- Result review tools
  - Time series data
  - Tables and graphs
- Data interface with temperature models

Model Operation

Load your computers

DRAFT
Tuolumne River Daily Operations Model
Model Description and User's Guide

Modesto Irrigation District
Turlock Irrigation District

Don Pedro Project Relicensing
FERC No. 2299

DRAFT Working Document
October, 2012

Tuolumne River Daily Operations Model
Model Description and User's Guide

Contents

1.0 Introduction

The Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) have developed a computerized Project Operations Model (Model) to assist in evaluating the relicensing of the Don Pedro Project (Project) (FERC Project 2299). On November 22, 2011, in accordance with the Integrated Licensing Process schedule for the relicensing of the Don Pedro Project, the Districts filed their Revised Study Plan containing 35 proposed studies with the Federal Energy Regulatory Commission (FERC) and relicensing participants. On December 22, 2011, FERC issued its Study Plan Determination approving, with modifications, the proposed studies, including Study Plan W&AR-2: Project Operations /Water Balance Model Study Plan. Consistent with the FERC-approved study plan, the objective of the Model is to provide a tool to compare current and potential future operations of the Project. Due to the fact that the geographic scope of the Model extends from the City and County of San Francisco's (CCSF) Hetch Hetchy system in the upper part of the watershed to the confluence of the Tuolumne and San Joaquin rivers, the Model is now entitled the Tuolumne River Daily Operations Model.

In accordance with the study plan, the Districts are preparing a Model Development Report due to be filed with FERC in January 2013 (W&AR-2 Study Plan, page 7). The Model Development Report will contain three components: (1) this Model Description and User's Guide (User's Guide), (2) a Validation Report, and (3) an executable version of the Model. Also in accordance with the FERC-approved study plan, the Districts are organizing and conducting a number of workshops with relicensing participants associated with the development of the Model. The first Workshop, held on April 9, 2012, was focused on the development of the hydrologic dataset; the second Workshop, held on September 21, dealt with accretion flows, Dry Creek flows, downstream nodes, and other related hydrologic investigations. The third Workshop, scheduled for October 23, will focus on Model architecture, logic, and functionality and provide an initial training opportunity for potential Model users. This Model Description and User's Guide provides information to be covered in the Workshop No. 3.

As fully described in this User's Guide, and consistent with the FERC-approved study plan, the Model includes numerous user-controlled parameters that allow the simulation of alternative Project operations, such as alternative flow regimes for the lower Tuolumne River. The Model performs a simulation of Project operations for a sequential period of years that covers a range of historical hydrologic conditions. The period of hydrologic record selected for the Model is Water Year 1971 through Water Year 2009, which includes extreme years of hydrology (1977 dry and 1983 wet) and multi-year periods of challenging water supply conditions such as 1976-1977, 1987-1992, and 2001-2004. The purpose of this User's Guide is to describe the structure of the Model, the interfaces available for operation of the Model, and methods available for the reviewing Model results. Procedures for development of input files for running alternative future operations are also described and illustrated. The data presented in this document are referenced to a "Test-Case" simulation of operations and are being incorporated for illustrative purposes of the Workshop.

As is the case with any model, the Tuolumne River Daily Operations Model is only a depiction of project operations, and is limited to representing CCSF and District operations to the extent that their operations can be described systematically by various equations and algorithms. Actual project operations may vary from those depicted by the Model due to circumstantial conditions of hydrology and weather,

facility operation, and human intervention. The FERC-approved study plan has identified a number of user-controlled variables for running alternatives. The fact that the Model provides these user-controlled inputs is not an indication that either the Districts or CCSF endorse or support any specific alternative developed by manipulating these inputs.

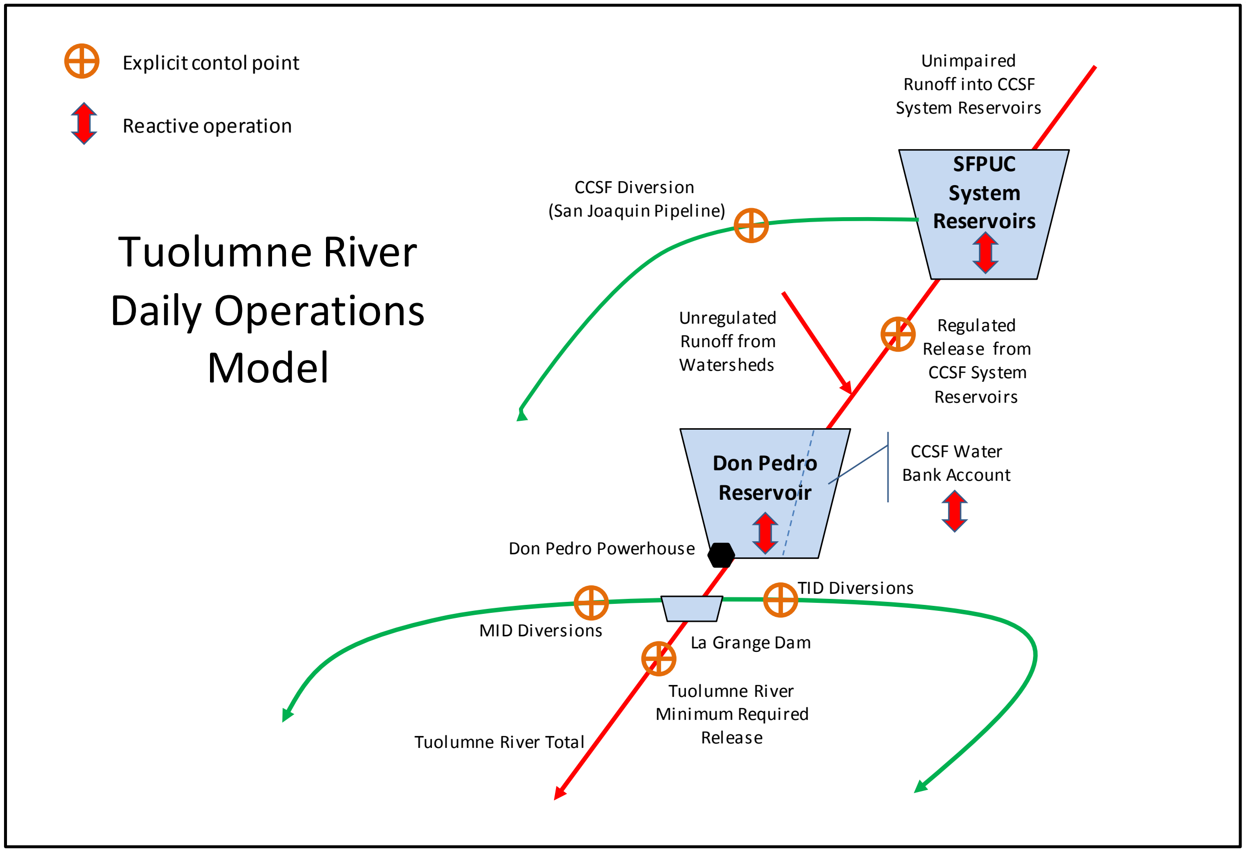
2.0 Geographical Range of Model and Underlying System Operation

As mentioned above, the geographic scope of the Model extends for CCSF's Hetch Hetchy system to the confluence of the Tuolumne and San Joaquin Rivers, as generally depicted in Figure 2.0-1. The Model comprises two primary subsystems -- the Districts' Don Pedro Project and CCSF's Hetch Hetchy Project, which are independently owned and operated by the respective parties. The Don Pedro Project includes the Don Pedro Reservoir and powerhouse. It provides water storage and flood control benefits. Water that flows into Don Pedro Reservoir is either stored or passed through to the lower Tuolumne River. Included in the model is the projected diversion of water at La Grange to serve irrigation and M&I customers of MID and TID. A model "node" (calculation point) is provided at the Districts' La Grange diversion dam, where the Model simulates flows to the Modesto Canal, the Turlock Canal, and the Tuolumne River below the La Grange diversion dam. The CCSF System is modeled as three physical reservoirs (Hetch Hetchy Reservoir, Lake Lloyd and Lake Eleanor), the San Joaquin Pipeline (SJPL), and an accounting for the Don Pedro Water Bank Account. All releases from the CCSF System, except those diverted to the SJPL enter Don Pedro Reservoir. A node is also provided to represent the location of the existing USGS stream flow gage entitled "Tuolumne River at Modesto" (Modesto). Additional nodes may be established above and/or below the Modesto gage node depending on the results of ongoing lower Tuolumne River accretion flow measurements.

The Model components operate with systematic algorithms that attempt to mimic operational decisions for reservoir and facility operations. For each subsystem, certain operation constraints can be user-controlled consistent with the FERC-approved study plan. Within each subsystem, each reservoir has the same underlying operation protocol. A daily mass balance is performed: *change in reservoir storage = inflow, minus outflow (releases), minus reservoir losses*. If the calculation results in a reservoir storage that is in excess of preferred/maximum capacity, an additional release is made.

Minimum releases for each modeled reservoir are in accordance with current stream flow requirements and diversion requirements. Each reservoir assumes a common "hold-unless-need-to-release" protocol, except as conditioned by minimum stream release requirements, diversions, preferred/maximum storage, snowmelt management releases, or other specified releases. In essence, each reservoir operates for its own "reservoir conservation" goal and retains storage as much as possible, only drawn down as needed to meet release requirements, diversions, or to achieve reservoir or flow management goals such as flood control or, in some cases hydropower.

Figure 2.0-1 - Tuolumne River Daily Operations Model



3.0 Don Pedro Project and La Grange Diversion Dam

The Don Pedro Project and the La Grange diversion dam operations are modeled to represent current operations for irrigation and municipal water deliveries, fishery and instream flow requirements and flood control. Hydropower production is a function of the releases made for these other purposes. The following elements of hydrology and objectives guide the modeled operation.

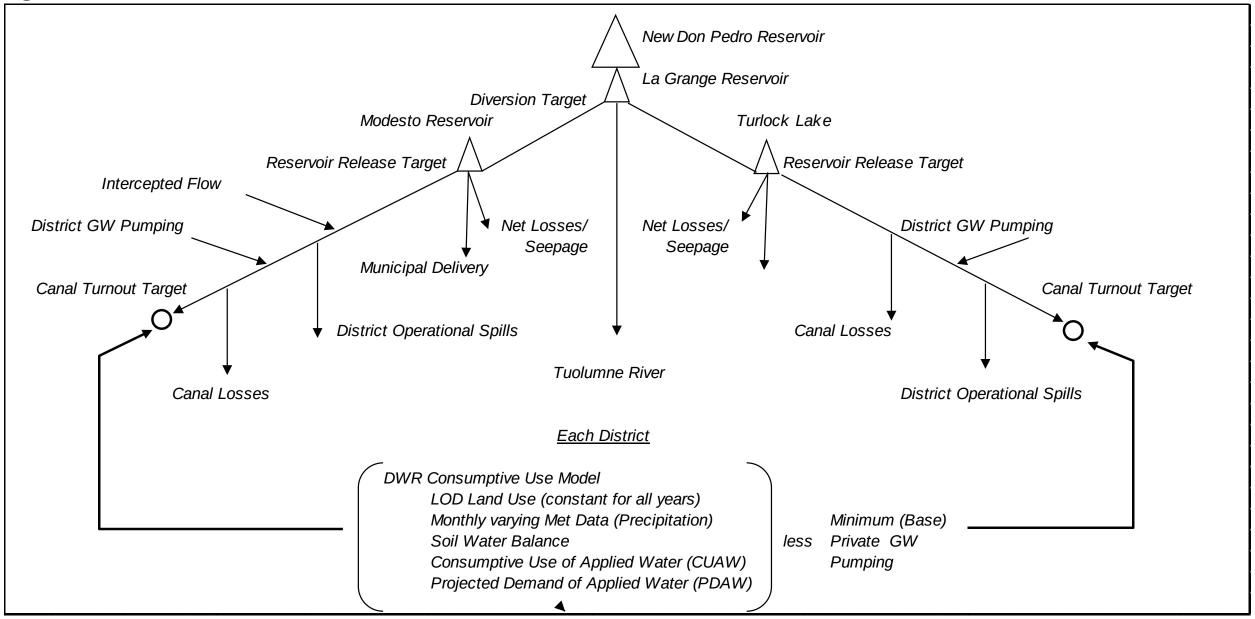
3.1 Reservoir Inflow

Inflow to Don Pedro Reservoir is modeled as two components: 1) a fluctuating unregulated inflow to Don Pedro Reservoir, and 2) the regulated releases (regulated Don Pedro Reservoir inflow) from the CCSF System. The inflow will reflect a daily fluctuating pattern which is mostly associated with the unregulated component of runoff in the basin, which is approximately 40 percent of the total runoff in the basin. The unregulated component of inflow to Don Pedro Reservoir remains the same among all operation simulations. The regulated inflow to Don Pedro is based on a projected level of development and operation for the CCSF System. This component of Don Pedro Reservoir inflow may change among operation simulations due to changed assumptions for CCSF System demands and level of development, or due to user-controlled parameters.

3.2 MID and TID Canal Demand

Figure 3.2-1 is a schematic of the parameters used by modeling to create each District's diversion demand at La Grange diversion dam.

Figure 3.2-1 - District Canal Demand Parameters



Due to changing land use and cropping patterns, groundwater use and irrigation and canal management practices throughout history, the historical record of recorded diversions does not provide a consistent definition of water diversion needs. Similar to depicting inflow, the Model uses a projected level of development for establishing irrigation and canal diversion demand.

The canal diversions are assumed to be driven by three components: 1) a fluctuating customer component, the (P)rojected (D)emand of (A)pplied (W)ater (PDAW), 2) a relatively constant depiction of operational system losses/efficiencies, and 3) a water supply availability factor based on Don Pedro Reservoir storage and inflow.

The PDAW is developed through use of DWR's consumptive use model, and considers precipitation, ET rates, soil moisture criteria, rooting depth, irrigation indicators, and other factors along with land use to estimate the CUAW on a monthly basis. Monthly water use varies based on input ET rates, which are constant each year. CUAW will only vary each year based on variation in precipitation. The PDAW has been adjusted to

reflect other routine irrigation practices not identifiable with strict ET, such as pre-irrigation. The estimate of monthly PDAW is distributed daily based on the historical (2009-2011) distribution of canal diversions within months.

In addition to the PDAW requirement, several canal operation and management components are incorporated into the projected diversion demand. The following tables provide the monthly estimates used for each component, Table 3.2-1 for MID and Table 3.2-2 for TID.

Table 3.2-1 – Canal Demand and Operation Components for MID

Modesto Irrigation District

	Turnout Delivery Factor	Nominal Private GW Pumping	Canal Operational Spills Critical	Canal Operational Spills Non-crit	System Losses below Modesto Res	Intercepted Flows	Nominal MID GW Pumping	Modesto Res and Upper Canal Losses/Div	Municipal Delivery from Modesto Res	Modesto Res Target Storage
Month	%	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF
January	35	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	17.0
February	35	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	18.0
March	65	1.0	1.0	3.0	0.6	0.9	1.0	2.0	2.7	18.0
April	70	2.0	3.0	6.0	0.6	0.9	2.3	2.9	2.7	19.0
May	85	3.0	4.0	6.5	0.6	1.2	2.3	3.9	3.0	20.0
June	85	4.0	3.5	6.5	0.6	1.0	2.3	4.3	3.2	20.0
July	77.5	4.0	3.5	6.5	0.6	1.0	2.6	4.9	3.3	21.0
August	70	4.0	4.9	7.0	0.6	1.4	2.4	4.9	3.3	22.0
September	65	2.0	5.0	7.0	0.6	1.2	2.3	4.2	3.3	20.0
October	40	1.0	2.8	6.9	0.6	0.9	2.1	2.0	3.2	17.0
November	30	0.0	2.0	2.0	0.1	0.0	0.0	2.0	2.7	15.0
December	35	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.5	15.0
Total		21.0	35.7	57.4	5.4	8.5	17.3	31.1	34.5	

Table 3.2-2 – Canal Demand and Operation Components for TID

Turlock Irrigation District

	Turnout Delivery Factor	Nominal Private GW Pumping	Canal Operational Spills Critical	Canal Operational Spills Non-crit	System Losses below Turlock Lk	Intercepted Flows	Nominal TID GW Pumping	Turlock Lk and Upper Canal Losses	Other Delivery from Turlock Lk	Turlock Lk Target Storage
Month	%	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF
January	30	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	18.0
February	30	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	25.0
March	65	1.2	3.0	3.0	4.5	0.0	4.1	1.0	0.0	30.0
April	57.5	2.4	5.1	6.3	4.5	0.0	8.0	6.6	0.0	30.0
May	85	3.6	4.6	6.7	4.5	0.0	10.3	7.7	0.0	32.0
June	92.5	5.2	4.2	6.7	4.5	0.0	12.4	8.2	0.0	32.0
July	72.5	6.4	4.2	6.7	4.5	0.0	14.6	8.7	0.0	32.0
August	62.5	6.2	4.0	7.3	4.5	0.0	13.3	9.0	0.0	30.0
September	67.5	3.9	3.2	7.3	4.5	0.0	9.1	5.0	0.0	27.0
October	40	2.4	2.3	7.3	4.5	0.0	5.3	2.0	0.0	13.0
November	30	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0
December	30	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0
Total		31.3	38.6	59.3	39.2	0.0	77.1	52.2	0.0	

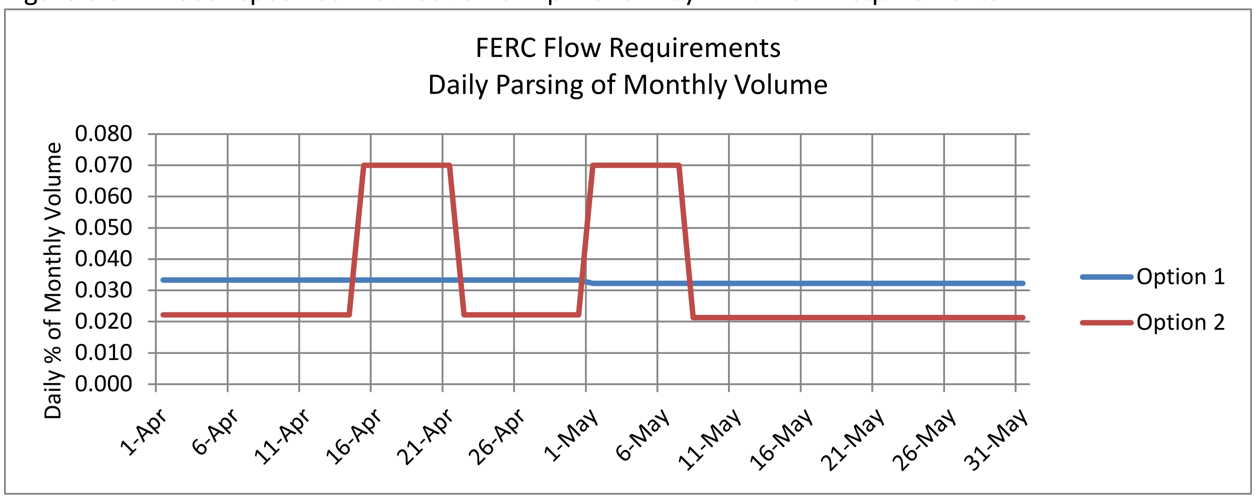
The turnout delivery factor is unique to each District and represents a modeling mechanism to adjust the PDAW for irrigation practices that are not included in the estimation of the CUAW, such as irrigation that provides for groundwater recharge.

3.3 Required FERC flows at La Grange Bridge

The current FERC minimum flow requirements at La Grange Bridge are included in the Model. In the Model the terms “La Grange releases”, “flows at La Grange Bridge” or “releases at La Grange diversion dam” are used interchangeably to mean the minimum flow requirements under the Project’s current FERC license as measured at the USGS gage “Tuolumne River at La Grange, CA”. The annual flow requirement is established for the April-March flow year beginning April based on pre-knowledge of the final San Joaquin River Index (60-20-20) for the year. The annual volume including “interpolation water” is computed using the FERC Settlement Agreement procedures, which includes a revised year type distribution using a 1906-2011 population of historical years. The interpolation water is assumed to be spread among April and May volumes.

The Model assumes each month’s volume of the annual volume is spread evenly across the days of the months, except during April and May where the user can define the distribution of daily flows. The user can define the distribution as: 1) total monthly volume spread evenly across all days of a month, or 2) a user-specified daily distribution of monthly volume during April and May. Figure 3.3-1 illustrates the outcome of the two assumed flow distributions during April and May. The pulsing pattern option shown in Figure 3.3-1 is being used by the Model.

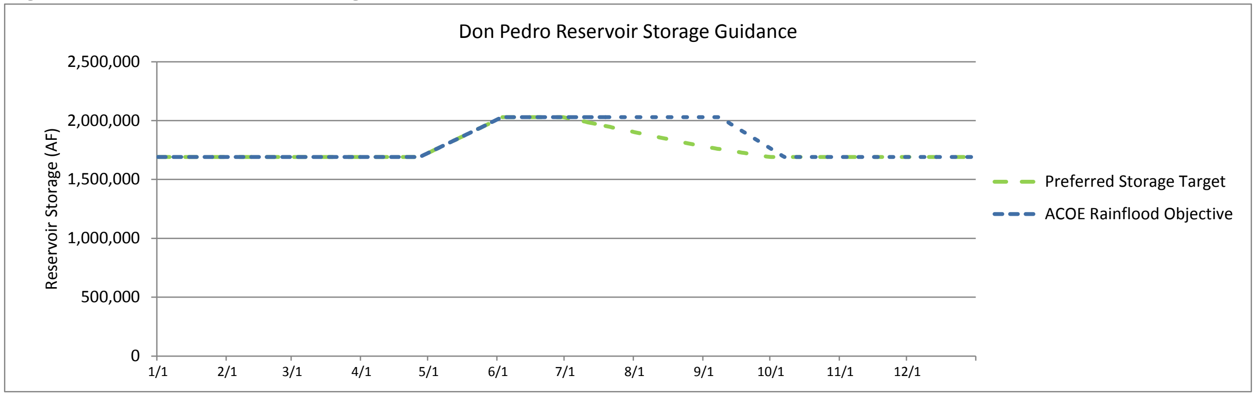
Figure 3.3-1 – User-specified Distribution of April and May FERC Flow Requirements



3.4 Reservoir and Release Management

Don Pedro Reservoir storage is initially checked against a preferred storage target. The Model allows the user to establish the preferred storage target. The preferred storage target is the ACOE rainflood reservation objective, except after July 1, when there is no required reservation space. The preferred storage target reflects a drawdown to evacuate storage during the summer in late and wet runoff years. The preferred target storage is again equal to the ACOE objective on October 7. Figure 3.4-1 illustrates the reservoir storage target used in the Model.

Figure 3.4-1 –Reservoir Storage Guidance



For a day of Don Pedro Reservoir operation, the day's inflow is a computed amount from upstream CCSF System operations and unregulated inflow. The stream flow requirements contained in the FERC license at La Grange Bridge and the MID and TID canal diversions are the release from Don Pedro Reservoir. The prior day's reservoir evaporation is included in the calculation. If the computation produces resulting Don Pedro Reservoir storage in excess (encroachment) of the preferred storage target, the encroachment is computed. Every 7th day the model checks for an encroachment, and if it exists a "check" release is computed. It is assumed that a constant supplemental release (in excess of minimum releases) will be initiated at a rate equal to the encroachment divided equally over the next 10 days. This protocol repeats itself every 7th day, reestablishing the level of check release each time. The end result of this procedure will allow encroachment of storage space above the preferred storage target and not require unrealistic "hard" releases of water to exactly conform to the target.

A second check release is made during the April through June period for management of anticipated snowmelt runoff. On the first day of each of these months a forecast is made of anticipated runoff into the reservoir and minimum releases and losses from the reservoir from the date of forecast through the end of June (the assumed target date of reservoir filling). These forecasts determine the volume of water (if any) that will require release in excess of minimum releases and losses and storage gain by the end of June. For April and May, the DWR "90 percent exceedence forecast" is used for anticipated runoff, along with known minimum releases and losses, and upstream impairment. The user defines

the percentage of volume (of the total volume) to be additionally released during each month. For April, 30 percent of the 3-month volume is advised for release, and during May 50 percent of the 2-month volume is advised for released. For June, the historically reported unimpaired flow (UF) flow is assumed for the runoff computation. This assumes pre-knowledge of the runoff volume for the month, and 100 percent of the excess is spread across the month. The snowmelt check release is evenly distributed across the days of the month. The release made in a day is the greater of the two check releases or the minimum release. At no time is the maximum capacity of the reservoir (2,030,000 acre-feet) allowed to be exceeded, and if necessary a release, regardless of magnitude, will be made by the Model to not exceed maximum storage capacity.

A Modesto flood control objective is incorporated into the release logic. The objective is to maintain a flow at Modesto no greater than a user specified flow rate (assumed as 9,000 cfs). The logic checks against an "allowable" La Grange release considering the lower Tuolumne River accretions and Dry Creek flow. Model logic compares the La Grange allowable release to the other check releases. The La Grange release is then reduced if necessary to not exceed the Modesto flow target objective, even if it results in an encroachment in Don Pedro Reservoir. The exception is when the reservoir reaches full (2,030,000 AF). Any computed encroachment above a full reservoir is passed and the Modesto flow objective will be exceeded.

Consistent with the original FERC license filings for the new Don Pedro Project, the minimum operating reservoir level is established at elevation 600 feet, corresponding to a storage volume of 308,960 AF. Below this elevation is referred to as the "dead pool" storage.

3.5 Water Supply Factor

A constraint to the Districts' canal diversions is recognized when there is a reduced water supply at Don Pedro Reservoir. The premise of the (W)ater (S)upply (F)actor (WSF) is to reduce the amount of water diverted to the canals during years when lack of carryover storage at Don Pedro Reservoir becomes a concern.

The modeling mechanism used to reduce canal diversions is a factor applied to the PDAW of the canal demand. This mechanism results in a reduction to the amount of water "turned out" to the customers while still recognizing the relatively constant efficiencies of canal operations.

The WSF is established by forecasting upcoming water supply, based on antecedent storage and anticipated inflow to Don Pedro Reservoir. The forecasting procedure begins in February and ends in April. The Factor Table is based on April forecast results. The February and March Forecasts act as adjustments to get to the April 1 state. The forecasts have the following protocol:

February Forecast (forecasting April 1 state):
End of January storage + Feb-Jul UF - Feb-Jul Upstream adjustment - Feb-Mar minimum river
March Forecast (forecasting April 1 state):
End of February storage + Mar-Jul UF - Mar-Jul Upstream adjustment - Mar minimum river
April Forecast: (final)
End of March storage + Apr-Jul UF - Apr-Jul Upstream adjustment

Pre-knowledge of unimpaired runoff for each forecast period is assumed, as well as knowledge of upcoming upstream impairment of the runoff.

The WSF factor / Don Pedro Storage + Inflow relationship is developed through iterations of multi-year system operation simulations. The WSF depicts actions that may be implemented during times of drought, and the projected canal diversions and reservoir storage operation during drought periods. The factors and index triggers were developed reviewing reservoir storage levels that occurred during the 1987-1992 drought.

3.6 Power Generation

Equations of Don Pedro powerhouse generation characteristics define capacity (MW) and efficiency (kWh/AF), based on reservoir storage. Capacity potential uses minimum storage of the day, while efficiency uses average storage of the day. The maximum flow through plant is assumed to be 5,400 cfs. Water that does not appear as passing through the generators is computed to be “spilled-bypassed”. The power generation “cutoff” also occurs at the reservoir storage of 308,960 acre-feet or the top of dead pool.

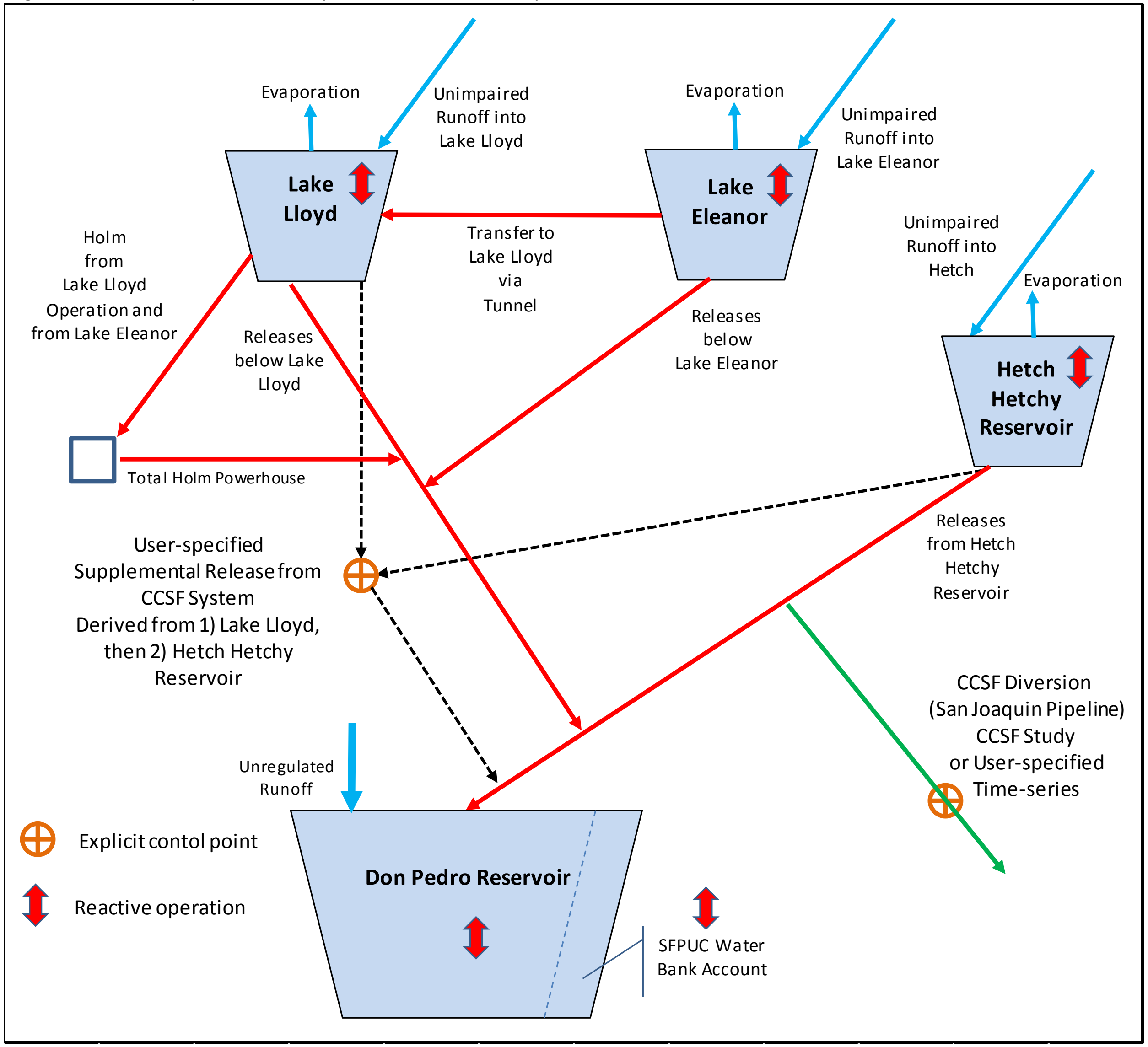
3.7 User-Interface Adjustments

The Model allows alternative user-specified data for two components of District operations: 1) user-specified assumptions for the La Grange Bridge minimum flow requirements, and 2) a user-specified diversion for the Districts' canals. An alternative La Grange Bridge flow requirement can be incorporated by definition of required flows by periods within a year, based on year type. Entered in this protocol the input will result as a daily time series for the Model. Alternatively, a flow requirement can be entered as a daily time series. For an alternative canal diversion, an array has been provided to input a monthly by 39-year matrix of alternative canal diversions. The monthly array of data is parsed by the Model into daily distributions reflecting the current depicted daily distribution of canal diversions.

4.0 City and County of San Francisco System

The Model representation of the CCSF System on the Tuolumne River includes the three physical reservoirs (Hetch Hetchy Reservoir, Lake Lloyd and Lake Eleanor), diversions to the Bay Area through the San Joaquin Pipeline, and an accounting for the Don Pedro Water Bank Account. The CCSF System is illustrated in Figure 4.0-1, with detail provided for the components of explicitly modeled hydrologic parameters.

Figure 4.0-1 – City and County of San Francisco System



Each CCSF System reservoir has the same underlying operation protocol. A daily mass balance is performed: *change in reservoir storage = inflow, minus outflow (releases), minus reservoir losses*. If the calculation results in reservoir storage exceeding preferred/maximum capacity, an additional release of water is made.

Minimum releases from each reservoir are in accordance with current requirements for Hetch Hetchy Reservoir, Lake Lloyd and Lake Eleanor.

Each reservoir assumes a common “hold-unless-need-to-release” protocol, except as conditioned by minimum release requirements, diversions, preferred/maximum storage, snowmelt management releases, hydropower, or other flow or management objectives. In essence, each reservoir operates for its own “reservoir conservation” goal of retaining storage unless drawn down by demands or reservoir management objectives. CCSF is required by State law and its Charter to operate its system for “water first”.

4.1 Hetch Hetchy Reservoir

Hetch Hetchy Reservoir storage is initially checked against a preferred storage target. The day's inflow is a given amount, and the SJPL diversion and minimum stream flow requirements below Hetch Hetchy Reservoir determine the release. The prior day's reservoir evaporation is included in the calculation. If the computation produces storage in excess (encroachment) of the preferred storage target, the encroachment is computed. Every 7th day the model checks for the encroachment, and if it exists a check release is computed. It is assumed that a constant supplemental release (in excess of minimum releases) will be initiated at a rate equal to the encroachment divided equally over the next 7 days. This protocol repeats itself every 7th day, reestablishing the level of check release each time. The end result of this procedure will allow encroachment of storage space above the preferred target storage and not require unrealistic releases of water to exactly conform to the target.

A second check release is made during the February through June period for management of anticipated snowmelt runoff. On the first day of each of these months a forecast is made of anticipated runoff into the reservoir and minimum releases and losses from the reservoir from the date of forecast through the end of June (assumed target of reservoir filling). These forecasts determine the volume of water (if any) that will require release in excess of minimum releases and losses and storage gain by the end of June. Pre-knowledge is used for anticipated runoff, minimum releases and losses. The user defines the percentage of volume (of the total volume for the period) to be additionally released during each month. For February through April, 10 percent of the additional release volume is advised for release, and may be additionally capped. This approach tends to hold Hetch Hetchy Reservoir releases for later release during May. The snowmelt check release is evenly distributed across the days of the month and can be capped in terms of rate (cfs) or minimum volume of the reservoir to which it can be drawn during the month. The particular release made in a day is the greater of the two check releases or the minimum release. At no time is the maximum capacity of the reservoir allowed to be exceeded, and if necessary a release, regardless of magnitude, will be made by the Model to not exceed maximum storage capacity.

For Hetch Hetchy Reservoir these two check releases typically guide the operation of the reservoir during the winter and spring. After reservoir filling, summer-time stream release requirements and the SJPL demand typically draw the reservoir down below the preferred storage targets.

Canyon Tunnel, Kirkwood Powerhouse, Mountain Tunnel and Moccasin Powerhouse are not explicitly modeled. The structure of the Model depicts the component of inflow to Don Pedro Reservoir that originates from the Hetch Hetchy Reservoir watershed. The detail of flow reaches below Hetch Hetchy Reservoir is not needed. Therefore, the simple gradation of flow between flow removed from the stream system by the SJPL and the remaining flow that will eventually reach Don Pedro Reservoir is sufficient for purposes related to the relicensing of the Districts' Don Pedro Project.

4.2 Lake Lloyd

The same underlying reservoir operation protocols of Hetch Hetchy Reservoir apply to Lake Lloyd, with a couple of modifications. Instead of the SJPL demand being assumed as an initial release requirement, a minimum Holm Powerhouse release during May through August is assumed from Lake Lloyd.

Both the initial check release for preferred storage encroachment and the snowmelt check release are computed and advised for reservoir operations. If supplemental releases above minimum releases are computed the Model routes the additional release through Holm Powerhouse up to its available capacity. The remainder of the supplemental release is routed to the stream below Lake Lloyd. A comparison is made between "Lloyd-only" use of Holm Powerhouse capacity and maximum capacity for passage to the Lake Eleanor model component.

The operation goal linkage between Lake Lloyd and Lake Eleanor assumes that Lake Eleanor will transfer water from its watershed to Lake Lloyd for the purpose of enhancing power generation at Holm Powerhouse. Thus, any available capacity at Holm Powerhouse after the Lloyd-only operation is assumed available and desired for use of a Lake Eleanor transfer. If water is transferred from Lake Eleanor the Model assumes the water to be directly routed to Holm Powerhouse which then becomes additional release from Lake Lloyd. The inclusion of the Holm Powerhouse logic in the Lloyd/Eleanor watershed logic is only done to facilitate the interaction between the two watersheds.

4.3 Lake Eleanor

Both the initial check release for preferred storage encroachment and the snowmelt check release are computed and employed into reservoir operations. In this instance of Lake Eleanor operations, the transfer “desire” for Holm Powerhouse generation is considered a disposition of the Lake Eleanor releases determined to be in excess of minimum stream requirements. To the extent that check (stream) releases are available from Lake Eleanor, they will be transferred. The amount transferred is limited by available Holm Powerhouse capacity and the assumed capacity of the Eleanor-Cherry Diversion Tunnel. The Lake Eleanor operation protocol will transfer water that would otherwise be released in excess of minimum flow requirements (largely dependent upon the preferred storage target and snowmelt releases) but it will not allow water to be “pulled” from Lake Eleanor to Lake Lloyd.

4.4 Don Pedro Inflow

The three components of regulated releases from Hetch Hetchy Reservoir (not including the SJPL), Lake Lloyd and Lake Eleanor are combined with the unregulated runoff below CCSF System reservoirs to provide the inflow data set for Don Pedro Reservoir.

4.5 Water Bank Account

A Water Bank Account calculation procedure is included in the Model. A running account of the Water Bank Account balance is computed daily, as limited by the Fourth Agreement and implementing agreement. The Model allows the computation of a “negative” balance. The accounting of the balance is incidental to model operations, and there is no auto-default feedback linkage to upstream operations if the balance is negative. To be consistent with current operations in the watershed, the user must employ the user-specified adjustment mechanism for supplemental CCSF System releases to remedy any negative balances.

For purposes of the FERC investigation, the protocols of Fourth Agreement Water Bank Accounting have been amended to incorporate a hypothetical implementation of “shared responsibility” for incremental increases in FERC-required flows for the Tuolumne River.[1] The incremental increase in FERC-required flows is determined by the daily difference between the current FERC requirements and scenario-required minimum flows. Approximately fifty-two percent (51.7121%) of the incremental difference between the flow schedules is assigned as CCSF’s responsibility and counted as a debit within Water Bank Accounting.

[1] The “shared responsibility” assumption is presented for the purpose of evaluating alternative operations. The assumption shall not be used as evidence in any proceeding relating to and shall not act as precedence for any allocation of Tuolumne River water between CCSF and the Districts for any purpose under the Fourth Agreement.

4.6 User Interface Adjustments

The Model allows alternative user-specified data for two components of CCSF operations: 1) user-specified supplemental releases from the CCSF System, and 2) user-specified SJPL diversions.

The user-specified release from the CCSF System is to allow the user to "pull" additional water from the CCSF System as supplemental inflow to Don Pedro Reservoir. A single entry is established that will first pull water from Lake Lloyd so that water supply is preserved in the Hetch Hetchy Reservoir system for diversion to the SJPL. At a point when such supplemental releases strain Lake Lloyd storage, the supplemental releases are directed to Hetch Hetchy Reservoir. When employed, a daily flow release is directed from a reservoir at a point in logic after most of the previously described logic occurs. Thus, this release occurs in addition to what operation is already occurring by default. Such a release can affect the following day's default operation or previous periods' operations, thus results require review to determine if the user's desired result occurs. It is also necessary to determine at the end of each simulation whether the operations depicted are consistent with the keeping of the Water Bank Account Balance from being negative.

This adjustment capability is used to maintain the Water Bank Account Balance greater than zero. There is no auto-default logic to keep the Water Bank Account Balance from going negative. In a typical scenario of normal CCSF System operations during most years, for this level of modeling, the Water Bank Account would not affect CCSF upstream operations. The exception is during prolonged drought when the default reservoir operation of CCSF System reservoirs attempts to hold stream releases to a minimum. In the modeled WY 1971 to 2009, the period 1987 through 1992, and possibly other periods may drive the Water Bank Account to a negative condition. The release adjustment is used to provide additional releases from the CCSF System to avoid driving the Water Bank Account negative.

The second adjustment to SF System hydrology can be made to the pre-specified time series of monthly SJPL diversion. The user is provided a tool to enter an alternative time series of data. This capability can be used to adjust CCSF System diversions from the Tuolumne River.

5.0 General Model Structure

The Model was constructed within the platform of a Microsoft Excel 2010 workbook. All Model logic is contained within cells of the workbook with no macros or calls to other forms of programming such as Visual Basic for Applications. Numerous worksheets within the workbook represent logical groupings of either sub-system facilities and operations, or input/output functionality. The worksheets of the Model are briefly described in Table 5.0-1. Some of the worksheets in the Model are fixed to prevent inadvertent changes to certain facility functions and operations. These aspects of the Model are consistent with the FERC-approved study plan.

Table 5.0-1 – Model Worksheets

Purpose	Worksheet Name	Description
Model Operations	UserInput*	Contains user inputs for La Grange Requirements, Canal Diversions, CCSF SJPL and CCSF Supplemental Releases
	Control	Contains inputs for facility characteristics and Test Case configuration
	DonPedro	Contains model logic for Don Pedro Reservoir operation
	SFHetchHetchy	Contains model logic for Hetch Hetchy Reservoir operation
	SFLloyd	Contains model logic for Lake Lloyd operation
	SFEleanor	Contains model logic for Lake Eleanor operation
	SFWaterBank	Contains model logic for Water Bank operation
	WaterBankRel*	Contains mode logic and user input for CCSF Supplemental Releases
View Model Results	DPGroup*	Plots simulation of Don Pedro Reservoir operations and River flows
	HHGroup*	Plots simulation of Hetch Hetchy Reservoir operation
	LloydGroup*	Plots simulation of Lake Lloyd operation
	ELGroup*	Plots simulation of Lake Eleanor operation
	WBGroup*	Plots simulation of Water Bank Balance computation
	SFSysGroup*	Plots simulation of CCSF System reservoirs
	DPGroup86_94*	Plots simulation of Don Pedro Reservoir operation during 1986-1994
	SFGroup86_94*	Plots simulation of CCSF System operation during 1986-1994
	ModelYearofDaily*	Plots and tables any single parameter for a calendar or water year
	ModelAnyGroup*	Plots any group of parameters for a calendar year
	ModelMonthTable*	Plots and tables up to four parameters, summarizing daily data by month
Model Operations	LaGrangeSchedule	Contains model logic for 1995 FERC minimum flow requirements
	DailyCanalsCompute	Contains model logic for computation of daily District canal demand
	DailyCanals	Contains model logic for computation of user-defined canal demand
	DPWSF	Contains model logic for computation of Don Pedro water supply factor
	CCSF	Contains model logic for CCSF release and diversion requirements
Model Inputs	Hydrology	Contains input data for hydrology
	602020	Contains input data for forecasting hydrology
View Output	Output*	Results of scenario specific simulation in HEC-DSS format
	DSSAnyGroup*	Plots any group of parameters for a calendar year from HEC-DSS format
	DSSMonthTable*	Plots and tables up to four parameters, summarizing daily data by month from HEC-DSS format
"*" Identifies worksheets accessible as user interfaces.		

5.1 UserInput Worksheet

This worksheet (UserInput) provides the interface for entering assumptions for minimum flow schedules for the lower Tuolumne River at La Grange Bridge, canal diversions by the Modesto Irrigation District and Turlock Irrigation District, supplemental releases to Don Pedro Reservoir from the CCSF System, and diversions by CCSF through the San Joaquin Pipeline. The worksheet is described below.

Contents Description and Study Name

User Defined Input
Variables Affected by User Entered in Blue Shaded Cells

Contents:
Section 1 - Alternative Flow Requirements at La Grange Bridge
Section 2 - Alternative Modesto and Turlock Canal Diversions
Section 3 - Supplemental Release from CCSF Upstream Reservoirs
Section 4 - Alternative CCSF San Joaquin Pipeline

(UI 1.00)	Enter Study Reference:	Test_Case	*For Part 6 of DSS file (minimize length of name)*

This section provides an index of the contents included in the worksheet, and identifies a named label for the particular study. An alpha numeric entry is entered (UI 1.00) for the study name, which is then incorporated into the DSS output interface tab (see worksheet Output description).

Section 1: Minimum Flow Requirements at La Grange Bridge

Section 1 - Alternative Flow Requirements La Grange Bridge

This table is used to enter a user-specified minimum flow schedule at La Grange Bridge. Twenty-four time periods are available to define a flow rate. Six different water year types can be established.
The year types correspond to the Preliminary Relicensing Year Type which is based on Tuolumne River unimpaired flow.

(UI 1.10) Turn alterantive flow requirement on: 0 *(1) on, and use alternative flow requirement, or (0) off, use current FERC flow requirement*

(UI 1.20) Use year type table below, or time series: 0 *(1) for table below, or (0) for time series (Column BM)* N/A

(UI 1.30)

Alternative Flow Requirements
Enter values in CFS

CYMo Day MM.DD	W 1	AN 2	N 3	BN 4	D 5	C 6
1.01	300	300	233	150	157	150
1.16	300	300	233	150	157	150
2.01	1,287	994	729	419	409	359
2.15	1,287	994	729	419	409	359
3.01	1,627	1,172	912	931	627	421
3.16	1,627	1,172	912	931	627	421
4.01	1,960	1,533	1,508	1,211	1,075	785
4.16	1,960	1,533	1,508	1,211	1,075	785
5.01	2,767	2,744	2,476	1,696	1,258	905
5.16	2,767	2,744	2,476	1,696	1,258	905
6.01	2,857	2,200	1,619	924	566	382
6.16	2,857	2,200	1,619	924	566	382
7.01	250	250	150	61	56	50
7.16	250	250	150	61	56	50
8.01	250	250	150	61	56	50
8.16	250	250	150	61	56	50
9.01	250	250	150	61	56	50
9.16	250	250	150	61	56	50
10.01	397	397	295	143	152	126
10.16	397	397	295	143	152	126
11.01	300	300	233	150	158	150
11.16	300	300	233	150	158	150
12.01	300	300	233	150	157	150
12.16	300	300	233	150	157	150

(UI 1.40) Enter beginning month of annual flow requirement schedule: Feb-Jun / Feb / 2

Preliminary Relicensing Year Type is based on a rank-ordering of the water-year runoff for the years 1921-2011. Each water year type W, AN, N, and BN represent 20% of the years of ranking. D and C year types each represent 10% of the years.

CCSF Responsibility* for La Grange Minimum Flows

CCSF responsibility is applied as a daily debit in the computation of CCSF debit or credit in the Water Bank Account.

0 *(0) not responsible, or*
(UI 1.31) *(1) responsible for 51.7121% of difference between 1995 FERC and scenario requirement.*

If responsibility option is selected, user should go to Section 3 of UserInput and use supplemental CCSF releases to maintain Water Bank Account > zero.

Existing FERC Flow Requirements at La Grange Bridge
Values in CFS

CYMo Day MM.DD	W 1	AN 2	N 3	BN 4	D 5	C 6
1.01	300	300	225	150	157	150
1.16	300	300	225	150	157	150
2.01	300	300	225	150	158	150
2.15	300	300	225	150	158	150
3.01	300	300	225	150	157	150
3.16	300	300	225	150	157	150
4.01	300	300	225	150	158	150
4.15	1,762	1,762	1,562	776	655	461
5.01	1,762	1,762	1,562	776	655	461
5.16	300	300	225	150	157	150
6.01	250	250	150	61	56	50
6.16	250	250	150	61	56	50
7.01	250	250	150	61	56	50
7.16	250	250	150	61	56	50
8.01	250	250	150	61	56	50
8.16	250	250	150	61	56	50
9.01	250	250	150	61	56	50
9.16	250	250	150	61	56	50
10.01	397	397	284	143	152	126
10.16	397	397	284	143	152	126
11.01	300	300	225	150	158	150
11.16	300	300	225	150	158	150
12.01	300	300	225	150	157	150
12.16	300	300	225	150	157	150

Existing FERC flow requirements averaged within Preliminary Relicensing Year Type designations. Existing annual FERC schedules are assumed to begin April 1. Values shown for comparison purposes.

*The “shared responsibility” assumption is presented for the purpose of evaluating alternative operations. The assumption shall not be used as evidence in any proceeding relating to and shall not act as precedence for any allocation of Tuolumne River water between CCSF and the Districts for any purpose under the Fourth Agreement.

This section provides an entry of the minimum flow schedule for the lower Tuolumne River. Switch UI 1.10 directs the use of the current 1995 FERC schedule (UI 1.10 = 0) or an alternative schedule (UI 1.10 = 1). If an alternative schedule is directed, Switch UI 1.20 directs the use of a user-defined daily times series (UI 1.20 = 0) or the use of a user-specified year type schedule (UI 1.20 = 1).

Daily Time Series

If the daily time series is directed, a flow value (expressed in average daily flow – cfs) must be entered in Column BM of this worksheet for each day beginning October 1, 1970 through September 30, 2009.

Year Type Schedule

If the year type schedule is directed, values must be entered into the matrix provided at UI 1.30. Values are entered as average daily flow (cfs) for 6 year types, for up to 24 discrete periods during the year. The periods are identified in MM.DD format. For instance, for a flow to be provided for January 1 through January 15 the flow would be identified with a period starting 01.01 (January [01], day 1) and ending

with a different flow identified with a starting period of 01.16 (January [01], day 16). The year type has been established by the naming of 6 year types, wet, above normal, normal, below normal, dry and critical. Using the water year runoff for the years 1921 through 2011 (91 years), the years were rank ordered from wettest to driest. The wettest 20 percent of the years (18 years) are designated the wet year type. The next wettest 18 years are designated the above normal year type. And so on for the normal and below normal year types. The driest 20 percent of years are split between the dry and critical year types. After the demarcation occurs for each year the data set is reduced to only the 1971 through 2009 modeling period (39 years). The reduced set of years of the modeling period maintains a year type frequency distribution similar to the larger data set's 20/20/20/20/10/10 percent frequency. Switch UI 1.40 directs the monthly sequence of the flow requirement year. For instance, if the flow schedule is to be established for a year beginning February 1 of the year, UI 1.40 would be set to "Feb". The applicable year type schedule would be applied beginning February 1 of the year and continue through January 31 of the following year. Switch UI 1.40 can be set to any month February (Feb) through June (Jun).

The current 1995 FERC minimum flows to the lower Tuolumne River at La Grange Bridge are illustrated in this section for comparison purposes only, and the values are arranged in the context of the year type designations described above. The values reflect an assumption of two equal periods of flow requirements during each month. If Switch UI 1.10 directs the use of the current schedule, the 1995 FERC schedule as defined by the 1995 FERC Settlement Agreement is implemented including the use of its definition of year types and discrete periods of flow requirements during the year. The 1995 FERC schedule is computed in worksheet LaGrangeSchedule.

Shared responsibility for incremental increases in FERC-required flows for the Tuolumne River is enabled with Switch 1.31.[2] The incremental increase in FERC-required flows is determined by the daily difference between the current FERC requirements and scenario-required minimum flows. Approximately fifty-two percent (51.7121%) of the incremental difference between the flow schedules is assigned as CCSF's responsibility and counted as a debit within Water Bank Accounting. If enabled, shared responsibility will cause an effect in the CCSF Water Bank Account which requires review and possible revision to CCSF supplemental releases.

[2] The "shared responsibility" assumption is presented for the purpose of evaluating alternative operations. The assumption shall not be used as evidence in any proceeding relating to and shall not act as precedence for any allocation of Tuolumne River water between CCSF and the Districts for any purpose under the Fourth Agreement.

Section 2: Canal Diversions of Modesto Irrigation District and Turlock Irrigation District

Section 2 - Alternative Modesto and Turlock Canal Diversions

These tables are used to enter user-specified canal diversions for Modesto ID and Turlock ID. Enter a value for each month of each year.

The monthly volumes of canal diversions are distributed daily within a month based on the daily distribution used for the Base case.

(UI 2.10) Turn alterantive canal diversion on: 0 *(1) on, and use table below, or (0) off, use Test Case canal diversion*

Alternative MID Canal Diversion

	Prelim Relicense Yr-Type	WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total WY
			Enter values in acre-feet												
(UI 2.20)	N	1971	20,952	2,700	2,500	4,300	3,300	14,746	30,656	42,917	47,253	54,987	49,086	32,192	305,589
	BN	1972	20,952	5,130	2,500	4,300	5,679	24,844	46,800	46,544	46,542	54,987	49,086	30,637	338,001
	N	1973	20,952	2,700	2,500	4,300	3,300	14,746	23,737	45,374	47,016	54,987	49,086	32,658	301,356
	AN	1974	20,952	2,700	2,500	4,300	3,300	14,746	18,115	42,917	45,239	49,733	49,086	32,658	286,246
	AN	1975	20,952	5,460	2,500	4,300	3,300	14,746	28,782	44,672	47,253	54,859	43,423	32,658	302,906
	C	1976	20,952	6,451	2,500	4,300	6,350	30,232	34,676	38,540	38,163	44,939	35,682	24,524	287,308
	C	1977	14,568	5,081	2,500	4,300	6,379	17,127	30,279	23,572	28,282	33,405	30,961	19,432	215,886
	W	1978	10,761	2,700	2,500	4,300	3,300	14,746	10,143	39,642	47,253	54,987	49,086	25,506	264,924
	N	1979	23,490	2,700	2,500	4,300	3,300	14,746	27,340	45,140	47,253	53,962	49,086	32,658	306,475
	W	1980	20,952	2,700	2,500	4,300	3,300	14,746	24,602	43,034	47,253	50,758	49,086	32,658	295,889
	D	1981	23,236	7,441	2,500	4,300	3,300	14,746	33,395	45,608	47,253	54,987	49,086	32,658	318,510
	W	1982	20,952	2,700	2,500	4,300	3,300	14,746	12,687	42,917	45,476	54,987	49,086	17,265	270,916
	W	1983	20,952	2,700	2,500	4,300	3,300	14,746	11,058	40,110	47,253	54,987	47,529	15,866	265,301
	AN	1984	20,952	2,700	2,500	4,300	3,300	14,746	37,719	46,777	47,253	54,859	49,086	32,502	316,695
	BN	1985	20,952	2,700	2,500	4,300	3,300	14,746	33,106	46,193	45,950	54,987	49,086	31,881	309,700
	W	1986	20,952	2,700	2,500	4,300	3,300	14,746	19,701	42,215	47,253	54,987	49,086	32,192	293,932
	C	1987	20,952	7,441	2,500	4,300	3,300	11,348	33,450	38,540	38,264	45,048	40,977	26,903	273,023
	C	1988	14,568	5,081	2,500	4,300	3,300	10,522	20,959	28,485	29,064	35,631	32,822	21,807	209,039
	BN	1989	13,109	2,700	2,500	4,300	5,631	11,348	37,004	38,341	38,264	45,048	40,375	15,537	254,156
	D	1990	14,568	5,361	2,500	4,300	5,590	15,190	29,936	21,644	29,236	34,588	31,919	20,952	215,784
	BN	1991	11,125	6,242	2,500	4,300	5,812	10,324	26,779	32,222	30,198	37,899	33,900	23,035	224,335
	C	1992	12,215	6,407	2,500	4,300	3,300	9,811	16,590	29,752	29,193	35,255	32,639	21,693	203,656
	AN	1993	11,399	2,700	2,500	4,300	3,300	14,746	23,160	36,951	44,528	54,987	49,086	32,658	280,315
	D	1994	20,952	2,700	2,500	4,300	3,300	17,718	28,427	26,707	38,264	45,048	40,977	26,639	257,531
	W	1995	14,568	2,700	2,500	4,300	3,300	14,746	15,953	32,974	43,936	54,987	49,086	32,658	271,707
	AN	1996	23,490	7,441	2,500	4,300	3,300	14,746	24,746	30,868	47,134	54,987	49,086	32,658	295,257
	W	1997	20,952	2,700	2,500	4,300	3,300	14,746	45,935	45,491	46,542	54,987	49,086	32,658	323,197
	W	1998	21,967	2,700	2,500	4,300	3,300	14,746	20,421	19,404	43,462	54,987	49,086	32,502	269,376
	AN	1999	20,952	2,700	2,500	4,300	3,300	14,746	31,232	43,619	47,134	54,987	49,086	32,347	306,904
	N	2000	23,236	6,781	2,500	4,300	3,300	14,746	19,989	29,347	38,722	54,987	49,086	32,192	279,187
	BN	2001	20,952	5,790	2,500	4,300	3,300	14,746	21,863	44,204	46,898	54,987	49,086	31,414	300,040
	N	2002	21,713	2,700	2,500	4,300	3,300	14,746	36,133	45,959	47,253	54,987	49,086	32,658	315,335
	N	2003	23,490	2,700	2,500	4,300	3,300	14,746	27,196	44,087	47,253	54,987	47,670	32,658	304,888
	BN	2004	23,490	6,781	2,500	4,300	5,959	25,777	51,269	46,777	47,253	54,987	49,086	32,192	350,369
	W	2005	20,952	2,700	2,500	4,300	3,300	14,746	36,422	46,193	47,134	54,987	49,086	30,792	313,112
	W	2006	22,982	6,121	2,500	4,300	3,300	14,746	13,115	41,747	47,253	54,987	49,086	32,502	292,640
	D	2007	20,952	2,700	2,500	4,300	5,672	22,068	36,391	38,142	38,264	45,048	40,977	25,317	282,330
	BN	2008	14,568	5,923	2,500	4,300	3,300	11,348	31,368	38,540	38,264	45,048	40,977	26,903	263,037
	N	2009	14,568	5,361	2,500	4,300	3,300	14,746	47,088	44,204	46,661	54,987	49,086	31,259	318,060
		Ave	19,262	4,197	2,500	4,300	3,830	15,412	28,160	38,984	42,875	50,662	45,333	28,663	284,177

Test Case MID Canal Diversion

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total WY	Full Dem Total WY
	Values in acre-feet													
1971	20,952	2,700	2,500	4,300	3,300	14,746	30,656	42,917	47,253	54,987	49,086	32,192	305,589	305,589
1972	20,952	5,130	2,500	4,300	5,679	24,844	46,800	46,544	46,542	54,987	49,086	30,637	338,001	338,001
1973	20,952	2,700	2,500	4,300	3,300	14,746	23,737	45,374	47,016	54,987	49,086	32,658	301,356	301,356
1974	20,952	2,700	2,500	4,300	3,300	14,746	18,115	42,917	45,239	49,733	49,086	32,658	286,246	286,246
1975	20,952	5,460	2,500	4,300	3,300	14,746	28,782	44,672	47,253	54,859	43,423	32,658	302,906	302,906
1976	20,952	6,451	2,500	4,300	6,350	30,232	34,676	38,540	38,163	44,939	35,682	24,524	287,308	324,478
1977	14,568	5,081	2,500	4,300	6,379	17,127	30,279	23,572	28,282	33,405	30,961	19,432	215,886	316,195
1978	10,761	2,700	2,500	4,300	3,300	14,746	10,143	39,642	47,253	54,987	49,086	25,506	264,924	271,015
1979	23,490	2,700	2,500	4,300	3,300	14,746	27,340	45,140	47,253	53,962	49,086	32,658	306,475	306,475
1980	20,952	2,700	2,500	4,300	3,300	14,746	24,602	43,034	47,253	50,758	49,086	32,658	295,889	295,889
1981	23,236	7,441	2,500	4,300	3,300	14,746	33,395	45,608	47,253	54,987	49,086	32,658	318,510	318,510
1982	20,952	2,700	2,500	4,300	3,300	14,746	12,687	42,917	45,476	54,987	49,086	17,265	270,916	270,916
1983	20,952	2,700	2,500	4,300	3,300	14,746	11,058	40,110	47,253	54,987	47,529	15,866	265,301	265,301
1984	20,952	2,700	2,500	4,300	3,300	14,746	37,719	46,777	47,253	54,859	49,086	32,502	316,695	316,695
1985	20,952	2,700	2,500	4,300	3,300	14,746	33,106	46,193	45,950	54,987	49,086	31,881	309,700	309,700
1986	20,952	2,700	2,500	4,300	3,300	14,746	19,701	42,215	47,253	54,987	49,086	32,192	293,932	293,932
1987	20,952	7,441	2,500	4,300	3,300	11,348	33,450	38,540	38,264	45,048	40,977	26,903	273,023	307,868
1988	14,568	5,081	2,500	4,300	3,300	10,522	20,959	28,485	29,064	35,631	32,822	21,807	209,039	288,428
1989	13,109	2,700	2,500	4,300	5,631	11,348	37,004	38,341	38,264	45,048	40,375	15,537	254,156	293,803
1990	14,568	5,361	2,500	4,300	5,590	15,190	29,936	21,644	29,236	34,588	31,919	20,952	215,784	304,883
1991	11,125	6,242	2,500	4,300	5,812	10,324	26,779	32,222	30,198	37,899	33,900	23,035	224,335	299,335
1992	12,215	6,407	2,500	4,300	3,300	9,811	16,590	29,752	29,193	35,255	32,639	21,693	203,656	285,286
1993	11,399	2,700	2,500	4,300	3,300	14,746	23,160	36,951	44,528	54,987	49,086	32,658	280,315	285,768
1994	20,952	2,700	2,500	4,300	3,300	17,718	28,427	26,707	38,264	45,048	40,977	26,639	257,531	287,956
1995	14,568	2,700	2,500	4,300	3,300	14,746	15,953	32,974	43,936	54,987	49,086	32,658	271,707	273,991
1996	23,490	7,441	2,500	4,300	3,300	14,746	24,746	30,868	47,134	54,987	49,086	32,658	295,257	295,257
1997	20,952	2,700	2,500	4,300	3,300	14,746	45,935	45,491	46,542	54,987	49,086	32,658	323,197	323,197
1998	21,967	2,700	2,500	4,300	3,300	14,746	20,421	19,404	43,462	54,987	49,086	32,502	269,376	269,376
1999	20,952	2,700	2,500	4,300	3,300	14,746	31,232	43,619	47,134	54,987	49,086	32,347	306,904	306,904
2000	23,236	6,781	2,500	4,300	3,300	14,746	19,989	29,347	38,722	54,987	49,086	32,192	279,187	279,187
2001	20,952	5,790	2,500	4,300	3,300	14,746	21,863	44,204	46,898	54,987	49,086	31,414	300,040	300,040
2002	21,713	2,700	2,500	4,300	3,300	14,746	36,133	45,959	47,253	54,987	49,086	32,658	315,335	315,335
2003	23,490	2,700	2,500	4,300	3,300	14,746	27,196	44,087	47,253	54,987	47,670	32,658	304,888	304,888
2004	23,490	6,781	2,500	4,300	5,959	25,777	51,269	46,777	47,253	54,987	49,086	32,192	350,369	350,369
2005	20,952	2,700	2,500	4,300	3,300	14,746	36,422	46,193	47,134	54,987	49,086	30,792	313,112	313,112
2006	22,982	6,121	2,500	4,300	3,300	14,746	13,115	41,747	47,253	54,987	49,086	32,502	292,640	292,640
2007	20,952	2,700	2,500	4,300	5,672	22,068	36,391	38,142	38,264	45,048	40,977	25,317	282,330	315,945
2008	14,568	5,923	2,500	4,300	3,300	11,348	31,368	38,540	38,264	45,048	40,977	26,903	263,037	299,996
2009	14,568	5,361	2,500	4,300	3,300	14,746	47,088	44,204	46,661	54,987	49,086	31,259	318,060	320,443
Ave	19,262	4,197	2,500	4,300	3,830	15,412	28,160	38,984	42,875	50,662	45,333	28,663	284,177	300,954

This section provides an entry of the diversions of the Modesto Irrigation District and Turlock Irrigation District. Switch UI 2.10 directs the use of Test Case diversions (UI 2.10 = 0) or user specified canal diversions (UI 2.10 = 1). If Test Case diversions are directed, a pre-processed daily time series of canal diversions is used. If directed to use user-specified canal diversions, the matrix tables shown at UI 2.30 (above for Modesto Irrigation District) and at UI 2.40 (below for Turlock Irrigation District) require input values for each month of each simulation year, beginning October 1970 (water year 1971) through September 2009. Values are entered as monthly volumes (acre-feet), which will be parsed by the Model into a daily distribution each month represented by the distribution pattern of the Test Case diversions. The Test Case diversions to the Modesto Canal and Turlock Canal are illustrated in this section for comparison purposes.

(UI 2.30)

Alternative TID Canal Diversion

Enter values in acre-feet

Prelim Relicense Yr-Type	WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total WY
N	1971	31,487	1,000	1,000	6,000	8,000	42,220	71,385	79,506	96,454	118,397	101,372	51,350	608,171
BN	1972	31,487	4,120	1,000	6,000	12,542	70,210	104,879	92,357	95,639	118,397	101,372	50,168	688,170
N	1973	31,487	1,000	1,000	6,000	8,000	42,220	44,833	89,056	96,105	118,397	101,372	52,681	592,149
AN	1974	31,487	1,000	1,000	6,000	8,000	42,220	39,626	82,689	92,845	106,930	101,372	52,681	565,851
AN	1975	31,487	4,761	1,000	6,000	8,000	42,220	59,410	85,755	96,454	117,430	92,559	52,681	597,756
C	1976	31,487	6,684	1,000	6,000	13,169	81,414	79,704	77,553	79,063	97,737	72,955	32,004	578,770
C	1977	20,773	1,000	1,000	6,000	13,371	50,509	72,025	45,645	54,416	68,098	57,243	26,675	416,755
W	1978	11,340	4,569	1,000	6,000	8,000	42,220	9,548	72,786	96,454	118,397	101,372	37,013	508,698
N	1979	31,487	1,000	1,000	6,000	8,000	42,220	53,683	87,405	96,454	115,219	101,372	52,681	596,521
W	1980	31,487	1,000	1,000	6,000	8,000	42,220	49,345	81,864	96,454	112,318	101,372	52,681	583,741
D	1981	31,487	7,966	1,000	6,000	11,130	42,220	78,153	90,235	96,454	118,397	101,372	52,681	637,093
W	1982	31,487	1,000	1,000	6,000	8,000	42,220	18,801	79,506	93,427	118,397	101,372	26,075	527,285
W	1983	31,487	1,000	1,000	6,000	8,000	42,220	14,289	73,376	96,454	118,397	97,046	25,780	515,047
AN	1984	31,487	1,000	1,000	6,000	8,000	42,220	89,260	92,475	95,173	118,120	101,372	51,794	637,901
BN	1985	31,487	1,000	1,000	6,000	8,000	42,220	80,930	92,003	92,845	118,397	101,372	51,942	627,195
W	1986	31,487	1,000	1,000	6,000	8,000	42,220	36,155	80,567	96,454	118,397	101,372	50,168	572,820
C	1987	31,487	7,645	1,000	6,000	11,080	37,117	80,884	77,453	79,756	97,972	82,761	40,798	553,954
C	1988	20,773	4,345	1,000	6,000	8,000	34,416	44,841	54,744	59,435	73,648	61,984	30,238	399,424
BN	1989	13,087	1,000	1,000	6,000	11,360	37,117	89,292	76,551	79,756	97,972	80,991	19,063	513,190
D	1990	20,773	4,889	1,000	6,000	11,491	42,592	67,733	41,090	58,355	70,954	59,683	28,700	413,261
BN	1991	12,239	5,799	1,000	6,000	12,548	33,362	63,975	63,689	62,376	79,506	64,759	32,781	438,033
C	1992	14,931	5,806	1,000	6,000	8,000	31,457	37,881	58,023	58,785	71,771	61,517	30,001	385,173
AN	1993	12,915	5,034	1,000	6,000	8,000	42,220	43,271	70,428	88,770	118,397	101,372	52,681	550,087
D	1994	31,487	4,441	1,000	6,000	8,000	42,220	67,460	54,104	79,756	97,972	82,761	39,040	514,241
W	1995	20,773	1,000	1,000	6,000	8,000	42,220	25,049	58,874	87,023	118,120	101,372	52,681	522,113
AN	1996	31,487	7,966	1,000	6,000	8,000	42,220	46,047	59,228	96,454	118,397	101,372	52,681	570,851
W	1997	31,487	1,000	1,000	6,000	8,000	42,220	107,135	91,532	95,173	118,397	101,372	52,089	655,405
W	1998	31,487	1,000	1,000	6,000	8,000	42,220	31,470	38,950	81,784	118,397	101,372	52,681	514,360
AN	1999	31,487	1,000	1,000	6,000	8,000	42,220	75,897	88,702	96,454	118,397	101,372	52,681	623,209
N	2000	31,487	5,723	1,000	6,000	8,000	42,220	36,503	56,634	83,065	118,397	101,372	52,681	543,081
BN	2001	31,487	4,761	1,000	6,000	8,000	42,220	49,518	83,515	96,105	118,397	101,372	50,168	592,542
N	2002	31,487	1,000	1,000	6,000	8,000	42,220	84,748	81,510	96,454	118,397	101,372	52,681	624,868
N	2003	31,487	1,000	1,000	6,000	8,000	42,220	66,179	82,454	96,454	118,397	99,129	52,681	604,999
BN	2004	31,487	6,363	1,000	6,000	8,000	42,220	111,474	89,763	91,215	112,042	96,725	52,681	648,970
W	2005	31,487	1,000	1,000	6,000	8,000	42,220	54,725	81,275	96,454	118,397	100,731	48,099	589,386
W	2006	31,487	6,363	1,000	6,000	8,000	42,220	29,387	71,607	96,454	118,397	101,372	52,681	564,968
D	2007	31,487	1,000	1,000	6,000	12,448	70,365	85,162	76,852	79,756	97,972	82,761	36,904	581,706
BN	2008	20,773	5,707	1,000	6,000	8,000	37,117	76,901	76,952	79,756	97,972	82,761	40,798	533,738
N	2009	20,773	4,617	1,000	6,000	8,000	42,220	103,144	85,047	95,522	118,397	101,372	50,611	636,704
	Ave	27,456	3,271	1,000	6,000	8,952	43,791	61,044	74,917	87,340	108,669	92,511	44,747	559,697

Test Case TID Canal Diversion

Values in acre-feet

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total WY	Full Dem Total
1971	31,487	1,000	1,000	6,000	8,000	42,220	71,385	79,506	96,454	118,397	101,372	51,350	608,171	608,171
1972	31,487	4,120	1,000	6,000	12,542	70,210	104,879	92,357	95,639	118,397	101,372	50,168	688,170	688,170
1973	31,487	1,000	1,000	6,000	8,000	42,220	44,833	89,056	96,105	118,397	101,372	52,681	592,149	592,149
1974	31,487	1,000	1,000	6,000	8,000	42,220	39,626	82,689	92,845	106,930	101,372	52,681	565,851	565,851
1975	31,487	4,761	1,000	6,000	8,000	42,220	59,410	85,755	96,454	117,430	92,559	52,681	597,756	597,756
1976	31,487	6,684	1,000	6,000	13,169	81,414	79,704	77,553	79,063	97,737	72,955	32,004	578,770	669,740
1977	20,773	1,000	1,000	6,000	13,371	50,509	72,025	45,645	54,416	68,098	57,243	26,675	416,755	669,171
1978	11,340	4,569	1,000	6,000	8,000	42,220	9,548	72,786	96,454	118,397	101,372	37,013	508,698	524,472
1979	31,487	1,000	1,000	6,000	8,000	42,220	53,683	87,405	96,454	115,219	101,372	52,681	596,521	596,521
1980	31,487	1,000	1,000	6,000	8,000	42,220	49,345	81,864	96,454	112,318	101,372	52,681	583,741	583,741
1981	31,487	7,966	1,000	6,000	11,130	42,220	78,153	90,235	96,454	118,397	101,372	52,681	637,093	637,093
1982	31,487	1,000	1,000	6,000	8,000	42,220	18,801	79,506	93,427	118,397	101,372	26,075	527,285	527,285
1983	31,487	1,000	1,000	6,000	8,000	42,220	14,289	73,376	96,454	118,397	97,046	25,780	515,047	515,047
1984	31,487	1,000	1,000	6,000	8,000	42,220	89,260	92,475	95,173	118,120	101,372	51,794	637,901	637,901
1985	31,487	1,000	1,000	6,000	8,000	42,220	80,930	92,003	92,845	118,397	101,372	51,942	627,195	627,195
1986	31,487	1,000	1,000	6,000	8,000	42,220	36,155	80,567	96,454	118,397	101,372	50,168	572,820	572,820
1987	31,487	7,645	1,000	6,000	11,080	37,117	80,884	77,453	79,756	97,972	82,761	40,798	553,954	640,376
1988	20,773	4,345	1,000	6,000	8,000	34,416	44,841	54,744	59,435	73,648	61,984	30,238	399,424	595,199
1989	13,087	1,000	1,000	6,000	11,360	37,117	89,292	76,551	79,756	97,972	80,991	19,063	513,190	610,352
1990	20,773	4,889	1,000	6,000	11,491	42,592	67,733	41,090	58,355	70,954	59,683	28,700	413,261	632,968
1991	12,239	5,799	1,000	6,000	12,548	33,362	63,975	63,689	62,376	79,506	64,759	32,781	438,033	624,153
1992	14,931	5,806	1,000	6,000	8,000	31,457	37,881	58,023	58,785	71,771	61,517	30,001	385,173	586,401
1993	12,915	5,034	1,000	6,000	8,000	42,220	43,271	70,428	88,770	118,397	101,372	52,681	550,087	564,462
1994	31,487	4,441	1,000	6,000	8,000	42,220	67,460	54,104	79,756	97,972	82,761	39,040	514,241	588,710
1995	20,773	1,000	1,000	6,000	8,000	42,220	25,049	58,874	87,023	118,120	101,372	52,681	522,113	527,941
1996	31,487	7,966	1,000	6,000	8,000	42,220	46,047	59,228	96,454	118,397	101,372	52,681	570,851	570,851
1997	31,487	1,000	1,000	6,000	8,000	42,220	107,135	91,532	95,173	118,397	101,372	52,089	655,405	655,405
1998	31,487	1,000	1,000	6,000	8,000	42,220	31,470	38,950	81,784	118,397	101,372	52,681	514,360	514,360
1999	31,487	1,000	1,000	6,000	8,000	42,220	75,897	88,702	96,454	118,397	101,372	52,681	623,209	623,209
2000	31,487	5,723	1,000	6,000	8,000	42,220	36,503	56,634	83,065	118,397	101,372	52,681	543,081	543,081
2001	31,487	4,761	1,000	6,000	8,000	42,220	49,518	83,515	96,105	118,397	101,372	50,168	592,542	592,542
2002	31,487	1,000	1,000	6,000	8,000	42,220	84,748	81,510	96,454	118,397	101,372	52,681	624,868	624,868
2003	31,487	1,000	1,000	6,000	8,000	42,220	66,179	82,454	96,454	118,397	99,129	52,681	604,999	604,999
2004	31,487	6,363	1,000	6,000	8,000	42,220	111,474	89,763	91,215	112,042	96,725	52,681	648,970	648,970
2005	31,487	1,000	1,000	6,000	8,000	42,220	54,725	81,275	96,454	118,397	100,731	48,099	589,386	589,386
2006	31,487	6,363	1,000	6,000	8,000	42,220	29,387	71,607	96,454	118,397	101,372	52,681	564,968	564,968
2007	31,487	1,000	1,000	6,000	12,448	70,365	85,162	76,852	79,756	97,972	82,761	36,904	581,706	662,937
2008	20,773	5,707	1,000	6,000	8,000	37,117	76,901	76,952	79,756	97,972	82,761	40,798	533,738	625,483
2009	20,773	4,617	1,000	6,000	8,000	42,220	103,144	85,047	95,522	118,397	101,372	50,611	636,704	642,676
Ave	27,456	3,271	1,000	6,000	8,952	43,791	61,044	74,917	87,340	108,669	92,511	44,747	559,697	601,215

Section 3: Supplemental Releases of City and County of San Francisco

This section provides entry of supplemental releases from CCSF upstream facilities. Switch UI 3.10 directs the use of a suggested method for defining daily supplemental releases (UI 3.10 = 1) or the use of a user-specified table of supplemental releases with or without consideration of Test Case supplemental releases (UI 3.10 = 0), other methods. If the suggested daily supplemental releases method is selected (UI 3.10 = 1) the user must go to worksheet WaterBankRel to complete Model input (see worksheet WaterBankRel description). If the "other methods" path is selected (UI 3.10 = 0) the user must provide additional direction. Switch UI 3.20 directs the use of Test Case supplemental releases (UI 3.20 = 0) or the use of a user-specified table of supplemental releases (UI 3.20 = 1). The user must also direct the consideration of Test Case supplemental releases. To only use the user-specified table of supplement releases, Switch UI 3.30 is set to 0. To add Test Case supplemental releases to the user-specified table of supplemental releases, Switch UI 3.30 is set to 1. The format and application of the user-specified table is the same as described for the entry of alternative flow requirements in Section 1. Values must be entered into the matrix provided at UI 3.40. Values are entered as a daily volume (acre-feet) for 6 year types, for up to 24 discrete periods during the year. The periods are identified in MM.DD format. The year type has been established by the naming of 6 year types, wet, above normal, normal, below normal, dry and critical. Switch UI 3.50 directs the monthly sequence of the supplemental release year. For instance, if the schedule is to be established for a year beginning February 1 of the year, UI 3.50 would be set to "Feb". The applicable year type schedule would be applied beginning February 1 of the year and continue through January 31 of the following year. Switch UI 3.50 can be set to any month February (Feb) through June (Jun). The Test Case supplemental release schedule is illustrated in this section for information purposes.

Section 3 - Supplemental Release from CCSF Upstream Reservoirs

This table is used to enter a user-specified supplemental release from CCSF upstream reservoirs. Twenty-four time periods are available to define the period and flow rate. Six different water year types can be established.
The year types correspond to the Preliminary Relicensing Year Type which is based on Tuolumne River unimpaired flow.
The supplemental release will be directed to Lake Lloyd until the reservoir storage reaches a defined limit, then the supplemental release is directed to Hetch Hetchy Reservoir.
User specifies whether or not Table supplemental releases are added to Test Case supplemental releases.
Alternatively, user can define a daily supplemental release from CCSF facilities. This option is the same method used to define Test Base supplemental releases to maintain the Water Bank Balance at or above zero. (Suggested method)

(UI 3.10) Use daily supplemental release option: 1 *(1) on, use daily defined option - go to worksheet WaterBankRel, or (0) off, use other supplemental release options*

If using other supplement release options, Switch UI 3.10 = 0, enter choices below.
(UI 3.20) Turn other user-specified supplemental releases on: 0 *(1) on, and use table below, or (0) off, use existing Test Case supplemental releases* N/A
(UI 3.30) If using table below, add to existing supplemental releases: 1 *(1) yes, add table to existing releases, or (0) no use table only*

Alternative Supplemental Releases

Enter values in acre-feet per day

(UI 3.40)

CYMo Day	W	AN	N	BN	D	C
MM.DD	1	2	3	4	5	6
1.01	0	0	0	0	0	0
1.16	0	0	0	0	0	0
2.01	0	0	0	0	2,000	2,000
2.15	0	0	0	0	2,000	2,000
3.01	0	0	0	0	2,000	2,000
3.16	0	0	0	0	2,000	2,000
4.01	0	0	0	0	2,000	2,000
4.16	0	0	0	0	2,000	2,000
5.01	0	0	0	0	2,000	2,000
5.16	0	0	0	0	2,000	2,000
6.01	0	0	0	0	2,000	2,000
6.16	0	0	0	0	2,000	2,000
7.01	0	0	0	0	0	0
7.16	0	0	0	0	0	0
8.01	0	0	0	0	0	0
8.16	0	0	0	0	0	0
9.01	0	0	0	0	0	0
9.16	0	0	0	0	0	0
10.01	0	0	0	0	0	0
10.16	0	0	0	0	0	0
11.01	0	0	0	0	0	0
11.16	0	0	0	0	0	0
12.01	0	0	0	0	0	0
12.16	0	0	0	0	0	0

Preliminary Relicensing Year Type is based on a rank-ordering of the water-year runoff for the years 1921-2011. Each water year type W, AN, N, and BN represent 20% of the years of ranking. D and C year types each represent 10% of the years.

(UI 3.50) Enter beginning month of annual supplemental release schedule:

Feb-Jun
Jun
6

Test Case Supplemental Releases (made to retain WB Balance above zero)

Prelim Relicense Yr-Type	WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
	Monthly Acre-feet													
N	1971	0	0	0	0	0	0	0	0	0	0	0	0	0
BN	1972	0	0	0	0	0	0	0	0	0	0	0	0	0
N	1973	0	0	0	0	0	0	0	0	0	0	0	0	0
AN	1974	0	0	0	0	0	0	0	0	0	0	0	0	0
AN	1975	0	0	0	0	0	0	0	0	0	0	0	0	0
C	1976	0	0	0	0	0	0	0	0	0	0	0	0	0
C	1977	0	0	0	0	0	0	0	0	0	0	0	0	0
W	1978	0	0	0	0	0	0	0	0	0	0	0	0	0
N	1979	0	0	0	0	0	0	0	0	0	0	0	0	0
W	1980	0	0	0	0	0	0	0	0	0	0	0	0	0
D	1981	0	0	0	0	0	0	0	0	0	0	0	0	0
W	1982	0	0	0	0	0	0	0	0	0	0	0	0	0
W	1983	0	0	0	0	0	0	0	0	0	0	0	0	0
AN	1984	0	0	0	0	0	0	0	0	0	0	0	0	0
BN	1985	0	0	0	0	0	0	0	0	0	0	0	0	0
W	1986	0	0	0	0	0	0	0	0	0	0	0	0	0
C	1987	0	0	0	0	0	0	0	0	0	0	0	0	0
C	1988	0	0	0	0	0	0	0	0	0	0	0	0	0
BN	1989	0	0	0	0	0	0	0	0	0	0	0	0	0
D	1990	0	0	0	0	0	0	0	0	0	0	0	0	0
BN	1991	0	0	0	0	0	0	0	0	0	0	0	0	0
C	1992	0	0	0	0	0	0	59,864	70,684	19,366	21,794	0	0	171,708
AN	1993	0	0	0	0	0	0	0	0	0	0	0	0	0
D	1994	0	0	0	0	0	0	0	0	0	0	0	0	0
W	1995	0	0	0	0	0	0	0	0	0	0	0	0	0
AN	1996	0	0	0	0	0	0	0	0	0	0	0	0	0
W	1997	0	0	0	0	0	0	0	0	0	0	0	0	0
W	1998	0	0	0	0	0	0	0	0	0	0	0	0	0
AN	1999	0	0	0	0	0	0	0	0	0	0	0	0	0
N	2000	0	0	0	0	0	0	0	0	0	0	0	0	0
BN	2001	0	0	0	0	0	0	0	0	0	0	0	0	0
N	2002	0	0	0	0	0	0	0	0	0	0	0	0	0
N	2003	0	0	0	0	0	0	0	0	0	0	0	0	0
BN	2004	0	0	0	0	0	0	0	0	0	0	0	0	0
W	2005	0	0	0	0	0	0	0	0	0	0	0	0	0
W	2006	0	0	0	0	0	0	0	0	0	0	0	0	0
D	2007	0	0	0	0	0	0	0	0	0	0	0	0	0
BN	2008	0	0	0	0	0	0	0	0	0	0	0	0	0
N	2009	0	0	0	0	0	0	0	0	0	0	0	0	0

Values are associated with Test Case scenario and are equal to daily supplemental releases made from CCSF facilities to maintain the Water Bank Account Balance at or above zero. Values are shown for comparison purposes.

Section 4: San Joaquin Pipeline Diversions of City and County of San Francisco

Section 4 - Alternative CCSF San Joaquin Pipeline

This section specifies the CCSF San Joaquin Pipeline diversion. Use Test Case diversions, or user-specified values by entering a value for each month of each year.
The monthly volumes of pipeline diversions will be distributed daily within a month equally.

(UI 4.10) Turn alterantive pipeline diversion on: 0 *(0) off, use Test Case pipeline diversion, (1) on, use table below*

(UI 4.20)

Alternative SJPL Diversion — Enter values in acre-feet

Prelim Relicense Yr-Type	WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total WY
N	1971	19,027	11,969	6,660	6,660	6,015	25,782	24,950	25,782	24,950	29,778	29,778	23,937	235,286
BN	1972	21,881	16,572	12,368	17,124	15,467	25,782	25,779	25,782	24,950	29,778	29,778	24,950	270,211
N	1973	21,881	14,731	12,368	6,660	6,015	6,660	16,572	25,782	24,950	29,778	29,778	23,937	219,110
AN	1974	17,124	10,127	6,660	6,660	6,015	6,660	7,365	24,735	23,937	29,778	29,778	24,950	193,789
AN	1975	17,124	0	0	25,782	11,171	6,660	10,127	24,735	23,937	29,778	29,778	24,950	204,042
C	1976	17,124	13,810	12,368	19,027	17,186	25,782	26,699	25,782	24,950	29,778	29,778	24,950	267,234
C	1977	21,881	16,572	17,124	17,124	15,467	25,782	27,620	26,638	25,779	27,589	25,782	21,175	268,535
W	1978	19,027	16,572	12,368	6,660	6,015	6,660	9,023	22,833	22,096	29,778	29,778	23,937	204,745
N	1979	17,124	13,810	17,124	15,222	6,015	17,124	22,096	25,782	24,950	29,778	29,778	23,937	242,741
W	1980	17,124	0	0	14,270	6,015	6,660	19,334	25,782	24,950	29,778	29,778	23,937	197,628
D	1981	17,124	13,810	12,891	12,368	11,171	22,833	23,937	25,782	24,950	29,778	29,778	23,937	248,358
W	1982	17,124	11,969	9,323	6,660	6,015	6,660	6,445	19,979	19,334	29,778	29,778	26,239	189,302
W	1983	19,979	11,969	6,660	6,660	6,015	6,660	7,365	12,368	11,969	29,778	29,778	28,817	178,015
AN	1984	22,833	9,023	6,660	6,660	6,015	25,782	24,950	24,735	23,937	29,778	29,778	24,950	235,099
BN	1985	21,881	0	0	25,782	20,623	25,782	28,817	25,782	24,950	29,778	29,778	23,937	257,109
W	1986	21,881	18,413	12,368	19,027	6,015	6,660	14,731	25,782	24,950	29,778	29,778	23,937	233,319
C	1987	17,124	13,810	17,124	17,124	15,467	25,782	26,239	25,782	24,950	29,778	29,778	24,950	267,909
C	1988	21,881	16,572	12,368	19,027	17,186	25,782	27,620	25,782	24,950	27,589	26,638	21,175	266,571
BN	1989	19,027	16,572	15,222	15,222	13,749	25,782	23,937	22,833	22,096	28,541	25,782	21,175	249,937
D	1990	19,027	0	0	25,782	20,623	25,782	28,817	22,833	22,096	28,541	25,782	21,175	240,458
BN	1991	19,027	16,572	12,891	17,124	15,467	19,979	22,096	22,833	22,096	27,589	25,782	21,175	242,632
C	1992	19,027	16,572	15,222	15,222	6,015	21,881	21,175	22,833	22,096	27,589	25,782	21,175	234,590
AN	1993	19,027	16,572	12,368	6,660	6,015	6,660	16,572	21,881	21,175	29,778	29,778	24,950	211,435
D	1994	17,124	13,810	17,124	17,124	13,749	24,735	24,950	25,782	24,950	29,778	29,778	24,950	263,855
W	1995	19,979	0	0	12,368	6,874	6,660	13,810	22,833	22,096	29,778	29,778	24,950	189,124
AN	1996	17,124	13,810	12,891	6,660	6,015	6,660	18,413	24,735	23,937	29,778	29,778	24,950	214,751
W	1997	17,124	7,365	6,660	6,660	6,015	19,979	23,937	25,782	24,950	29,778	29,778	23,937	221,964
W	1998	21,881	11,969	12,368	6,660	6,015	6,660	6,445	19,979	19,334	29,778	29,778	24,950	195,814
AN	1999	17,124	13,810	15,222	14,270	6,015	12,368	13,810	24,735	23,937	29,778	29,778	23,937	224,785
N	2000	17,124	0	0	25,782	11,171	6,660	23,937	25,782	24,950	29,778	29,778	23,937	218,898
BN	2001	19,027	13,810	12,368	19,027	12,889	17,124	22,096	25,782	24,950	29,778	29,778	23,937	250,566
N	2002	17,124	13,810	9,323	15,222	13,749	24,735	23,937	25,782	24,950	29,778	29,778	24,950	253,138
N	2003	19,979	14,731	6,660	6,660	6,015	25,782	24,950	22,833	22,096	29,778	29,778	24,950	234,209
BN	2004	21,881	13,810	14,270	15,222	6,015	19,027	24,950	25,782	24,950	29,778	29,778	23,937	249,400
W	2005	19,979	0	0	12,368	6,874	6,660	13,810	24,735	23,937	29,778	29,778	24,950	192,868
W	2006	17,124	13,810	10,465	6,660	6,015	9,323	6,445	22,833	22,096	29,778	29,778	24,950	199,276
D	2007	19,027	13,810	15,222	17,124	15,467	24,735	23,937	25,782	24,950	29,778	29,778	24,950	264,561
BN	2008	21,881	16,572	12,368	9,323	6,015	21,881	23,937	25,782	24,950	29,778	29,778	24,950	247,215
N	2009	19,979	14,731	17,124	17,124	6,015	6,660	23,937	25,782	24,950	29,778	29,778	23,937	239,795
	Ave	19,174	11,586	10,056	13,763	9,761	16,390	19,886	24,296	23,512	29,490	29,185	24,138	231,238

Test Case SJPL Diversion — Values in acre-feet

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total WY	CCSF Sys Action
1971	19,027	11,969	6,660	6,660	6,015	25,782	24,950	25,782	24,950	29,778	29,778	23,937	235,286	0
1972	21,881	16,572	12,368	17,124	15,467	25,782	25,779	25,782	24,950	29,778	29,778	24,950	270,211	0
1973	21,881	14,731	12,368	6,660	6,015	6,660	16,572	25,782	24,950	29,778	29,778	23,937	219,110	0
1974	17,124	10,127	6,660	6,660	6,015	6,660	7,365	24,735	23,937	29,778	29,778	24,950	193,789	0
1975	17,124	0	0	25,782	11,171	6,660	10,127	24,735	23,937	29,778	29,778	24,950	204,042	0
1976	17,124	13,810	12,368	19,027	17,186	25,782	26,699	25,782	24,950	29,778	29,778	24,950	267,234	0
1977	21,881	16,572	17,124	17,124	15,467	25,782	27,620	26,638	25,779	27,589	25,782	21,175	268,535	1
1978	19,027	16,572	12,368	6,660	6,015	6,660	9,023	22,833	22,096	29,778	29,778	23,937	204,745	0
1979	17,124	13,810	17,124	15,222	6,015	17,124	22,096	25,782	24,950	29,778	29,778	23,937	242,741	0
1980	17,124	0	0	14,270	6,015	6,660	19,334	25,782	24,950	29,778	29,778	23,937	197,628	0
1981	17,124	13,810	12,891	12,368	11,171	22,833	23,937	25,782	24,950	29,778	29,778	23,937	248,358	0
1982	17,124	11,969	9,323	6,660	6,015	6,660	6,445	19,979	19,334	29,778	29,778	26,239	189,302	0
1983	19,979	11,969	6,660	6,660	6,015	6,660	7,365	12,368	11,969	29,778	29,778	28,817	178,015	0
1984	22,833	9,023	6,660	6,660	6,015	25,782	24,950	24,735	23,937	29,778	29,778	24,950	235,099	0
1985	21,881	0	0	25,782	20,623	25,782	28,817	25,782	24,950	29,778	29,778	23,937	257,109	0
1986	21,881	18,413	12,368	19,027	6,015	6,660	14,731	25,782	24,950	29,778	29,778	23,937	233,319	0
1987	17,124	13,810	17,124	17,124	15,467	25,782	26,239	25,782	24,950	29,778	29,778	24,950	267,909	0
1988	21,881	16,572	12,368	19,027	17,186	25,782	27,620	25,782	24,950	27,589	26,638	21,175	266,571	1
1989	19,027	16,572	15,222	15,222	13,749	25,782	23,937	22,833	22,096	28,541	25,782	21,175	249,937	1
1990	19,027	0	0	25,782	20,623	25,782	28,817	22,833	22,096	28,541	25,782	21,175	240,458	1
1991	19,027	16,572	12,891	17,124	15,467	19,979	22,096	22,833	22,096	27,589	25,782	21,175	242,632	1
1992	19,027	16,572	15,222	15,222	6,015	21,881	21,175	22,833	22,096	27,589	25,782	21,175	234,590	1
1993	19,027	16,572	12,368	6,660	6,015	6,660	16,572	21,881	21,175	29,778	29,778	24,950	211,435	0
1994	17,124	13,810	17,124	17,124	13,749	24,735	24,950	25,782	24,950	29,778	29,778	24,950	263,855	0
1995	19,979	0	0	12,368	6,874	6,660	13,810	22,833	22,096	29,778	29,778	24,950	189,124	0
1996	17,124	13,810	12,891	6,660	6,015	6,660	18,413	24,735	23,937	29,778	29,778	24,950	214,751	0
1997	17,124	7,365	6,660	6,660	6,015	19,979	23,937	25,782	24,950	29,778	29,778	23,937	221,964	0
1998	21,881	11,969	12,368	6,660	6,015	6,660	6,445	19,979	19,334	29,778	29,778	24,950	195,814	0
1999	17,124	13,810	15,222	14,270	6,015	12,368	13,810	24,735	23,937	29,778	29,778	23,937	224,785	0
2000	17,124	0	0	25,782	11,171	6,660	23,937	25,782	24,950	29,778	29,778	23,937	218,898	0
2001	19,027	13,810	12,368	19,027	12,889	17,124	22,096	25,782	24,950	29,778	29,778	23,937	250,566	0
2002	17,124	13,810	9,323	15,222	13,749	24,735	23,937	25,782	24,950	29,778	29,778	24,950	253,138	0
2003	19,979	14,731	6,660	6,660	6,015	25,782	24,950	22,833	22,096	29,778	29,778	24,950	234,209	0
2004	21,881	13,810	14,270	15,222	6,015	19,027	24,950	25,782	24,950	29,778	29,778	23,937	249,400	0
2005	19,979	0	0	12,368	6,874	6,660	13,810	24,735	23,937	29,778	29,778	24,950	192,868	0
2006	17,124	13,810	10,465	6,660	6,015	9,323	6,445	22,833	22,096	29,778	29,778	24,950	199,276	0
2007	19,027	13,810	15,222	17,124	15,467	24,735	23,937	25,782	24,950	29,778	29,778	24,950	264,561	0
2008	21,881	16,572	12,368	9,323	6,015	21,881	23,937	25,782	24,950	29,778	29,778	24,950	247,215	0
2009	19,979	14,731	17,124	17,124	6,015	6,660	23,937	25,782	24,950	29,778	29,778	23,937	239,795	0
Ave	19,174	11,586	10,056	13,763	9,761	16,390	19,886	24,296	23,512	29,490	29,185	24,138	231,238	

This section provides an entry for the diversions of the CCSF System to the San Joaquin Pipeline. Switch UI 4.10 directs the use of Test Case diversions (UI 4.10 = 0), or user-specified diversions (UI 4.10 = 1). If Test Case diversions are directed, a pre-processed time series of diversions is used. If directed to use user-specified diversions, the matrix table shown at UI 4.20 requires input values for each month of each simulation year, beginning October 1970 (water year 1971) through September 2009. Values are entered as monthly volumes (acre-feet), which will be parsed by the Model into an equal daily distribution each month.

5.2 WaterBankRel Workheet

This worksheet (WaterBankRel) provides for entry of daily supplemental releases from the CCSF System. Without any other manual intervention the Model will direct releases from the CCSF System under a "hold-unless-need-to-release" protocol. Additional releases greater than provided by the default protocol may be needed. An example of such a need is during periods when CCSF System operations would otherwise deplete the Water Bank Account to a point of a "negative" balance.

The manual adjustment to releases from the CCSF System is provided to allow the user to "pull" additional water from the CCSF System as supplemental inflow to Don Pedro Reservoir. A single entry is established that will first pull water from Lake Lloyd so that water supply is preserved in the Hetch Hetchy Reservoir system for diversion to the SJPL. At a point when such supplemental releases strain Lake Lloyd storage, the supplemental releases are directed to Hetch Hetchy Reservoir. The supplemental release is directed from a reservoir at a point in logic after the default protocol releases occur. Thus, the release occurs in addition to what operation is already occurring by default. Such a release can affect the following day's default operation or previous periods' operations, thus results require review to determine if the user's desired result occurs. This worksheet is employed when Switch UI 3.10 directs the use of this suggested method for defining daily supplemental releases (UI 3.10 = 1).

Shown below is a snapshot of the worksheet. The worksheet provides the daily accounting of the Water Bank Account Balance for the Model. Information ported from other worksheets of the Model into this worksheet is Don Pedro Reservoir inflow (Column E) and the unimpaired flow at La Grange (Column F). These data and the protocols associated with Fourth Agreement Water Bank Balance accounting (Columns G through Column O) derive the daily credit or debit of CCSF and then the daily balance of the Water Bank Account (Column M).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1			1		San Francisco Water Bank Account Balance Computation and Supplement Release																			
2	Unit Title		2		CFS	CFS	CFS	CFS	CFS	AF		AF	AF		AF		AF			AF				
3	Parameter Title		3		DP Inflow	La Grange	Fourth Ag	Districts' E	SF Credit/	SF Credit/Debit w/ C		SF WB Eva	SF Water Bank Balan		Max Water Bank Cap		Credit Adj fc			SF Supplemental Release				
4																	Advice							
5	Acre-foot to CFS conversion				From	From																		
6	divide by :	1.983471			DonPedro	Hydrology		Warnings																
7																								
8																								
9																	(UI 1.31)			(UI 3.10)	Yes, this method is being used			
10																	0			1	Min Lloyd Storage		Min	Min
11																	(0) N, (1) Y				for WB		103,852	84,135
12																	- Debit				Call (acre-feet)		Min	Min
13												Max	740,000				+ Credit				45,000		Non 76-77	Non 76-77
14												Min	0			Sum:	0		Sum:	171,708	171,708	0	103,852	114,720
15					SF Water Bank Account Balance Calculation												La Grange			Supplemental Release and Storage Check				
16							Fourth	Daily	SF	SF C/D	SF Gross	SF WB	SF Net	SF Share	SF Max		Credit Adj			WB	1st Call	2nd Call		
17	Month				DP	La Grange	Agree	Districts'	Credit/	w/	WB	Evap	WB	RFlood	WB	WB	in SF			Supp	Lloyd	HH	Lloyd	HH
18	Index	Date	Day	Days	Inflow	UF	Check	Entitle	Debit	Credit Adj	Balance	Losses	Balance	DP	Balance	Neg Flag	WB	Mark	Mark	Release	Release	Release	Storage	Storage
19					CFS	CFS	CFS	CFS	CFS	AF	AF	AF	570,000	AF	AF	AF	AF			AF	AF	AF	AF	AF
20	1970.10	10/1/1970	T	31	322	159	2,416	159	163	324	570,324	48	570,000	0	570,000	0	0			0	0	0	200,091	249,349
21	1970.10	10/2/1970	F	31	453	55	2,416	55	398	790	570,790	48	570,000	0	570,000	0	0			0	0	0	200,080	248,379
22	1970.10	10/3/1970	S	31	541	265	2,416	265	276	548	570,548	48	570,000	0	570,000	0	0			0	0	0	200,090	247,622
23	1970.10	10/4/1970	S	31	625	-166	2,416	-166	791	1,569	571,569	48	570,000	0	570,000	0	0			0	0	0	199,278	247,032
24	1970.10	10/5/1970	M	31	75	180	2,416	180	-105	-208	569,792	48	569,744	0	570,000	0	0			0	0	0	199,896	246,150
25	1970.10	10/6/1970	T	31	475	92	2,416	92	383	760	570,504	48	570,000	0	570,000	0	0			0	0	0	199,781	245,360
26	1970.10	10/7/1970	W	31	526	150	2,416	150	376	746	570,746	48	570,000	0	570,000	0	0			0	0	0	199,660	244,595
27	1970.10	10/8/1970	T	31	209	153	2,416	153	56	111	570,111	48	570,000	0	570,000	0	0			0	0	0	199,746	243,730
28	1970.10	10/9/1970	F	31	264	146	2,416	146	118	234	570,234	48	570,000	0	570,000	0	0			0	0	0	199,746	242,867
29	1970.10	10/10/1970	S	31	210	99	2,416	99	111	220	570,220	48	570,000	0	570,000	0	0			0	0	0	199,677	242,119
30	1970.10	10/11/1970	S	31	620	293	2,416	293	327	649	570,649	49	570,000	0	570,000	0	0			0	0	0	199,112	241,661
31	1970.10	10/12/1970	M	31	60	-285	2,416	-285	345	684	570,684	49	570,000	0	570,000	0	0			0	0	0	199,319	240,049
32	1970.10	10/13/1970	T	31	29	335	2,416	335	-306	-607	569,393	48	569,345	0	570,000	0	0			0	0	0	199,568	239,666
33	1970.10	10/14/1970	W	31	192	-15	2,416	-15	207	411	569,755	48	569,707	0	570,000	0	0			0	0	0	199,310	239,002
34	1970.10	10/15/1970	T	31	181	135	2,416	135	46	91	569,798	48	569,749	0	570,000	0	0			0	0	0	199,262	238,351
35	1970.10	10/16/1970	F	31	393	210	2,416	210	183	363	570,112	49	570,000	0	570,000	0	0			0	0	0	199,172	237,490
36	1970.10	10/17/1970	S	31	606	439	2,416	439	167	331	570,331	49	570,000	0	570,000	0	0			0	0	0	199,106	236,626
37	1970.10	10/18/1970	S	31	710	407	2,416	407	303	601	570,601	49	570,000	0	570,000	0	0			0	0	0	198,622	236,098
38	1970.10	10/19/1970	M	31	-115	20	2,416	20	-135	-268	569,732	49	569,684	0	570,000	0	0			0	0	0	199,115	235,023
39	1970.10	10/20/1970	T	31	318	130	2,416	130	188	373	570,057	49	570,000	0	570,000	0	0			0	0	0	199,014	234,169

For purposes of the FERC investigation, the protocols of Fourth Agreement Water Bank Accounting have been amended to incorporate a hypothetical implementation of "shared responsibility" for incremental increases in FERC-required flows for the Tuolumne River.[3] If running the option with shared responsibility has been selected (worksheet UserInput Switch UI 1.31 = 1), the incremental increase in FERC-required flows is determined by the daily difference between the current 1995 FERC Settlement requirements and scenario-required minimum flows. This computation occurs in worksheet LaGrangeSchedule with information regarding the scenario-required flows directed through worksheet UserInput. Approximately fifty-two percent (51.7121%) of the incremental difference between the flow schedules is assigned as CCSF's responsibility and is ported into the worksheet in Column Q as a "debit". This debit then enters the current protocols of Fourth Agreement Water Bank Accounting at Column J, and subsequently contributes to the determination of the daily Water Bank Account Balance (Column M).

Water Bank Account Balances which are less than zero ("negative") are highlighted, and the minimum balance, whether negative or positive, is reported in Cell M14. When a negative balance occurs, the user is to enter into Column T (WB Supplemental Release) a volume of release needed to maintain the Water Bank Account Balance at, or greater than zero. The Model will first direct the supplemental release to Lake Lloyd,

[3] The "shared responsibility" assumption is presented for the purpose of evaluating alternative operations. The assumption shall not be used as evidence in any proceeding relating to and shall not act as precedence for any allocation of Tuolumne River water between CCSF and the Districts for any purpose under the Fourth Agreement.

and continue releases until storage at Lake Lloyd is drawn to a specified 45,000 acre-feet minimum level (shown in Cell Q10 and entered at worksheet CCSF Switch 3.00). Subsequent supplemental releases will be drawn from Hetch Hetchy Reservoir any time storage is less than the Lake Lloyd minimum. The result of entering the supplemental release will cause a recalculation of the entire Model with results refreshed in the worksheet. Lake Lloyd, Hetch Hetchy Reservoir and Don Pedro Reservoir storage is ported from other worksheets to provide the status of their storage as supplemental releases are entered.

Warnings and advice are provided in the worksheet when several conditions occur. The snapshots below illustrate the occurrence of these conditions.

Example 1: A Reservoir Empties and the Model Crashes

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1			1		San Francisco Water Bank Account Balance Computation and Supplement Release																				
2	Unit Title		2		CFS	CFS	CFS	CFS	CFS	AF		AF	AF		AF		AF			AF					
3	Parameter Title		3		DP Inflow	La Grange	Fourth Ag	Districts' F	SF Credit/	SF Credit/Debit w/ C		SF WB Eva	SF Water Bank Balan		Max Water Bank Cap		Credit Adj fc			SF Supplemental Release					
4																	Advice								
5	Acre-foot to CFS conversion				From	From											#N/A								
6	divide by :	1.983471			DonPedro	Hydrology		Warnings									#N/A								
7									Warning: Your have likely drained a reservoir, check reservoirs.								#N/A								
8									#N/A	#N/A															
9										#N/A							(UI 1.31)			(UI 3.10)	Yes, this method is being used				
10									#N/A	#N/A							1			1	Min Lloyd Storage		Min	Min	Min
11										#N/A							(0) N, (1) Y				WB Call (CCSF 3.00)		24,474	#N/A	#N/A
12																	- Debit				(acre-feet)		Min	Min	Min
13												Max	#N/A				+ Credit				45,000		Non76-77	Non76-77	Non76-77
14												Min	#N/A			Sum:	-5,922,391		Sum:	1,197,522	714,938	482,584	24,474	#N/A	#N/A
15									SF Water Bank Account Balance Calculation								La Grange				Supplemental Release and Storage Check				
16							Fourth	Daily	SF	SF C/D	SF Gross	SF WB	SF Net	SF Share	SF Max		Credit Adj			WB	1st Call	2nd Call			
17	Month				DP	La Grange	Agree	Districts'	Credit/	w/	WB	Evap	WB	RFlood	WB	WB	in SF			Supp	Lloyd	HH	Lloyd	HH	DP
18	Index	Date	Day	Days	Inflow	UF	Check	Entitle	Debit	Credit Adj	Balance	Losses	Balance	DP	Balance	Neg Flag	WB	Mark	Mark	Release	Release	Release	Storage	Storage	Storage
19					CFS	CFS	CFS	CFS	CFS	AF	AF	AF	570,000	AF	AF	AF	AF			AF	AF	AF	AF	AF	AF
8018	1992.08	8/24/1992	M	31	205	5	2,416	5	200	396	-122,421	0	-122,421	0	570,000	-396	0			0	0	0	30,461	1,488	528,302
8019	1992.08	8/25/1992	T	31	445	28	2,416	28	417	827	-121,594	0	-121,594	0	570,000	-827	0			0	0	0	30,065	262	526,440
8020	1992.08	8/26/1992	W	31	#N/A	201	2,416	201	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0			0	0	0	29,709	#N/A	#N/A
8021	1992.08	8/27/1992	T	31	#N/A	104	2,416	104	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0			0	0	0	29,370	#N/A	#N/A

A warning has been provided that a reservoir has likely been depleted by the current operation assumptions. In this particular example, Tuolumne River minimum flows were increased with responsibility shared with CCSF, and a set of supplemental releases were established. In this iteration of results it is discovered in Column X (Hetch Hetchy Reservoir storage) an error (reported as “#N/A”) on August 26, 1992 has occurred in the Model. By review of the previous day’s storage results for Lake Lloyd (Column W), Hetch Hetchy Reservoir (Column X) and Don Pedro Reservoir (Column Y), and the rate of depletion for each of these reservoirs, it is concluded that Hetch Hetchy Reservoir likely drained on August 26 and thus crashed the Model. Although noted, a negative Water Bank Account Balance (Column M) will not cause the Model to crash. To remedy the condition, the user uses worksheet UserInput to revise (lower) SJPL diversions from Hetch Hetchy Reservoir (UI 4.10 and UI 4.20) and retain water in Hetchy Hetchy Reservoir for release. If Don Pedro Reservoir storage was the culprit of causing the Model to crash, the user uses worksheet UserInput to revise (lower) MID and TID canal diversions (UI 2.10, UI 2.20 and UI 2.30 to retain water in Don Pedro Reservoir for release. Alternatively, the user could reduce the scenario’s designated minimum flow requirement, which would change flow needed from the upstream systems.

Example 2: Water Bank is Negative

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1			1		San Francisco Water Bank Account Balance Computation and Supplement Release																				
2	Unit Title		2		CFS	CFS	CFS	CFS	CFS	AF		AF	AF		AF		AF			AF					
3	Parameter Title		3		DP Inflow	La Grange	Fourth Ag	Districts' E	SF Credit/	SF Credit/Debit w/ C		SF WB Eva	SF Water Bank Balan		Max Water Bank Cap		Credit Adj fc			SF Supplemental Release					
4																	Advice								
5	Acre-foot to CFS conversion				From	From											If Water Bank Balance is negative (shown as highlighted value in								
6	divide by :	1.983471			DonPedro	Hydrology		Warnings									Column M) enter volume of supplemental release into Column T to								
7																	maintin balance at zero or greater. Use Column M and Column P for guidance.								
8								Warning: SF Water Bank is 'negative'. Add supplemental release																	
9								(Column T) to maintain balance at least zero.									(UI 1.31)			(UI 3.10)	Yes, this method is being used				
10																	0			1	Min Lloyd Storage		Min	Min	Min
11																	(0) N, (1) Y				WB Call (CCSF 3.00)		131,254	84,135	508,489
12																	- Debit				(acre-feet)		Min	Min	Min
13												Max	740,000				+ Credit				45,000		Non76-77	Non76-77	Non76-77
14												Min	-150,778			Sum:	0		Sum:	0	0	0	131,254	114,720	740,875
15					SF Water Bank Account Balance Calculation												La Grange			Supplemental Release and Storage Check					
16							Fourth	Daily	SF	SF C/D	SF Gross	SF WB	SF Net	SF Share	SF Max		Credit Adj			WB	1st Call	2nd Call			
17	Month				DP	La Grange	Agree	Districts'	Credit/	w/	WB	Evap	WB	RFlood	WB	WB	in SF			Supp	Lloyd	HH	Lloyd	HH	DP
18	Index	Date	Day	Days	Inflow	UF	Check	Entitle	Debit	Credit Adj	Balance	Losses	Balance	DP	Balance	Neg Flag	WB	Mark	Mark	Release	Release	Release	Storage	Storage	Storage
19					CFS	CFS	CFS	CFS	CFS	AF	AF	AF	570,000	AF	AF	AF	AF			AF	AF	AF	AF	AF	AF
7887	1992.04	4/15/1992	W	30	2138	4,322	4,066	4,066	-1,928	-3,824	4,011	0	4,011	0	570,000	0	0			0	0	0	256,353	262,227	969,641
7888	1992.04	4/16/1992	T	30	1628	3,150	4,066	3,150	-1,521	-3,017	994	0	994	0	570,000	0	0			0	0	0	257,148	263,740	969,822
7889	1992.04	4/17/1992	F	30	1925	4,267	4,066	4,066	-2,141	-4,247	-3,253	0	-3,253	0	570,000	4,247	0			0	0	0	259,037	265,786	970,196
7890	1992.04	4/18/1992	S	30	1980	5,507	4,066	4,066	-2,086	-4,137	-7,390	0	-7,390	0	570,000	4,137	0			0	0	0	260,795	270,314	970,897

A warning has been provided that the Water Bank Account Balance is negative for one or more days of the scenario. In this instance, all Model reservoirs are operating within a viable operation (the Model did not crash due an emptying reservoir); however, the objective to maintain a positive Water Bank Account Balance has been violated. Upon inspection of the results the user can find the first instance of violation and remedy the violation by entry into Column T an amount of release that maintains at least a zero balance in the Water Bank Account Balance. For the first day of violation the reported negative balance (e.g., -3,253 acre-feet) is needed as a supplemental release. The ensuing days of supplemental release are informed by Column P.

It is possible that within the remedy of Example 2 the error exemplified by Example 1 may occur as Hetchy Hetchy Reservoir may be drained through the efforts of maintaining a positive Water Bank Account Balance. At that point, the procedures of Example 1 will be required and the values already derived for supplemental releases may need to be revisited and possibly changed.

5.3 Control Workheet

This worksheet (Control) provides an interface for entering assumptions for reservoir operations and several facility characteristics of District and CCSF facilities. The worksheet is described below.

Contents Description and Study Name

Operation Control Parameters and Facility Characteristics Variables Affecting Case and Facility Operation
Contents: Section 1 - Don Pedro Reservoir and District Facilities Section 2 - CCSF Facilities Section 3 - Don Pedro Reservoir and CCSF Reservoir Elevation/Storage/Area and Evaporation Factors Section 4 - Don Pedro Reservoir Flood Control Reservation Space and Discretionary Target

This section provides an index to the contents of this worksheet (Control).

Section 1: Don Pedro Reservoir and District Facilities

Reservoir Management, Preferred Storage Target and Drawdown, Modesto Flood Control Objective, Snowmelt Runoff, and Storage Constraints

Section 1 - Don Pedro Reservoir and District Facilities

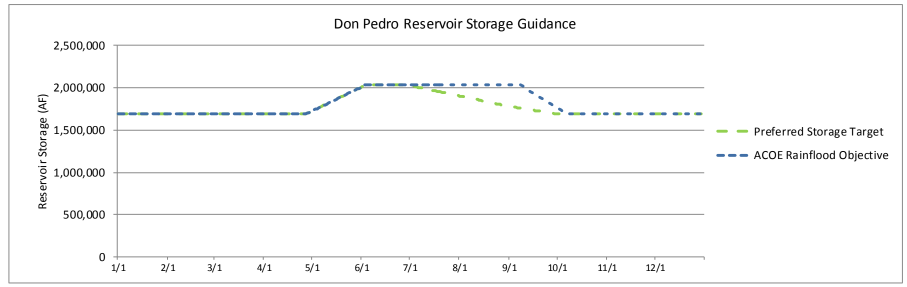
Reservoir Management

Rainflood reservoir reservation space according to ACOE manual.

"Flood control reservoir increases uniformly at a rate of 11,700 acre-feet per day from zero requirement on September 8 to the maximum reservation of 340,000 acre-feet by October 7. The reservation is maintained at 340,000 acre-feet through April 27 after which, unless additional reservation is indicated by the snowmelt parameters, it will decrease uniformaly at a rate of 9,200 acre-feet per day to zero requirement by June 3."

Preferred Storage Targets

ACOE through June 30. Target 1,906,000 acre-feet for July 31, 1,782,000 acre-feet August 31, and 1,692,000 acre-feet for September 30. UCOE thereafter.



Modesto flood control objective

(C 1.00) *9,000* *cfs. Target flow not to exceed in Tuolumne River below Modesto.*

Snowmelt release forecast parameters

90% exceedence DWR forecast of watershed runoff for April 1 and May 1
Historical watershed runoff for June 1

Release of forecasted excess runoff

(C 1.10)	*30*	*percent of April - June excess runoff during April*
(C 1.11)	*50*	*percent of May - June excess runoff during May*
(C 1.12)	*100*	*percent of June excess runoff during June*

Reservoir Storage Constraints/Objectives

	2,030,000	*acre-feet Maximum reservoir storage*
(C 1.20)	*308,960*	*acre-feet dead pool, cutoff of generation capability/no release**
(C 1.21)	*5,400*	*cfs maximum Don Pedro Powerhouse discharge*

** The Model will not crash upon simulating an operation below dead pool. However, to conform with operational limitations the user is to modify input assumptions to maintain reservoir storage at or above dead pool.*

This section describes the parameters that provide guidance to the management of Don Pedro Reservoir storage and provides entry of several parameters that advise reservoir operations. United States Army Corps of Engineers (ACOE) and preferred reservoir storage guidance is described. User specified values for specific storage targets are input in Section 4 of this worksheet. The maximum targeted flood flow in the Tuolumne River at Modesto (below Dry Creek) is entered at C 1.00. Releases to the Tuolumne River will be constrained to not exceed this flow level when reservoir space is available in Don Pedro Reservoir to defer releases. Guidance is also provided for the release of anticipated runoff during the snowmelt runoff season. Values entered at C 1.10, C 1.11 and C 1.12 advise the amount of projected excess runoff (from the date of forecast through June) to be released during April, May and June. For instance, the value entered at C 1.10 (30 percent) advises the Model to release 30 percent of the excess runoff volume forecasted to occur during April through June during April. The Model estimates the total excess runoff volume as being the projected inflow to Don Pedro Reservoir less projected canal diversions, reservoir evaporation and minimum Tuolumne River flow requirements, with an objective to fill Don Pedro Reservoir at the end of June. An entry at C 1.20 directs the Model to cease

the simulation of power generation at Don Pedro Powerhouse when reservoir storage is below the value. A warning occurs when Don Pedro Reservoir storage is less than the value. The warning informs the study that the reservoir is being simulated below dead pool. The study should be revised through inputs in worksheet UserInput to remedy reservoir storage that is less than dead pool. The entry at C 1.21 informs the Model of the maximum flow through the Don Pedro powerhouse. Releases from Don Pedro Dam in excess of this value is labeled spill or bypassed at the dam.

FERC Minimum Flow Requirements

FERC Minimum Flow Requirements

FERC Flow Schedules

(C 1.30)	*Year Type*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
	Oct 1-15 (CFS)	*100*	*100*	*150*	*150*	*180*	*200*	*300*
	Oct 16-31 (CFS)	*150*	*150*	*150*	*150*	*180*	*175*	*300*
	Total Base (AF)	*7,736*	*7,736*	*9,223*	*9,223*	*11,068*	*11,504*	*18,447*
	Attraction (AF)	*0*	*0*	*0*	*0*	*1,676*	*1,736*	*5,950*
	Total Oct (AF)	*7,736*	*7,736*	*9,223*	*9,223*	*12,744*	*13,240*	*24,397*
	Nov (CFS)	*150*	*150*	*150*	*150*	*180*	*175*	*300*
	AF	*8,926*	*8,926*	*8,926*	*8,926*	*10,711*	*10,413*	*17,852*
	Dec (CFS)	*150*	*150*	*150*	*150*	*180*	*175*	*300*
	AF	*9,223*	*9,223*	*9,223*	*9,223*	*11,068*	*10,760*	*18,447*
	Jan (CFS)	*150*	*150*	*150*	*150*	*180*	*175*	*300*
	AF	*9,223*	*9,223*	*9,223*	*9,223*	*11,068*	*10,760*	*18,447*
	Feb (CFS)	*150*	*150*	*150*	*150*	*180*	*175*	*300*
	AF	*8,331*	*8,331*	*8,331*	*8,331*	*9,997*	*9,719*	*16,661*
	Mar (CFS)	*150*	*150*	*150*	*150*	*180*	*175*	*300*
	AF	*9,223*	*9,223*	*9,223*	*9,223*	*11,068*	*10,760*	*18,447*
	Apr (CFS)	*150*	*150*	*150*	*150*	*180*	*175*	*300*
	AF	*8,926*	*8,926*	*8,926*	*8,926*	*10,711*	*10,413*	*17,852*
	May (CFS)	*150*	*150*	*150*	*150*	*180*	*175*	*300*
	AF	*9,223*	*9,223*	*9,223*	*9,223*	*11,068*	*10,760*	*18,447*
	Migration Flow							
	AF	*11,091*	*20,091*	*32,619*	*37,060*	*35,920*	*60,027*	*89,882*
	Jun (CFS)	*50*	*50*	*50*	*75*	*75*	*75*	*250*
	AF	*2,975*	*2,975*	*2,975*	*4,463*	*4,463*	*4,463*	*14,876*
	Jul (CFS)	*50*	*50*	*50*	*75*	*75*	*75*	*250*
	AF	*3,074*	*3,074*	*3,074*	*4,612*	*4,612*	*4,612*	*15,372*
	Aug (CFS)	*50*	*50*	*50*	*75*	*75*	*75*	*250*
	AF	*3,074*	*3,074*	*3,074*	*4,612*	*4,612*	*4,612*	*15,372*
	Sep (CFS)	*50*	*50*	*50*	*75*	*75*	*75*	*250*
	AF	*2,975*	*2,975*	*2,975*	*4,463*	*4,463*	*4,463*	*14,876*
	Total Annual	*94,001*	*103,001*	*117,017*	*127,508*	*142,503*	*165,004*	*300,926*

April - May distribution of spring migration volume

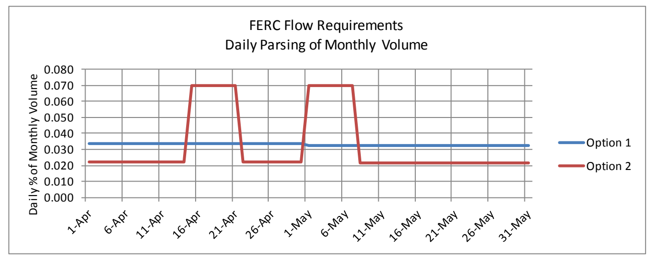
(C 1.40)	*16*	*parts (days) during April*
(C 1.41)	*15*	*parts (days) during May*
	31	*parts total during April and May*

Forecast of San Joaquin River Index

(C 1.50)	*1*	
	1	*Actual*
	2	*90% Exc.*
	3	*75% Exc.*
	4	*Med.*
	5	*10% Exc.*

April - May daily parsing of monthly volume of flow

(C 1.60)	*2*	
	1	*Even*
	2	*2-Pulse*



This section defines the 1995 FERC minimum flow requirements. Values are entered (C 1.30) for each defined flow period by year type, consistent with the FERC order issued July 31, 1996. Seven year types are defined based on the San Joaquin Basin 60-20-20 water supply index. The sequence year of the flow schedule begins in April and continues through the following March. The water supply index of each year of the simulation period is found in worksheet 602020, and the projection method of the index is defined at C 1.50. For the Test Case condition, the historical actual 60-20-20 index is used. The volume of water interpolated between annual schedules is distributed among April and May in proportion to the values provided at C 1.40 (April) and C 1.41 (May). The total volume of water designated for April and May is distributed daily during April and May is directed by C 1.60. If directed to use an equal distribution of the volume of flow during April and May, C 1.60 is set as 1. If C 1.60 is set as 2, two 7-day pulse flows will occur with the remaining volume evenly spread over the remaining days of the months. The pattern of these schedules can be modified in worksheet LaGrangeSchedule.

Test Case District Canal Demands

Test Case Canal Demands

Modesto Irrigation District

		Turnout Delivery Factor	Nominal Private GW Pumping	Canal Operation Spills Critical	Canal Operation Spills Non-crit	Canal Losses blw Modesto Reservoir	Intercptd Flows	Nominal MID GW Pumping	Mod Res & Upper Canal Losses	Modesto Reservoir Municipal Delivery	Target Storage	Target Storage Change
	Month	%	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF
(C 1.70)	Jan	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	17.0	2.0
	Feb	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	18.0	1.0
	Mar	65.0	1.0	1.0	3.0	0.6	0.9	1.0	2.0	2.7	18.0	0.0
	Apr	70.0	2.0	3.0	6.0	0.6	0.9	2.3	2.9	2.7	19.0	1.0
	May	85.0	3.0	4.0	6.5	0.6	1.2	2.3	3.9	3.0	20.0	1.0
	Jun	85.0	4.0	3.5	6.5	0.6	1.0	2.3	4.3	3.2	20.0	0.0
	Jul	77.5	4.0	3.5	6.5	0.6	1.0	2.6	4.9	3.3	21.0	1.0
	Aug	70.0	4.0	4.9	7.0	0.6	1.4	2.4	4.9	3.3	22.0	1.0
	Sep	65.0	2.0	5.0	7.0	0.6	1.2	2.3	4.2	3.3	20.0	-2.0
	Oct	40.0	1.0	2.8	6.9	0.6	0.9	2.1	2.0	3.2	17.0	-3.0
	Nov	30.0	0.0	2.0	2.0	0.1	0.0	0.0	2.0	2.7	15.0	-2.0
	Dec	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.5	15.0	0.0
	Total		21.0	35.7	57.4	5.4	8.5	17.3	31.1	34.5		

March TO Factor

TO Del Fac Break Point	Factor %
0	65
9.9	65
13.2	65
20	65
9999	65

Turlock Irrigation District

		Turnout Delivery Factor	Nominal Private GW Pumping	Canal Operation Spills Critical	Canal Operation Spills Non-crit	Canal Losses blw Turlock Lake	Intercptd Flows	Nominal TID GW Pumping	Turlock Lk & Upper Canal Losses	Turlock Lake Delivery	Target Storage	Target Storage Change
	Month	%	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF
(C 1.80)	Jan	30	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	18.0	5.0
	Feb	30	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	25.0	7.0
	Mar	65	1.2	3.0	3.0	4.5	0.0	4.1	1.0	0.0	30.0	5.0
	Apr	57.5	2.4	5.1	6.3	4.5	0.0	8.0	6.6	0.0	30.0	0.0
	May	85	3.6	4.6	6.7	4.5	0.0	10.3	7.7	0.0	32.0	2.0
	Jun	92.5	5.2	4.2	6.7	4.5	0.0	12.4	8.2	0.0	32.0	0.0
	Jul	72.5	6.4	4.2	6.7	4.5	0.0	14.6	8.7	0.0	32.0	0.0
	Aug	62.5	6.2	4.0	7.3	4.5	0.0	13.3	9.0	0.0	30.0	-2.0
	Sep	67.5	3.9	3.2	7.3	4.5	0.0	9.1	5.0	0.0	27.0	-3.0
	Oct	40	2.4	2.3	7.3	4.5	0.0	5.3	2.0	0.0	13.0	-14.0
	Nov	30	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0	0.0
	Dec	30	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0	0.0
	Total		31.3	38.6	59.3	39.2	0.0	77.1	52.2	0.0		

March TO Factor

TO Del Fac Break Point	Factor %
0	65
19.8	65
27.5	65
40	65
9999	65

This section of parameters contributes to the computation of District canal demands. The values entered at C 1.70 for Modesto Irrigation District and at C 1.80 for Turlock Irrigation District are utilized by worksheet DailyCanalsCompute in the projection of daily canal demands for the simulation period. These parameters represent various components of water supplies and disposition that result in the need for canal diversion. These components are combined with the projected demand for applied water associated with lands within the Districts. The projected demand for applied water is provided to the model in worksheet DailyCanalsCompute, and is adjusted by the turnout delivery factor entered in C 1.70 and C 1.80, which adjusts for applied water not associated with immediate consumptive use such as pre-irrigation and groundwater recharge. The computation of daily canal demand is processed by parsing the monthly values of C 1.70 and C 1.80 evenly across the days of a month and combining them with the monthly value of applied water that has been parsed daily in a pattern reflective of recent historical daily diversions for the canals.

Don Pedro Water Supply Factor

Don Pedro Water Supply Factor

	Don Pedro Stor + Infl Index	M/TID WS Factor
	TAF	%
(C 1.90)	0	0.60
	1,350	0.60
	1,600	0.85
	2,000	0.85
	2,001	1.00
	2,300	1.00
	9,999	1.00

The reservoir index method adds the end-of-March Don Pedro Reservoir storage to the projected April through July inflow to assess water availability for diversion.

The Don Pedro Water Supply Factor directs the reduction of District canal diversions during periods of anticipated limited water supply. The values at C 1.90 provide the model with a relationship between water availability at Don Pedro Reservoir and advised canal diversions. The parameters of the relationship is an index of water availability which is computed as the storage in Don Pedro Reservoir at the end of March plus the projected inflow into Don Pedro Reservoir for April through July, and the water supply factor which is applied to projected demand for applied water described above. A water supply factor of 1.00 will provide a diversion equal to projected canal demand (full demand). A water supply factor less than 1.00 will reduce the canal diversion to less than full canal demand.

Section 2: City and County of San Francisco Facilities
Hetch Hetchy Reservoir

This section provides parameters that direct or advise the operation of Hetch Hetchy Reservoir. Minimum flow releases below Hetch Hetchy Reservoir are directed by C 2.00, C 2.01 and C 2.02. These parameters and schedules are consistent with the stipulations for the Canyon Power Project and the modifications thereof for Kirkwood Powerhouse Unit No. 3. The application of these flow schedules and the addition of 64 cfs to the minimum flow schedule below Hetch Hetchy Reservoir are embedded in model logic in worksheet CCSF.

Section 2 - CCSF Facilities

Hetch Hetchy Reservoir Control

Minimum releases below reservoir

(C 2.00)

Schedule Index - Accum Inches or Storage

CY Month	A (1)	B (2)	C (3)
1	8.80	6.10	
2	14.00	9.50	
3	18.60	14.20	
4	23.00	18.00	
5	26.60	19.50	
6	28.45	21.25	
7	575,000	390,000	
8	640,000	400,000	

(C 2.01)

Below Dam Flow Requirement - CFS

CY Month	A (1)	B (2)	C (3)
1	50	40	35
2	60	50	35
3	60	50	35
4	75	65	35
5	100	80	50
6	125	110	75
7	125	110	75
8	125	72.5	75
9	90	65	62.5
10	60	50	35
11	60	50	35
12	50	40	35

(C 2.02)

Discretionary Schedule - Acre-feet

CY Month	A (1)	B (2)	C (3)
	15,000	6,500	4,400
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0
7	0	0	0
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
12	0	0	0

Reservoir Management

(C 2.10)

Target Storage - Acre-feet

CY Month	Soft Trgt EOM	Hard Limit EOM
1	320,000	360,360
2	320,000	360,360
3	320,000	360,360
4	320,000	360,360
5	360,360	360,360
6	360,360	360,360
7	360,360	360,360
8	360,360	360,360
9	360,360	360,360
10	330,000	360,360
11	320,000	360,360
12	320,000	360,360

Snowmelt release forecast parameters

Historical watershed runoff used for all forecasts of inflow (perfect foresight)

Release of forecasted excess runoff

(C 2.20)	10	*percent of Februay - June excess runoff during February*
(C 2.21)	10	*percent of March - June excess runoff during March*
(C 2.22)	10	*percent of April - June excess runoff during April*
(C 2.23)	100	*percent of May - June excess runoff during June*
(C 2.24)	100	*percent of June excess runoff during June*

Minimum storage of draw down for snowmelt release

(C 2.30) 100,000 *acre-feet*

Maximum advised release for snowmelt

(C 2.25)	1,200	*cfs - February*
(C 2.26)	1,150	*cfs - March*
(C 2.27)	1,200	*cfs - April*
(C 2.28)	100,000	*cfs - May*
(C 2.29)	100,000	*cfs - June*

Target storage for filling at end of June

(C 2.31) 360,360 *acre-feet*

Values entered at C 2.10 advise the management of reservoir storage throughout a year. The hard limit entered into C 2.10 directs the maximum allowed storage in Hetch Hetchy Reservoir at the end of each month. Model logic will not allow exceedence of these values and will release addition water from the facility if needed to not exceed the values. The soft target, also representing a value at the end of each month, when

exceeded advises the Model to make additional releases in order to not exceed that reservoir storage. Model logic computes the storage exceedence, if any, every seventh day and advises a release in addition to minimum releases. The rate of this additional release is equal to the exceedence volume spread over seven days. For transitional months when the soft target value at the end of a month differs from a previous month, the transition in storage target is parsed equally within the days of the month.

Entries at C 2.20 through C 2.24 advise the amount of projected excess runoff (from the date of forecast through June) to be released during February, March, April, May and June. For instance, the value entered at C 2.20 (10 percent) advises the Model to release 10 percent of the excess runoff volume forecasted to occur during the February through June during February. The Model estimates the total excess runoff volume as being the projected inflow to Hetch Hetchy Reservoir less projected San Joaquin Pipeline diversions, deliveries to Groveland and Moccasin Fish Hatchery, reservoir evaporation and minimum flow requirements below Hetch Hetchy Reservoir, with an objective to fill Hetch Hetchy Reservoir at the end of June.

Entries at C 2.25 through C 2.29 work in concert with the advised snowmelt runoff releases, and limit the rate at which those releases will be made. The functionality of the limit provides an ability to manage releases in recognition of downstream facility protection, the efficiency of releases through power generation facilities and reservoir storage goals. The example of C 2.25 being set as 1,200 cfs for February results in the advised snowmelt release being limited to no more than that value regardless of the rate of release advised by the projection of excess runoff. These releases are in addition to the already established minimum releases described previously. C 2.30 and C 2.31 also affect the advisement of snowmelt runoff releases. C 2.30 limits the drawdown of Hetch Hetchy Reservoir for snowmelt runoff, and its value will limit the release to not lower Hetch Hetchy reservoir storage below such value. C 2.31 directs the storage goal for Hetch Hetchy Reservoir at the assumed fill date of the end of June.

Lake Lloyd

The section of parameters that direct or advise the operation of Lake Lloyd (show below) is very similar in content and structure as the section just described for Hetch Hetchy Reservoir. Minimum flow releases below Lake Lloyd are directed by C 2.40 and C 2.41. A single schedule of flow requirements is provided for Lake Lloyd and is consistent with the stipulations for the Cherry River Project. The application of the flow schedule is embedded in Model logic in worksheet CCSF. Entry of a value at C 2.41 provides a release from Lake Lloyd through Holm Powerhouse during the months of May through August, established as 950 cfs for four hours per day. The entry at C 2.41 also advises the maximum flow rate through Holm Powerhouse.

Values entered at C 2.50 advise the management of reservoir storage throughout a year. The hard limit entered into C 2.50 directs the maximum allowed storage in Lake Lloyd at the end of each month. Model logic will not allow exceedence of these values and will release addition water from the facility if needed to not exceed the values. The soft target, also representing a value at the end of each month, when exceeded advises the Model to make additional releases in order to not exceed that reservoir storage. Model logic computes the storage exceedence, if any, every

seventh day and advises a release in addition to minimum releases. The rate of this additional release is equal to the exceedence volume spread over seven days. For transitional months when the soft target value at the end of a month differs from a previous month, the transition in storage target is parsed equally within the days of the month.

Entries at C 2.60 through C 2.64 advise the amount of projected excess runoff (from the date of forecast through June) to be released during February, March, April, May and June. The model estimates the total excess runoff volume as being the projected inflow to Lake Lloyd less reservoir evaporation, minimum flow requirements below Lake Lloyd and releases to Holm Powerhouse, with an objective to fill Lake Lloyd at the end of June.

Entries at C 2.65 through C 2.69 work in concert with the advised snowmelt runoff releases, and limit the rate at which those releases will be made. C 2.70 and C 2.71 also affect the advisement of snowmelt runoff releases. These releases are in addition to the already established minimum releases described previously. C 2.70 limits the drawdown of Lake Lloyd for snowmelt runoff, and its value will limit the release to not lower Lake Lloyd storage below such value. C 2.71 directs the storage goal for Lake Lloyd at the assumed fill date of the end of June.

Lake Lloyd Control

Minimum releases below reservoir

	Blw Lake Lloyd - CFS	
	CY Month	*Flow Req*
(C 2.40)	*1*	*5*
	2	*5*
	3	*5*
	4	*5*
	5	*5*
	6	*5*
	7	*15.5*
	8	*15.5*
	9	*15.5*
	10	*5*
	11	*5*
	12	*5*

Holm Target Releases

May (Memorial Day) thru	(C 2.41)	
August (Labor Day)		
Holm Capacity	*950*	*cfs*
Day	*1,884*	*acre-feet*
4-hours per day	*314*	*acre-feet*

Reservoir Management

	Target Storage - Acre-feet		
		Soft Trgt	*Hard Limit*
	CY Month	*EOM*	*EOM*
(C 2.50)	*1*	*238,000*	*273,300*
	2	*238,000*	*273,300*
	3	*238,000*	*273,300*
	4	*273,300*	*273,300*
	5	*273,300*	*273,300*
	6	*273,300*	*273,300*
	7	*268,000*	*273,300*
	8	*258,000*	*273,300*
	9	*248,000*	*273,300*
	10	*248,000*	*273,300*
	11	*238,000*	*273,300*
	12	*238,000*	*273,300*

Snowmelt release forecast parameters

Historical watershed runoff used for all forecasts of inflow (perfect foresight)

Release of forecasted excess runoff

(C 2.60)	*20*	*percent of Februay - June excess runoff during February*
(C 2.61)	*25*	*percent of March - June excess runoff during March*
(C 2.62)	*33*	*percent of April - June excess runoff during April*
(C 2.63)	*50*	*percent of May - June excess runoff during June*
(C 2.64)	*100*	*percent of June excess runoff during June*

Minimum storage of draw down for snowmelt release

(C 2.70) *100,000* *acre-feet*

Maximum advised release for snowmelt

(C 2.65)	*1,000*	*cfs - February*
(C 2.66)	*1,000*	*cfs - March*
(C 2.67)	*1,000*	*cfs - April*
(C 2.68)	*1,000*	*cfs - May*
(C 2.69)	*1,000*	*cfs - June*

Target storage for filling at end of June

(C 2.71) *273,300* *acre-feet*

Lake Eleanor

This section provides parameters that direct or advise the operation of Lake Eleanor. Minimum flow releases below Lake Eleanor are directed by C 2.80. These flow schedules are consistent with the stipulations for the Cherry-Eleanor Pumping Station. The application of these flow schedules are embedded in Model logic in worksheet CCSF, and always assume the schedule associated with pumping. An entry at C 2.81 directs the maximum flow rate through the Eleanor-Cherry Diversion Tunnel. This value may limit the rate at which water can be transferred from Lake Eleanor to Lake Lloyd.

Lake Eleanor Control

Minimum releases below reservoir

(C 2.80)

Blw Lake Eleanor - CFS		
CY Month	w/Pump Flow Req	w/o Flow Req
1	5	5
2	5	5
3	10	5
4	15	5
5	20	5
6	20	5
7	20	16
8	20	16
9	15	16
10	10	5
11	5	5
12	5	5

Always uses w/Pump flow requirement

	Eleanor to Lloyd tunnel capacity
(C 2.81)	400 cfs

Reservoir Management

(C 2.90)

Target Storage - Acre-feet		
CY Month	Soft Trgt EOM	Hard Limit EOM
1	21,495	27,100
2	21,495	27,100
3	21,495	27,100
4	27,100	27,100
5	27,100	27,100
6	27,100	27,100
7	27,100	27,100
8	27,100	27,100
9	15,000	27,100
10	15,000	27,100
11	15,000	27,100
12	18,250	27,100

Snowmelt release forecast parameters

Historical watershed runoff used for all forecasts of inflow (perfect foresight)

Release of forecasted excess runoff

(C 2a.10)	20	percent of Februay - June excess runoff during February
(C 2a.11)	25	percent of March - June excess runoff during March
(C 2a.12)	33	percent of April - June excess runoff during April
(C 2a.13)	70	percent of May - June excess runoff during June
(C 2a.14)	100	percent of June excess runoff during June

Minimum storage of draw down for snowmelt release

(C 2a.20) 1,000 acre-feet

Maximum advised release for snowmelt

(C 2a.15)	2,000	cfs - February
(C 2a.16)	2,000	cfs - March
(C 2a.17)	2,000	cfs - April
(C 2a.18)	2,000	cfs - May
(C 2a.19)	2,000	cfs - June

Target storage for filling at end of June

(C 2a.21) 27,100 acre-feet

Values entered at C 2.90 advise the management of reservoir storage throughout a year. The hard limit entered into C 2.90 directs the maximum allowed storage in Lake Eleanor at the end of each month. Model logic will not allow exceedence of these values and will release addition water from the facility if needed to not exceed the values. The soft target, also representing a value at the end of each month, when exceeded advises the Model to make additional releases in order to not exceed that reservoir storage. Model logic computes the storage exceedence, if any, every seventh day and advises a release in addition to minimum releases. The rate of this additional release is equal to the exceedence volume spread

over seven days. For transitional months when the soft target value at the end of a month differs from a previous month, the transition in storage target is parsed equally within the days of the month.

Entries at C 2a.10 through C 2a.14 advise the amount of projected excess runoff (from the date of forecast through June) to be released during February, March, April, May and June. The model estimates the total excess runoff volume as being the projected inflow to Lake Eleanor less reservoir evaporation and minimum flow requirements below Lake Eleanor, with an objective to fill Lake Eleanor at the end of June.

Entries at C 2a.15 through C 2a.19 work in concert with the advised snowmelt runoff releases, and limit the rate at which those releases will be made. These releases are in addition to the already established minimum releases described previously. C 2a.20 and C 2a.21 also affect the advisement of snowmelt runoff releases. C 2a.20 limits the drawdown of Lake Eleanor for snowmelt runoff, and its value will limit the release to not lower Lake Eleanor storage below such value. C 2a.21 directs the storage goal for Lake Eleanor at the assumed fill date of the end of June.

CCSF Water Supply Parameters

The matrix describing the San Francisco water supply parameters provides the model information to report the state of Test Case condition water supply action levels and the potential changes in the occurrence of action level due to alternative operations.

CCSF Water Supply Parameters

	Actions		
	Level	*Trigger Tot Sys Stor*	*Action % Del Reduc*
(C 2a.30)	*0*		*0*
	1	*1,100,000*	*10*
	2	*1,100,000*	*10*
	3	*700,000*	*20*

Entries at C 2a.30 represent the relationship between CCSF total system storage (at the end of June each year) and the advisement of water supply actions. Total system storage includes CCSF's local watershed reservoirs, its Hetch Hetchy Project reservoirs, and also the Don Pedro Water Bank Account Balance. Local watershed storage is provided from CCSF's system operation model (HHLSM) as pre-processed values for the simulation period. These values are combined with the Model's depiction of CCSF reservoir storage for the Tuolumne River system to depict total system storage. A water supply action level for each year of each study is determined by the matrix, relating total system storage thresholds to advised action levels. For instance, if total system storage at the end of June of a year is greater than 700,000 acre-feet and less than 1,100,000 acre-feet, an action level of 10 percent rationing is advised. The CCSF Test Case condition SJPL diversions include the effect of occasional water delivery shortages due to these water supply parameters.

<u>Section 3: Don Pedro Reservoir and CCSF Elevation/Storage/Area and Evaporation Factors</u>

The section provides entry of the physical elevation/storage/area relationship for Don Pedro Reservoir and CCSF reservoirs. The values entered at C 3.00 for Hetch Hetchy Reservoir, Lake Lloyd, Lake Eleanor and Don Pedro Reservoir are currently being used by the Model. The Model employs a table lookup function to determine the area of a reservoir based on storage. The area is multiplied by a reservoir's evaporation factor for the estimation of reservoir evaporation. The monthly evaporation factor for CCSF reservoirs is entered at C 3.10 and Don Pedro Reservoir's evaporation factors are entered at C 3.20. These reservoir rating tables and evaporation factors are consistent with the daily accounting of Tuolumne River flows between the Districts and CCSF.

Section 3 - Don Pedro Reservoir and CCSF Reservoir Elevation/Storage/Area and Evaporation Factors

(C 3.00)

Hetch Hetchy Reservoir			Lake Lloyd			Lake Eleanor			Don Pedro Reservoir		
Elev - FT	Stor - AF	Area- Ac	Elev - FT	Stor - AF	Area- Ac	Elev - FT	Stor - AF	Area- Ac	Elev - FT	Stor - AF	Area- Ac
3520.0	410	124.0	4440.0	0.0	5.0	4605.0	0.0	0.0		0	0
3520.1	439	127.9	4440.1	1.0	5.1	4605.1	0.0	2.5		0	0
3520.2	468	131.8	4440.2	2.0	5.1	4605.2	0.0	5.0		0	0
3520.3	497	135.7	4440.3	2.0	5.2	4605.3	1.0	7.6		1	1
3520.4	526	139.6	4440.4	3.0	5.2	4605.4	1.0	10.1		1	1
3520.5	555	143.5	4440.5	4.0	5.3	4605.5	1.0	12.6		3	2
3520.6	583	147.4	4440.6	5.0	5.3	4605.6	2.0	15.1		5	3
3520.7	612	151.3	4440.7	5.0	5.4	4605.7	2.0	17.6		8	3
3520.8	641	155.2	4440.8	6.0	5.4	4605.8	2.0	20.2		12	4
3520.9	670	159.1	4440.9	7.0	5.5	4605.9	2.0	22.7		17	6
3521.0	699	163.0	4441.0	8.0	5.5	4606.0	2.0	25.2	300.0	35	7
3521.1	728	166.9	4441.1	8.0	5.6	4606.1	3.0	27.7		42	7
3521.2	757	170.8	4441.2	9.0	5.6	4606.2	3.0	30.2		50	8
3521.3	786	174.7	4441.3	10.0	5.7	4606.3	3.0	32.7		57	8
3521.4	815	178.6	4441.4	11.0	5.7	4606.4	3.0	35.3		65	8
3521.5	843	182.5	4441.5	11.0	5.8	4606.5	4.0	37.8		74	8
3521.6	872	186.4	4441.6	12.0	5.8	4606.6	4.0	40.3		82	9
3521.7	901	190.3	4441.7	13.0	5.9	4606.7	4.0	42.8		91	9
3521.8	930	194.2	4441.8	14.0	5.9	4606.8	4.0	45.3		100	9
3521.9	959	198.1	4441.9	14.0	6.0	4606.9	5.0	47.9		110	10
3522.0	988	202.0	4442.0	15.0	6.0	4607.0	5.0	50.4	310.0	120	10
3522.1	1017	205.9	4442.1	16.0	6.1	4607.1	5.0	52.9		130	10
3522.2	1046	209.8	4442.2	17.0	6.1	4607.2	5.0	55.4		140	10
3522.3	1075	213.7	4442.3	17.0	6.2	4607.3	6.0	57.9		150	11
3522.4	1104	217.6	4442.4	18.0	6.2	4607.4	6.0	60.4		161	11
3522.5	1133	221.5	4442.5	19.0	6.3	4607.5	6.0	63.0		172	11
3522.6	1161	225.4	4442.6	20.0	6.3	4607.6	6.0	65.5		183	11
3522.7	1190	229.3	4442.7	20.0	6.4	4607.7	7.0	68.0		194	11
3522.8	1219	233.2	4442.8	21.0	6.4	4607.8	7.0	70.5		206	12
3522.9	1248	237.1	4442.9	22.0	6.5	4607.9	7.0	73.0		218	12
3523.0	1277	241.0	4443.0	23.0	6.5	4608.0	7.0	75.6	320.0	229	12
3523.1	1306	244.9	4443.1	23.0	6.6	4608.1	8.0	78.1		242	13
3523.2	1335	248.8	4443.2	24.0	6.6	4608.2	8.0	80.6		255	13
3523.3	1364	252.7	4443.3	25.0	6.7	4608.3	8.0	83.1		268	14
3523.4	1393	256.6	4443.4	26.0	6.7	4608.4	8.0	85.6		283	15
3523.5	1422	260.5	4443.5	26.0	6.8	4608.5	9.0	88.2		297	15

Evaporation Factors

CCSF Reservoirs		(C 3.10)
		CFS/Ac/Day
Jan	1 =	-0.00325
Feb	2 =	-0.0036
Mar	3 =	0
Apr	4 =	0
May	5 =	0.003253
Jun	6 =	0.006722
Jul	7 =	0.009758
Aug	8 =	0.009758
Sep	9 =	0.006722
Oct	10 =	0.003253
Nov	11 =	0
Dec	12 =	0

Evaporation Factors

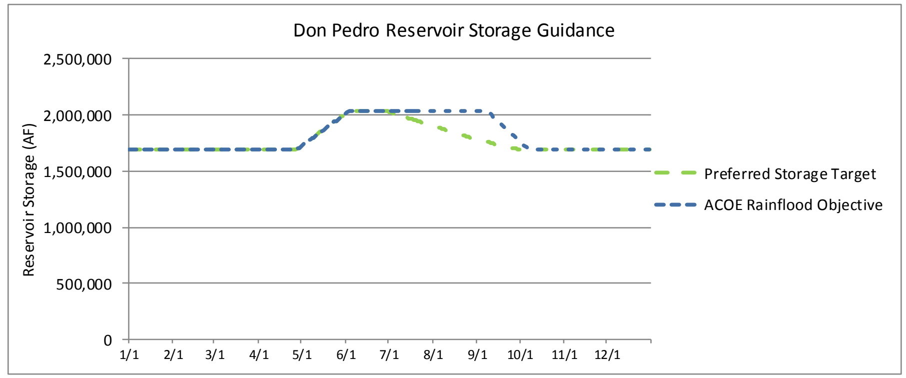
Don Pedro Reservoir		(C 3.20)
		CFS/Ac/Day
Jan	1 =	-0.00088
Feb	2 =	-0.00026
Mar	3 =	0.001135
Apr	4 =	0.003081
May	5 =	0.007968
Jun	6 =	0.010947
Jul	7 =	0.013976
Aug	8 =	0.014109
Sep	9 =	0.01072
Oct	10 =	0.006395
Nov	11 =	0.001781
Dec	12 =	-0.00013

Section 4: Don Pedro Reservoir Flood Control Reservation and Discretionary Target

The section provides for the entry of the preferred storage target for Don Pedro Reservoir.
Values entered at C 4.00 and C 4.01 advises the management of reservoir storage throughout a year. A hard limit of 2,030,000 acre-feet directs the maximum allowed storage in Don Pedro Reservoir at the end of each month. Model logic will not allow exceedence of these values and will release addition water from the facility if needed to not exceed the values. The soft target (“Final Target Storage” at C 4.00), also representing a value at the end of each day, when exceeded advises the model to make additional releases in order to not exceed that reservoir storage. Model logic computes the storage exceedence, if any, every seventh day and advises a release in addition to minimum releases. The rate of this additional release is equal to the exceedence volume spread over ten days. For transitional months when the soft target value at the end of a month differs from a previous month, the transition in storage target is parsed equally within the days of the month.

Section 4 - Don Pedro Reservoir Flood Control Reservation Space and Preferred Storage Target

	ACOE thru June
Full Res (2,030,000) Less ACOE RF Space	*1,906,000*
	Jul 31
	1,782,000
	Aug 31
	1,692,000
	Sep 30
	UCOE therefter



(C 4.00)

Don Pedro Reservoir FC/Discretionary/Drawdown Space							
Mo/Day	Mo/Day Index		ACOE RF Space AF	DP RF Storage AF	Add Descr Storage AF	Add Descr Modifier AF	Final Target Storage AF
1/1	1.01		340,000	1,690,000			1,690,000
1/2	1.02		340,000	1,690,000			1,690,000
1/3	1.03		340,000	1,690,000			1,690,000
1/4	1.04		340,000	1,690,000			1,690,000
1/5	1.05		340,000	1,690,000			1,690,000
1/6	1.06		340,000	1,690,000			1,690,000
1/7	1.07		340,000	1,690,000			1,690,000
1/8	1.08		340,000	1,690,000			1,690,000
1/9	1.09		340,000	1,690,000			1,690,000
1/10	1.10		340,000	1,690,000			1,690,000
1/11	1.11		340,000	1,690,000			1,690,000
1/12	1.12		340,000	1,690,000			1,690,000
1/13	1.13		340,000	1,690,000			1,690,000
1/14	1.14		340,000	1,690,000			1,690,000
1/15	1.15		340,000	1,690,000			1,690,000
1/16	1.16		340,000	1,690,000			1,690,000
1/17	1.17		340,000	1,690,000			1,690,000

ACOE Rainflood (AF) End-of-month

Jan	1,690,000	Jul	2,030,000
Feb	1,690,000	Aug	2,030,000
Mar	1,690,000	Sep	1,772,600
Apr	1,717,600	Oct	1,690,000
May	2,002,800	Nov	1,690,000
Jun	2,030,000	Dec	1,690,000

(C 4.01)

	Discretionar Guide AF
1 Jan	0
2 Feb	0
3 Mar	0
4 Apr	0
5 May	0
6 Jun	0
7 Jul	0
8 Aug	0
9 Sep	0
10 Oct	0
11 Nov	0
12 Dec	0

The guidance provided by this parameter manages Don Pedro Reservoir storage throughout the year for both ACOE objectives during the season of rainflood reservation space and additional discretionary reservoir storage space or targets to manage reservoir storage from one year to another.

5.4 Output Worksheet

This worksheet (Output) provides an interface between Model computations and data summary and analysis tools. It also provides a formatted set of information usable for exchange into an HEC-DSS database file, such as used to provide information to the temperature models used for this FERC investigation. Information concerning HEC-DSS can be found on the HEC web site at:

http://www.hec.usace.army.mil/software/hec-dss/hecdss-dss.html

The structure and contents of worksheet Output accommodates the use of the HEC-DSS Excel Data Exchange Add-in which is an application for retrieving and storing interval time series data, in this circumstance the daily results of the Model.

Results provided in worksheet Output are directly linked to the computational and input worksheets of the Model. For instance, the daily inflow to Don Pedro Reservoir listed in worksheet Output is the value provided to worksheet DonPedro for its computations, which is dependent upon several other computation worksheets. As such, any change to model assumptions or data which causes a recalculation by the model will automatically update the values in worksheet Output. To preserve or store the results of a particular model study a copy of the worksheet should be created with a unique tab name and its contents converted to values. The HEC-DSS Add-in could also be used to create a unique database file for later use. Alternatively, but storage consuming, the entire Model could be saved as a unique study. However, this approach is not recommended as the worksheet Output will continue to be dynamically linked to the model's computational worksheets and any subsequent change to model assumptions will overwrite the results previously provided in the worksheet.

More than 80 parameters are reported in the worksheet, representing salient information concerning the simulated operations and hydrology of the Tuolumne River and the Districts' and CCSF's facilities. Table 5.4-1 provides a listing of the parameters including their HEC-DSS name parts. Shown below is a snapshot of the content and format of the worksheet.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	1	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE	TUOLUMNE
2	2	TUOLUMNEI	TUOLUMNEI	TUOLUMNEI	TUOLUMNEI	TUOLUMNEI	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO	DONPEDRO
3	3	FLOW-LAGRANGEUNIMP	FLOW-HHUNIMP	FLOW-LLOYDUNIMP	FLOW-ELEANORUNIMP	FLOW-UNREGUNIMP	FLOW-TOTINFLOW	FLOW-SUP1INFLOWLL	FLOW-SUP2INFLOWHH	FLOW-INFLOWHH	FLOW-INFLOWLL	FLOW-INFLOWEL	STORAGE	EVAP
4	4	2	3	4	5	6	7	8	9	10	11	12	13	14
5	5	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY	1DAY
6	6	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base	Test_Base
7	7	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70	1-Oct-70
8	8	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400
9	9	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09	30-Sep-09
10	10	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400
11	11	CFS	CFS	CFS	CFS	CFS	CFS	AF	AF	CFS	CFS	CFS	AF	AF
12		PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER	PER_AVER
13	10/1/1970	159	79	56	25	-1	322	0	0	90	223	10	1,666,767	143
14	10/2/1970	55	-82	5	2	130	453	0	0	90	223	10	1,664,567	141
15	10/3/1970	265	25	15	7	218	541	0	0	90	223	10	1,662,719	141
16	10/4/1970	-166	110	-399	-179	302	625	0	0	90	223	10	1,659,892	141
17	10/5/1970	180	-38	322	144	-248	75	0	0	90	223	10	1,656,745	141
18	10/6/1970	92	9	-48	-21	152	475	0	0	90	223	10	1,654,119	141
19	10/7/1970	150	21	-51	-23	203	526	0	0	90	223	10	1,652,009	140
20	10/8/1970	153	-29	54	24	104	209	0	0	90	5	10	1,650,525	140
21	10/9/1970	146	-28	10	5	159	264	0	0	90	5	10	1,648,926	140
22	10/10/1970	99	30	-25	-11	105	210	0	0	90	5	10	1,647,059	140
23	10/11/1970	293	176	-275	-123	515	620	0	0	90	5	10	1,645,737	140

Table 5.4-1 – Worksheet Output Parameters

Column	Col No	DSS - Part B	DSS - Part C	Units	Column	Col No	DSS - Part B	DSS - Part C	Units
B	2	TUOLUMNERIVER	FLOW-LAGRANGEUNIMP	CFS	BD	56	MIDCANAL	MIDFULLREQ	AF
C	3	TUOLUMNERIVER	FLOW-HHUNIMP	CFS	BE	57	TIDCANAL	TIDAGPDAW	AF
D	4	TUOLUMNERIVER	FLOW-LLOYDUNIMP	CFS	BF	58	TIDCANAL	TIDMI	AF
E	5	TUOLUMNERIVER	FLOW-ELEANORUNIMP	CFS	BG	59	TIDCANAL	TIDFACT	AF
F	6	TUOLUMNERIVER	FLOW-UNREGUNIMP	CFS	BH	60	TIDCANAL	TIDNOMGWPRVT	AF
G	7	DONPEDRO	FLOW-TOTINFLOW	CFS	BI	61	TIDCANAL	TIDOPSPLS	AF
H	8	DONPEDRO	FLOW-SUP1INFLOWLL	AF	BJ	62	TIDCANAL	TIDLOSS	AF
I	9	DONPEDRO	FLOW-SUP2INFLOWHH	AF	BK	63	TIDCANAL	TIDINTCP	AF
J	10	DONPEDRO	FLOW-INFLOWHH	CFS	BL	64	TIDCANAL	TIDNOMGWDIST	AF
K	11	DONPEDRO	FLOW-INFLOWLL	CFS	BM	65	TIDCANAL	TIDUPSYSLOSSDIV	AF
L	12	DONPEDRO	FLOW-INFLOWEL	CFS	BN	66	TIDCANAL	TIDLKDIV	AF
M	13	DONPEDRO	STORAGE	AF	BO	67	TIDCANAL	TIDLKSTORCHNG	AF
N	14	DONPEDRO	EVAP	AF	BP	68	TIDCANAL	TIDFULLREQ	AF
O	15	DONPEDRO	STORAGE-RFTRG	AF	BQ	69	DONPEDRO	DPFACT	UNIT
P	16	DONPEDRO	STORAGE-SOFTTRG	AF	BR	70	SANFRAN	SFSJPLBASE	AF
Q	17	DONPEDRO	RELEASE-7DAYENCRADVISE	CFS	BS	71	SANFRAN	SFLOCALSTOR	AF
R	18	DONPEDRO	RELEASE-SNOWADVISE	CFS	BT	72	SANFRAN	SFSJPL	AF
S	19	DONPEDRO	RELEASE-TOTAL	CFS	BU	73	SANFRAN	SFTOTSYSSTOR	AF
T	20	DONPEDRO	POWR-MW	MW	BV	74	SANFRAN	SFTOTTRSYSSTOR	AF
U	21	DONPEDRO	POWR-EFF	kWh/AF	BW	75	SANFRAN	SFSUPPREL	UNIT
V	22	DONPEDRO	POWR-MWh	MWh	BX	76	SANFRAN	SFSUPPTAB	UNIT
W	23	DONPEDRO	RELEASE-PH	AF	BY	77	SANFRAN	TRIGGER	UNIT
X	24	DONPEDRO	RELEASE-BYPASS	AF	BZ	78	SANFRAN	WBBAL	UNIT
Y	25	DONPEDRO	FLOW-TOTCANALS	AF	CA	79	HETCH	HATCH-GRVLND	CFS
Z	26	LAGRANGE	RELEASE-MINQ	CFS	CB	80	HETCH	HATCH-RTRN	CFS
AA	27	LAGRANGE	RELEASE-TOTAL	CFS	CC	81	HETCH	RELEASE-MINQ1	CFS
AB	28	LAGRANGE	RELEASE-MCANAL	CFS	CD	82	HETCH	RELEASE-TOTMINQ	CFS
AC	29	LAGRANGE	RELEASE-TCANAL	CFS	CE	83	HETCH	RELEASE-7DAYENCRADVISE	CFS
AD	30	LAGRANGE	FULLCANALREQ	AF	CF	84	HETCH	RELEASE-SNOWADVISE	CFS
AE	31	RIVER	FLOW-LTRACC1	CFS	CG	85	HETCH	RELEASE-TOTAL	CFS
AF	32	RIVER	FLOW-LTRACC2	CFS	CH	86	HETCH	STORAGE	AF
AG	33	RIVER	FLOW-LTRACC3	CFS	CI	87	HETCH	EVAP	AF
AH	34	RIVER	FLOW-LTRACC4	CFS	CJ	88	HETCH	STORAGE-SOFTTRG	AF
AI	35	RIVER	FLOW-DRYCK	CFS	CK	89	LLOYD	RELEASE-MINSTRMQ	CFS
AJ	36	RIVER	FLOW-LTRACC5	CFS	CL	90	LLOYD	RELEASE-MINHOLM	CFS
AK	37	RIVER	FLOW-TR1	CFS	CM	91	LLOYD	RELEASE-7DAYENCRADVISE	CFS
AL	38	RIVER	FLOW-TR2	CFS	CN	92	LLOYD	RELEASE-SNOWADVISE	CFS
AM	39	RIVER	FLOW-TR3	CFS	CO	93	LLOYD	RELEASE-LLOYDONLYHOLM	CFS
AN	40	RIVER	FLOW-TR4	CFS	CP	94	LLOYD	HOLMAVAILEL	CFS
AO	41	RIVER	FLOW-MODMAX	CFS	CQ	95	LLOYD	RELEASE-TOTHOLM	CFS
AP	42	RIVER	FLOW-MODMAXLG	CFS	CR	96	LLOYD	RELEASE-TOTLLOYD	CFS
AQ	43	RIVER	FLOW-MODESTO	CFS	CS	97	LLOYD	STORAGE	AF
AR	44	RIVER	FLOW-TR5	CFS	CT	98	LLOYD	EVAP	AF
AS	45	MIDCANAL	MIDAGPDAW	AF	CU	99	LLOYD	STORAGE-SOFTTRG	AF
AT	46	MIDCANAL	MIDMI	AF	CV	100	ELEANOR	RELEASE-MINSTRMQ	CFS
AU	47	MIDCANAL	MIDFACT	PERCENT	CW	101	ELEANOR	RELEASE-7DAYENCRADVISE	CFS
AV	48	MIDCANAL	MIDNOMGWPRVT	AF	CX	102	ELEANOR	RELEASE-SNOWADVISE	CFS
AW	49	MIDCANAL	MIDOPSPLS	AF	CY	103	ELEANOR	TUNTRNSFCAP	CFS
AX	50	MIDCANAL	MIDLOSS	AF	CZ	104	ELEANOR	FLOW-TUNNEL	CFS
AY	51	MIDCANAL	MIDINTCP	AF	DA	105	ELEANOR	RELEASE-STREAM	CFS
AZ	52	MIDCANAL	MIDNOMGWDIST	AF	DB	106	ELEANOR	RELEASE-TOTELEANOR	CFS
BA	53	MIDCANAL	MIDUPSYSLOSSDIV	AF	DC	107	ELEANOR	STORAGE	AF
BB	54	MIDCANAL	MIDLKDIV	AF	DD	108	ELEANOR	EVAP	AF
BC	55	MIDCANAL	MIDLKSTORCHNG	AF	DE	109	ELEANOR	STORAGE-SOFTTRG	AF

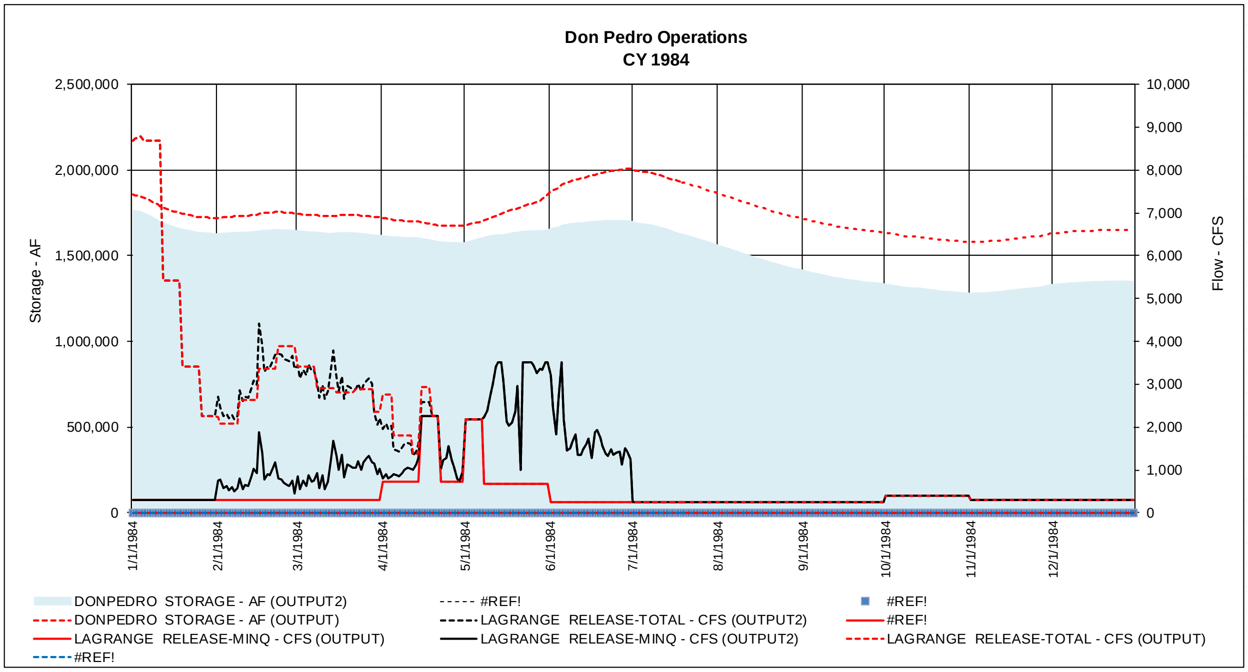
5.5 DSSAnyGroup Worksheet

This worksheet (DSSAnyGroup) provides plotting of up to ten parameters provided in worksheet Output or another equally formatted worksheet of results. One calendar year (the same year or different years) of data for a parameter can be plotted. The parameter(s) to be plotted are identified by reference worksheet name and column. A snapshot of the identification parameters and result values is shown below.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	DSSAnyGroup													
2	This sheet illustrates a CY of daily results from Model sheets in graphic format.													
3	Axis Reference	1		1		2		2		2		2		1
4	Enter CY Graph Year:	1984		1984		1984		1984		1984		1984		1984
5	Enter Sheet Name:	OUTPUT1		OUTPUT2		OUTPUT2		OUTPUT1		OUTPUT		OUTPUT2		OUTPUT
6	Column:	#N/A		13		27		#N/A		26		26		#N/A
7	Enter Column:			M		AA				Z		Z		
8	Data Reference:	#REF!	Date	DONPEDRO STORAGE - AF (OUTPUT2)	Date	LAGRANGE RELEASE-TOTAL - CFS (OUTPUT2)	Date	#REF!	Date	LAGRANGE RELEASE-MINQ - CFS (OUTPUT)	Date	LAGRANGE RELEASE-MINQ - CFS (OUTPUT2)	Date	#REF!
9	Enter Scaler:	1		1		1		1		1		1		1
10	1-Jan-84	#REF!	1-Jan-84	1,765,400	1-Jan-84	8,681	1-Jan-84	#REF!	1-Jan-84	300	1-Jan-84	300	1-Jan-84	#REF!
11	2-Jan-84	#REF!	2-Jan-84	1,762,808	2-Jan-84	8,732	2-Jan-84	#REF!	2-Jan-84	300	2-Jan-84	300	2-Jan-84	#REF!
12	3-Jan-84	#REF!	3-Jan-84	1,759,443	3-Jan-84	8,758	3-Jan-84	#REF!	3-Jan-84	300	3-Jan-84	300	3-Jan-84	#REF!
13	4-Jan-84	#REF!	4-Jan-84	1,757,150	4-Jan-84	8,773	4-Jan-84	#REF!	4-Jan-84	300	4-Jan-84	300	4-Jan-84	#REF!
14	5-Jan-84	#REF!	5-Jan-84	1,749,651	5-Jan-84	8,683	5-Jan-84	#REF!	5-Jan-84	300	5-Jan-84	300	5-Jan-84	#REF!
15	6-Jan-84	#REF!	6-Jan-84	1,741,186	6-Jan-84	8,683	6-Jan-84	#REF!	6-Jan-84	300	6-Jan-84	300	6-Jan-84	#REF!
16	7-Jan-84	#REF!	7-Jan-84	1,735,636	7-Jan-84	8,683	7-Jan-84	#REF!	7-Jan-84	300	7-Jan-84	300	7-Jan-84	#REF!
17	8-Jan-84	#REF!	8-Jan-84	1,726,314	8-Jan-84	8,683	8-Jan-84	#REF!	8-Jan-84	300	8-Jan-84	300	8-Jan-84	#REF!
18	9-Jan-84	#REF!	9-Jan-84	1,718,101	9-Jan-84	8,683	9-Jan-84	#REF!	9-Jan-84	300	9-Jan-84	300	9-Jan-84	#REF!
19	10-Jan-84	#REF!	10-Jan-84	1,708,161	10-Jan-84	8,683	10-Jan-84	#REF!	10-Jan-84	300	10-Jan-84	300	10-Jan-84	#REF!
20	11-Jan-84	#REF!	11-Jan-84	1,696,327	11-Jan-84	8,683	11-Jan-84	#REF!	11-Jan-84	300	11-Jan-84	300	11-Jan-84	#REF!
21	12-Jan-84	#REF!	12-Jan-84	1,691,421	12-Jan-84	5,421	12-Jan-84	#REF!	12-Jan-84	300	12-Jan-84	300	12-Jan-84	#REF!
22	13-Jan-84	#REF!	13-Jan-84	1,686,396	13-Jan-84	5,421	13-Jan-84	#REF!	13-Jan-84	300	13-Jan-84	300	13-Jan-84	#REF!
23	14-Jan-84	#REF!	14-Jan-84	1,680,358	14-Jan-84	5,421	14-Jan-84	#REF!	14-Jan-84	300	14-Jan-84	300	14-Jan-84	#REF!
24	15-Jan-84	#REF!	15-Jan-84	1,674,328	15-Jan-84	5,421	15-Jan-84	#REF!	15-Jan-84	300	15-Jan-84	300	15-Jan-84	#REF!
25	16-Jan-84	#REF!	16-Jan-84	1,669,263	16-Jan-84	5,421	16-Jan-84	#REF!	16-Jan-84	300	16-Jan-84	300	16-Jan-84	#REF!

Values are plotted to either the primary y-axis or secondary y-axis. The “axis reference” indicates to which axis the value will be plotted by default. The designation of y-axis assignment is not modified by this field, and the user must edit the series data within the plot to change the y-axis assignment, graph type or line or shape characteristics. The “enter graph year” is a user entry. The same year or different year of a parameter or multiple parameters can be plotted. “Sheet name” is a user entry, and identifies from which Output-formatted worksheet the parameter is to be acquired. The “enter column” entry identifies from which column the parameter occurs. Refer to Table 5.4-1 of the description for worksheet Output for the identification of the column associated with each parameter. Upon proper entry of a parameter a return of the parameter’s label and source worksheet will occur in the “data reference” field. Values for the specified calendar year will also be returned in the data field. If a plotting position is not used, a “#VALUE!” or “#REF!” will be returned. The “scaler” field is provided to allow the conversion or scaling of the data returned from the result worksheet. For instance, if the daily data occurs in the result worksheet in units of daily average flow (cfs) it could be plotted in units of daily volume (acre-feet) by entering the conversion factor of 1.983471. The entry in the field acts as a multiplier to the value occurring in the result worksheet. This field can also be used to scale two different “order of magnitude” parameters to use the same y-axis.

The results of up to ten parameters will be plotted. An example of the several plotted parameters from two different studies is shown below.



Unused plotting positions will appear with values plotted at "zero" and will have legends of "#VALUE!" or "#REF!". To create graphs without unused positions a copy of the plot can be made and positioned elsewhere in the worksheet. The unwanted positions can then be deleted from the plot.

5.6 DSSMonthTable Worksheet

This worksheet (DSSMonthTable) provides summation or averaging, and plotting of up to four parameters provided in worksheet Output or another equally formatted worksheet of results. The function of this worksheet is to provide a synthesis of the daily result data into monthly results thus reducing the handling and display of over 14,000 values for each parameter (39 years of days) to 468 values (39 years of months).

The parameter(s) to be plotted or tabled are identified by reference worksheet name and column, very similarly to the method identified for worksheet DSSAnyGroup. A snapshot of the identification parameters and result values is shown below.

5				Conversion Key:			
6				0	1 >> 1	Native	1
7				1	CFS >> AF	AF	1.9834700
8				2	AF >> CFS	CFS	0.5041669
9				3	CFS >> TAF	TAF	0.0019835
10				4	EOM Stor	AF	1
11				5	Ave Day	Native	1
12			Enter Conversion (0-5):	4	4	4	4
13			Enter Sheet Name:	Output	Output1	Output3c	Output2b
14			Enter Column Letter:	M	M	M	M
15			Column No:	13	13	13	13
16			Label:	O STORAG	D STORAGE	D STORAGE	D STORAGE
17			Native Unit:	AF	AF	AF	AF
18			Convert Unit:	AF	AF	AF	AF
19	Index	Date	Day	1	1	1	1
20	1970.10	10/1/1970	T	1,666,767	1,666,767	1,666,767	1,666,969
21	1970.10	10/2/1970	F	1,664,567	1,664,567	1,664,567	1,664,971
22	1970.10	10/3/1970	S	1,662,719	1,662,719	1,662,719	1,663,323
23	1970.10	10/4/1970	S	1,659,892	1,659,892	1,659,892	1,660,699
24	1970.10	10/5/1970	M	1,656,745	1,656,745	1,656,745	1,657,753
25	1970.10	10/6/1970	T	1,654,119	1,654,119	1,654,119	1,655,329

Each parameter is tabled and plotted separately for the entire 39-year simulation period. "Sheet name" is a user entry, and identifies from which Output-formatted worksheet the parameter is to be acquired. The "enter column letter" entry identifies from which column the parameter occurs. Refer to Table 5.4-1 of the description for worksheet Output for the identification of the column associated with each parameter. Upon proper entry of a parameter a return of the parameter's label, source worksheet and the native unit of the parameter will occur. Depending on need, the "conversion" entry is provided. This entry, a keyed value of 0 to 5, directs the worksheet on the handling of the daily data. An entry of 1 will direct the worksheet to sum the daily data into monthly increments in the parameter's native units (e.g., daily acre-feet into monthly volumes). An entry of 1 will convert the daily data from a native unit of flow (cfs) into monthly volumes of acre-feet. An entry of 2 will convert the daily data from a native unit of volume (acre-feet) into a monthly sum of daily flow in units of cfs. An entry of 3 will act as an entry of 1 except convert the result into monthly volumes with units of 1,000 acre-feet. An entry of 4 will table and plot the daily value associated with the last day of each month in its native unit, and is primarily intended to analyze reservoir storage. An entry of 5 will report the average of daily values within a month. Depending on the entry in the conversion field, the converted unit will be returned to "converted unit" field. Values for the each month of the simulation period will also be returned in the data field. If a plotting position is not used, a "#VALUE!" or "#REF!" will be returned.
A "scaler" field is also provided for each parameter (in the row above the data fields) to allow the conversion or scaling of the data returned from the result worksheet. The results of up to four parameters will be tabled and plotted. Examples of the formats of reports are shown below.

Standardized Tables

An example of a standardized table for the illustration of results is shown below (Table 1 Form). In this example the current minimum daily flow requirement at La Grange Bridge has been synthesized into monthly volumes for the simulation period, and water year totals and for the annual period February through January.

Conversion (0-5):	1
Sheet Name:	Output1
Column Letter:	Z
Column No:	26
Label:	ELEASE-MI
Native Unit:	CFS
Convert Unit:	AF

Table 1
LAGRANGE RELEASE-MINQ (Output1)
AF

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Feb-Jan
1971	24,397	17,851	18,447	18,447	16,661	18,447	66,685	63,515	4,463	4,612	4,612	4,463	262,598	228,631
1972	13,240	10,413	10,760	10,760	9,719	10,760	30,288	29,251	2,975	3,074	3,074	2,975	137,292	128,713
1973	9,223	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	240,823	283,369
1974	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1975	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1976	24,397	17,851	18,447	18,447	16,661	18,447	20,153	19,749	2,975	3,074	3,074	2,975	166,250	122,217
1977	7,736	8,926	9,223	9,223	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	94,000	94,000
1978	7,736	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	239,336	283,369
1979	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1980	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1981	24,397	17,851	18,447	18,447	16,661	18,447	29,339	28,532	4,463	4,612	4,612	4,463	190,269	156,718
1982	12,744	10,711	11,068	11,068	9,997	11,068	64,241	61,936	14,876	15,372	15,372	14,876	253,329	286,880
1983	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1984	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1985	24,397	17,851	18,447	18,447	16,661	18,447	34,656	33,346	4,463	4,612	4,612	4,463	200,400	157,854
1986	9,223	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	240,823	283,369
1987	24,397	17,851	18,447	18,447	16,661	18,447	24,481	23,806	2,975	3,074	3,074	2,975	174,636	130,603
1988	7,736	8,926	9,223	9,223	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	94,000	94,000
1989	7,736	8,926	9,223	9,223	8,331	9,223	25,991	25,222	2,975	3,074	3,074	2,975	115,975	115,975
1990	7,736	8,926	9,223	9,223	8,331	9,223	19,362	19,008	2,975	3,074	3,074	2,975	103,131	103,131
1991	7,736	8,926	9,223	9,223	8,331	9,223	25,870	25,109	2,975	3,074	3,074	2,975	115,740	115,740
1992	7,736	8,926	9,223	9,223	8,331	9,223	19,995	19,601	2,975	3,074	3,074	2,975	104,357	104,357
1993	7,736	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	239,336	283,369
1994	24,397	17,851	18,447	18,447	16,661	18,447	25,903	25,140	2,975	3,074	3,074	2,975	177,391	134,846
1995	9,223	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	240,823	283,369
1996	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1997	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1998	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
1999	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
2000	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
2001	24,397	17,851	18,447	18,447	16,661	18,447	28,572	27,642	4,463	4,612	4,612	4,463	188,612	146,067
2002	9,223	8,926	9,223	9,223	8,331	9,223	32,729	31,539	4,463	4,612	4,612	4,463	136,567	136,567
2003	9,223	8,926	9,223	9,223	8,331	9,223	55,641	53,161	4,463	4,612	4,612	4,463	181,101	189,680
2004	13,240	10,413	10,760	10,760	9,719	10,760	28,696	27,758	4,463	4,612	4,612	4,463	140,257	131,678
2005	9,223	8,926	9,223	9,223	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	240,823	283,369
2006	24,397	17,851	18,447	18,447	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	300,923	300,923
2007	24,397	17,851	18,447	18,447	16,661	18,447	26,085	25,310	2,975	3,074	3,074	2,975	177,743	133,710
2008	7,736	8,926	9,223	9,223	8,331	9,223	27,470	26,609	2,975	3,074	3,074	2,975	118,840	120,328
2009	9,223	8,926	9,223	9,223	8,331	9,223	42,919	41,235	4,463	4,612	4,612	4,463	156,452	
Average	16,957	13,625	14,079	14,079	12,717	14,079	46,531	44,910	9,078	9,381	9,381	9,078	213,897	214,289
Min	7,736	8,926	9,223	9,223	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	94,000	94,000
Max	24,397	17,851	18,447	18,447	16,661	18,447	66,685	63,515	14,876	15,372	15,372	14,876	300,923	300,923

Conversion (0-5):	5
Sheet Name:	Output1
Column Letter:	Z
Column No:	26
Label:	ELEASE-MI
Native Unit:	CFS
Convert Unit:	Native

The values could also be tabled in the parameter's native unit of flow (cfs) representing the average daily flow requirement during each month. Annual totals are not included as the value is non-sensible.

Table 1
LAGRANGE RELEASE-MINQ (Output1)
CFS — Average Daily Value

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1971	397	300	300	300	300	300	1,121	1,033	75	75	75	75
1972	215	175	175	175	169	175	509	476	50	50	50	50
1973	150	150	150	150	150	150	1,080	1,007	250	250	250	250
1974	397	300	300	300	300	300	1,080	1,007	250	250	250	250
1975	397	300	300	300	300	300	1,080	1,007	250	250	250	250
1976	397	300	300	300	290	300	339	321	50	50	50	50
1977	126	150	150	150	150	150	246	237	50	50	50	50
1978	126	150	150	150	150	150	1,080	1,007	250	250	250	250
1979	397	300	300	300	300	300	1,080	1,007	250	250	250	250
1980	397	300	300	300	290	300	1,080	1,007	250	250	250	250
1981	397	300	300	300	300	300	493	464	75	75	75	75
1982	207	180	180	180	180	180	1,080	1,007	250	250	250	250
1983	397	300	300	300	300	300	1,080	1,007	250	250	250	250
1984	397	300	300	300	290	300	1,080	1,007	250	250	250	250
1985	397	300	300	300	300	300	582	542	75	75	75	75
1986	150	150	150	150	150	150	1,080	1,007	250	250	250	250
1987	397	300	300	300	300	300	411	387	50	50	50	50
1988	126	150	150	150	145	150	246	237	50	50	50	50
1989	126	150	150	150	150	150	437	410	50	50	50	50
1990	126	150	150	150	150	150	325	309	50	50	50	50
1991	126	150	150	150	150	150	435	408	50	50	50	50
1992	126	150	150	150	145	150	336	319	50	50	50	50
1993	126	150	150	150	150	150	1,080	1,007	250	250	250	250
1994	397	300	300	300	300	300	435	409	50	50	50	50
1995	150	150	150	150	150	150	1,080	1,007	250	250	250	250
1996	397	300	300	300	290	300	1,080	1,007	250	250	250	250
1997	397	300	300	300	300	300	1,080	1,007	250	250	250	250
1998	397	300	300	300	300	300	1,080	1,007	250	250	250	250
1999	397	300	300	300	300	300	1,080	1,007	250	250	250	250
2000	397	300	300	300	290	300	1,080	1,007	250	250	250	250
2001	397	300	300	300	300	300	480	450	75	75	75	75
2002	150	150	150	150	150	150	550	513	75	75	75	75
2003	150	150	150	150	150	150	935	865	75	75	75	75
2004	215	175	175	175	169	175	482	451	75	75	75	75
2005	150	150	150	150	150	150	1,080	1,007	250	250	250	250
2006	397	300	300	300	300	300	1,080	1,007	250	250	250	250
2007	397	300	300	300	300	300	438	412	50	50	50	50
2008	126	150	150	150	145	150	462	433	50	50	50	50
2009	150	150	150	150	150	150	721	671	75	75	75	75
Average	276	229	229	229	227	229	782	730	153	153	153	153
Min	126	150	150	150	145	150	246	237	50	50	50	50
Max	397	300	300	300	300	300	1,121	1,033	250	250	250	250

For each parameter the sequential, the chronological annual values and associated monthly values are also grouped by water type, in descending order of annual runoff. The rank ordering of the years within the simulation period is established by the naming of 6 year types, wet, above normal, normal, below normal, dry and critical. Using the water year runoff for the years 1921 through 2011 (91 years), the years were rank ordered from wettest to driest. The wettest 20 percent of the years (18 years) are designated the wet year type. The next wettest 18 years are designated the above normal year type.

And so on for the normal and below normal year types. The driest 20 percent of years are split between the dry and critical year types. After the demarcation occurs for each year the data set is reduced to only the 1971 through 2009 modeling period (39 years). A switch at cell X216 directs the monthly sequence of the year. For instance, if the year is to begin February 1 of the year and continue through January of the following year, the switch would be set to “Feb”. The switch can be set to any month February (Feb) through June (Jun). The first form of standardized table (Table 1a Form) for this information follows, which identifies the year type associated with each chronologically-based listed year. Averages for each year type follow the listing.

	Table 1a													
Prelim	LAGRANGE RELEASE-MINQ (Output1)													
Relicense	AF													
Yr-Type	Yr Begin	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Total
3	1971	16,661	18,447	66,685	63,515	4,463	4,612	4,612	4,463	13,240	10,413	10,760	10,760	228,631
4	1972	9,719	10,760	30,288	29,251	2,975	3,074	3,074	2,975	9,223	8,926	9,223	9,223	128,713
3	1973	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
2	1974	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
2	1975	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
6	1976	16,661	18,447	20,153	19,749	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	122,217
6	1977	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	94,000
1	1978	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
3	1979	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
1	1980	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
5	1981	16,661	18,447	29,339	28,532	4,463	4,612	4,612	4,463	12,744	10,711	11,068	11,068	156,718
1	1982	9,997	11,068	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	286,880
1	1983	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
2	1984	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
4	1985	16,661	18,447	34,656	33,346	4,463	4,612	4,612	4,463	9,223	8,926	9,223	9,223	157,854
1	1986	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
6	1987	16,661	18,447	24,481	23,806	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	130,603
6	1988	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	94,000
4	1989	8,331	9,223	25,991	25,222	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	115,975
5	1990	8,331	9,223	19,362	19,008	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	103,131
4	1991	8,331	9,223	25,870	25,109	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	115,740
6	1992	8,331	9,223	19,995	19,601	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	104,357
2	1993	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
5	1994	16,661	18,447	25,903	25,140	2,975	3,074	3,074	2,975	9,223	8,926	9,223	9,223	134,846
1	1995	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
2	1996	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
1	1997	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
1	1998	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
2	1999	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
3	2000	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
4	2001	16,661	18,447	28,572	27,642	4,463	4,612	4,612	4,463	9,223	8,926	9,223	9,223	146,067
3	2002	8,331	9,223	32,729	31,539	4,463	4,612	4,612	4,463	9,223	8,926	9,223	9,223	136,567
3	2003	8,331	9,223	55,641	53,161	4,463	4,612	4,612	4,463	13,240	10,413	10,760	10,760	189,680
4	2004	9,719	10,760	28,696	27,758	4,463	4,612	4,612	4,463	9,223	8,926	9,223	9,223	131,678
1	2005	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
1	2006	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
5	2007	16,661	18,447	26,085	25,310	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	133,710
4	2008	8,331	9,223	27,470	26,609	2,975	3,074	3,074	2,975	9,223	8,926	9,223	9,223	120,328
3	2009	8,331	9,223	42,919	41,235	4,463	4,612	4,612	4,463					

LAGRANGE RELEASE-MINQ (Output1) - AF														
Water Year	Type	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Total
W	1	12,663	14,019	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	292,497
AN	2	15,273	16,909	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	297,997
N	3	11,901	13,176	55,814	53,608	8,926	9,223	9,223	8,926	18,149	13,884	14,347	14,347	240,016
BN	4	11,108	12,298	28,792	27,848	3,613	3,733	3,733	3,613	8,798	8,926	9,223	9,223	130,908
D	5	14,579	16,141	25,172	24,497	3,347	3,459	3,459	3,347	9,360	9,372	9,684	9,684	132,101
C	6	11,663	12,913	18,786	18,467	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	109,035
All		12,717	14,079	46,531	44,910	9,078	9,381	9,381	9,078	16,762	13,514	13,964	13,964	214,289

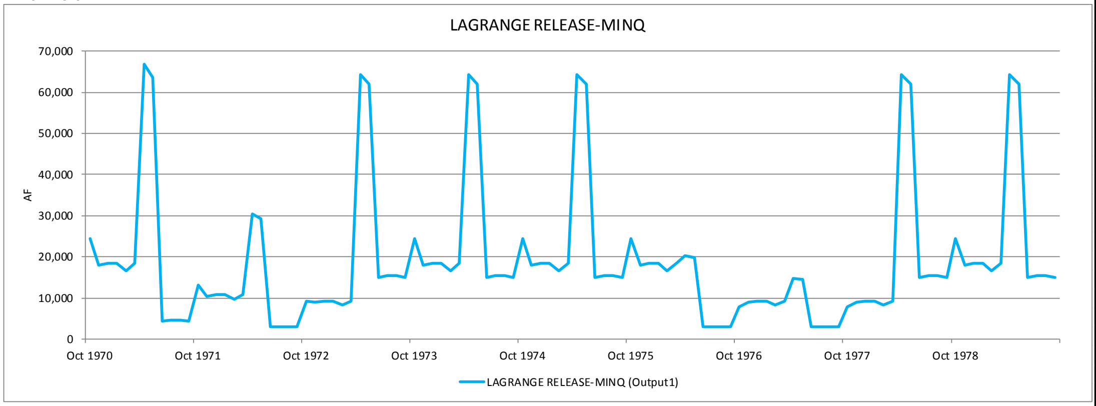
The second form of report (Table 1b Form) for the water year type based ranking is shown below. This form rank orders the years according to descending volume of watershed runoff, named by the convention described above. The same averaging results occur for this format of report.

	Table 1b													
Prelim	LAGRANGE RELEASE-MINQ (Output1)													
Relicense	AF													
Yr-Type	Yr Begin	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Total
W	1983	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
W	1995	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
W	1982	9,997	11,068	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	286,880
W	1998	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
W	2006	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
W	1997	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
W	1980	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
W	1986	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
W	2005	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
W	1978	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
AN	1984	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
AN	1993	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
AN	1996	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
AN	1974	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
AN	1999	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
AN	1975	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
N	1973	8,331	9,223	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	283,369
N	2000	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
N	1979	16,661	18,447	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	300,923
N	1971	16,661	18,447	66,685	63,515	4,463	4,612	4,612	4,463	13,240	10,413	10,760	10,760	228,631
N	2009	8,331	9,223	42,919	41,235	4,463	4,612	4,612	4,463					
N	2003	8,331	9,223	55,641	53,161	4,463	4,612	4,612	4,463	13,240	10,413	10,760	10,760	189,680
N	2002	8,331	9,223	32,729	31,539	4,463	4,612	4,612	4,463	9,223	8,926	9,223	9,223	136,567
BN	1989	8,331	9,223	25,991	25,222	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	115,975
BN	2004	9,719	10,760	28,696	27,758	4,463	4,612	4,612	4,463	9,223	8,926	9,223	9,223	131,678
BN	1985	16,661	18,447	34,656	33,346	4,463	4,612	4,612	4,463	9,223	8,926	9,223	9,223	157,854
BN	1972	9,719	10,760	30,288	29,251	2,975	3,074	3,074	2,975	9,223	8,926	9,223	9,223	128,713
BN	2008	8,331	9,223	27,470	26,609	2,975	3,074	3,074	2,975	9,223	8,926	9,223	9,223	120,328
BN	1991	8,331	9,223	25,870	25,109	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	115,740
BN	2001	16,661	18,447	28,572	27,642	4,463	4,612	4,612	4,463	9,223	8,926	9,223	9,223	146,067
D	1981	16,661	18,447	29,339	28,532	4,463	4,612	4,612	4,463	12,744	10,711	11,068	11,068	156,718
D	2007	16,661	18,447	26,085	25,310	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	133,710
D	1990	8,331	9,223	19,362	19,008	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	103,131
D	1994	16,661	18,447	25,903	25,140	2,975	3,074	3,074	2,975	9,223	8,926	9,223	9,223	134,846
C	1992	8,331	9,223	19,995	19,601	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	104,357
C	1988	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	94,000
C	1976	16,661	18,447	20,153	19,749	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	122,217
C	1987	16,661	18,447	24,481	23,806	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	130,603
C	1977	8,331	9,223	14,649	14,589	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	94,000
LAGRANGE RELEASE-MINQ (Output1) - AF														
Water Year Type		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Total
W	1	12,663	14,019	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	292,497
AN	2	15,273	16,909	64,241	61,936	14,876	15,372	15,372	14,876	24,397	17,851	18,447	18,447	297,997
N	3	11,901	13,176	55,814	53,608	8,926	9,223	9,223	8,926	18,149	13,884	14,347	14,347	240,016
BN	4	11,108	12,298	28,792	27,848	3,613	3,733	3,733	3,613	8,798	8,926	9,223	9,223	130,908
D	5	14,579	16,141	25,172	24,497	3,347	3,459	3,459	3,347	9,360	9,372	9,684	9,684	132,101
C	6	11,663	12,913	18,786	18,467	2,975	3,074	3,074	2,975	7,736	8,926	9,223	9,223	109,035
All		12,717	14,079	46,531	44,910	9,078	9,381	9,381	9,078	16,762	13,514	13,964	13,964	214,289

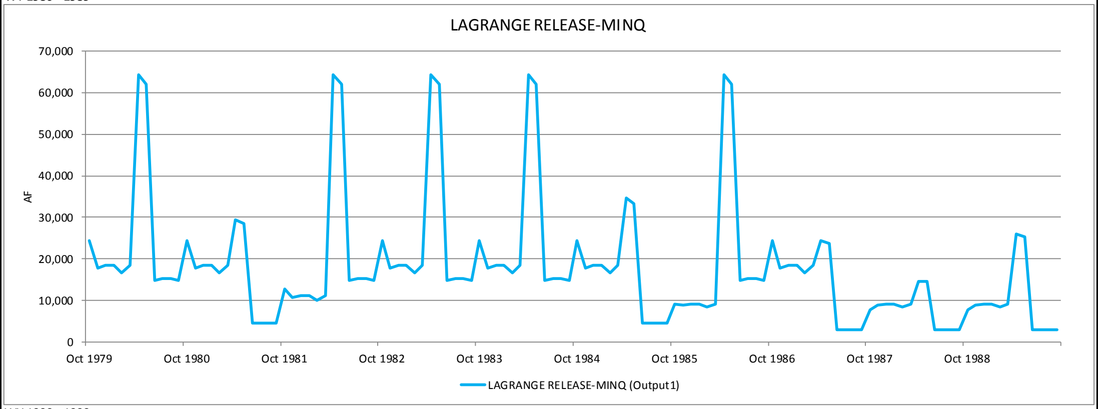
Standardized Graphs

Several standardized graphs are also provided for each parameter. The first graph provides a trace of the monthly sequence of data developed for the standardized chronological table. Following is the minimum flow requirement at La Grange Bridge synthesized as monthly volume during the simulation.

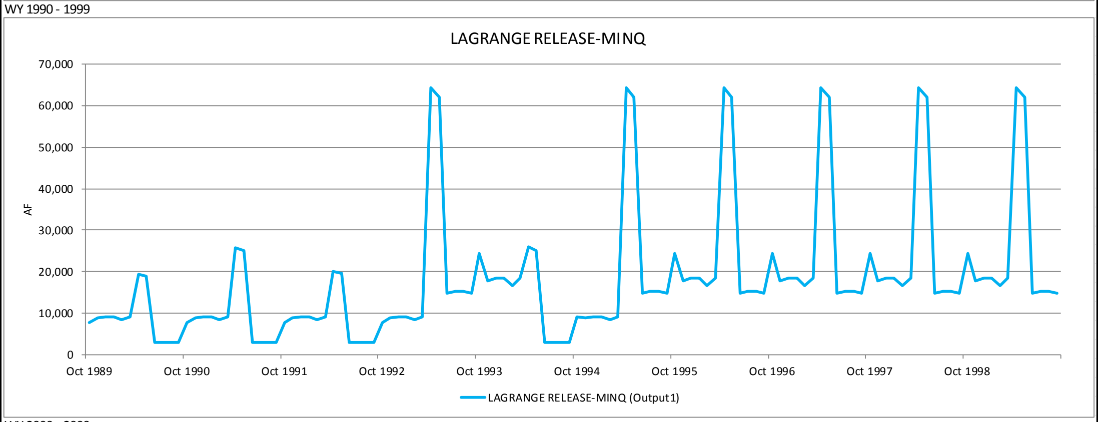
WY 1971-1979



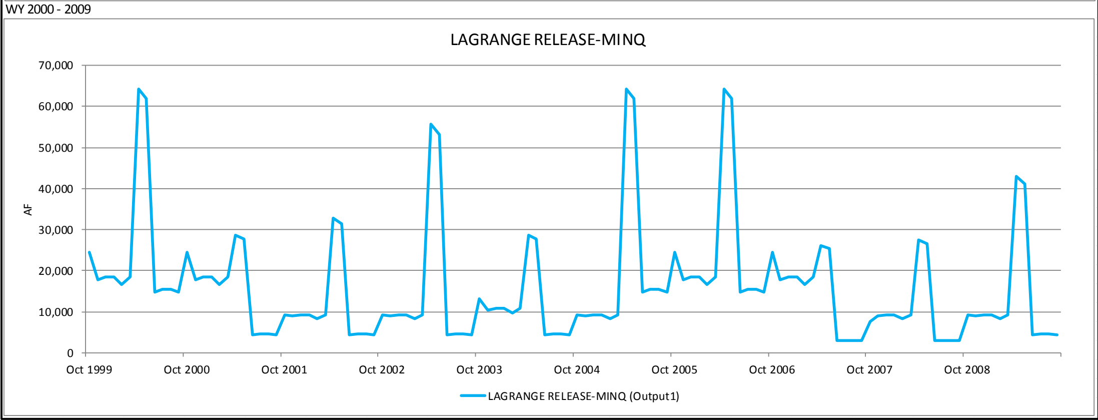
WY 1980 - 1989



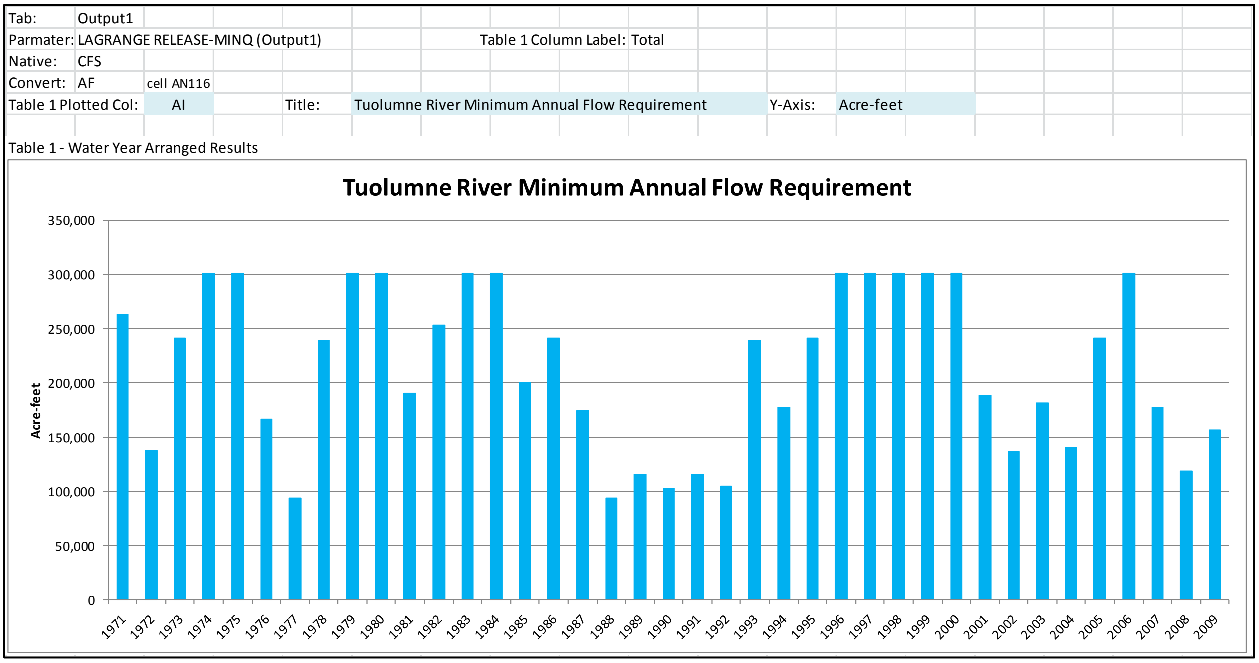
WY 1990 - 1999



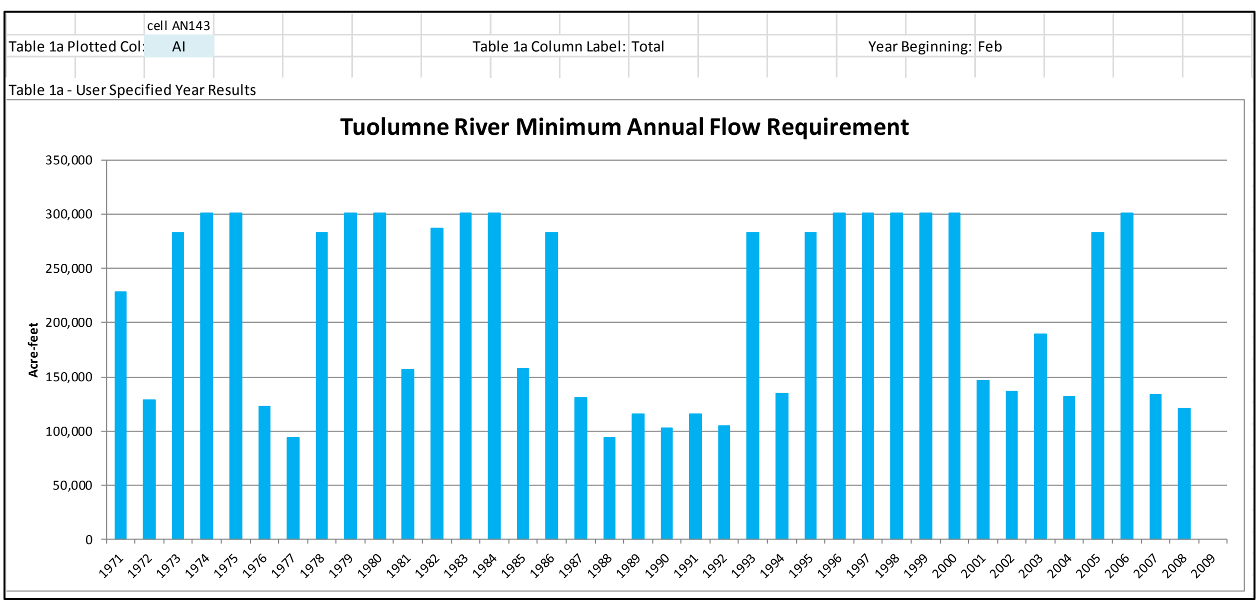
WY 2000 - 2009



A user-defined graph is also available to depict a particular column of data from the water year-based standardized table (Table 1) described above. A column of interest within the Table 1 standardized table is selected (such as column AI representing a water year total volume) in cell AN116 to display the 39 annual values.

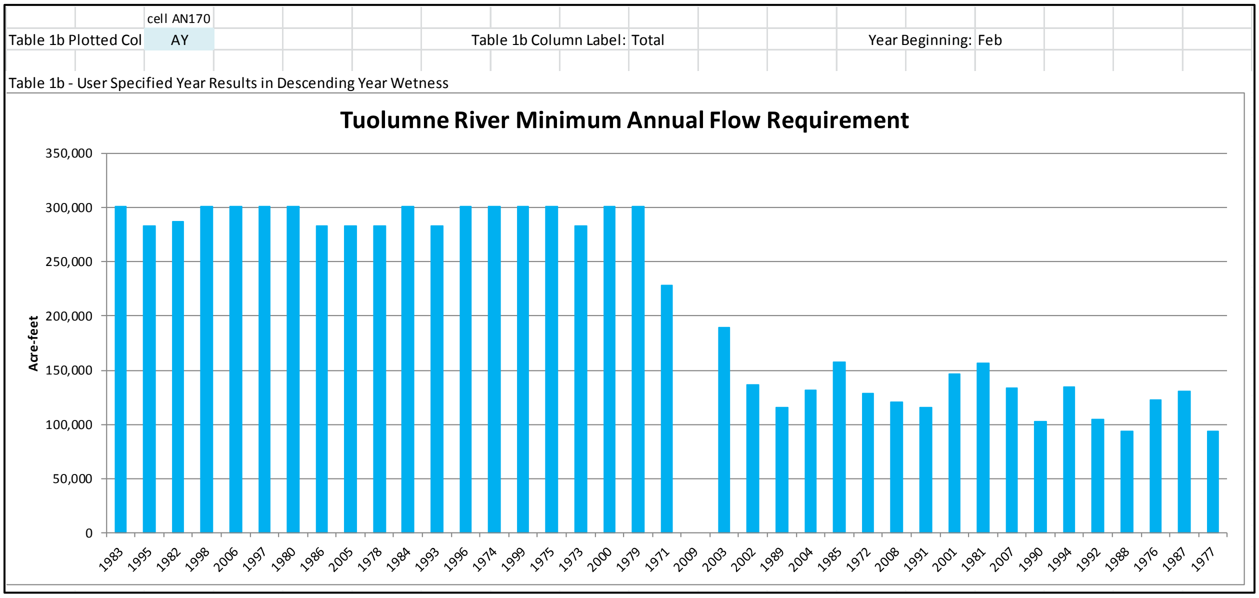


A similar display of columnar results can be keyed to the chronological sequence year table described above. Entry of the desired column of information from the table (e.g., Table 1a) is done at cell AN143.

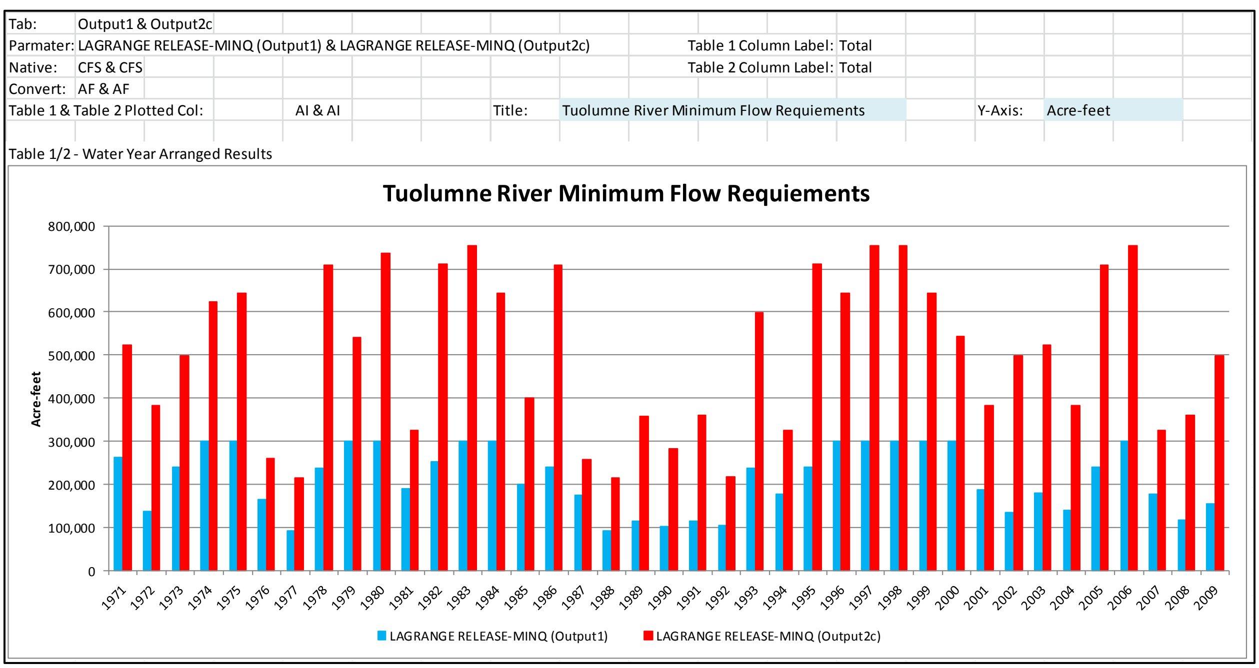


The third version of standardized graph for the same information displays results from a column of a table that rank-ordered the years of simulation according to descending runoff (e.g., Table 1b). Entry of

the desired column of information from that table is done at cell AN170, with results exemplified by the following graph.

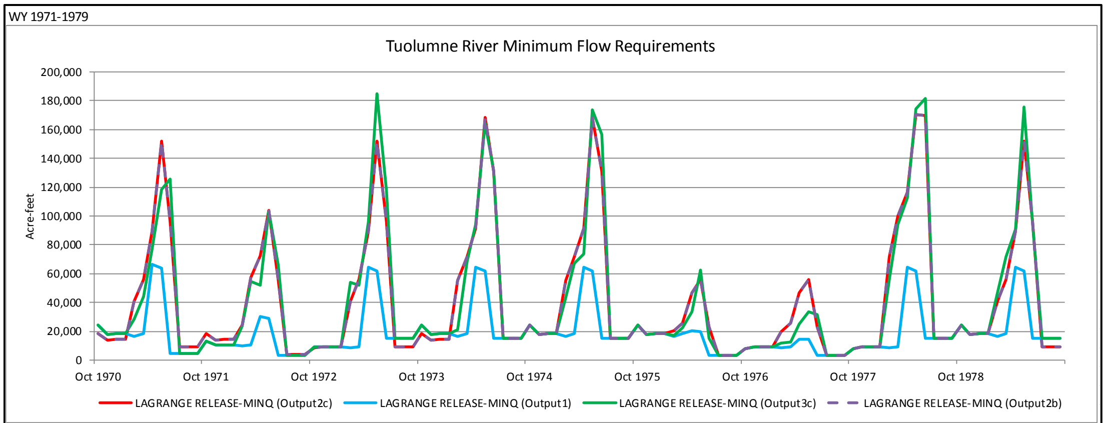


The same tables and graphics are provided for each of the three other parameters. Additionally, standardized graphics are provided for a columnar comparison of Table 1 and Table 2 values. An example of those graphics is shown below, with the column(s) of interest defined by the Table 1-specific and Table 2-specific entries.

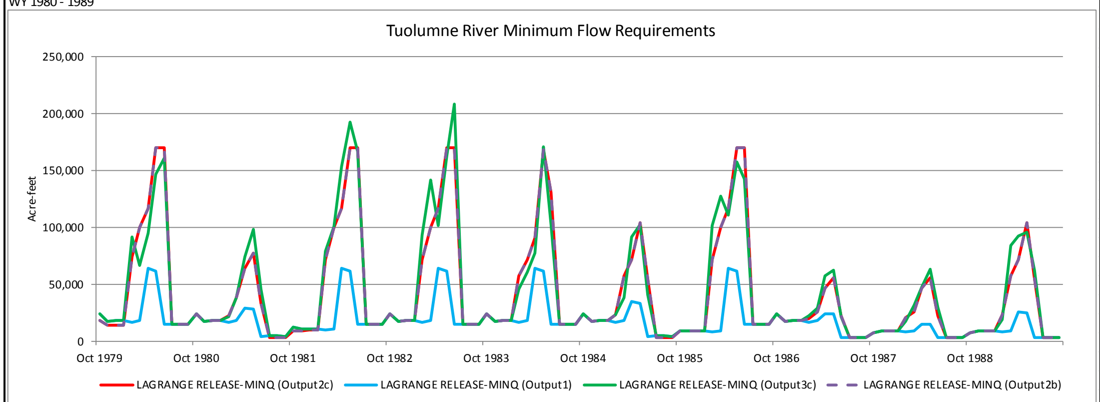


A standardized graphic comparison of Table 1, Table 2, Table 3 and Table 4 form monthly data is also provided. The four-way comparison graphs are shown below.

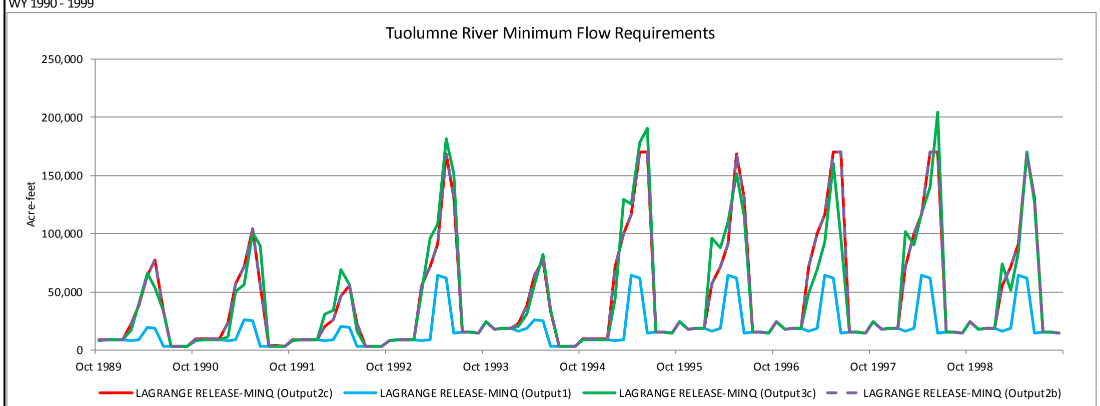
WY 1971-1979



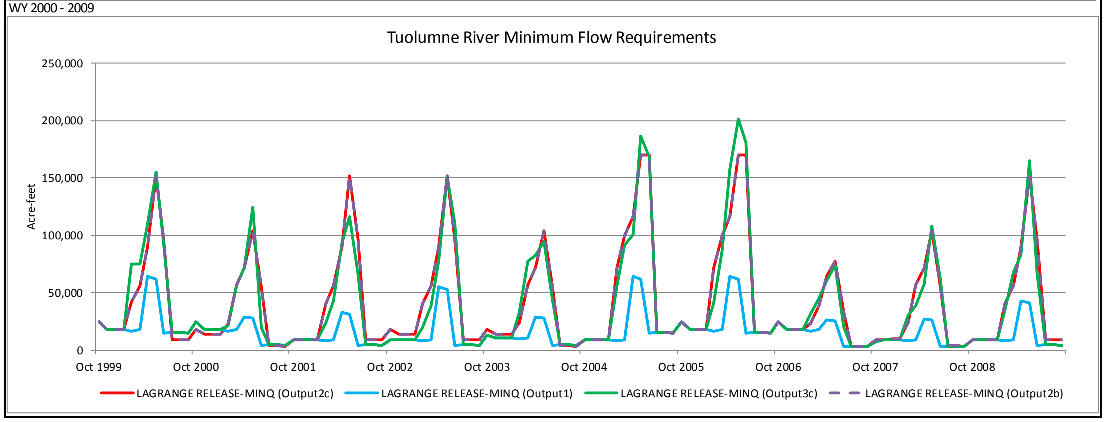
WY 1980 - 1989



WY 1990 - 1999



WY 2000 - 2009



5.7 XXGroup Worksheets

These worksheets provide graphical display of a single calendar year of operation for several model components. The model components represent groupings of physical features of the Tuolumne River system that make up logical components of operation. The model components are:

<u>Don Pedro Reservoir, the Distircts' facilities, and the Lower Tuolumne River</u>
Modeled with computational worksheet DonPedro and displayed by worksheet DPGroup

<u>Hetch Hetchy Reservoir, the San Joaquin Pipeline and downstream releases</u>
Modeled with computational worksheet SFHetchHetchy and displayed by worksheet HHGroup

<u>Lake Lloyd, Holm Powerhouse and its downstream releases</u>
Modeled with computational worksheet SFLloyd and displayed by worksheet LloydGroup

<u>Lake Eleanor, the Eleanor-Cherry Tunnel and its downstream releases</u>
Modeled with computational worksheet SFEleanor and displayed by worksheet ELGroup

<u>CCSF Water Bank and Supplemental Releases</u>
Modeled with computational worksheet SFWaterBank and displayed by worksheet WBGroup

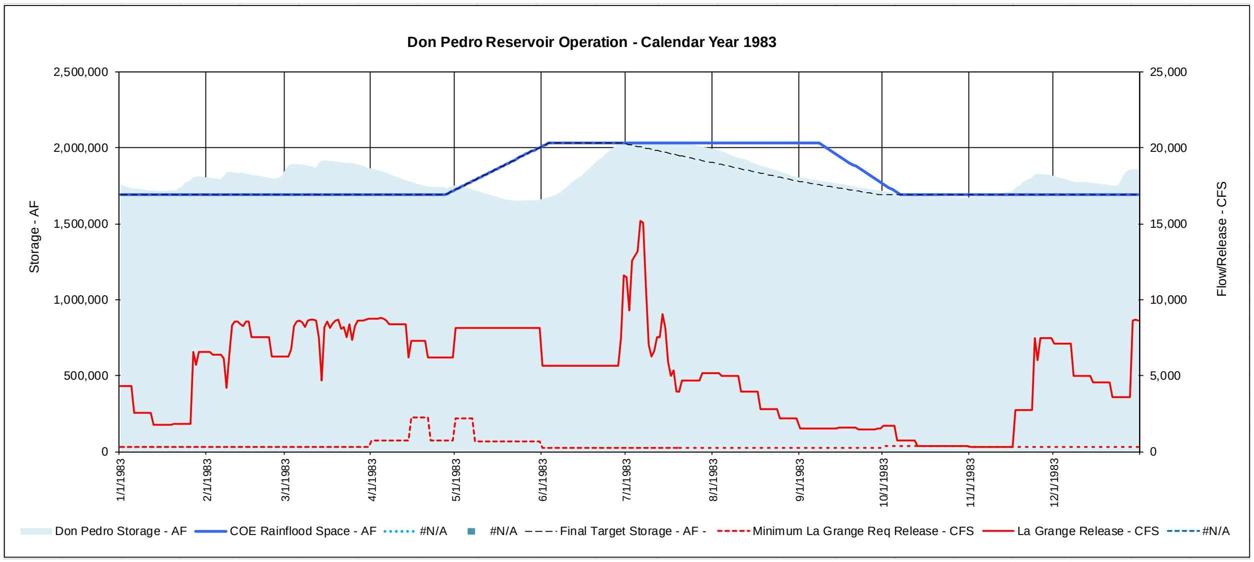
<u>CCSF System Storage</u> displayed by worksheet SFSysGroup.

Both the Districts' and CCSF's operations are additionally displayed for the 1986 through 1994 period by worksheets DPGroup86_94 and SFGroup86_94.

These component-specific display worksheets provide plotting of numerous parameters provided in the computation worksheets. One calendar year (the same year) of data for all parameters can be plotted. These display worksheets are similar to worksheet DSSAnyGroup except they rely upon the data being computed by the current study within the computational worksheets. A comparison between the same parameter from two different studies is not possible. Those comparisons are intended to be made through the worksheet Output and its tools. The parameter(s) to be plotted are identified by reference worksheet name and column. A snapshot of the identification parameters and result values is shown below for worksheet DPGroup.

	A	B	C	D	E	F	G	H
1	**DPGroup**							
2	This sheet illustrates a CY of daily results for Don Pedro operations in graphic format.							
3	Axis Reference	1	1	2	2	2	2	2
4	Enter CY Graph Year:	1983	1983	1983	1983	1983	1983	1983
5	Enter Sheet Name:	DonPedro	DonPedro	DonPedro	DonPedro	DonPedro	DonPedro	DonPedro
6	Column:	28	72	5	7	13	15	70
7	Enter Column:	AB	BT	E	G	M	O	BR
8	Data Reference:	COE Rainflood Space - AF	Don Pedro Storage - AF	Reservoir Inflow - CFS	Minimum La Grange Req Release - CFS	MID Canal - CFS	TID Canal - CFS	La Grange Release - CFS
9	Enter Scaler:	1	1	1	1	1	1	1
10	1-Jan-83	1,690,000	1,752,672	2,688	300	70	98	4,301
11	2-Jan-83	1,690,000	1,748,069	2,138	300	70	98	4,301
12	3-Jan-83	1,690,000	1,742,799	1,801	300	70	98	4,301
13	4-Jan-83	1,690,000	1,737,746	1,911	300	70	98	4,301
14	5-Jan-83	1,690,000	1,732,665	1,897	300	70	98	4,301
15	6-Jan-83	1,690,000	1,730,261	1,501	300	70	98	2,555
16	7-Jan-83	1,690,000	1,728,957	2,055	300	70	98	2,555
17	8-Jan-83	1,690,000	1,726,043	1,244	300	70	98	2,555
18	9-Jan-83	1,690,000	1,724,497	1,933	300	70	98	2,555

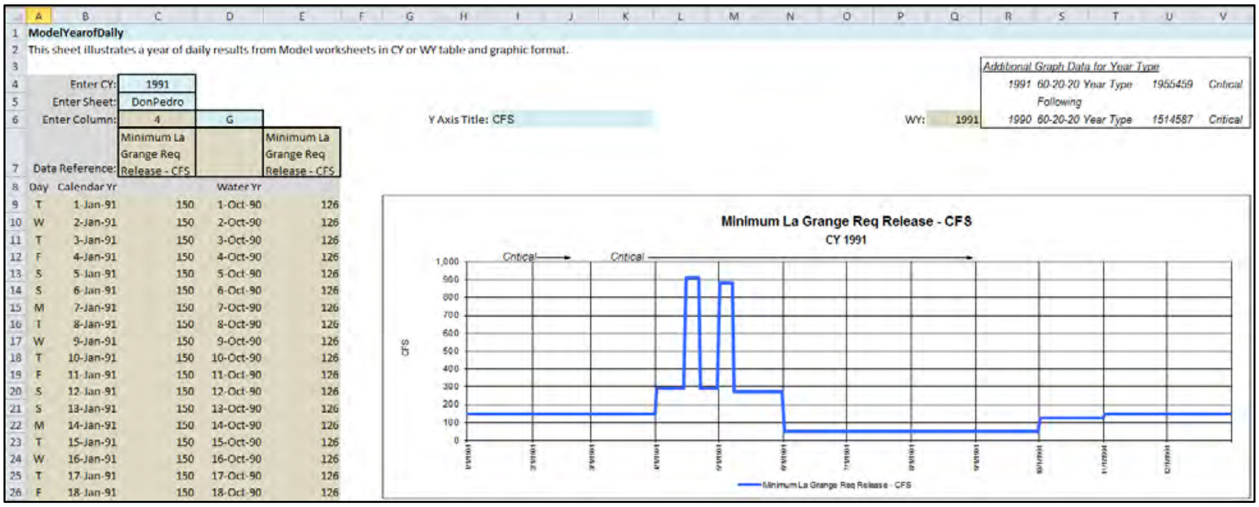
Values are plotted to either the primary y-axis or secondary y-axis. The “axis reference” indicates to which axis the value will be plotted by default. The designation of y-axis assignment is not modified by this field, and the user must edit the series data within the plot to change the y-axis assignment, graph type or line or shape characteristics. The “enter graph year” is a user entry. The same year or different year of a parameter or multiple parameters can be plotted. “Sheet name” is a user entry, and identifies from which Output-formatted worksheet the parameter is to be acquired. The “enter column” entry identifies from which column the parameter occurs. Upon proper entry of a parameter a return of the parameter’s label and source worksheet will occur in the “data reference” field. Values for the specified calendar year will also be returned in the data field. If a plotting position is not used, a “#VALUE” or “#REF” will be returned. The “scaler” field is provided to allow the conversion or scaling of the data returned from the result worksheet. For instance, if the daily data occurs in the result worksheet in units of daily average flow (cfs) it could be plotted in units of daily volume (acre-feet) by entering the conversion factor of 1.983471. The entry in the field acts as a multiplier to the value occurring in the result worksheet. This field can also be used to scale two different “order of magnitude” parameters to use the same y-axis. An example of the several plotted parameters from an active scenario study is shown below.



Unused plotting positions will appear with values plotted at “zero” and will have legends of “#VALUE!”, “#REF!” or “#N/A”. To create graphs without unused positions a copy of the plot can be made and positioned elsewhere in the worksheet. The unwanted positions can then be deleted from the plot.

5.8 ModelYearofDaily Worksheet

This worksheet (ModelYearofDaily) provides graphical and table display of the daily result for a single calendar or water year for any parameter within a Model component worksheet (e.g., worksheet DonPedro). A snapshot of the data entry interface and a sample of graphical display are shown below.



The calendar year, Model worksheet, and column of interest are entered by the user. The result data are plotted by calendar year and water year. The result data are also tabled by calendar year (shown below) and water year.

Minimum La Grange Req Release - CFS												
CY 1991	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	150	150	150	289	886	50	50	50	50	126	150	150
2	150	150	150	289	886	50	50	50	50	126	150	150
3	150	150	150	289	886	50	50	50	50	126	150	150
4	150	150	150	289	886	50	50	50	50	126	150	150
5	150	150	150	289	886	50	50	50	50	126	150	150
6	150	150	150	289	886	50	50	50	50	126	150	150
7	150	150	150	289	886	50	50	50	50	126	150	150
8	150	150	150	289	269	50	50	50	50	126	150	150
9	150	150	150	289	269	50	50	50	50	126	150	150
10	150	150	150	289	269	50	50	50	50	126	150	150
11	150	150	150	289	269	50	50	50	50	126	150	150
12	150	150	150	289	269	50	50	50	50	126	150	150
13	150	150	150	289	269	50	50	50	50	126	150	150
14	150	150	150	289	269	50	50	50	50	126	150	150
15	150	150	150	913	269	50	50	50	50	126	150	150
16	150	150	150	913	269	50	50	50	50	126	150	150
17	150	150	150	913	269	50	50	50	50	126	150	150
18	150	150	150	913	269	50	50	50	50	126	150	150
19	150	150	150	913	269	50	50	50	50	126	150	150
20	150	150	150	913	269	50	50	50	50	126	150	150
21	150	150	150	913	269	50	50	50	50	126	150	150
22	150	150	150	289	269	50	50	50	50	126	150	150
23	150	150	150	289	269	50	50	50	50	126	150	150
24	150	150	150	289	269	50	50	50	50	126	150	150
25	150	150	150	289	269	50	50	50	50	126	150	150
26	150	150	150	289	269	50	50	50	50	126	150	150
27	150	150	150	289	269	50	50	50	50	126	150	150
28	150	150	150	289	269	50	50	50	50	126	150	150
29	150	---	150	289	269	50	50	50	50	126	150	150
30	150	---	150	289	269	50	50	50	50	126	150	150
31	150	---	150	---	269	---	50	50	---	126	---	150
Ave	150	150	150	435	408	50	50	50	50	126	150	150
AF	9,223	8,331	9,223	25,871	25,109	2,975	3,074	3,074	2,975	7,736	8,926	9,223
Annual	115,742 AF		160 Ave CFS									

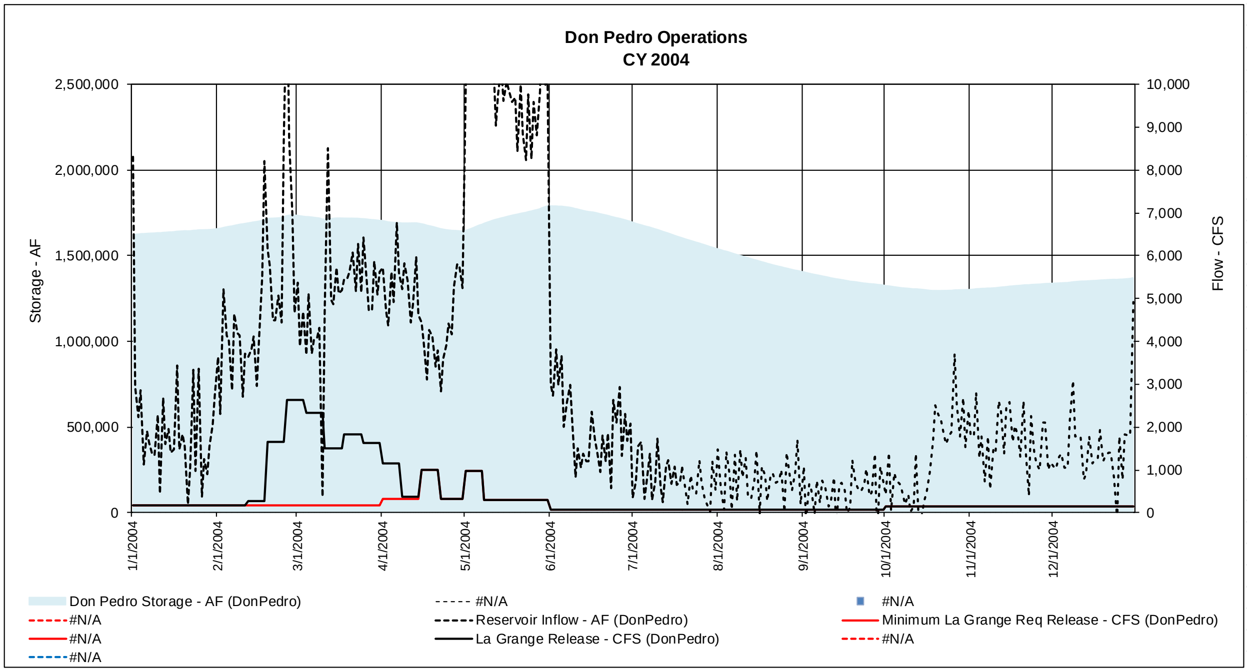
5.9 ModelAnyGroup Worksheet

This worksheet (ModelAnyGroup) provides plotting of up to ten parameters provided in any Model component worksheet (e.g., worksheet DonPedro). One calendar year (the same year or different years) of data for a parameter can be plotted. The parameter(s) to be plotted are identified by reference worksheet name and column. A snapshot of the identification parameters and result values is shown below. This worksheet performs the same function as the DSSAnyGroup worksheet except the source of its data are the Model component worksheets instead of DSS interface worksheets.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**ModelAnyGroup**													
2	This sheet illustrates a CY of daily results from Model worksheets in graphic format.													
3	Axis Reference	1		1		2		2		2		2		1
4	Enter CY Graph Year:	2004		2004		2004		2004		2004		2004		2004
5	Enter Sheet Name:	DonPedro		DonPedro		DonPedro		DonPedro		DonPedro		DonPedro		DonPedro
6	Column:	#N/A		72		6		7		#N/A		70		#N/A
7	Enter Column:			BT		F		G				BR		
8	Data Reference:	#N/A	Date	Don Pedro Storage - AF (DonPedro)	Date	Reservoir Inflow - AF (DonPedro)	Date	La Grange Req Release - CFS	Date	#N/A	Date	La Grange Release - CFS (DonPedro)	Date	#N/A
9	Enter Scaler:	1		1		1		1		1		1		1
10	1-Jan-04	#N/A	1-Jan-04	1,622,829	1-Jan-04	8,300	1-Jan-04	175	1-Jan-04	#N/A	1-Jan-04	175	1-Jan-04	#N/A
11	2-Jan-04	#N/A	2-Jan-04	1,625,102	2-Jan-04	2,934	2-Jan-04	175	2-Jan-04	#N/A	2-Jan-04	175	2-Jan-04	#N/A
12	3-Jan-04	#N/A	3-Jan-04	1,626,670	3-Jan-04	2,229	3-Jan-04	175	3-Jan-04	#N/A	3-Jan-04	175	3-Jan-04	#N/A
13	4-Jan-04	#N/A	4-Jan-04	1,628,860	4-Jan-04	2,850	4-Jan-04	175	4-Jan-04	#N/A	4-Jan-04	175	4-Jan-04	#N/A
14	5-Jan-04	#N/A	5-Jan-04	1,629,314	5-Jan-04	1,115	5-Jan-04	175	5-Jan-04	#N/A	5-Jan-04	175	5-Jan-04	#N/A
15	6-Jan-04	#N/A	6-Jan-04	1,630,546	6-Jan-04	1,892	6-Jan-04	175	6-Jan-04	#N/A	6-Jan-04	175	6-Jan-04	#N/A
16	7-Jan-04	#N/A	7-Jan-04	1,631,507	7-Jan-04	1,621	7-Jan-04	175	7-Jan-04	#N/A	7-Jan-04	175	7-Jan-04	#N/A
17	8-Jan-04	#N/A	8-Jan-04	1,632,196	8-Jan-04	1,349	8-Jan-04	175	8-Jan-04	#N/A	8-Jan-04	175	8-Jan-04	#N/A
18	9-Jan-04	#N/A	9-Jan-04	1,632,895	9-Jan-04	1,359	9-Jan-04	175	9-Jan-04	#N/A	9-Jan-04	175	9-Jan-04	#N/A
19	10-Jan-04	#N/A	10-Jan-04	1,634,514	10-Jan-04	2,279	10-Jan-04	175	10-Jan-04	#N/A	10-Jan-04	175	10-Jan-04	#N/A
20	11-Jan-04	#N/A	11-Jan-04	1,634,300	11-Jan-04	446	11-Jan-04	175	11-Jan-04	#N/A	11-Jan-04	175	11-Jan-04	#N/A
21	12-Jan-04	#N/A	12-Jan-04	1,636,320	12-Jan-04	2,680	12-Jan-04	175	12-Jan-04	#N/A	12-Jan-04	175	12-Jan-04	#N/A
22	13-Jan-04	#N/A	13-Jan-04	1,637,275	13-Jan-04	1,615	13-Jan-04	175	13-Jan-04	#N/A	13-Jan-04	175	13-Jan-04	#N/A
23	14-Jan-04	#N/A	14-Jan-04	1,638,581	14-Jan-04	1,967	14-Jan-04	175	14-Jan-04	#N/A	14-Jan-04	175	14-Jan-04	#N/A
24	15-Jan-04	#N/A	15-Jan-04	1,639,327	15-Jan-04	1,406	15-Jan-04	175	15-Jan-04	#N/A	15-Jan-04	175	15-Jan-04	#N/A
25	16-Jan-04	#N/A	16-Jan-04	1,640,134	16-Jan-04	1,466	16-Jan-04	175	16-Jan-04	#N/A	16-Jan-04	175	16-Jan-04	#N/A

Values are plotted to either the primary y-axis or secondary y-axis. The “axis reference” indicates to which axis the value will be plotted by default. The designation of y-axis assignment is not modified by this field, and the user must edit the series data within the plot to change the y-axis assignment, graph type or line or shape characteristics. The “enter CY graph year” is a user entry. The same year or different year of a parameter or multiple parameters can be plotted. “Sheet name” is a user entry, and identifies from which Model component worksheet the parameter is to be acquired. The “enter column” entry identifies from which column the parameter occurs. Upon proper entry of a parameter a return of the parameter’s label and source worksheet will occur in the “data reference” field. Values for the specified calendar year will also be returned in the data field. If a plotting position is not used, a “#VALUE!” or “#REF!” will be returned. The “scaler” field is provided to allow the conversion or scaling of the data returned from the result worksheet. For instance, if the daily data occurs in the result worksheet in units of daily average flow (cfs) it could be plotted in units of daily volume (acre-feet) by entering the conversion factor of 1.983471. The entry in the field acts as a multiplier to the value occurring in the result worksheet. This field can also be used to scale two different “order of magnitude” parameters to use the same y-axis.

The results of up to ten parameters will be plotted. An example of the several plotted parameters from an active scenario is shown below.



Unused plotting positions will appear with values plotted at “zero” and will have legends of “#VALUE!” or “#REF!”. To create graphs without unused positions a copy of the plot can be made and positioned elsewhere in the worksheet. The unwanted positions can then be deleted from the plot.

5.10 ModelMonthTable Worksheet

This worksheet (ModelMonthTable) provides summation or averaging, and plotting of up to four parameters provided in Model component worksheets (e.g., DonPedro worksheet). The function of this worksheet is to provide a synthesis of the daily result data into monthly results thus reducing the handling and display of over 14,000 values for each parameter (39 years of days) to 468 values (39 years of months). This worksheet and its functionality are identical to the DSSMonthTable worksheet except the source of its data are the Model component worksheets instead of DSS interface worksheets.

The parameter(s) to be plotted or tabled are identified by reference worksheet name and column, very similarly to the method identified for the ModelAnyGroup worksheet. A snapshot of the identification parameters and result values is shown below.

5				Conversion Key:			
6				0	1 >> 1	Native	1
7				1	CFS >> AF	AF	1.9834700
8				2	AF >> CFS	CFS	0.5041669
9				3	CFS >> TAF	TAF	0.0019835
10				4	EOM Stor	AF	1
11				5	Ave Day	Native	1
12			Enter Conversion (0-5):	4	1	1	1
13			Enter Sheet Name:	DonPedro	DonPedro	DonPedro	DonPedro
14			Enter Column Letter:	BT	F	BR	G
15			Column No:	72	6	70	7
16			Label:	ro Storage	oir Inflow (	ge Release	ange Req F
17			Native Unit:	AF	AF	CFS	CFS
18			Convert Unit:	AF	AF	AF	AF
19	Index	Date	Day	1	1	1	1
20	1970.10	10/1/1970	T	1,666,767	1,268	787	787
21	1970.10	10/2/1970	F	1,664,567	1,783	787	787
22	1970.10	10/3/1970	S	1,662,719	2,130	787	787
23	1970.10	10/4/1970	S	1,659,892	2,460	787	787
24	1970.10	10/5/1970	M	1,656,745	296	787	787
25	1970.10	10/6/1970	T	1,654,119	1,870	787	787

Each parameter is tabled and plotted separately for the entire 39-year simulation period. “Sheet name” is a user entry, and identifies from which Model component worksheet the parameter is to be acquired. The “enter column letter” entry identifies from which column the parameter occurs. Upon proper entry of a parameter a return of the parameter’s label, source worksheet and the native unit of the parameter will occur. Depending on need, the “conversion” entry is provided. This entry, a keyed value of 0 to 5, directs the worksheet on the handling of the daily data. An entry of 1 will direct the worksheet to sum the daily data into monthly increments in the parameter’s native units (e.g., daily acre-feet into monthly volumes). An entry of 1 will convert the daily data from a native unit of flow (cfs) into monthly volumes of acre-feet. An entry of 2 will convert the daily data from a native unit of volume (acre-feet) into a monthly sum of daily flow in units of cfs. An entry of 3 will act as an entry of 1 except convert the result into monthly volumes with units of 1,000 acre-feet. An entry of 4 will table and plot the daily value associated with the last day of each month in its native unit, and is primarily intended to analyze reservoir storage. An entry of 5 will report the average of daily values within a month. Depending on the entry in the conversion field, the converted unit will be returned to “converted unit” field. Values for the each month of the simulation period will also be returned in the data field. If a plotting position is not used, a “#VALUE!” or “#REF!” will be returned.

A “scaler” field is also provided for each parameter (in the row above the data fields) to allow the conversion or scaling of the data returned from the result worksheet.

The results of up to four parameters will be tabled and plotted. The content formats of reports are identified below. Refer to section 5.5 DSSMonthTable for illustrations of each format.

Standardized Tables

- Data synthesized into monthly volumes for the simulation period.
- Chronological annual values and associated monthly values are also grouped by water type, in descending order of annual runoff.

Standardized Graphs

- Graphs providing a trace of the monthly sequence of data developed for the standardized chronological table.
- Graphs depicting a particular column of data from the water year-based standardized table.
- Graphs for the same information displayed rank-ordered according to descending runoff.
- Standardized graphics are provided for a columnar comparison of the four parameters.

5.11 DonPedro Worksheet

This Model component worksheet (DonPedro) simulates the operation of Don Pedro Reservoir. Several sections of logic provide a systematic operation of the reservoir based on inflow and forecasted hydrology and water demands. As described earlier, the Model will direct releases from the Don Pedro Project under a “hold-unless-need-to-release” protocol, except as conditioned by minimum release requirements, diversions, preferred/maximum storage, and snowmelt management releases. The several sections of logic are illustrate and discussed below.

Don Pedro Release Demands

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1			1		Don Pedro Model																			
2	Unit Title		2		CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF					CFS	AF
3	Parameter Title		3		DP Reserv	DP Reserv	Minimum L	Minimum	MID Full D	MID Full D	TID Full Di	TID Full Di	MID Canal	MID Canal	TID Canal	TID Canal	Total Cana	Total Canals					Total Rese	Total Rese
4																								
5	Acre-foot to CFS conversion				This Scenario													Difference from Base						
6	divide by	1.983471			Check Sums		Sum AF	39-ave		Other	39-ave			39-ave	39-ave				39-yr Ave	39-yr Ave				
7						Inflow	65,915,187	1,690,133		MID Canal	284,177		Inflow	1,690,133	284,177	MID Canal		Inflow	0	0	MID Canal			
8						Evap	1,740,362	44,625		TID Canal	559,697		Evap	44,625	559,697	TID Canal		Evap	0	0	TID Canal			
9						River	31,532,459	808,525					River	808,525				River	0					
10						Canals	32,911,098	843,874		Minimum River	213,897		Canals	843,874	213,897	Minimum River		Canals	0	0	Minimum River			
11						Net	-268,732																	
12						Chng Stor	-268,732																	
13		39-year Ave or Max											1,257	284,177	2,404	559,697		843,874		16,777		41,518		1,057,771
14				Min						Using WSF = 1.000 All Years			41		1									
15					Inflow		La Grange Require		Existing Level Full Diversion Demand				Scenario Canal Diversions						Diversion Shortage from Full Demand				Total DP Demands	
16										300,954		601,215											Total	Total
17	Month				Reservoir	Reservoir	Minimum	Minimum	MID	MID	TID	TID	MID	MID	TID	TID	Total	Total	MID	MID	TID	TID	Res Rel	Res Rel
18	Index	Date	Day	Days	Inflow	Inflow	Req	Req	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canals	Canals	Canal	Canal	Canal	Canal	Demands	Demands
19					CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF
20	1970.10	10/1/1970	T	31	322	639	397	787	531	1,053	1,406	2,789	531	1,053	1,406	2,789	1,937	3,842	0	0	0	0	2,334	4,629
21	1970.10	10/2/1970	F	31	453	899	397	787	434	860	661	1,311	434	860	661	1,311	1,094	2,171	0	0	0	0	1,491	2,958
22	1970.10	10/3/1970	S	31	541	1,074	397	787	424	840	582	1,154	424	840	582	1,154	1,006	1,994	0	0	0	0	1,402	2,781
23	1970.10	10/4/1970	S	31	625	1,240	397	787	463	918	1,119	2,220	463	918	1,119	2,220	1,582	3,139	0	0	0	0	1,979	3,926
24	1970.10	10/5/1970	M	31	75	149	397	787	461	915	733	1,453	461	915	733	1,453	1,194	2,368	0	0	0	0	1,591	3,155
25	1970.10	10/6/1970	T	31	475	943	397	787	491	973	841	1,668	491	973	841	1,668	1,332	2,641	0	0	0	0	1,728	3,428

This section of logic assembles the underlying water demands placed for Don Pedro Reservoir releases. Reservoir inflow is derived from other Model component worksheets and is the sum of unregulated inflow to Don Pedro Reservoir (Hydrology worksheet) and regulated releases from the CCSF System (SFHetchHetchy worksheet, SFLLoyd worksheet and SFEleanor worksheet). The minimum flow requirement for the Tuolumne River is provided by worksheet LaGrangeSchedule as directed by worksheet UserInput. The “Existing Level Full Diversion Demand” is a projection of canal diversion requirements if no water supply shortages occurred and full demands are provided. “Scenario Canal Diversion Demand” is the canal diversions of MID and TID for the active scenario. These diversions are determined by either pre-processed computations of diversions (e.g, fixed Test Case diversions), user specified diversions, or dynamic computations. “Total DP Demands” are the summation of minimum release requirements for the river and canal diversions. Other information is developed in this section concerning the difference between scenario diversions and full diversion demand, and an overall summary of water disposition for the entire simulation period.

Reservoir Evaporation / Initial Storage Computation and Encroachment Release

This section performs an initial check of reservoir storage assuming the previously described minimum releases for the river and canals. A daily mass balance is performed: *change in reservoir storage = inflow, minus outflow (releases), minus reservoir losses*. The prior day’s reservoir evaporation is included in the calculation. If the computation produces resulting Don Pedro Reservoir storage in excess (encroachment) of the preferred storage target, the encroachment is computed. Every 7th day the model checks for an encroachment, and if it exists a check release is computed. It is assumed that a constant supplemental release (in excess of minimum releases) will be initiated at a rate equal to the encroachment divided equally over the next 10 days. This protocol repeats itself every 7th day,

reestablishing the level of check release each time. The end result of this procedure will allow encroachment of storage space above the preferred storage target and not require unrealistic hard releases of water to exactly conform to the target.

	A	B	C	D	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1			1											
2	*Unit Title*		2					AF						
3	*Parameter Title*		3		rvoir Release Demands			COE Rainfl	Final Target Storage - AF					
4														
5	*Acre-foot to CFS conversion*													
6	*divide by :*	*1.983471*												
7														
8														
9														
10														
11														
12														
13		*39-year Ave or Max*												
14				*Min*										
15						Evap/loss	Initial Storage Computation and Encroachment Release							
16							Initial	COE				Spread	Spread	
17	Month					Net Res	DP	Rainflood	Target	Initial	Encroach	Encroach	7th Day	
18	Index	Date	Day	Days		Evap/Loss	Storage	Target	Stroage	Encroach	7th Day	10 days	10 days	7-day
19						AF	1,670,900	AF	AF	AF	AF	AF	CFS	Count
20	1970.10	10/1/1970	T	31		143	1,666,767	1,760,900	1,690,000	0	0	0	0	1
21	1970.10	10/2/1970	F	31		141	1,664,567	1,749,200	1,690,000	0	0	0	0	0
22	1970.10	10/3/1970	S	31		141	1,662,719	1,737,500	1,690,000	0	0	0	0	0
23	1970.10	10/4/1970	S	31		141	1,659,892	1,725,800	1,690,000	0	0	0	0	0
24	1970.10	10/5/1970	M	31		141	1,656,745	1,714,100	1,690,000	0	0	0	0	0
25	1970.10	10/6/1970	T	31		141	1,654,119	1,702,400	1,690,000	0	0	0	0	0

Snow-melt Management

	A	B	C	D	AK	AL	AM	AN	AO	AP	AQ
1			1								
2	*Unit Title*		2								
3	*Parameter Title*		3								
4											
5	*Acre-foot to CFS conversion*										
6	*divide by :*	*1.983471*			*Lookup of*	*Est of*	*Uses*	*Compute*	*Compute*	*Compute*	*Amount*
7					*1-Apr*	*Apr-Jun*	*Current Yr*	*Upstream*	*Availble*	*Total*	*to be*
8					*90% Exc*	*Portion*	*Canal +*	*Adjust*	*DP Stor*	*Excess*	*Released*
9					*Apr-Jul*	*of*	*Min River*	*to*	*through*	*Apr-Jun*	*during*
10					*Runoff*	*Apr-Jul*	*+Typ Evap*	*UF*	*June*	*Release*	*April*
11											
12					*23*	*% Apr/Apr AJ*					
13		*39-year Ave or Max*			*35*	*% May/Apr AJ*					*(C 1.10)*
14				*Min*	*29*	*% Jun/Apr AJ*			*% of Apr-Jun excess rel in April*		30
15					April Snow-melt Release Routine						
16								April			
17	Month				1-Apr	1-Apr	A-Jun	A-Jun	A-Jun	A-Jun	April
18	Index	Date	Day	Days	A-Jul Fcst	A-Jun Fcst	Can+Riv+E	USAdj	DP Avail	Excess	SM Rel
19					AF	AF	AF	AF	AF	AF	CFS
20	1970.10	10/1/1970	T	31	0	0	0	0	0	0	0
21	1970.10	10/2/1970	F	31	0	0	0	0	0	0	0
22	1970.10	10/3/1970	S	31	0	0	0	0	0	0	0
23	1970.10	10/4/1970	S	31	0	0	0	0	0	0	0
24	1970.10	10/5/1970	M	31	0	0	0	0	0	0	0
25	1970.10	10/6/1970	T	31	0	0	0	0	0	0	0

	AS	AT	AU	AV	AW	AX	AY
6	*Lookup of*	*Est of*	*Uses*	*Compute*	*Compute*	*Compute*	*Amount*
7	*1-May*	*May-Jun*	*Current Yr*	*Upstream*	*Availble*	*Total*	*to be*
8	*90% Exc*	*Portion*	*Canal +*	*Adjust*	*DP Stor*	*Excess*	*Released*
9	*Apr-Jul*	*of*	*Min River*	*to*	*through*	*May-Jun*	*during*
10	*Runoff*	*Apr-Jul*	*+Typ Evap*	*UF*	*June*	*Release*	*May*
13	*49*	*% May/May MJ*					*(C 1.20)*
14	*38*	*% Jun/May MJ*		*% of May-Jun excess rel in May*			50
15	May Snow-melt Release Routine						
16				May			
17	1-May	1-May	M-Jun	M-Jun	M-Jun	M-Jun	May
18	A-Jul Fcst	MJune Fcst	Can+Riv+E	USAdj	DP Avail	Excess	SM Rel
19	AF	AF	AF	AF	AF	AF	CFS
20	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0

	BA	BB	BC	BD	BE	BF	BG	BI
2								CFS
3								Target SM
6	*Lookup of*	*Est of*	*Uses*	*Compute*	*Compute*	*Compute*	*Amount*	
7	*Actual*	*June*	*Current Yr*	*Upstream*	*Availble*	*Total*	*to be*	
8	*June*	*Portion*	*Canal +*	*Adjust*	*DP Stor*	*Excess*	*Released*	
9	*Runoff*	*of*	*Min River*	*to*	*through*	*Jun*	*during*	
10		*June*	*+Typ Evap*	*UF*	*June*	*Release*	*June*	
13							*(C 1.30)*	
14					*% of June excess rel in June*		100	
15	June Snow-melt Release Routine							
16				June				Target
17	1-Jun	1-Jun	June	June	June	June	June	SM
18	June UF	June Fcst	Can+Riv+E	USAdj	DP Avail	Excess	SM Rel	Release
19	AF	AF	AF	AF	AF	AF	CFS	CFS
20	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0

A second check release is made during the April through June period for management of anticipated snowmelt runoff. On the first day of each of these months a forecast is made of anticipated runoff into the reservoir and minimum releases and losses from the reservoir from the date of forecast through the end of June (the assumed target date of reservoir filling). These forecasts determine the volume of water (if any) that will require release in excess of minimum releases and losses and storage gain by the end of June. For April and May, the DWR 90 percent exceedence forecast is used for anticipated runoff, along with known minimum releases and losses, and upstream impairment. The user defines the percentage of volume (of the total volume) to be additionally released during each month. For April, 30 percent of the 3-month volume is advised for release, and during May 50 percent of the 2-month volume is advised for released. For June, the historically reported UF flow is assumed for the runoff computation. This assumes pre-knowledge of the runoff volume for the month, and 100 percent of the excess is spread across the month. The snowmelt check release is evenly distributed across the days of the month. The release made in a day is the greater of the two check releases or the minimum release. At no time is the maximum capacity of the reservoir (2,030,000 acre-feet) allowed to be exceeded, and if necessary a release, regardless of magnitude, will be made by the model to not exceed maximum storage capacity.

Modesto Flood Control Objective, Don Pedro Reservoir, and Tuolumne River Release

A	B	C	D	BK	BL	BM	BN	BO	BQ	BR	BS	BT	BU	BV	BW	BX	BY
Unit Title		2		CFS	CFS	CFS	CFS	CFS	AF	CFS		AF		Acres			AF
Parameter Title		3		Re Dry Creek	LTR Accr	Tot Unreg	Trg Max LC	Modesto Flo	La Grange	La Grange Release		Don Pedro Storage		DP Surface Area			DP Total E
Acre-foot to CFS conversion																	
divide by :	1.983471																
	39-year Ave or Max						(C 1.00)		808,525			508,489	Min 1976-77				44,626
	Min			Enter Modesto FC Target:			9,000	CFS				785,605	Min 1987-92				
				Modesto Flood Control Flow Objective					Final La Grange River		Don Pedro Reservoir						
														Net Don Pedro Loss Calculation			
Month Index	Date	Day	Days	Report Dry Creek Flow CFS	Est LTR Acc Flow CFS	Total Unreg Blw LG CFS	Target Max LaGrange CFS	Calc Modesto Flow CFS	Final La Grange Release AF	Final La Grange Release CFS	DP Storage Change AF	DP Storage 1,670,900	Encroach above 2,030,000	Area 11,156	Factor	CFS	AF
1970.10	10/1/1970	T	31	30	99	129	8,871	526	787	397	-4,133	1,666,767	0	11,139	0.006395	71.2	141.3
1970.10	10/2/1970	F	31	30	99	129	8,871	526	787	397	-2,200	1,664,567	0	11,127	0.006395	71.2	141.1
1970.10	10/3/1970	S	31	30	99	129	8,871	526	787	397	-1,849	1,662,719	0	11,116	0.006395	71.1	141.0
1970.10	10/4/1970	S	31	30	100	130	8,870	526	787	397	-2,826	1,659,892	0	11,099	0.006395	71.0	140.8
1970.10	10/5/1970	M	31	30	100	130	8,870	527	787	397	-3,147	1,656,745	0	11,082	0.006395	70.9	140.6
1970.10	10/6/1970	T	31	30	100	130	8,870	527	787	397	-2,626	1,654,119	0	11,071	0.006395	70.8	140.4

A Modesto flood control objective is incorporated into the release logic. The objective is to maintain a flow at Modesto no greater than a user-specified flow rate (assumed as 9,000 cfs). The logic checks against an allowable river release that would not exceed the flood control objective after considering the lower Tuolumne River accretions and Dry Creek flow. Logic is applied to the previous check releases in comparison to the allowable release. The La Grange release is then reduced if necessary to not exceed the Modesto flow target objective, even if it results in an encroachment in Don Pedro Reservoir. The exception is when the reservoir reaches full (2,030,000 AF). Any computed encroachment above a full reservoir is passed and the Modesto flow objective will be exceeded.

The several advised releases, storage conditions and water demands all culminate in determining the "Final La Grange River" release. The "Don Pedro Reservoir" section of logic reports the final reservoir storage of a day and the computation of Don Pedro Reservoir losses. Reservoir losses are computed in accordance with procedures of the Fourth Agreement.

Don Pedro Project Generation, and River Flows

A	B	C	D	CA	CB	CC	CD	CE	CF	CG	CH	CJ	CK	CL	CM	CN	CO	CP
Unit Title		2				MW	kWh/AF	AF	AF	AF	MWh	CFS				CFS	CFS	
Parameter Title		3		vaporation		DP PH Cap	DP PH Eff	Total DP R	DP Power	DP Spill /	Don Pedro Er	La Grange Release				TR abv Mc	TR blw Dry Creek	
Acre-foot to CFS conversion																		
divide by	1.983471																	
									(C 1.22)									
					39-yr Ave	191	392	1,652,399	1,488,570	163,829	607,705							
	39-year Ave or Max				Max	198	440	154,471	10,711	143,760	4,710							
	Min				Min	127	258	410	410	0	106							
				Don Pedro Power Operations								River Flows						
Month Index	Date	Day	Days	Per Ave DPStor (for Eff) AF	Per Min DPStor (for Cap) AF	(C 1.20) 308,960 Capability MW	Efficiency kWh/AF	Total DP Release AF	Thru PH (cfs) 5,400 AF	Spill/ Bypass AF	Don Pedro Energy MWh	La Grange RM 51.8 CFS	Waterford RM 42.0 CFS	Hickman RM 31.0 CFS	Santa Fe RM 21.6 CFS	LTR abv Modesto RM 16.2 CFS	LTR blw Modesto RM CFS	Mouth RM 0.0 CFS
1970.10	10/1/1970	T	31	1,668,834	1,666,767	195	408	4,629	4,629	0	1,888	397				496	526	
1970.10	10/2/1970	F	31	1,665,667	1,664,567	195	408	2,958	2,958	0	1,205	397				496	526	
1970.10	10/3/1970	S	31	1,663,643	1,662,719	195	407	2,781	2,781	0	1,133	397				496	526	
1970.10	10/4/1970	S	31	1,661,305	1,659,892	195	407	3,926	3,926	0	1,598	397				496	526	
1970.10	10/5/1970	M	31	1,658,319	1,656,745	195	407	3,155	3,155	0	1,284	397				497	527	
1970.10	10/6/1970	T	31	1,655,432	1,654,119	195	407	3,428	3,428	0	1,394	397				497	527	

Based on the hydrologic operation of Don Pedro Reservoir in the Model, power characteristics of the scenario are computed. Equations of Don Pedro powerhouse generation characteristics define capacity (MW) and efficiency (kWh/AF), based on reservoir storage. Capacity potential uses minimum storage of

the day, while efficiency uses average storage of the day. The maximum water through plant is assumed to be 5,400 cfs. Water that does not appear as passing through the generators is computed to be “spilled-bypassed”. The power generation is “cutoff” at reservoir storage of 308,960 acre-feet, the top of the dead pool.

Flow in the river below La Grange diversion dam is computed and reported. The flow is a determined value by the Model. The same hydrologic information used within the Modesto flow objective logic is added to La Grange releases to estimate flow at downstream points in the river. Currently an estimate of total Tuolumne River accretion between La Grange Bridge and the confluence of Dry Creek is added to La Grange releases to provide an estimate of flow above the Dry Creek confluence. The estimated flow of Dry Creek is added to that estimate to provide an estimate of flow below the Dry Creek confluence at “Modesto”. Additional flow points can be added as information becomes available.

Don Pedro Inflow Components

	A	B	C	D	CT	CU	CV	CW	CX	CY	CZ	DA	DB	DC	DD
1			1												
2	*Unit Title*		2			AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS
3	*Parameter Title*		3			DP Inflow	DP Inflow	DP Inflow	DP Inflow	DP Inflow	DP Inflow	Unreg Infl	Unreg Infl	DP Inflow	DP Inflow
4															
5	*Acre-foot to CFS conversion*														
6	*divide by :*	*1.983471*				*Read*		*Read*		*Read*			*Read*		*Read by*
7						*from*		*from*		*from*			*from*		*Model*
8						*SFHetchHetchy*		*SFLloyd*		*SFEleanor*			*Hydrology*		
9						*incl*									
10						*Return of*									
11						*Moc Hatch*									
12															
13		*39-year Ave or Max*				*39-year average*									
14				*Min*		*525,724*		*378,296*		*102,781*		*683,332*		*1,690,133*	
15						Inflow to Don Pedro Reservoir									
16						Inflow	Inflow	Inflow	Inflow	Inflow	Inflow				
17	Month					from	from	from	from	from	from	Unreg	Unreg	DP	DP
18	Index	Date	Day	Days		HH	HH	Lloyd	Lloyd	Eleanor	Eleanor	Inflow	Inflow	Inflow	Inflow
19						AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS
20	1970.10	10/1/1970	T	31		179	90	443	223	20	10	-2	-1	639	322
21	1970.10	10/2/1970	F	31		179	90	443	223	20	10	258	130	899	453
22	1970.10	10/3/1970	S	31		179	90	443	223	20	10	433	218	1,074	541
23	1970.10	10/4/1970	S	31		179	90	443	223	20	10	599	302	1,240	625
24	1970.10	10/5/1970	M	31		179	90	443	223	20	10	-492	-248	149	75
25	1970.10	10/6/1970	T	31		179	90	443	223	20	10	302	152	943	475

This section of logic assembles the Don Pedro Reservoir inflow components from other Model component worksheets.

5.12 SFHetchHetchy Worksheet

This Model component worksheet (SFHetchHetchy) simulates the operation of Hetch Hetchy Reservoir. Several sections of logic provide a systematic operation of the reservoir based on inflow and forecasted hydrology and water demands. As described earlier, the Model will direct releases from Hetch Hetchy Reservoir under a "hold-unless-need-to-release" protocol, except as conditioned by minimum release requirements, diversions, preferred/maximum storage, and snowmelt management releases. The several sections of logic are illustrate and discussed below.

Hetch Hetchy Release Demands / Reservoir Evaporation / Initial Storage Computation and Encroachment Release

This section of logic assembles the underlying water demands placed for Hetchy Hetchy Reservoir releases. Reservoir inflow is derived from worksheet Hydrology and is the unimpaired flow entering the reservoir. The initial releases are comprised of the minimum flow requirement below Hetch Hetchy Reservoir (from the worksheet CCSF) and represent requirements prior to consideration of Canyon Tunnel flows, Mountain Tunnel flows that consist of diversions for the SJPL (from the worksheet CCSF), Moccasin Fish Hatchery releases and diversions by Groveland CSD from Mountain Tunnel.

This section also performs an initial check of reservoir storage assuming the previously described minimum releases for the river and Mountain Tunnel. A daily mass balance is performed: *change in reservoir storage = inflow, minus outflow (releases), minus reservoir losses*. The prior day's reservoir evaporation is included in the calculation. If the computation produces resulting Hetch Hetchy Reservoir storage in excess (encroachment) of the preferred storage target, the encroachment is computed. Every 7th day the model checks for an encroachment, and if it exists a check release is computed. For the preferred reservoir storage target encroachment it is assumed that a constant supplemental release (in excess of minimum releases) will be initiated at a rate equal to the encroachment divided equally over the next 7 days. This protocol repeats itself every 7th day, reestablishing the level of check release each time. The end result of this procedure will allow encroachment of storage space above the preferred storage target and not require unrealistic hard releases of water to exactly conform to the target.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1			1		**Hetch Hetchy Reservoir Model**																	
2	*Unit Title*		2		CFS	AF		CFS	AF	CFS	AF	CFS	AF	AF								
3	*Parameter Title*		3		Hetch Het	Hetch Het		SJPL + Mo	SJPL + Mo	SJPL	SJPL	HH Req St	HH Req St	HH Net Evap								
4																						
5	*Acre-foot to CFS conversion*				*This scenario*								_Base_					_Difference from Base_				
6	*divide by :*	*1.983471*			_Check Sums_		_Sum AF_	_39-ave_		_Other Sums_		_Sum AF_		_39-ave_		_Sum AF_		_39-ave_		_Sum AF_		
7						*Inflow*	*29,761,289*	*763,110*			*Supplmtl*	*0*	*Inflow*	*763,110*	*Supplmtl*	*0*	*Inflow*	*0*	*Supplmtl*	*0*		
8						*Evap*	*149,655*	*3,837*					*Evap*	*3,837*			*Evap*	*0*				
9						*SJPL+*	*9,922,420*	*254,421*					*SJPL+*	*254,421*			*SJPL+*	*0*				
10						*Non-SJPL*	*19,655,587*	*503,989*					*Non-SJPL*	*503,989*			*Non-SJPL*	*0*				
11						*Net*	*33,627*															
12						*Chng Stor*	*33,627*															
13		_39-year Ave_				*763,110*			*254,421*		*231,238*			*3,837*								
14								*32*	*Moc Hatch + Groveland (CFS)*													
15					Inflow			Initial Releases						Evap/loss	Initial Storage Computation and Encroachment Release							
16					HH	HH		SJPL	SJPL			w/o 64	w/o 64		Initial	Target	Hard			Spread	Spread	
17	Month				Reservoir	Reservoir		+ Moc Hat	+ Moc Hat			Req	Req	Net Res	HH	HH	Limit	Initial	Encroach	Encroach	7th Day	
18	Index	Date	Day	Days	Inflow	Inflow		Grove	Grove	SJPL	SJPL	Blw HH	Blw HH	Evap/Loss	Storage	Storage	Storage	Encroach	7th Day	over 7	Enc over 7	7-day
19					CFS	AF		CFS	AF	CFS	AF	CFS	AF	AF	250,000	360,360	AF	AF	AF	AF	CFS	Count
20	1970.10	10/1/1970	T	31	79	157		341	677	309	614	60	119	11	249,349	359,381	360,360	0	0	0	0	1
21	1970.10	10/2/1970	F	31	-82	-163		341	677	309	614	60	119	11	248,379	358,401	360,360	0	0	0	0	0
22	1970.10	10/3/1970	S	31	25	50		341	677	309	614	60	119	11	247,622	357,422	360,360	0	0	0	0	0
23	1970.10	10/4/1970	S	31	110	218		341	677	309	614	60	119	11	247,032	356,443	360,360	0	0	0	0	0
24	1970.10	10/5/1970	M	31	-38	-75		341	677	309	614	60	119	11	246,150	355,463	360,360	0	0	0	0	0
25	1970.10	10/6/1970	T	31	9	18		341	677	309	614	60	119	11	245,360	354,484	360,360	0	0	0	0	0

Supplemental Releases and Final Reservoir and Release Computation

Unit Title 2 — AF | CFS | AF | AF | CFS
Parameter Title 3 — HH Supple | HH Releas | HH Releas | HH Storag | Total HH R
Acre-foot to CFS conversion
divide by : 1.983471
39-year Ave — 503,989

Final Release and Storage

Month Index	Date	Day	Days	Supplmtl Release CFS	Supplmtl Release AF	HH Release abv Mnt CFS	HH Release abv Mnt AF	HH Storage 250,000	HH Storage Change AF	Hetch Hetchy Reservoir Loss Calculation: Area	Factor	CFS	AF	HH Total Release CFS
1970.10	10/1/1970	T	31	0	0	60	119	249,349	-651	1,722	0.003253	5.6	11.1	401
1970.10	10/2/1970	F	31	0	0	60	119	248,379	-970	1,721	0.003253	5.6	11.1	401
1970.10	10/3/1970	S	31	0	0	60	119	247,622	-758	1,718	0.003253	5.6	11.1	401
1970.10	10/4/1970	S	31	0	0	60	119	247,032	-589	1,716	0.003253	5.6	11.1	401
1970.10	10/5/1970	M	31	0	0	60	119	246,150	-883	1,714	0.003253	5.6	11.1	401
1970.10	10/6/1970	T	31	0	0	60	119	245,360	-789	1,711	0.003253	5.6	11.0	401

This section of logic performs the final computation of reservoir storage and releases. Incorporated into the logic is inclusion of user specified supplemental releases (from WaterBankRel or SFWaterBank worksheets) and snowmelt management releases (described later). Reservoir losses are computed in accordance with procedures of the Fourth Agreement.

Snow-melt Management

A second check release is made during the February through June period for management of anticipated snowmelt runoff. On the first day of each of these months a forecast is made of anticipated runoff into the reservoir and minimum releases and losses from the reservoir, from the date of forecast through the end of June (assumed target of reservoir filling). These forecasts determine the volume of water (if any) that will require release in excess of minimum releases and losses and storage gain by the end of June.

Unit Title 2
Parameter Title 3
Acre-foot to CFS conversion
divide by: 1.983471
39-year Ave
June Storage Target (AF): 360,360 — Max Rel
Minimum HH Storage for SM Drawdown (AF): 100,000 — Tgt (CFS)
% Feb Release of Feb-June Excess: 10 — 1,200
% Mar Release of Mar-June Excess: 10 — Max Rel Tgt (CFS) 1,150
% Apr Release of Apr-June Excess: 10 — Max Rel Tgt (CFS) 1,200

February Snow-melt Release Routine — February

Month Index	Date	Day	Days	1-Feb AJ Fcst AF	1-Feb FJune Fcst AF	FJune SJPL+MRiv AF	FJune HH Avail AF	FJune Excess AF	Feb SM Rel CFS	Max Stor Draw CFS
1970.10	10/1/1970	T	31	0	0	0	0	0	0	0
1970.10	10/2/1970	F	31	0	0	0	0	0	0	0
1970.10	10/3/1970	S	31	0	0	0	0	0	0	0
1970.10	10/4/1970	S	31	0	0	0	0	0	0	0
1970.10	10/5/1970	M	31	0	0	0	0	0	0	0
1970.10	10/6/1970	T	31	0	0	0	0	0	0	0

March Snow-melt Release Routine — March

Month Index	Date	Day	Days	1-Mar AJ Fcst AF	1-Mar MJune Fcst AF	MJune SJPL+MRiv AF	MJune HH Avail AF	MJune Excess AF	March SM Rel CFS	Max Stor Draw CFS
1970.10	10/1/1970	T	31	0	0	0	0	0	0	0
1970.10	10/2/1970	F	31	0	0	0	0	0	0	0
1970.10	10/3/1970	S	31	0	0	0	0	0	0	0
1970.10	10/4/1970	S	31	0	0	0	0	0	0	0
1970.10	10/5/1970	M	31	0	0	0	0	0	0	0
1970.10	10/6/1970	T	31	0	0	0	0	0	0	0

April Snow-melt Release Routine — April

Month Index	Date	Day	Days	1-Apr AJ Fcst AF	1-Apr AJune Fcst AF	AJune SJPL+MRiv AF	AJune HH Avail AF	AJune Excess AF	April SM Rel CFS	Max Stor Draw CFS
1970.10	10/1/1970	T	31	0	0	0	0	0	0	0
1970.10	10/2/1970	F	31	0	0	0	0	0	0	0
1970.10	10/3/1970	S	31	0	0	0	0	0	0	0
1970.10	10/4/1970	S	31	0	0	0	0	0	0	0
1970.10	10/5/1970	M	31	0	0	0	0	0	0	0
1970.10	10/6/1970	T	31	0	0	0	0	0	0	0

Unit Title 2 — CFS / AF
Parameter Title 3 — HH Target / HH Target
Acre-foot to CFS conversion
divide by 1.983471
19-year Ave

% May Release of May-June Excess: 100 — Max Rel Tgt (CFS) 100,000
% Jun Release of June Excess: 100 — Max Rel Tgt (CFS) 100,000 — Max Rel Tgt (CFS) 100,000 — Max

				May Snow-melt Release Routine							June Snow-melt Release Routine								
				May							June								
Month Index	Date	Day	Days	1-May AJ Fcst AF	1-May MJune Fcst AF	MJune SJPL+MRiv AF	MJune HH Avail AF	MJune Excess AF	May SM Rel CFS	Max Stor Draw CFS	1-Jun June UF AF	1-Jun June Fcst AF	June SJPL+MRiv AF	June HH Avail AF	June Excess AF	June SM Rel CFS	Max Stor Draw CFS	Target SM Release CFS	Target SM Release AF
1970.10	10/1/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/2/1970	F	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/3/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/4/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/5/1970	M	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/6/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Pre-knowledge is used for anticipated runoff, minimum releases and losses. The user defines the percentage of volume (of the total volume for the period) to be additionally released during each month. For February through April, 10 percent of the additional release volume is advised for release, and may be additionally capped. This approach tends to hold Hetch Hetchy Reservoir releases for later release during May. The snowmelt check release is evenly distributed across the days of the month and can be capped in terms of rate (cfs) or minimum volume of the reservoir to which it can be drawn during the month. The particular release made in a day is the greater of the two check releases or the minimum release. At no time is the maximum capacity of the reservoir allowed to be exceeded, and if necessary a release, regardless of magnitude, will be made by the model to not exceed maximum storage capacity.

5.13 SFLloyd Worksheet

This Model component worksheet (SFLloyd) simulates the operation of Lake Lloyd. Several sections of logic provide a systematic operation of the reservoir based on inflow and forecasted hydrology and water demands. The Model will direct releases from Lake Lloyd under a "hold-unless-need-to-release" protocol, except as conditioned by minimum release requirements, diversions, preferred/maximum storage, snowmelt management releases and target releases for Holm Powerhouse. The several sections of logic are illustrate and discussed below.

Lake Lloyd Release Demands, Initial Storage Computation and Encroachment Release

This section of logic assembles the underlying water demands placed for Lake Lloyd releases. Reservoir inflow is derived from the Hydrology worksheet and is the unimpaired flow entering the reservoir. The initial releases are comprised of the minimum flow requirement below Lake Lloyd (from worksheet CCSF) and target releases for Holm Powerhouse (from worksheet CCSF).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1			1		Lake Lloyd Model																
2	*Unit Title*		2		CFS	AF	CFS	AF		AF	CFS	AF		AF		AF	AF				
3	*Parameter Title*		3		Lake Lloyc	Lake Lloyc	Min Holm Ti	Min Holm		Suppleme	Lloyd Req	Lloyd Req		Lloyd Net Evap		Lloyd Targe	Lloyd Limi				
4																					
5	*Acre-foot to CFS conversion*				*This scenario*								*Base*				*Difference from Base*				
6	*divide by :*	*1.983471*			*Check Sums*		*Sum AF*	*39-ave*		*Other Sums*		*Sum AF*		*39-ave*		*Sum AF*		*39-ave*		*Sum AF*	
7						*Inflow*	*11,743,646*	*301,119*			*Supplmtl*	*171,708*	*Inflow*	*301,119*	*Supplmtl*	*171,708*	*Inflow*	*0*	*Supplmtl*	*0*	
8						*Tun Inflow*	*3,196,266*	*81,956*					*Tun Inflow*	*81,956*			*Tun Inflow*	*0*			
9						*Evap*	*136,660*	*3,504*					*Evap*	*3,504*			*Evap*	*0*			
10						*Stream*	*1,298,823*	*33,303*					*Stream*	*33,303*			*Stream*	*0*			
11						*Holm*	*13,454,734*	*344,993*					*Holm*	*344,993*			*Holm*	*0*			
12						*Net*	*49,694*														
13						*Chng Stor*	*49,694*														
14				*39-year Ave*		*301,119*		*38,628*		*4,403*		*5,538*		*3,504*							
15					Inflow		Initial Release			Suppl	Initial Release			Evap/loss	Initial Storage and Encroachment Release						
16					Lake	Lake	Min	Min		171,708	Stream	Stream			Initial	Lloyd				Spread	Spread
17	Month				Lloyd	Lloyd	Holm	Holm		Supplmtl	Req	Req		Net Res	Lloyd	Target	Limit	Initial	Encroach	Encroach	7th Day
18	Index	Date	Day	Days	Inflow	Inflow	Target	Target		Release	Blw Lloyd	Blw Lloyd		Evap/Loss	Storage	Storage	Storage	Encroach	7th Day	over 7	Enc over 7'
19					CFS	AF	CFS	AF		AF	CFS	AF		AF	200,000	200,000	AF	AF	AF	AF	CFS
20	1970.10	10/1/1970	T	31	56	111	0	0		0	5	10		10	200,091	248,000	273,300	0	0	0	0
21	1970.10	10/2/1970	F	31	5	10	0	0		0	5	10		10	200,080	248,000	273,300	0	0	0	0
22	1970.10	10/3/1970	S	31	15	30	0	0		0	5	10		10	200,090	248,000	273,300	0	0	0	0
23	1970.10	10/4/1970	S	31	-399	-791	0	0		0	5	10		10	199,278	248,000	273,300	0	0	0	0
24	1970.10	10/5/1970	M	31	322	638	0	0		0	5	10		10	199,896	248,000	273,300	0	0	0	0
25	1970.10	10/6/1970	T	31	-48	-94	0	0		0	5	10		10	199,781	248,000	273,300	0	0	0	0

This section also performs an initial check of reservoir storage assuming the previously described minimum releases for the river and Holm Powerhouse. A daily mass balance is performed: *change in reservoir storage = inflow, minus outflow (releases), minus reservoir losses*. The prior day's reservoir evaporation is included in the calculation. If the computation produces resulting Lake Lloyd storage in excess (encroachment) of the preferred storage target, the encroachment is computed. Every 7^{th} day the model checks for an encroachment, and if it exists a check release is computed. It is assumed that a constant supplemental release (in excess of minimum releases) will be initiated at a rate equal to the encroachment divided equally over the next 7 days. This protocol repeats itself every 7^{th} day, reestablishing the level of check release each time. The end result of this procedure will allow encroachment of storage space above the preferred storage target and not require unrealistic hard releases of water to exactly conform to the target. User specified supplemental releases are reported in this section but are not incorporated into the worksheet's logic until later.

<u>Supplemental Releases, Lake Eleanor Transfers and Final Reservoir and Release Computation</u>

Row	A	B	C	D	W	X	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM
1			1														
2	Unit Title		2				CFS		CFS	AF	CFS	AF	CFS	AF	CFS	AF	AF
3	Parameter Title		3				Lloyd-only Holm		Final Stre	Final Stre	Tunnel Inf	Tunnel Inf	Final Holn	Final Holn	Total Lloy	Total Lloy	Lake Lloyc
5	Acre-foot to CFS conversion																
6	divide by	1.983471															
12					Holm	(C 2.41)											
13					950	CFS Max											
14			39-year Ave														

Month Index	Date	Day	Days	Prior to Eleanor: Holm Capacity for Elnr CFS	Holm Capacity for Elnr AF	Llyd-only Rel w/o Suppl Rel CFS	Llyd-only Rel w/o Suppl Rel AF	Revised Routed Holm CFS	Revised Routed Holm AF	Holm Prior to Tun Infl CFS	Holm Prior to Tun Infl AF
1970.10	10/1/1970	T	31	950	1,884	5	10	0	0	0	0
1970.10	10/2/1970	F	31	950	1,884	5	10	0	0	0	0
1970.10	10/3/1970	S	31	950	1,884	5	10	0	0	0	0
1970.10	10/4/1970	S	31	950	1,884	5	10	0	0	0	0
1970.10	10/5/1970	M	31	950	1,884	5	10	0	0	0	0
1970.10	10/6/1970	T	31	950	1,884	5	10	0	0	0	0

Month Index	Date	Final Routing: Stream w/ Suppl Release CFS	Stream w/ Suppl Release AF	Eleanor to Holm CFS	Eleanor to Holm AF	Final Holm Total CFS	Final Holm Total AF	Lloyd Total Release CFS	Lloyd Total Release AF	Final Storage: Lake Lloyd Storage 200,000	Lloyd Storage Change AF	Lake Lloyd Loss Calculation: Area	Factor	CFS	AF
1970.10	10/1/1970	5	10	218	433	218	433	223	443	200,091	91	1,607	0.003253	5.2	10.4
1970.10	10/2/1970	5	10	218	433	218	433	223	443	200,080	-11	1,607	0.003253	5.2	10.4
1970.10	10/3/1970	5	10	218	433	218	433	223	443	200,090	10	1,607	0.003253	5.2	10.4
1970.10	10/4/1970	5	10	218	433	218	433	223	443	199,278	-811	1,607	0.003253	5.2	10.4
1970.10	10/5/1970	5	10	218	433	218	433	223	443	199,896	617	1,605	0.003253	5.2	10.4
1970.10	10/6/1970	5	10	218	433	218	433	223	443	199,781	-115	1,607	0.003253	5.2	10.4

This section of logic performs the final computation of reservoir storage and releases, including consideration of snowmelt management releases (described later) and transfers from Lake Eleanor. Both the initial check release for preferred storage encroachment and the snowmelt check release are computed and advised for reservoir operations. If supplemental releases above minimum releases are computed the Model routes the additional release through Holm Powerhouse up to its available capacity. The remainder of the supplemental release is routed to the stream below Lake Lloyd. A comparison is made between "Lloyd-only" use of Holm Powerhouse capacity and maximum capacity for passage to the Lake Eleanor model component.

The operation goal linkage between Lake Lloyd and Lake Eleanor assumes that Lake Eleanor will transfer water from its watershed to Lake Lloyd for the purpose of enhancing power generation at Holm Powerhouse. Thus, any available capacity at Holm Powerhouse <u>after</u> the Lloyd-only operation is assumed available and desired for use of a Lake Eleanor transfer. If water is transferred from Lake Eleanor the Model assumes the water to be directly routed to Holm Powerhouse which then becomes additional release from Lake Lloyd.

Also incorporated into the logic is inclusion of user specified supplemental releases (from the WaterBankRel or SFWaterBank worksheets). Supplemental releases are added to any other release established for Lake Lloyd. Reservoir losses are compute in accordance with procedures of the Fourth Agreement.

Snow-melt Management

Unit Title 2
Parameter Title 3
Acre-foot to CFS conversion
divide by: 1.983471

June Storage Target (AF): 273,300
Minimum HH Storage for SM Drawdown (AF): 300,000
39-year Ave

% Feb Release of Feb-June Excess: 20 — Max Rel Tgt (CFS): 1,000

Month Index	Date	Day	Days	1-Feb AJ Fcst AF	1-Feb FJune Fcst AF	FJune Riv+Trg Holm AF	FJune Ch Avail AF	FJune Excess AF	Feb SM Rel CFS	Max Stor Draw CFS
1970.10	10/1/1970	T	31	0	0	0	0	0	0	0
1970.10	10/2/1970	F	31	0	0	0	0	0	0	0
1970.10	10/3/1970	S	31	0	0	0	0	0	0	0
1970.10	10/4/1970	S	31	0	0	0	0	0	0	0
1970.10	10/5/1970	M	31	0	0	0	0	0	0	0
1970.10	10/6/1970	T	31	0	0	0	0	0	0	0

% Mar Release of Mar-June Excess: 25 — Max Rel Tgt (CFS): 1,000

Month Index	Date	Day	Days	1-Mar AJ Fcst AF	1-Mar MJune Fcst AF	MJune Riv+Trg Holm AF	MJune Ch Avail AF	MJune Excess AF	March SM Rel CFS	Max Stor Draw CFS
1970.10	10/1/1970	T	31	0	0	0	0	0	0	0
1970.10	10/2/1970	F	31	0	0	0	0	0	0	0
1970.10	10/3/1970	S	31	0	0	0	0	0	0	0
1970.10	10/4/1970	S	31	0	0	0	0	0	0	0
1970.10	10/5/1970	M	31	0	0	0	0	0	0	0
1970.10	10/6/1970	T	31	0	0	0	0	0	0	0

% Apr Release of Apr-June Excess: 33 — Max Rel Tgt (CFS): 1,000

Month Index	Date	Day	Days	1-Apr AJ Fcst AF	1-Apr AJune Fcst AF	AJune Riv+Trg Holm AF	AJune Ch Avail AF	AJune Excess AF	April SM Rel CFS	Max Stor Draw CFS
1970.10	10/1/1970	T	31	0	0	0	0	0	0	0
1970.10	10/2/1970	F	31	0	0	0	0	0	0	0
1970.10	10/3/1970	S	31	0	0	0	0	0	0	0
1970.10	10/4/1970	S	31	0	0	0	0	0	0	0
1970.10	10/5/1970	M	31	0	0	0	0	0	0	0
1970.10	10/6/1970	T	31	0	0	0	0	0	0	0

% May Rlease of Ma y-June Excess: 50 — Max Rel Tgt (CFS): 1,000

Month Index	Date	Day	Days	1-May AJ Fcst AF	1-May MJune Fcst AF	MJune Riv+Trg Holm AF	MJune Ch Avail AF	MJune Excess AF	May SM Rel CFS	Max Stor Draw CFS
1970.10	10/1/1970	T	31	0	0	0	0	0	0	0
1970.10	10/2/1970	F	31	0	0	0	0	0	0	0
1970.10	10/3/1970	S	31	0	0	0	0	0	0	0
1970.10	10/4/1970	S	31	0	0	0	0	0	0	0
1970.10	10/5/1970	M	31	0	0	0	0	0	0	0
1970.10	10/6/1970	T	31	0	0	0	0	0	0	0

% Jun Release of June Excess: 100 — Max Rel Tgt (CFS): 1,000; Max Rel Tgt (CFS): 1,000 Max
CFS Lloyd Targ; AF Lloyd Targ

Month Index	Date	Day	Days	1-Jun June UF AF	1-Jun June Fcst AF	June Riv+Trg Holm AF	June Ch Avail AF	June Excess AF	June SM Rel CFS	Max Stor Draw CFS	Target SM Release CFS	Target SM Release AF
1970.10	10/1/1970	T	31	0	0	0	0	0	0	0	0	0
1970.10	10/2/1970	F	31	0	0	0	0	0	0	0	0	0
1970.10	10/3/1970	S	31	0	0	0	0	0	0	0	0	0
1970.10	10/4/1970	S	31	0	0	0	0	0	0	0	0	0
1970.10	10/5/1970	M	31	0	0	0	0	0	0	0	0	0
1970.10	10/6/1970	T	31	0	0	0	0	0	0	0	0	0

A second check release is made during the February through June period for management of anticipated snowmelt runoff. On the first day of each of these months a forecast is made of anticipated runoff into the reservoir and minimum releases and losses from the reservoir, from the date of forecast through the end of June (assumed target of reservoir filling). These forecasts determine the volume of water (if any) that will require release in excess of minimum releases and losses and storage gain by the end of June. Pre-knowledge is used for anticipated runoff, minimum releases and losses. The user defines the percentage of volume (of the total volume for the period) to be additionally released during each month. For February through May, a varying percentage of the additional release volume is advised for release, and is capped in rate as a means to confine releases within the capacity of Holm Powerhouse. The snowmelt check release is evenly distributed across the days of the month. The release can also be capped in terms of minimum volume of the reservoir to which it can be drawn during the month.

5.14 SFEleanor Worksheet

This Model component worksheet (SFEleanor) simulates the operation of Lake Eleanor. Several sections of logic provide a systematic operation of the reservoir based on inflow and forecasted hydrology and water demands. The Model will direct releases from Lake Eleanor under a “hold-unless-need-to-release” protocol, except as conditioned by minimum release requirements, diversions, preferred/maximum storage, snowmelt management releases. When advised releases exceed the minimum Model logic attempts to transfer water to Lake Lloyd. The several sections of logic are illustrated and discussed below.

<u>Lake Eleanor Release Demands, Initial Storage Computation and Encroachment Release</u>

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1			1		Lake Eleanor Model																	
2	Unit Title		2		CFS	AF					CFS	AF				AF	AF					
3	Parameter Title		3		Lake Elear	Lake Eleanor Inflow					Eleanor R	Eleanor Req Stream Rel				Eleanor T	Eleanor Limit Storage					
4																						
5	Acre-foot to CFS conversion				This scenario								Base				Difference from Base					
6	divide by :	1.983471			Check Sums		Sum AF	39-ave		Other Sums		39-yr Ave		39-ave		39-yr Ave		39-ave		39-yr Ave		
7						Inflow	7,276,607	186,580			Tunnel	81,956	Inflow	186,580	Tunnel	81,956	Inflow	0	Tunnel	0		
8						Evap	72,708	1,864					Evap	1,864			Evap	0				
9						Tun Out	3,196,266	81,956					Tun Out	81,956			Tun Out	0				
10						Stream	4,008,460	102,781					Stream	102,781			Stream	0				
11						Net	-826															
12						Chng Stor	-826															
13																						
14				39-year Ave		186,580						9,087		1,864								
15					Inflow						Initial Release			Evap/loss	Initial Storage and Encroachment Release							
16					Lake	Lake					Stream	Stream			Initial	Eleanor	Hard			Spread	Spread	
17	Month				Eleanor	Eleanor					Req	Req		Net Res	Eleanor	Target	Limit	Initial	Encroach	Encroach	7th Day	
18	Index	Date	Day	Days	Inflow	Inflow					Bl Eleanor	Bl Eleanor		Evap/Loss	Storage	Storage	Storage	Encroach	7th Day	over 7	Enc over 7	7-day
19					CFS	AF					CFS	AF		AF	18,000	AF	AF	AF	AF	AF	CFS	Count
20	1970.10	10/1/1970	T	31	25	50					10	20		6	18,030	15,000	27,100	3,030	3,030	433	218	1
21	1970.10	10/2/1970	F	31	2	4					10	20		6	17,576	15,000	27,100	2,576	3,030	433	218	0
22	1970.10	10/3/1970	S	31	7	14					10	20		6	17,131	15,000	27,100	2,131	3,030	433	218	0
23	1970.10	10/4/1970	S	31	-179	-355					10	20		6	16,317	15,000	27,100	1,317	3,030	433	218	0
24	1970.10	10/5/1970	M	31	144	287					10	20		6	16,145	15,000	27,100	1,145	3,030	433	218	0
25	1970.10	10/6/1970	T	31	-21	-42					10	20		6	15,644	15,000	27,100	644	3,030	433	218	0

This section of logic assembles the underlying water demands placed for Lake Eleanor releases. Reservoir inflow is derived from the Hydrology worksheet and is the unimpaired flow entering the reservoir. The initial releases are comprised of the minimum flow requirement below Lake Eleanor (from the CCSF worksheet). An initial check of reservoir storage occurs assuming the minimum releases for the river. A daily mass balance is performed: *change in reservoir storage = inflow, minus outflow (releases), minus reservoir losses*. The prior day’s reservoir evaporation is included in the calculation. If the computation produces resulting Lake Eleanor storage in excess (encroachment) of the preferred storage target, the encroachment is computed. Every 7th day the model checks for an encroachment, and if it exists a check release is computed. For the preferred reservoir storage target encroachment it is assumed that a constant supplemental release (in excess of minimum releases) will be initiated at a rate equal to the encroachment divided equally over the next 7 days. This protocol repeats itself every 7th day, reestablishing the level of check release each time. The end result of this procedure will allow encroachment of storage space above the preferred storage target and not require unrealistic hard releases of water to exactly conform to the target.

Lake Eleanor Transfers and Final Reservoir and Release Computation

	A	B	C	D	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR
1			1																							
2	Unit Title		2						CFS	AF	CFS	AF					CFS	AF	CFS	AF	AF					
3	Parameter Title		3						Tunnel	Tunnel	Eleanor St	Eleanor Stream Release					Tun Trans	Tun Trans	Total Elea	Total Elea	Lake Eleanor Storage					
4																										
5	Acre-foot to CFS conversion																									
6	divide by	1.983471																								
7																										
8																										
9																										
10																										
11													Tunnel Capacity (C 2-81)													
12													400 CFS Max													
13																										
14			19-year Ave							81,956		102,781								184,737						
15					Revised and Final Routing																Final Storage					
16					Revised	Revised	Excess	Excess	Put	Put			Avail	Avail	Limit by	Limit by			Total	Total	Revised	Eleanor	Lake Eleanor Loss Calculation			
17	Month				Stream	Stream	abv Min	abv Min	to	to	Final	Final	Holm Cap	Holm Cap	Tunnel	Tunnel	Transfer	Transfer	Eleanor	Eleanor	Eleanor	Storage	Area	Factor		
18	Index	Date	Day	Days	Release	Release	Stream	Stream	Tunnel	Tunnel	Stream	Stream	for El	for El	Available	Available	Capacity	Capacity	Release	Release	Storage	Change				
19					CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	18,000	AF	Acres		CFS	AF
20	1970.10	10/1/1970	T	31	228	453	218	433	218	433	10	20	950	1,884	400	793	400	793	228	453	17,591	-409	896	0.003253	2.9	5.8
21	1970.10	10/2/1970	F	31	228	453	218	433	218	433	10	20	950	1,884	400	793	400	793	228	453	17,137	-454	893	0.003253	2.9	5.8
22	1970.10	10/3/1970	S	31	228	453	218	433	218	433	10	20	950	1,884	400	793	400	793	228	453	16,692	-445	890	0.003253	2.9	5.7
23	1970.10	10/4/1970	S	31	228	453	218	433	218	433	10	20	950	1,884	400	793	400	793	228	453	15,878	-814	885	0.003253	2.9	5.7
24	1970.10	10/5/1970	M	31	228	453	218	433	218	433	10	20	950	1,884	400	793	400	793	228	453	15,707	-172	876	0.003253	2.8	5.7
25	1970.10	10/6/1970	T	31	228	453	218	433	218	433	10	20	950	1,884	400	793	400	793	228	453	15,206	-501	874	0.003253	2.8	5.6

This section of logic performs the final computation of reservoir storage and releases, including consideration of snowmelt management releases (described later) and transfers from Lake Eleanor to Lake Lloyd.

Both the initial check release for preferred storage encroachment and the snowmelt check release are computed and advised for reservoir operations. If excess releases above minimum releases are computed the Model routes the additional release through the tunnel up to the limit of its available capacity or the capacity available at Holm Powerhouse. The remainder of the supplemental release is routed to the stream below Lake Eleanor. The Lake Eleanor operation protocol will transfer water that would otherwise be released in excess of minimum flow requirements (largely dependent upon the preferred target storage and snowmelt releases) but it will not allow water to be "pulled" from Lake Eleanor to Lake Lloyd.

The operation goal linkage between Lake Lloyd and Lake Eleanor assumes that Lake Eleanor will transfer water from its watershed to Lake Lloyd for the purpose of enhancing power generation at Holm Powerhouse. Thus, any available capacity at Holm Powerhouse after the Lloyd-only operation is assumed available and desired for use of a Lake Eleanor transfer. If water is transferred from Lake Eleanor the model assumes the water to be directly routed to Holm Powerhouse which then becomes additional release from Lake Lloyd. Reservoir losses are computed in accordance with procedures of the Fourth Agreement.

Snow-melt Management

	1
Unit Title	2
Parameter Title	3
Acre-foot to CFS conversion	
divide by: 1.983471	

June Storage Target (AF):	27,100	Max Rel Tgt (CFS)	
Minimum Eleanor Storage for SM Drawdown (AF):	1,000		
% Feb Release of Feb-June Excess:	20	2,000	39-year Ave
% Mar Release of Mar-June Excess:	25	2,000	Max Rel Tgt (CFS)
% Apr Release of Apr June Excess:	33	2,000	Max Rel Tgt (CFS)

Month Index	Date	Day	Days	February Snow-melt Release Routine: 1-Feb AJ Fcst AF	1-Feb FJune Fcst AF	FJune MinRiv+Tun AF	FJune El Avail St AF	FJune Excess AF	Feb SM Rel CFS	Max Stor Draw CFS	March Snow-melt Release Routine: 1-Mar AJ Fcst AF	1-Mar MJune Fcst AF	MJune MinRiv+Evap AF	MJune El Avail St AF	MJune Excess AF	March SM Rel CFS	Max Stor Draw CFS	April Snow-melt Release Routine: 1-Apr AJ Fcst AF	1-Apr AJune Fcst AF	AJune MinRiv+Evap AF	AJune El Avail St AF	AJune Excess AF	April SM Rel CFS	Max Stor Draw CFS
1970.10	10/1/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/2/1970	F	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/3/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/4/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/5/1970	M	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/6/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	1
Unit Title	2
Parameter Title	3
Acre-foot to CFS conversion	
divide by: 1.983471	

% May Rlease of Ma y-June Excess:	70	2,000	Max Rel Tgt (CFS)
% Jun Release of June Excess:	100	2,000	Max Rel Tgt (CFS)
Max 1,385		2,000	Max Rel Tgt (CFS)
39-year Ave			Max

Month Index	Date	Day	Days	May Snow-melt Release Routine: 1-May AJ Fcst AF	1-May MJune Fcst AF	MJune MinRiv+Evap AF	MJune El Avail St AF	MJune Excess AF	May SM Rel CFS	Max Stor Draw CFS	June Snow-melt Release Routine: 1-Jun June UF AF	1-Jun June Fcst AF	June MinRiv+Evap AF	June Ch Avail AF	June Excess AF	June SM Rel CFS	Max Stor Draw CFS	Target SM Release CFS	Target SM Release AF
1970.10	10/1/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/2/1970	F	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/3/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/4/1970	S	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/5/1970	M	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1970.10	10/6/1970	T	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

A second check release is made during the February through June period for management of anticipated snowmelt runoff. On the first day of each of these months a forecast is made of anticipated runoff into the reservoir and minimum releases and losses from the reservoir, from the date of forecast through the end of June (assumed target of reservoir filling). These forecasts determine the volume of water (if any) that will require release in excess of minimum releases and losses and storage gain by the end of June. Pre-knowledge is used for anticipated runoff, minimum releases and losses. The user defines the percentage of volume (of the total volume for the period) to be additionally released during each month. For February through May, a varying percentage of the additional release volume is advised for release. The snowmelt check release is evenly distributed across the days of the month. The release can also be capped in terms of minimum volume of the reservoir to which it can be drawn during the month.

5.15 SFWaterBank Workheet

This worksheet (SFWaterBank) provides for entry of daily supplemental releases from the CCSF System. The worksheet is comparable to worksheet WaterBankRel except that this worksheet provides alternative methods of identifying supplemental releases (UI 3.10 = 0). Employing this option, the user can identify year type table-based supplemental flow, without or without addition of the pre-processed Test Case supplemental release.

Without any other manual intervention the Model will direct releases from the CCSF System under a “hold-unless-need-to-release” protocol. Additional releases greater than provided by the default protocol may be needed. An example of such a need is during periods when CCSF System operations would otherwise deplete the Water Bank Account to a point of a “negative” balance.

The manual adjustment to releases from the CCSF System is provided to allow the user to “pull” additional water from the CCSF System as supplemental inflow to Don Pedro Reservoir. An entry of supplemental release is established that will first pull water from Lake Lloyd so that water supply is preserved in the Hetch Hetchy Reservoir system for diversion to the SJPL. At a point when such supplemental releases strain Lake Lloyd storage, the supplemental releases are directed to Hetch Hetchy Reservoir. The supplemental release is directed from a reservoir at a point in logic after the default protocol releases occur. Thus, the release occurs in addition to what operation is already occurring by default. Such a release can affect the following day’s default operation or previous periods’ operations, thus results require review to determine if the user’s desired result occurs.

<u>*SF Water Bank Account Balance Accounting, CCSF La Grange Flow Responsibility and Test Case Supplemental Releases*</u>

Shown below is a snapshot of the worksheet. The worksheet provides the daily accounting of the Water Bank Account Balance for the Model. Information ported from other worksheets of the Model into this worksheet is Don Pedro Reservoir inflow (Column E) and the unimpaired flow at La Grange (Column F). These data and the protocols associated with Fourth Agreement Water Bank Account Balance accounting (Columns G through Column O) derive the daily credit or debit of CCSF and then the daily balance of the Water Bank Account (Column M).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1			1		San Francisco Water Bank Account Credit Computation															SF Water Bank Release - Base				
2	Unit Title		2		CFS	CFS	CFS	CFS	CFS				AF		AF					AF				
3	Parameter Title		3		DP Inflow	La Grange	District Ra	Districts' E	SF Credit/Debit				SF Water Bank Balan		Max Water Bank Capacity					Water Bank Release				
4																	Advice							
5	Acre-foot to CFS conversion				From	From																		
6	divide by :	1.983471			DonPedro	Hydrology		Warnings																
7																								
8																								
9																	(UI 1.31)			(UI 3.10)	No, this method is not being used			
10																	0			1	Min Lloyd Storage			
11																	(0) N, (1) Y				WB Call (CCSF 3.00)			
12																	- Debit				(acre-feet)			
13												Max	740,000				+ Credit				45,000			
14												Min	0			Sum:	0		Sum:	171,708	171,708	0		
15					SF Water Bank Account Balance Calculation												La Grange			Direct Entry Only				
16							Fourth	Daily	SF	SF C/D	SF Gross	SF WB	SF Net	SF Share	SF Max		Credit Adj			WB	1st Call	2nd Call		
17	Month				DP	La Grange	Agree	Districts'	Credit/	w/	WB	Evap	WB	RFlood	WB	WB	in SF			Supp	Lloyd	HH		
18	Index	Date	Day	Days	Inflow	UF	Check	Entitle	Debit	Credit Adj	Balance	Losses	Balance	DP	Balance	Neg Flag	WB	Mark	Mark	Release	Release	Release		
19					CFS	CFS	CFS	CFS	CFS	AF	AF	AF	570,000	AF	AF	AF	AF			AF	AF	AF		
20	1970.10	10/1/1970	T	31	322	159	2,416	159	163	324	570,324	48	570,000	0	570,000	0	0			0	0	0		
21	1970.10	10/2/1970	F	31	453	55	2,416	55	398	790	570,790	48	570,000	0	570,000	0	0			0	0	0		
22	1970.10	10/3/1970	S	31	541	265	2,416	265	276	548	570,548	48	570,000	0	570,000	0	0			0	0	0		
23	1970.10	10/4/1970	S	31	625	-166	2,416	-166	791	1,569	571,569	48	570,000	0	570,000	0	0			0	0	0		
24	1970.10	10/5/1970	M	31	75	180	2,416	180	-105	-208	569,792	48	569,744	0	570,000	0	0			0	0	0		
25	1970.10	10/6/1970	T	31	475	92	2,416	92	383	760	570,504	48	570,000	0	570,000	0	0			0	0	0		

For purposes of the FERC investigation, the protocols of Fourth Agreement Water Bank Accounting have been amended to incorporate a hypothetical implementation of "shared responsibility" for incremental increases in FERC-required flows for the Tuolumne River.[4] If running the scenario with shared responsibility has been selected (worksheet UserInput Switch UI 1.31 = 1), the incremental increase in FERC-required flows is determined by the daily difference between the current 1995 FERC Settlement requirements and scenario-required minimum flows. This computation occurs in worksheet LaGrangeSchedule with information regarding the scenario-required flows directed through worksheet UserInput. Approximately fifty-two percent (51.7121%) of the incremental difference between the flow schedules is assigned as CCSF's responsibility and is ported into the worksheet in Column Q as a "debit". This debit then enters the current protocols of Fourth Agreement Water Bank Accounting at Column J, and subsequently contributes to the determination of the daily Water Bank Account Balance (Column M).

Water Bank Account Balances which are less than zero ("negative") are highlighted, and the minimum balance, whether negative or positive, is reported in Cell M14. By default, the base supplemental releases to maintain a positive Water Bank Account Balance at or above zero have been entered into Column T (WB Supplemental Release). An alternative time series can be used. The Model will first direct the supplemental release to Lake Lloyd, and continue releases until storage at Lake Lloyd is drawn to a specified 45,000 acre-feet minimum level (shown in Cell Q10 and entered at worksheet CCSF Switch 3.00). Subsequent supplemental releases will be drawn from Hetch Hetchy Reservoir any time storage is less than the Lake Lloyd minimum.

<u>User Specified Table of Supplemental Releases and Reservoir Status Computation</u>

The snapshot below illustrates the section of logic that incorporates a user Specified table of supplemental releases (UI 3.40) into the Model. A daily time series (Column Y) of supplemental releases is developed from the user specified table in worksheet UserInput. By selection, the user identifies whether or not the year type table-based supplemental release is added the preprocessed Test Case supplemental releases (Column T previously described). The Model then uses the selected supplemental release in its computation of operations.

	A	B	C	D	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI
1			1			User-defined SF Upstream Supplemental Release									
2	*Unit Title*		2							AF					
3	*Parameter Title*		3							Total SF Suppl Release					
4															
5	*Acre-foot to CFS conversion*														
6	*divide by :*	*1.983471*								*(UI 3.10)*	1	No, this method is not being used			
7					*2,704,000*	*2,875,708*	*2,875,708*	*0*							
8						Add Base									
9						Supp				Final Supplimental Release from Other Method					
10						1	N/A			0	*(UI 3.20)*				
11						*(0) no*	*(UI 3.30)*			*(0) Base*			Min	Min	Min
12						*(1) yes*				*(1) User-defined*			103,852	84,135	508,489
13					Supplemental Table Entry								Min	Min	Min
14						Supp							Non 76-77	Non 76-77	Non 76-77
15					Supp	Table	1st Call	2nd Call					103,852	114,720	785,605
16					Table	Only, or	To	To	*Sum:*	*171,708*	*171,708*	*0*			
17	Month				Release	Table +	Lloyd	HH			Lloyd	HH	Lloyd	HH	DP
18	Index	Date	Day	Days	Only	Existing	Release	Release		Total	Release	Release	Storage	Storage	Storage
19					AF	AF	AF	AF		AF	AF	AF	AF	AF	AF
20	1970.10	10/1/1970	T	31	0	0	0	0		0	0	0	200,091	249,349	1,666,767
21	1970.10	10/2/1970	F	31	0	0	0	0		0	0	0	200,080	248,379	1,664,567
22	1970.10	10/3/1970	S	31	0	0	0	0		0	0	0	200,090	247,622	1,662,719
23	1970.10	10/4/1970	S	31	0	0	0	0		0	0	0	199,278	247,032	1,659,892
24	1970.10	10/5/1970	M	31	0	0	0	0		0	0	0	199,896	246,150	1,656,745
25	1970.10	10/6/1970	T	31	0	0	0	0		0	0	0	199,781	245,360	1,654,119

[4] The "shared responsibility" assumption is presented for the purpose of evaluating alternative operations. The assumption shall not be used as evidence in any proceeding relating to and shall not act as precedence for any allocation of Tuolumne River water between CCSF and the Districts for any purpose under the Fourth Agreement.

The result of entering the supplemental release will cause a recalculation of the entire Model with results refreshed in the worksheet. Lake Lloyd, Hetch Hetchy Reservoir and Don Pedro Reservoir storage is ported from other worksheets to provide the status of their storage as supplemental releases are entered.

Warnings and advice are provided in the worksheet when several conditions occur. The snapshots below illustrate the occurrence of these conditions.

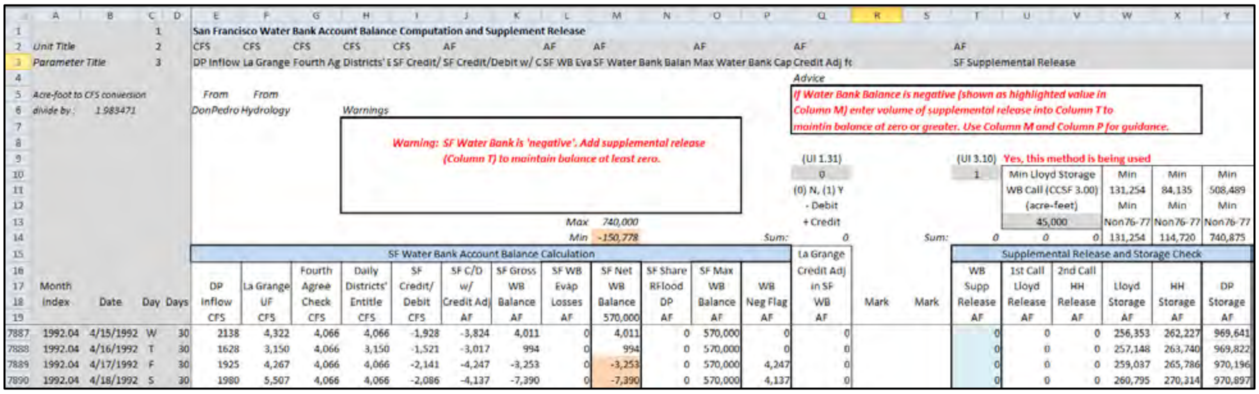
Example 1: A Reservoir Empties and the Model Crashes

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1			1		San Francisco Water Bank Account Balance Computation and Supplement Release																				
2	Unit Title		2		CFS	CFS	CFS	CFS	CFS	AF		AF	AF		AF		AF			AF					
3	Parameter Title		3		DP Inflow	La Grange	Fourth Ag	Districts' F	SF Credit/	SF Credit/Debit w/ C		SF WB Eva	SF Water Bank Balan		Max Water Bank Cap		Credit Adj fc			SF Supplemental Release					
4																	Advice								
5	Acre-foot to CFS conversion				From	From											#N/A								
6	divide by :	1.983471			DonPedro	Hydrology		Warnings									#N/A								
7									Warning: Your have likely drained a reservoir, check reservoirs.								#N/A								
8									#N/A	#N/A															
9										#N/A							(UI 1.31)			(UI 3.10)	Yes, this method is being used				
10									#N/A	#N/A							1			1	Min Lloyd Storage		Min	Min	Min
11										#N/A							(0) N, (1) Y				WB Call (CCSF 3.00)		24,474	#N/A	#N/A
12																	- Debit				(acre-feet)		Min	Min	Min
13												Max	#N/A				+ Credit				45,000		Non76-77	Non76-77	Non76-77
14												Min	#N/A			Sum:	-5,922,391		Sum:	1,197,522	714,938	482,584	24,474	#N/A	#N/A
15					SF Water Bank Account Balance Calculation												La Grange			Supplemental Release and Storage Check					
16							Fourth	Daily	SF	SF C/D	SF Gross	SF WB	SF Net	SF Share	SF Max		Credit Adj			WB	1st Call	2nd Call			
17	Month				DP	La Grange	Agree	Districts'	Credit/	w/	WB	Evap	WB	RFlood	WB	WB	in SF			Supp	Lloyd	HH	Lloyd	HH	DP
18	Index	Date	Day	Days	Inflow	UF	Check	Entitle	Debit	Credit Adj	Balance	Losses	Balance	DP	Balance	Neg Flag	WB	Mark	Mark	Release	Release	Release	Storage	Storage	Storage
19					CFS	CFS	CFS	CFS	CFS	AF	AF	AF	570,000	AF	AF	AF	AF			AF	AF	AF	AF	AF	AF
8018	1992.08	8/24/1992	M	31	205	5	2,416	5	200	396	-122,421	0	-122,421	0	570,000	-396	0			0	0	0	30,461	1,488	528,302
8019	1992.08	8/25/1992	T	31	445	28	2,416	28	417	827	-121,594	0	-121,594	0	570,000	-827	0			0	0	0	30,065	262	526,440
8020	1992.08	8/26/1992	W	31	#N/A	201	2,416	201	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0			0	0	0	29,709	#N/A	#N/A
8021	1992.08	8/27/1992	T	31	#N/A	104	2,416	104	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0			0	0	0	29,370	#N/A	#N/A

Note: This screen save is from the worksheet WaterBankRel description. Identical warnings are included in worksheet SFWaterBank.

A warning has been provided that a reservoir has likely been depleted by the current operation assumptions. In this particular example, Tuolumne River minimum flows were increased with responsibility shared with CCSF, and a set of supplemental releases were established. In this iteration of results it is discovered in Column X (Hetch Hetchy Reservoir storage) an error (reported as "#N/A") on August 26, 1992 has occurred in the Model. By review of the previous day's storage results for Lake Lloyd (Column W), Hetch Hetchy Reservoir (Column X) and Don Pedro Reservoir (Column Y), and the rate of depletion for each of these reservoirs, it is concluded that Hetch Hetchy Reservir likely drained on August 26 and thus crashed the Model. Although noted, a negative Water Bank Account Balance (Column M) will not cause the Model to crash. To remedy the condition, the user uses worksheet UserInput to revise (lower) SJPL diversions from Hetch Hetchy Reservoir (UI 4.10 and UI 4.20) and retain water in Hetchy Hetchy Reservoir for release. If Don Pedro Reservoir storage was the culprit of causing the Model to crash, the user uses worksheet UserInput to revise (lower) MID and TID canal diversions (UI 2.10, UI 2.20 and UI 2.30 to retain water in Don Pedro Reservoir for release. Alternatively, the user could reduce the scenario's designated minimum flow requirement, which would change flow needed from the upstream systems.

Example 2: Water Bank is Negative.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1			1		San Francisco Water Bank Account Balance Computation and Supplement Release																				
2	Unit Title		2		CFS	CFS	CFS	CFS	CFS	AF		AF	AF		AF		AF			AF					
3	Parameter Title		3		DP Inflow	La Grange	Fourth Ag	Districts' E	SF Credit/	SF Credit/Debit w/ C		SF WB Eva	SF Water Bank Balan		Max Water Bank Cap		Credit Adj fc			SF Supplemental Release					
4																	Advice								
5	Acre-foot to CFS conversion				From	From											If Water Bank Balance is negative (shown as highlighted value in								
6	divide by :	1.983471			DonPedro	Hydrology		Warnings									Column M) enter volume of supplemental release into Column T to								
7																	maintin balance at zero or greater. Use Column M and Column P for guidance.								
8									Warning: SF Water Bank is 'negative'. Add supplemental release																
9									(Column T) to maintain balance at least zero.								(UI 1.31)			(UI 3.10)	Yes, this method is being used				
10																	0			1	Min Lloyd Storage		Min	Min	Min
11																	(0) N, (1) Y				WB Call (CCSF 3.00)		131,254	84,135	508,489
12																	- Debit				(acre-feet)		Min	Min	Min
13												Max	740,000				+ Credit				45,000		Non76-77	Non76-77	Non76-77
14												Min	-150,778			Sum:	0		Sum:	0	0	0	131,254	114,720	740,875
15					SF Water Bank Account Balance Calculation												La Grange			Supplemental Release and Storage Check					
16							Fourth	Daily	SF	SF C/D	SF Gross	SF WB	SF Net	SF Share	SF Max		Credit Adj			WB	1st Call	2nd Call			
17	Month				DP	La Grange	Agree	Districts'	Credit/	w/	WB	Evap	WB	RFlood	WB	WB	in SF			Supp	Lloyd	HH	Lloyd	HH	DP
18	Index	Date	Day	Days	Inflow	UF	Check	Entitle	Debit	Credit Adj	Balance	Losses	Balance	DP	Balance	Neg Flag	WB	Mark	Mark	Release	Release	Release	Storage	Storage	Storage
19					CFS	CFS	CFS	CFS	CFS	AF	AF	AF	570,000	AF	AF	AF	AF			AF	AF	AF	AF	AF	AF
7887	1992.04	4/15/1992	W	30	2138	4,322	4,066	4,066	-1,928	-3,824	4,011	0	4,011	0	570,000	0	0			0	0	0	256,353	262,227	969,641
7888	1992.04	4/16/1992	T	30	1628	3,150	4,066	3,150	-1,521	-3,017	994	0	994	0	570,000	0	0			0	0	0	257,148	263,740	969,822
7889	1992.04	4/17/1992	F	30	1925	4,267	4,066	4,066	-2,141	-4,247	-3,253	0	-3,253	0	570,000	4,247	0			0	0	0	259,037	265,786	970,196
7890	1992.04	4/18/1992	S	30	1980	5,507	4,066	4,066	-2,086	-4,137	-7,390	0	-7,390	0	570,000	4,137	0			0	0	0	260,795	270,314	970,897

Note: This screen save is from the worksheet WaterBankRel description. Identical warnings are included in worksheet SFWaterBank.

A warning has been provided that the Water Bank Account Balance is negative for one or more days of the scenario. In this instance, all Model reservoirs are operating within a viable operation (the Model did not crash due an emptying reservoir); however, the objective to maintain a positive Water Bank Account Balance has been violated. Upon inspection of the results the user can find the first instance of violation and remedy the violation by entry into Column T an amount of release that maintains at least a zero balance in the Water Bank Account Balance, and/or modify the year type table-based supplemental flows in worksheet UserInput. For the first day of violation the reported negative balance (e.g., -3,253 acre-feet) is needed as a supplemental release. The ensuing days of supplemental release are informed by Column P.

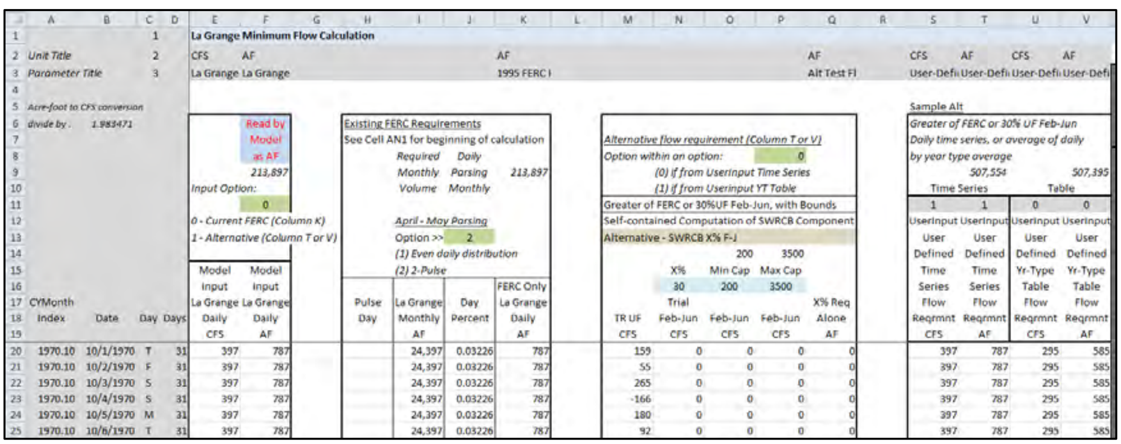
It is possible that within the remedy of Example 2 the error exemplified by Example 1 may occur as Hetchy Hetchy Reservoir may be drained through the efforts of maintaining a positive Water Bank Account Balance. At that point, the procedures of Example 1 will be required and the values already derived for supplemental releases may need to be revisited and possibly changed.

5.16 LaGrangeSchedule Workheet

This worksheet (LaGrangeSchedule) assembles the designation of the minimum flow requirement for the Tuolumne River. By user specification (UI 1.10) either the current 1995 FERC schedule is selected (UI 1.10 = 0) or the user defined minimum flow requirement is selected (UI 1.10 = 1). If the current 1995 FERC schedule is selected the computation of the schedule is computed in this worksheet (later described).

Minimum Flow Requirement Options

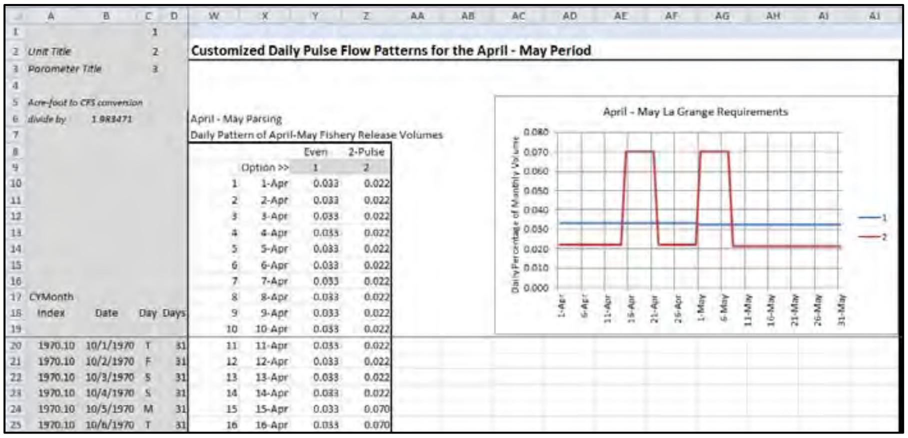
When using current 1995 FERC minimum flow requirements, the user can within worksheet Control (C 1.60) direct which shape of releases to assume for pulse flows during April and May. This section of the worksheet performs the parsing the monthly flow requirements into daily flow requirements. If using the user specified flow schedule (identified and processed in worksheet UserInput), this section prepares the use of that data for use by the Model. Upon selection of the flow requirement, Column F is used to provide the minimum flow requirement to the rest of the Model. Although not directly linked through user switches, this section of the worksheet illustrates an example of developing an alternative flow requirement for testing. Columns M through Column Q perform a synthesis of an alternative flow requirement as has been suggested by the SWRCB. This particular flow requirement currently serves as the example alternative requirement for this documentation. The specifics of this component of flow requirement (February through June) in combination with the current 1995 FERC minimum flow requirement has been provided to worksheet UserInput for illustration purposes.



CYMonth Index	Date	Day	Days	Model Input La Grange Daily CFS	Model Input La Grange Daily AF	Pulse Day	La Grange Monthly AF	Day Percent	FERC Only La Grange Daily AF	TR UF CFS	Trial Feb-Jun CFS	Feb-Jun CFS	Feb-Jun CFS	X% Req Alone AF	UserInput User Defined Time Series Flow Reqrmnt CFS	UserInput User Defined Time Series Flow Reqrmnt AF	UserInput User Defined Yr-Type Table Flow Reqrmnt CFS	UserInput User Defined Yr-Type Table Flow Reqrmnt AF
1970.10	10/1/1970	T	31	397	787		24,397	0.03226	787	159	0	0	0	0	397	787	295	585
1970.10	10/2/1970	F	31	397	787		24,397	0.03226	787	55	0	0	0	0	397	787	295	585
1970.10	10/3/1970	S	31	397	787		24,397	0.03226	787	265	0	0	0	0	397	787	295	585
1970.10	10/4/1970	S	31	397	787		24,397	0.03226	787	-166	0	0	0	0	397	787	295	585
1970.10	10/5/1970	M	31	397	787		24,397	0.03226	787	180	0	0	0	0	397	787	295	585
1970.10	10/6/1970	T	31	397	787		24,397	0.03226	787	92	0	0	0	0	397	787	295	585

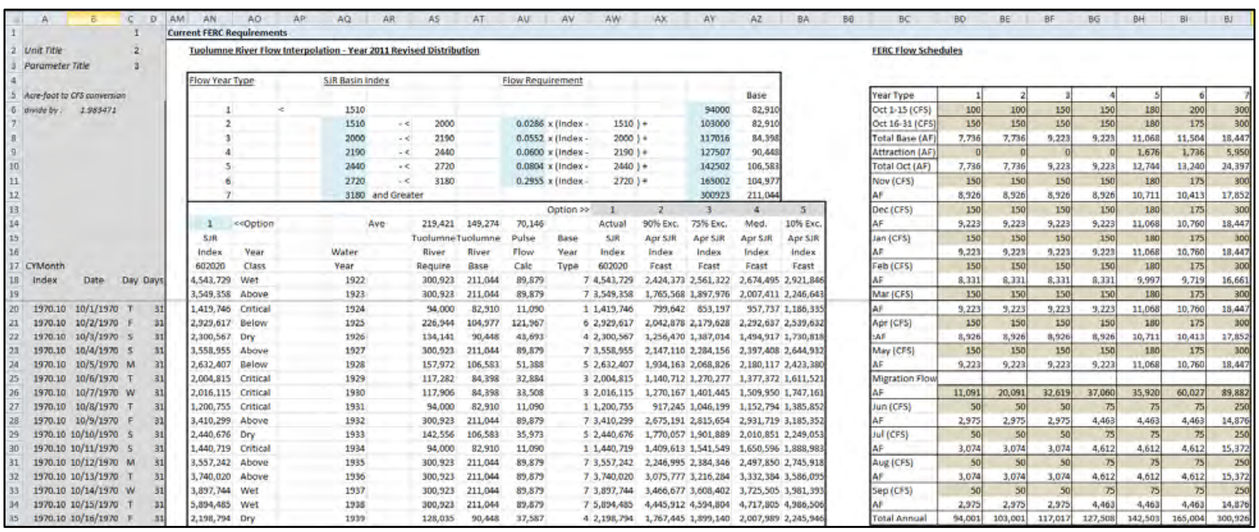
April – May Daily Parsing of Flow Requirements

This section of the worksheet provides information to parse monthly-designated minimum flow requirements into daily patterns during April and May. Worksheet Control designates which parsing pattern is to be used.



Computation of 1995 FERC Minimum Flow Requirement

This section of the worksheet computes the current 1995 FERC flow requirement. Several elements of information provided in this worksheet and from worksheet Control provide the computation of flow requirement based on 1995 FERC Settlement procedures and flow rates. The basis of the year type flow requirements is the SWRCB San Joaquin River Basin 60-20-20 index. The annual flow schedules are assumed to be apply on a April through March year, with the interpolation water of the schedules applied to April and May pulse flows. A snapshot of the worksheet's computation area is shown below.



San Francisco La Grange Responsibility

Also performed in this worksheet is the computation of the hypothetical responsibility of CCSF for Tuolumne River incremental flow requirements.[5] A snapshot of the computation area is shown below.

[5] The "shared responsibility" assumption is presented for the purpose of evaluating alternative operations. The assumption shall not be used as evidence in any proceeding relating to and shall not act as precedence for any allocation of Tuolumne River water between CCSF and the Districts for any purpose under the Fourth Agreement.

SF La Grange Responsibility Computation

Unit Title 2
Parameter Title 3

Acre-foot to CFS conversion
divide by : 1.983471

Approach - SF 52% Responsibility Scenario

Compute difference between existing FERC minimum flow requirement and test scenario
Test scenario: SWRCB 30% UF February-June w/ 200/3,500 cfs bounds on SWRCB component, or existing FERC whichever is greater

CYMonth Index	Date	Day	Days	Exsiting FERC CFS	Exsiting FERC AF	Scenario SWRCB 30% CFS	Scenario SWRCB 30% AF	Total Diff Alt minus FERC AF	51.7121 SF Debit AF
					213,897		213,897	0	0
1970.10	10/1/1970	T	31	397	787	397	787	0	0
1970.10	10/2/1970	F	31	397	787	397	787	0	0
1970.10	10/3/1970	S	31	397	787	397	787	0	0
1970.10	10/4/1970	S	31	397	787	397	787	0	0
1970.10	10/5/1970	M	31	397	787	397	787	0	0
1970.10	10/6/1970	T	31	397	787	397	787	0	0

The 1995 FERC flow requirement and the scenario flow requirement are compared on a daily basis to identify the difference between the two schedules. The CCSF 52% responsibility factor is applied to the total difference, which values are then provided to the WaterBankRel and SFWaterBank worksheets for use if selected.

5.17 DailyCanalsCompute Workheet

This worksheet (DailyCanalsCompute) performs the computation of the daily canal demands of the MID and TID. The computation of canal demands incorporate the PDAW and canal operations practices of the districts. This worksheet also incorporates the application of a Water Supply Factor (from worksheet DPWSF) that reduces canal diversions during limited water supply conditions. The results from this worksheet have been provided to the Model for the Test Case scenario.

Projected Demand for Applied Water and Don Pedro Water Supply Factor

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1			1		District Canal Diversion Computed by Canal Assumptions and Don Pedro Water Supply Factor									
2	Unit Title		2		Factor		Factor	Factor			AF	AF	AF	AF
3	Parameter Title		3		DP WSF Full		DP WSF	Dynamic WSF			MID Daily	TID Daily /	MID Daily	TID Daily
4														
5	Acre-foot to CFS conversion													
6	divide by :	1.983471			Pre-Proc	Pre-Proc	Active	Read	Read	Read				
7					Full	Base	Factor	from	from	from				
8					Factor	Factor	Used in	DPWSF	BU20:487	BV20:487				
9					1		Scenario							
10				39-yr Ave							170,364	406,025	34,500	0
11				Max	1.0000	1.0000	1.0000	1.0000	36,100		1,822	4,116	110	0
12				Min	1.0000	0.6000	0.6000	0.6000	0		0	0	74	0
13					DP Water Supply Factor				District Projected Demand of Applied Water					
14						10-4-2012								
15					DP	DP								
16					WS Factor	WS Factor	Model	DP	MID	TID	MID	TID	MID	TID
17	Month				Full	Base	DP	WS Factor	PDAW	PDAW	Daily	Daily	Daily	Daily
18	Index	Date	Day	Days	Demand	Case	WS Factor	Dynamic	Monthly	Monthly	PDAW	PDAW	M&I	M&I
19									AF	AF	AF	AF	AF	AF
20	1970.10	10/1/1970	T	31	1.0000	1.0000	1.0000	1.0000	6,000	16,000	347	1,217	103	0
21	1970.10	10/2/1970	F	31	1.0000	1.0000	1.0000	1.0000	6,000	16,000	270	626	103	0
22	1970.10	10/3/1970	S	31	1.0000	1.0000	1.0000	1.0000	6,000	16,000	262	564	103	0
23	1970.10	10/4/1970	S	31	1.0000	1.0000	1.0000	1.0000	6,000	16,000	293	990	103	0
24	1970.10	10/5/1970	M	31	1.0000	1.0000	1.0000	1.0000	6,000	16,000	292	683	103	0
25	1970.10	10/6/1970	T	31	1.0000	1.0000	1.0000	1.0000	6,000	16,000	315	769	103	0

This section of logic incorporates two components of information into the computation of canal demands. The PDAW for each District is a pre-processed Model entry based on an estimate developed by the California Department of Water Resources Consumptive Use model. The monthly time series for PDAW for the simulation period is modified prior to use in the computation to refine the demand to recognize the local districts' delivery records. The second component of information is the Don Pedro Water Supply Factor (WSF). This fraction is computed in worksheet DPWSF and reflects limited water supplies during periods of drought. The factor is used to reduce canal diversions, based on antecedent reservoir storage and forecasted inflow to Don Pedro Reservoir. There are several versions of the WSF available for use in the Model if user access is allowed. The "full demand" WSF will produce a canal demand/diversion equal to full needs, as if the available water supply is sufficient to meet the full canal demands. The WSF table included in the Model represents canal demands including reductions from full diversions, and manages water supplies to produce a reservoir operation similar to that occurred during the 1987-1992 drought.

District Canal Demand Calculation

The sections of logic shown below illustrate the components of District canal operations that factor into the computation of daily canal demands/diversions. These components build on top of the PDAW to develop a daily canal demand from Don Pedro Reservoir. The PDAW is represented as a daily varying demand based on recent historical daily diversion shapes while the canal operation parameters are generally represented by an even distribution pattern within each month.

	A	B	C	D	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE
1			1																		
2	Unit Title		2			AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF		AF		CFS	
3	Parameter Title		3		M&I	MID Turnc	MID Nom	MID Turnc	MID Canal	MID Canal	MID Canal	MID Lwr C	MID Nom	MID Lwr C	MID M&I I	MID Upper Sys Losse		MID La Grange Diver		MID La Grange Diver-	
4																					
5	Acre-foot to CFS conversion				Override for DailyCanals		(UI 2.10)		0	(1) on, use user-defined table, (0) off, use Base Case canal diversion								Capacity Check		2,000 cfs	
6	divide by :	1.983471				0			0	(0) off, use UserInput option (UI 2.10), or (2) use calculated canal diversion									Max	1,257	
7					If <> 2, use UserInput or Base				1	If using calculated canal diversion, (1) Base, (2) Full Demand, or (3) Dynamic											
8					If = 2, use calculated																Pre-Proc
9																					Factor
10			39-yr Ave			215,775	20,995	194,780	44,510	5,059	8,492	235,857	17,280	218,577	34,500	31,100	0	284,177			
11			Max			2,323	133	2,291	233	21	45	2,314	84	2,282	110	158	65	2,492			
12			Min			0	0	0	0	0	0	0	0	0	74	0	-97	81			
13					MID Canal Demand Calculation																
14–19	Month Index	Date	Day	Days	MID Factor %	MID Turnout w/o Prvt Pmp AF	MID Nom Prvt Pmp AF	MID Turnout Delivery AF	MID Canal Op Spills AF	MID Canal Losses AF	MID Canal Intercpt Flow AF	MID Lwr Canal bfr MID Nom Pmp AF	MID Nom Pmp AF	MID Lwr Canal Diversion AF	MID M&I Div frm Modesto Lake AF	MID Upper System Losses AF	MID Modesto Lake Daily Change AF	MID La Grange Diversion AF	MID Monthly Sum Diversion AF	MID La Grange Diversion CFS	MID 7-day 3-yr Ave Day Percent % of Mo
20	1970.10	10/1/1970	T	31	40	869	32	836	223	20	29	1,050	68	982	103	65	-97	1,053	20,952	531	0.06
21	1970.10	10/2/1970	F	31	40	676	32	643	223	20	29	857	68	789	103	65	-97	860	20,952	434	0.05
22	1970.10	10/3/1970	S	31	40	656	32	623	223	20	29	837	68	769	103	65	-97	840	20,952	424	0.04
23	1970.10	10/4/1970	S	31	40	734	32	701	223	20	29	915	68	847	103	65	-97	918	20,952	463	0.05
24	1970.10	10/5/1970	M	31	40	730	32	698	223	20	29	911	68	844	103	65	-97	915	20,952	461	0.05
25	1970.10	10/6/1970	T	31	40	789	32	756	223	20	29	970	68	902	103	65	-97	973	20,952	491	0.05

	A	B	C	D	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV
1			1																		
2	Unit Title		2			AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF		AF		CFS	
3	Parameter Title		3		sion	TID Turnoi	TID Nom F	TID Turnoi	TID Canal	MID Canal	TID Canal	TID Lwr Ca	TID Nom F	TID Lwr Ca	TID M&I D	TID Upper Sys Losse		TID La Grange Divers		TID La Grange Divers	
4																					
5	Acre-foot to CFS conversion																	Capacity Check		3,400 cfs	
6	divide by	1.983471																	Max	2,404	
7																					
8																					Pre-Proc
9																					Factor
10			39-yr Ave			532,337	31,298	501,039	46,871	36,555	0	584,465	77,066	507,399	0	52,200	0	559,697			
11			Max			4,535	206	4,455	243	150	0	4,815	471	4,548	0	290	250	4,768			
12			Min			0	0	0	0	0	0	0	0	0	0	32	-452	1			
13					TID Canal Demand Calculation																
14–19	Month Index	Date	Day	Days	TID Factor %	TID Turnout w/o Prvt Pmp AF	TID Nom Prvt Pmp AF	TID Turnout Delivery AF	TID Canal Op Spills AF	TID Canal Losses AF	TID Canal Intercpt Flow AF	TID Lwr Canal bfr TID Nom Pmp AF	TID Nom Pmp AF	TID Lwr Canal Diversion AF	TID M&I Div frm Turlock Lake AF	TID Upper System Losses AF	Turlock Lake Daily Change AF	TID La Grange Diversion AF	TID Monthly Sum Diversion AF	TID La Grange Diversion CFS	TID 7-day 3-yr Ave Day Percent % of Mo
20	1970.10	10/1/1970	T	31	40	3,044	77	2,966	235	145	0	3,347	171	3,176	0	65	-452	2,789	31,487	1,406	0.08
21	1970.10	10/2/1970	F	31	40	1,565	77	1,488	235	145	0	1,869	171	1,698	0	65	-452	1,311	31,487	661	0.04
22	1970.10	10/3/1970	S	31	40	1,409	77	1,332	235	145	0	1,712	171	1,541	0	65	-452	1,154	31,487	582	0.04
23	1970.10	10/4/1970	S	31	40	2,475	77	2,398	235	145	0	2,779	171	2,608	0	65	-452	2,220	31,487	1,119	0.06
24	1970.10	10/5/1970	M	31	40	1,708	77	1,631	235	145	0	2,011	171	1,841	0	65	-452	1,453	31,487	733	0.04
25	1970.10	10/6/1970	T	31	40	1,923	77	1,845	235	145	0	2,226	171	2,055	0	65	-452	1,668	31,487	841	0.05

District Canal Operation Assumptions

The canal operation assumptions, e.g., seepage and losses and canal operation spills, are identified in this worksheet (entered into worksheet Control). These parameters are provided to the computations shown above. The canal operation assumptions for each District are shown below.

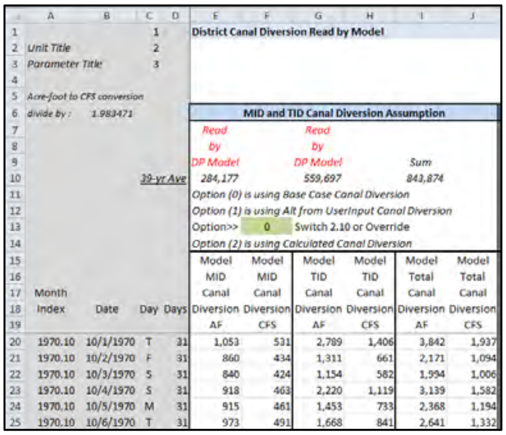
Modesto Irrigation District											
	Turnout Delivery Factor	Nominal Private GW Pumping	Canal Operational Spills Critical	Canal Operational Spills Non-crit	System Losses below Modesto Res	Intercepted Flows	Nominal MID GW Pumping	Modesto Res and Upper Canal Losses/Div	Municipal Delivery from Modesto Res	Modesto Res Target Storage	Modesto Res Target Storage Change
Month	%	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF
January	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	17.0	2.0
February	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.3	18.0	1.0
March	65.0	1.0	1.0	3.0	0.6	0.9	1.0	2.0	2.7	18.0	0.0
April	70.0	2.0	3.0	6.0	0.6	0.9	2.3	2.9	2.7	19.0	1.0
May	85.0	3.0	4.0	6.5	0.6	1.2	2.3	3.9	3.0	20.0	1.0
June	85.0	4.0	3.5	6.5	0.6	1.0	2.3	4.3	3.2	20.0	0.0
July	77.5	4.0	3.5	6.5	0.6	1.0	2.6	4.9	3.3	21.0	1.0
August	70.0	4.0	4.9	7.0	0.6	1.4	2.4	4.9	3.3	22.0	1.0
September	65.0	2.0	5.0	7.0	0.6	1.2	2.3	4.2	3.3	20.0	-2.0
October	40.0	1.0	2.8	6.9	0.6	0.9	2.1	2.0	3.2	17.0	-3.0
November	30.0	0.0	2.0	2.0	0.1	0.0	0.0	2.0	2.7	15.0	-2.0
December	35.0	0.0	2.0	2.0	0.1	0.0	0.0	0.0	2.5	15.0	0.0
Total		21.0	35.7	57.4	5.4	8.5	17.3	31.1	34.5		

Turlock Irrigation District											
	Turnout Delivery Factor	Nominal Private GW Pumping	Canal Operational Spills Critical	Canal Operational Spills Non-crit	System Losses below Turlock Lk	Intercepted Flows	Nominal TID GW Pumping	Turlock Lk and Upper Canal Losses	Other Delivery from Turlock Lk	Turlock Lk Target Storage	Turlock Lk Target Storage Change
Month	%	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF	TAF
January	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	18.0	5.0
February	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	25.0	7.0
March	65.0	1.2	3.0	3.0	4.5	0.0	4.1	1.0	0.0	30.0	5.0
April	57.5	2.4	5.1	6.3	4.5	0.0	8.0	6.6	0.0	30.0	0.0
May	85.0	3.6	4.6	6.7	4.5	0.0	10.3	7.7	0.0	32.0	2.0
June	92.5	5.2	4.2	6.7	4.5	0.0	12.4	8.2	0.0	32.0	0.0
July	72.5	6.4	4.2	6.7	4.5	0.0	14.6	8.7	0.0	32.0	0.0
August	62.5	6.2	4.0	7.3	4.5	0.0	13.3	9.0	0.0	30.0	-2.0
September	67.5	3.9	3.2	7.3	4.5	0.0	9.1	5.0	0.0	27.0	-3.0
October	40.0	2.4	2.3	7.3	4.5	0.0	5.3	2.0	0.0	13.0	-14.0
November	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0	0.0
December	30.0	0.0	2.0	2.0	0.8	0.0	0.0	1.0	0.0	13.0	0.0
Total		31.3	38.6	59.3	39.2	0.0	77.1	52.2	0.0		

5.18 DailyCanals Workheet

This worksheet (DailyCanals) assembles the appropriate canal demands for the scenario. While worksheet DailyCanalsCompute is capable of providing several versions of canal demands, worksheet DailyCanals readies either those selected demands or alternatively defined demands for the Model.

Model (scenario) Canal Demands

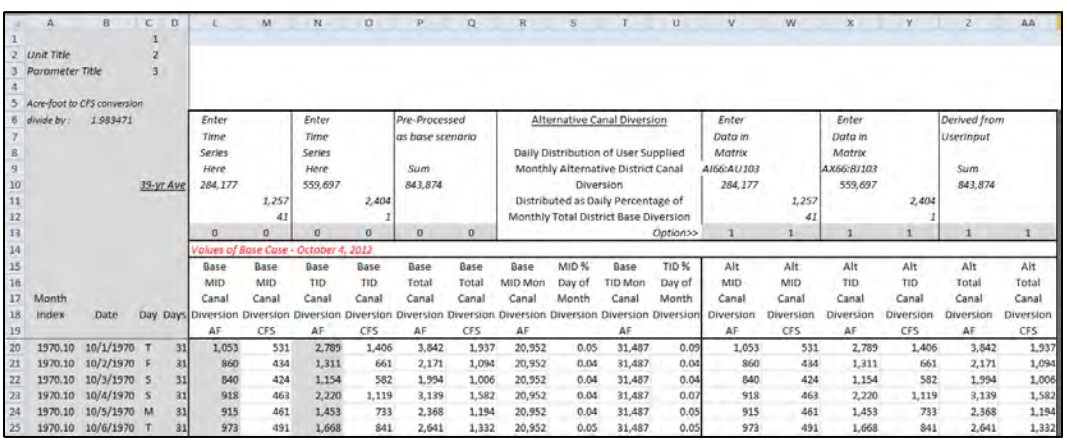


	A	B	C	D	E	F	G	H	I	J
1			1		District Canal Diversion Read by Model					
2	*Unit Title*		2							
3	*Parameter Title*		3							
4										
5	*Acre-foot to CFS conversion*									
6	*divide by :*	*1.983471*			MID and TID Canal Diversion Assumption					
7					*Read*		*Read*			
8					*by*		*by*			
9					*DP Model*		*DP Model*		*Sum*	
10			*39-yr Ave*		*284,177*		*559,697*		*843,874*	
11					*Option (0) is using Base Case Canal Diversion*					
12					*Option (1) is using Alt from UserInput Canal Diversion*					
13					Option>>	0	Switch 2.10 or Override			
14					*Option (2) is using Calculated Canal Diversion*					
15					Model	Model	Model	Model	Model	Model
16					MID	MID	TID	TID	Total	Total
17	Month				Canal	Canal	Canal	Canal	Canal	Canal
18	Index	Date	Day	Days	Diversion	Diversion	Diversion	Diversion	Diversion	Diversion
19					AF	CFS	AF	CFS	AF	CFS
20	1970.10	10/1/1970	T	31	1,053	531	2,789	1,406	3,842	1,937
21	1970.10	10/2/1970	F	31	860	434	1,311	661	2,171	1,094
22	1970.10	10/3/1970	S	31	840	424	1,154	582	1,994	1,006
23	1970.10	10/4/1970	S	31	918	463	2,220	1,119	3,139	1,582
24	1970.10	10/5/1970	M	31	915	461	1,453	733	2,368	1,194
25	1970.10	10/6/1970	T	31	973	491	1,668	841	2,641	1,332

The section of logic shown above illustrates the two columns of data used by the Model (worksheet DonPedro) for canal diversions by MID and TID. The data version of demand used is user specified. If using the worksheet UserInput interface, UI 2.10 selects whether pre-processed Test Case diversions are used or a user specified table of diversions are used. If access to worksheet DailyCanalsCompute is granted, a time series of canal diversions from worksheet DailyCanalsCompute is used.

Test Case and Alternative Canal Diversions

This section of logic provides the Model either a pre-processed time series of canal diversions (Test Case) or a time series of canal diversions that has been specified by the user in worksheet UserInput (UI 2.20 and UI 2.30) as monthly canal demands for the simulation period. A snapshot of the worksheet is shown below. This section of logic also parses the user specified monthly table of canal diversions into a daily diversion pattern based on the Test Case scenario's daily pattern of diversions.



	A	B	C	D	L	M	N	O	P	Q
1			1							
2	*Unit Title*		2							
3	*Parameter Title*		3							
4										
5	*Acre-foot to CFS conversion*									
6	*divide by :*	*1.983471*			*Enter*		*Enter*		*Pre-Processed*	
7					*Time*		*Time*		*as base scenario*	
8					*Series*		*Series*			
9					*Here*		*Here*		*Sum*	
10			*39-yr Ave*		*284,177*		*559,697*		*843,874*	
11						*1,257*		*2,404*		
12						*41*		*1*		
13					0	0	0	0	0	0
14					*Values of Base Case - October 4, 2012*					
15					Base	Base	Base	Base	Base	Base
16					MID	MID	TID	TID	Total	Total
17	Month				Canal	Canal	Canal	Canal	Canal	Canal
18	Index	Date	Day	Days	Diversion	Diversion	Diversion	Diversion	Diversion	Diversion
19					AF	CFS	AF	CFS	AF	CFS
20	1970.10	10/1/1970	T	31	1,053	531	2,789	1,406	3,842	1,937
21	1970.10	10/2/1970	F	31	860	434	1,311	661	2,171	1,094
22	1970.10	10/3/1970	S	31	840	424	1,154	582	1,994	1,006
23	1970.10	10/4/1970	S	31	918	463	2,220	1,119	3,139	1,582
24	1970.10	10/5/1970	M	31	915	461	1,453	733	2,368	1,194
25	1970.10	10/6/1970	T	31	973	491	1,668	841	2,641	1,332

	R	S	T	U	V	W	X	Y	Z	AA
6	Alternative Canal Diversion				*Enter*		*Enter*		*Derived from*	
7					*Data in*		*Data in*		*UserInput*	
8	Daily Distribution of User Supplied				*Matrix*		*Matrix*			
9	Monthly Alternative District Canal				*AI66:AU103*		*AX66:BJ103*		*Sum*	
10	Diversion				*284,177*		*559,697*		*843,874*	
11	Distributed as Daily Percentage of					*1,257*		*2,404*		
12	Monthly Total District Base Diversion					*41*		*1*		
13				*Option>>*	1	1	1	1	1	1
15	Base	MID %	Base	TID %	Alt	Alt	Alt	Alt	Alt	Alt
16	MID Mon	Day of	TID Mon	Day of	MID	MID	TID	TID	Total	Total
17	Canal	Month	Canal	Month	Canal	Canal	Canal	Canal	Canal	Canal
18	Diversion	Diversion	Diversion	Diversion	Diversion	Diversion	Diversion	Diversion	Diversion	Diversion
19	AF		AF		AF	CFS	AF	CFS	AF	CFS
20	20,952	0.05	31,487	0.09	1,053	531	2,789	1,406	3,842	1,937
21	20,952	0.04	31,487	0.04	860	434	1,311	661	2,171	1,094
22	20,952	0.04	31,487	0.04	840	424	1,154	582	1,994	1,006
23	20,952	0.04	31,487	0.07	918	463	2,220	1,119	3,139	1,582
24	20,952	0.04	31,487	0.05	915	461	1,453	733	2,368	1,194
25	20,952	0.05	31,487	0.05	973	491	1,668	841	2,641	1,332

Adjacent to the above illustrated area of computations are several components of data assemblage. The monthly time series columns serve to summarize daily Test Case diversions assumptions and provide user specified monthly diversions for daily parsing. The chronological matrices provide an alternative listing of the monthly data.

	A	B	C	D
1			1	
2	*Unit Title*		2	
3	*Parameter Title*		3	
4				
5	*Acre-foot to CFS conversion*			
6	*divide by :*	*1.983471*		
10			*39-yr Ave*	
17	Month			
18	Index	Date	Day	Days
20	1970.10	10/1/1970	T	31
21	1970.10	10/2/1970	F	31
22	1970.10	10/3/1970	S	31
23	1970.10	10/4/1970	S	31
24	1970.10	10/5/1970	M	31
25	1970.10	10/6/1970	T	31

Monthly Time Series Data

AC	AD	AE	AF	AG
	Monthly from Daily Input Pre-Proc	*Enter Data in Matrix AI66:AU103 UserInput*	*Monthly from Daily Input Pre-Proc*	*Enter Data in Matrix AX66:BJ103 UserInput*
39-yr Ave	*284,177*	*284,177*	*559,697*	*559,697*
	1	2	1	2
Yr-Month	MID Base Assumpt Monthly Volume AF	MID Alt Assumpt Monthly Volume AF	TID Base Assumpt Monthly Volume AF	TID Alt Assumpt Monthly Volume AF
1970.10	20,952	20,952	31,487	31,487
1970.11	2,700	2,700	1,000	1,000
1970.12	2,500	2,500	1,000	1,000
1971.01	4,300	4,300	6,000	6,000
1971.02	3,300	3,300	8,000	8,000
1971.03	14,746	14,746	42,220	42,220

Monthly Matrix Time Series Data

User-defined District Canal Diversions at AI66:AU103 and AX66:BJ103

Test_Base MID Canal Assumption - Read from Time Series in Column AD
Acre-feet

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total WY
1971	20,952	2,700	2,500	4,300	3,300	14,746	30,656	42,917	47,253	54,987	49,086	32,192	305,589
1972	20,952	5,130	2,500	4,300	5,679	24,844	46,800	46,544	46,542	54,987	49,086	30,637	338,001
1973	20,952	2,700	2,500	4,300	3,300	14,746	23,737	45,374	47,016	54,987	49,086	32,658	301,356
1974	20,952	2,700	2,500	4,300	3,300	14,746	18,115	42,917	45,239	49,733	49,086	32,658	286,246
1975	20,952	5,460	2,500	4,300	3,300	14,746	28,782	44,672	47,253	54,859	43,423	32,658	302,906
1976	20,952	6,451	2,500	4,300	6,350	30,232	34,676	38,540	38,163	44,939	35,682	24,524	287,308

5.19 DPWSF Workheet

This worksheet (DPSWF) computes the Don Pedro Water Supply Factor (WSF). The premise of the WSF factor is to reduce the amount of water diverted to the canals during years when lack of carryover storage at Don Pedro Reservoir becomes a concern. The modeling mechanism used to reduce canal diversions is a factor applied to the PDAW of the canal demand. This mechanism results in a reduction to the amount of water "turned out" to the customers while still recognizing the relatively constant efficiencies of canal operations.

The WSF is established by forecasting upcoming water supply, based on antecedent storage and anticipated inflow to Don Pedro Reservoir. The forecasting procedure begins in February and ends in April. The Factor Table is based on April forecast results. The February and March Forecasts act as adjustments to get to the April 1 state. The forecasts have the following protocol:

February Forecast (forecasting April 1 state):
End of January storage + Feb-Jul UF - Feb-Jul US adjustment - Feb-Mar minimum river
March Forecast (forecasting April 1 state):
End of February storage + Mar-Jul UF - Mar-Jul US adjustment - Mar minimum river
April Forecast: (final)
End of March storage + Apr-Jul UF - Apr-July US adjustment

Pre-knowledge of unimpaired runoff for each forecast period is assumed, as well as knowledge of upcoming upstream impairment of the runoff.

The WSF factor / Don Pedro Storage + Inflow relationship is developed through iterations of multi-year system operation simulations. The WSF depicts actions that may be implemented during times of drought, and the projected canal diversions and reservoir storage operation during drought periods. The factors and index triggers were developed reviewing reservoir storage levels that occurred during the 1987-1992 drought.

A snapshot of the worksheet is shown below.

		1
Unit Title		2
Parameter Title		3
Acre-foot to CFS conversion		
divide by :	*1.983471*	

Don Pedro Reservoir Inflow Forecast for Diversion of Water Supply

Reservoir Index Method - Active Matrix

	M/T NDP Stor + Infl Index	M/TID WS Factor	+1	+1
	kaf	%		
Enter	0	0.6	1350	0.6
Values	1350	0.6	1600	0.85
	1600	0.85	2000	0.85
	2000	0.85	2001	1
	2001	1	2300	1
	2300	1	9999	1
	9999	1		

(W)ater (S)upply (F)actor is established by forecasting upcoming water supply, based on antecedent storage and anticipated inflow to Don Pedro Reservoir.

Forecast begins for February:
EO-January storage + Feb-July UF - Feb-July US adj - Feb-Mar minimum river
March Forecast:
EO-February storage + Mar-July UF - Mar-July US adj - Mar minimum river
April Forecast: (final)
EO-March storage + Apr-July UF - Apr-July US adj

Factor Table is April Forecast based
February and March Forecasts act as adjustments to estimate April 1 state.

Read by Daily Canals Compute

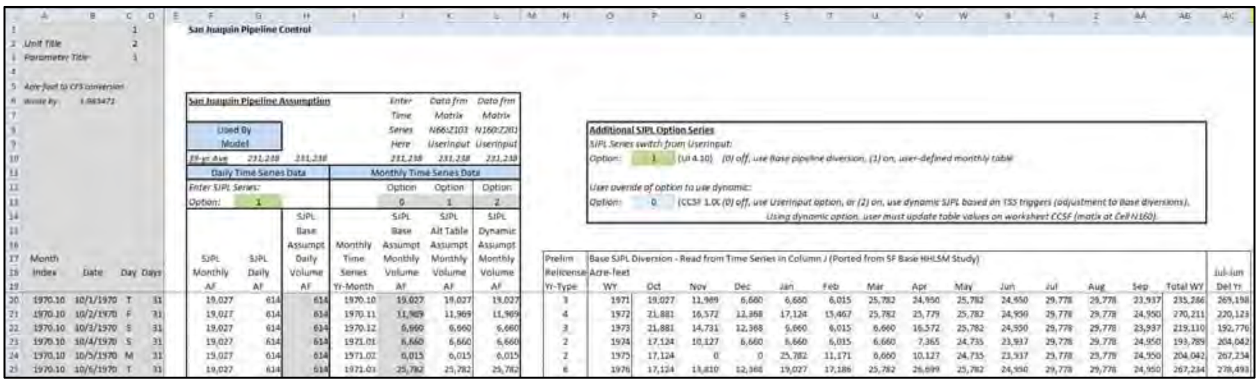
Month Index	Date	Day	Days	Month	Model DP Storage AF	Unimpaired Flow - Actual Used: Feb UF AF	Mar UF AF	Apr UF AF	May UF AF	Jun UF AF	Jul UF AF	F-Jul UF AF	M-Jul UF AF	A-Jul UF AF	Upstream Adjustement to UF: F-Jul US AF	M-Jul US AF	A-Jul US AF	River: Feb River AF	Mar River AF	Storage: Prev Stor AF	Forecast: Forecast AF	WSF: Lower WSP Factor Unit	Upper WSP Factor Unit	Lower Break Point Unit	Upper Break Point Unit	WSF Unit
1970.10	10/1/1970	T	31	10	1666767	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,500,000	1.0000	1.0000	2300	9999	1.0000
1970.10	10/2/1970	F	31	10	1664567	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,500,000	1.0000	1.0000	2300	9999	1.0000
1970.10	10/3/1970	S	31	10	1662719	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,500,000	1.0000	1.0000	2300	9999	1.0000
1970.10	10/4/1970	S	31	10	1659892	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,500,000	1.0000	1.0000	2300	9999	1.0000
1970.10	10/5/1970	M	31	10	1656745	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,500,000	1.0000	1.0000	2300	9999	1.0000
1970.10	10/6/1970	T	31	10	1654119	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,500,000	1.0000	1.0000	2300	9999	1.0000

5.20 CCSF Workheet

This worksheet (CCSF) identifies, assembles and directs several elements of CCSF System operations, and provides input to other Model component worksheets.

San Joaquin Pipeline Diversions

The first section of logic concerns the identification of SJPL diversions. A snapshot of this section is shown below. By user selection (UI 4.10) either pre-processed Test Case SJPL diversions are used, or a user specified table of monthly diversions for the simulation period are used. This section assembles the user selected version of diversions for use by the Model. These two versions of SJPL diversions are available for selection through worksheet UserInput. If access is granted, a third version of SJPL diversions is provided which revises Test Case diversions based on circumstances of the scenario that changes CCSF's operation. Procedures are described below the monthly diversion matrix describing how to employ this third version of SJPL diversions.



San Joaquin Pipeline Control

Unit Title 2
Parameter Title 3
Acre-feet to CFS conversion
divide by: 1.983471

San Joaquin Pipeline Assumption

Used By Model

Additional SJPL Option Series
SJPL Series switch from UserInput:
Option: 1 (UI 4.10) (0) off, use Base pipeline diversion, (1) on, user-defined monthly table
User override of option to use dynamic:
Option: 0 (CCSF 1.0((0) off, use UserInput option, or (2) on, use dynamic SJPL based on TSS triggers (adjustment to Base diversions).
Using dynamic option, user must update table values on worksheet CCSF (matix at Cell N160).

							Enter Time Series Here	Data from Matrix N66:Z103 UserInput	Data from Matrix N160:Z201 UserInput
				19-yr Ave	231,238	231,238		231,238	231,238	231,238
				Daily Time Series Data			Monthly Time Series Data			
				Enter SJPL Series: Option: 1				Option 0	Option 1	Option 2
Month Index	Date	Day	Days	SJPL Monthly AF	SJPL Daily AF	SJPL Base Assumpt Daily Volume AF	Monthly Time Series Yr-Month	SJPL Base Assumpt Monthly Volume AF	SJPL Alt Table Assumpt Monthly Volume AF	SJPL Dynamic Assumpt Monthly Volume AF
1970.10	10/1/1970	T	31	19,027	614	614	1970.10	19,027	19,027	19,027
1970.10	10/2/1970	F	31	19,027	614	614	1970.11	11,969	11,969	11,969
1970.10	10/3/1970	S	31	19,027	614	614	1970.12	6,660	6,660	6,660
1970.10	10/4/1970	S	31	19,027	614	614	1971.01	6,660	6,660	6,660
1970.10	10/5/1970	M	31	19,027	614	614	1971.02	6,015	6,015	6,015
1970.10	10/6/1970	T	31	19,027	614	614	1971.03	25,782	25,782	25,782

Prelim Relicense Yr-Type	Base SJPL Diversion - Read from Time Series in Column J (Ported from SF Base HHLSM Study) Acre-feet WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total WY	Jul-Jun Del Yr
3	1971	19,027	11,969	6,660	6,660	6,015	25,782	24,950	25,782	24,950	29,778	29,778	23,937	235,286	269,198
4	1972	21,881	16,572	12,368	17,124	15,467	25,782	25,779	25,782	24,950	29,778	29,778	24,950	270,211	220,123
3	1973	21,881	14,731	12,368	6,660	6,015	6,660	16,572	25,782	24,950	29,778	29,778	23,937	219,110	192,776
2	1974	17,124	10,127	6,660	6,660	6,015	6,660	7,365	24,735	23,937	29,778	29,778	24,950	193,789	204,042
2	1975	17,124	0	0	25,782	11,171	6,660	10,127	24,735	23,937	29,778	29,778	24,950	204,042	267,234
6	1976	17,124	13,810	12,368	19,027	17,186	25,782	26,699	25,782	24,950	29,778	29,778	24,950	267,234	278,493

CCSF System Storage and Action Levels

This section of logic provides reporting and computational functions. The CCSF System action level computation analyzes scenario results concerning CCSF's reservoir storage and extrapolates that information into advised action levels within the CCSF System. Germane to the FERC investigation is the potential effect that flow responsibility placed upon CCSF may have upon its water system and deliveries. The relationship between CCSF System reservoir storage and action levels (translated to increased delivery rationing) is incorporated into this worksheet. Upon changed conditions within a scenario (as compared to Test Case conditions), the change in action levels is identified. This change is also provided the SJPL diversion logic described above, and if allowed to be selected this worksheet will perform an adjustment to SJPL diversions.

San Francisco System Storage and Action Levels

	A	B	C	D
1			1	
2	Unit Title		2	
3	Parameter Title		3	
5	Acre-foot to CFS conversion			
6	divide by :	1.983471		

Row 2 (Level): Level AF AF AF AF AF AF AF AF
Row 3 (Parameter Title): Ping Mode Hetch Het Lake Lloyd Lake Eleanor Storage Total HH S Local Stor Total Syst Model Action Level

SF System Storage and Action Level Status - Daily Time Series Data

Linked to SF Base HHLSM Study "Hydrology" — Use Only Last Day of Month Plotting

Scenario Model Results plus SF Base HHLSM Study Local System Storage

Row	Month Index	Date	Day	Days	Base Action Level	Scenario Hetch Hetchy Storage AF	Scenario Lake Lloyd Storage AF	Scenario Lake Eleanor Storage AF	Scenario Water Bank Balance AF	Scenario Total Upcountry Storage AF	Scenario Total HH System Storage AF	Base Local Storage incl GW EOM AF	Total System Storage incl GW EOM AF	Scenario Action Level
20	1970.10	10/1/1970	T	31	0	249,349	200,091	17,591	570,000	467,031	1,037,031	211,136	3,000,000	0
21	1970.10	10/2/1970	F	31	0	248,379	200,080	17,137	570,000	465,596	1,035,596	211,136	3,000,000	0
22	1970.10	10/3/1970	S	31	0	247,622	200,090	16,692	570,000	464,404	1,034,404	211,136	3,000,000	0
23	1970.10	10/4/1970	S	31	0	247,032	199,278	15,878	570,000	462,189	1,032,189	211,136	3,000,000	0
24	1970.10	10/5/1970	M	31	0	246,150	199,896	15,707	569,744	461,752	1,031,496	211,136	3,000,000	0
25	1970.10	10/6/1970	T	31	0	245,360	199,781	15,206	570,000	460,347	1,030,347	211,136	3,000,000	0

SF System Action Level Computation

Actions	C2a.30	C2a.30			
Level	BaseTrigger	BaseAction	ScenarioT	ScenarioA	
0		0			
1	1,100,000	10	1,100,000	10	CCSF 2.00
2	1,100,000	10	1,100,000	10	
3	700,000	20	700,000	20	

Action Level Count

Level	Base Count	Scenario Count
0	33	33
1	0	0
2	6	6
3	0	0
Total	39	39

SF Action Level & SJPL Adjustment — "Hydrology"

EO-Jun	Year	SF Base June 30 TSS AF	SF Base Action Level (0-3)	Scenario June 30 TSS AF	Scenario Action Level (0-3)

Hetch Hetchy Reservoir Control

This section of logic identifies several underlying operation constraints for Hetch Hetchy Reservoir. Snapshots of this section are shown below. The minimum stream release below Hetch Hetchy Reservoir is computed in this section. Also identified in this section are reservoir storage targets and limits. This information is used in worksheet SFHetchHetchy for several operational constraints and objectives.

Hetch Hetchy Reservoir Control (BH: 15,000; BI: 6,500; BJ: 4,400)

Schedule Index - Accum Inches or Storage

Cal Mon	A (1)	B (2)	C (3)
1	8.80	6.1	
2	14	9.5	
3	18.6	14.2	
4	23	18	
5	26.6	19.5	
6	28.45	21.25	
7	575,000	390,000	
8	640,000	400,000	

Below Hetch Hetchy Requirement - CFS

Cal Mon	A (1)	B (2)	C (3)
1	50	40	35
2	60	50	35
3	60	50	35
4	75	65	35
5	100	80	50
6	125	110	75
7	125	110	75
8	125	72.5	75
9	90	65	62.5
10	60	50	35
11	60	50	35
12	50	40	35

Discretionary Schedule - Acre-feet

Cal Mon	A (1)	B (2)	C (3)
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0
7	0	0	0
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
12	0	0	0

Row	Month Index	Date	Day	Days	HH Accum Precip beginning Oct 1 Inches	Sum of WY HH Inflow To Date AF	Trigger Due to Inflow Jul-Dec AF	Schedule Due to Inflow Jul	Schedule Due to Inflow Aug - Dec	Jan Schedule	Feb Schedule	Mar Schedule	Apr Schedule	May Schedule	Jun Schedule	10 Oct Schedule CFS	11 Nov Schedule CFS	12 Dec Schedule CFS
19							709,538		1									
20	1970.10	10/1/1970	T	31	0.73	157	709,538	0	1	0	0	0	0	0	0	60	0	0
21	1970.10	10/2/1970	F	31	0.73	-6	709,538	0	1	0	0	0	0	0	0	60	0	0
22	1970.10	10/3/1970	S	31	0.73	44	709,538	0	1	0	0	0	0	0	0	60	0	0
23	1970.10	10/4/1970	S	31	0.73	262	709,538	0	1	0	0	0	0	0	0	60	0	0
24	1970.10	10/5/1970	M	31	0.73	186	709,538	0	1	0	0	0	0	0	0	60	0	0
25	1970.10	10/6/1970	T	31	0.73	204	709,538	0	1	0	0	0	0	0	0	60	0	0

BU notes: Month on 5 — *Does not include offramp of Discret "C" Sch due to HH Stor*; BV: *Does not include Canyon 64 cfs*; BW: *Lagged by 1 day to avoid circular reference*. BX: AF Total Mini; BY: CFS Total Mini.

Target Storage - Acre-feet

Cal Mon	Target EOM	Limit EOM
0	320000	
1	320,000	360,360
2	320,000	360,360
3	320,000	360,360
4	320,000	360,360
5	360,360	360,360
6	360,360	360,360
7	360,360	360,360
8	360,360	360,360
9	360,360	360,360
10	330,000	360,360
11	320,000	360,360
12	320,000	360,360

Row	Month Index	Date	Day	Days	1 Jan Schedule CFS	2 Feb Schedule CFS	3 Mar Schedule CFS	4 Apr Schedule CFS	5 May Schedule CFS	6 Jun Schedule CFS	7 Jul Schedule CFS	8 Aug Schedule CFS	9 Sep Schedule CFS	Basic Schedule AF	Discret Schedule AF	Min HH Basic + Discret Schedule AF	Canyon 64 cfs Schedule AF	w/ 64 cfs Total Min HH Schedule AF	w/ 64 cfs Total Min HH Schedule CFS		Day Chg Target	Target
19																						360,360
20	1970.10	10/1/1970	T	31	0	0	0	0	0	0	0	0	0	119	0	119		119	60		-979	359,381
21	1970.10	10/2/1970	F	31	0	0	0	0	0	0	0	0	0	119	0	119	0	119	60		-979	358,401
22	1970.10	10/3/1970	S	31	0	0	0	0	0	0	0	0	0	119	0	119	0	119	60		-979	357,422
23	1970.10	10/4/1970	S	31	0	0	0	0	0	0	0	0	0	119	0	119	0	119	60		-979	356,443
24	1970.10	10/5/1970	M	31	0	0	0	0	0	0	0	0	0	119	0	119	0	119	60		-979	355,463
25	1970.10	10/6/1970	T	31	0	0	0	0	0	0	0	0	0	119	0	119	0	119	60		-979	354,484

Lake Lloyd Control

This section of logic identifies several underlying operation constraints for Lake Lloyd. A snapshot of this section is shown below. The minimum stream release below Lake LLoyd is computed in this section. Also identified in this section are reservoir storage targets and limits, and the target release objective for Holm Powerhouse. The maximum drawdown of Lake Lloyd due to supplemental releases is identified. This information is used in worksheet SFLloyd for several operational constraints and objectives.

	A	B	C	D	CF	CG	CH
1			1		Lake Lloyd and Lake Eleanor Control		
2	Unit Title		2		Lloyd Target Storage - Acre-feet		
3	Parameter Title		3			Soft Trgt	Hard Limit
4					Cal Mon	EOM	EOM
5	Acre-foot to CFS conversion				0	238,000	
6	divide by	1.983471			1	238,000	273,300
7					2	238,000	273,300
8					3	238,000	273,300
9					4	273,300	272,300
10					5	273,300	273,300
11					6	273,300	273,300
12					7	268,000	273,300
13					8	258,000	273,300
14					9	248,000	273,300
15					10	248,000	273,300
16					11	238,000	273,300
17	Month				12	238,000	273,300
18	Index	Date	Day	Days	Day Chg	Target	
19					Target	248,000	
20	1970.10	10/1/1970	T	31	0	248,000	
21	1970.10	10/2/1970	F	31	0	248,000	
22	1970.10	10/3/1970	S	31	0	248,000	
23	1970.10	10/4/1970	S	31	0	248,000	
24	1970.10	10/5/1970	M	31	0	248,000	
25	1970.10	10/6/1970	T	31	0	248,000	

	CJ	CK	CL	CM	CN	CP	CQ	CS	CT	CU	CV
1											
2	Lake Lloyd/Lake Eleanor Split of Combined Inflow					Blw Lake Lloyd - CFS		Holm Target Releases			
3		Lloyd	Eleanor			Cal Mon	Req				
4	Cal Mon	%	%	Note:		1	5	May (Memorial Day) thru			
5	1	53	47	Watershed		2	5	August (Labor Day)			
6	2	52	48	proportions		3	5	Holm Capacity		950	cfs
7	3	52	48	were developed		4	5			Day	1,884 acre-feet
8	4	57	43	from the record		5	5		4-hours per day		314 acre-feet
9	5	65	35	of runoff each basin		6	5				
10	6	72	28	basin prior to 1960.		7	15.5	Minimum Lloyd Storage to Draw			
11	7	72	28			8	15.5	for Water Bank/Supplemental Release			
12	8	56	44			9	15.5	Release:	45,000 acre-feet	CCSF 3.00	
13	9	52	48			10	5				
14	10	69	31			11	5		May-Aug		
15	11	58	42			12	5		Min		
16	12	57	43						Holm		
17	Total	Lloyd	Lloyd	Eleanor	Eleanor	Min Req	Min Req		Target		
18	Inflow	Inflow	Inflow	Inflow	Inflow	Release	Release		Release		
19	CFS	CFS	AF	CFS	AF	CFS	AF	CFS	AF		
20	81	56	111	25	50	5	10	0	0		
21	7	5	10	2	4	5	10	0	0		
22	22	15	30	7	14	5	10	0	0		
23	-578	-399	-791	-179	-355	5	10	0	0		
24	466	322	638	144	287	5	10	0	0		
25	-69	-48	-94	-21	-42	5	10	0	0		

Lake Eleanor Control

This section of logic identifies several underlying operation constraints for Lake Eleanor. A snapshot of this section is shown below. The minimum stream release below Lake LLoyd is computed in this section. Also identified in this section are reservoir storage targets and limits. This information is used in worksheet SFEleanor for several operational constraints and objectives.

	A	B	C	D	CX	CY	CZ	DB	DC	DD
1			1							
2	Unit Title		2		Blw Lake Eleanor - CFS			Eleanor Target Storage - Acre-f		
3	Parameter Title		3			w/Pump	w/o		Soft Trgt	Hard Limit
4					Cal Mon	Req	Req	Cal Mon	EOM	EOM
5	Acre-foot to CFS conversion				1	5	5	0	18,250	
6	divide by	1.983471			2	5	5	1	21,495	27,100
7					3	10	5	2	21,495	27,100
8					4	15	5	3	21,495	27,100
9					5	20	5	4	27,100	27,100
10					6	20	5	5	27,100	27,100
11					7	20	16	6	27,100	27,100
12					8	20	16	7	27,100	27,100
13					9	15	16	8	27,100	27,100
14					10	10	5	9	15,000	27,100
15					11	5	5	10	15,000	27,100
16					12	5	5	11	15,000	27,100
17	Month				Min Req	Min Req	Always	12	18,250	27,100
18	Index	Date	Day	Days	Release	Release	Assume	Day Chg	Target	
19					CFS	AF	Pump	Target	15,000	
20	1970.10	10/1/1970	T	31	10	20		0	15,000	
21	1970.10	10/2/1970	F	31	10	20		0	15,000	
22	1970.10	10/3/1970	S	31	10	20		0	15,000	
23	1970.10	10/4/1970	S	31	10	20		0	15,000	
24	1970.10	10/5/1970	M	31	10	20		0	15,000	
25	1970.10	10/6/1970	T	31	10	20		0	15,000	

5.21 Hydrology Workheet

This worksheet (Hydrology) identifies and assembles underlying watershed hydrologic data necessary for Model operation. Required elements of historical hydrology include inflows to CCSF System reservoirs and the unregulated inflow to Don Pedro Reservoir. Also necessary are certain Test Case conditions for the CCSF System, namely Test Case SJPL diversions and water delivery (action levels) associated with Test Case conditions. Also needed is the status of local watershed reservoir storage associated with the Test Case condition.

5.22 602020 Workheet

This worksheet (602020) identifies and assembles underlying watershed hydrologic data necessary for Model operation. Included is the computation of the San Joaquin River Index. Also included are published results of DWR runoff forecasts.

Attachment B

December 7, 2012 Operations Model (W&AR-02) Workshop Notes

Don Pedro Project Relicensing
Operations Model Workshop and Training Session (W&AR-02)
Final Meeting Notes
December 7, 2012
HDR Office, Sacramento

Attendees

Bob Hackamack	Donn Furman, CCSF
Patrick Koepele, Tuolumne River Trust	Bob Hughes, CDFG
Chris Shutes, CSPA	Jenna Borovansky, HDR
Annie Manji, CDFG	Dan Steiner, consultant to TID/MID
Larry Thompson, NMFS	Rob Sherrick, HDR
Ramon Martin, USFWS	Rick Jones, HDR
Carin Loy, HDR	Monica Gutierrez, NMFS (by phone)
Ellen Levin, CCSF	Tim Heyne, CDFG (by phone)
Tim Findley, Bay Area Water Users (by phone)	Chandra Ferrari, Trout Unlimited (by phone)

Meeting Materials

Meeting materials are attached to the Final Notes filed with FERC.

Meeting materials provided were:
- Agenda (attached)
- PowerPoint Presentation (attached)
- Model Version 1.01 (provided at the meeting—and available by request to the Districts)

Meeting Summary

Mr. Steiner illustrated validation of the operations model and reviewed validation information. The meeting PowerPoint presentation is attached. Mr. Steiner explained the validation approach.

Mr. Hughes noted that synthesized unimpaired hydrology reflecting CDFG comments was not in the validation. Mr. Steiner replied that the validation used historical hydrology when appropriate to illustrate the validity of model logic; Mr. Steiner noted that the Districts will be replying to CDFG's recent letter to the SWRCB regarding CDFG's suggested approach to the unimpaired hydrology dataset.

Mr. Steiner reviewed validation materials with the group comparing historical to modeled information. Discussion regarding the modeling logic of accounting for snowmelt, flood control rules, and other factors previously covered in the October 23, 2012 Workshop also occurred during the demonstration and training.

Mr. Martin asked if pulse flows are provided for in the model. Mr. Steiner noted that flows are modeled at a daily level based on the monthly FERC required minimum flows. Mr. Steiner confirmed that VAMP flow is not shown in the current "test case" of the model. However, definition of a pulse flow during April and May is available within the model. October currently does not include a daily pulse flow capability.

Ms. Manji asked if there was any point at which high flows downstream in the SJR would trump the minimum flows in the Tuolumne River. Mr. Furman replied that no, this is not the case.

Mr. Steiner noted that the model validation for generation is still underway and that the Districts will provide this to Relicensing Participants for review when available in early 2013. A question was asked whether the model will include value of generation. Mr. Steiner noted that the value of generation is not a model component, but the Districts will be including this information in the license application (Exhibit D).

As part of the model training, Mr. Steiner walked Relicensing Participants through an example modeling scenario and addressed questions from participants regarding model assumptions, inputs, and outputs. There were questions regarding which elements of the model can be user-specified (i.e, "knobs") and which do not. Mr. Steiner noted that the model includes all the variables and "knobs" identified in the FERC-approved study plan.

Don Pedro Project Relicensing
W&AR-02: Tuolumne River Operations Model
Model Validation and User Training

December 7, 2012
10:00 a.m. to 4:00 p.m.

TRAINING LOCATION

HDR's Sacramento Office, located at 2379 Gateway Oaks Drive, Suite 200

CONFERENCE CALL-IN NUMBER

Conference Call-In Number 866-994-6437; Conference Code 542 469 7994

ON-LINE MEETING LINK

Join online meeting
https://meet.hdrinc.com/jenna.borovansky/3D64F0F5

First online meeting?

NOTE: If this is your first time attending an ONLINE MEETING, you will need to click on the "First online meeting?" link to load the ONLINE MEETING program. It is best that you do this step PRIOR to the meeting start.

EQUIPMENT NEEDS

Please bring your computer to this training session

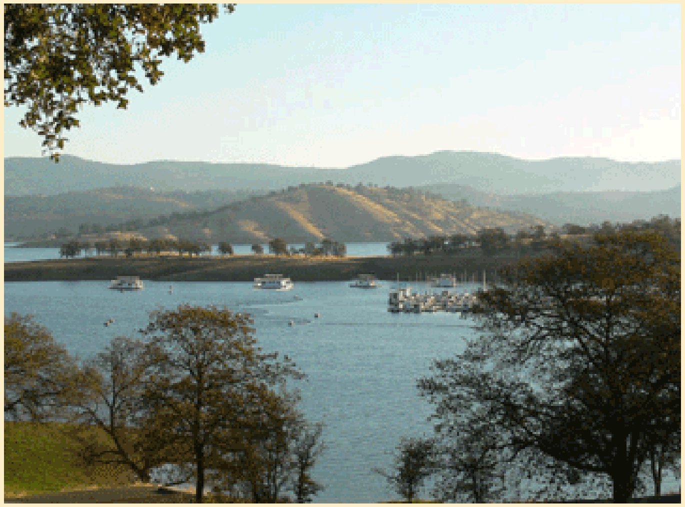
AGENDA

10:00 a.m. - 10:15 a.m.	Introductions and Meeting Purpose
10:15 a.m. - 11:30 a.m.	Operations Model Validation
11:30 a.m. - 12:00 p.m.	Lunch break (pizza to be provided)
12:00 p.m. - 4:00 p.m.	Operations Model User Training

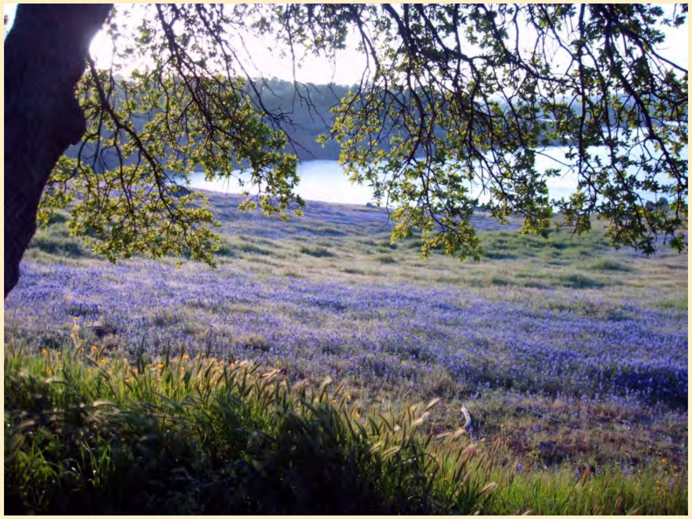
Don Pedro Project Relicensing

W&AR-2: Project Operations Model Training Session and Model Validation

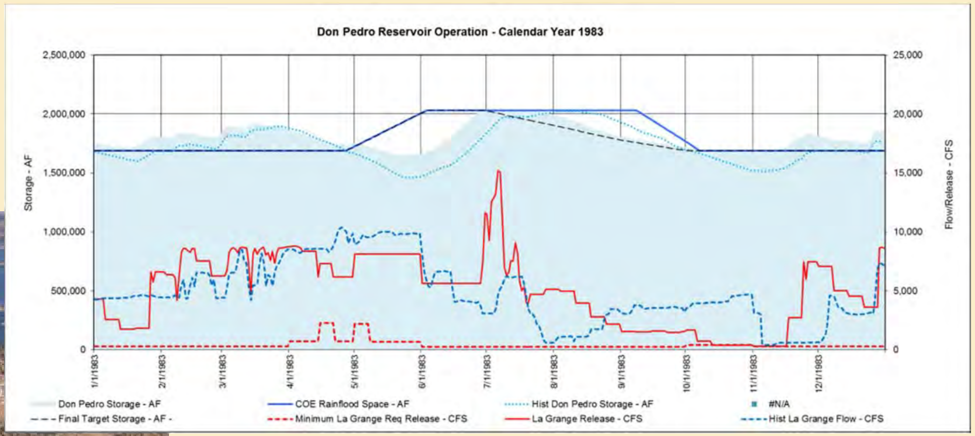
MODESTO IRRIGATION DISTRICT | TURLOCK IRRIGATION DISTRICT



FERC PROJECT No. 2299



Tuolumne River
Daily Operations Model



W&AR-2 Training Session and
Model Validation
December 7, 2012

Agenda and Topics

- Introductions and Meeting Purpose
- Operations Model Validation
- Operations Model User Training

Purpose

- Review Path Forward
- Illustrate Model Validation
- Receive Feedback on Model
- Provide Additional Training on Model Use

Prior Workshops

- **Workshop #1 --- April 9, 2012**
  - Model Overview and Development of Don Pedro Unimpaired Flow Data Set
- **Workshop #2 -- September 21, 2012**
  - Accretion Flow Measurement Results and Proposed Hydrologic Investigations
- **Workshop #3 -- October 23, 2012**
  - Model Description and Users' Guide, and Initial Training to Model Use

Future Path

- Today – Illustration of Model Validation / User Training
- January – ISR Submittal on January 17, 2013; ISR Meeting on January 30/31, 2013
- March 20, 2013 (Preliminary) – Training on Integrating the Use of all Three Project Models (Ops Model, Two Temp Models)

Model Validation

- Validation is used to illustrate the “wellness” of the Model to assist in evaluating alternative Project operations as part of the relicensing process
- The Model is only a depiction of project operations, and is limited to representing CCSF and District operations to the extent that their operations can be described numerically and consistently by various equations and algorithms
- Model results are used to compare scenarios

Model Validation

- The historical operation of the two systems serve as the Model's validation comparison

- Actual operations of the two independently operated systems may vary from those depicted by the Model due to circumstantial conditions of hydrology and weather, facility operation, and complicated and sometimes inconsistent human decisions

Model Validation

- The tuning of the Model is intended to provide a depiction that represents a "here and now" Tuolumne River, a contemporary model for the operations of the two systems
- The historical record of operations represents real-time decision making about facilities, water use and operations

Model Validation

Elements of Validation

- Don Pedro Reservoir Storage and Stream Release
- Consideration of Modesto Flood Management Objective
- Don Pedro Reservoir Inflow and CCSF Upstream Operation
- District Canal Diversions
- Don Pedro Project Hydroelectric Generation

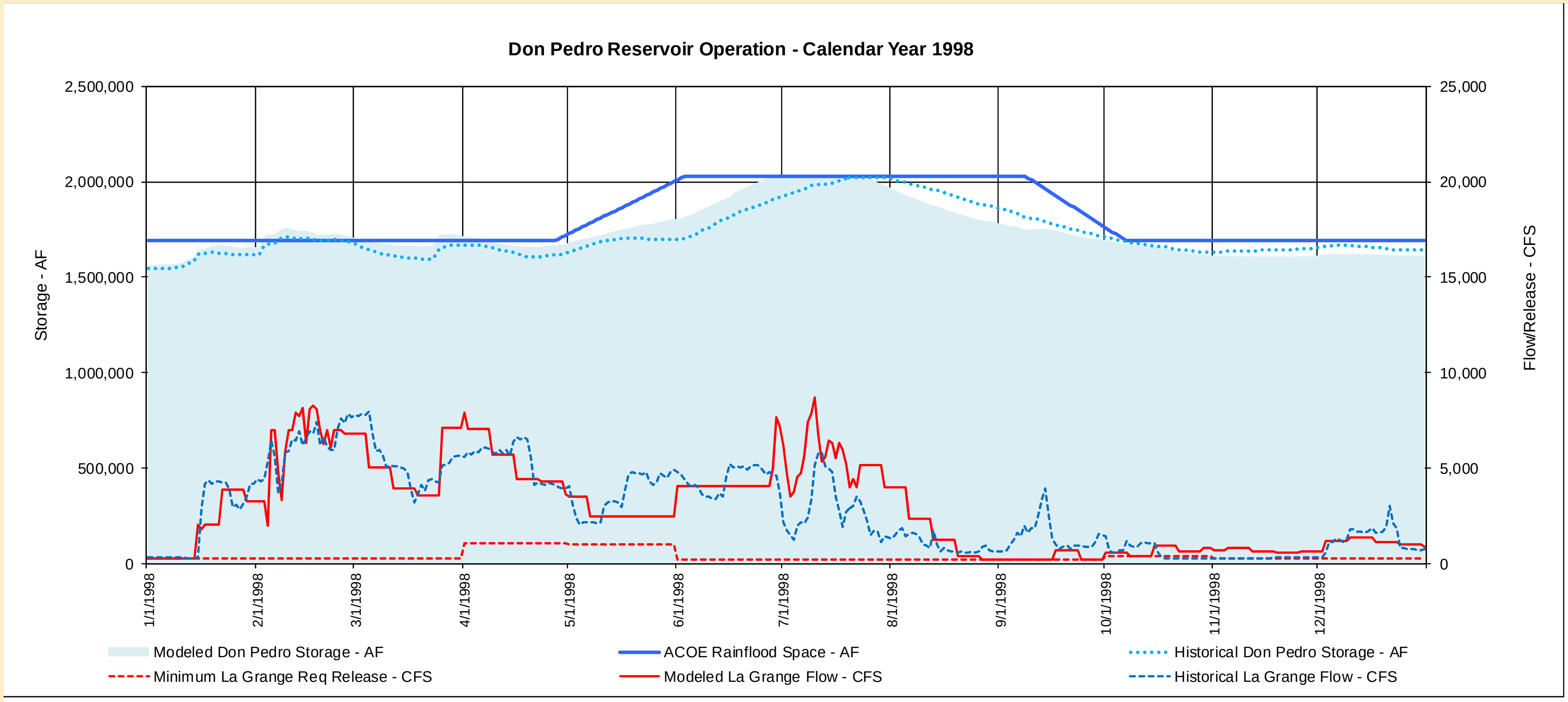
Model Validation

Don Pedro Reservoir Storage and Stream Release

- At previous workshop we discussed reservoir operation goals/algorithms
  - Minimum releases from reservoir
    - Instream flow requirements
    - Diversion demand - MID/TID Canals
  - Additional releases for reservoir and release management
    - Flood control
    - Snowmelt release management
    - Other storage goals

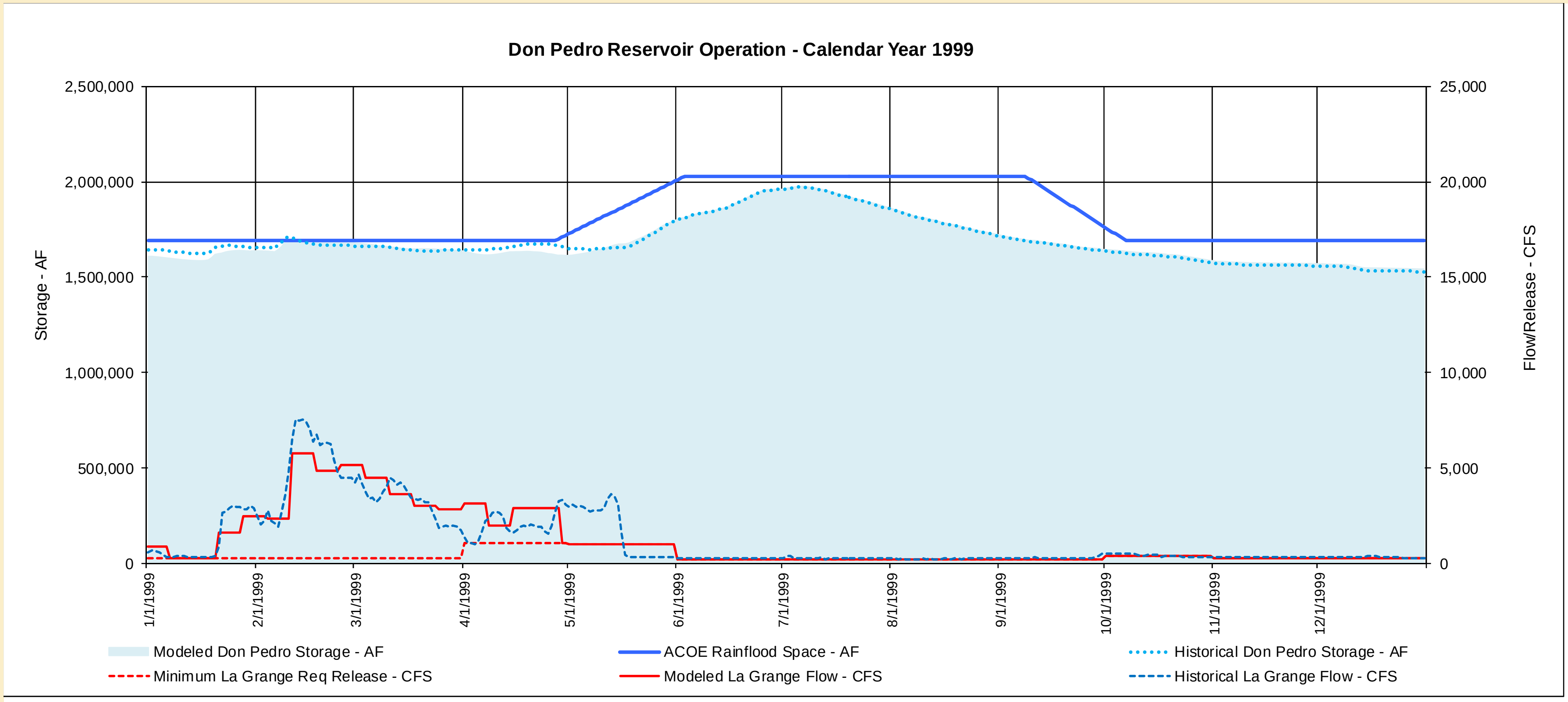
Model Validation

Don Pedro Reservoir Storage and Stream Release



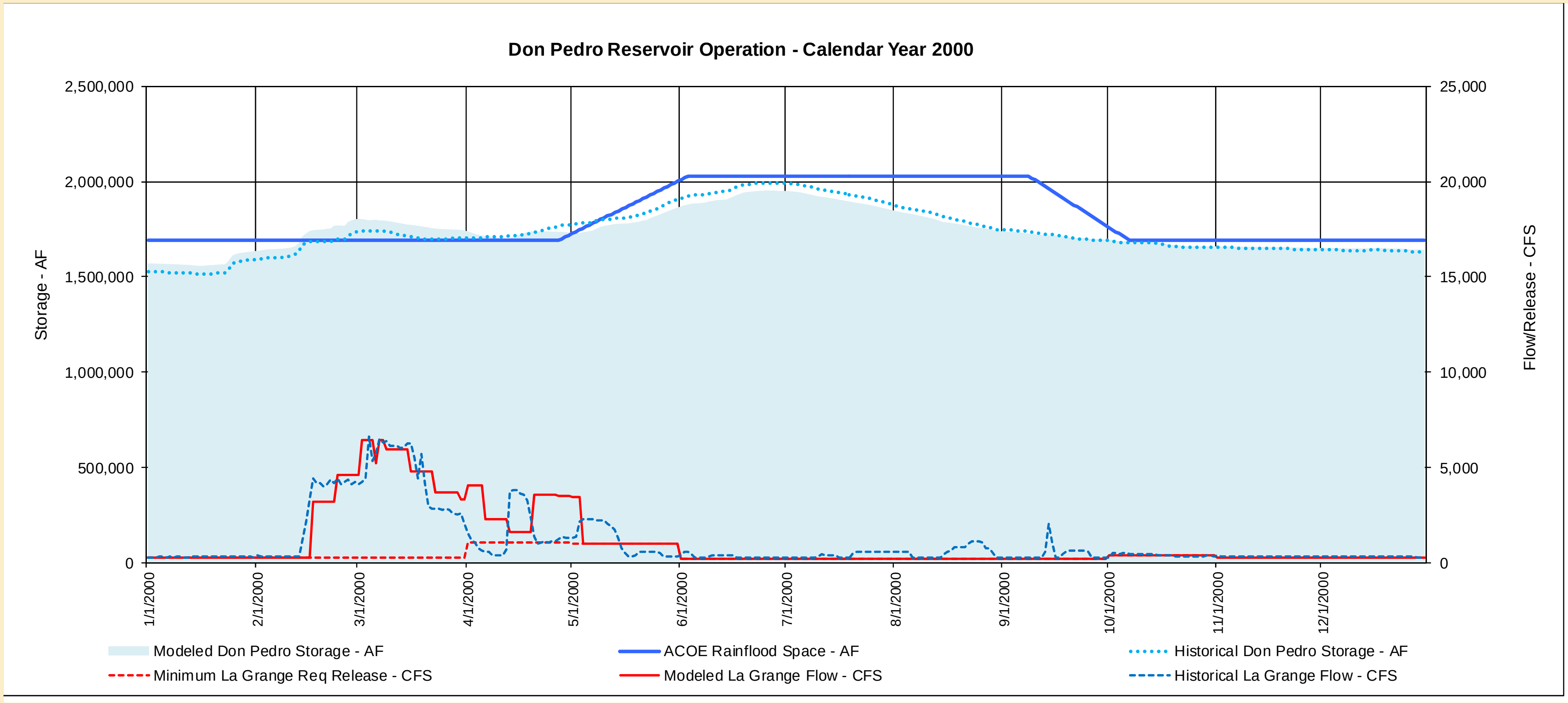
Model Validation

Don Pedro Reservoir Storage and Stream Release



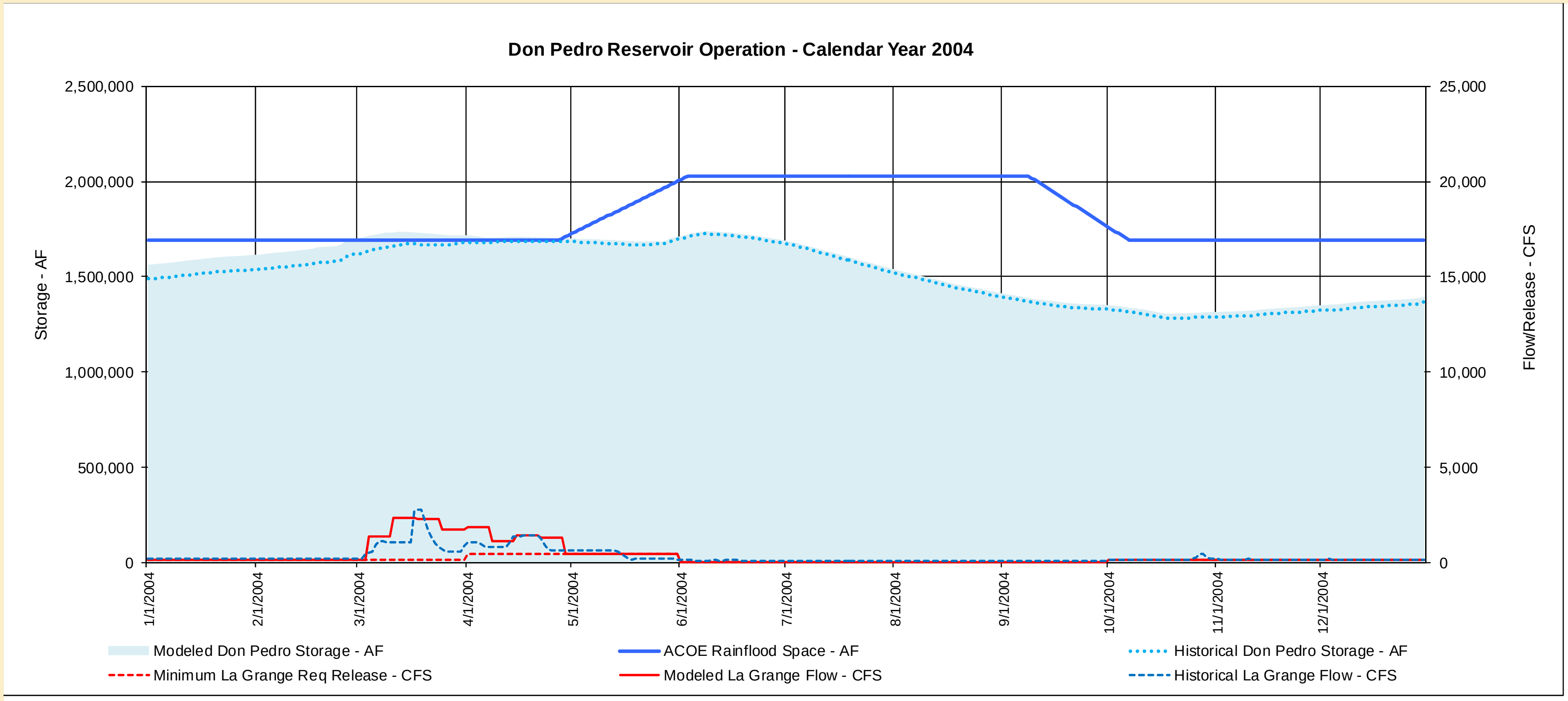
Model Validation

Don Pedro Reservoir Storage and Stream Release



Model Validation

Don Pedro Reservoir Storage and Stream Release

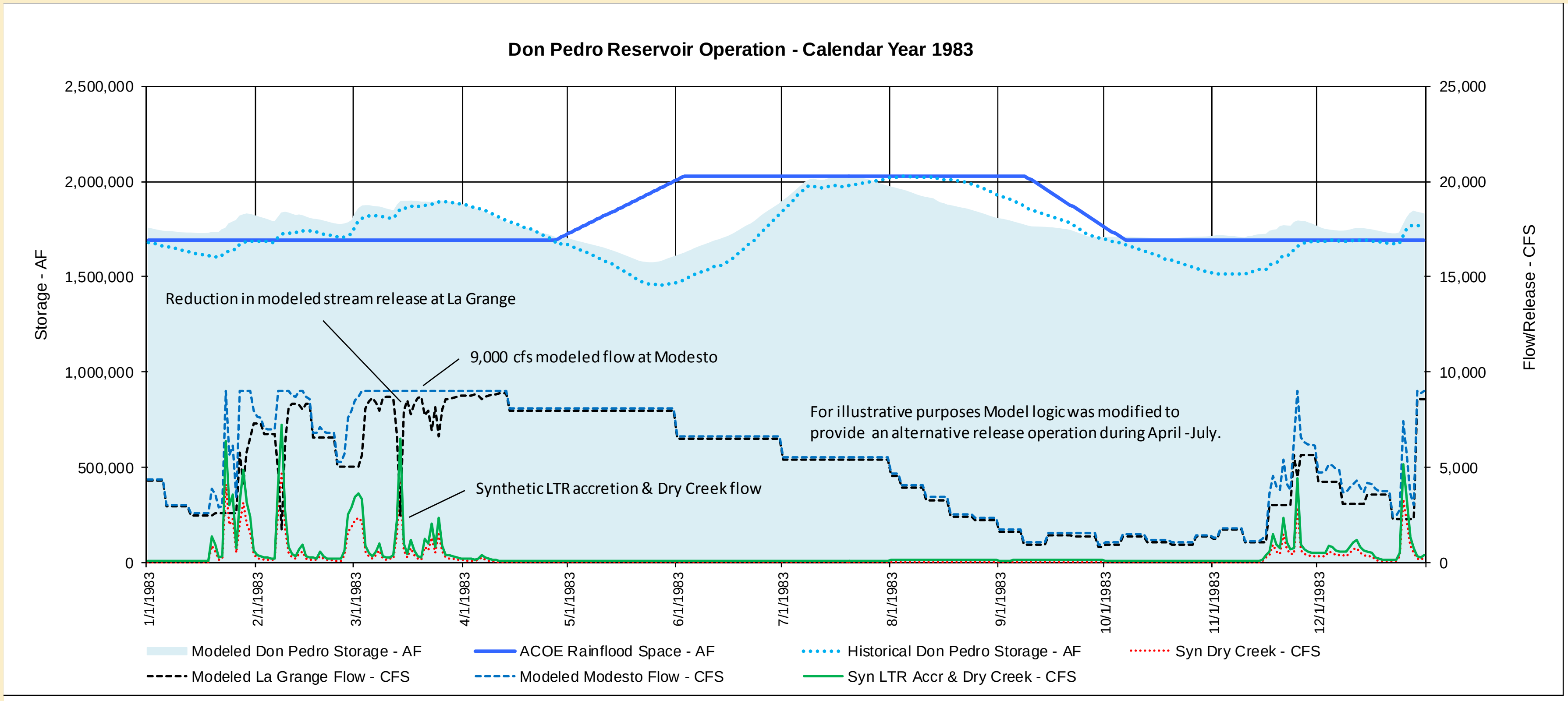


Model Validation
Consideration of Modesto Flood Management Objective

- Flood management operations are constrained due to flood flow guidelines at the Modesto 9th Street Bridge location
  - ACOE flood flow guideline at the Modesto location is to not exceed 9,000 cfs
  - Accretion flow in Lower Tuolumne River and flow from Dry Creek
- Model will decrease the release from Don Pedro Reservoir in order to maintain the flow objective

Model Validation

Consideration of Modesto Flood Management Objective

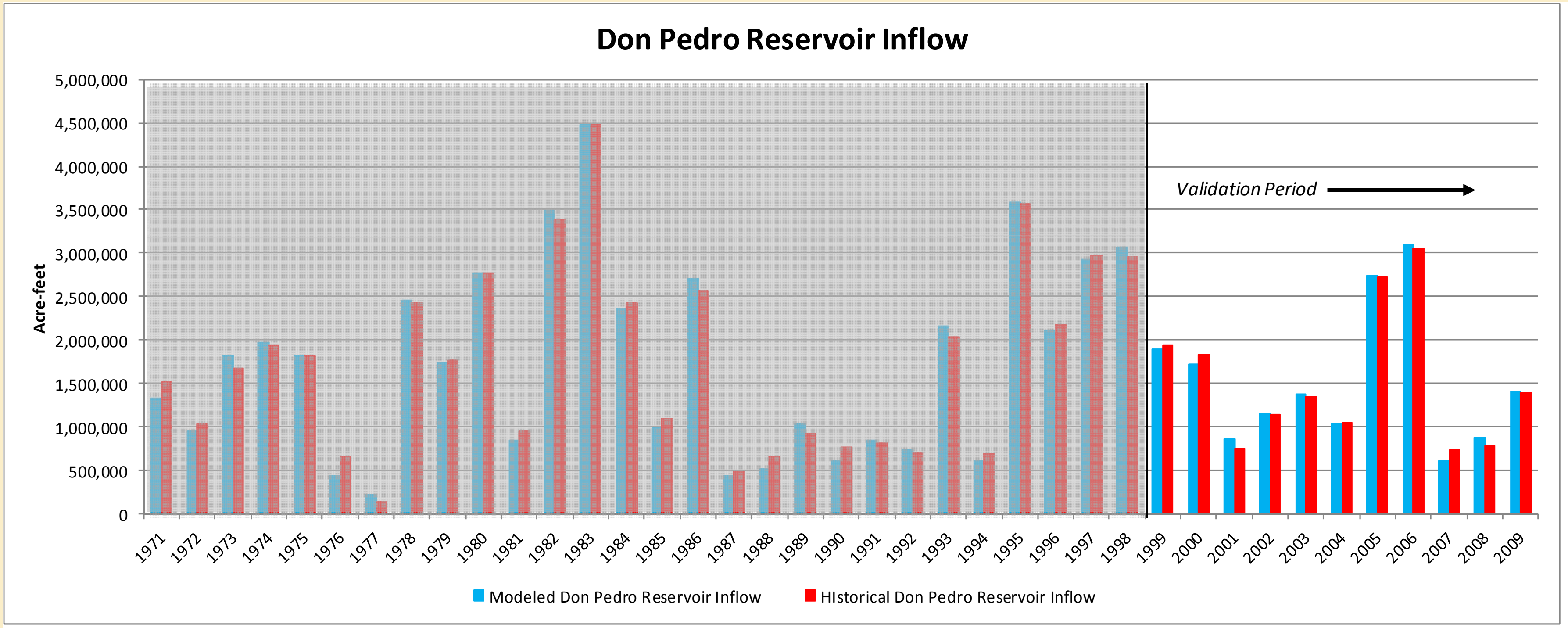


Model Validation

Don Pedro Reservoir Inflow and CCSF Upstream Operation

- The operation of CCSF's facilities upstream of Don Pedro Reservoir has changed throughout the modeling period
  - Model incorporates a contemporary operation of CCSF's system layered on top of the underlying hydrology of the basin
  - Incorporates the diversion demand of the San Joaquin Pipeline (SJPL) which is developed by the CCSF planning model
- The upstream operation leads to the depiction of inflow to Don Pedro Reservoir
  - The inflow to Don Pedro Reservoir is constructed of two components, regulated and unregulated inflow

Model Validation
Don Pedro Reservoir Inflow and CCSF Upstream Operation



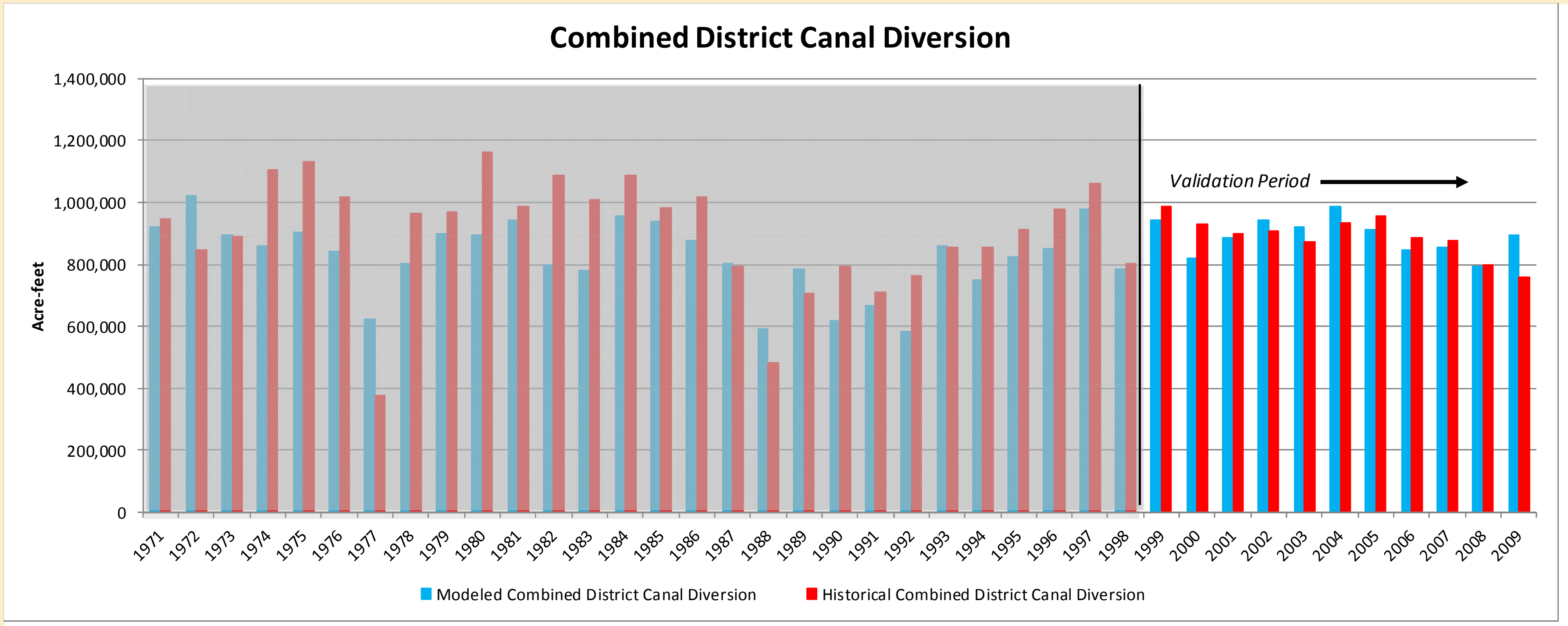
Model Validation
District Canal Diversions

- Due to annual changes in land use (crops planted), groundwater use, rainfall, and changing District and land owner practices the historical record of diversions varies from year-to-year
  - Model uses a projected canal diversion demand based on a planning model approach

- Projected canal diversions are assumed to be driven by three components
  - Fluctuating customer component, called the projected demand of applied water (PDAW), that varies year to year and month to month
  - Relatively constant depiction of District and land owner system operation efficiencies
  - Overriding water supply availability factor based on Don Pedro Reservoir storage and inflow

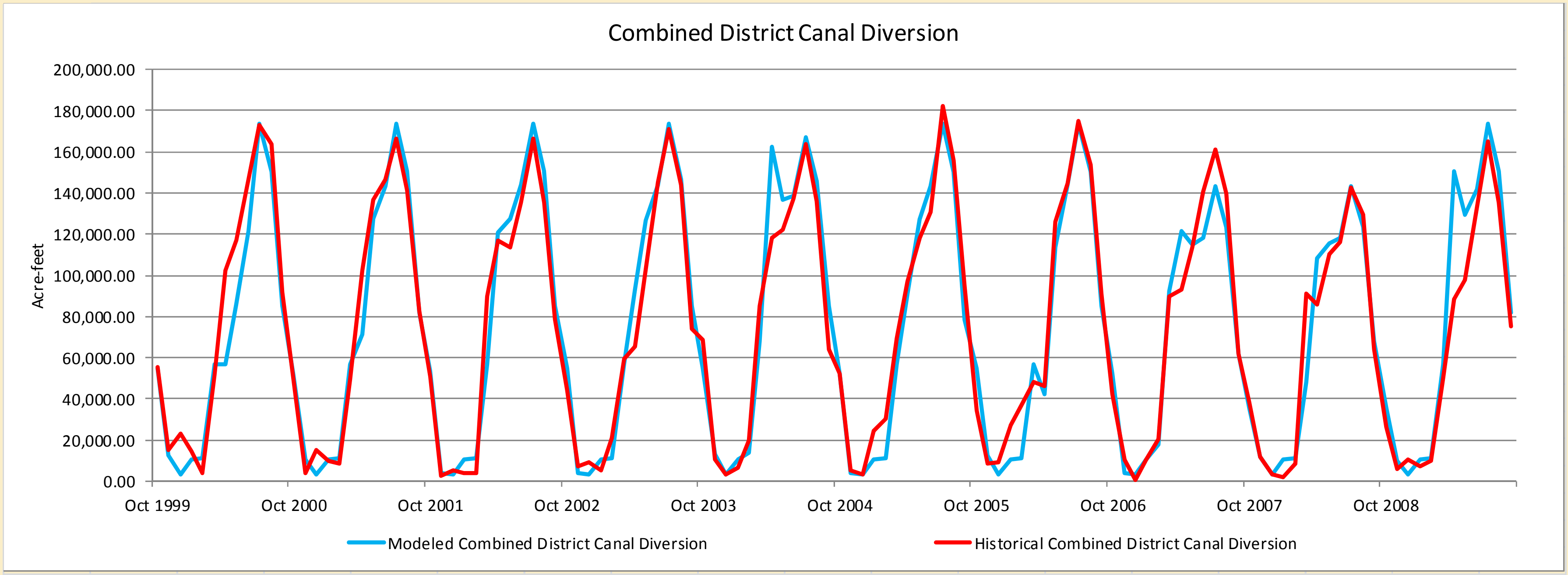
Model Validation

District Canal Diversions



Model Validation

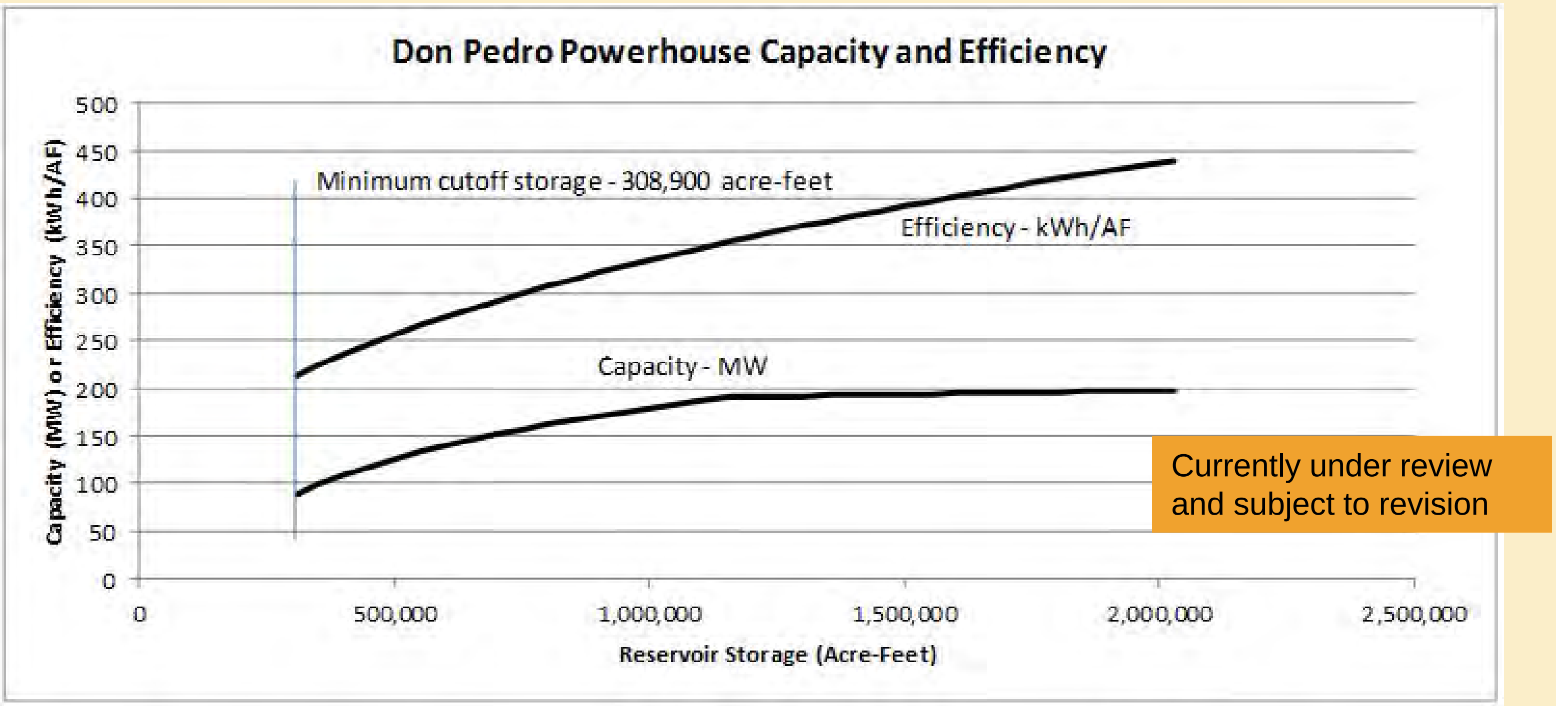
District Canal Diversions



Model Validation

Don Pedro Project Hydroelectric Generation

- Hydroelectric generation capability of the Don Pedro powerhouse has been depicted in the Model by mathematical equations relating station electrical output to Don Pedro Reservoir storage



Model Use Training

- Model has been revised
  - TuolumneDailyModel(Version1.01).xlsx

- Minor hydrology revisions
  - Lower Tuolumne River accretions and Dry Creek flow – synthetic data
  - Unregulated component of Don Pedro Reservoir inflow – adjusted

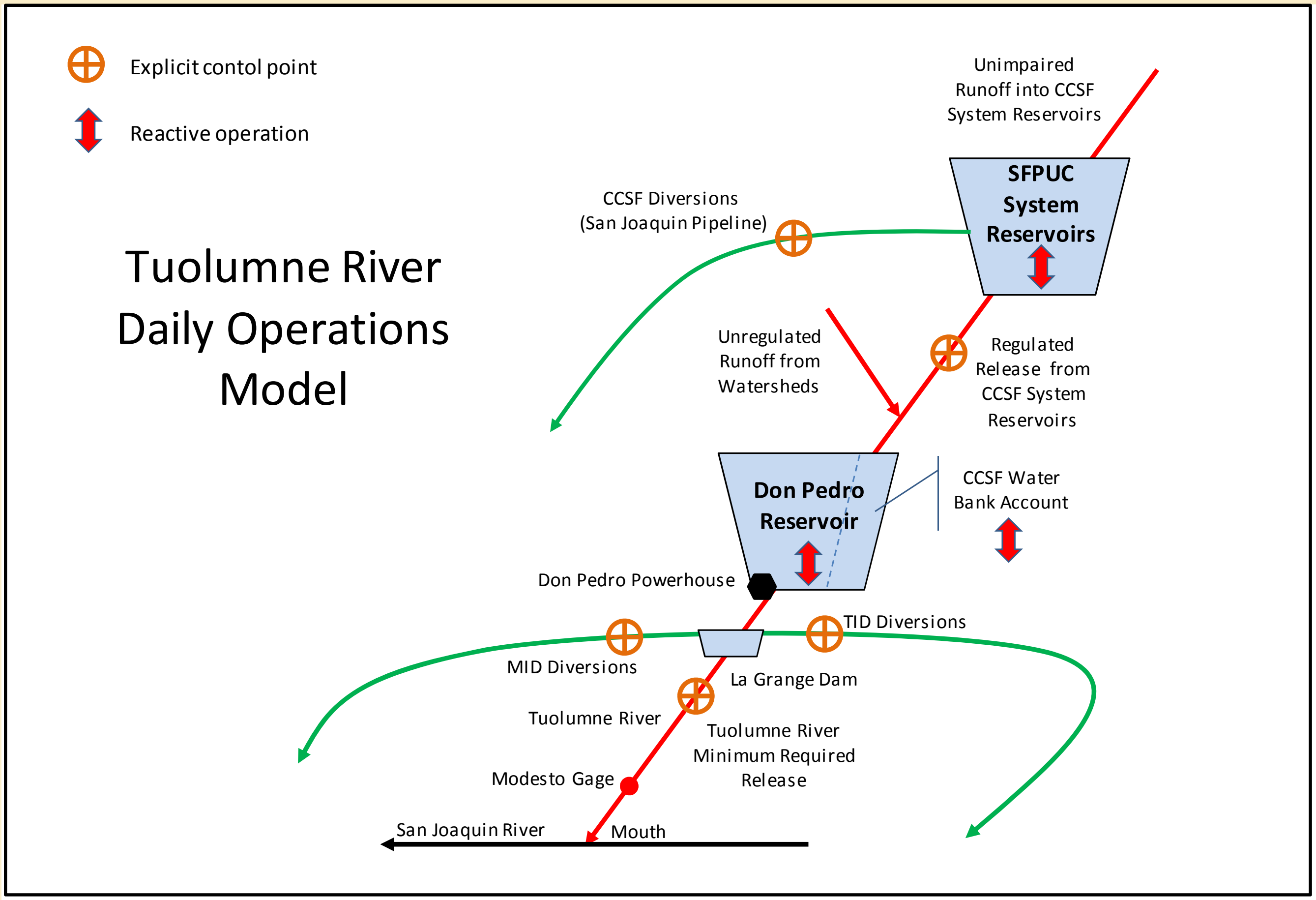
- Worksheet revisions
  - Incorporated columnar description of Output worksheet
  - Added "Switches" worksheet to provide documentation of input parameters

Load your computers

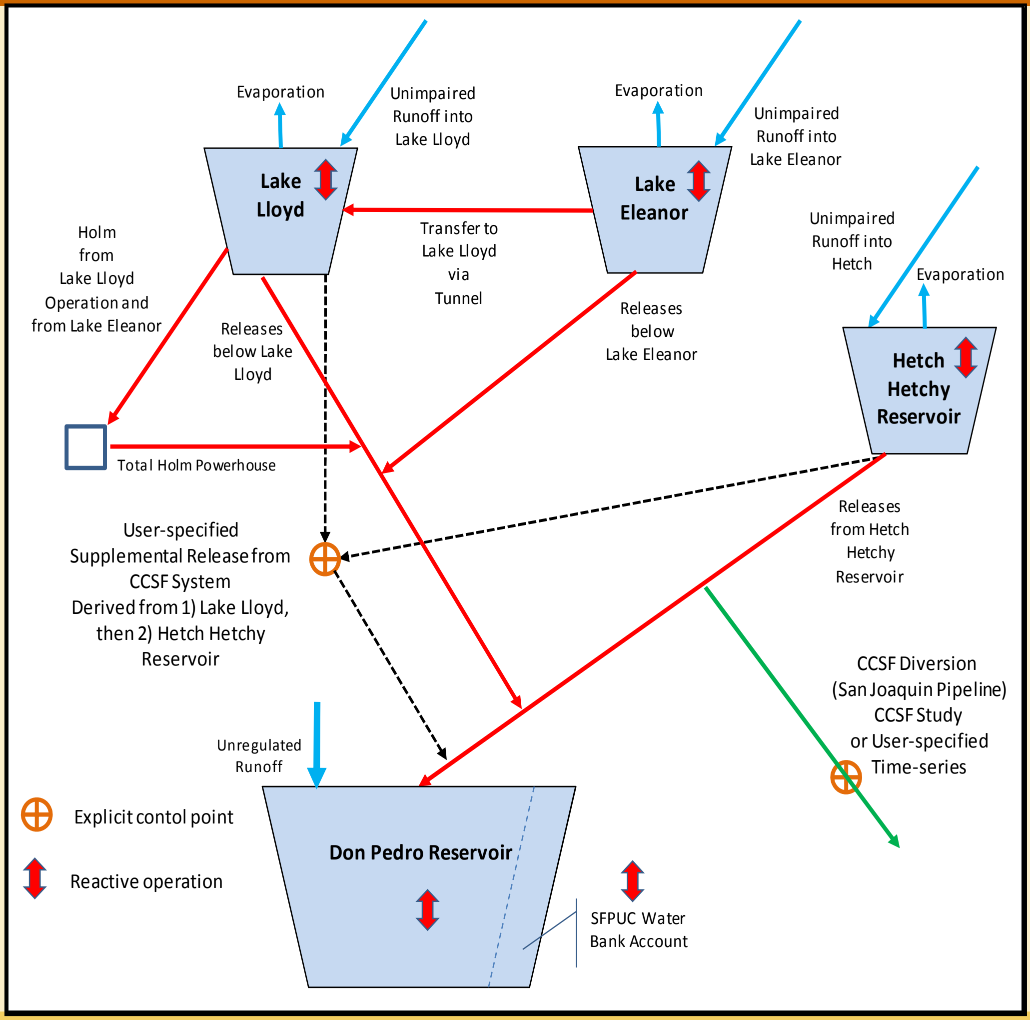
Model Overview

General Schematic and Geographical Range

Supplemental Slide from October 23, 2012 Workshop



Model Overview
Schematic of Upstream CCSF Facilities
Supplemental Slide from October 23, 2012 Workshop



Model Operations

Supplemental Slide from October 23, 2012 Workshop

- Model performs sequential operation for entire simulation period
- User can modify parameters to develop alternative operations
  - Minimum flow requirement for lower Tuolumne River
  - MID/TID Canals diversions
  - CCSF supplemental releases
  - CCSF SJPL diversions

Model Outputs

Supplemental Slide from October 23, 2012 Workshop

- Daily results
- Don Pedro Reservoir and District facilities
  - Reservoir inflow, release, storage and generation
  - MID/TID Canals diversions
  - Release to Tuolumne River
- CCSF facilities
  - Reservoir inflow, release, and storage
  - SJPL diversions
- Additional flow information
  - Lower Tuolumne River flow locations
- Result review tools
  - Time series data
  - Tables and graphs
- Data interface with temperature models

Hydrology Workshop No. 4

March 27, 2013

From: Staples, Rose
Sent: Monday, February 25, 2013 6:18 PM
To: 'Alves, Jim'; 'Amerine, Bill'; 'Anderson, Craig'; 'Asay, Lynette'; 'Barnes, James'; 'Barnes, Peter'; 'Barrera, Linda'; 'Beniamine Beronia'; 'Blake, Martin'; 'Bond, Jack'; Borovansky, Jenna; 'Boucher, Allison'; 'Bowes, Stephen'; 'Bowman, Art'; 'Brenneman, Beth'; 'Brewer, Doug'; 'Buckley, John'; 'Buckley, Mark'; 'Burke, Steve'; 'Burt, Charles'; 'Byrd, Tim'; 'Cadagan, Jerry'; 'Carlin, Michael'; 'Charles, Cindy'; 'Colvin, Tim'; 'Costa, Jan'; 'Cowan, Jeffrey'; 'Cox, Stanley Rob'; 'Cranston, Peggy'; 'Cremeen, Rebecca'; 'Damin Nicole'; 'Day, Kevin'; 'Day, P'; 'Denean'; 'Derwin, Maryann Moise'; Devine, John; 'Donaldson, Milford Wayne'; 'Dowd, Maggie'; 'Drake, Emerson'; 'Drekmeier, Peter'; 'Edmondson, Steve'; 'Eicher, James'; 'Fargo, James'; 'Ferranti, Annee'; 'Ferrari, Chandra'; 'Fety, Lauren'; 'Findley, Timothy'; 'Fleming, Mike'; 'Fuller, Reba'; 'Furman, Donn W'; 'Ganteinbein, Julie'; 'Giglio, Deborah'; 'Gorman, Elaine'; 'Grader, Zeke'; 'Gutierrez, Monica'; 'Hackamack, Robert'; 'Hastreiter, James'; 'Hatch, Jenny'; 'Hayat, Zahra'; 'Hayden, Ann'; 'Hellam, Anita'; 'Heyne, Tim'; 'Holley, Thomas'; 'Holm, Lisa'; 'Horn, Jeff'; 'Horn, Timi'; 'Hudelson, Bill'; 'Hughes, Noah'; 'Hughes, Robert'; 'Hume, Noah'; 'Jackson, Zac'; 'Jauregui, Julia'; 'Jennings, William'; 'Jensen, Art'; 'Jensen, Laura'; 'Johannis, Mary'; 'Johnson, Brian'; 'Jones, Christy'; 'Jsansley'; 'Justin'; 'Keating, Janice'; 'Kempton, Kathryn'; 'Kinney, Teresa'; 'Koepele, Patrick'; 'Kordella, Lesley'; Le, Bao; 'Lein, Joseph'; 'Levin, Ellen'; 'Lewis, Reggie'; 'Linkard, David'; Loy, Carin; 'Lwenya, Roselynn'; 'Lyons, Bill'; 'Madden, Dan'; 'Manji, Annie'; 'Marko, Paul'; 'Marshall, Mike'; 'Martin, Michael'; 'Martin, Ramon'; 'Mathiesen, Lloyd'; 'McDaniel, Dan'; 'McDevitt, Ray'; 'McDonnell, Marty'; 'Mein Janis'; 'Mills, John'; 'Minami Amber'; 'Monheit, Susan'; 'Morningstar Pope, Rhonda'; 'Motola, Mary'; 'Murphey, Gretchen'; 'Murray, Shana'; 'O'Brien, Jennifer'; 'Orvis, Tom'; 'Ott, Bob'; 'Ott, Chris'; 'Paul, Duane'; 'Pavich, Steve'; 'Pool, Richard'; 'Porter, Ruth'; 'Powell, Melissa'; 'Puccini, Stephen'; 'Raeder, Jessie'; 'Ramirez, Tim'; 'Rea, Maria'; 'Reed, Rhonda'; 'Richardson, Daniel'; 'Richardson, Kevin'; 'Ridenour, Jim'; 'Riggs T'; 'Robbins, Royal'; 'Romano, David O'; 'Roos-Collins, Richard'; 'Roseman, Jesse'; 'Rothert, Steve'; 'Sandkulla, Nicole'; 'Saunders, Jenan'; 'Schutte, Allison'; 'Sears, William'; 'Shakal, Sarah'; 'Shipley, Robert'; 'Shumway, Vern'; 'Shutes, Chris'; 'Sill, Todd'; 'Slay, Ron'; 'Smith, Jim'; Staples, Rose; 'Stapley, Garth'; 'Steindorf, Dave'; 'Steiner, Dan'; 'Stender, John'; 'Stone, Vicki'; 'Stork, Ron'; 'Stratton, Susan'; 'Taylor, Mary Jane'; 'Terpstra, Thomas'; 'TeVelde, George'; 'Thompson, Larry'; 'Tmberliner'; 'Ulibarri, Nicola'; 'Ulm, Richard'; 'Vasquez, Sandy'; 'Verkuil, Colette'; 'Vierra, Chris'; 'Wantuck, Richard'; 'Welch, Steve'; 'Wenger, Jack'; 'Wesselman, Eric'; 'Wheeler, Dan'; 'Wheeler, Dave'; 'Wheeler, Douglas'; 'White, David K'; 'Wilcox, Scott'; 'Williamson, Harry'; 'Willy, Allison'; 'Wilson, Bryan'; 'Winchell, Frank'; 'Wooster, John'; 'Workman, Michelle'; 'Yoshiyama, Ron'; 'Zipser, Wayne'
Subject: Don Pedro Unimpaired Hydrology Methods Workshop No 4 Planned for March 14
Attachments: Don Pedro Unimpaired Hydrology Methods Workshop.pdf

SWRCB and CDFW have raised concerns about the hydrology developed for use in Study Plan W&AR-02: Tuolumne River Operations Model. SWRCB, CDFW and the Districts have had ongoing evaluations and discussions regarding issues raised by CDFW and SWRCB. On February 14, 2013, the parties agreed to undertake one additional Hydrology Workshop to further collaboratively examine the Operations Model hydrology.

This Workshop is scheduled to be held on Thursday, March 14 from 8:30 to 12:00 noon in HDR's Sacramento office. The Workshop will be entirely devoted to a technical discussion of potential alternative methods for refinement of the daily hydrology for the Operations Model. Due to the highly technical and detailed nature of the discussions, attendance at the meeting is required for participation; neither a conference line nor a call-in number will be available for the Workshop.

SWRCB, CDFW and the Districts have agreed to the following matters as a precursor to the Workshop:

· The monthly water volumes already developed through the Districts' mass balance approach to hydrology are acceptable and shall remain unchanged;

· The daily flows in the model will be examined through a collaborative discussion of certain alternative analytical methods by the participants at the Workshop; the Districts are to develop two to three "strawman" approaches to enable and focus the discussions based on the preliminary discussions that occurred among the parties on February 14 (the attachment to this announcement contains three approaches to be considered at the Workshop);

· A single Workshop should be sufficient to resolve outstanding differences; however, neither the Districts, CDFW nor SWRCB are committing to a final agreement just for the sake of agreeing; any final daily hydrology must incorporate technically robust and defensible methods of analysis; and

· Time is of the essence; final resolution shall be reached by March 29, 2013 in order to limit the resulting delay to the Don Pedro relicensing process.

It is recognized that these further deliberations regarding daily hydrology will have the following effect on schedule:

· Issuance of the "base case" Operations Model currently scheduled for March 13 will be delayed to April 16

· The Integrated Model Training session currently scheduled for March 20 will be rescheduled to May 2

· The presentation and discussion of the W&AR-06: Tuolumne River Chinook Salmon Population Model currently scheduled for March 27 is rescheduled to April 18.

The Districts look forward to the March 14 collaborative discussion with relicensing participants on Operations Model hydrology.

Please let me know by March 8th at rose.staples@hdrinc.com if you will be attending the Workshop.

W&AR-02: Tuolumne River Operations Model

Consultation Workshop No. 4: Further Discussion of Model Hydrology

Purpose: Hold a Workshop to further discuss the hydrology used in the Tuolumne River Operations Model

A letter dated September 10, 2012 from CDFW to the SWRCB, and copied to the Districts, outlined concerns about the unimpaired hydrology developed by the Districts for use in the Tuolumne River Operations Model. In the letter, the CDFW suggested that an alternative approach to the mass balance method employed by the Districts be considered. CDFW suggested that a "gauge proration" approach might be more applicable.

The Districts subsequently undertook an analysis of such an approach and submitted its report to SWRCB and CDFW on December 21, 2012. The report indicated that the lack of long-term gages over sufficient portions of the Tuolumne River watershed cast significant doubt on the reliability of the gauge-proration approach for the Tuolumne River. SWRCB and CDFW met on February 14, 2013 to further discuss this matter.

As a result of discussions at the February 14 meeting, the Districts and SWRCB/CDFW intend to hold one additional Workshop to further discuss model hydrology. The goal of this meeting is attempt to reach consensus on the Operations Model hydrology through discussing the watershed-specific technical issues and pros and cons of the alternative approaches.

Background: At the February 14 meeting, Bob Hughes explained and clarified CDFW's concerns with the existing mass balance approach, as summarized below:

- The unregulated portion of inflow to Don Pedro Reservoir is calculated using the mass balance approach based on historical records at Hetch Hetchy Reservoir, Cherry and Eleanor lakes, and Don Pedro Reservoir.
    - All four of these mass balance calculations contain negative daily flow values and somewhat erratic daily flow fluctuations which are an artifact of the imprecision of daily readings of reservoir storage gauges when developing daily unimpaired flow estimates.
    - Those random negative flows and fluctuations are then aggregated by subtraction to calculate the unregulated portion of the runoff into Don Pedro, creating the potential for greater uncertainty in the daily flow rates.
- CDFW agreed that the monthly mass balance should be preserved as developed by the model for all methods considered for daily flow estimation because it is recognized that at a monthly time scale the reservoir storage gauges are reliable for inflow volume estimation purposes.
- For the period examined by the Districts in their December 21, 2012 report as a candidate for a gauge proration approach (WY 1971-83), scaling the results to the monthly mass balance would be satisfactory to both SWRCB and CDFW without further comment.

- For the remaining period of WY 1984-2009 (representing the balance of the Period of Record of the Districts' Operations Model), CDFW recommended that the Districts, SWRCB, CDFW and other interested relicensing participants should further examine different methods side-by-side in a collaborative workshop setting and make an informed decision to use for other time periods.
  - A "mixed methodology" is acceptable to SWRCB and CDFW; preference is for gauge proration where adequate gauge representation is available and smoothed or synthetically-shaped mass balance techniques when it's not available.

Approach to the Workshop: It was agreed at the February 14 meeting that HDR would develop several "strawman" methods for consideration at the Workshop for discussion with interested relicensing participants. The methods that HDR would propose to evaluate for their potential viability are:

1. Complete implementation of a gauge proration method, scaled with **monthly mass balance**
   a. This would be undertaken as outlined in the Districts' December 21, 2012 report for each subbasin for the period 1983 to 2009:
      i. Unregulated Inflow to Don Pedro
         1. Gage data availability may be limiting for this area and this introduces considerable uncertainty because the area is large and there is a lack of low-elevation unimpaired gages
      ii. Inflow to upper watershed three CCSF reservoirs
         1. The gage proration method for these basins may be adequately supported by the Merced River at Happy Isles gauges, and other local gages for the period of record
   b. This approach may be significantly limited for the full relicensing Period of Record, particularly the later period from 1998 to 2009; however, this would be a reasonable starting point for comparative analysis.
2. Various smoothing and synthetic shaping methods applied to the existing mass balance approach:
   a. An attempt can be made to smooth the reservoir storage readings, prior to the flow back-calculation, where day-to-day inconsistencies appear to exist;
   b. An attempt can be made to smooth the four mass-balance flow calculations before making the final calculation for the unregulated inflows to Don Pedro Reservoir; and/or
   c. The Workshop can examine natural (exponential) decay rates in conjunction with smoothing for the snowmelt recession period, as an alternative to the current multi-day averaging approach in the Model that results in hydrograph "steps" that may be an

unrealistic portrait of natural hydrology. The recession limb of unregulated hydrographs can typically be well-characterized through the use of decay functions.

3. A combination of methods (2) and (3) above. Portions of the period of record may be able to be developed by gauge proration scaled to mass balance, and portions by smoothing of the mass balance alone.

It should be noted that, regardless of the above methods ultimately decided upon for the daily flow record for the Operations Model (including the existing method), the Districts, SWRCB and CDFW have all agreed that the monthly mass balance volumes are sound and shall be preserved.

Doody, Andrew

From: Staples, Rose
Sent: Saturday, March 16, 2013 4:40 PM
To: Alves, Jim; Amerine, Bill; Anderson, Craig; Asay, Lynette; Barnes, James; Barnes, Peter; Barrera, Linda; Beniamine Beronia; Blake, Martin; Bond, Jack; Borovansky, Jenna; Boucher, Allison; Bowes, Stephen; Bowman, Art; Brenneman, Beth; Brewer, Doug; Buckley, John; Buckley, Mark; Burke, Steve; Burt, Charles; Byrd, Tim; Cadagan, Jerry; Carlin, Michael; Charles, Cindy; Colvin, Tim; Costa, Jan; Cowan, Jeffrey; Cox, Stanley Rob; Cranston, Peggy; Cremeen, Rebecca; Damin Nicole; Day, Kevin; Day, P; Denean; Derwin, Maryann Moise; Devine, John; Donaldson, Milford Wayne; Dowd, Maggie; Drake, Emerson; Drekmeier, Peter; Edmondson, Steve; Eicher, James; Fargo, James; Ferranti, Annee; Ferrari, Chandra; Fety, Lauren; Findley, Timothy; Fleming, Mike; Fuller, Reba; Furman, Donn W; Ganteinbein, Julie; Giglio, Deborah; Gorman, Elaine; Grader, Zeke; Gutierrez, Monica; Hackamack, Robert; Hastreiter, James; Hatch, Jenny; Hayat, Zahra; Hayden, Ann; Hellam, Anita; Heyne, Tim; Holley, Thomas; Holm, Lisa; Horn, Jeff; Horn, Timi; Hudelson, Bill; Hughes, Noah; Hughes, Robert; Hume, Noah; Jackson, Zac; Jauregui, Julia; Jennings, William; Jensen, Art; Jensen, Laura; Johannis, Mary; Johnson, Brian; Jones, Christy; Jsansley; Justin; Keating, Janice; Kempton, Kathryn; Kinney, Teresa; Koepele, Patrick; Kordella, Lesley; Le, Bao; Lein, Joseph; Levin, Ellen; Lewis, Reggie; Linkard, David; Loy, Carin; Lwenya, Roselynn; Lyons, Bill; Madden, Dan; Manji, Annie; Marko, Paul; Marshall, Mike; Martin, Michael; Martin, Ramon; Mathiesen, Lloyd; McDaniel, Dan; McDevitt, Ray; McDonnell, Marty; Mein Janis; Mills, John; Minami Amber; Monheit, Susan; Morningstar Pope, Rhonda; Motola, Mary; Murphey, Gretchen; Murray, Shana; O'Brien, Jennifer; Orvis, Tom; Ott, Bob; Ott, Chris; Paul, Duane; Pavich, Steve; Pool, Richard; Porter, Ruth; Powell, Melissa; Puccini, Stephen; Raeder, Jessie; Ramirez, Tim; Rea, Maria; Reed, Rhonda; Richardson, Daniel; Richardson, Kevin; Ridenour, Jim; Riggs T; Robbins, Royal; Romano, David O; Roos-Collins, Richard; Rosekrans, Spreck; Roseman, Jesse; Rothert, Steve; Sandkulla, Nicole; Saunders, Jenan; Schutte, Allison; Sears, William; Shakal, Sarah; Shipley, Robert; Shumway, Vern; Shutes, Chris; Sill, Todd; Slay, Ron; Smith, Jim; Staples, Rose; Stapley, Garth; Steindorf, Dave; Steiner, Dan; Stender, John; Stone, Vicki; Stork, Ron; Stratton, Susan; Taylor, Mary Jane; Terpstra, Thomas; TeVelde, George; Thompson, Larry; Tmberliner; Ulibarri, Nicola; Ulm, Richard; Vasquez, Sandy; Verkuil, Colette; Vierra, Chris; Wantuck, Richard; Welch, Steve; Wenger, Jack; Wesselman, Eric; Wheeler, Dan; Wheeler, Dave; Wheeler, Douglas; White, David K; Wilcox, Scott; Williamson, Harry; Willy, Allison; Wilson, Bryan; Winchell, Frank; Wooster, John; Workman, Michelle; Yoshiyama, Ron; Zipser, Wayne
Subject: Don Pedro Project Hydrology Workshop No. 4 Rescheduled for March 27

Wednesday, **MARCH 27**, from **1:00 to 4:30 p.m**., is the new DATE and TIME for the Don Pedro Project Hydrology Workshop No. 4, initially scheduled for March 14. It will be held at the HDR Offices in Sacramento (2379 Gateway Oaks Drive, Suite 200). Due to the highly technical and detailed nature of the discussions, attendance at the meeting is required for participation. ***Please let me know at rose.staples@hdrinc.com if you plan to attend this meeting; thank you.***

The workshop will be entirely devoted to a technical discussion of potential alternative methods for refinement of the daily hydrology for the Operations Model.

ROSE STAPLES
CAP-OM

HDR Engineering, Inc.
Executive Assistant, Hydropower Services

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Doody, Andrew

From: Staples, Rose
Sent: Monday, March 25, 2013 6:52 PM
To: Alves, Jim; Amerine, Bill; Anderson, Craig; Asay, Lynette; Barnes, James; Barnes, Peter; Barrera, Linda; Beniamine Beronia; Blake, Martin; Bond, Jack; Borovansky, Jenna; Boucher, Allison; Bowes, Stephen; Bowman, Art; Brenneman, Beth; Brewer, Doug; Buckley, John; Buckley, Mark; Burke, Steve; Burt, Charles; Byrd, Tim; Cadagan, Jerry; Carlin, Michael; Charles, Cindy; Colvin, Tim; Costa, Jan; Cowan, Jeffrey; Cox, Stanley Rob; Cranston, Peggy; Cremeen, Rebecca; Damin Nicole; Day, Kevin; Day, P; Denean; Derwin, Maryann Moise; Devine, John; Donaldson, Milford Wayne; Dowd, Maggie; Drake, Emerson; Drekmeier, Peter; Edmondson, Steve; Eicher, James; Fargo, James; Ferranti, Annee; Ferrari, Chandra; Fety, Lauren; Findley, Timothy; Fleming, Mike; Fuller, Reba; Furman, Donn W; Ganteinbein, Julie; Giglio, Deborah; Gorman, Elaine; Grader, Zeke; Gutierrez, Monica; Hackamack, Robert; Hastreiter, James; Hatch, Jenny; Hayat, Zahra; Hayden, Ann; Hellam, Anita; Heyne, Tim; Holley, Thomas; Holm, Lisa; Horn, Jeff; Horn, Timi; Hudelson, Bill; Hughes, Noah; Hughes, Robert; Hume, Noah; Jackson, Zac; Jauregui, Julia; Jennings, William; Jensen, Art; Jensen, Laura; Johannis, Mary; Johnson, Brian; Jones, Christy; Jsansley; Justin; Keating, Janice; Kempton, Kathryn; Kinney, Teresa; Koepele, Patrick; Kordella, Lesley; Le, Bao; Lein, Joseph; Levin, Ellen; Lewis, Reggie; Linkard, David; Loy, Carin; Lwenya, Roselynn; Lyons, Bill; Madden, Dan; Manji, Annie; Marko, Paul; Marshall, Mike; Martin, Michael; Martin, Ramon; Mathiesen, Lloyd; McDaniel, Dan; McDevitt, Ray; McDonnell, Marty; Mein Janis; Mills, John; Monheit, Susan; Morningstar Pope, Rhonda; Motola, Mary; Murphey, Gretchen; Murray, Shana; O'Brien, Jennifer; Orvis, Tom; Ott, Bob; Ott, Chris; Paul, Duane; Pavich, Steve; Pool, Richard; Porter, Ruth; Powell, Melissa; Puccini, Stephen; Raeder, Jessie; Ramirez, Tim; Rea, Maria; Reed, Rhonda; Richardson, Daniel; Richardson, Kevin; Ridenour, Jim; Riggs T; Robbins, Royal; Romano, David O; Roos-Collins, Richard; Rosekrans, Spreck; Roseman, Jesse; Rothert, Steve; Sandkulla, Nicole; Saunders, Jenan; Schutte, Allison; Sears, William; Shakal, Sarah; Shipley, Robert; Shumway, Vern; Shutes, Chris; Sill, Todd; Slay, Ron; Smith, Jim; Staples, Rose; Stapley, Garth; Steindorf, Dave; Steiner, Dan; Stender, John; Stone, Vicki; Stork, Ron; Stratton, Susan; Taylor, Mary Jane; Terpstra, Thomas; TeVelde, George; Thompson, Larry; Tmberliner; Ulibarri, Nicola; Ulm, Richard; Vasquez, Sandy; Verkuil, Colette; Vierra, Chris; Wantuck, Richard; Welch, Steve; Wenger, Jack; Wesselman, Eric; Wheeler, Dan; Wheeler, Dave; Wheeler, Douglas; White, David K; Wilcox, Scott; Williamson, Harry; Willy, Allison; Wilson, Bryan; Winchell, Frank; Wooster, John; Workman, Michelle; Yoshiyama, Ron; Zipser, Wayne
Subject: Advance Documents for March 27 Don Pedro Hydrology Workshop
Attachments: Unimpaired.dss; TuolumneGaugeProratioIIIn.pdf

Please find attached the Districts' "Strawman", which will be used as a starting point for discussion at the meeting on Wednesday (March 27, from 1:00 to 4:30 p.m.) at HDR's Offices in Sacramento (2379 Gateway Oaks Drive Suite 200—Call 916-679-8700 if you need directions). As this is an in-person meeting only, I have received RSVPs in the affirmative from Peter Barnes, Bob Hackamack, Robert Hughes, Annie Manji, and Chris Shutes; and not-able-to-attend messages from Spreck Rosekrans and John Stender. ***If you plan to attend this meeting and have not yet let me know, please do so at rose.staples@hdrinc.com. Thank you!***

The DSS database contains all of the intermediate steps to develop the strawman:

- Gage proration hydrology (not scaled)
- Gage proration hydrology (scaled to monthly volumes)
- Gage proration hydrology (scaled with smoothed factors)
- Gage summation hydrology (original, not smoothed)

In order to view, you will need to have HEC-DSSVue installed. If you do not have this software, you can download it from here.

<u>Districts "Strawman" for Considering Further Development of Unimpaired Hydrology for the Tuolumne River in Advance of Workshop On March 27, 2013</u>

1.0 Objective

Relicensing participants and the Districts are continuing to consider and discuss Tuolumne River hydrology for use in the Tuolumne River Operations Model (W&AR-02). This draft report is intended to be an initial "strawman" describing one possible approach to discuss further on March 27, 2013. The objective of this particular "strawman" is to develop a daily flow dataset that contains no negative values, results in more gradual changes in day-to-day flows, and conforms to the historical monthly volumes previously recorded by the Districts and CCSF. The period of record under consideration is Water Year 1971 – 2009. It is noted that the period of record may be extended to 2012 for use in the development of the river and reservoir temperature models.

2.0 Background

On September 10, 2012, the California Department of Fish & Wildlife (CDFW), provided comments to the State Water Resources Control Board (SWRCB) related to the unimpaired hydrology for the operations/water balance model being developed for the Don Pedro Project relicensing. In summary, CDFW is concerned "that the Districts' proposed method of estimating unimpaired hydrology is not appropriate for the purpose of the state of California's environmental review process required for a new license."

The Districts subsequently undertook an investigation of CDFW's suggested approach and submitted its report to SWRCB, CDFW and FERC on December 21, 2012. This report was also provided as Attachment A, Appendix A, of the W&AR-2 initial study report issued January 17, 2013. On February 14, 2013, representatives from CDFW, SWRCB, and CCSF met with the Districts to discuss the Districts' report and the comparison of the two approaches. The Districts maintained that there was insufficient Tuolumne River gauge data to support the gauge proration approach for the period of record of the Operations Model. CDFW and SWRCB expressed interest in using all available gauge proration hydrology even if the period of record was not as complete as might be desired. CDFW and SWRCB suggested that alternatives be developed collaboratively in a workshop environment. CDFW and SWRCB agreed that the monthly mass balance from the existing gauge summation hydrology was sound and need not be adjusted. The Districts agreed to continue to discuss and consider alternative approaches, and agreed to provide a "strawman" for to advance and promote dialogue at a meeting to be held on March 27.

3.0 Methods

Hydrologic input to the Operations Model currently includes daily unimpaired hydrology estimates for three locations in the watershed: "La Grange" (at the USGS gage), "Hetch Hetchy Reservoir", and Lake Lloyd Reservoir/Lake Eleanor combined "Cherry/Eleanor". The Operations Model uses these inputs to calculate a fourth dataset of operational significance: the unimpaired flow from the unregulated portion of the watershed above Don Pedro Reservoir (“Unregulated”). Details of these calculations are described in the ISR of W&AR-2, Attachment A.

3.1 Gauge Proration “Strawman”

To promote and advance discussions for the March 27 Workshop, the Districts, as agreed with SWRCB, CCSF and CDFW, have evaluated approaches to developing a hybrid flow record for the Tuolumne River using a combination of gauge proration conforming to the existing monthly mass balances underlying the Operations Model. This “strawman” is described below.

In order to prorate the gauged data to a larger ungauged area (application basin), three physical variables were considered – elevation, drainage area, and average annual precipitation (precipitation). Each gauged basin, along with each application basin (Hetch Hetchy, Cherry/Eleanor, and Unregulated), was divided into 100-foot “elevation bands” for its entire drainage area. This was done using USGS National Elevation Dataset, 1/3 arc-second (USGS, 2009), which equates to about a 30 foot pixel size. Each elevation band for each gauge had attributes added for the drainage area within this band (e.g., the number of square miles of the Tuolumne River drainage that exists between elevation 500 and 600 feet) and precipitation (e.g. the average annual precipitation for the drainage area between elevation 500 and 600 feet).

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

Areas at low elevations and high elevations in each of the application basins that are poorly represented or not represented at all by the reference gauges were “artificially added” into the elevation distributions of the most representative gauges in order to provide some amount of coverage for those elevation ranges. When artificial areas were added to the gauges, the amount of area added for each gauge was nominally established as one percent of the total application basin area for that elevation bin. For precipitation in artificially augmented elevation bands, a multiplier was applied to the application basin precipitation values equal to the multiplier for the nearest observed elevation band for that gauge.

The proration calculation includes two main steps. First, the daily flow for a given gauge is divided across the elevation range that the gauge represents, in equal proportion to the drainage area represented within each 100-foot elevation band. Second, the sum of each of the individual “elevation band flows” for each gauge is scaled up to the area of that elevation band in the application basin. Each of these steps includes a scaling factor for both area and precipitation. Equation 1 shows the calculation for prorated flow on a single day, with the first step in the left set of parenthesis, and the second step in the right set of parenthesis (mathematical summation form).

$$q_u = \sum_{e=1}^{n} \sum_{g=1}^{n} q_g \left(\frac{a_{ge} p_{ge}}{\sum_e a_{ge} p_{ge}}\right) \left(\frac{a_{ue} p_{ue}}{\sum_g a_{ge} p_{ge}}\right)$$

Equation 3.1.1 Daily unimpaired flow where q is daily average flow, a is area, and p is average annual precipitation. Where g is each gauged basin, u is the application basin, and e is the lower limit of each 100-foot elevation band divided by 100.

It is worth noting here that a few of the reference gauge basins had facilities that resulted in measurable amounts of stream regulation and/or diversion during the period of data use; no effort was made to modify the observed data to account for these hydrologic effects. However, it is not expected that these water regulation facilities would have a meaningful impact on the results of this analysis.

The following three sections of the "strawman" contain specific data to each application basin. Figure 3.1.1 shows where all the gauges used provide elevation coverage in reference to the application basin. The first table in each subbasin description contains a list of gauges used for gauge proration hydrology in that subbasin. The final table in each subbasin description shows gauge data availability from USGS, where white is unavailable, light gray is available but not used, and dark gray means it is being used in the subbasin gauge proration calculation. Some gauged data went unused when better gauged data (closer, more similar in elevation range) were available.

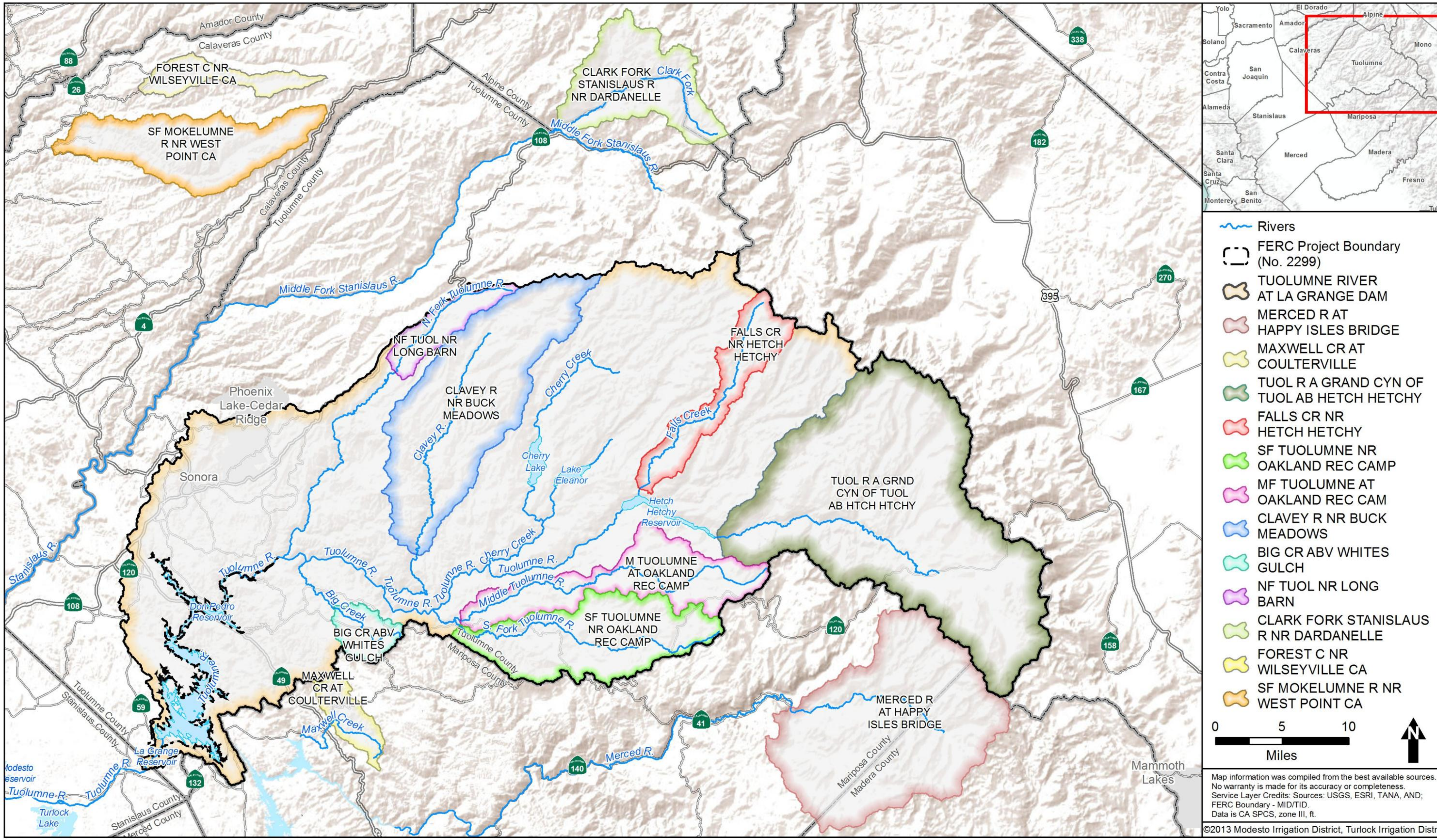

Figure 3.1.1 Map of gauges used in proration method for unimpaired hydrology

3.1.1 Hetchy Hetchy Subbasin

Table 3.1.1 Gauges used for gauge proration of Hetch Hetchy subbasin

11292500	CLARK FORK STANISLAUS R NR DARDANELLE CA
11274790	TUOLUMNE R A GRAND CYN OF TUOLUMNE AB HETCH HETCHY
11264500	MERCED R A HAPPY ISLES BRIDGE NR YOSEMITE CA
11275000	FALLS C NR HETCH HETCHY
11282000	M TUOLUMNE R A OAKLAND RECREATION CAMP CA

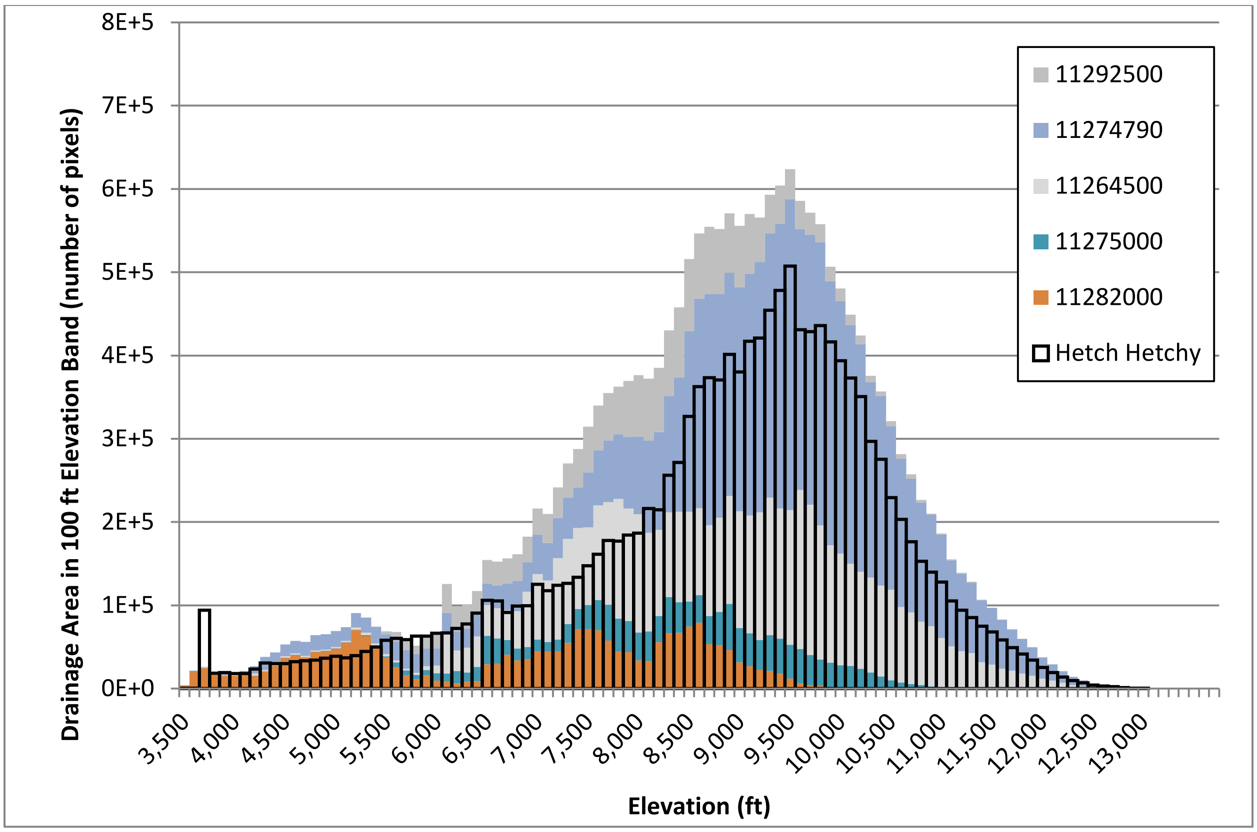

Figure 3.1.2 Elevation histograms for unimpaired gauges, compared to the Hetch Hetchy subbasin

Table 3.1.2 Gauge inventory for gauge proration of Cherry/Eleanor subbasin

WY	11292500	11274790	11264500	11275000	11282000
1971					
1972					
1973					
1974					
1975					
1976					
1977					
1978					

WY	11292500	11274790	11264500	11275000	11282000
1979					
1980					
1981					
1982					
1983					
1984					
1985					
1986					
1987					
1988					
1989					
1990					
1991					
1992					
1993					
1994					
1995					
1996					
1997					
1998					
1999					
2000					
2001					
2002					
2003					
2004					
2005					
2006					
2007					
2008					
2009					
2010					
2011					
2012					

3.1.2 Cherry/Eleanor Subbasin

Table 3.1.3 Gauges used for gauge proration of Cherry/Eleanor subbasin

11292500	CLARK FORK STANISLAUS R NR DARDANELLE CA
11274790	TUOLUMNE R A GRAND CYN OF TUOLUMNE AB HETCH HETCHY

11264500	MERCED R A HAPPY ISLES BRIDGE NR YOSEMITE CA
11283500	CLAVEY R NR BUCK MEADOWS CA
11275000	FALLS C NR HETCH HETCHY
11282000	M TUOLUMNE R A OAKLAND RECREATION CAMP CA
11284700	NF TUOLUMNE R NR LONG BARN CA
11281000	SF TUOLUMNE R NR OAKLAND RECREATION CAMP CA

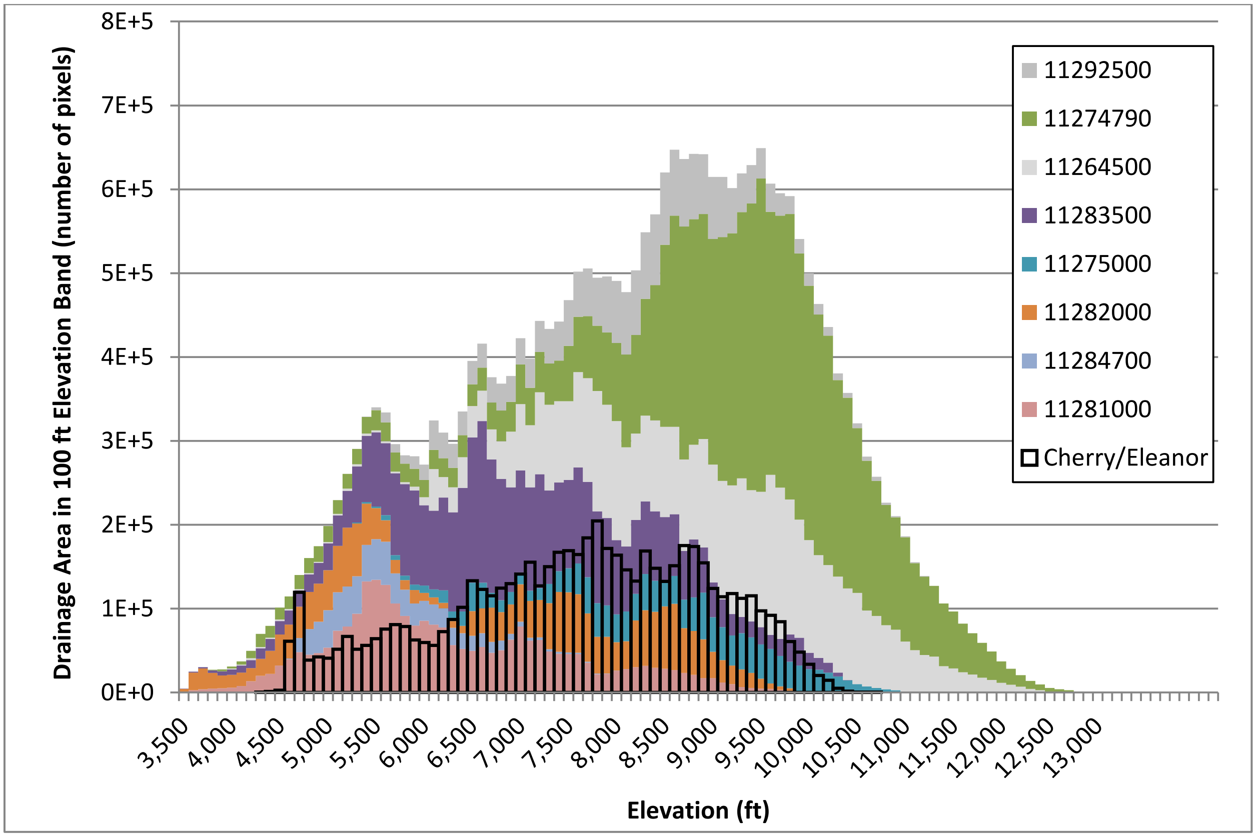

Figure 3.1.3 Elevation histograms for unimpaired gauges, compared to the Cherry/Eleanor subbasin

Table 3.1.4 Gauge inventory for gauge proration of Cherry/Eleanor subbasin

WY	11292500	11274790	11264500	11283500	11275000	11282000	11284700	11281000
1971								
1972								
1973								
1974								
1975								
1976								
1977								
1978								
1979								
1980								

WY	11292500	11274790	11264500	11283500	11275000	11282000	11284700	11281000
1981								
1982								
1983								
1984								
1985								
1986								
1987								
1988								
1989								
1990								
1991								
1992								
1993								
1994								
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2002								
2003								
2004								
2005								
2006								
2007								
2008								
2009								
2010								
2011								
2012								

3.1.3 Unregulated Subbasin

Table 3.1.5 Gauges used for gauge proration of Unregulated subbasin

11**3185**00	SF MOKELUMNE R NR WEST POINT CA
11**2693**00	MAXWELL C A COULTERVILLE CA
11**3168**00	FOREST C NR WILSEYVILLE CA
11**2844**00	BIG CR ABV WHITES GULCH

11283500	CLAVEY R NR BUCK MEADOWS CA
11264500	MERCED R A HAPPY ISLES BRIDGE NR YOSEMITE CA
11282000	M TUOLUMNE R A OAKLAND RECREATION CAMP CA
11284700	NF TUOLUMNE R NR LONG BARN CA
11281000	SF TUOLUMNE R NR OAKLAND RECREATION CAMP CA

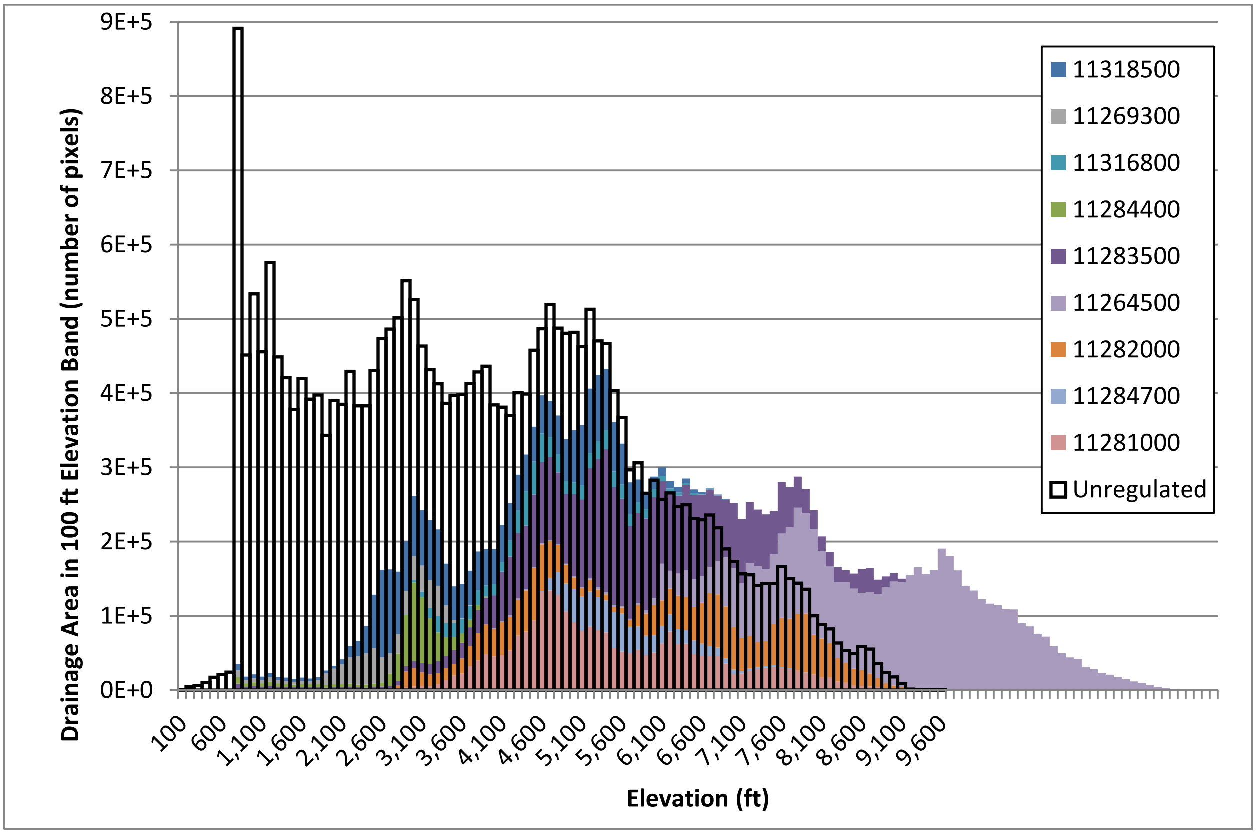

Figure 3.1.4 Elevation histograms for unimpaired gauges, compared to the Unregulated subbasin

Table 3.1.6 Gauge inventory for gauge proration of Unregulated subbasin

WY	3185	2693	3168	2844	2835	2645	2820	2847	2810
1971									
1972									
1973									
1974									
1975									
1976									
1977									
1978									
1979									
1980									
1981									

WY	3185	2693	3168	2844	2835	2645	2820	2847	2810
1982									
1983									
1984									
1985									
1986									
1987									
1988									
1989									
1990									
1991									
1992									
1993									
1994									
1995									
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2002									
2003									
2004									
2005									
2006									
2007									
2008									
2009									
2010									
2011									
2012									

3.2 Monthly Volume

In order to scale the gauge proration hydrology to the observed historical monthly volumes, some adjustments had to be made to deal with months where the total monthly volume was calculated negative. Negative monthly volumes in the current Tuolumne record are an artifact of gauge summation calculations involving numerous flow and reservoir level gauges, each with small errors. These calculations are described in detail in Attachment A of the ISR of W&AR-2. Negative monthly volumes occur during certain low flow periods (August-January) of Cherry/Eleanor, Hetch Hetchy, and unregulated inflow to Don Pedro. In total, adjustments were needed in 39 of the 504 months of the extended period of record (WY 1971 – WY 2012). This resulted in small changes to the annual volume from contributing subbasins for 22 of the 42 water years.

In order to eliminate negative monthly volumes without disturbing the gauge summation record, each of the upper subbasins (Cherry/Eleanor and Hetch Hetchy) were re-balanced with the Unregulated subbasin so that the monthly unimpaired volume at La Grange remains the same. Rather than transferring just enough volume to 'zero' out the negative month, an attempt was made to use the gauge proration record to find a reasonable value for the month being adjusted.

In the gauge proration hydrology record, typically the gauges being used don't change during a water year due to the way USGS reports data. Monthly volumes were examined as a percentage of the total water year volume for both the gauge summation, and gauge proration data. The monthly percentage of the annual volume was used as a guide to form an 'expected' monthly volume.

When the Unregulated subbasin had a negative month, Cherry/Eleanor and/or Hetch Hetchy volumes for that month were examined for closeness to their 'expected' amount. In many cases, the Cherry/Eleanor subbasin was far wetter than 'expected' and an adjustment down fixed a large portion of the imbalance. In most cases, a blend of both Hetch Hetchy, and Cherry/Eleanor volumes were used to offset a negative volume in the Unregulated subbasin. The exact percentage from each subbasin varies depending on how the adjustment affected each subbasin.

When Cherry/Eleanor or Hetch Hetchy subbasins had a negative month, an 'expected' value was used as a guide for the offset volume. All of the re-balancing volume came from the Unregulated subbasin. In most cases, this volume had to be further adjusted manually in order to keep normal volumes in the Unregulated subbasin. Table 3.2.1 shows these adjustments.

The only "*new water*" adjustment comes in October 2002, where 2000 AF was added to the La Grange gauge. This was the minimum volume that could be used to produce a positive 'expected normal' month in the Unregulated subbasin (and Cherry/Eleanor subbasin). All of the adjustments made to the Unregulated subbasin balance to a net of 2000 acre feet. In other words, for the period of record, CCSF/Districts have the same amount of water flowing into the watersheds. The 2000 AF addition to La Grange goes exclusively to the Unregulated subbasin.

Table 3.2.1 Adjustments to unregulated inflow volume to Don Pedro, in AF. Red indicates water going from the Unregulated subbasin to Cherry/Eleanor, orange to Hetch Hetchy, and green indicates water going from a combination of Cherry/Eleanor and Hetch Hetchy to the Unregulated subbasin.

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1971	-1,633										-3,369	-2,260
1972	-4,146										-3,024	-1,515
1973											-3,271	-4,695
1974												-4,741
1975	-3,518											
1976				8,000								

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1977			-1,041								-1,359	7,287
1978	-1,545											
1981	-6,652											
1987				4,400								-400
1988												-800
1989										6,600	4,500	
1990										3,088	3,600	2,800
1991	1,700		-1,500									
1994				-7,923							-7,500	-981
1995	6,143											
1996	2,400	-200										
2000	-1,527											
2003	**4,400**											
2004	1,945	5,037										
2007												4,200
2012												-500

Monthly scaling factors were used to scale the gauge proration hydrology up or down to the adjusted historical monthly volume. The monthly scaling factor is defined as the adjusted historical monthly volume divided by the gauge proration monthly volume. A scaling factor of less than one means the gauge proration overestimated the historical flow. A scaling factor of greater than one means the gauge proration underestimated the historical flow. When multiplied by the scaling factor, the daily gauge proration flow values will result in adjusted historical monthly volumes. The following three sections show computed scaling factors used for each subbasin, with red to orange indicating a reduction in gauge proration flow, and yellow to green representing an increase in gauge proration flow.

3.2.1 Hetchy Hetchy Subbasin

Table 3.2.2 Hetch Hetchy monthly scaling factors for gauge proration. Bold indicates reduced volume and italics indicates increased volume.

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1971	0.11	1.08	1.15	1.00	0.84	0.87	0.82	0.91	0.95	0.79	0.60	0.57
1972	0.48	0.75	1.04	0.98	0.96	0.82	0.81	0.89	0.84	0.56	0.32	0.27
1973	0.54	0.73	0.90	1.00	1.06	1.01	0.80	0.84	0.88	0.64	0.41	0.02
1974	0.32	0.87	1.02	0.94	0.72	0.88	0.79	0.83	0.87	0.85	0.57	0.07
1975	0.12	0.11	0.96	0.93	1.21	1.23	1.00	0.81	0.86	0.84	0.49	0.36
1976	0.81	0.87	0.74	*0.05*	0.98	0.94	0.83	0.93	0.82	0.71	0.70	0.44
1977	0.81	0.68	0.57	0.52	0.69	0.96	0.89	1.01	1.10	1.12	1.04	*0.97*
1978	0.52	0.96	1.25	1.67	1.67	1.15	0.91	0.79	0.88	1.03	0.73	0.64
1979	0.57	0.73	0.84	1.04	1.19	1.09	0.86	0.89	0.86	0.76	0.45	0.09
1980	0.82	0.92	0.83	1.03	0.98	0.93	0.80	0.80	1.00	1.18	0.84	0.36

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1981	0.16	0.26	0.59	0.64	0.95	1.08	0.84	0.94	0.90	0.53	0.41	0.28
1982	0.91	1.09	1.03	1.09	0.94	0.78	0.74	0.81	0.89	0.87	0.86	0.91
1983	0.90	1.06	1.10	1.00	1.05	1.11	0.80	0.77	0.86	0.88	0.93	0.74
1984	0.95	1.80	1.45	0.96	1.06	1.17	1.22	1.58	1.76	1.24	0.79	0.60
1985	0.97	1.83	1.50	1.15	1.36	1.61	1.42	1.65	1.69	0.89	0.54	0.92
1986	1.55	1.63	2.13	1.90	1.57	1.19	1.27	1.45	1.62	1.56	1.01	0.57
1987	1.31	0.70	0.62	*0.50*	1.83	1.87	1.47	1.57	1.34	0.71	0.30	**0.15**
1988	0.56	1.10	1.77	2.03	1.43	1.40	1.55	1.59	1.40	0.80	0.55	0.57
1989	0.15	0.63	1.35	2.10	2.52	2.00	1.40	1.67	1.69	*1.07*	*0.22*	0.58
1990	1.34	1.41	1.50	2.03	2.14	1.81	1.58	1.61	1.50	*0.76*	*0.39*	*0.12*
1991	*0.20*	0.66	0.53	0.50	1.15	2.66	1.62	1.49	1.53	1.16	0.84	0.50
1992	1.18	1.39	1.35	1.44	2.02	1.70	1.39	1.37	1.00	1.02	0.74	0.61
1993	1.17	0.91	1.55	2.03	1.82	1.39	1.19	1.25	1.33	1.30	0.93	0.47
1994	0.88	0.56	1.28	**0.62**	1.84	2.08	1.64	1.70	1.64	0.62	**2.06**	**0.61**
1995	*0.60*	2.05	1.95	2.36	1.86	1.46	1.23	1.19	1.35	1.43	1.48	1.14
1996	*0.39*	0.95	1.91	1.74	1.78	1.34	1.30	1.47	1.84	1.70	1.05	1.01
1997	1.34	1.40	1.76	1.32	1.00	1.03	1.03	1.20	1.48	1.14	0.87	0.71
1998	1.03	1.17	1.96	2.49	1.72	1.58	1.19	1.23	1.34	1.35	0.87	0.77
1999	1.23	1.82	1.86	2.05	1.79	1.51	1.31	1.55	2.06	1.94	1.13	1.05
2000	1.54	1.61	1.26	2.42	1.98	1.54	1.45	1.49	1.50	1.17	1.11	0.92
2001	1.35	1.39	2.19	1.94	2.12	1.83	1.55	1.42	1.17	1.01	1.14	1.38
2002	2.46	1.71	2.09	1.81	1.67	1.51	1.40	1.57	1.61	1.13	1.22	2.06
2003	*0.84*	1.32	1.91	1.43	1.01	1.08	1.20	1.12	1.03	0.74	0.84	0.43
2004	*1.27*	*1.26*	1.90	0.89	0.95	1.20	1.22	1.40	1.33	0.88	0.96	1.55
2005	1.91	1.22	1.46	1.74	1.49	1.39	1.03	0.95	0.92	0.78	0.52	0.60
2006	0.88	1.09	2.14	1.23	1.24	1.14	1.06	0.99	1.10	0.88	0.56	0.27
2007	0.52	1.22	1.62	1.44	1.79	1.43	1.31	1.43	1.16	0.74	0.83	*0.16*
2008	1.28	1.32	1.90	1.52	1.58	1.36	1.26	1.36	1.32	0.83	0.48	0.77
2009	1.67	1.28	1.27	1.60	1.48	1.46	1.24	1.47	1.48	1.00	0.85	0.83
2010	1.31	1.03	1.52	1.56	1.57	1.52	1.49	1.36	1.31	1.06	0.75	1.06
2011	1.67	1.32	1.92	1.42	1.49	1.88	1.38	1.32	1.41	1.42	1.19	0.95
2012	1.02	0.92	0.58	1.38	1.18	1.30	1.32	1.28	1.07	0.69	0.58	0.61

3.2.2 Cherry/Eleanor Subbasin

Table 3.2.3 Cherry/Eleanor monthly scaling factors for gauge proration. Bold indicates reduced volume and italics indicates increased volume.

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1971	**0.52**	2.91	2.04	1.66	1.42	1.46	1.37	1.47	1.37	1.00	**0.52**	**0.52**
1972	**0.53**	2.46	1.63	1.44	1.47	1.64	1.54	1.52	1.41	0.17	**0.53**	**0.52**
1973	0.67	1.80	2.11	1.48	1.15	1.19	1.43	1.45	1.30	0.44	**0.49**	**0.49**
1974	0.83	2.76	1.62	1.44	1.07	1.36	1.29	1.43	1.28	1.09	0.14	**0.52**
1975	**0.48**	0.23	1.52	1.75	1.37	1.38	1.39	1.46	1.28	1.16	0.42	0.39
1976	2.52	1.61	1.28	*0.09*	1.83	1.89	1.90	1.62	0.81	0.24	2.14	1.63
1977	1.65	0.82	**0.71**	1.57	2.40	2.38	2.16	2.25	1.48	0.14	**0.72**	*1.80*
1978	**0.54**	2.54	3.55	2.05	1.32	1.40	1.25	1.49	1.39	1.30	0.78	2.27

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1979	0.05	1.27	1.78	2.10	1.62	1.41	1.51	1.44	1.28	0.99	1.15	1.62
1980	2.78	3.02	2.55	1.75	1.09	1.08	1.42	1.34	1.76	2.02	1.06	0.76
1981	**0.62**	0.44	1.61	1.65	2.28	1.85	1.98	1.66	1.36	1.27	3.38	2.36
1982	2.76	3.23	1.83	1.13	1.22	1.33	1.16	1.19	1.21	1.09	0.58	1.75
1983	2.39	1.52	1.03	0.96	0.91	0.84	0.99	1.27	1.27	1.32	1.21	1.07
1984	1.49	4.50	2.33	1.39	1.55	2.26	1.95	2.12	1.80	0.97	0.09	0.17
1985	2.47	5.03	3.28	2.01	2.66	3.12	2.95	2.43	1.91	0.81	0.92	1.16
1986	4.32	4.31	5.71	5.17	2.54	2.11	2.15	2.19	2.14	1.79	0.82	1.50
1987	1.38	0.71	0.98	*0.67*	3.76	3.25	3.89	2.65	1.66	0.36	0.76	0.63
1988	2.70	4.08	5.10	1.04	1.69	3.14	3.44	3.05	2.38	1.52	0.08	**0.51**
1989	1.27	4.80	4.05	4.02	3.73	3.25	2.30	2.36	2.02	*0.52*	*0.09*	3.64
1990	6.66	3.93	2.43	3.50	3.47	3.25	3.14	2.80	2.15	*0.80*	*0.17*	*0.32*
1991	*0.47*	0.67	**0.92**	1.02	2.53	5.29	3.43	3.01	2.68	2.25	0.84	0.24
1992	1.65	4.19	1.95	2.56	3.24	2.95	3.10	2.42	1.43	4.22	1.36	0.11
1993	3.35	3.58	3.09	2.44	1.74	2.08	2.02	2.11	2.20	2.36	1.09	0.40
1994	1.37	0.63	2.69	2.39	3.39	3.75	3.71	3.01	1.98	0.70	0.03	0.05
1995	*1.79*	11.40	4.67	1.83	2.07	1.28	1.80	1.96	2.01	1.64	1.38	0.35
1996	*0.37*	**0.003**	6.32	3.28	3.37	2.11	2.13	2.20	1.76	1.19	0.74	0.33
1997	2.40	3.24	5.53	2.56	1.70	2.05	1.69	1.14	1.06	0.52	0.24	1.27
1998	2.36	3.49	4.36	3.74	1.70	2.51	2.09	1.97	1.93	1.69	0.83	0.82
1999	1.13	5.78	3.78	3.34	2.36	2.49	2.28	2.25	2.27	1.52	0.30	0.04
2000	**0.90**	3.37	1.47	5.53	2.69	2.63	2.63	2.19	1.72	0.86	0.72	1.57
2001	3.18	4.09	5.20	5.25	5.16	4.28	2.84	1.78	0.92	1.02	3.35	3.66
2002	2.25	7.05	5.22	4.21	3.31	3.52	2.43	2.08	1.55	0.35	2.15	2.22
2003	*1.43*	4.70	6.20	4.35	2.99	3.03	2.24	1.42	0.99	0.63	1.18	2.60
2004	*1.63*	*3.32*	7.47	4.33	4.91	2.32	1.87	1.44	0.89	0.48	0.58	0.15
2005	7.77	4.56	5.68	4.44	3.54	2.79	1.99	1.64	1.21	0.85	0.27	0.84
2006	3.79	3.65	7.66	3.42	4.13	3.37	2.51	1.15	0.96	0.71	0.50	0.68
2007	2.07	5.46	7.26	6.35	6.84	3.92	2.59	1.74	1.11	1.68	4.46	*2.06*
2008	5.19	0.74	6.16	5.68	3.91	4.03	3.04	1.79	1.14	0.54	0.70	0.32
2009	2.78	4.80	3.51	5.02	4.01	3.55	2.93	2.61	2.19	1.08	1.02	1.47
2010	4.95	1.72	4.10	3.90	2.81	3.22	2.45	2.22	2.09	1.61	0.80	0.84
2011	4.61	4.01	3.06	2.60	2.86	2.26	2.46	2.51	1.78	1.66	1.71	1.71
2012	2.59	2.11	0.89	5.82	3.82	4.49	3.07	1.70	1.21	0.62	0.45	**0.48**

3.2.3 Unregulated Subbasin

Table 3.2.4 Unregulated subbasin scaling factors for gauge proration. Bold indicates reduced volume and italics indicates increased volume.

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1971	*2.11*	1.73	1.42	1.31	1.01	0.92	0.84	0.85	0.93	1.38	*1.51*	*1.48*
1972	*0.59*	1.24	1.20	1.66	1.19	0.87	0.83	0.88	1.15	2.63	*3.78*	*2.21*
1973	1.18	1.98	1.45	1.27	1.43	1.27	0.84	0.78	1.15	1.89	*1.99*	*1.52*
1974	1.98	1.00	1.23	1.04	0.94	0.92	0.92	0.86	1.14	1.55	2.03	*2.77*
1975	*2.45*	1.39	1.24	1.33	1.60	1.30	1.07	0.70	0.81	0.88	1.73	1.77
1976	1.22	1.45	1.47	**0.81**	1.18	1.13	1.01	0.94	1.35	3.25	3.13	2.87

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1977	1.47	1.62	0.39	1.45	1.14	0.95	0.86	0.96	1.03	0.40	*2.77*	**1.02**
1978	*0.61*	1.52	1.44	1.25	1.22	1.05	0.97	0.93	0.92	1.08	2.62	2.40
1979	1.22	2.85	1.45	1.46	1.50	1.17	0.83	0.79	0.96	1.60	1.52	1.79
1980	1.57	0.96	1.05	0.99	1.03	1.00	0.85	0.92	0.79	0.91	1.96	2.79
1981	*1.48*	0.90	1.56	1.76	0.93	1.40	0.83	0.89	1.40	2.88	8.09	3.69
1982	2.04	1.17	1.10	1.41	0.93	1.37	0.92	0.90	1.25	2.07	1.72	2.08
1983	1.09	1.16	1.01	1.22	1.13	1.05	0.97	0.79	0.75	0.90	0.92	1.12
1984	1.64	1.45	1.21	1.25	1.43	1.23	1.08	0.81	0.90	0.57	0.86	0.52
1985	1.22	1.49	1.15	1.06	1.40	1.62	1.07	0.81	0.73	1.25	3.49	2.36
1986	1.50	1.70	1.33	1.21	1.09	1.25	1.01	0.77	0.53	1.22	1.38	1.97
1987	1.19	0.65	0.77	**0.37**	1.12	1.30	0.73	0.81	1.64	1.87	3.59	*0.66*
1988	1.82	1.42	2.59	2.63	1.86	1.14	0.88	0.85	1.07	3.63	3.11	*0.41*
1989	0.56	2.05	1.65	1.45	1.16	0.94	0.78	0.77	0.94	**0.71**	**0.86**	*0.64*
1990	0.86	0.33	0.54	0.98	1.69	0.98	0.83	0.76	0.90	**0.89**	**0.59**	**0.72**
1991	**0.14**	3.34	*0.86*	1.39	1.18	1.59	0.98	0.94	1.00	3.28	6.76	5.02
1992	3.34	0.77	1.04	1.51	1.32	1.00	0.88	1.08	1.72	1.88	4.97	3.45
1993	2.13	0.40	1.49	1.50	1.31	0.94	0.76	0.76	0.89	1.54	2.77	2.74
1994	1.45	0.81	0.89	*1.48*	1.61	0.91	0.94	0.96	1.77	7.56	*9.85*	*7.59*
1995	**0.40**	1.06	1.77	1.28	0.96	1.10	0.95	0.89	0.92	0.94	0.85	0.70
1996	**0.12**	*0.00*	1.17	1.49	1.30	1.27	1.00	0.96	0.82	0.67	0.94	1.80
1997	0.90	1.44	1.44	1.22	1.04	1.41	1.07	0.74	0.25	0.77	1.77	1.18
1998	0.51	1.01	1.11	1.86	1.47	1.35	1.25	1.07	1.03	0.93	0.72	0.64
1999	0.39	1.00	1.13	1.31	1.17	1.09	1.11	0.97	1.02	1.25	1.65	2.27
2000	*0.86*	0.84	0.81	1.25	1.47	1.51	1.16	0.96	1.04	1.04	1.62	1.34
2001	1.23	0.54	0.85	1.22	1.46	1.33	1.11	0.86	0.85	1.51	2.39	2.60
2002	2.83	1.25	1.49	1.31	1.14	1.20	1.10	0.88	0.78	1.50	2.97	2.05
2003	**0.16**	1.16	1.51	0.94	0.93	1.19	0.92	0.76	0.56	0.66	1.75	1.75
2004	**0.28**	**0.91**	1.02	1.11	1.32	0.86	0.88	0.58	0.27	0.36	2.62	1.54
2005	2.52	0.52	1.14	1.61	1.43	1.25	1.10	1.09	0.99	0.84	1.36	2.22
2006	0.67	0.61	1.08	1.09	0.91	1.20	1.12	1.08	0.46	0.25	0.48	0.97
2007	0.92	0.57	0.68	0.18	1.19	0.79	0.82	0.47	0.42	0.68	0.75	**0.55**
2008	0.92	0.33	1.52	1.86	1.62	1.18	0.85	0.74	0.37	0.52	3.70	2.44
2009	0.24	0.88	0.81	1.74	1.20	0.99	0.83	0.80	0.55	1.00	2.01	1.73
2010	0.99	0.07	1.23	1.39	1.35	1.19	0.79	0.69	0.67	0.42	0.38	1.13
2011	1.01	1.28	1.32	1.25	1.20	1.27	1.03	0.76	0.82	0.69	0.96	1.00
2012	0.64	0.65	0.26	0.84	0.79	1.31	0.94	0.59	0.92	1.65	2.01	*2.14*

3.3 Smoothing Between Scaling Factors

It can be seen in the record of scaling factors that most of the period of record contains gradually changing scaling factors each month. In several cases there are some abrupt changes, which have the potential to artificially shape the gauge proration. This is particularly the case during snowmelt recession, when a large factor in June might drop to a very small factor in July. This would make the hydrograph appear to drop quite rapidly to the baseflow rate, instead of the expected gradual recessional limb of a hydrograph.

In order to alleviate this problem, caused by the boundaries between monthly scaling factors, a smoothing technique was used to gradually shift between scaling factors over the course of two weeks (one week in each month). Any monthly volumetric changes resulting from this smoothing were applied as a multiplier adjustment to the middle two weeks of the month. In most months, where scaling factors do not change significantly, these adjustments do not change the hydrograph in any noticeable way.

The function used to smooth between scaling factors was a cumulative normal distribution with a standard deviation of 1.80. In several cases, in order to maintain the monthly volume, the standard deviation had to be decreased in order to provide a more abrupt transition. An example of typical daily scaling factors can be seen in Figure 3.3.1.

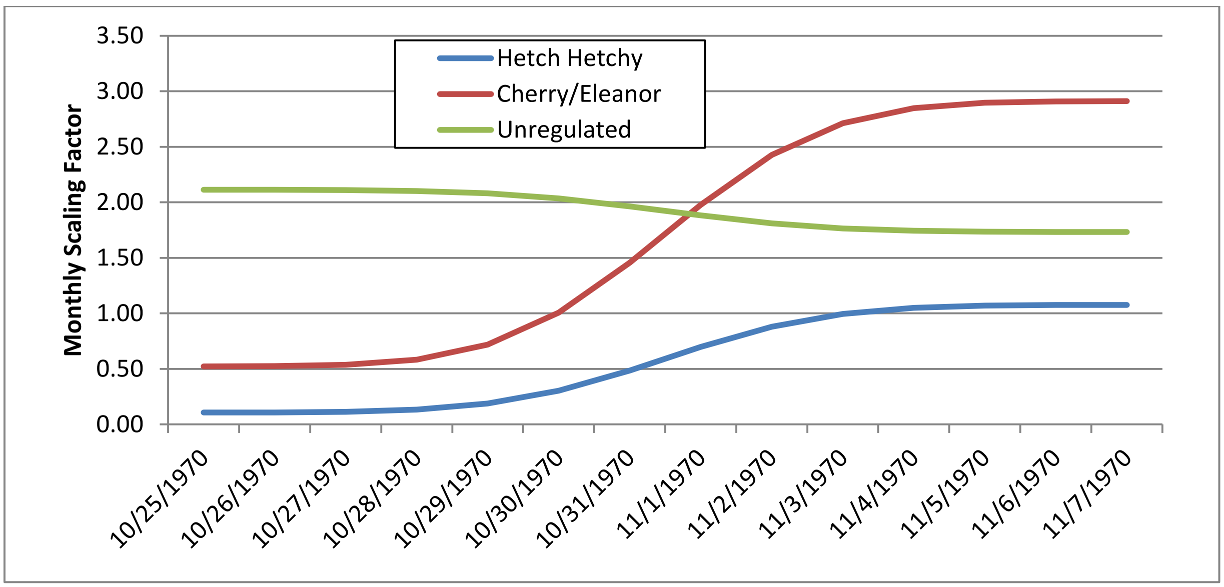

Figure 3.3.1 Typical daily scaling factor smoothing

4.0 Results

The resulting “strawman” can be seen in the attached HEC-DSS database.

5.0 Discussion

In water year 1997, and water years 2003-2008 there are only four unimpaired gauges representing the Unregulated subbasin. Two of those gauges are in the Mokelumne River basin, one in the Merced River basin, and the smallest one is in the Tuolumne River basin. Together, these four gauges provide a poor representation of the Unregulated subbasin, and combined have a drainage area equal to less than 27% of the Unregulated subbasin (Figure 5.1). This period is the poorest representation of any of the application areas for the period of record. Despite the poor match in drainage size, elevation range, and even overall geography, the gauge proration provides a reasonable looking daily hydrograph when scaled to the historical monthly volumes (Figure 5.2).

In the Operations Model, the function of the model is to allow comparisons to be made of different scenarios. Absolute accuracy is not the goal. Relative differences between modeling scenarios is a powerful decision making tool. While statistically accurate daily values may not be achieved using the gauge proration methods described herein, they do create a dataset that:

- Describes general hydrograph shape, variability, and magnitude of peak flows
- Maintains the historical monthly volumes
- Provides a reasonable depiction of daily flow conditions over the period of record

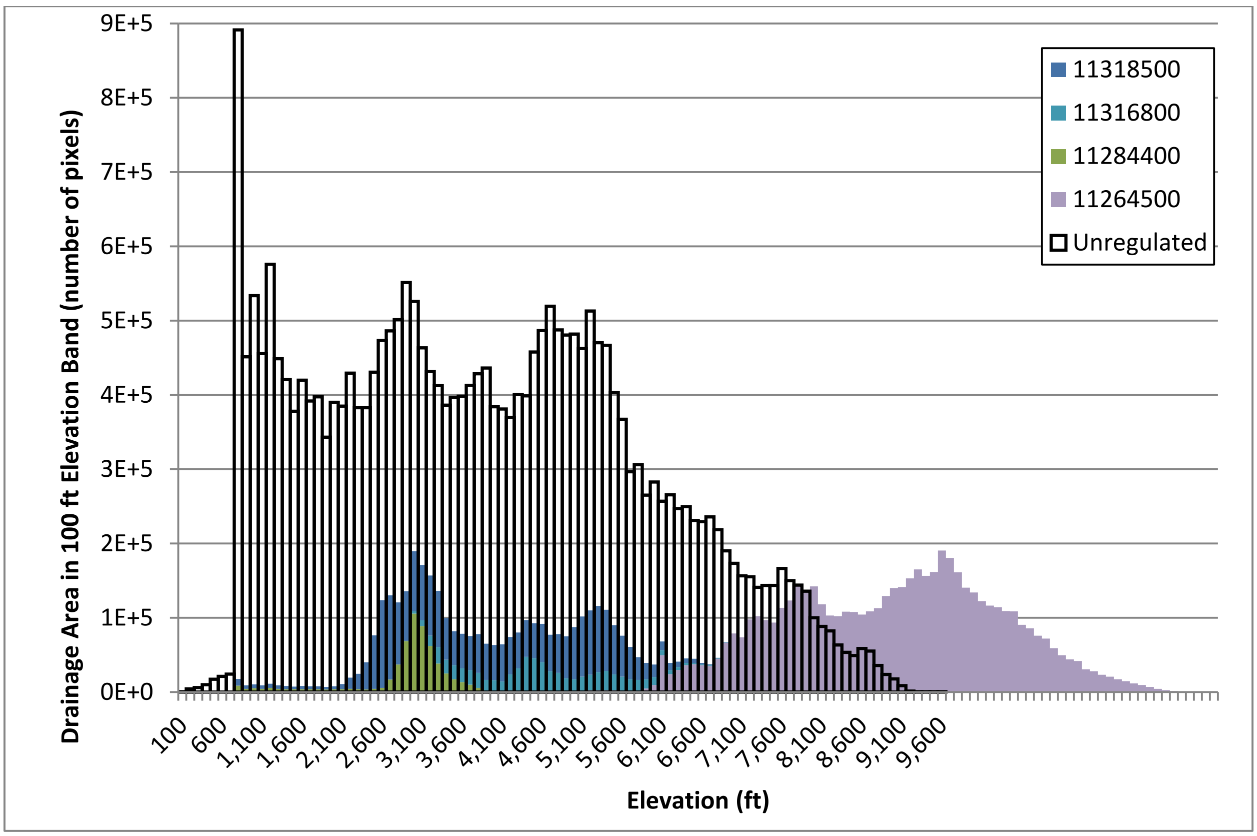

Figure 5.1 Elevation histogram for Unregulated subbasin gauge proration (WY 97, 02-08)

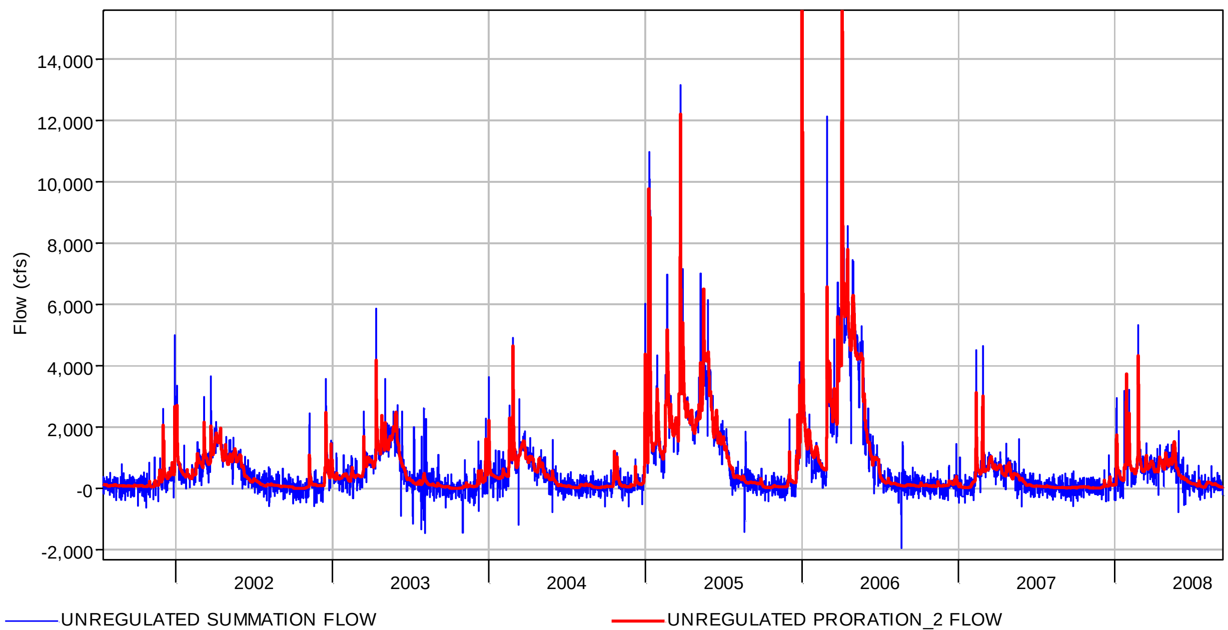

Figure 5.2 Hydrograph comparison gauge summation (W&AR-02) and gauge proration

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April 9, 2013
Via Electronic Filing

Project No. 2299-075-California
Don Pedro Project

Kimberly D Bose, Secretary
Federal Energy Regulatory Commission
888 First Street NE
Washington DC 20426

RE: Don Pedro Project P-2299-075
Districts' Response to Relicensing Participants Comments on the Initial Study Report

Dear Secretary Bose:

Pursuant to 18 C.F.R. § 5.15(c)(5) of the Federal Energy Regulatory Commission ("FERC") regulations, this letter contains Turlock Irrigation District and Modesto Irrigation District (collectively, the "Districts") response to Relicensing Participants ("RPs") comments on the Don Pedro Project Initial Study Report. The response has considered the study criteria set forth in Sections 5.9(b), 5.15(d), and 5.15(e) of FERC's regulations, applicable law, FERC policy and practice, and FERC staff's December 22, 2011 Study Plan Determination ("SPD").

FERC's SPD for the Don Pedro Project approved, or approved with modifications, 34 studies proposed in the Districts' Revised Study Plan ("RSP"), filed on November 22, 2011. These studies addressed cultural and historic resources, recreational resources, terrestrial resources, and water and aquatic resources. FERC staff recommended that one of the Districts' proposed studies, the Water and Aquatic Resources ("W&AR") Study No. 09, not be undertaken.

As required by the SPD, the Districts filed three revised study plans with more detailed methodologies on February 28, 2012 (W&AR-18: *Sturgeon Study*, W&AR-19: *Lower Tuolumne River Riparian Information and Synthesis Study*, and W&AR-20: *Oncorhynchus mykiss Scale and Age Determination Study*) and one modified study plan on April 6, 2012 (W&AR-12 *Oncorhynchus mykiss Habitat Survey*) after further consultation with RPs. FERC approved or approved with modifications these studies on July 25, 2012.

The Districts filed an Initial Study Report ("ISR") for the Don Pedro Project on January 17, 2013; held an ISR Meeting on January 30 and 31, 2013; and filed a summary of the meeting on February 8, 2013. Comments on the meeting summary and requests for new studies and study modifications were filed by the U.S. Bureau of Land Management ("BLM"), U.S. Forest Service ("USFS"), National Marine Fisheries Service ("NMFS"), National Park Service ("NPS"), U.S. Fish & Wildlife

Service ("USFWS"), California Department Fish & Wildlife ("CDFW"), State Water Resources Control Board ("SWRCB"), All-Outdoor, American River Tour Association ("ARTA"), Conservation Groups ("CGs"), Robert Hackamack, O.A.R.S., Restore Hetch Hetchy ("RHH"), Tuolumne River Trust ("TRT"), and Sierra Mac.

The Districts' response to comments contained herein does not address all comments; it only addresses RPs' comments on study variances, requests for study modifications, or requests for new studies. Pursuant to Section 5.15(d) of FERC's regulations, any proposal to modify an ongoing study must be accompanied by a showing of good cause why the proposal should be approved and must include a demonstration that: (1) the approved studies were not conducted as provided for in the approved study plan; or (2) the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way. As specified in Section 5.15(e), new study requests must also show good cause and a statement explaining: (1) any material changes in the law or regulations applicable to the information request, (2) why the goals and objectives of any approved study could not be met with the approved study methodology; (3) why the request was not made earlier; (4) significant changes in the project proposal or that significant new information material to the study objectives has become available; and (5) why the new study request satisfies the study criteria in Section 5.9(b).

I. Districts' Response to Requests for New Studies

The RPs submitted a number of requests for new studies. However, most of these requests for new studies were identical, or nearly so, to study requests made in 2011 during the initial study plan development process. Section 5.15(e) of FERC's regulations governing the Integrated Licensing Process ("ILP") requires that any request for new information gathering subsequent to the ISR must not only meet the basic requirements for study requests set forth in Section 5.9(b), but also must be accompanied by a showing of "good cause" why the new study should be approved. To meet the requirement of "good cause," a request for a new study must identify a material change in relevant law or regulation, provide an explanation of why the request was not made earlier, or explain what significant new information material to the study objectives has become available. The Districts have reviewed each of the requests for new studies submitted by RPs and provide their response below.

[1] NMFS
In Enclosure B of its March 11, 2013 comments on the Districts' ISR, NMFS identified four new study requests. Each of these requests is virtually identical to study requests previously submitted during the initial study development process leading to the Districts' November 22, 2011 RSP and FERC's December 22, 2011 SPD. NMFS' new study requests are repeated below:

- Original Request #1: *Study of the Effects of the (Don Pedro) Project and Related La Grange "Complex" on Anadromous Fishes*
- Original Request #3: *Effects of the Project on Fish Passage*
- Original Request #7: *Evaluation of Upper Tuolumne River Habitats for Anadromous Fish*

- Original Request #9: *Effects of the Project on Ecosystem/Marine Derived Nutrients for Anadromous Fish*

Regarding NMFS Study Request #1: *Study of the Effects of the (Don Pedro) Project and Related La Grange "Complex" on Anadromous Fishes*, (Elements #3 and #6), NMFS presents this as a new study request, but it is a request for existing information and is, therefore, not relevant to either study modifications or new study requests. In any event, the Districts have a different interpretation of the direction provided by FERC to the Districts in the May 24, 2012 Formal Study Dispute Determination. NMFS seems to be indicating that the Districts were directed by FERC's Dispute Determination to identify existing information in its possession broadly related to NMFS-1 Elements 3 and 6 and to actually include all of the raw data as part of the Initial Study Report; and further, that the Districts failed to do this. To the contrary, the Districts provided in the ISR, consistent with FERC's determination related to NMFS-1 (Elements 3 and 6) as described on page 10 of FERC's Dispute Determination, additional information and an assessment of the combined effects of the Don Pedro and La Grange projects "on the hydrology of the Tuolumne River" as depicted in Figures 1.4-1, 1.4-2, and 1.4-3.

FERC's Dispute Determination also instructed the Districts to "identify the specific sources of the information that would address NMFS-1, Elements 3 and 6, and file it with the Commission in the Initial Study Report." The Districts identified the information it had that might be "associated with the cumulative environmental effects of the operations of La Grange dam on the Tuolumne River between La Grange dam and the La Grange stream gage." The Districts filed this information list with FERC in Table 1.4-2 of the ISR. If FERC's intent was for the Districts to simply file all the raw data with the ISR, this seemed inappropriate to do before it was determined to be relevant and "associated with cumulative environmental effects." The Districts are certainly willing to provide the actual raw data if that was the direction intended by FERC.

However, we would like to point out that much of the information in NMFS-1 Elements 3 and 6 has either already been provided to NMFS as part of the Don Pedro relicensing (e.g., in the Don Pedro PAD, at meetings, or in meeting notes), is known to already be in NMFS possession, or is public information. For example, as NMFS is well aware, the Districts have recently filed substantial information about the La Grange facilities and operations with FERC as part of FERC's jurisdictional investigation of La Grange dam. This includes information responsive to Element 3(a), (b), (d), (e), (f) and virtually all of (h). It seems unreasonable that the Districts now have to separately provide this information once again to NMFS.

Regarding NMFS Request #3, #7, and #9, NMFS indicates in its March 11, 2013, letter that it is re-submitting these study requests, without modification, for reconsideration by FERC. Each of these requests proposes studies which deal with anadromous fish passage at the Don Pedro Project and/or the potential for habitats upstream of the Don Pedro Project to support anadromous fish life stages. NMFS attempts to show "good cause" as required by FERC's regulations at 18 C.F.R. § 5.15(e) by asserting that "[s]ignificant new information material to the study objectives has become available" in the form of FERC's December 19, 2012 Order finding that the Districts' La Grange diversion dam is subject to FERC jurisdiction and therefore the Districts must obtain a license from FERC if TID is to continue the operation of the small hydro plant in the TID forebay. NMFS concludes that given this new information coupled with NMFS Section 18 fish passage prescription authority, it is now "reasonably foreseeable" that anadromous fish could be present below Don Pedro Dam and would need to migrate through Don Pedro Reservoir.

The Districts disagree with NMFS' claims that FERC's December 19, 2012 Order related to the La Grange diversion dam is sufficient to meet the "good cause" test and represents "significant new information." The Districts disagree that the December 19, 2012 Order on La Grange now makes it "reasonably foreseeable" that anadromous fish will be present below Don Pedro Dam.

FERC's December 22, 2011 SPD did not adopt the original NMFS Requests #3, #7, or #9 because FERC found that "the Don Pedro Project does not block the upstream migration of anadromous fish because the upstream extent of anadromous fish in the Tuolumne River is currently limited to areas below La Grange Dam." FERC provides its underlying rationale for this decision when it states on page 74 that "the facts are clear" that "La Grange Dam is not a **Commission-licensed** facility under the FPA" and that the "**unlicensed** La Grange dam is the downstream barrier to upstream migration of anadromous fish" [emphasis added]. These facts have not changed. It continues to be a fact that the La Grange dam is not a FERC-licensed facility. FERC's December 19, 2012 Order does not alter that fact. It remains highly uncertain whether the Districts will file an application for license, whether FERC will issue a license upon reasonable terms, or whether the Districts would accept a license issued by FERC for La Grange dam. Indeed, the Districts have contested FERC's Order finding the La Grange Project is subject to its jurisdiction. For these reasons, the Districts disagree with NMFS' assertion that fish passage at La Grange dam is now "reasonably foreseeable."

FERC also cited other reasons in the December 22, 2011 SPD for not requiring the Districts to undertake several of NMFS' study requests. While the Districts consider these other reasons unnecessary to support the decision not to adopt NMFS' resubmitted study requests, they are worth reiterating here. FERC noted that the Draft Central Valley (Spring-Run) Recovery Plan remains a draft and no specific fish passage plans have been developed, approved, or funded, and therefore, it is unknown when fish passage might occur or which part of the San Joaquin or Sacramento river basins would be targeted. FERC's statement is true; the NMFS Central Valley Recovery Plan remains a draft. Appropriately, FERC also stated on page 84 of the SPD that "the suitability of upstream habitat for anadromous salmonids, as it relates to recovery planning under NMFS guidelines, pertains to management decisions and actions which most appropriately fall under NMFS jurisdiction." The Districts agree with these rationales. NMFS' purpose in requesting these studies is to use the FERC licensing process as a means to gather data and studies that NMFS itself should be undertaking for its own programs. In years past, the FERC licensing process had become a means for resource agencies to obtain data for their own programs, unrelated to the needs of FERC decision-making required under the Federal Power Act ("FPA"). Preventing this acknowledged abuse of the FERC licensing process, as NMFS attempts here, was a large part of the rationale for the development of the seven study request criteria under the ILP regulations. FERC should not undermine this important component of the ILP by assenting to NMFS in this case.

Finally, NMFS, on page 6 of Enclosure B, clearly and concisely spells out that NMFS believes that the information to be obtained through the resubmitted study request is needed by NMFS to exercise NMFS' various statutory authorities. The Districts would point out that FERC, supported by the courts (*see, e.g. U.S. Department of the Interior v. FERC* (952 F.2d 538 (D.C. Cir. 1992)), has long held that there is nothing in the FPA that requires FERC to conduct the studies that the fish and wildlife agencies deem necessary for the exercise of their Section 10(j) or Section 18 authorities. Nothing in the FPA suggests that FERC must order studies that resource agencies desire but which FERC deems unnecessary to evaluate the public interest.

[2] USFWS

In its comments on the ISR dated March 11, 2013, USFWS requests five new studies, three of which are repeats of studies previously requested during the initial study plan development process (USFWS-A, B, and D), one of which is very similar to a previously requested study (USFWS-C), and one of which is a request for further consultation (USFWS-E). The Districts respond to each of these below. These study requests are:

- USFWS-A: *Instream Flow and Juvenile Chinook Salmon Floodplain Rearing Study*
- USFWS-B: *Juvenile Chinook Salmon Outmigration Study*
- USFWS-C: *IFIM Study on Pacific Lamprey, Sacramento Splittail, and Non-Native Predatory Fish of the Lower Tuolumne River*
- USFWS-D: *Bioenergetics Study*
- USFWS-E: *California Red-Legged Frog Surveys*

USFWS-A is similar to study request FWS-1 contained in USFWS' June 9, 2011 letter providing comments on the Districts' PAD and containing USFWS' original study requests. Although the Districts are uncertain exactly what new studies USFWS is actually requesting in USFWS-A, it appears that this request actually contains several comments on the Districts' IFIM study submitted for resource agency review and comment on February 28, 2013 and one new study request.

Regarding the recently issued IFIM study, USFWS makes several comments that were raised in prior consultation meetings related to salmonid rearing habitat, including the need for cover and adjacent velocity information, preference for using 2-D rather than 1-D PHABSIM, use of logistic regression, and development of river-specific habitat suitability data. In general, the Districts point out that the in-channel 1-D PHABSIM and the 2-D "Pulse Flow" studies were conducted consistent with FERC-approved study plans. The PHABSIM model includes elements of depth, velocity, and cover, as applicable per the direction of the technical working group that USFWS was part of which discussed all of these issues. The IFIM study included data collection and evaluation of adjacent velocity to examine whether fish are occupying lower velocity locations than those used for habitat suitability criteria determination. No other rearing habitat parameters were requested or proposed. Results from individual sampling sites for the 1-D PHABSIM study were extrapolated to the rest of the study reach using standard methods. Time series analyses were performed to evaluate total habitat under different flow conditions on a seasonal basis. The modeling studies (W&AR-06: *Tuolumne River*

Chinook Salmon Population Model and W&AR-10: *Oncorhynchus mykiss Population Study*) will further develop this information for use in evaluating the juvenile salmonid rearing life stage in the context of overall population dynamics. The PHABSIM model provides sufficient information to inform these models on habitat availability for the salmonid juvenile rearing life stage as well as to address beneficial uses in the CVRWQCB Basin Plan related to anadromous fish spawning and migration. Further, the Districts contend that the USFWS comments are premature and are more relevant to the recently issued IFIM study conducted by the Districts under the July 2009 Order.[1]

USFWS appears to have focused the new study request part of USFWS-A on two elements. The first element contained in USFWS' request is to have the Districts perform a hydraulic analysis of the amount of floodplain inundated between RM 52.2 and RM 21.5 at river flows that would supplement those used by USFWS in its own 2008 assessment of floodplain inundation. USFWS conducted an analysis of inundated floodplain (USFWS 2008) at historically observed flows of approximately 1,100 cfs; 3,100 cfs; 5,300 cfs; and 8,400 cfs. USFWS indicates that "without the intermediate data, the Service must assume a linear relationship that does not take gradient and topography into consideration." USFWS requests that the Districts perform the necessary analyses to provide this "intermediate data." Although the Districts previously provided an analysis of the applicability of the USFWS (2008) report as part of the 2-D Pulse Flow Study (Stillwater Sciences 2012), the Districts agree to perform the USFWS' requested analyses, subject to further discussions with USFWS intended to define the requirements of this task to a greater level of detail. This will require close coordination with USFWS in the planning of the analysis (e.g., the data sources to be used, agreement on hydraulic parameters) to make certain the analysis meets the intended purpose. The second new study element requested by USFWS is to evaluate inundation frequency and inundation period at a range of flows. The Districts believe that this analysis should be performed in coordination with the Operations Modeling of alternative future operating scenarios, and comparing these scenarios to the current baseline conditions. The Districts are amenable to performing these assessments once potential alternative future operating scenarios have been defined. USFWS also requests that Project-related effects be evaluated by comparing "pre- and post-project flows." The Districts disagree that this analysis is appropriate as it would not inform the development of license conditions (18 C.F.R. § 5.9(b)(5)). FERC had previously addressed this issue in its December 22, 2011 SPD. Related to evaluating either a partial unimpaired flow scenario (Don Pedro removed and Hetch Hetchy in place) or a full unimpaired flow scenario, FERC staff stated that neither of these scenarios "is necessary for our evaluation of project effects and [we] are not recommending it (study criterion 5)" (see page 23 of the SPD).

In some respects **USFWS-B** is very similar to study request FWS-4 originally submitted by USFWS in its June 9, 2011 submittal. The original study request was entitled *Juvenile Chinook Salmon Survival Study* and it consisted of measuring smolt survival during outmigration at various pulse flows over a two- year period. In its March 11, 2013 letter providing comments on the ISR, USFWS states that the Districts have not explained in the ISR "why such a study [of salmon smolt survival] is not needed as was originally ordered by FERC in the Study Plan Determination." In reality, FERC's

[1] On April 2, 2013, USFWS requested additional time to comment on the IFIM study; the Districts agreed to a new date of April 8, 2013 for the USFWS to submit comments.

December 22, 2011 SPD did not adopt the original FWS-4 request, but did adopt the Districts' W&AR-07: *Predation Study* and stated that the Districts' study, when combined with the river temperature model, would provide the information necessary to inform decisions about the high rate of smolt mortality experienced on the Tuolumne River.

Many of the comments in USFWS-B are basically comments on the Districts' W&AR-07: *Predation Study* and are addressed in Section II of this response to comments.

In USFWS-B, USFWS does recommend a second year predation study. The Districts concur and will be issuing a proposed 2013 study plan by April 12, 2013. However, the 2013 study is likely to be able to investigate only predator abundance because the necessary permits have not yet been received to allow a repeat of the predation rate effort. The Districts assert the investigation of predator abundance will still be valuable. The Districts will also be proposing to perform, subject to FERC approval, a repeat of the full 2012 Predation Study in 2014, possibly combined with a series of pulse flows, as suggested by USFWS, to examine outmigration survival under different pulse flow regimes. As 2013 is another dry year, there is insufficient water to do an extensive study of this nature in 2013. The Districts do note, however, that the flow schedule for 2013 being proposed by the resource agencies already envisions some pulse flow events that should yield valuable survival data at the Rotary Screw Traps ("RSTs"). The Districts' proposed studies for 2013 and 2014 will be limited to the Tuolumne River and are not planned to include acoustic tagging and tracking. The Districts' proposed second-year Predation Study will largely be consistent with its original FERC-approved study plan. The Districts are not proposing to extend the study into and through the San Joaquin River ("SJR") because this will not inform the development of license conditions for the Don Pedro Project because the direct effects of the Project on smolt survival in the SJR and Delta cannot be parsed out from the numerous confounding impacts on smolts that occur in these areas. The Districts propose to work with resource agencies to develop a revised predation study plan for 2014 and submit it to FERC for approval by September 2013.

USFWS-C is a request for a new study intended to evaluate the cumulative effects to habitat on the Tuolumne River for Pacific lamprey, splittail, and various non-native predator species. As a new study request, the entity proposing the study must address not only the criteria for second-year studies, but also the study request criteria of 18 C.F.R. § 5.9(e). USFWS makes no attempt to address these criteria and, therefore, does not explain why the study is needed, why existing information is not adequate, what potential Project effect on the resource is being evaluated, or how the study would inform the development of license conditions. In fact, FERC did not adopt a somewhat similar request made in the original study development process for just these reasons (see page 90-91 of the SPD). This is the second attempt by USFWS to get FERC to approve this study without ever formally submitting a study request that meets FERC criteria under Section 5.9(b). Further, USFWS does not address the required criteria under Section 5.15(e) for new study requests. The information it provides is essentially a repetition of its USFWS-B rationale and has nothing at all to do with Pacific lamprey, splittail, or non-native predators. The Districts contend that existing information is adequate to assess the cumulative effects to these species on the lower Tuolumne River.

In **USFWS-D,** USFWS is requesting a new study intended to provide information on growth rates for salmonids in the lower Tuolumne River. USFWS indicated that this is not a new study request, but one made originally in its June 9, 2011 submittal. This is not the case; USFWS made no request for a Bioenergetics Study in its June 9, 2011 submittal to FERC. However, USFWS did submit study request FWS-2 entitled *Age and Growth Study of O.mykiss in the Tuolumne River* which was a study proposed to evaluate growth differences between *O.mykiss* captured above and below La Grange Dam. The Districts developed study plan W&AR-20: *Oncorhynchus mykiss Scale Collection and Age Determination* in response to this request, FERC approved the study plan, and the Districts performed the study. Therefore, the study request USFWS-D is a completely new study request being submitted by the USFWS and as such must explain how it meets the study criteria under 18 C.F.R. § 5.9(b). Since USFWS makes no attempt to do this, its request must be denied. In any event, CDFW also has made a request for a new Bioenergetics study, which is a repeat of a prior CDFW request. The Districts respond to this below; and this response also addresses concerns raised by USFWS in its USFWS-D request.

In **USFWS-E**, it does not appear to the Districts that there is any new study requested. This request deals with the need for continued consultation between the Districts and USFWS regarding California Red-Legged Frog and potential Project effects on the species. The Districts will continue to consult with the USFWS in this regard and look forward to USFWS guidance on development of the draft Biological Assessment.

[3] CDFW

CDFW requests that the Districts undertake three new studies, listed below:

- *Reservoir Water Temperature Management Feasibility Study*
- *Instream Flow Study* (adapted from Districts' ongoing study)
- *Bioenergetics Study*

The first of CDFW's requests for a new study is a repeat of a study request, CDFG-3, originally made in CDFW's letter dated June 10, 2011. CDFW asks that the Districts undertake a study to evaluate the feasibility of engineering alternatives for reservoir water temperature management and selective withdrawal of cold water from Don Pedro Reservoir. FERC did not adopt this study when originally proposed because FERC determined that the study was an evaluation of a potential protection, mitigation and enhancement ("PM&E") measure, the need for which had not been shown at that point. This continues to be the case, and therefore, CDFW has not met the study criteria under Section 5.9(b). Further, CDFW makes no attempt to address the requirements under Section 5.15(e) for new study requests. The Districts explain their proposed approach to reservoir water temperature management below.

The first requirement of any engineering feasibility study is the development of a clear and detailed definition of what the study is intended to achieve, otherwise no amount of effort will result in a satisfactory outcome. In engineering terms, this is accomplished by providing at the outset the design basis and the design criteria, including the basis for judging whether a particular engineering solution can deliver the expected results. The study objectives provided by CDFW in its study request are insufficient to begin or undertake an engineering feasibility study of selective withdrawal structures or a reservoir water management plan. Developing a reservoir cold water management plan or configuring a selective withdrawal structure is not an end unto itself. The proof of feasibility is whether such a plan or structure can be effective in meeting the defined goals, in this case, specific temperatures in the lower Tuolumne River at specific locations at specific times of the year. Absent this clear definition, there can be no way to know whether a particular plan or structure can deliver the expected results. The Districts can already conclude that the cold water in Don Pedro Reservoir can be readily accessed by the existing reservoir outlets. In addition, the Districts' 3-D Reservoir Temperature Model can model the extraction of water from any location in Don Pedro Reservoir. The Districts selected a 3-D reservoir temperature model for the express purpose of being able to evaluate a range of options for water withdrawal. The 3-D Reservoir Temperature Model can be run to determine if the existing facilities can meet the numeric goals. If existing facilities are not able to meet the specific goals, then and only then, would such a study requested by CDFW be justified. Therefore, FERC's decision in the December 22, 2011 SPD is still valid – development of a specific management plan or consideration of the need for, and cost of, a selective withdrawal study remains a PM&E measure not yet shown to be needed.

By CDFW's definition, "feasible means capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social, and technological factors." CDFW also indicates the goal is to assess "biological" feasibility." All of these terms are too generic for attempting to undertake a detailed engineering feasibility study. All of these terms must be defined from the outset; otherwise the engineer is left in the dark while trying to imagine alternatives which might meet such goals as "biologically feasible" or "environmentally feasible." The Districts are willing to work with CDFW in a collaborative fashion to define the necessary design basis and criteria; but until this is accomplished and it is shown that the existing facilities cannot meet the specified numeric goals, FERC should not adopt this study request for the identical reason it rejected the original study request.

The second new study requested by CDFW is related to the IFIM study performed by the Districts in response to FERC's July 2009 Order, not as a study approved under the relicensing process. A draft IFIM study report was issued for review and comment to interested parties on February 28, 2013. CDFW's request for a new study appears to be a placeholder indicating the desire to have the draft IFIM study be considered a study under relicensing, to which the Districts do not object. Based on CDFW's expectations as listed in its proposed study plan in Section 6.0 – Product, information already presented in the IFIM study meets all these goals except for providing floodplain frequency and inundation of juvenile salmon rearing habitat. The Districts have addressed this request for new information under USFWS-A above.

The third new study request is for a Bioenergetics Study, which is very similar to a study request originally made in June 2011 as CDFG-5. The purpose of the study, according to CDFW, is to provide information to RPs concerning the effects of Don Pedro Project on the key variables of water temperature and food and how this impacts salmonid growth, abundance, survival, and habitat. According to CDFW, the objectives of the study are to:

- Determine factors limiting salmonid growth (food and/or water temperature) under existing conditions.
- Predict the effects of changes in instream flow/water temperature and food availability on salmonid growth, abundance, survival, and habitat.

CDFW's proposed new study would use a combination of existing data and collecting additional data to model and analyze the bioenergetic relationships of these variables. The stated goal is to use the bioenergetics relationships to analyze alternative instream flow/temperature regime effects on juvenile salmonid growth and relate the information to abundance and survival in order to identify the instream flow/water temperature regimes that provide for optimal growth of juvenile salmonids in the lower Tuolumne River and guide development of PM&E measures. CDFW indicates that understanding the site specific bioenergetic relationships would allow resource managers to evaluate when and where potential alternatives to the EPA water temperature benchmarks might be justified. The additional data collection proposed by CDFW includes one year of macroinvertebrate data collection beginning in the spring of the year and extending to the late fall.

The population models under development by the Districts are designed to serve the purposes outlined by CDFW, and further, to consider other variables as well, including density-dependence, habitat selection, growth, predation, and temperature-related mortality affecting juvenile production. The Districts, under FERC-approved study plans, have developed reservoir and river temperature models, IFIM models, and population models through Workshops held with the RPs. The bioenergetics study proposed by CDFW will not provide any further information than is already being planned and nearing completion. The W&AR-05: *Salmonid Populations Information Integration & Synthesis* report illustrates that the Districts have extensive historical information on the macroinvertebrate species and abundance along the lower Tuolumne River (1983-2009) which shows the lower Tuolumne has plentiful food resources for rearing juvenile salmonids. Growth of Chinook juveniles are modeled as part of the population models (W&AR-06: *Tuolumne River Chinook Salmon Population* and W&AR-10: *Oncorhynchus mykiss Population*) using existing food ration estimates (e.g. TID/MID 1997, Report 96-9) fitted to size at age information using a bioenergetics model as a function of water temperature and ration (Stauffer 1973).

FERC did not adopt the CDFW's original request for a Bioenergetics study due to the fact that the Districts' proposed models would provide a more comprehensive consideration of relevant factors. Nothing has changed since FERC's original decision. Nor does CDFW attempt to address FERC's regulations under Section 5.15(e) explaining what new information has become available that would now justify this study. CDFW provides no specific explanation of why the Districts studies are not sufficient to perform the same assessment of instream flows, temperatures, and survival. There is also no explanation as to why new macroinvertebrate data is now needed, when existing data indicate that benthic food sources are plentiful in the Tuolumne River. Therefore, this new study request should not be adopted.

[4] SWRCB

In its March 11, 2013 letter, SWRCB requests two new studies identified below:

- *Reservoir Water Temperature Management Feasibility Study*
- *Juvenile Chinook Salmon Outmigration Flow Study*

The first of these studies is identical to the CDFW's study request of the same name. The Districts have responded to this new study request above. SWRCB comments on two aspects of water temperature management that are not covered by CDFW. SWRCB suggests that the requested Reservoir Water Temperature Management Study also include an "assessment of engineering feasibility at the lower District-operated dam, La Grange." The Districts point out that the La Grange pool is very small and does not stratify. Temperature data collected at La Grange indicates very little change in water temperature from Don Pedro outlet to the lower end of La Grange pool. The reach from Don Pedro outlet to the La Grange dam is included in the HEC-RAS model developed under W&AR-16: *Lower Tuolumne River Temperature*. SWRCB also states that the Districts have not proposed to perform any assessments of the feasibility of reservoir water temperature management in the relicensing process. The Districts disagree with this statement. The Districts have developed at considerable expense a complete three-dimensional temperature model of the Don Pedro Reservoir for the very purpose of examining reservoir water temperature management. The 3-D model will be able to reliably predict reservoir thermal regime under a broad range of conditions, and with the elevation of all reservoir outlets geometrically input to the model, different water release strategies can be fully evaluated. In the Districts' response above to CDFW's similar new study request, the Districts simply point out that before undertaking the considerable cost of engineering feasibility studies of selective withdrawal facilities, specific temperature goals of the resource agencies should be defined and the model used to determine if existing facilities, or any facilities, can reliably meet the resource agencies spatially and temporally specific goals. The Districts also point out that, similar to the CDFW study, the SWRCB study request does not address the ILP requirements contained in Section 5.15 (e) applicable to new study requests.

The second new study request is intended to provide data to update information from prior studies in order to evaluate the ability of the Project to (1) enhance fry emigration survival by providing variable flows in February, March, and April and (2) induce emigration of larger juveniles including smolts by providing variable flows during the April and May time period. SWRCB recommends that the both mark-recapture techniques and acoustic tagging be employed and the study extended to the San Joaquin River at Vernalis. As SWRCB states, the Districts proposed a similar fry emigration component of this study in 2011. However, the Districts were not able to reach consensus with RPs on the usefulness of studying whether there were any benefits to early emigration. SWRCB suggests that the Districts should design, in consultation with RPs, a flow schedule for the juvenile Chinook salmon fry and smolt outmigration study period from February to May that may stimulate fry and smolt emigration. SWRCB recommends that the Districts and RPs should collaboratively develop the flow schedule at a workshop in December 2013 and adaptively manage flows so that the juvenile Chinook salmon outmigration flow study objectives and the conditions under Article 37 of the existing license are met.

FERC did not approve the original District study plan W&AR-09: *Chinook Salmon Fry Movement Study*, indicating that such a measure amounted to a PM&E measure that could be examined if early emigration were shown to be beneficial. It should be noted that the SWRCB's comments incorrectly ascribe preliminary regression analyses of flow vs. various production and recruitment estimates (e.g. RST passage, subsequent escapement) as "otolith analyses" contained in Mesick et all (2008) and Mesick (2009, 2010). Subject to cooperative analysis of historical otolith samples collected by CDFW, information directly assessing the benefits of early fry emigration or later smolt emigration of Chinook salmon is currently being developed as part of the Otolith study (W&AR-11).

In this study request, the SWRCB does not address the requirements of the ILP regulations for new studies at Section 5.15(e). Absent any explanation of why SWRCB believes this new study is now justified, the Districts are unable to understand or comment on SWRCB's rationale as to how this new study request meets the ILP requirements. The Districts do not believe this request meets these requirements.

However, the Districts are willing to participate in the Workshop suggested by the SWRCB to determine whether a cost-effective study similar to the one requested by SWRCB could be undertaken. The Districts would propose that those discussions begin in June 2013 with the goal to submit a study plan to FERC for approval by September 2013, if a study plan can be agreed upon. This would allow sufficient time to acquire the necessary permits and conduct the study starting in February 2014.

[5] Conservation Groups

The Conservation Groups ("CGs") propose that the Districts undertake three new studies identified below:

- *Upper Tuolumne River Habitats for Anadromous Fishes*
- *Bioenergetics Study*
- *Juvenile Chinook Salmon Outmigration Study – Chinook*

The second and third of these studies are identical to new studies proposed by CDFW (*Bioenergetics*) and USFWS (*Juvenile Chinook Salmon Outmigration Study*). The Districts have responded to these new study requests above. However, comments provided by the CGs in their request for a study of upper river habitats include several erroneous statements that should be corrected on the record. On page 2 of the CGs' March 11, 2013 submittal, they state that the FERC "Study Plan Determination rejected several studies on the basis that La Grange was not jurisdictional." CGs reference page 74 of FERC's Determination. However, this is not what FERC actually states on page 74 of the Determination. Page 74 clearly and correctly states that "La Grange dam is not a **Commission-licensed** facility under the FPA", and further that "the **unlicensed** La Grange dam is the downstream barrier to upstream migration" [emphasis added]. As CGs well know, there is a considerable difference between a jurisdictional project and a licensed project. The CGs go on to exacerbate their error when they next state that FERC's Order finding licensing of La Grange is required is a "final agency action." This is patently false, as rehearing requests of that order are currently pending before FERC and FERC action on them will be subject to judicial review, and the CG must know this. Therefore, as the Districts have pointed out previously in this response to ISR comments, the facts have not changed related to La Grange; it remains an unlicensed facility and it is highly uncertain at this point in time that its status will change.

With regard to the CGs' new study request to evaluate upstream habitats for anadromous fish, the Districts point out that a similar study was requested in June 2011 which FERC did not adopt because the Don Pedro Project is not a barrier to anadromous fish and it is not reasonably foreseeable that this will change in the near future (see also response to NMFS requests above). Even if FERC were to decide that fish passage studies at Don Pedro were warranted, which the Districts strongly disagree with, requiring the Districts to examine habitats and hydrology upstream of the Don Pedro Project does not meet FERC study criteria of 18 C.F.R. § 5.9(b)(5) in that there is no Project effect on these habitats or flows and such a study would not inform the development of license conditions. It is abundantly clear that the Don Pedro Project does not affect the physical habitats in the upper Tuolumne River. It is also clear that flows and river temperatures, two primary components of habitat suitability, for most of the upstream areas identified by the CGs are materially influenced by the operation of CCSF's Hetch Hetchy water system. FERC has no authority to modify the operation of that water system. Investigating the upstream habitats, temperatures, and hydrology under current CCSF operations does not provide information that would inform FERC's decision-making because these conditions can change in the near or long term and FERC has no authority to maintain current, or require certain future, habitat conditions upstream of the Don Pedro Project.

Nevertheless, the CGs contend that these studies are needed by FERC to inform decision-making on the need for fish passage facilities at Don Pedro and, further, that the Districts are somehow obligated to provide the information. The Districts strongly disagree. These studies would be very costly, exceeding $500,000 to acquire these data. The Districts should not be obligated to acquire these data just because relicensing is underway. One of the express purposes of the ILP study criteria is to eliminate studies thrust upon the licensee simply because relicensing was underway. This study does not meet the bare requirements of the Section 5.9 (b) study criteria because, *inter alia*, it is tied to fish passage at Don Pedro, an area the Director has already determined is not an appropriate topic for study. Further, NMFS has strongly indicated to FERC that it is a NMFS program goal to restore migratory fish to this geographical area. Thus, this request for data is related to the exercise of a NMFS statutory authority. However, as explained previously, FERC and its applicants are not obligated to conduct studies to assist NMFS to exercise its statutory authorities. See the discussion of *U.S. Department of the Interior vs. FERC, supra.*

II. Response to Study Modifications and Study Variances

Fifteen entities filed comments on the Districts' ISR and/or ISR Meeting Summary. The comments can be considered to be subdivided into three categories described below:

Category 1: Comments on a study variance identified by the Districts in the resource report, or a variance identified by the commenting entity.
Category 2: Request for a study modification proposed by a commenting entity.
Category 3: Technical comment on a study that is neither a variance nor a request for study modification.

Due to the number of comments filed by the RPs, the Districts developed a spreadsheet format for providing their responses. The Districts have attempted to capture and respond to all Category 1 and Category 2 comments in the spreadsheet attached to this submittal (Attachment 1). General technical comments will be addressed in the final reports, or in the draft and final license applications, as appropriate and are not included in this submittal.

The spreadsheet format is described below:

Column 1: Sequential numbering, within each resource table, for reference purposes. The first half of the number indicates the resource table (i.e. Table 2, Table 3, etc.); the second half, the sequential number.

Column 2: The study number (e.g. W&AR-01, RR-02, CR-01, etc.) as assigned by the Districts and included in the RSP.

Column 3: Describes the type of comment, generally either a comment about a study variance or a request for study modification.

Column 4: Identifies the entity providing the comment; similar comments are combined and each of the entities providing similar comments is identified. In general, the Districts identified the most comprehensive comment on a particular subject and responded to that comment, thereby responding to all similar comments.

Column 5: The comment number is the Districts' internal tracking number used to differentiate among individual comments and is only used in the table for cross-referencing.

Column 6: Designation of the page number(s) of the letter where the entity's comment can be found.

Column 7: Provides the quote or paraphrased comment by a RP.

Column 8: Provides the Districts' response.

The Districts have made a good faith effort to respond to all Category 1 and Category 2 comments herein within the set of tables enumerated below:

Table 1:	Identifies Category 1 and Category 2 comments provided by an RP and further identifies the relevant resource area and study plan.
Table 2:	Provides responses to all comments on water and aquatic resources studies.
Table 3:	Provides responses to all comments on terrestrial resources studies.
Table 4:	Provides response to all comments on recreation resources studies.
Table 5:	Provides responses to all comments on cultural resources studies.

III. Update on Hydrology for the Lower Tuolumne River Operations Model

On September 10, 2012, CDFW provided comments to SWRCB related to the unimpaired hydrology for the operations/water balance model being developed for the Don Pedro Project relicensing under study plan W&AR-02: *Project Operations/Water Balance Model*. In summary, CDFW raised a concern "that the Districts' proposed method of estimating unimpaired hydrology is not appropriate for the purpose of the state of California's environmental review process required for a new license." CDFW suggested an alternative approach for consideration by the Districts. The Districts subsequently undertook an investigation of CDFW's suggested approach and submitted its report to SWRCB, CDFW, and FERC on December 21, 2012. This report was also provided as Attachment A, Appendix A, of the W&AR-02 Initial Study Report issued January 17, 2013. On February 14, 2013, representatives from CDFW, SWRCB, and CCSF met with the Districts to discuss the Districts' report and the comparison of the two approaches. The Districts maintained that there are insufficient stream flow gage data in the Tuolumne River basin to support the gage proration approach for the period of record of the Operations Model. CDFW and SWRCB expressed interest in using all available gage proration hydrology even if the period of record was not as complete as might be desired and encouraged the Districts to search outside the immediate Tuolumne River watershed for flow records. CDFW and SWRCB suggested that alternatives be developed collaboratively in a workshop environment. CDFW and SWRCB also agreed that the monthly mass balances provided by the existing gage summation hydrology used by the Districts was sound and need not be adjusted. The Districts agreed to continue to discuss and consider alternative approaches, and agreed to provide a "strawman" to advance and promote dialogue at a meeting to be held on March 27, 2013.

The Districts issued a notice of meeting on March 16, 2013 to RPs for a Workshop to be held on March 27, 2013. On March 25, 2013, the Districts forwarded a "strawman" approach to developing a hybrid gauge summation/gage proration hydrologic record for Tuolumne River unimpaired flow. At the Workshop on March 27, 2013, the parties worked through the "strawman" and came to a consensus on an acceptable record of unimpaired flow for the Tuolumne River. The Workshop notes and the report presenting the consensus approach and the hydrologic record are provided in Attachment 2.

IV. Lower Tuolumne River Instream Flow Study

The instream flow study undertaken by the Districts as directed by FERC in its July 2009 Order on Rehearing was submitted to agencies and interested parties for review and comment on February 28, 2013. Parties were to submit comments by April 1, 2013 and the Districts are scheduled to submit the final report to FERC by April 30, 2013. No parties provided comments during the 30-day review period. One party (USFWS) requested additional time to comment, with comments to be provided by April 8, 2013. The Districts will be incorporating these comments into the IFIM study report and providing responses to comments not incorporated. It was suggested at the ISR meeting on January 30, 2013 that the Districts should consider holding a workshop to discuss the comments following report submittal. The Districts are open to this approach, depending on the nature of, and if, any comments are received. The workshop would be held in May 2013 with a recommended date published within the next two weeks.

V. Response to General Comments Provided by California Department of Fish and Wildlife

In addition to the detailed comments provided on the ISR, CDFW also included some more general comments which the Districts believe are in need of addressing. The two areas of CDFW's general comments are (1) salmon population modeling and (2) 2012 spring pulse flows and 2012 predation study (W&AR-07). Each is discussed below.

A. Salmon Population Modeling

In its comment letter, CDFW devoted considerable attention to the principles it believes should be followed in developing, and the requirements of the data to support, the Districts' salmonid population models. Regarding process principles, CDFW notes that "information based on flawed assumptions can result in erroneous conclusions," that "responsible communication of study results includes a clear statement of study limitations," and that scientific research should be supported by a rigorous quality assurance program. From the Districts perspective, rigorous quality assurance requires an open and transparent data sharing and model development process. On the subject of the types of data needed to support model development, CDFW emphasizes the "need to have empirical data to populate the model." After laying this foundation of principles, CDFW then goes on to criticize what it believes is the Districts' lack of information on juvenile growth and health factors for in-river rearing life stages of salmon, citing especially "a lack of quantitative information on bioenergetics relationships within the Tuolumne River." Therefore, CDFW "reiterate(s) our recommendation for a bioenergetics study" as critical to the salmon model's ability to "assess Project effects on juvenile salmonid fish populations in Project-affected stream reaches." CDFW provides the Districts a study plan to undertake the necessary work. The study plan provided by CDFW states that "[t]here is a need to utilize the existing data and **collect additional data** [emphasis added] to model and analyze the bioenergetics relationships of these variables" (i.e., food consumption, instream flow/water temperature, and growth). CDFW states that such information is needed to "guide the development of PM&E measures."

After providing this guidance on the principles of model development and data/information needs, CDFW then provides a summary of the SalSim model (Version 2.0), which it is "currently updating" to provide "scientific support for flow recommendations filed with the SWRCB" for the San Joaquin basin, including the Tuolumne River. According to CDFW, SalSim has been under development since 2005, and "uses empirical data from the San Joaquin watershed to predict how changes in a variety of environmental factors (both flow and non-flow) impact Chinook salmon populations." CDFW declares that due to SalSim's "specificity" and "use of empirical data," it will have "great utility" for the Don Pedro relicensing. The SalSim model, according to CDFW, has evolved into a complex model capable of evaluating the effects on salmon populations due to changes in flow, temperature, water quality, predation, and redd superimposition, among other variables. CDFW states that the model is currently being completed and the "exact release date is not set at this time." Finally, CDFW declares that SalSim will be the best available tool for assessing the impacts of different Don Pedro operations on salmon given (1) its "reliance on both empirical data for multiple parameters and life stages" and (2) the review process it has undergone (which as yet does not include any public participation).

The Districts are pleased to have this opportunity to respond to these comments on population modeling provided by CDFW. To date, the Districts have conducted an open and transparent process of model development, and will continue to do so. Through information requests and a series of Consultation Workshops (W&AR-05: *Salmonid Information Integration and Synthesis*), the Districts have requested all relevant reports and supporting data from all RPs, and have openly identified and shared information and data with RPs. CDFW, on the other hand, has yet to conduct any similar public meetings on SalSim, Version 2.0, preferring instead to develop the model without inviting external participation by interested parties.

CDFW strongly endorses the use of site-specific empirical data and claims its model will have "great utility" because of its reliance on such empirical data. At the same time, CDFW states that the Districts' model is in dire need of additional empirical data on bioenergetics relationships and has proposed that the Districts undertake an extensive study to acquire such data. This strikes the Districts as odd. Either CDFW already has obtained such data from the Tuolumne River and is withholding it from the Districts, or CDFW's SalSim model is itself lacking the tributary-specific empirical data it claims the Districts' model needs. If CDFW is in possession of such data, the Districts, once again, request that this empirical data be shared with the Districts and all RPs, as would be consistent with "responsible communication of study results" and "sound scientific research," both guiding principles of CDFW. If CDFW truly believes that the Districts' population model needs this additional bioenergetics data, then, obviously, so would the SalSim model. Furthermore, it seems premature for CDFW to be providing recommendations to the SWRCB on flow-based alternatives for the Tuolumne River based on an incomplete model lacking certain critically important data. CDFW states that SalSim is still under development and not ready for public release and review, with no "exact date for release" identified. Yet, CDFW states that it has provided "scientific support for flow recommendations filed with the SWRCB" based on SalSim, Version 2.0. The Districts do not believe, and neither does CDFW judging by its own statements, that it is proper scientific practice to provide highly important "scientific support" to a regulatory body based on a model which the model developer itself acknowledges is not yet complete and may be lacking critical empirical data which the model developer is seeking to obtain from another party. Simply put, CDFW is leveling criticism at the Districts' model for its alleged lack of critical data, data that its own model developers evidently do not possess.

B. The 2012 Spring Pulse Flow and the 2012 Predation Study

On pages 13 and 14 of its comment letter, CDFW states that "in accordance with W&AR-07: *Predation Study*, the Don Pedro Project intentionally manipulated instream flows for study purposes during a time when State and Federal agencies already faced difficult water allocation decisions." CDFW goes on to imply that CDFW requested that the "W&AR-07 study be altered to prevent significant impact to resources." Both the accusation and implication are surprising since, as explained below, the Districts engaged in a lengthy process with CDFW concerning the flow schedule, which culminated in CDFW agreeing with the schedule proposed and implemented by the Districts.

As CDFW understands, the seasonal flow schedule must be established before the beginning of the new fish flow season which commences on April 15th of each year. Unfortunately, when the flow schedule is proposed and established the Districts do not have the ability to know what weather and air temperatures will be occurring in late April or May. On March 30, 2012 the Districts forwarded to resources agencies, including CDFW, a proposed flow schedule to commence on April 15. This flow schedule attempted to meet the FERC-approved W&AR-07: *Predation* study plan developed in late 2011 and approved by FERC in December 2011, well before there could be any knowledge of reduced levels of snowpack occurring in the winter of 2011/2012. CDFW provided comments on the Districts' March 30, 2012 flow schedule on April 6, 2012, the fundamental difference between the two being that CDFW based its schedule on assuming that the available pulse flow volume should be 35,361 acre-feet while the Districts had estimated, in accordance with its long-standing practice, an available pulse flow volume of 20,091 acre-feet based on the 90% exceedance probability of April-July runoff forecasts.

This set up a debate over the method of calculating the spring pulse flow with CDFW wanting to apply a different method for the fish flow year than had been used in the past. The Districts were unwilling to do this. On April 9, 2012, the Districts filed the proposed schedule with FERC using its standard method of calculating the total volume of the spring pulse flow. In any event, the Tuolumne River flow forecast provided by the State of California, which provides the basis for the schedule, was modified on April 17, 2012, and on April 20, 2012, the Districts submitted to the agencies and FERC a revised flow schedule with higher releases more closely resembling the previous schedule proposed by CDFW. Discussions between CDFW and the Districts continued through the next several days. On April 25, 2012 Robert Nees of TID spoke directly with Dean Marston of CDFW; on April 26, 2012 CDFW provided a revised recommended flow schedule; on April 27, 2012 CDFW and the Districts came to an agreement on a flow schedule. Figure 1 below shows CDFW's flow proposal provided on April 26, 2012 and the final agreed-upon flow schedule, which corresponds to the actual flows recorded at the La Grange gage.

As the above recitation shows, the Districts did not intentionally manipulate the flow schedule for study purposes. Using the best available information throughout the spring of 2012, the Districts worked openly and collaboratively with FERC, CDFW, and other interested resource agencies to develop an appropriate flow schedule. This effort resulted in CDFW agreeing with the flow schedule proposed by the Districts, and agreeing to make the fish available to conduct the W&AR 07: *Predation Study* in 2012. In light of the above, the Districts do not understand and cannot explain the comments submitted by CDFW.

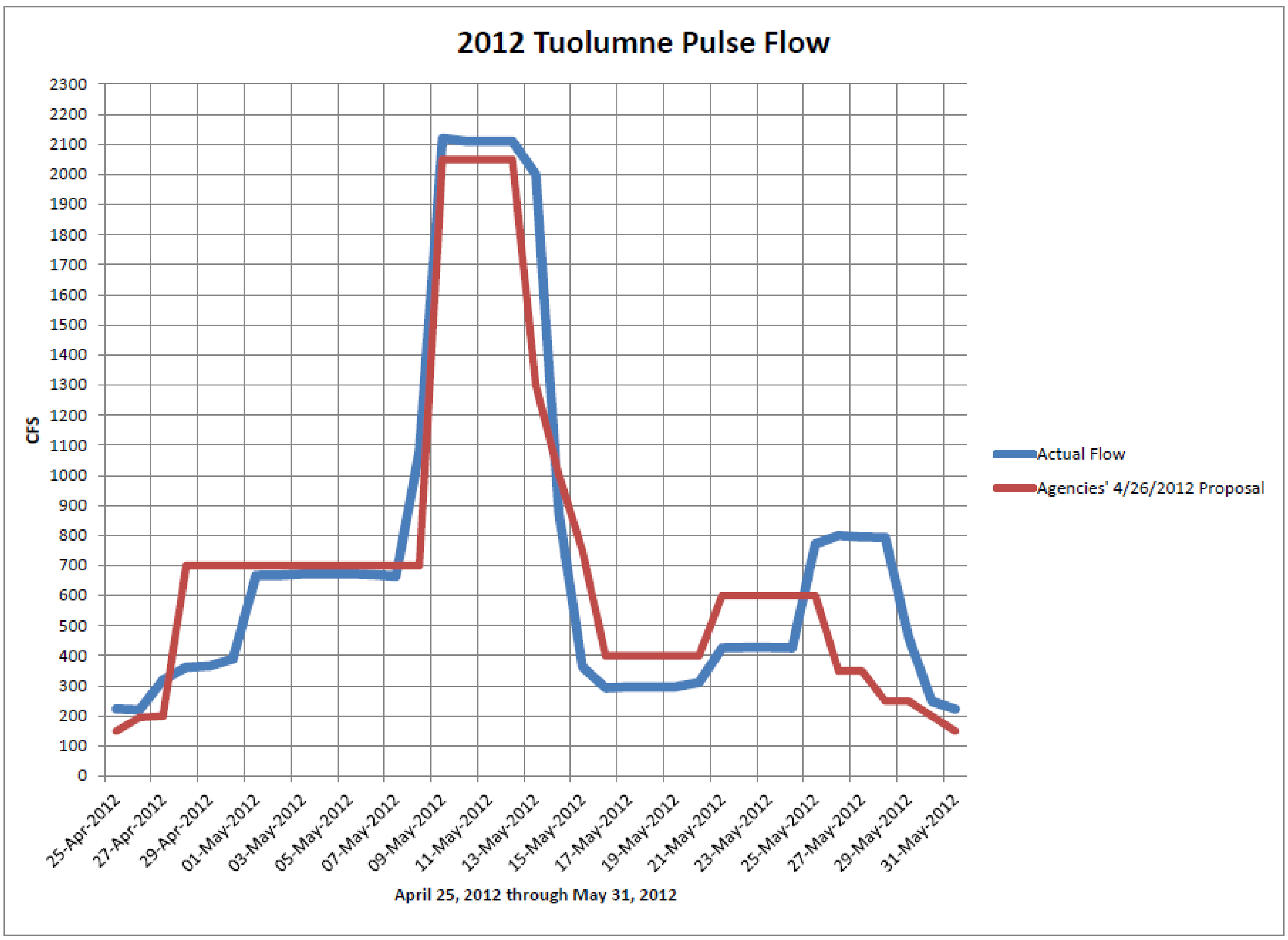

Figure 1. Comparison of CDFW's April 26, 2012 Flow Schedule and the Actual 2012 Tuolumne River Flows Corresponding to CDFW's/Districts' April 27, 2012 Agreed-On Flows.

VI. References

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Mesick, C. 2009. The High Risk of Extinction for the Natural Fall-Run Chinook Salmon Population in the Lower Tuolumne River Due to Insufficient Instream Flow Releases. California Sportfishing Protection Alliance, U.S. Fish and Wildlife Service, Energy and Instream Flow Branch, Sacramento.

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VII. Conclusion

The Districts appreciate this opportunity to respond to the comments provided by RPs, and look forward to continuing discussions during the relicensing process.

Sincerely,

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Attachments:

1. Tables 1 through 5: Districts' Response to RPs Comments on Study Variances and Requests for Study Modifications
2. Draft Notes for March 27, 2013 Hydrology Workshop No. 4
3. Final Meeting Notes for October 26, 2012 W&AR-03 and W&AR-16 Consultation Workshop

ATTACHMENTS

1. **Tables 1-5: Districts' Response to RPs' Comments on Study Variances and Requests for Study Modifications**

2. **Draft Notes for March 27, 2013 Hydrology Workshop #4**

3. **Final Meeting Notes for October 26, 2012 W&AR-03 and W&AR-16 Consultation Workshop**

ATTACHMENT 1

Tables 1-5: Districts' Response to RPs' Comments on Study Variances and Requests for Study Modifications

ATTACHMENT 1

Table 1. Summary of relicensing participants' commenting on study variances or requests for study modifications.

Study Number	Study Name	BLM	National Park Service	NMFS	USFWS	USFS Stanislaus	CDFW	SWRCB	All-Outdoors California	ARTA	Bob Hackamack	Conservation Groups	O.A.R.S.	Restore Hetch Hetchy	Sierra Mac River Trips	Tuolumne River Trust
		Government Agencies							**Non-Governmental Organizations**							
		Federal					**State**									
W&AR-01	Water Quality Assessment				X			X								
W&AR-02	Project Operations/Water Balance Model			X			X	X						X		
W&AR-04	Spawning Gravel in the Lower Tuolumne River Study			X	X			X								
W&AR-05	Salmonid Population Information Integration and Synthesis Study				X		X	X				X				
W&AR-06	Tuolumne River Chinook Salmon Population Model				X											
W&AR-07	Predation Study			X	X		X	X				X				
W&AR-10	*Oncorhynchus mykiss* Population Study				X											
W&AR-12	*Oncorhynchus mykiss* Habitat Assessment			X	X							X				
W&AR-14	Temperature Criteria Assessment (Chinook Salmon and *Oncorhynchus mykiss*)			X												
W&AR-15	Socioeconomics Study															X
W&AR-16	Lower Tuolumne River Temperature Model			X	X		X	X								

Study Number	Study Name	Government Agencies							Non-Governmental Organizations								
		Federal					State									
		BLM	National Park Service	NMFS	USFWS	USFS Stanislaus	CDFW	SWRCB	All-Outdoors California	ARTA	Bob Hackamack	Conservation Groups	O.A.R.S.	Restore Hetch Hetchy	Sierra Mac River Trips	Tuolumne River Trust
W&AR-18	Sturgeon Study				X			X				X				
W&AR-19	Lower Tuolumne River Riparian Information and Synthesis Study				X											
W&AR-20	*Oncorhynchus mykiss* Scale Collection and Age Determination Study				X											
CR-01	Historic Properties Study	X														
RR-02	Whitewater Boating Take Out Improvement Feasibility Study	X	X			X			X	X	X	X	X		X	
RR-03	Lower Tuolumne River Lowest Boatable Flow Study	X	X								X	X				
TR-01	Special-Status Plants Study	X														
TR-02	ESA- and CESA-Listed Plant Study	X														
TR-07	ESA-Listed Amphibians - California Red-Legged Frog Study	X			X											
TR-10	Bald Eagle Study				X											

Table 2. Comments on Water & Aquatic Resource Studies.

Response No.	Study No.	Type of Comment	Organization	Comment No.	Page No.	RP Comment (quote or paraphrase)	Districts' Response
2-1	W&AR-01	Study Comment	USFWS	1	p. 2	EPA's temperature water quality standards were not used in this assessment. A description of the water quality standards that are not meeting the State standards needs to be included in this study.	Water quality study results that were potentially inconsistent with the CVRWRCB's Basin Plan narrative and numeric water quality objectives are discussed in Section 6.0 of the W&AR-01: *Water Quality Assessment Study Report*. Temperature was explicitly excluded from the report, as it is addressed by W&AR-16: *Lower Tuolumne River Temperature Model*. Attachment 2-3 of the Water Quality Assessment Report presents water quality data in tables, highlighting results that are greater than the standards, criteria, and benchmarks listed in Table 4.3-1. The standards, criteria, and benchmarks provided in Table 4.3-1 were initially presented in the FERC-approved study plan (Table 5-3.2 of that document), which was initially presented in the Pre-Application Document ("PAD"). As detailed in the FERC-approved study plan, screening numbers were selected when a numeric objective was not provided in the Basin Plan. It was necessary to include other lines of evidence, other than screening numbers, in the Section 6.0 discussion because some results were not applicable "as is." For example, MCLs were used in the comparisons, but they apply to treated drinking water, not untreated surface water. EPA (2003) provides guidance for water temperatures, not standards.
2-2	W&AR-01	Study Comment	SWRCB	SWRCB-1	p.4	The Water Quality Assessment Study Report disagrees with the benchmark values for temperatures presented by the Districts as both references cited for development deal primarily with brown trout and are based upon studies conducted in Europe. SWRCB staff believe that these are inappropriate for this study and anticipate relying upon temperature water quality standards put forth for salmonids in the 2003 USEPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards.	The Districts note that the W&AR-01: *Water Quality Assessment* Study Plan was initially presented in the PAD, was not modified through the relicensing participant meeting process, and was later adopted without modification by FERC. The Districts agree that the temperature benchmark values presented in the FERC-approved Water Quality Assessment study plan are no longer appropriate and will be changed in the final report. As stated elsewhere in the study plan, as well as in the Water Quality Study Report, lower Tuolumne River temperature is being evaluated within Study W&AR-16: *Lower Tuolumne Temperature Model*.
2-3	W&AR-02	Variance	NMFS,CDFW,SWRCB	N/A	N/A	The biggest driver in producing a valid tool to meet all the relicensing applications of this model is the development of an unimpaired hydrology data set. Uncertainties and associated errors within the model result in the production of negative inflow values to Don Pedro Reservoir, often during low flow periods that can extend for multiple weeks. Additional errors within the unimpaired hydrology due to these uncertainties are also possible, particularly when deriving peak-flow magnitudes on a daily step.	The Districts and Relicensing Participants ("RPs") have been discussing this issue since September 2012. On March 25, 2013 the Districts issued a "strawman" outlining a possible analytical approach to developing a hybrid gage summation and gage proration approach to developing unimpaired hydrology. The Districts and RPs held Hydrology Workshop No. 4 on March 27, 2013 in Sacramento. At this meeting, a consensus was reached on the unimpaired hydrology. Participants also agreed that the Meeting Notes from this meeting should be included with the Districts' April 9th response to ISR comments to document resolution of this issue. (See Attachment 2 to this submittal.)

Response No.	Study No.	Type of Comment	Organization	Comment No.	Page No.	RP Comment (quote or paraphrase)	Districts' Response
2-4	W&AR-02	Study Modification	Restore Hetch Hetchy	6	N/A	Good cause exists to modify the water balance model to include CCSF's upstream hydropower production. Inclusion of upstream hydropower production was contemplated in the final Revised Water Balance Study Plan. Modification would require minimal additional effort.	RHH is incorrect when it states that the Districts intended to include CCSF's hydropower generation in the Operations Model. The Revised Study Plan ("RSP") W&AR-02: *Project Operations/Water Balance Model* never once even mentions CCSF's upstream hydropower facilities; Table 5.3-1 specifically identifies model nodes and outputs; CCSF hydropower generation is not included. On the other hand, Don Pedro generation is specifically identified. The word "Project" with a capital "P" is specifically referenced to, and only to, the Don Pedro Project on page 1 of every study plan, and specifically on W&AR-02. Again, contrary to RHH's assertion, the Don Pedro Project contains four generators in the powerhouse, not one, and these have multiple capacities. The Operations Model study plan never contemplated, nor did FERC's Determination require, that CCSF hydropower generation be a component of the model. Therefore, this request is a study modification, not a variance from the study plan. As such, the study modification must show that the study was not conducted as approved or that the study was conducted under anomalous environmental conditions. RHH does not show either of these. Nor does RHH ever attempt to show that a study of CCSF hydropower generation meets the criteria under Section 5.9(b) of the ILP regulations.
2-5	W&AR-02	Study Comment	Restore Hetch Hetchy	9	p. 16-17	The ISR mischaracterizes the size of the water bank. The water bank can hold up to 740,000 acre-feet--not 570,000 acre-feet as the ISR incorrectly states. For example, in its reporting to the Districts of historic water bank volumes, San Francisco reported that the end of month storage in the water bank was 733,555 in July 1983, 728,086 in July 1995, 729,692 in June 2005 and 726,481 in June 2006. To be consistent, it makes sense to describe the reservoir as having a capacity of 2,030,000 acre-feet and the water bank a capacity of 740,000 acre-feet, even though those maximum levels cannot be realized year-round.	The water bank is allowed to credit up to 740 TAF, however this is on a single year basis and must be used by October 2 of the year in which it exceeds 570 TAF; therefore, for water supply planning purposes, it is prudent to consider the water bank as having a capacity of 570 TAF.
2-6	W&AR-04	Variance	NMFS	6	p. A-7	There are important differences between the FERC-approved study elements and the alternative approaches developed in W&AR-04; the alternative approaches do not quantify how much coarse sediment is currently stored in an active, semi-active, or inactive state, and that provides current and potential future, geomorphic, and habitat function.	In its SPD, FERC staff recommended, based on NMFS Request Element #3, that the Districts quantify coarse sediment storage in the lower Tuolumne River and develop a sediment budget for the purpose of determining the annual ongoing cumulative effects of the Project in the lower Tuolumne River. The gravel-bedded reach of the lower Tuolumne River contains large, deep stores of coarse sediment that cannot be quantified without costly geophysical and stratigraphic investigation of the subsurface. This cost of such an effort to accurately determine total gravel in the gravel-bedded reach would be approximately $120,000. More importantly, this information is not needed to address the concerns raised. These deep sediment stores are not mobilized and/or affected by the Project and are not relevant to the intent of NMFS Request Element #3. The intent of NMFS Request

Response No.	Study No.	Type of Comment	Organization	Comment No.	Page No.	RP Comment (quote or paraphrase)	Districts' Response
							Element #3 was to assess the potential cumulative effects of the Project on changes in coarse bed material storage and spawning gravel. This objective was achieved by (1) simulating reach average changes in bed material storage through sediment transport modeling, and (2) estimating spatially explicit changes in bed material storage by differencing 2005 and 2012 digital terrain models in the Dominant Salmon Spawning Reach. This approach complied with the intent of NMFS Request Element #3 and is consistent with the direction given by FERC in the December 22, 2011 Study Plan Determination ("SPD"). The coarse sediment budget for the Dominant Salmon Spawning Reach (RM 52.1 to RM 45.5) indicates that approximately 3,500–6,035 yd^3 (4,550–7,846 tons) of coarse bed material was lost from storage between 2005 and 2012. If the estimated total storage change is distributed over the total channel area, it equates to 12 mm of bed lowering from 2005 to 2012. The estimated lowering in the reach during the 2005–2012 period is less than 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. Assuming 12 mm of bed lowering from 2005 to 2012 and an average thickness of gravel deposits in the lower Tuolumne River channel of approximately 3 to 5 feet, it is highly unlikely that coarse sediment storage and associated spawning gravel availability in the Tuolumne River would limit anadromous fish population size over the next 50 years.
2-7	W&AR-04	Study Comment	NMFS	7	p. A-7	The alternative approaches, which are interpreted as intended to fulfill the FERC-ordered sediment budget, only provide analysis over a 12-year interval, as opposed to analysis of longer-term trends that could be reasonably foreseen over the remaining term of the current license and the term of a potential new license.	Neither the FERC SPD nor the approved W&AR-4: *Spawning Gravel in the Lower Tuolumne River* study plan specify a time period over which sediment budget analyses should occur; therefore, the study is not contrary to the study plan (Section 5.15 (d)(1)). The study plan was implemented using the best available information to determine changes in coarse sediment storage. River channel bathymetry developed in 2005 from approximately RM 51.8 to approximately RM 38 provided the best available information for determining changes in coarse bed material storage relative to current river channel bathymetry. The need for the analysis to cover a longer period is not explained by NMFS, especially in light of the response to NMFS (6) immediately above. (Section 5.9(b)(4))
2-8	W&AR-04	Study Modification	NMFS, SWRCB	NMFS 8 & 9, SWRCB-4	N/A	NMFS and SWRCB requested that the Districts conduct model runs utilizing the entire Project-related hydrology set, as well as with- and without-Project, in order to gain greater understanding in sediment transport capacity and changes in coarse sediment storage. NMFS also requested that data for model	This request is a study modification that does not meet Section 5.15 (d)(1) nor Section 5.9(b)(4) or (5). Neither NMFS nor SWRCB explains adequately what this analysis would be used for or how it would inform the development of license conditions. Running the model under "without project hydrology" would not inform the development of license

Response No.	Study No.	Type of Comment	Organization	Comment No.	Page No.	RP Comment (quote or paraphrase)	Districts' Response
						runs for the interval of WY 1970 to 2010 should be presented with and without WY 1997 so that the effects of WY 1997 can be isolated.	conditions and is contrary to FERC policy. The Districts acknowledge that performing the requested analysis for "with project" 1970-2009 hydrology is low cost and will provide this information to NMFS and SWRCB.
2-9	W&AR-04	Study Modification	NMFS	10	p. A-8	NMFS recommends presenting the results at a scale of order of every 1 to 2 miles, or providing the results to Relicensing Participants separately. From aerial photograph analysis of the 6 miles from RM 52 to 45.5, NMFS recognized at least 3 notable geomorphic breaks based on channel configuration and emergence of mid-channel bar/island features.	The Districts will provide this information.
2-10	W&AR-04	Study Modification	NMFS, USFWS SWRCB	NMFS-10, USFWS-2, SWRCB-5	N/A	The NMFS, USFWS, and SWRCB requested that the DREAM-2 model be made available for use by relicensing participants and that the Districts conduct a limited number of model runs to evaluate potential gravel augmentation scenarios.	The DREAM-2 sediment transport model was used to assess bedload flux and storage changes. The model will be made available to the RPs. Due to the complexity of the model, support from the model developer, Yantao Cui, will likely be required for RPs to effectively use the model. The Districts will perform a limited number of model runs if these are defined by RPs.
2-11	W&AR-04	Study Modification	NMFS	12	p. A-9	A sensitivity analysis should be conducted to determine what vertical resolution the DEM differencing analysis can accurately detect in actual change in topography, as opposed to measuring errors in both DEM generation and attempting to horizontally and vertically align DEM's created from different time periods.	The FERC SPD did not require, nor did the study plan propose, a sensitivity analysis and therefore this study modification does not meet the requirements of Section 5.15(d)(1). NMFS does not explain how this request meets Section 5.15(e)(2), (3), (4), or (5). Therefore, this request should not be approved. The W&AR-04 study as completed addresses uncertainties related to construction of the 2012 geometric surface. Uncertainties related to the 2005 surface and analyses conducted using it cannot be quantified. Changes in coarse sediment storage estimated from modeling and surface differencing agree within about 50 percent, therefore, sensitivity analysis is not justified, especially when the loss of material is placed in context (see response to NMFS(6) above).
2-12	W&AR-04	Study Modification	NMFS	13	p. A-9 & A-10	NMFS requests that the DEM difference polygons be intersected in GIS with certain geomorphic features (i.e., spawning gravel, riffles, fine bed material deposits) in order to gain a more spatially explicit and quantitative understanding of how these geomorphic and habitat features are changing, and may be influenced by the Project's operations. NMFS indicates that this additional modification represents minimal additional effort, since it involves a desktop exercise of intersecting already developed GIS layers and then relatively minor data presentation time.	Spatial data for bed elevation changes derived from surface differencing, geomorphology (e.g., spawning gravel and fine sediment mapping), and habitat (e.g., spawning habitat and riffle meso-habitat mapping) can be provided in a format compatible with Arc-GIS. Geomorphic mapping was conducted in accordance with the FERC SPD and approved as proposed in the Districts RSP; therefore, this study modification does not meet 5.15(d)(1) or (2). As a new study request, the study does not meet any of the criteria of 5.15(e). Habitat mapping was conducted consistent with the approved Lower Tuolumne River Instream Flow Study (Stillwater Sciences 2013). These geomorphic and habitat mapping data were collected at different spatial scales using methods appropriate to inform individual elements of the respective studies. The utility of these data to appropriately and accurately inform objectives different from these individual elements of the respective studies may be

Response No.	Study No.	Type of Comment	Organization	Comment No.	Page No.	RP Comment (quote or paraphrase)	Districts' Response
							limited, and inherent differences in scale and resolution among the different data sets should be carefully considered when conducting additional spatial analyses. The need for this information or how it would inform the development of license conditions is not addressed by NMFS. FERC should reject this request.
2-13	W&AR-04	Variance	USFWS	3,5	p. 3	Study Objective 2 and Study Objective 4 are not being met. [See USFWS Comments 4 and 5]. Inclusion of a reach-specific sediment budget for the entire study area is extremely important to this study's objectives.	The Districts disagree. Appropriate methods and analyses were applied where relevant and feasible to meet Study Objectives 2 and 4. Sediment transport modeling and surface differencing approaches were used to develop a reach-specific coarse sediment budget that includes estimates of changes in coarse sediment storage in the Dominant Salmon Spawning Reach (RM 52.1 to RM 39.7). This reach is where over half of the salmon spawning activity occurs, potential for storage change is greatest, and channel morphology is suited to these methods. These results can be found in Section 5.1 of the W&AR-4 Study Report. In the Dominant Salmon Spawning Reach and other reaches included in the study where developing a coarse sediment budget was infeasible due to natural and anthropogenically influenced channel conditions, therefore, spawning gravel deposits and spawning habitat were mapped in detail and compared to results from previous surveys. These results can be found in Section 5.4 of the W&AR-4 Study Report. Also refer to the Districts' response to NMFS (6) above.
2-14	W&AR-04	Variance	USFWS	4	p. 3	The Districts need to establish the amount, distribution, and thus availability of coarse salmon spawning gravel within the extent of the pre-defined study area.	The Districts disagree. In accordance with the FERC SPD and approved study plan, spawning gravel deposits and spawning habitat were mapped over the entire study length (RM 52.1 to RM 23) for this study element. Refer to the W&AR-4 Study Report Section 4.4 for methods and Section 5.4 for results.
2-15	W&AR-04	Study Modification	USFWS	6	p. 3	The Districts should modify the study to include the entire spatial extent of salmonid spawning habitat.	The Districts disagree. The extent of spawning gravel availability between RM 52.1 to RM 23 of the lower Tuolumne River, the full gravel-bedded reach, was evaluated in W&AR-04, in accordance with the FERC SPD. The study methods and results implemented in W&AR-04 provide the information needed to address the potential cumulative effects of the Project on changes in coarse bed material storage and spawning gravel in the lower Tuolumne River, which was the intent of the approved study.
2-16	W&AR-04	PM&E	SWRCB	SWRCB-3	p.6	The Spawning Gravel Study utilizes the DREAM-2 Sediment Transport Model. While the study looked at current conditions, it did not look at any possible future flows.	In accordance with FERC's SPD, W&AR-04 study methods and results provide the information necessary, when combined with the Operations Model, to evaluate the potential cumulative effects to the resource over the next license term. The evaluation of possible future flows was not a stated goal of the FERC SPD or approved W&AR-4 study plan. The evaluation of future flows would be developed through scenarios in the Operations Model.
2-17	W&AR-05/06	Study Modification /	USFWS	8	p. 3-4	The collection of data on the quantity and quality of juvenile rearing habitat should be included in the information integration. USFWS recommends	The USFWS request proposes the gathering of entirely new information, or is at least a study modification. USFWS makes no attempt in this comment to address either Section 5.15(d) or

Response No.	Study No.	Type of Comment	Organization	Comment No.	Page No.	RP Comment (quote or paraphrase)	Districts' Response
		New Study				collecting data on the attributes of successful rearing habitat, such as temperature, LWM abundance, prey availability, over story cover, and marine-derived 2-nutrients.	(e) requirements. The Districts' study was conducted in accordance with the FERC-approved Study Plan. Individual components of this comment are addressed under Section II of the Districts' response (*II. Response to Study Modifications and Study Variances)*. As reported in the W&AR-05 ISR, the ongoing IFIM Study (Stillwater Sciences 2013 Draft) reports on the relationship between flow and the quantity and quality of juvenile rearing habitat. FERC should reject this request for the collection of additional data.
2-18	W&AR-05	Study Modification	USFWS	9	p. 4	Further study is needed to determine the prevalence of infection in juvenile Chinook salmon.	The Districts disagree. This study request/study modification was previously submitted during the original study development process and was not approved by FERC in its SPD. As reported in the W&AR-05 ISR, disease incidence was specifically evaluated and although low levels of infection were identified in prior juvenile health surveys (Nichols and Foott 2002), no clinical levels of infection were found in the Tuolumne River. Although the results have not been published, it is the Districts' understanding that more recent 2012 USFWS health data for the Tuolumne are consistent with the prior 2001-2002 surveys. No additional study is required.
2-19	W&AR-05	Study Comment	USFWS	7	p. 3	This study (W&AR-05) is not complete because the supporting studies are not complete.	The Districts disagree. The study was completed consistent with the Study Plan and Consultation required under the 2011 FERC SPD. Conceptual models presented in the W&AR-05: *Salmonid Population Information Integration and Synthesis Study* ISR are based upon existing information and form the basis of inter-related population modeling that will examine the relative importance of modeled factors. Any modifications to W&AR-05 study findings as a result of these or other inter-related studies will be made as part of the Final License Application.
2-20	W&AR-05	Study Comment	CDFW	n/a	p. 10-11	We note that issues pertaining to bioenergetics of juvenile salmon are classified by the Districts as "inconclusive" or "unlikely" or "not available" for the Tuolumne River. The Districts build upon this lack of information by failing to mention juvenile growth or health in the ISR presentation on W&AR-05 study findings for the in-river rearing life stage for Chinook salmon. To address the apparent data gap [in the Districts population model] and the Districts apparent intention to not include bioenergetics relationships within the Chinook salmon model, we reiterate our recommendation for a bioenergetics model.	The W&AR-05 ISR states that based upon juvenile Chinook stomach content analysis (TID/MID 1992, App 16, TID/MID 1997, Report 96-9) as well as recent smolt condition and health assessments (Nichols and Foott 2002), there is no evidence that suggests that food resources are limiting for Tuolumne River salmon. Contrary to CDFW's statement, it should be noted that bioenergetics modeling will be used as the basis for growth under various temperature regimes associated with alternative flow scenarios in the Districts' model under Study W&AR-06: *Tuolumne River Chinook Salmon Population*. The CDFW request for a new Bioenergetics study is further discussed in Section I of this response to comments.
2-21	W&AR-05	Study Comment	CDFW	n/a	p. 11	Again referring to the June 24, 2012 Workshop 2 draft meeting notes, in-river migration timing and survival is not listed at all, not even as an "unlikely" issue. It is also absent from the ISR summary of W&AR-05 findings.	Timing of upmigration, fry emergence and emigration timing are specifically discussed in the W&AR-05 ISR, which acknowledges that water temperature is an important driver of life history timing. It should be noted that timing of life history progression and transitions are explicitly included in the W&AR-

Response No.	Study No.	Type of Comment	Organization	Comment No.	Page No.	RP Comment (quote or paraphrase)	Districts' Response
							06 population model.
2-22	W&AR-05	Study Comment	SWRCB		p. 6	In the Salmonids Population Information Integration and Synthesis Study Report (Study Report) the Districts state that importance of temperature as a factor contributing to Chinook salmon spawning success is unknown because the Water Temperature Criteria Assessment Study Plan (W&AR Study Plan No. 14) is ongoing.	This statement is not in the W&AR-05 report. While this statement cannot be found, it should be noted that water temperature effects on spawner preference, egg incubation, as well as fry and juvenile growth and survival are incorporated in the W&AR-06: *Tuolumne River Chinook Salmon Population* and W&AR-10: *Oncorhynchus mykiss Population* models.
2-23	W&AR-05	Study Modification	Cons. Groups		p. 3	We recommend that the Districts revise their Study Report and matrix to reflect that a controversy exists over the causes of and the potential PM&Es for lack of juvenile salmonid outmigration success. We also recommend that the models offer flexibility to evaluate various hypotheses regarding this lifestage and potential improvements	As filed with FERC, the W&AR-05 report incorporated all information provided by RPs in support of particular comments as part of the required Consultation Workshop process. Regarding potential factors limiting outmigration success, it should be noted that several factors were identified in the W&AR-05 report and the inter-related W&AR-06 model is being developed to evaluate a range of potential scenarios regarding potentially limiting factors. The Districts believe it is premature to state that there is controversy over PM&Es when none have yet been proposed.
2-24	W&AR-05	Study Comment	Cons. Groups		p. 4	If the Districts follow through on their proposal to use this study's key findings to inform the life cycle models that will be built in Study W&AR-06 (Salmon) and W&AR-10 (*O.mykiss*), we anticipate that the models will single out predation as the primary stressor to juveniles of both species, and probably the single most important in-river stressor overall. The models are only as good as the assumptions and data on which they are built. If there are concerns about the inputs, there will likely be disputes about the outputs.	Although the presentation of the relative importance of identified factors for Chinook salmon and *O. mykiss* was updated based upon additional literature and data review occurring between the 2nd Consultation workshop and the ISR report issuance, it should be noted that the W&AR-06 and W&AR-10 models are intended to evaluate the relative importance of these factors. Specifically, mechanistic representations of the effects of flow, temperature, food availability, and predation upon juvenile production have been incorporated in these models based upon RP comments and discussions.
2-25	W&AR-06	Study Modification	USFWS	14	p. 5	The USFWS recommends that age structure be a component of the model or be modeled separately and used as a model input.	The USFWS request is not based on a showing that the study did not conform with the FERC-approved Study Plan as required by Section 5.15(d)(1). Although age structure was not proposed to be modeled separately in the FERC-approved W&AR-06 study plan, age composition and fecundity will be explicitly included as data inputs to the W&AR-06 population model.
2-26	W&AR-06	Study Comment	USFWS	10	p. 4	Reduced quantity and quality of juvenile rearing habitat is a well-known stressor on salmonid populations.	Although the W&AR-05 ISR provides an initial assessment that juvenile rearing habitat is unlikely to be of greater importance than other factors, fry and juvenile rearing will be explicitly modeled as part of the interrelated W&AR-06 and -10 population model studies. In addition, the separate IFIM study quantifies juvenile rearing habitat.
2-27	W&AR-06	Study Comment	USFWS	11	p. 4	Only looking at Predation Study as a primary stressor will likely bias modeling and decision-making.	Contrary to this USFWS comment, factors contributing to predation and other sources of mortality have been well detailed in the W&AR-05 ISR. In addition to predation mortality, flow, habitat, and water temperature factors contributing to growth and mortality have been included in the interrelated W&AR-06 and -10 population models.

Response No.	Study No.	Type of Comment	Organization	Comment No.	Page No.	RP Comment (quote or paraphrase)	Districts' Response
2-28	W&AR-06	Study Comment	USFWS	12	p. 4	The model may misrepresent the underlying predatory/prey relationships and the true sources of mortality affecting juvenile Chinook Salmon. For instance, the most significant health issue that has been observed in the San Joaquin tributaries is infection in the out-migrant Chinook salmon during April and May	Reviews on disease incidence in the Central Valley and Tuolumne River are summarized in the W&AR-05 ISR (Attachment B to the ISR). Only smolts sampled from the lower San Joaquin River showed any evidence of clinical levels of infection and no clinical levels were identified in health surveys of juvenile Chinook from the Tuolumne River during the spring of 2000 and 2001 (Nichols and Foott 2002).
2-29	W&AR-06	Study Comment	USFWS	13	p. 5	The relationship between Large Woody Material (LWM) and large woody debris (LWD) with nutrients, prey availability, and cover has been overlooked in the model.	As reported in the W&AR-05 ISR, the relationship of LWD and invertebrate production as well as the importance of cover to juvenile rearing are acknowledged. The interrelated W&AR-06 and -10 population models rely upon WUA estimates from the ongoing IFIM study (Stillwater Sciences 2013 draft) that includes cover attributes of the sampled habitats. Lastly, based upon juvenile Chinook stomach content analysis (TID/MID 1992, App 16, TID/MID 1997, Report 96-9) as well as recent smolt conditions assessments (Nichols and Foott 2002), food resources do not appear to be limiting for Tuolumne River salmon.
2-30	W&AR-07	Study Comment	NMFS	14	p. A-11	In 2012, the spring "pulse flow" release did not occur until late in the spring (May), and it should be recognized that greater out-migration success may occur in years when pulse flows are released earlier in the year (when predators are likely less abundant and less active, due to colder stream temperatures). NMFS is concerned that too much weight is given to the results of this single-year study.	Predation rate sampling was conducted during March and May. If predators were less effective earlier in the year, the results from sampling in March should have indicated lower predation rates than during May. No difference in predation rates was found between the two events. NMFS' position is not supported by the available data.
2-31	W&AR-07	Study Modification	NMFS, SWRCB, USFWS	NMFS 15 and 18, SWRCB-9, USFWS-20	p. A-11 & A-12	The NMFS, SWRCB, and USFWS request additional samplings of both predator stomach contents and predator abundance to increase the certainty of study conclusions. The samples should be collected concurrently and should be collocated. Predator abundance data collected later in time cannot be expected to accurately depict the predator abundances that existed earlier in time (when the juvenile salmon are out-migrating)....Warm and cool water predatory fishes are much more likely to move upstream into the lower Tuolumne River in late summer, and exist there in larger numbers and higher densities than in the late winter and early spring.	Predator densities observed during predation rate sampling in March and May and during summer abundance sampling were similar indicating that the predator abundance estimates from 2012 are representative of abundance during the salmon migration period. In developing a plan to repeat the study in 2014 the Districts will coordinate with RPs regarding the timing of sampling. Predator abundance sampling is planned for summer 2013 pending receipt of permits. Predator density data will be added to the final report.
2-32	W&AR-07	Study Comment	USFWS	22	p. 7	Use of shoreline lengths to estimate abundance is inappropriate….therefore, the Districts' abundance estimates of piscivore-sized fish between Waterford and Grayson may have been overestimated.	The approach used to calculate river wide abundance is appropriate. Two methods of estimating predator abundance were described in the study plan. The correlation plots were provided to show that the ratio-regression estimator would not be appropriate to use because of the poor positive correlation (or in some cases, no correlation) between the unit sizes (measured as unit shoreline lengths or unit areas) and unit abundances (derived from the k-pass depletion methods). Due to the lack of strong

Response No.	Study No.	Type of Comment	Organization	Comment No.	Page No.	RP Comment (quote or paraphrase)	Districts' Response
							positive correlation between unit sizes and unit abundances, the ratio-regression estimator was not used to produce any predator abundance estimates. Reported abundance estimates were derived from the first general estimator described in section 4.2.2.3, which does not depend on the correlation between unit size and unit abundance.
2-33	W&AR-07	Study Comment	NMFS	17	p. A-12	Information from the trap catches at Waterford and Grayson are compared with the predation mortality estimates and the report notes consistency and states as plausible that the overwhelming majority of the mortality was due to predation. But are the mortality estimates between these locations (based on rotary screw trap information) accurate? To what degree are the catch differences (attributed to predation losses) due to inefficient trapping? How much of the juvenile Chinook migration period was sampled?	The mortality estimates between the traps are not based on differences in catch. Trapping efficiency is estimated by mark-recapture and is used in conjunction with daily catch data to estimate abundance at each site. As described on page 6-5 of the report, rotary screw trap monitoring was conducted between January 3 and June 15, 2012, encompassing the entire juvenile outmigration period. More information regarding rotary screw trap operation is available in the annual report.
2-34	W&AR-07	Study Comment	NMFS	19	p. A-13	The information in the Predation Study Report may represent highly uncertain input to the salmon model now under development; this requires FERC staff oversight.	The findings of this study represent the best available science regarding quantification of predator abundance and predation rates in the lower Tuolumne River. This information will be interpreted in the context of findings from long-term monitoring efforts such as seining and rotary screw trap monitoring, in addition to previous predation work and survival studies.
2-35	W&AR-07	Study Modification	SWRCB	SWRCB-6	p.7	In an attempt to fulfill the Predation Study goal of determining relative habitat use by juvenile Chinook salmon and predator species during the outmigration period, the report presents habitat types, locations, and sizes of each sampled area. CDFW's California Salmonid Stream Habitat Restoration Manual (CDFW 1998) defines habitat as "the place where a population lives and its surroundings, both living and nonliving; includes the provision of life requirements such as food and shelter." Using this definition, the habitat information presented is insufficient with no information regarding the substrate, instream structures, complexity, instream cover, and riparian cover. SWRCB requests that the Predation Study Plan be amended to include the collection of this information during the second year of study.	Habitat typing was never planned to be undertaken and was not included as part of the approved study plan. Habitat typing was not necessary to fulfilling the stated study objective. The study plan clearly states that the objective was to determine *relative* habitat use, or in other words, whether predators and juvenile Chinook salmon were using the same areas or were segregated. Answering this question does not require detailed information regarding specific habitat features, nor would such information contribute to answering the question of whether high flows were effective in separating juvenile Chinook salmon from predators. FERC should reject this request.
2-36	W&AR-07	Study Comment	SWRCB	SWRCB-8	p.8	When calculating predation rates, the Districts used gastric evacuation rates which assume that the rate of food consumption is constant and a predator's ability to constantly feed is not affected by river conditions or predator/prey behavior. Of the 246 stomachs examined during the study, only 30 contained juvenile Chinook salmon. This is a small sample size from which to extract a representative predation rate....SWRCB staff believe that due to the many uncertainties of the Districts assumptions and the	This is incorrect. The sample size was 295 total (180 examined from March sampling event and 115 examined from May sampling event), not 246, and certainly not 30. Of the 295 stomachs sampled, 49 were empty resulting in 246 samples which were analyzed. Standard methods to estimate predation proportions and associated error terms as well as predation ratios and associated error terms were followed. The sample size equals the denominator in these estimators, not the numerator (e.g. number of successes / number of trials = proportion of interest with number of trials equal to the sample size). The

Response No.	Study No.	Type of Comment	Organization	Comment No.	Page No.	RP Comment (quote or paraphrase)	Districts' Response
						small sample sizes, the predation rates presented in the Predation Study Report cannot be considered representative of actual predation rates occurring in the Tuolumne River.	Districts contend that this data is represented clearly and accurately in sections 5.3.3 and 5.3.5 of the report. The Districts maintain that the predation rates presented are representative of actual predation occurring in the Tuolumne River.
2-37	W&AR-07	Study Comment	SWRCB USFWS	SWRCB-11 USFWS-21	p.9 p.6	Include hydrophone array information from Grayson in the second year study report and provided to relicensing participants now.	Districts will include this information in the Final Report.
2-38	W&AR-07	Study Modification	USFWS	17	p. 6	The USFWS requests that [the river-wide predator abundance estimates in Table 5.2-6] be removed and that the study plan be modified to use the mark-and-recapture method…to estimate predator population size…and that the Districts consult with the USFWS on appropriate analytical techniques that can be used to assess the cumulative impacts of predation.	USFWS misreads the draft report. Two methods of estimating predator abundance were described in the study plan. The correlation plots were provided to show that the ratio-regression estimator would not be appropriate to use because of the poor positive correlation (and in some cases, no correlation) between the unit sizes (measured as unit shoreline). The abundance estimates are accurate and will remain in the report.
2-39	W&AR-07	Study Comment	USFWS	15	P. 5	The analysis used to estimate depletion estimates may not be appropriate because the k-pass removal estimator used for this study is mainly used in shallow streams that can be waded and thoroughly sampled with electrofishing gear. The Special Run Pool habitat...may be too deep to effectively use a depletion method. The mark-and-recapture method is generally preferred over the depletion method and has been shown to be unbiased when more than 50 percent of a population is marked (Jensen 1992).	The Districts maintain that the methods used to estimate predator abundance are statistically valid, appropriate, and consistent with the study plan. The approved study plan was thoroughly discussed with and reviewed by RPs during the study plan development process. The Districts note that none of the RPs, including USFWS, previously raised any concerns regarding the proposed depletion sampling method. While mark-recapture may under certain conditions provide less biased estimates, there are many instances where required assumptions cannot be met and/or the approach is not logistically feasible, not cost effective, and carries the potential for undue harm. Mark-recapture sampling requires multiple sampling events - one to mark the fish and at least one, but preferably more, recapture events. This substantial increase in the level of effort required is not justified. In addition to substantially increased cost, the increased sampling effort presents an increased risk of adverse impacts to the target species and other fish that may be present in the study sites, including ESA listed CV *O. mykiss*. The Districts also note that depletion estimates are more likely to underestimate abundance. The depletion model overestimates sampling efficiency and underestimates population size under conditions of decreasing sampling efficiencies (Zippin 1958; Riley and Fausch 1992). Fish that remain after initial capture occasions may be less catchable due to physiological or behavioral response to the disturbance of the previous passes (Mesa and Schreck 1989). Also, the depletion model would be expected to overestimate sampling efficiency and therefore underestimate population size if fish are present in some deep areas that are beyond the range of the electrofisher (greater than approximately 6 ft).
2-40	W&AR-07	Study Comment	USFWS	16	p. 5	It is inappropriate to use the referenced estimator to expand the site specific predator population estimates and calculate river wide abundance.	The Districts maintain that the approach used to calculate river wide abundance is appropriate. Two methods of estimating predator abundance were described in the study plan. The correlation plots were provided to show that the ratio-regression

Response No.	Study No.	Type of Comment	Organization	Comment No.	Page No.	RP Comment (quote or paraphrase)	Districts' Response
							estimator would not be appropriate to use because of the poor positive (or in some cases, no correlation) correlation between the unit sizes (measured as unit shoreline lengths or unit areas) and unit abundances (derived from the k-pass depletion methods). Due to the lack of strong positive correlation between unit sizes and unit abundances, the ratio-regression estimator was not used to produce any predator abundance estimates. Reported abundance estimates were derived from the first general estimator described in section 4.2.2.3, which does not depend on the correlation between unit size and unit abundance.
2-41	W&AR-07	Study Modification	USFWS	18	p. 6	Additional age and growth information would provide invaluable insight regarding the reproductive success of predators and what environmental conditions might be influencing the reproductive success and recruitment of *Micropterus* spp. residing in the Tuolumne River. The USFWS recommends that scales and/or otoliths be collected from all sampled predators for use in describing population dynamics...of the various predator species.	The Districts will include the collection of otoliths in future predation rate and predator abundance sampling efforts. The suggestion by USFWS was not made during the study plan development process for the 2012 study, but can be included in future sampling.
2-42	W&AR-07	Study Comment	USFWS	19	p. 6	There is a lot of variability in the reported predation rates from the various studies that have been implemented in the Tuolumne River and very low sample sizes used to estimate predation rates, especially since the majority of predator stomachs that were examined were without any salmon.	The sample size equals the total number of fish examined for stomach contents regardless of whether juvenile Chinook salmon were found. Standard methods to estimate both predation proportions and associated error terms as well as predation ratios and associated error terms were followed. The Districts maintain that the sample sizes to estimate predation rates for largemouth bass (n=132) and smallmouth bass (n=131), and striped bass (n=26) were adequate to provide reliable estimates and exceeded sample sizes from all previous efforts to document predation rates in the Tuolumne River.
2-43	W&AR-07	Study Comment	USFWS	22	p. 7	The Districts reported an estimated 21,701 largemouth bass instead of 2,701 on page 6-4.	The estimate of 21,701 largemouth bass on p. 6-4 is a typographical error and should have read 2,701 as reflected both in the example calculation of the estimated number of juvenile Chinook salmon consumed (two sentences later, bottom of pg. 6-4) and in the Table 6.3-1 on the following page.
2-44	W&AR-07	Study Modification	CDFW	CDFW-6	p.14	In 2012, the Districts' implementation of a flow schedule consistent with the Commission-approved W&AR-07 study, but against requests by CDFW to alter the study to prevent significant impact to resources as well as provide a more natural test flow regime, made a drier than normal water supply situation even more extreme. This caused river temperatures to soar well above the USEPA 2003 criteria and resulted in high mortality of juvenile Chinook salmon indicated by rotary screw trap data. To avoid such undesirable impacts in the future, CDFW recommends a blanket amendment to Commission-approved study plans for this project which involve intentional manipulation of natural	The Districts must point out that the flow schedule implemented by the Districts in 2012 was developed in coordination with CDFW, USFWS, NMFS, and DWR, and was very similar to the schedule suggested by the agencies themselves, including CDFW, on April 26, 2012. Following discussion with the agencies, the schedule implemented by the Districts was approved by all parties, including CDFW, on April 27, 2012. The Districts also note that CDFW's decision to allocate hatchery fish for this study was conditional on agreement to a satisfactory flow schedule. The Districts appreciate CDFW's cooperation in allocating hatchery fish for this study to be completed in 2012. The rise in water temperatures did not occur until after the May sampling event. In fact, the river temperatures in May during the sampling event were lower than normal.

Response No.	Study No.	Type of Comment	Organization	Comment No.	Page No.	RP Comment (quote or paraphrase)	Districts' Response
						resources, to include the following general concept in each respective Methods Section: "Resource protection is an important consideration of this study. If a Trustee Agency determines the information cannot be collected in a manner that avoids unacceptable impacts on natural resources, the Trustee Agency will notify the Commission, the Districts, and fellow relicensing participants as soon as possible via email to discuss alternative approaches to perform the study." We urge the Commission to require the inclusion of such a provision in any other studies approved for the remainder of this preceding that involve potential resource manipulation.	
2-45	W&AR-10	Study Comment	USFWS	25	p. 8	Information included in this study did not include essential stressors and limiting factors that must be addressed in order to sustain populations. For example, reduced quantity and quality of juvenile rearing habitats is a well-known stressor on salmonid populations. In addition, the energetics of prey availability is an essential population driver.	Initial factors of greater relative importance identified in the interrelated W&AR-05 ISR include juvenile rearing habitat, particularly during summer. Fry and juvenile rearing habitat as well as bioenergetic modeling of growth rates as a function of water temperature and ration will be explicitly modeled as part of the W&AR-10 population model study. See also the response to USFWS-22.
2-46	W&AR-10	Study Modification	USFWS	27	p. 8	The USFWS recommends that age structure be analyzed so that decisions and interpretations can be made regarding the health of *O. mykiss* populations in the lower Tuolumne River.	The USFWS request for study modification does not meet the requirements of 5.15(d)(1) or (2) and does not identify any instance where the study did not conform with the FERC-approved study plan. Although the FERC-approved study plan does not include any assessment of the "health" of the Tuolumne River *O. mykiss* population, age composition and fecundity will be explicitly included as data inputs to the W&AR-10 population model.
2-47	W&AR-12	Study Comment	NMFS	20	p. A-13	Contrary to FERC's July 25, 2012 Order, the W&AR-12 study report does not propose to conduct a second season of quantitative wood surveys in Don Pedro Reservoir: "therefore no additional studies on LWD are recommended."	NMFS is incorrect. The study was completed consistent with FERC's study plan approval of July 25, 2012, which stated "we recommend that the Districts produce an estimate of the average annual volume and frequency of LWD removed from Don Pedro reservoir using quantitative and anecdotal historical data, including appropriate aerial photography analysis methods, such as those described by NMFS in its April 24, 2012 comment letter, as well as two annual quantitative surveys of LWD in Don Pedro reservoir to be conducted upon the cessation of seasonal high flow events." Multiple years of quantitative LWD raft and burn pile volume data were collected by the DPRA from 2009-2012 following the cessation of seasonal high flow events. Stillwater Sciences conducted additional inventory data on burn piles in 2012, consistent with the approved study plan. NMFS misuses the study report statement "therefore no additional studies on LWD are recommended" to imply that it referred to the Don Pedro Reservoir LWD assessment. The correct context of this quote can be seen in report section 7.0 Variances and Modifications where it refers to the reason why a second LWD inventory is unnecessary on the **lower Tuolumne River**, not in

Response No.	Study No.	Type of Comment	Organization	Comment No.	Page No.	RP Comment (quote or paraphrase)	Districts' Response
							Don Pedro Reservoir.
2-48	W&AR-12	Study Modification	NMFS	23	p. A-14	NMFS recommends modification of the W&AR-12 study to include a census of all the wood raft volumes upstream of Wards Ferry Bridge for the 2009 to 2012 analysis, or at the very least explain how they were accounted for.	This is actually a request for additional information, not a study modification. The Districts will provide the additional information in the Draft and Final License Applications, including a census of wood raft volumes upstream of Wards Ferry Bridge for the 2009-2012 analysis and explain how they were accounted for.
2-49	W&AR-12	Study Comment	NMFS	21 & 22	p. A-14	The single reservoir survey conducted (March 15, 2012) occurred in a dry year where little to no wood was transported into the reservoir (Table 5.3-1), and the wood pieces that were surveyed were remnants from 2011 DPRA burn piles (not the much large wood rafts that are typically left perched on the shoreline when the reservoir recedes). Districts should conduct a second-year quantitative wood survey in Don Pedro Reservoir, as ordered by FERC (on July 25, 2012).	The study was completed consistent with the study plan approved by FERC in the July 25, 2012 letter, which stated "we recommend that the Districts produce an estimate of the average annual volume and frequency of LWD removed from Don Pedro reservoir using quantitative and anecdotal historical data, including appropriate aerial photography analysis methods, such as those described by NMFS in its April 24, 2012 comment letter, as well as two annual quantitative surveys of LWD in Don Pedro reservoir to be conducted upon the cessation of seasonal high flow events." Multiple years of quantitative LWD raft and burn pile volume data were collected by the DPRA from 2009-2012 following the cessation of seasonal high flow events, and Stillwater Sciences conducted an additional inventory of large partially burned logs that were left over from 2011 rafts and in 30 unburned burn piles in 2012. The context for the NMFS comment was that the Don Pedro Reservoir LWD piece size inventory was skewed toward not capturing larger pieces of LWD due to the survey being conducted after burning of the rafts. However, the study did inventory many large (>16 inches in diameter and >13 ft long) remnant logs (partially burned and unburned), which led to the conclusion that the percentage of large logs was more than double in the reservoir than below La Grange Dam (Table 5.4-1, pg. 5-17). In addition, the calculated W&AR-12 Don Pedro Reservoir LWD volumes overestimate the amount of large wood in the rafts and burn piles. This is because a significant portion of these DPRA wood accumulations are composed of piece sizes that are smaller than the minimum LWD size criteria of 4 inches in diameter and 3 feet long (i.e. sticks, bark, and chunks). A considerable amount of small woody debris in the wood rafts and piles can be seen in Figures 4.1-2 to 4.1-4 on pages 4-6 and 4-7 of the W&AR-12 report.
2-50	W&AR-12	Study Modification	USFWS, CG	USFWS-29, CG-1		The USFWS and CG requested additional years of data collection, ranging from one to five years of additional study for LWD removed from the Don Pedro Reservoir in order to provide for a much improved, quantitative, and empirically based estimate of annual LWD.	The study was completed consistent with the approved study plan, which stated "we recommend that the Districts produce an estimate of the average annual volume and frequency of LWD removed from Don Pedro reservoir using quantitative and anecdotal historical data, including appropriate aerial photography analysis methods, such as those described by NMFS in its April 24, 2012 comment letter, as well as two annual quantitative surveys of LWD in Don Pedro reservoir to be

Response No.	Study No.	Type of Comment	Organization	Comment No.	Page No.	RP Comment (quote or paraphrase)	Districts' Response
							conducted upon the cessation of seasonal high flow events." Multiple years of quantitative LWD raft and burn pile volume data were collected by the DPRA from 2009-2012 following the cessation of seasonal high flow events, and Stillwater Sciences conducted an additional inventory of burn piles in 2012. The request for study modification does not meet the requirements of Section 5.15(d)(1) or (2). In addition, the study used data collected over a range of water year types (dry to wet) that would result in varying levels of LWD recruitment.
2-51	W&AR-12	Study Modification	USFWS	30	p. 9	USFWS also believes that in order for the Districts to better estimate (quantitatively/empirically) the average annual frequency of LWD removed from Don Pedro Reservoir (per high flow event, as directed), LWD surveys within the reservoir should also be conducted prior to such high flow events (and not just after such events).	The study was completed consistent with the approved study plan. Multiple years of quantitative LWD raft and burn pile volume data were collected by the DPRA from 2009-2012 following the cessation of seasonal high flow events, and Stillwater Sciences conducted an additional inventory of burn piles in 2012. The requested study modification does not meet the requirements of Section 5.15(d)(1) or (2), nor any of the requirements of Section 5.15 (e).
2-52	W&AR-12	Study Comment	USFWS	31	p. 9	Note that the USFWS believes that an annual survey period of 3-5 years, as opposed to just 2 years, should also help to account for variation caused by water year type.	Multiple years of quantitative LWD raft and burn pile volume data were collected over the 4-year period from 2009-2012 following the cessation of seasonal high flow events, and Stillwater Sciences conducted an additional inventory of large partially burned logs that were left over from 2011 rafts and in 30 unburned burn piles in 2012. The study was conducted using data over a range of water year types (dry to wet) that would result in varying levels of LWD recruitment. In addition, the calculated W&AR-12 Don Pedro Reservoir LWD volumes overestimate the amount of large wood in the rafts and burn piles. This is because a significant portion of these DPRA wood accumulations are composed of piece sizes that are smaller than the minimum LWD size criteria of 4 inches in diameter and 3 feet long (i.e. sticks, bark, and chunks). A considerable amount of small woody debris in the wood rafts and piles can be seen in Figures 4.1-2 to 4.1-4 on pages 4-6 and 4-7 of the report.
2-53	W&AR-12	Study Modification	USFWS	32	p. 9	Applicants should specify what the annual flow percent exceedance was for 2009-2011. The USFWS recommends looking at additional years of DPRA data, particularly for a very wet year, such as 1996-97 (Section 4.1.2.3).	Multiple years of quantitative LWD raft and burn pile volume data were collected by the DPRA from 2009-2012 following the cessation of seasonal high flow events, and Stillwater Sciences conducted an additional inventory of burn piles in 2012. The study was conducted using data over a range of water year types (dry to wet) that would result in varying levels of LWD recruitment. The DPRA did not collect burn pile and wood raft data prior to 2005; therefore no data are available for water years 1996 or 1997. The Districts will include the requested flow exceedance information in the final report.
2-54	W&AR-12	Study Comment	USFWS	33	p. 9	The text is missing an explanation of how average shelter rating values were computed. The explanation should be included in the text or as a footnote (Table 5.1-5).	This information will be provided in the final report.
2-55	W&AR-	Study	USFWS	34	p. 9	The USFWS recommends calculating a weighted	The study was conducted using data over a range of water year

Response No.	Study No.	Type of Comment	Organization	Comment No.	Page No.	RP Comment (quote or paraphrase)	Districts' Response
	12	Modification				average based on the percentage of years in the historic record with each water year type and the water year type of 2009-12, because it would better represent the long-term average delivery of wood to the Tuolumne River (Table 5.3-1).	types (dry to wet) that would result in varying levels of LWD recruitment. In addition, a weighted average estimate based on the historical flow record would not necessarily be more precise, since recruitment into the reservoir is a function of more than just the water year type (e.g., intervals between particular year types may have significant effects on a weighted estimate).
2-56	W&AR-12	Study Comment	USFWS	35	p. 10	The report is inconsistent with the study plan in that data is not presented on similar stream systems outside of the Central Valley. The Yakima River is an excellent example of a similar stream outside of the Central Valley. Other similar stream systems could be selected and evaluated. In addition, the comparison given for the Central Valley is weak: Wood delivery from the upper watershed is impacted for both the Tuolumne and Merced. The USFWS is aware that there are data available for other streams in the Central Valley (e.g., the Mokelumne River), and data is currently being collected for the Yuba River. The USFWS recommends a comparison with the Cosumnes River, given that it is unregulated and does not have a large upstream reservoir capturing LWD (Section 6.1).	The Districts will include additional information regarding the Mokelumne River's instream habitat and LWD. The Districts do not believe that the Yakima River in central Washington is a similar stream as this is a watershed on the east side of the Cascade Range. No information is provided by USFWS showing why the Yakima River would be similar to the Tuolumne. In fact, LWD quantities are highly basin specific, and great care should be taken in the use of any such comparison. The Cosumnes River, being undammed, does not have similar recruitment potential as a system with dams throughout the watershed, as the Tuolumne does.
2-57	W&AR-12	Study Comment	SWCRB	SWRCB-0	p. 10	State Water Board staff strongly disagree that trapping fine sediment in Don Pedro Reservoir would result in less embedded cobble/boulder substrates downstream of La Grange Dam.	Please refer to the Coarse Sediment Management Plan for the Lower Tuolumne River (McBain and Trush 2004) for a discussion of the sediment trapping ability of Don Pedro Reservoir. In 2001, Stillwater Sciences conducted a three-day reconnaissance-level snorkel survey from Riffle A3/4 (RM 52.0) to Roberts Ferry Bridge (RM 39.5) to estimate the volume of fine sediment accumulation in pools and other discrete fine sediment deposits (within the bankfull channel), and to assess the contribution of fine sediment from small tributary inputs (Stillwater Sciences 2001). Only limited sand deposits were observed in pools in the reach upstream of Basso Bridge (RM 47.5). The amount of sand in the pools increased in a downstream direction as inputs from tributaries and bank scour accumulated. Habitat typing conducted as part of the W&AR-12 study recorded dominant and subdominant substrate composition within the La Grange tailrace to Martins Ferry Bridge reach (RM 51.8 to 39.5). Sand was not identified as a dominant substrate in any recorded habitat unit within that reach (pg. 5-4, Table 5.1-6). Sand was identified as the subdominant substrate in 17 percent of the reach, primarily in pools and flatwaters (pg. 5-4, Table 5.1-7). In addition, 87 percent of the pooltails/riffle crests had cobble embeddedness levels of 1 (<25% embedded. This level of

Response No.	Study No.	Type of Comment	Organization	Comment No.	Page No.	RP Comment (quote or paraphrase)	Districts' Response
							embeddedness indicates relatively "clean" cobble/gravel substrates within the survey reach. The W&AR-4 study also concluded that total volume of discrete fine bed material (<2mm in size) deposits in the reach from La Grange (RM 52.1) to Roberts Ferry Bridge (RM 39.6) decreased by 44 percent from 2001 to 2012. In addition, fine bed material storage in the low flow channel diminished 36 percent from approximately 67,229 yd^3 in 2001 to approximately 42,770 yd^3 in 2012. These results indicate that trapping of fine sediment in the Don Pedro Reservoir may be reducing the supply of fine sediment to downstream reaches and coarsening the lower Tuolumne River substrate. SWRCB does not offer any evidence to support its basis for disagreement.
2-58	W&AR-12	Study Modification	SWCRB	SWRCB-12	p.9	The *O. mykiss* Habitat Survey Study reports on LWD under current conditions but should also identify LWD that would be available for *O. mykiss* to use under different flow conditions.	The study was completed consistent with the study plan and identified LWD that was within the active channel, which includes the area inundated under different flow conditions. Identification of LWD that would be available under flow conditions beyond the active channel would require additional field surveys at different flows, and given the general scarcity, small size, and high mobility of the LWD in general, would be unlikely to provide significant useful data (e.g., flows beyond the active channel would likely scour much of the existing LWD away). SWRCB's request for study modification does not met the requirement of Section 5.15(d)(1) or (2).
2-59	W&AR-12	Study Modification	CG	CG-2	p.7	For the W&AR-12 study, the methodology for calculating average annual LWD supply was not identified and described in the approved study plan. The Conservation Groups request that the Districts provide copies of the original data sheets as an appendix to the report, along with a detailed description of the methodology used in collecting the data, size classes of LWD, etc. The Conservation Groups also request that the Districts provide copies of the Google aerial images for the years that were studied in an appendix and that these images encompass the reservoir upstream along the Tuolumne arm to the max pool location and downstream to the Jacksonville Road.	The Districts will provide the requested additional information in the final report.
2-60	W&AR-12	Study Modification	CG	CG-3	p.10	The W&AR-12 Study compared LWD on the Tuolumne River to the Merced River. However the Districts have not shown that this single comparison provides useful information. The Conservation Groups request that the Districts examine LWD data, information, and reports from the Cosumnes River, an undammed west slope Sierran stream as it would offer	The study was completed consistent with the Study Plan, which stated "...place LWD function in the lower Tuolumne River in context with other streams of similar stream order, recruitment potential, and sources." The Cosumnes River, being undammed, does not have similar recruitment potential as a system with dams throughout the watershed, as the Tuolumne does. Such a comparison would not inform the development of PM&E

Response No.	Study No.	Type of Comment	Organization	Comment No.	Page No.	RP Comment (quote or paraphrase)	Districts' Response
						a base case comparison of LWD storage in a Central Valley stream on an unregulated system.	measures. The Districts will include information relating to LWD and instream habitat in the Mokelumne River in the license application.
2-61	W&AR-15	Study Comment	Tuolumne River Trust	TRT-1	p. 1	The Tuolumne River Trust (TRT) is concerned that the Socioeconomics Study for the relicensing of Don Pedro Dam is focusing solely on the potential negative impacts of increasing instream flows and ignoring the potential economic benefits to commercial and sport fishing, recreation and tourism.	The proposed study is intended to document the baseline economic values associated with Project operations under current conditions. This information will be used to estimate changes in economic benefits and costs and related socioeconomic effects under proposed alternatives that may alter Project operations; these alternatives have not been defined at this point in time. In addition, the Districts believe that extending the analysis to commercial and sport fishing, recreation, and tourism in the lower Tuolumne River is not appropriate for several reasons: (1) measurement of the effects on recreation and fisheries downstream of Don Pedro Dam is an issue for the cumulative analysis and those effects are not appropriately attributable solely to the Project, (2) complexities associated with measuring fishery-related effects and ancillary implications for recreation, and (3) recreation conditions in the lower Tuolumne River are not expected to change significantly with changes in stream flows. The river is primarily a swift-water/flat -water resource. This will not change appreciably under future flow conditions.
2-62	W&AR-15	Study Modification	Tuolumne River Trust	TRT-2	p.1	Furthermore, we believe the Study should take into consideration ways MID and TID might adapt to improved instream flow requirements in order to reduce the potential negative economic impacts. The Socioeconomic Study should consider ways MID and TID might adjust to an improved flow regime in order to minimize negative economic impacts. Through better monitoring of the snowpack, water use efficiency, and modest crop-shifting, agriculture could remain a vibrant economic driver while reducing the negative impacts of water diversion on the Tuolumne River ecosystem.	Regarding potential adaptations to reduced water supplies, the Districts contend that analyzing changes in their customers' consumptive use or on-farm practices would not inform the development of license requirements, and therefore, are not included in the proposed study. Further, such actions do not represent mitigation measures to address potential adverse impacts of the Project in the context of NEPA, but instead represent anticipated behavior by farmers. Similar study requests were made by the RPs in their June 2011 study requests. FERC's SD2 (pages 16-17) addressed these requests when FERC indicated that "recommended alternatives, that address the consumptive use of water in the Tuolumne River through construction of new structures or methods designed to alter or reduce consumptive use of water (bullets 2 through 6), are alternative mitigation strategies that could not replace the Don Pedro hydroelectric project. As such, these recommended alternatives do not satisfy the NEPA purpose and need for the proposed project and are not reasonable alternatives for the NEPA analysis."
2-63	W&AR-15	Study Comment	Tuolumne River Trust	TRT-3	p.1	Through improved monitoring of the snowpack, more water could be released from Don Pedro Reservoir in the spring to enhance the out-migration of juvenile salmon, and then late season run-off could be captured for storage. Currently, in many years water is captured when the salmon need it most, and then released later in the season to create capacity for flood water storage. Better management would allow for	This comment pertains to Project operations, which is addressed by Operations Modeling. This request can be modeled but TRT needs to provide a more detailed specification of potential operations.

Response No.	Study No.	Type of Comment	Organization	Comment No.	Page No.	RP Comment (quote or paraphrase)	Districts' Response
						both beneficial releases and storage.	
2-64	W&AR-15	Study Comment	Tuolumne River Trust	TRT-4 TRT-5 TRT-6 TRT-7	p.1 p.2	MID and TID could encourage greater implementation of water efficient technologies by providing rebates for equipment to offset initial capital investments. MID and TID could further encourage efficiency by providing educational and technical assistance to their customers. Providing farmers with meteorological and hydrological information on climate, soil conditions and crop water needs would be very beneficial. MID and TID might consider water pricing, or crop shifting, or water efficient crops as a means of promoting best management practices. Through water budgets and tiered pricing, efficiency would be rewarded and encouraged.	This comment is not directly related to the Socioeconomics Study; instead, it represents recommendations to the Districts to modify their irrigation practices and alter their consumptive use of water. FERC's SD2 has addressed these types of requests (see SD2, pages 16/17 where FERC states that "recommended alternatives, that address the consumptive use of water in the Tuolumne River through construction of new structures or methods designed to alter or reduce consumptive use of water (bullets 2 through 6), are alternative mitigation strategies that could not replace the Don Pedro hydroelectric project. As such, these recommended alternatives do not satisfy the NEPA purpose and need for the proposed project and are not reasonable alternatives for the NEPA analysis."
2-65	W&AR-16	Study Comment	USFWS	36	p. 10	Districts should incorporate the EPA (2003) temperature standards for Pacific Salmonids and set spatial and temporal points in the Lower Tuolumne River to evaluate Project effects.	The Districts maintain this is best done in collaboration with RPs. The 3-D Reservoir Model and the river HEC-RAS model are well suited to evaluate such alternatives, including EPA (2003) guidance and other temperature goals. Developing alternative spatial and temporal temperature goals is envisioned within the current study plan.
2-66	W&AR-16	Study Modification	NMFS	25	p. A-16	NMFS is concerned with the HEC-RAS model's ability to be integrated with the existing CalFed San Joaquin River Basin water temperature model, which has not been adequately demonstrated….NMFS seeks information about the Project's effects on Endangered Species Act (ESA) critical habitat for anadromous fish, not only in the lower Tuolumne River, but also in freshwater rearing sites, freshwater migration corridors, and estuarine areas extending downstream into the Delta; these include potential thermal influences that could be most efficiently evaluated with a (HEC-5Q) model that integrates the Tuolumne River.	The FERC-approved study plan explicitly indicated that the geographic extent of the Districts' river temperature model was from the Don Pedro project to its confluence with the San Joaquin River, as other river models can be used for the purpose of SJR and Delta temperatures. FERC's approved study plan also required the Districts model output to be in a format appropriate for use as input to the CalFed SJR model. This is readily accomplished. If NMFS or CDFW would indicate the preferred format, the Districts will make certain the output from its HEC-RAS model can serve as input to the CalFed model. At this point, RPs have provided no specifications for this format. By this comment, the Districts are formally requesting the RPs preferred format.
2-67	W&AR-16	Study Comment	SWRCB	SWRCB-13	p.11	The final Lower Tuolumne River Temperature Model Study Report (Study Report) must include adequate discussion and analysis of temperature in the Tuolumne River and must contain information regarding: • The Tuolumne River's listing under Section 303(d) of the Clean Water Act as impaired for temperature; • How the Project is impacting temperature in the Tuolumne River; • Temperatures that would be protective of the various designated beneficial uses (USEPA 2003); and • How temperature in the Tuolumne River is	In accordance with the approved study plan W&AR-16: *Lower Tuolumne River Temperature Model*, the report is to include the model itself and a discussion of the calibration and validation work. The Districts will also include a description of the base case. The items identified by SWRCB will be thoroughly discussed in the Draft and Final License Applications.

Response No.	Study No.	Type of Comment	Organization	Comment No.	Page No.	RP Comment (quote or paraphrase)	Districts' Response
						influenced by different flows.	
2-68	W&AR-16	Study Comment	SWRCB	SWRCB-14	p.11	It is imperative that the model accurately represents conditions in the Tuolumne River. The SWCRB requests that the Districts hold a workshop to discuss model calibration efforts with interested RPs.	The Districts have held two Workshops related to W&AR-16. The Districts will hold an additional Workshop. The Districts have already informed the RPs that they will conduct a training session on use of the model and a session dedicated to the use of all three models together through an Integrated Model Training Session. We will work with SWRCB to set a date for the Workshop.
2-69	W&AR-16	Study Modification	CDFW	n/a	p.5	The Districts propose to modify the original study plan methodology and change the modeling platform to HEC-RAS. CDFW does not support this change and considers this to be inconsistent with study plan criterion 6, namely utilizing a method that is generally accepted practice in the scientific community. A shift in the analytical tool and outputs will unnecessarily complicate the interface between these closely related modeling efforts in neighboring watersheds. Validating results with those predicted by the existing HEC-5Q will be a time consuming exercise that further delays preparation of a comprehensive analysis. Based on the historical use of HEC-5Q within the basin and the high priority of obtaining seamless output from related modeling efforts, CDFW believes there is large benefit in continuing to utilize the HEC-5Q platform to assess the water temperature effects of different operational scenarios on the lower Tuolumne River. CDFW does not support the Districts rationale for the change in modeling platforms, and believes that even there is limited benefited in shifting from HEC-5Q. CDFW consulted the HEC-5Q developer, who stated that there is at most a 0.05C difference between the six-hour time step calculations of the HEC-5Q model and the one-hour time step of HEC-RAS.	CDFW does not agree with the Districts' use of the HEC-RAS model instead of the HEC-5Q model. CDFW indicates this in its March 7, 2013 comments, a full 4 months after the Districts explained the significant improvements that HEC-RAS model provide and why use of the HEC-5Q platform would not meet the study needs. CDFW states that the HEC-RAS model should not be considered as a generally accepted model in the scientific community because CDFW is unaware of it being used in California for water temperature modeling, The HEC-RAS software may be the most widely used hydraulic model in the country, if not the world. HEC-RAS is an acronym for the Army Corps of Engineers Hydrologic Engineering Center's River Analysis **System**. HEC-RAS is a complete **set of software**, one component of which is the one-dimensional flow hydraulic software that is used extensively around the world (and in California). Another component of this same **software system** is the water quality component, including temperature. It is completely without basis to acknowledge that the hydraulic component of the HEC-RAS package is world-class, but the water quality component of the same HEC-RAS model is not "generally accepted" in the scientific community. CDFW then goes on to state that the HEC-5Q model is the preferred model because it has been used previously by CDFW for its San Joaquin River Basin-Wide Temperature Model. CDFW points out correctly that the Districts original W&AR-16 study plan indicated that the Districts planned to use the same model. After months of working with the HEC-5Q model, the Districts had uncovered a number of concerns about the model which led the Districts to move to the HEC-RAS platform, which is the next generation software of the HEC-5Q software. The Districts shared this with RPs, including CDFW, at the October 26, 2012 Consultation Workshop, and explained the improvements that would result from moving to this most recent HEC modeling tool. On November 14, 2012, the Districts reiterated several of the reasons for migrating to the HEC-RAS package in an email to Robert Hughes of CDFW and offered to further meet with CDFW and others for further discussion if this were necessary. CDFW later indicated this would not be necessary, and no further meeting occurred (see Attachment 3 to this submittal--draft Meeting Notes dated December 14 and asking for

Response No.	Study No.	Type of Comment	Organization	Comment No.	Page No.	RP Comment (quote or paraphrase)	Districts' Response
							comments by January 14, 2013 in accordance with the Consultation Workshop protocols). No comments were received. Below, the Districts provide a number, but not all, of their concerns with the HEC-5Q model proposed to be used by CDFW: 1) Contrary to the designation, the Districts found that the version of the model being used by CDFW for the San Joaquin basin modeling is not a HEC model and should not be indicated to be a HEC model. The HEC designation improperly implies that this particular model would be a Corp-supported, open code model. It is not. Because of concerns encountered in trying to use the model, the Districts attempted to obtain the source code and were informed that source code would not be available. The proper designation of the model, we believe, should be SJR5Q which would eliminate the impression of HEC endorsement. On the other hand, HEC-RAS is a fully supported HEC program, including all of its components. 2) This non-transparency of the SJR5Q model, and the difficulties the Districts were experiencing with trying to get it to validate using all the available lower Tuolumne River data, is a significant concern to the Districts. The study goal of the Districts was to employ a fully transparent model. SJR5Q is not. HEC-RAS is. Without code transparency, the Districts' challenges with model use could not be resolved. In other discussions, CDFW has raised significant concerns that the Districts models be open code and transparent, and readily usable by RPs. 3) The Districts had committed to provide all RPs with a user-friendly model that they could be taught to use with little computer skill. SJR5Q does not meet that goal. It is extremely difficult to use, indeed some input files are still in binary code. 4) Contrary to CDFW's statement, the HEC-RAS output can be made compatible with the SJR5Q input, and the Districts will provide this. 5) As an example of Districts' concerns on technical matters, the Tuolumne River portion of the SJR5Q model contains a 1-D depiction of the Don Pedro Reservoir which the Districts have already moved away from with their 3-D reservoir model. Depicting a reservoir as complex as the Don Pedro Reservoir as a 1-D model cannot be justified. Further, the Districts discovered that the SJR5Q model has no reservoir inflow temperature data directly from the Tuolumne River, and it is not apparent from model inspection or

Response No.	Study No.	Type of Comment	Organization	Comment No.	Page No.	RP Comment (quote or paraphrase)	Districts' Response
							documentation how the reservoir inflow temperature data set is obtained. This is a concern. The Districts are surprised by CDFW's willingness to accept a 6-hour time step for temperature when the HEC-RAS provides a 1-hour time step. The Districts have shared data with all RPs showing the significant summertime variations in diurnal temperature fluctuations that occur along the lower Tuolumne River. CDFW reports on an analysis performed by Mr. Smith regarding the difference between the 1-hour and 6-hour time step. By this response, the Districts request a copy of Mr. Smith's analysis.
2-70	W&AR-18	Study Comment	USFWS	37	p. 10	Spawning of Southern DPS green sturgeon has been confirmed in the Feather River through collection of fertilized eggs on artificial substrate samplers.	The Feather River is a tributary to the Sacramento River and has been identified by NMFS as critical habitat for Southern DPS green sturgeon. The report will be revised to state that spawning occurs in the Sacramento River Basin.
2-71	W&AR-18	Study Comment	USFWS	38	p. 10	Until the USFWS initiated a sturgeon spawning survey in the San Joaquin River in 2011, white sturgeon were not known to spawn there either. The second year of the USFWS San Joaquin River Sturgeon Spawning Survey documented at least six distinct white sturgeon spawning events and three newly identified spawning locations. Perhaps most importantly, sturgeon do not only spawn in wet years, as evidenced by the multiple spawning events documented during 2012 (Below Normal Water Year) on the San Joaquin River (Jackson and Van Eenennaam 2013).	White sturgeon spawning has long been suspected to occur in the San Joaquin River based on the observation of adults in spawning condition. Recent evidence of white sturgeon spawning was acknowledged in the Districts' report, and the report also acknowledges that spawning appears to occur in other years, and during various water year types. No information was found to suggest that adult green sturgeon migrate into, spawn, or in any way occupy the Tuolumne River.
2-72	W&AR-18	Study Comment	USFWS	39, 40	p. 11	Rotary screw trap operation in the Tuolumne River has not occurred during the appropriate time period.	This is incorrect. Rotary screw traps have operated during roughly half or more of the May 16-August 29 period cited by USFWS. In addition to juveniles, spawning migrations have been documented in the Sacramento River. No information was found to suggest that adult green sturgeon migrate into, spawn, or in any way occupy the Tuolumne River so there is no reason to expect juveniles to be present. Also, USFWS cites fyke netting as an appropriate technique for sampling green sturgeon. As reflected in the report, fyke netting was conducted during eight years. Electrofishing, snorkeling, and angling conducted during spring and summer would also be expected to detect green sturgeon which would be expected to migrate and spawn during March through July.
2-73	W&AR-18	Study Comment	SWCRB	SWRCB-15	p.12	The Sturgeon Study Report found that there are "some habitat features within the river that meet requirements for various lifestages," but then states that "this does not imply that the green sturgeon could utilize this habitat, particularly since spawning adults appear to select areas containing a suite of habitat suitability components that are not readily separable."	The statement is supported. For example, suitable substrate for spawning may not be utilized if depth, velocity, and water temperature conditions are not suitable. The Districts also note SWRCB's inconsistent use of "habitat" between this comment and comment SWRCB-6 regarding W&AR-07 Predation Study. The comment regarding W&AR-07 cited to CDFW's California Salmonid Stream Habitat Restoration Manual (CDFW 1998)

Response No.	Study No.	Type of Comment	Organization	Comment No.	Page No.	RP Comment (quote or paraphrase)	Districts' Response
						The second part of this statement is not supported and should be removed from the Study Report. If habitat is available, it is possible that it has or could be used.	definition of habitat as "the place where a population lives and its surroundings, both living and nonliving; includes the provision of life requirements such as food and shelter." The Districts report analyzed each of the individual primary constituent elements of green sturgeon habitat identified by NMFS (2009) including food resources, substrate type and size, water quality, migratory corridor, water depth, sediment quality, and flow. Here the SWRCB is suggesting that habitat does not consist of a suite of factors.
2-74	W&AR-19	Study Comment	USFWS	42	p. 12	Final Restoration Plan (USFWS 2001) is called out in the References section (Section 8.0) of the report; however, there is no indication that this reference was actually used as part of the literature review component of this study. All the existing information on the Project effects that are associated with floodplain and riparian habitat are discussed in the Final Restoration Plan (USFWS 2001), and this reference should therefore be included in the Methodology (Section 4.0) of the study and evaluated accordingly.	The information from USFWS (2001) was used in development of the report, and will be cited in the Final Report, along with the citation of similar information from other sources.
2-75	W&AR-20	Study Comment	USFWS	43	p. 12	Service disagrees with the Applicants' assertion that a population of mature *O. mykiss* that range in size from 194 to 523 mm (fork length) could be described as in "good condition." In addition the data from this study shows that *O. mykiss* are not living more than 4 years, which is another indicator that the population is not in good condition. Service suggests that for this study to be informative, input to the *O. mykiss* population model must contain a comparison of the results to other regional and national systems and that these should be discussed in the report. Focusing on local studies should not be discussed, because it is misleading. Brouder et al. (2009) (in Enclosure 6) provides some national and regional results that would be a beneficial addition to this report	The study was completed consistent with the approved Study Plan and FERC's SPD. It must be noted that an error was detected by Stillwater Sciences in the W&AR-20 report regarding the Zimmerman et al. (2009) *O. mykiss* age classes. Zimmerman et al. (2009) grouped all age 4 and older fish into a single age 4 category. This error will be corrected in the final report by deleting all comparisons of W&AR-20 age 4 fish to the Zimmerman et al. (2009) age 4+ fish. In the event that older age-classes cannot be separated from the age 4+ category, the W&AR-20 report will still contain a comparison of the study's ages 1 to 3 fish to Zimmerman et al's (2009) ages 1 to 3 fish. Contrary to the USFWS comment, nowhere in the W&AR-20 report is the assertion that a population that ranges in size from 194 to 523 mm is described as being in "good condition." The words "good condition" or any description of the condition of *O. mykiss* (other than growth rates) in the lower Tuolumne River do not appear in the report. The data within the W&AR-20 report do not show that *O. mykiss* in the Tuolumne River are not living more than 4 years. The fact that no fish were collected from the 450-550 mm size group (potentially 5+ year old fish) does not indicate that 5+ year old fish are not present in the river. Page 4-1 in the report states the reason why the largest size group was not collected. "… continuing to try and collect fish to fill in the 50–150 and 450–

Response No.	Study No.	Type of Comment	Organization	Comment No.	Page No.	RP Comment (quote or paraphrase)	Districts' Response
							550 mm size groups would have required capturing large numbers of *O. mykiss* in the already filled 150–250 mm, 250–350 mm, 350–450 mm categories. That could have potentially resulted in injury, and possibly mortality, to a significant number of fish, so the sampling was halted." In addition, the fact that Zimmerman et al. (2009) did capture 38 age 4+ fish in the Tuolumne River shows that older age classes do exist. In regard to the USFWS comment that "Focusing on local studies should not be discussed, because it is misleading," the table below shows comparisons of fork lengths of the fish Zimmerman et al. (2009) captured in the non-local Stanislaus, Calaveras, and Yuba river, as well as the Tuolumne River. As can be seen, the Tuolumne River size ranges match closely with, and in some cases are larger than, the Stanislaus, Calaveras, and Yuba rivers. Note that the 700 mm fish in the Calaveras River column was a steelhead that had ocean residency. The next largest Calaveras fish was 535 mm and also a steelhead.

Age	Size range (mm)			
	Stanislaus	Calaveras	Yuba	Tuolumne
0	nd	76-158	33-157	nd
1	142-195	170-203	225-229	145-192
2	200-295	204-296	230-296	205-310
3	300-398	298-382	301-389	325-398
4+	412-535	405-700	390-510	400-523
n=	155	180	141	151

As stated in the W&AR-20 report, the reason for the relatively smaller size fish captured for this study compared to Zimmerman et al. (2009) was due to differences in the time of sample collection; the fish in this study were collected during the winter and early spring when annuli would be forming and only early season growth occurred, while Zimmerman et al. (2009) samples were collected between October and May when substantial growth would have followed annulus formation.

Table 3. Comments on Cultural Resource Studies.

Response No.	Study No.	Type of Request	Organization	Comment No.	Page No.	Comment (Quote or Paraphrase)	District's Draft Response
3-1	CR-01	Study	BLM	BLM-1-CR-	p. 2	The BLM requests that the schedule in Results 5.0 of the	The Districts will modify the schedule in Results 5.0 to reflect

Response No.	Study No.	Type of Request	Organization	Comment No.	Page No.	Comment (Quote or Paraphrase)	District's Draft Response
		Modification		01		ISR for the Historic Properties Study plan be updated to give the BLM, the Tribes, and other appropriate parties the opportunity to review the draft reports from May 2013 to the end of October 2013.	a new review period from May 2013 to the end of October 2013 for the BLM, the Tribes, and other appropriate parties to review the study report.
3-2	CR-01	Study Modification	BLM	BLM-2-CR-01	p. 2	The BLM requests that the SHPO review of the study report not occur until agency and tribal review is complete.	The Districts, on behalf of FERC, will not request SHPO's review and concurrence on the study report until agencies and tribes have been provided the opportunity to review the report.
3-3	CR-01	Study Modification	BLM	BLM-3-CR-01	p. 2	The BLM requests that the schedule in Results 5.0 of the ISR for the Historic Properties Study plan be updated to give the BLM, the Tribes, and other appropriate parties an opportunity to review the draft HPMP and that the review period be in January and February 2014.	The Districts will modify the schedule in Results 5.0 to reflect a review period from January to February 2014 for the BLM, the Tribes, and other appropriate parties to review the HPMP.
3-4	CR-01	Study Modification	BLM	BLM-4-CR-01	p. 2	The BLM requests that the HPMP not be submitted to SHPO for review and concurrence until agency and tribal review is complete.	The Districts, on behalf of FERC, will not request SHPO's review and concurrence of the HPMP until agencies and Tribes have been provided the opportunity to review the HPMP as specified in response to Comment BLM-3-CR-01.
3-5	CR-01	Study Modification	BLM	BLM-5-CR-01	p. 2-3	The BLM disagrees with the following footnote found in the ISR section titled Results 5.0: "The Tuolumne River arm of the Don Pedro Reservoir could not be safely accessed during the field season; however, the Districts will attempt to access this area when it is safe to do so. It appears that the area can be safely accessed when the reservoir is near full (at least 815 feet above mean sea level) and motorized water craft can safely travel close to the end of the Project boundary in this area." The BLM requests that this statement be modified to consider other alternatives such as hiking overland on the Mohican Trail (accessed on Ferretti Road out of Groveland) to this trail's terminus on the Tuolumne River. From here, a professional rafting company can pick up the consultants and safely boat them down the river, providing opportunities to inventory within the Project area of potential effects.	The Districts and the Districts' consultants do not agree that white water rafting is a reasonable mode of transportation to access a site, especially as a safer alternative will be available (i.e. motorized boating during high water levels). Districts' subconsultant, Far Western, which has performed numerous cultural resource studies for the BLM, indicated that they were not willing to ask their employees to undertake the inherent risk in a rafting trip with Class 4 rapids to document resources along the way. It would be inappropriate of the Districts to ask another subconsultant to undertake this risk if a recognized professional in this field thought it unwise.

Table 4. Comments on Recreation Resource Studies.

Response No.	Study No.	Type of Request	Organization	Comment No.	Page No.	Comment (Quote or Paraphrase)	District's Draft Response
4-1	RR-02	Study Modification	BLM, NPS, USFS Stanislaus, and Private Citizens and organizations	BLM-19 NPS-1 NPS-2 NPS-4 USFS-12 BLM-13 BLM-18 BLM-21 BLM-22	p.12 p.4 p.4 p.5 p.4 p.11 p.12 p.13 p.13	Multiple RPs requested that the study report include a more detailed description of what considerations were taken into account in the study, and made a number of requests for study of additional interests. The comments included requests for additional analysis regarding expansion and enhancement of the Ward's Ferry take-out, including multiple lanes, parking options, staging areas and restrooms, as well as the environmental impacts associated with the various alternatives.	The report includes engineering drawings and materials and cost estimating sheets at an appropriate level of detail for a feasibility study. The alternatives presented for improvements on either river right or river left at the Ward's Ferry Bridge demonstrate that at least one functional option exists to make improvements for whitewater boating take-out at the conclusion of Upper Tuolumne River trips. The engineering feasibility study starts with the stated purpose to investigate improvements to the existing take-out at Wards Ferry. The purpose of the

				BLM-23 NPS-1 NPS-3 NPS-4 USFS-2 USFS-5 Hackamack-1 SierraMac-2 Hackamack-6 Hackamack-7 Hackamack-8	p.13 p.4 p.4 p.5 p.3 p.4 p.2 p.2 p.6 p.6 p.6		take-out facility is to consider alternatives to address specific problems being experienced with the existing take-out, these being getting boats and boaters off the river safely and efficiently and minimizing traffic problems and hazardous conditions at the bridge and public roadway. The study was not ever intended to be the development of a new recreation facility at Wards Ferry. The feasibility study examined alternatives, focusing first, as would be expected, on whether this could be accomplished at the Wards Ferry site. The study determined it could. It was evident by inspection that the Deer Creek area would be considerably more expensive and result in significant new environmental impact. It would only be considered if egress at Wards Ferry was not feasible. Goals in engineering studies are always to identify the least cost alternative that meets the purpose. There is no need to have ramps on both sides of the river. The final report will be expanded to provide more details on the Ward's Ferry alternatives such as parking, bathroom location, and road width.
4-2	RR-02	Study Modification	BLM, NPS, USFS Stanislaus, CG, and Private Citizens and organizations	CG-5 BLM-12 NPS-2 BLM-15 BLM-17 BLM-20 BLM-24 NPS-2 USFS-3 USFS-4 Hackamack-2 Hackamack-4 Hackamack-5 AO-1 SierraMac-1 SierraMac-3 SierraMac-4 OARS-1	p.14-15 p.11 p.4 p.12 p.12 p.13 p.14 p.4 p.3 p.4 p.3 p.5 p.6 p.1 p.2 p.2 p.3 p.1	Several RPs requested additional study or made comments regarding the alternative locations for whitewater boating take-out locations. The requests for study modification include additional analysis of the Deer Creek location, as well as river left at Ward's Ferry Bridge, and that more input from take-out users be incorporated.	The final report will be expanded to provide more details on the apparent constraints associated with development of the Deer Creek and Deer Flats locations, and other locations included in the analysis. The request that security matters be included in the study is a new request presented without any explanation of why the request was not made earlier. Also, law enforcement is not the responsibility of FERC licensees.
4-3	RR-02	Study Comment	BLM	BLM-7	p.6	The whitewater boating take-out at Ward's Ferry Bridge should be treated the same in the license as any other developed project related recreation facility managed by the Don Pedro Recreation Agency (DPRA). This needs to be clarified […].	The whitewater boating take-out does not provide access to the Don Pedro Reservoir in the same manner as facilities at Blue Oak, Fleming Meadows, and Moccasin Point. These DPRA-managed recreation areas are highly developed sites on the modern end of the recreation opportunity spectrum where encounters with others are expected, management is highly visible, and amenities are of an improved nature (e.g., plumbing, pavement, buildings). The take-out for non-motorized whitewater boating at the terminus of a Class IV and V wilderness experience, on the other hand, is appropriately maintained and managed as primitive facility, providing for

							challenging, unimproved conditions balanced with development only to the extent necessary for sanitation and long-term maintenance. Intensively developed improvements at Ward's Ferry Bridge would lead to user conflicts and diminished functionality as a whitewater boating take-out as motorboaters, anglers, and general recreationists would be drawn any amenities made available at the site.
4-4	RR-02	Study Comment	BLM	BLM-9	p.10	In the study report, and elsewhere, it is inferred that Ward's Ferry is "above the project" which is incorrect.	The Project Boundary extends upstream on the Tuolumne Arm above the Ward's Ferry Bridge. This will be clarified in the final report.
4-5	RR-02	Study Comment	BLM and USFS	BLM-11 USFS-4	p.11 p.2	The BLM and Forest Service do not consider Moccasin Point to be a viable option for whitewater rafting take-out.	The Moccasin Point Recreation Area is a physically viable take-out alternative, as evidenced by statements made at the focus group meeting and the fact that it is used by some whitewater boaters at times. The Districts understand that the opinion of most boaters who have participated in the relicensing process is that the Moccasin Point alternative for whitewater boating take-out is not preferred when compared to a take-out closer to the terminus of the whitewater run.
4-6	RR-02	Study Modification	BLM	BLM-14 BLM-16	p.12	A summary of the conclusions from the focus group and ranking of the various alternatives should be included in the body of the main report.	The Districts maintain that the summary is adequate in its content and comprehensiveness. Participants in the focus group meeting may submit their own meeting summaries to the record.
4-7	RR-02	Study Modification	NPS	NPS-5	p.5	Request for engineering feasibility assessment including drawings, costs, and environmental constraints, geotechnical surveys and topography surveys for river right at Deer Flat and the Deer Creek side of the river.	The request for geotechnical surveys and topography surveys is a new request presented without any explanation of why the request was not made earlier. The approved study did not include performing such work. This level of investigation is appropriate as part of a final design effort, and was not needed for this feasibility study.
4-8	RR-02	Study Modification	USFS Stanislaus	USFS-1	p.1	Site visits and take-out studies should be conducted with RPs.	The communication and meeting requirements of the approved study plan were adhered to. Nonetheless, further communication, including site visits can be conducted without a study modification during the upcoming stages of the ILP.
4-9	RR-02	Study Comment	USFS Stanislaus	USFS-03	p. 2	The ISR did not take into consideration mitigating the loss of a major recreation use, whitewater boating, which was a direct result of the construction of the project and how it is operated.	This request was made earlier in the ILP process and was not adopted because the appropriate baseline for relicensing studies is the Project as currently licensed.
4-10	RR-02	Study Comment	USFS Stanislaus	USFS-07 And -15	p. 3	The Forest Service is concerned about what is being characterized as "reasonable" fee recovery for capital improvements of Ward's Ferry. There is no precedent for the entire cost of capital improvements being amortized and shifted on to users as has been suggested by HDR. The Forest Service would also like to elevate the importance of the economic impact that commercial rafting has on the economy of Groveland, California.	This is not a study modification or a new study request, but a consideration to be taken into account during development and analysis of PM&Es.
4-11	RR-02	Study Comment	USFS Stanislaus	USFS-08	p. 3	Currently, there are no fees associated with parking, permits, or access required to boat the Tuolumne WSR. As DPRA and the BLM are the principle land owners at the Ward's Ferry Bridge site, and the Forest Service is the lead agency in managing the Tuolumne WSR, the Forest Service is available to meet with DPRA and the	This is not a study modification or a new study request, but an offer to collaborate on recreation improvements and site management.

						BLM to discuss operations and maintenance strategies and user fees for any improvements built at Ward's Ferry Bridge or any other location that may be selected.	
4-12	RR-02	Study Modification	All-Outdoor and ARTA	AO-1 ARTA-1	p.1 p.1	Additional information should be included in the study, such as draft proposals, boater surveys, additional focus group meetings, analysis from outside engineering firms, and collaboration with users.	This is a new request for a revised methodology presented without any explanation of why the request was not made earlier. Study goals were achieved: 1) assessing the feasibility of improving the existing take-out location for continued use by whitewater boaters on the upstream end of the Don Pedro Project, and 2) evaluating the feasibility of physical improvements to the Ward's Ferry Bridge location and also assess the feasibility of alternative take out locations.
4-13	RR-02	Study Comment	Hackamack USFS Stanislaus	Hackamack-3 USFS-9	p.4 P.4	The study should consider the projected future growth of whitewater rafting, including commercial and non-commercial interests.	The final report will be expanded to discuss the capacity of proposed facilities compared to current facilities and projected future use.
4-14	RR-03	Study Comment	BLM	BLM-29	p.15	The study plan, in the methodology section step 5, calls for "the lowest boatable flow reported by study participants for each type of non-motorized boating opportunity." This information cannot be provided by the existing study's results.	This variance from the study plan was acknowledged in the ISR. The study report details that in spite of this variance, the study goals and objectives were achieved. While study methods described the number of volunteers and watercraft type sought, it was not a goal of the study to have any specific level of volunteer participation.
4-15	RR-03	Study Modification	BLM	BLM-38	p.17	The BLM would also like to see more qualitative information (i.e. preferences, crowding and user conflict issues) in the new study.	This request is a new request presented without any explanation of why the request was not made earlier. There is no information available that indicates crowding or conflicts are issues on the lower Tuolumne; and anecdotal observations during the 2012 study identified no potential for conflict or crowding issues under current conditions. This request should be rejected.
4-16	RR-03	Study Comment	BLM	BLM-26	p.14	Standard practices and due diligence for recruiting boating flow study volunteers did not occur. For example, the flow studies were simply announced once in a brief email and in the case of the first 2-day flow study less than 7 days advance notice was given. But regardless of the instance of the short notice, one email with minimal follow-up is not an adequate outreach plan.	The record reflects that the Districts' contractor solicited participation via several emails. Also, RPs assisted in the development of the study plan and therefore were aware of the plan to engage volunteer boaters.
4-17	RR-03	Study Modification	BLM, CG, Hackamack	BLM-25 BLM-27 BLM-28 Hackamack-2 CG-10		The number of volunteers and types of watercrafts used in the volunteer lowest boatable flow study were inadequate to make a determination. The study should include an additional survey to include more boaters and types of boats.	This variance from the study plan was acknowledged in the ISR. The study report details that in spite of this variance, the study goals and objectives were achieved. While study methods did describe the number of volunteers and watercraft type sought, it was not a goal of the study to have any specific level of volunteer participation.
4-18	RR-03	Study Comment	BLM	BLM-30	p.15	Due to the flow gage calibration problem last summer flow estimates were off by about 50-60 cfs. That's an error of about 25% which is significant. Given this problem we never did even get down to the minimal flow, which was the objective.	This variance from the study plan was acknowledged in the ISR. As explained in the study report, in spite of early season recalibration of the USGS gage which revised the flow estimates for May and June study events, the flows prescribed in the study plan were provided September 29-October 1 for a volunteer boater study event. The study report details that in spite of this variance, the study goals and objectives were achieved.
4-19	RR-03	Study Comment	BLM	BLM-31	p.15	While this is a minimum boatable flow study, boatable implies a safe boating experience and given the amount	The lower Tuolumne River at flows in the 100 cfs range as measured at the La Grange gage provides a boating

						of times most boaters had to exit their watercraft the flows recorded in the ISR do not represent a safe minimum boating experience. Minimum flows should be evaluated using the craft that draws the most water to assist us in determining the minimum.	experience suitable for beginners to learn boating skills in a relatively safe environment. An experienced boater can navigate the lower Tuolumne at flows in the 100 cfs range without the need of exiting the boat.
4-20	RR-03	Study Comment	BLM	BLM-33	p.16	The ISR states that, "Flows as low as 100 cfs as recorded at the USGS La Grange gage were determined to be boatable in the reach between Old La Grange Bridge and Turlock Lake State Recreation Area (Turlock SRA)." This conclusion was based on the opinion of one boater in an inflatable kayak which has the lowest draw of any of the watercraft intended to be included in the study and by no means should be considered a conclusion of the study.	Clearly watercraft with greater draw will require a higher flow. A conclusion of the study is that the lower Tuolumne is boatable in some recreational watercraft in the 100 cfs range as measured at the La Grange gage.
4-21	RR-03	Study Modification	BLM, Hackamack, NPS	BLM-34 Hackamack-4 NPS-4	p.16 p.8 p.8	The boatable flow survey was not sufficient and needs to be performed again with better defined goals (i.e., preferences, crowding, and user conflict issues).	The survey instrument for the *Lower Tuolumne River Lowest Boatable Flow Study* was developed in consultation with RPs and included as Attachment A in the RSP that was submitted to FERC and approved in the SPD.
4-22	RR-03	Study Modification	BLM, Hackamack	BLM-35	p.16	As we have requested in the past, the Shiloh Bridge access site to be included in the study.	The final report will be expanded to provide information about the Shiloh Bridge access site.
4-23	RR-03	Study Modification	BLM	BLM-37	p.17	The study should be revised to include a better definition of a minimum boatable flow. Additional study should also explicitly name the take-out sites where data will be collected, outline specific protocols for ensuring participation, and state an adequate lead-time for announcing study days.	This is a new request presented without any explanation of why the request was not made earlier.
4-24	RR-03	Study Modification	NPS	NPS-1, Hackamack-1	p.6	Modified study should include a second season of flow study between June 1 and November 30, 2013.	A second season of flow study is not warranted. The flows prescribed in the study plan were provided September 29-October 1 for a volunteer boater study event. The ISR reports on the variances from the approved study plan and describes how the study goals were achieved in spite of variances from specific steps of the approved study method. The final report will be expanded to include additional information as requested by RPs in comments on the ISR. Regarding boatable flows, RPs who have boated the lower Tuolumne River may provide information on their opinions of boatability to the record.
4-25	RR-03	Study Modification	Hackamack	Hackamack-3	p.8	Include November in the revised study because this is prime time for viewing salmon and boats may be heavier due to cold weather gear.	This request is a new request presented without any explanation of why the request was not made earlier.
4-26	RR-03	Study Modification	Hackamack	Hackamack-6	p.8	A new study should clearly classify data by segment where data is collected. Outline specific protocols for ensuring participation, and provide adequate lead-time for announcing study days.	It is not clear what is meant by "classify data by segment where data is collected." The report clearly describes segment of the lower Tuolumne and clearly reports results of volunteer and contractor runs at various flows by river segment. The request for participation protocols is a new request presented without any explanation of why the request was not made earlier. The lead time for announcing the September 29-October 1 study days was six weeks, an adequate time.
4-27	RR-03	Study Modification	Hackamack	Hackamack-7	p.9	Provide more days of steady flow to accommodate repeat runs at different flows.	It is not clear why more days would be needed at any one flow to achieve the goals and objectives of the study. Nonetheless,

							this request is a new request presented without any explanation of why the request was not made earlier.

Table 5. Comments on Terrestrial Resource Studies.

Response No.	Study No.	Type of Request	Organization	Comment No.	Page No.	Comment (Quote or Paraphrase)	District's Draft Response
5-1	TR-01	Study Comment	BLM	BLM-39	p.17	The BLM requests that all of the raw data on special status plants collected by the licensee be sent to BLM Mother Lode Field Office Botanist Beth Brenneman electronically.	These data will be provided to the BLM as requested.
5-2	TR-02	Study Comment	BLM	BLM-40	p.17	The BLM requests that all of the raw data on ESA-CESA listed plants collected by the licensee be sent to BLM Mother Lode Field Office Botanist Beth Brenneman electronically.	These data will be provided to the BLM as requested.
5-3	TR-07	Study Comment	BLM	BLM-41	p.18	The study is not complete. Step 5 of the Study Plan (Consult with USFWS) has not been completed. Step 5 is intended to identify additional data that is needed and to discuss the potential for Project activities to affect California red-legged frogs.	The Districts have completed the CRLF study consistent with the FERC-approved study plan, including step 5, which requires that the Districts engage in informal consultation with the USFWS. The Districts have been designated FERC's non-federal representative for the purposes of informal consultation under the Endangered Species Act (ESA). The Districts' PAD and study plan development process as well as the provision of study reporting and data in the ISR and during the ISR meeting fulfills this study plan requirement, and provides FERC with the information needed for FERC to engage in ESA consultation with USFWS. The Districts look forward to continuing discussions with the USFWS in developing a Draft Biological Assessment that analyzes Project effects on ESA-listed species such as CRLF.
5-4	TR-07	Study Comment	BLM	BLM-42	p.18-19	The BLM disagrees with the statement, "None of these sites will be potentially affected by Project O&M due to proximity to project facilities or Don Pedro Reservoir" (Section 5.3, page 5-3, paragraph 2).	The Districts recognize that CRLF, although not likely to be present in the Tuolumne basin or Project vicinity, could potentially use sites within the Project Boundary and surrounding one-mile area, because the sites meet basic CRLF habitat criteria. (No CRLF are reported to occur within five miles of the Project, and the study results indicated generally poor habitat conditions for CRLF within the study area.) Regardless, the majority of potential sites (320 of 337) that met basic CRLF habitat criteria (20 weeks of water present during the CRLF breeding season) are geographically removed from any Project-related O&M activity and are not properly considered Project-affected sites. The hypothetical potential that reservoir fluctuations could trigger bullfrog dispersal to these areas is not relevant, as bullfrogs are already ubiquitous in the study area and much of California as a whole.
5-5	TR-07	Study Comment	BLM	BLM-43	p.20	The BLM disagrees with the conclusion that "the presence of bullfrogs diminishes the potential suitability of most of the sites." Bullfrogs were detected in a sufficient number of locations to indicate both the presence of potential California red-legged habitat and the potential that those	While bullfrog presence can be suggestive of suitable hydrologic conditions for CRLF, the literature clearly shows that CRLF are detrimentally affected by bullfrogs. Research in California has shown that CRLF populations decline and eventually disappear after bullfrogs become established

Response No.	Study No.	Type of Request	Organization	Comment No.	Page No.	Comment (Quote or Paraphrase)	District's Draft Response
						bullfrogs are a significant stressor on the local California red-legged frog population(s). Because bullfrogs optimize the best California red-legged frog habitat, they are an excellent indicator of the potential suitability of the site (Section 5.3.1, page 5-3). The BLM also disagrees that ponds and streams within the one-mile action area boundary are not affected by Project operations and maintenance (Section 5.3.2, page 5-5).	(Fisher and Shaffer 1996). The presence of predatory fish, particularly bass and sunfish, is also a good indicator of bullfrog habitat suitability, but diminishes CRLF habitat suitability because bullfrogs enjoy an advantage from the presence of fish which are deleterious to CRLF (Kruse and Francis 1977, Werner and McPeek 1994, Adams et al. 2003, Gilliland 2010). As noted in the BLM's comments (p. 20, "as a non-native predator, bullfrogs have the ability to adversely affect the aquatic ecosystem where they become established."
5-6	TR-07	Study Comment	USFWS	USFWS TR-1	p.12	Step 5 of the Study Plan (Consult with USFWS) has not been completed. Step 5 is intended to identify additional data gathering that is needed and to discuss the potential for Project activities to affect California red-legged frogs.	See response to BLM Comments 41-43.
5-7	TR-07	Study Comment	USFWS	USFWS TR-2	p.13	The USFWS disagrees with the statement "None of these sites will be potentially affected by Project operations and maintenance (O&M) due to proximity to project facilities or Don Pedro Reservoir" (Section 5.3, page 5-3, paragraph 2).	See response to BLM Comments 41-43.
5-8	TR-07	Study Comment	USFWS	USFWS TR-3	p.14	The USFWS disagrees with the conclusion that "the presence of bullfrogs diminishes the potential suitability of most of the sites" (Section 5.3.1, page 5-3).	See response to BLM Comments 41-43.
5-9	TR-07	Study Comment	USFWS	USFWS TR-4	p.14	The USFWS disagrees that ponds and streams within the one-mile action area boundary are not affected by Project operations and maintenance (Section 5.3.2, page 5-5).	See response to BLM Comments 41-43.
5-10	TR-10	Study Modification	USFWS	USFWS TR-5	p.15	The USFWS is concerned that this study was not implemented in a manner that could be used to determine Project effects and determine the level of take of bald eagles that could occur from disturbance (agitation or bothering) of nesting eagles as a result of recreational activities. The USFWS recommends that a second year of study is needed to better understand the Project effects to bald eagles associated with O&M and recreational activities occurring in the FERC Project Boundary.	The Bald Eagle study was completed consistent with the FERC-approved study plan and as specified in agency comments requesting the study. The Districts contend the study results document that Project operations are fully compatible with successful bald eagle nesting and breeding at Don Pedro Reservoir. No evidence of detrimental Project effects on bald eagles has been presented. Nevertheless, the Districts will conduct a second year of bald eagle nest observations as requested, consisting of one survey visit in April (to confirm nest occupancy) and one in June-July (to confirm nest success).
5-11	TR-10	PM&E	USFWS	USFWS TR-6	p.15	The Applicant should assess and report measures to reduce collision mortality to bald eagles from the distribution circuit power lines associated with the Project. Transmission and distribution power lines should be designed according to guidelines provided in the "Avian Protection Plan" [Avian Power Line Interaction Committee (APLIC) and USFWS 2005].	Compliance with APLIC guidelines will be described in the Draft and Final License Applications for the Project.
5-12	TR-10	PM&E	USFWS	USFW STR-7	p.15	The Applicants should assess and report all rodenticide use within the Project footprint.	The Districts will make this information available to the USFWS.
5-13	TR-10	PM&E	USFWS	USFW STR-9	p.16	The USFWS recommends that the Applicants coordinate with the USFWS regarding their responsibilities under the BGEPA and MBTA for the bald eagle to address potential	The Districts agree, and assert the Bald Eagle study results provide information sufficient to inform this discussion.

Response No.	Study No.	Type of Request	Organization	Comment No.	Page No.	Comment (Quote or Paraphrase)	District's Draft Response
						Project effects.	
5-14	TR-10	PM&E	USFWS	USFWS TR-10	p.16	The USFWS recommends that, in addition to conducting a second year of studies for the Bald Eagle Study Report, that the Applicant develops a Bald Eagle Management Plan and apply for a programmatic eagle take permit under BGEPA to determine if a permit is necessary and avoid unpermitted take of eagles.	The Districts will develop a Bald Eagle Management Plan and engage in BGEPA-related coordination with the USFWS. The information provided by the Districts' Bald Eagle Study is sufficient to support these discussions and ensure the protection of bald eagles within the Project Boundary.

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ATTACHMENT 2

Draft Notes for March 27, 2013 Hydrology Workshop #4

ATTACHMENT 2

DON PEDRO RELICENSING

HYDROLOGY WORKSHOP No. 4
March 27, 2013 – 1:00 P. M.
HDR OFFICE – SACRAMENTO, CA

DRAFT NOTES

Participants (All in person; no phone participants):

CCSF:	Ellen Levin
CDFW:	Robert Hughes, Annie Manji
CSPA:	Chris Shutes
HDR:	John Devine, Rick Jones, Rob Sherrick, and Dan Steiner
MID:	Bill Johnston
TID:	Steve Boyd
SWRCB:	Peter Barnes
For TRT:	Bob Hackamack
USFWS:	Alison Willy

The participants began the meeting by reviewing the unimpaired hydrology "strawman" provided by HDR on March 25, 2013. Rob Sherrick described his process for "refining" the unimpaired hydrology for the Tuolumne River. The "strawman" Mr. Sherrick described provides unimpaired hydrology for four locations of the Tuolumne River watershed – La Grange, Hetch Hetchy, Cherry/Eleanor, and the remaining unregulated watershed above La Grange. The daily hydrologic record Mr. Sherrick described eliminates the negative and somewhat erratic flows that show up in the unimpaired hydrology previously developed for the Operations Model.

The "Gage Proration" method has been developed by using unimpaired stream gage flows from gages within and nearby the Tuolumne River watershed where the gage data provide a more complete record for various elevations represented within the Tuolumne River watershed.

This "Gage Proration" method is basically another estimate of the unimpaired flow of the Tuolumne River. The monthly volumes of water are not changed from the total used by the Districts and CCSF in developing historical water records. However, there are adjustments made to the daily shaping of flows within the monthly periods.

Mr. Sherrick showed a series of smoothing hydrographs to illustrate how the smoothing process depicted in the "strawman" added and subtracted volumes of water to eliminate the negative flows, but maintained the same monthly volume of runoff. Storm differences between watersheds are obvious in the hydrographs for storms that produce unequal precipitation over small areas. The methods illustrated by Mr. Sherrick were the same ones provided in the HDR memo that was issued to relicensing participants on March 25, 2013. Mr. Sherrick walked through each step of the daily hydrology contained in the “strawman.” He noted that October 2002 was the only month where “new water” (2,000 acre-feet) had to be added to account for an overall negative total watershed volume at La Grange and to make the proration come into line with the two adjacent months.

All the parties agreed that the resulting unimpaired flow estimates provided in the “strawman” were reasonable and acceptable. These flows will be used as appropriate for the Operations Model. Dan Steiner did note that use of these flows will affect the shares of water supply between the Districts and CCSF in the base case. However, since the Operations Model is used to make comparisons between a base case and potential future scenarios, it will not affect comparisons between alternatives. The unimpaired flows resulting from the smoothing contained in the “strawman” will look more like an expected hydrograph, but it will not change the overall results on comparing one scenario against another.

It was clearly stated that the Districts and CCSF will not change the way they calculate the water in the water bank or the division of water between the agencies. This “Gage Proration” method will only be used to estimate unimpaired flow for the base case and other models used for the FERC relicensing, and will not be used to redefine the computation of historical operations.

John Devine mentioned that Tuesday, April 16, 2013, is now the tentative date for the roll-out of the Operations Model Base Case, and that the Districts will confirm this next week. All the parties also agreed that the meeting notes should reflect the agreement reached and these notes should then be added to the Districts’ upcoming April 9, 2013 filing with FERC that deals with responses to relicensing participant comments on the Initial Study Report.

Districts "Strawman" for Considering Further Development of Unimpaired Hydrology for the Tuolumne River in Advance of Workshop On March 27, 2013

1.0 Objective

Relicensing participants and the Districts are continuing to consider and discuss Tuolumne River hydrology for use in the Tuolumne River Operations Model (W&AR-02). This draft report is intended to be an initial "strawman" describing one possible approach to discuss further on March 27, 2013. The objective of this particular "strawman" is to develop a daily flow dataset that contains no negative values, results in more gradual changes in day-to-day flows, and conforms to the historical monthly volumes previously recorded by the Districts and CCSF. The period of record under consideration is Water Year 1971 – 2009. It is noted that the period of record may be extended to 2012 for use in the development of the river and reservoir temperature models.

2.0 Background

On September 10, 2012, the California Department of Fish & Wildlife (CDFW), provided comments to the State Water Resources Control Board (SWRCB) related to the unimpaired hydrology for the operations/water balance model being developed for the Don Pedro Project relicensing. In summary, CDFW is concerned "that the Districts' proposed method of estimating unimpaired hydrology is not appropriate for the purpose of the state of California's environmental review process required for a new license."

The Districts subsequently undertook an investigation of CDFW's suggested approach and submitted its report to SWRCB, CDFW and FERC on December 21, 2012. This report was also provided as Attachment A, Appendix A, of the W&AR-2 initial study report issued January 17, 2013. On February 14, 2013, representatives from CDFW, SWRCB, and CCSF met with the Districts to discuss the Districts' report and the comparison of the two approaches. The Districts maintained that there was insufficient Tuolumne River gauge data to support the gauge proration approach for the period of record of the Operations Model. CDFW and SWRCB expressed interest in using all available gauge proration hydrology even if the period of record was not as complete as might be desired. CDFW and SWRCB suggested that alternatives be developed collaboratively in a workshop environment. CDFW and SWRCB agreed that the monthly mass balance from the existing gauge summation hydrology was sound and need not be adjusted. The Districts agreed to continue to discuss and consider alternative approaches, and agreed to provide a "strawman" for to advance and promote dialogue at a meeting to be held on March 27.

3.0 Methods

Hydrologic input to the Operations Model currently includes daily unimpaired hydrology estimates for three locations in the watershed: "La Grange" (at the USGS gage), "Hetch Hetchy Reservoir", and Lake Lloyd Reservoir/Lake Eleanor combined "Cherry/Eleanor". The Operations Model uses these inputs to calculate a fourth dataset of operational significance: the unimpaired flow from the unregulated portion of the watershed above Don Pedro Reservoir (“Unregulated”). Details of these calculations are described in the ISR of W&AR-2, Attachment A.

3.1 Gauge Proration “Strawman”

To promote and advance discussions for the March 27 Workshop, the Districts, as agreed with SWRCB, CCSF and CDFW, have evaluated approaches to developing a hybrid flow record for the Tuolumne River using a combination of gauge proration conforming to the existing monthly mass balances underlying the Operations Model. This “strawman” is described below.

In order to prorate the gauged data to a larger ungauged area (application basin), three physical variables were considered – elevation, drainage area, and average annual precipitation (precipitation). Each gauged basin, along with each application basin (Hetch Hetchy, Cherry/Eleanor, and Unregulated), was divided into 100-foot “elevation bands” for its entire drainage area. This was done using USGS National Elevation Dataset, 1/3 arc-second (USGS, 2009), which equates to about a 30 foot pixel size. Each elevation band for each gauge had attributes added for the drainage area within this band (e.g., the number of square miles of the Tuolumne River drainage that exists between elevation 500 and 600 feet) and precipitation (e.g. the average annual precipitation for the drainage area between elevation 500 and 600 feet).

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

Areas at low elevations and high elevations in each of the application basins that are poorly represented or not represented at all by the reference gauges were “artificially added” into the elevation distributions of the most representative gauges in order to provide some amount of coverage for those elevation ranges. When artificial areas were added to the gauges, the amount of area added for each gauge was nominally established as one percent of the total application basin area for that elevation bin. For precipitation in artificially augmented elevation bands, a multiplier was applied to the application basin precipitation values equal to the multiplier for the nearest observed elevation band for that gauge.

The proration calculation includes two main steps. First, the daily flow for a given gauge is divided across the elevation range that the gauge represents, in equal proportion to the drainage area represented within each 100-foot elevation band. Second, the sum of each of the individual “elevation band flows” for each gauge is scaled up to the area of that elevation band in the application basin. Each of these steps includes a scaling factor for both area and precipitation. Equation 1 shows the calculation for prorated flow on a single day, with the first step in the left set of parenthesis, and the second step in the right set of parenthesis (mathematical summation form).

$$q_u = \sum_{e=1}^{n} \sum_{g=1}^{n} q_g \left(\frac{a_{ge} p_{ge}}{\sum_e a_{ge} p_{ge}} \right) \left(\frac{a_{ue} p_{ue}}{\sum_g a_{ge} p_{ge}} \right)$$

Equation 3.1.1 Daily unimpaired flow where q is daily average flow, a is area, and p is average annual precipitation. Where g is each gauged basin, u is the application basin, and e is the lower limit of each 100-foot elevation band divided by 100.

It is worth noting here that a few of the reference gauge basins had facilities that resulted in measurable amounts of stream regulation and/or diversion during the period of data use; no effort was made to modify the observed data to account for these hydrologic effects. However, it is not expected that these water regulation facilities would have a meaningful impact on the results of this analysis.

The following three sections of the "strawman" contain specific data to each application basin. Figure 3.1.1 shows where all the gauges used provide elevation coverage in reference to the application basin. The first table in each subbasin description contains a list of gauges used for gauge proration hydrology in that subbasin. The final table in each subbasin description shows gauge data availability from USGS, where white is unavailable, light gray is available but not used, and dark gray means it is being used in the subbasin gauge proration calculation. Some gauged data went unused when better gauged data (closer, more similar in elevation range) were available.

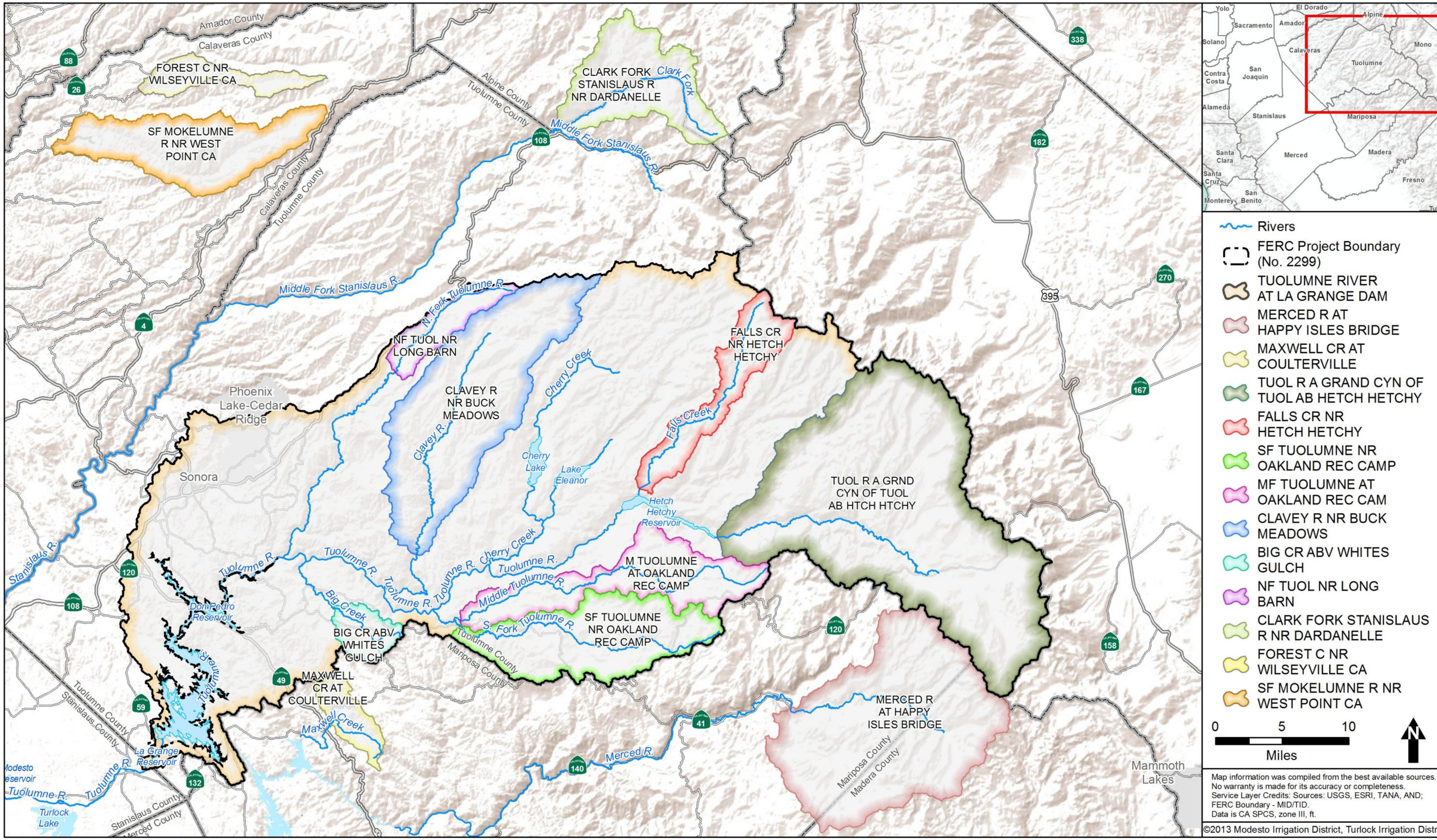

Figure 3.1.1 Map of gauges used in proration method for unimpaired hydrology

3.1.1 Hetchy Hetchy Subbasin

Table 3.1.1 Gauges used for gauge proration of Hetch Hetchy subbasin

11292500	CLARK FORK STANISLAUS R NR DARDANELLE CA
11274790	TUOLUMNE R A GRAND CYN OF TUOLUMNE AB HETCH HETCHY
11264500	MERCED R A HAPPY ISLES BRIDGE NR YOSEMITE CA
11275000	FALLS C NR HETCH HETCHY
11282000	M TUOLUMNE R A OAKLAND RECREATION CAMP CA

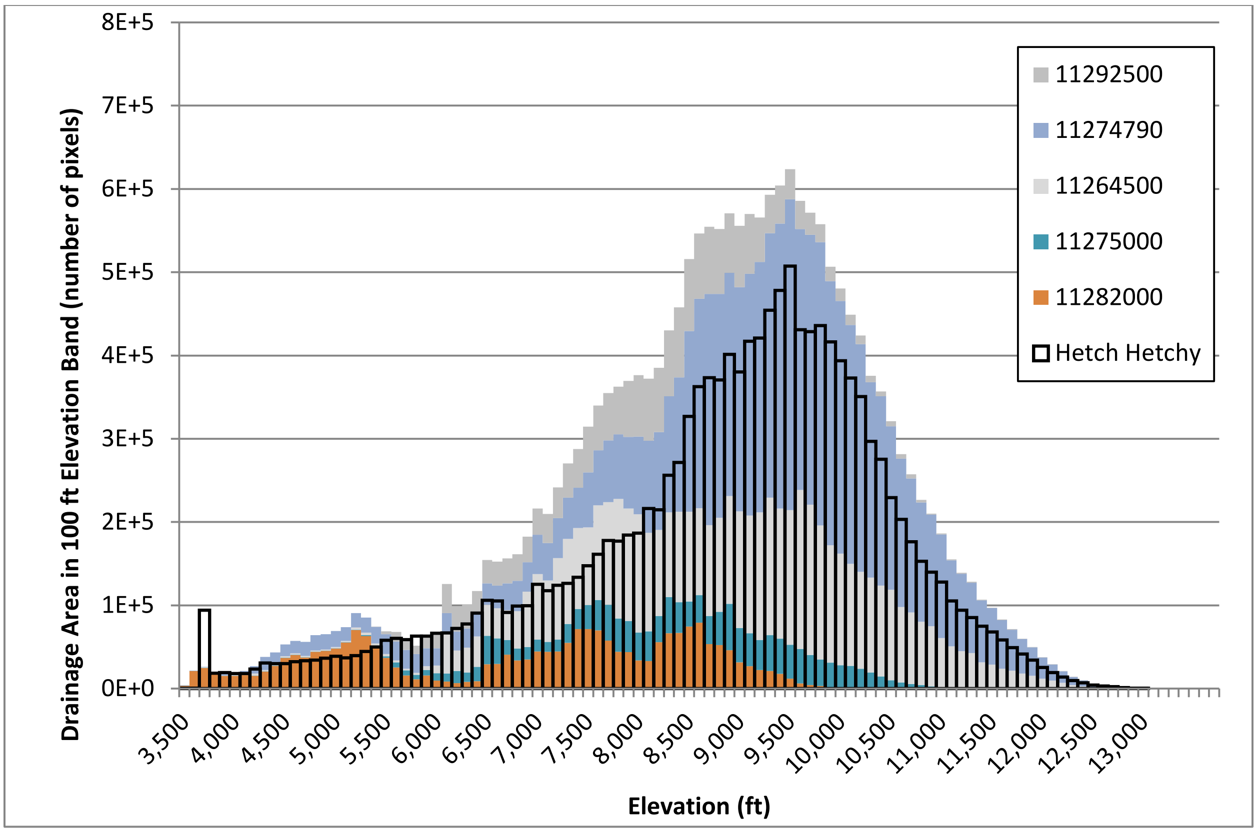

Figure 3.1.2 Elevation histograms for unimpaired gauges, compared to the Hetch Hetchy subbasin

Table 3.1.2 Gauge inventory for gauge proration of Cherry/Eleanor subbasin

WY	11292500	11274790	11264500	11275000	11282000
1971					
1972					
1973					
1974					
1975					
1976					
1977					
1978					

WY	11292500	11274790	11264500	11275000	11282000
1979					
1980					
1981					
1982					
1983					
1984					
1985					
1986					
1987					
1988					
1989					
1990					
1991					
1992					
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2003					
2004					
2005					
2006					
2007					
2008					
2009					
2010					
2011					
2012					

3.1.2 Cherry/Eleanor Subbasin

Table 3.1.3 Gauges used for gauge proration of Cherry/Eleanor subbasin

11292500	CLARK FORK STANISLAUS R NR DARDANELLE CA
11274790	TUOLUMNE R A GRAND CYN OF TUOLUMNE AB HETCH HETCHY

11264500	MERCED R A HAPPY ISLES BRIDGE NR YOSEMITE CA
11283500	CLAVEY R NR BUCK MEADOWS CA
11275000	FALLS C NR HETCH HETCHY
11282000	M TUOLUMNE R A OAKLAND RECREATION CAMP CA
11284700	NF TUOLUMNE R NR LONG BARN CA
11281000	SF TUOLUMNE R NR OAKLAND RECREATION CAMP CA

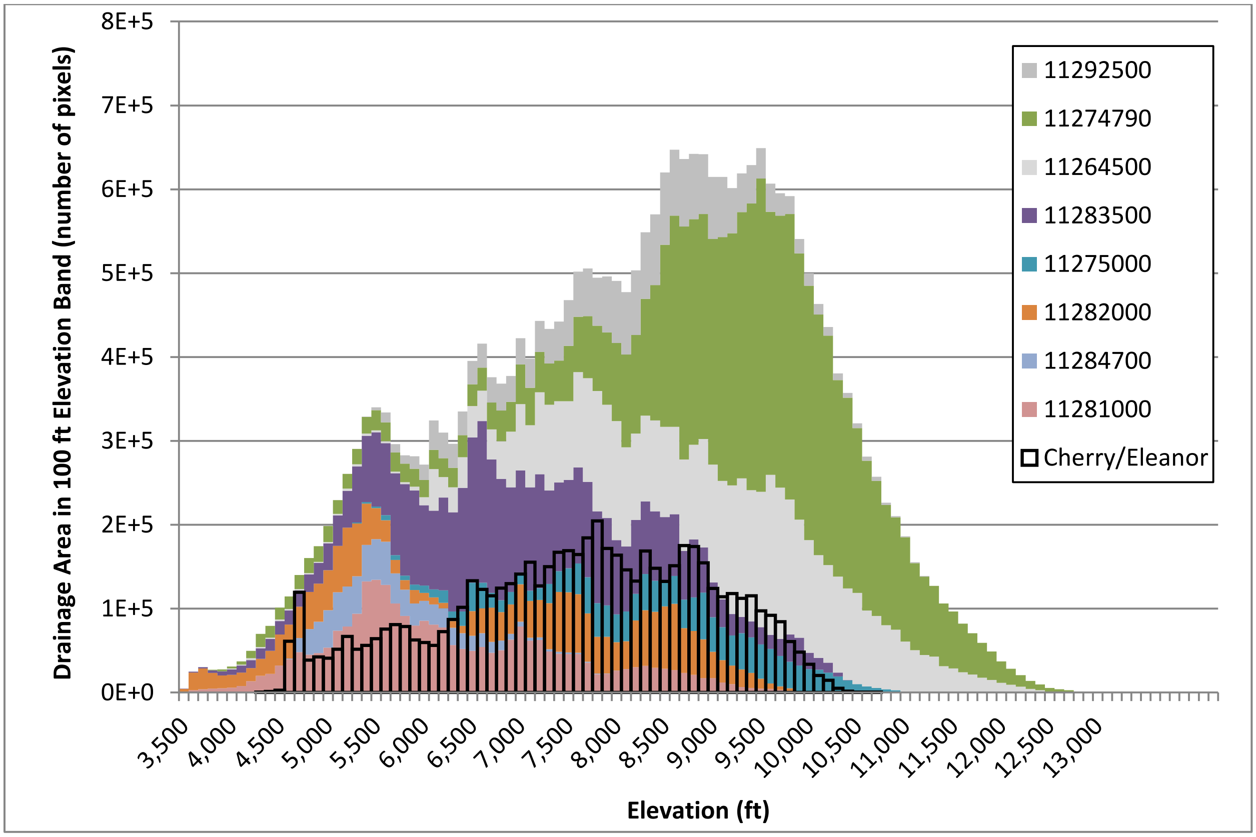

Figure 3.1.3 Elevation histograms for unimpaired gauges, compared to the Cherry/Eleanor subbasin

Table 3.1.4 Gauge inventory for gauge proration of Cherry/Eleanor subbasin

WY	11292500	11274790	11264500	11283500	11275000	11282000	11284700	11281000
1971								
1972								
1973								
1974								
1975								
1976								
1977								
1978								
1979								
1980								

WY	11292500	11274790	11264500	11283500	11275000	11282000	11284700	11281000
1981								
1982								
1983								
1984								
1985								
1986								
1987								
1988								
1989								
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2008								
2009								
2010								
2011								
2012								

3.1.3 Unregulated Subbasin

Table 3.1.5 Gauges used for gauge proration of Unregulated subbasin

11**3185**00	SF MOKELUMNE R NR WEST POINT CA
11**2693**00	MAXWELL C A COULTERVILLE CA
11**3168**00	FOREST C NR WILSEYVILLE CA
11**2844**00	BIG CR ABV WHITES GULCH

11283500	CLAVEY R NR BUCK MEADOWS CA
11264500	MERCED R A HAPPY ISLES BRIDGE NR YOSEMITE CA
11282000	M TUOLUMNE R A OAKLAND RECREATION CAMP CA
11284700	NF TUOLUMNE R NR LONG BARN CA
11281000	SF TUOLUMNE R NR OAKLAND RECREATION CAMP CA

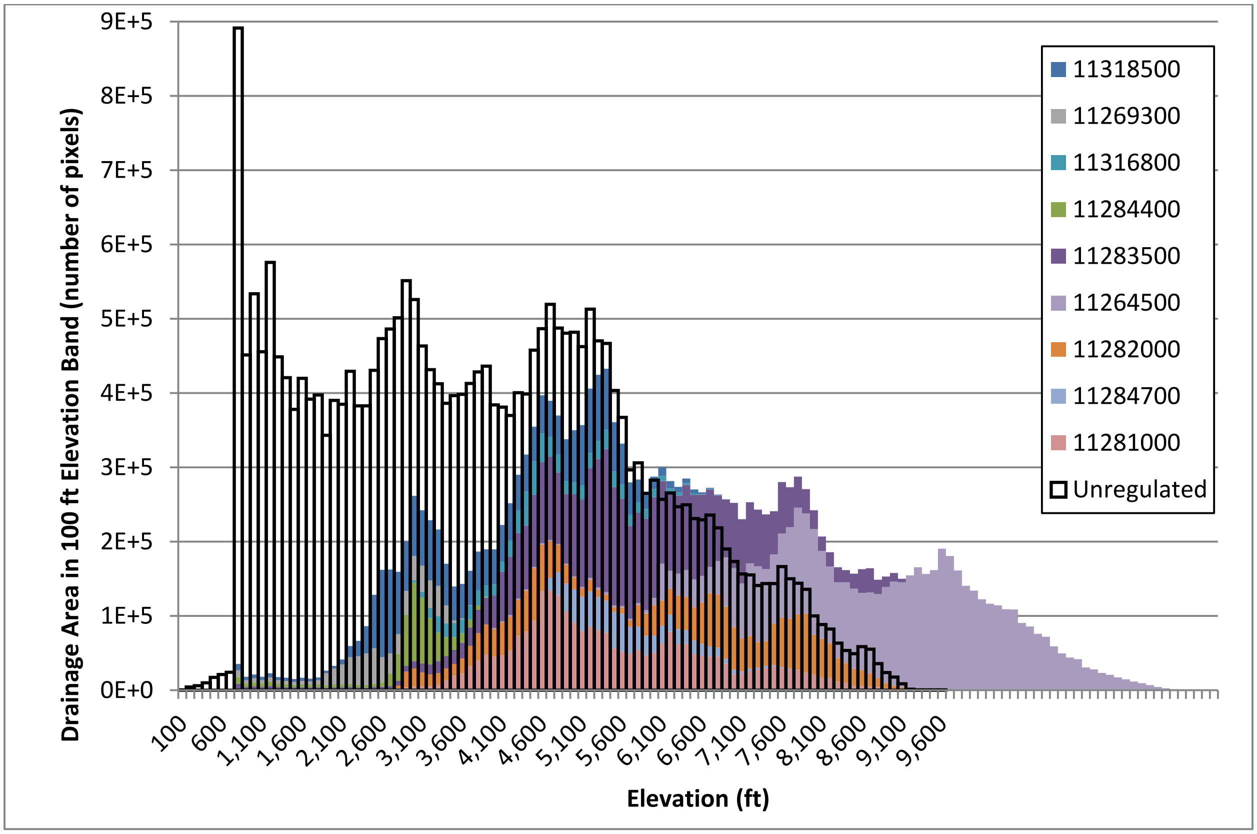

Figure 3.1.4 Elevation histograms for unimpaired gauges, compared to the Unregulated subbasin

Table 3.1.6 Gauge inventory for gauge proration of Unregulated subbasin

WY	3185	2693	3168	2844	2835	2645	2820	2847	2810
1971									
1972									
1973									
1974									
1975									
1976									
1977									
1978									
1979									
1980									
1981									

WY	3185	2693	3168	2844	2835	2645	2820	2847	2810
1982									
1983									
1984									
1985									
1986									
1987									
1988									
1989									
1990									
1991									
1992									
1993									
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2006									
2007									
2008									
2009									
2010									
2011									
2012									

3.2 Monthly Volume

In order to scale the gauge proration hydrology to the observed historical monthly volumes, some adjustments had to be made to deal with months where the total monthly volume was calculated negative. Negative monthly volumes in the current Tuolumne record are an artifact of gauge summation calculations involving numerous flow and reservoir level gauges, each with small errors. These calculations are described in detail in Attachment A of the ISR of W&AR-2. Negative monthly volumes occur during certain low flow periods (August-January) of Cherry/Eleanor, Hetch Hetchy, and unregulated inflow to Don Pedro. In total, adjustments were needed in 39 of the 504 months of the extended period of record (WY 1971 – WY 2012). This resulted in small changes to the annual volume from contributing subbasins for 22 of the 42 water years.

In order to eliminate negative monthly volumes without disturbing the gauge summation record, each of the upper subbasins (Cherry/Eleanor and Hetch Hetchy) were re-balanced with the Unregulated subbasin so that the monthly unimpaired volume at La Grange remains the same. Rather than transferring just enough volume to 'zero' out the negative month, an attempt was made to use the gauge proration record to find a reasonable value for the month being adjusted.

In the gauge proration hydrology record, typically the gauges being used don't change during a water year due to the way USGS reports data. Monthly volumes were examined as a percentage of the total water year volume for both the gauge summation, and gauge proration data. The monthly percentage of the annual volume was used as a guide to form an 'expected' monthly volume.

When the Unregulated subbasin had a negative month, Cherry/Eleanor and/or Hetch Hetchy volumes for that month were examined for closeness to their 'expected' amount. In many cases, the Cherry/Eleanor subbasin was far wetter than 'expected' and an adjustment down fixed a large portion of the imbalance. In most cases, a blend of both Hetch Hetchy, and Cherry/Eleanor volumes were used to offset a negative volume in the Unregulated subbasin. The exact percentage from each subbasin varies depending on how the adjustment affected each subbasin.

When Cherry/Eleanor or Hetch Hetchy subbasins had a negative month, an 'expected' value was used as a guide for the offset volume. All of the re-balancing volume came from the Unregulated subbasin. In most cases, this volume had to be further adjusted manually in order to keep normal volumes in the Unregulated subbasin. Table 3.2.1 shows these adjustments.

The only "*new water*" adjustment comes in October 2002, where 2000 AF was added to the La Grange gauge. This was the minimum volume that could be used to produce a positive 'expected normal' month in the Unregulated subbasin (and Cherry/Eleanor subbasin). All of the adjustments made to the Unregulated subbasin balance to a net of 2000 acre feet. In other words, for the period of record, CCSF/Districts have the same amount of water flowing into the watersheds. The 2000 AF addition to La Grange goes exclusively to the Unregulated subbasin.

Table 3.2.1 Adjustments to unregulated inflow volume to Don Pedro, in AF. Red indicates water going from the Unregulated subbasin to Cherry/Eleanor, orange to Hetch Hetchy, and green indicates water going from a combination of Cherry/Eleanor and Hetch Hetchy to the Unregulated subbasin.

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1971	-1,633										-3,369	-2,260
1972	-4,146										-3,024	-1,515
1973											-3,271	-4,695
1974												-4,741
1975	-3,518											
1976				8,000								

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1977			-1,041								-1,359	7,287
1978	-1,545											
1981	-6,652											
1987				4,400								-400
1988												-800
1989										6,600	4,500	
1990										3,088	3,600	2,800
1991	1,700		-1,500									
1994				-7,923							-7,500	-981
1995	6,143											
1996	2,400	-200										
2000	-1,527											
2003	**4,400**											
2004	1,945	5,037										
2007												4,200
2012												-500

Monthly scaling factors were used to scale the gauge proration hydrology up or down to the adjusted historical monthly volume. The monthly scaling factor is defined as the adjusted historical monthly volume divided by the gauge proration monthly volume. A scaling factor of less than one means the gauge proration overestimated the historical flow. A scaling factor of greater than one means the gauge proration underestimated the historical flow. When multiplied by the scaling factor, the daily gauge proration flow values will result in adjusted historical monthly volumes. The following three sections show computed scaling factors used for each subbasin, with red to orange indicating a reduction in gauge proration flow, and yellow to green representing an increase in gauge proration flow.

3.2.1 Hetchy Hetchy Subbasin

Table 3.2.2 Hetch Hetchy monthly scaling factors for gauge proration. Bold indicates reduced volume and italics indicates increased volume.

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1971	0.11	1.08	1.15	1.00	0.84	0.87	0.82	0.91	0.95	0.79	0.60	0.57
1972	0.48	0.75	1.04	0.98	0.96	0.82	0.81	0.89	0.84	0.56	0.32	0.27
1973	0.54	0.73	0.90	1.00	1.06	1.01	0.80	0.84	0.88	0.64	0.41	0.02
1974	0.32	0.87	1.02	0.94	0.72	0.88	0.79	0.83	0.87	0.85	0.57	0.07
1975	0.12	0.11	0.96	0.93	1.21	1.23	1.00	0.81	0.86	0.84	0.49	0.36
1976	0.81	0.87	0.74	*0.05*	0.98	0.94	0.83	0.93	0.82	0.71	0.70	0.44
1977	0.81	0.68	0.57	0.52	0.69	0.96	0.89	1.01	1.10	1.12	1.04	*0.97*
1978	0.52	0.96	1.25	1.67	1.67	1.15	0.91	0.79	0.88	1.03	0.73	0.64
1979	0.57	0.73	0.84	1.04	1.19	1.09	0.86	0.89	0.86	0.76	0.45	0.09
1980	0.82	0.92	0.83	1.03	0.98	0.93	0.80	0.80	1.00	1.18	0.84	0.36

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1981	0.16	0.26	0.59	0.64	0.95	1.08	0.84	0.94	0.90	0.53	0.41	0.28
1982	0.91	1.09	1.03	1.09	0.94	0.78	0.74	0.81	0.89	0.87	0.86	0.91
1983	0.90	1.06	1.10	1.00	1.05	1.11	0.80	0.77	0.86	0.88	0.93	0.74
1984	0.95	1.80	1.45	0.96	1.06	1.17	1.22	1.58	1.76	1.24	0.79	0.60
1985	0.97	1.83	1.50	1.15	1.36	1.61	1.42	1.65	1.69	0.89	0.54	0.92
1986	1.55	1.63	2.13	1.90	1.57	1.19	1.27	1.45	1.62	1.56	1.01	0.57
1987	1.31	0.70	0.62	*0.50*	1.83	1.87	1.47	1.57	1.34	0.71	0.30	**0.15**
1988	0.56	1.10	1.77	2.03	1.43	1.40	1.55	1.59	1.40	0.80	0.55	0.57
1989	0.15	0.63	1.35	2.10	2.52	2.00	1.40	1.67	1.69	*1.07*	*0.22*	0.58
1990	1.34	1.41	1.50	2.03	2.14	1.81	1.58	1.61	1.50	*0.76*	*0.39*	*0.12*
1991	*0.20*	0.66	0.53	0.50	1.15	2.66	1.62	1.49	1.53	1.16	0.84	0.50
1992	1.18	1.39	1.35	1.44	2.02	1.70	1.39	1.37	1.00	1.02	0.74	0.61
1993	1.17	0.91	1.55	2.03	1.82	1.39	1.19	1.25	1.33	1.30	0.93	0.47
1994	0.88	0.56	1.28	**0.62**	1.84	2.08	1.64	1.70	1.64	0.62	**2.06**	**0.61**
1995	*0.60*	2.05	1.95	2.36	1.86	1.46	1.23	1.19	1.35	1.43	1.48	1.14
1996	*0.39*	0.95	1.91	1.74	1.78	1.34	1.30	1.47	1.84	1.70	1.05	1.01
1997	1.34	1.40	1.76	1.32	1.00	1.03	1.03	1.20	1.48	1.14	0.87	0.71
1998	1.03	1.17	1.96	2.49	1.72	1.58	1.19	1.23	1.34	1.35	0.87	0.77
1999	1.23	1.82	1.86	2.05	1.79	1.51	1.31	1.55	2.06	1.94	1.13	1.05
2000	1.54	1.61	1.26	2.42	1.98	1.54	1.45	1.49	1.50	1.17	1.11	0.92
2001	1.35	1.39	2.19	1.94	2.12	1.83	1.55	1.42	1.17	1.01	1.14	1.38
2002	2.46	1.71	2.09	1.81	1.67	1.51	1.40	1.57	1.61	1.13	1.22	2.06
2003	*0.84*	1.32	1.91	1.43	1.01	1.08	1.20	1.12	1.03	0.74	0.84	0.43
2004	*1.27*	*1.26*	1.90	0.89	0.95	1.20	1.22	1.40	1.33	0.88	0.96	1.55
2005	1.91	1.22	1.46	1.74	1.49	1.39	1.03	0.95	0.92	0.78	0.52	0.60
2006	0.88	1.09	2.14	1.23	1.24	1.14	1.06	0.99	1.10	0.88	0.56	0.27
2007	0.52	1.22	1.62	1.44	1.79	1.43	1.31	1.43	1.16	0.74	0.83	*0.16*
2008	1.28	1.32	1.90	1.52	1.58	1.36	1.26	1.36	1.32	0.83	0.48	0.77
2009	1.67	1.28	1.27	1.60	1.48	1.46	1.24	1.47	1.48	1.00	0.85	0.83
2010	1.31	1.03	1.52	1.56	1.57	1.52	1.49	1.36	1.31	1.06	0.75	1.06
2011	1.67	1.32	1.92	1.42	1.49	1.88	1.38	1.32	1.41	1.42	1.19	0.95
2012	1.02	0.92	0.58	1.38	1.18	1.30	1.32	1.28	1.07	0.69	0.58	0.61

3.2.2 Cherry/Eleanor Subbasin

Table 3.2.3 Cherry/Eleanor monthly scaling factors for gauge proration. Bold indicates reduced volume and italics indicates increased volume.

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1971	**0.52**	2.91	2.04	1.66	1.42	1.46	1.37	1.47	1.37	1.00	**0.52**	**0.52**
1972	**0.53**	2.46	1.63	1.44	1.47	1.64	1.54	1.52	1.41	0.17	**0.53**	**0.52**
1973	0.67	1.80	2.11	1.48	1.15	1.19	1.43	1.45	1.30	0.44	**0.49**	**0.49**
1974	0.83	2.76	1.62	1.44	1.07	1.36	1.29	1.43	1.28	1.09	0.14	**0.52**
1975	**0.48**	0.23	1.52	1.75	1.37	1.38	1.39	1.46	1.28	1.16	0.42	0.39
1976	2.52	1.61	1.28	*0.09*	1.83	1.89	1.90	1.62	0.81	0.24	2.14	1.63
1977	1.65	0.82	**0.71**	1.57	2.40	2.38	2.16	2.25	1.48	0.14	**0.72**	*1.80*
1978	**0.54**	2.54	3.55	2.05	1.32	1.40	1.25	1.49	1.39	1.30	0.78	2.27

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1979	0.05	1.27	1.78	2.10	1.62	1.41	1.51	1.44	1.28	0.99	1.15	1.62
1980	2.78	3.02	2.55	1.75	1.09	1.08	1.42	1.34	1.76	2.02	1.06	0.76
1981	**0.62**	0.44	1.61	1.65	2.28	1.85	1.98	1.66	1.36	1.27	3.38	2.36
1982	2.76	3.23	1.83	1.13	1.22	1.33	1.16	1.19	1.21	1.09	0.58	1.75
1983	2.39	1.52	1.03	0.96	0.91	0.84	0.99	1.27	1.27	1.32	1.21	1.07
1984	1.49	4.50	2.33	1.39	1.55	2.26	1.95	2.12	1.80	0.97	0.09	0.17
1985	2.47	5.03	3.28	2.01	2.66	3.12	2.95	2.43	1.91	0.81	0.92	1.16
1986	4.32	4.31	5.71	5.17	2.54	2.11	2.15	2.19	2.14	1.79	0.82	1.50
1987	1.38	0.71	0.98	*0.67*	3.76	3.25	3.89	2.65	1.66	0.36	0.76	0.63
1988	2.70	4.08	5.10	1.04	1.69	3.14	3.44	3.05	2.38	1.52	0.08	**0.51**
1989	1.27	4.80	4.05	4.02	3.73	3.25	2.30	2.36	2.02	*0.52*	*0.09*	3.64
1990	6.66	3.93	2.43	3.50	3.47	3.25	3.14	2.80	2.15	*0.80*	*0.17*	*0.32*
1991	*0.47*	0.67	**0.92**	1.02	2.53	5.29	3.43	3.01	2.68	2.25	0.84	0.24
1992	1.65	4.19	1.95	2.56	3.24	2.95	3.10	2.42	1.43	4.22	1.36	0.11
1993	3.35	3.58	3.09	2.44	1.74	2.08	2.02	2.11	2.20	2.36	1.09	0.40
1994	1.37	0.63	2.69	2.39	3.39	3.75	3.71	3.01	1.98	0.70	0.03	0.05
1995	*1.79*	11.40	4.67	1.83	2.07	1.28	1.80	1.96	2.01	1.64	1.38	0.35
1996	*0.37*	**0.003**	6.32	3.28	3.37	2.11	2.13	2.20	1.76	1.19	0.74	0.33
1997	2.40	3.24	5.53	2.56	1.70	2.05	1.69	1.14	1.06	0.52	0.24	1.27
1998	2.36	3.49	4.36	3.74	1.70	2.51	2.09	1.97	1.93	1.69	0.83	0.82
1999	1.13	5.78	3.78	3.34	2.36	2.49	2.28	2.25	2.27	1.52	0.30	0.04
2000	**0.90**	3.37	1.47	5.53	2.69	2.63	2.63	2.19	1.72	0.86	0.72	1.57
2001	3.18	4.09	5.20	5.25	5.16	4.28	2.84	1.78	0.92	1.02	3.35	3.66
2002	2.25	7.05	5.22	4.21	3.31	3.52	2.43	2.08	1.55	0.35	2.15	2.22
2003	*1.43*	4.70	6.20	4.35	2.99	3.03	2.24	1.42	0.99	0.63	1.18	2.60
2004	*1.63*	*3.32*	7.47	4.33	4.91	2.32	1.87	1.44	0.89	0.48	0.58	0.15
2005	7.77	4.56	5.68	4.44	3.54	2.79	1.99	1.64	1.21	0.85	0.27	0.84
2006	3.79	3.65	7.66	3.42	4.13	3.37	2.51	1.15	0.96	0.71	0.50	0.68
2007	2.07	5.46	7.26	6.35	6.84	3.92	2.59	1.74	1.11	1.68	4.46	*2.06*
2008	5.19	0.74	6.16	5.68	3.91	4.03	3.04	1.79	1.14	0.54	0.70	0.32
2009	2.78	4.80	3.51	5.02	4.01	3.55	2.93	2.61	2.19	1.08	1.02	1.47
2010	4.95	1.72	4.10	3.90	2.81	3.22	2.45	2.22	2.09	1.61	0.80	0.84
2011	4.61	4.01	3.06	2.60	2.86	2.26	2.46	2.51	1.78	1.66	1.71	1.71
2012	2.59	2.11	0.89	5.82	3.82	4.49	3.07	1.70	1.21	0.62	0.45	**0.48**

3.2.3 Unregulated Subbasin

Table 3.2.4 Unregulated subbasin scaling factors for gauge proration. Bold indicates reduced volume and italics indicates increased volume.

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1971	*2.11*	1.73	1.42	1.31	1.01	0.92	0.84	0.85	0.93	1.38	*1.51*	*1.48*
1972	*0.59*	1.24	1.20	1.66	1.19	0.87	0.83	0.88	1.15	2.63	*3.78*	*2.21*
1973	1.18	1.98	1.45	1.27	1.43	1.27	0.84	0.78	1.15	1.89	*1.99*	*1.52*
1974	1.98	1.00	1.23	1.04	0.94	0.92	0.92	0.86	1.14	1.55	2.03	*2.77*
1975	*2.45*	1.39	1.24	1.33	1.60	1.30	1.07	0.70	0.81	0.88	1.73	1.77
1976	1.22	1.45	1.47	**0.81**	1.18	1.13	1.01	0.94	1.35	3.25	3.13	2.87

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1977	1.47	1.62	0.39	1.45	1.14	0.95	0.86	0.96	1.03	0.40	*2.77*	**1.02**
1978	*0.61*	1.52	1.44	1.25	1.22	1.05	0.97	0.93	0.92	1.08	2.62	2.40
1979	1.22	2.85	1.45	1.46	1.50	1.17	0.83	0.79	0.96	1.60	1.52	1.79
1980	1.57	0.96	1.05	0.99	1.03	1.00	0.85	0.92	0.79	0.91	1.96	2.79
1981	*1.48*	0.90	1.56	1.76	0.93	1.40	0.83	0.89	1.40	2.88	8.09	3.69
1982	2.04	1.17	1.10	1.41	0.93	1.37	0.92	0.90	1.25	2.07	1.72	2.08
1983	1.09	1.16	1.01	1.22	1.13	1.05	0.97	0.79	0.75	0.90	0.92	1.12
1984	1.64	1.45	1.21	1.25	1.43	1.23	1.08	0.81	0.90	0.57	0.86	0.52
1985	1.22	1.49	1.15	1.06	1.40	1.62	1.07	0.81	0.73	1.25	3.49	2.36
1986	1.50	1.70	1.33	1.21	1.09	1.25	1.01	0.77	0.53	1.22	1.38	1.97
1987	1.19	0.65	0.77	**0.37**	1.12	1.30	0.73	0.81	1.64	1.87	3.59	*0.66*
1988	1.82	1.42	2.59	2.63	1.86	1.14	0.88	0.85	1.07	3.63	3.11	*0.41*
1989	0.56	2.05	1.65	1.45	1.16	0.94	0.78	0.77	0.94	**0.71**	**0.86**	*0.64*
1990	0.86	0.33	0.54	0.98	1.69	0.98	0.83	0.76	0.90	**0.89**	**0.59**	**0.72**
1991	**0.14**	3.34	*0.86*	1.39	1.18	1.59	0.98	0.94	1.00	3.28	6.76	5.02
1992	3.34	0.77	1.04	1.51	1.32	1.00	0.88	1.08	1.72	1.88	4.97	3.45
1993	2.13	0.40	1.49	1.50	1.31	0.94	0.76	0.76	0.89	1.54	2.77	2.74
1994	1.45	0.81	0.89	*1.48*	1.61	0.91	0.94	0.96	1.77	7.56	*9.85*	*7.59*
1995	**0.40**	1.06	1.77	1.28	0.96	1.10	0.95	0.89	0.92	0.94	0.85	0.70
1996	**0.12**	*0.00*	1.17	1.49	1.30	1.27	1.00	0.96	0.82	0.67	0.94	1.80
1997	0.90	1.44	1.44	1.22	1.04	1.41	1.07	0.74	0.25	0.77	1.77	1.18
1998	0.51	1.01	1.11	1.86	1.47	1.35	1.25	1.07	1.03	0.93	0.72	0.64
1999	0.39	1.00	1.13	1.31	1.17	1.09	1.11	0.97	1.02	1.25	1.65	2.27
2000	*0.86*	0.84	0.81	1.25	1.47	1.51	1.16	0.96	1.04	1.04	1.62	1.34
2001	1.23	0.54	0.85	1.22	1.46	1.33	1.11	0.86	0.85	1.51	2.39	2.60
2002	2.83	1.25	1.49	1.31	1.14	1.20	1.10	0.88	0.78	1.50	2.97	2.05
2003	**0.16**	1.16	1.51	0.94	0.93	1.19	0.92	0.76	0.56	0.66	1.75	1.75
2004	**0.28**	**0.91**	1.02	1.11	1.32	0.86	0.88	0.58	0.27	0.36	2.62	1.54
2005	2.52	0.52	1.14	1.61	1.43	1.25	1.10	1.09	0.99	0.84	1.36	2.22
2006	0.67	0.61	1.08	1.09	0.91	1.20	1.12	1.08	0.46	0.25	0.48	0.97
2007	0.92	0.57	0.68	0.18	1.19	0.79	0.82	0.47	0.42	0.68	0.75	**0.55**
2008	0.92	0.33	1.52	1.86	1.62	1.18	0.85	0.74	0.37	0.52	3.70	2.44
2009	0.24	0.88	0.81	1.74	1.20	0.99	0.83	0.80	0.55	1.00	2.01	1.73
2010	0.99	0.07	1.23	1.39	1.35	1.19	0.79	0.69	0.67	0.42	0.38	1.13
2011	1.01	1.28	1.32	1.25	1.20	1.27	1.03	0.76	0.82	0.69	0.96	1.00
2012	0.64	0.65	0.26	0.84	0.79	1.31	0.94	0.59	0.92	1.65	2.01	*2.14*

3.3 Smoothing Between Scaling Factors

It can be seen in the record of scaling factors that most of the period of record contains gradually changing scaling factors each month. In several cases there are some abrupt changes, which have the potential to artificially shape the gauge proration. This is particularly the case during snowmelt recession, when a large factor in June might drop to a very small factor in July. This would make the hydrograph appear to drop quite rapidly to the baseflow rate, instead of the expected gradual recessional limb of a hydrograph.

In order to alleviate this problem, caused by the boundaries between monthly scaling factors, a smoothing technique was used to gradually shift between scaling factors over the course of two weeks (one week in each month). Any monthly volumetric changes resulting from this smoothing were applied as a multiplier adjustment to the middle two weeks of the month. In most months, where scaling factors do not change significantly, these adjustments do not change the hydrograph in any noticeable way.

The function used to smooth between scaling factors was a cumulative normal distribution with a standard deviation of 1.80. In several cases, in order to maintain the monthly volume, the standard deviation had to be decreased in order to provide a more abrupt transition. An example of typical daily scaling factors can be seen in Figure 3.3.1.

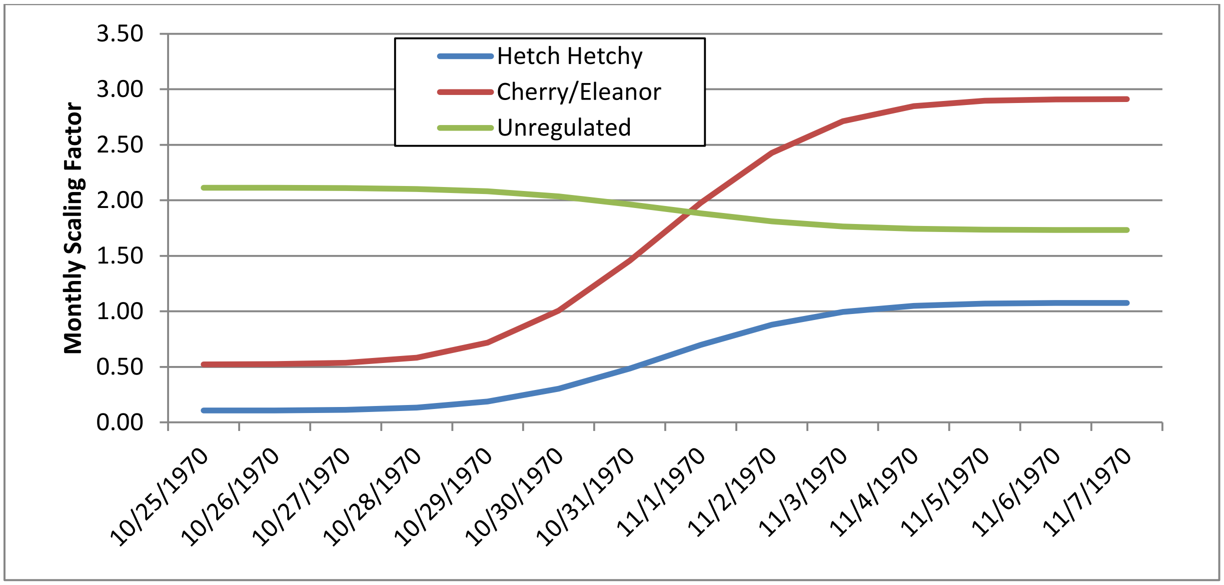

Figure 3.3.1 Typical daily scaling factor smoothing

4.0 Results

The resulting “strawman” can be seen in the attached HEC-DSS database.

5.0 Discussion

In water year 1997, and water years 2003-2008 there are only four unimpaired gauges representing the Unregulated subbasin. Two of those gauges are in the Mokelumne River basin, one in the Merced River basin, and the smallest one is in the Tuolumne River basin. Together, these four gauges provide a poor representation of the Unregulated subbasin, and combined have a drainage area equal to less than 27% of the Unregulated subbasin (Figure 5.1). This period is the poorest representation of any of the application areas for the period of record. Despite the poor match in drainage size, elevation range, and even overall geography, the gauge proration provides a reasonable looking daily hydrograph when scaled to the historical monthly volumes (Figure 5.2).

In the Operations Model, the function of the model is to allow comparisons to be made of different scenarios. Absolute accuracy is not the goal. Relative differences between modeling scenarios is a powerful decision making tool. While statistically accurate daily values may not be achieved using the gauge proration methods described herein, they do create a dataset that:

- Describes general hydrograph shape, variability, and magnitude of peak flows
- Maintains the historical monthly volumes
- Provides a reasonable depiction of daily flow conditions over the period of record

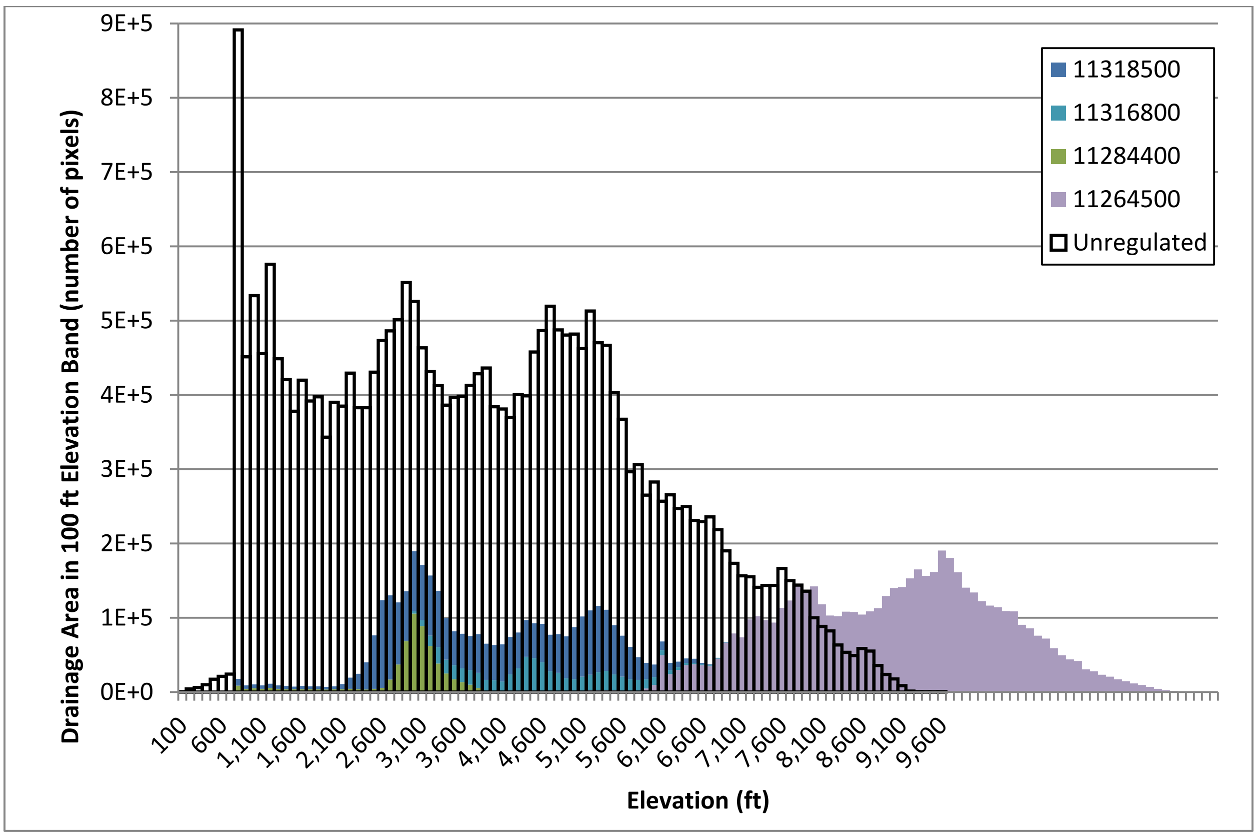

Figure 5.1 Elevation histogram for Unregulated subbasin gauge proration (WY 97, 02-08)

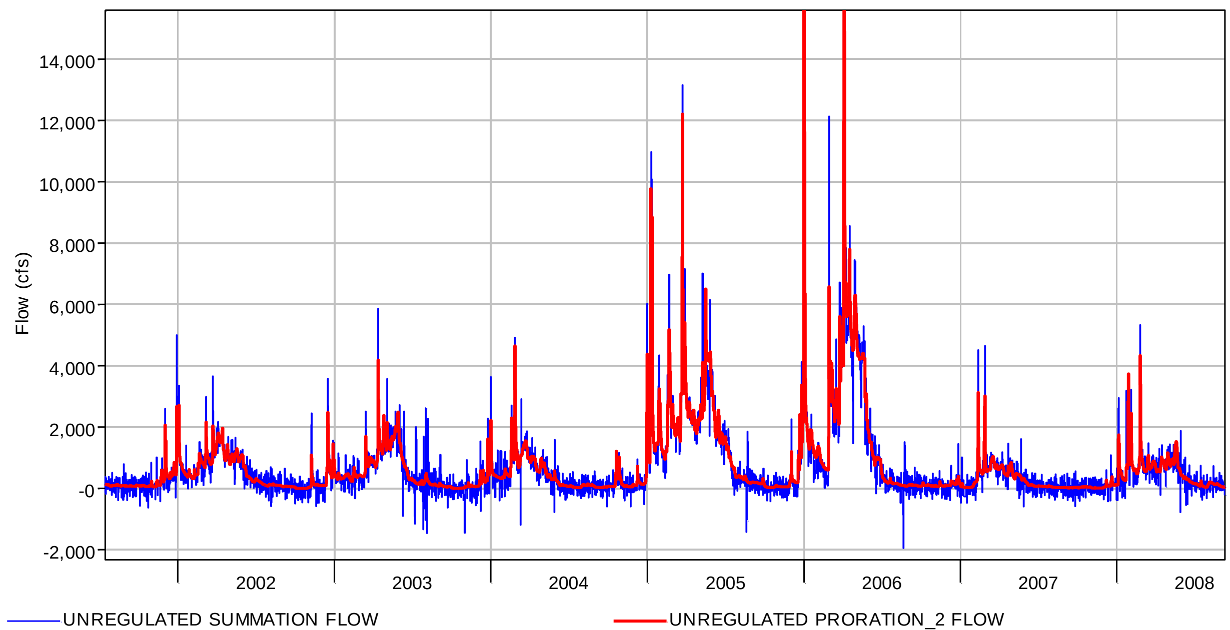

Figure 5.2 Hydrograph comparison gauge summation (W&AR-02) and gauge proration

References

Study Report W&AR-02. Project Operations/Water Balance Model. Attachment A. Tuolumne River Daily Operations Model

PRISM Climate Group, 2006, *United States Average Monthly or Annual Precipitation 1971 – 2000*, <http://prism.oregonstate.edu>, Oregon State University, Created 12 Jun 2006.

United States Geologic Survey (USGS), 2009, *1/3 Arc Second National Elevation Dataset*, <http://seamless.usgs.gov>, USGS Earth Resources Observation & Science (EROS) Center, Sioux Falls, SD, Created 23 March 2009.

INSTRUCTIONS FOR DOWNLOADING AND VIEWING .DSS FILE

The DSS database contains all of the intermediate steps to develop the strawman:

- Gage proration hydrology (not scaled)
- Gage proration hydrology (scaled to monthly volumes)
- Gage proration hydrology (scaled with smoothed factors)
- Gage summation hydrology (original, not smoothed)

You can download the .dss file referenced above via the www.donpedro-relicensing website (CALENDAR Tab / Go to the March Calendar and click on the Workshop notice on the March 27, 2013 date to see the attachments, which include the .dss file).

In order to view the .dss file, you will need to have HEC-DSSVue installed. If you do not have this software, you can download it via a link on the www.donpedro-relicensing website (CALENDAR Tab / Go to the March Calendar and click on the Workshop notice on the March 27, 2013 date to see the attachments, which include instructions/link for viewing the .dss file).

ATTACHMENT 3

Final Meeting Notes for October 26, 2012

W&AR-03 and W&AR-16 Consultation Workshop

Attachment 3

Don Pedro Project Relicensing
River & Reservoir Temperature Models Consultation Workshop #2
Don Pedro Relicensing Studies W&AR-3 & W&AR-16
Final Meeting Notes

Friday, October 26, 2012
9:00 a.m. to 4:00 p.m. - MID Offices

Attendees

Art Godwin (TID)
Bill Johnston (MID)
Bill Paris (MID)
Bill Sears (CCSF)
Bob Hughes (CDFG)
Bob Nees (TID)
Carin Loy (HDR)
Greg Dias (MID)
Jenna Borovansky (HDR)
John Devine (HDR)
Mike Maher (SWRCB)
Scott Lowe (HDR)
Steve Boyd (TID)
Zac Jackson (USFWS)

Attended via phone:
Allison Boucher (FOTR)
Chris Shutes (CalSPA)
Ellen Levin (CCSF)
John Wooster (NMFS)
Tim Findley (BAWSCA)

Purpose of Meeting

The Temperature Model Workshop #2 was held on October 26, 2012 to discuss with the Don Pedro Relicensing Participants (RPs) the status of the temperature models being developed for the Don Pedro Reservoir (W&AR-3) and the Lower Tuolumne River (W&AR-16), including:

(1) Review initial calibration and validation results of both the Don Pedro Reservoir 3D temperature model and the Lower Tuolumne River temperature model

(2) Path forward and schedule for model completion

This Workshop follows the protocols of the consultation workshop process; draft meeting notes are provided for a 30-day review following issuance by the Districts.

The Districts reviewed the FERC ILP process schedule as well and alerted RPs to the fact that the ISR meeting will cover two days, January 30, 2013 and January 31, 2013. A detailed schedule will be forthcoming in early December.

Meeting Materials

Materials provided to Relicensing Participants to support the meeting discussion:

- Don Pedro Reservoir Bathymetric Study Report, October 2012. NOTE: Attachments A & B referenced in this report are extremely large files containing plots of bathymetry data. These plots are available upon request to rose.staples@hdrinc.com.
- W&AR-16: Lower Tuolumne River Temperature Model Status Report, September 2012. An 8 MB file, available on the relicensing website (www.donpedro-relicensing.com).
- W&AR-03: Reservoir Temperature Model: Upstream Water Temperature and Meteorological Data Sets for Model Verification, September 2012.
- Study Reports W&AR-3 and W&AR-16 Reservoir Temperature Model and Lower Tuolumne River Temperature Model Water Temperature Data Set October 2012 Update. NOTE: This report contains extremely large files with plots of Tuolumne River stream temperature and Don Pedro Reservoir temperature data and profiles, the raw data used for the plots, and the data collected from the Districts metrological stations, installed in 2010. Available on Compact Disc (CD), upon request rose.staples@hdrinc.com.

Meeting Summary

The Districts distributed the meeting agenda on October 18, 2012 via email and it was reviewed prior to starting the presentation and discussions. The only suggested change in the agenda was the addition of a discussion of the integration between the operations model and the temperature model.

Don Pedro Reservoir Temperature Model (W&AR-3)

The following topics were covered in the meeting:
- Study Plan Overview
- Reservoir Bathymetry Study
- Model Design and Calculations
- Data Sources and Collection: Meteorology; Inflow Temperatures; Reservoir Profiles
- Calibration
- Validation

Study Plan Overview
The study plan (W&AR-3) specifies the model platform and data acquisition requirements for the Reservoir Temperature Model. DHI's MIKEFM 3D Model is the platform. Data compiled and collected to support the model's development include reservoir bathymetry, reservoir temperature profiles, and local meteorological data.

Reservoir Bathymetry Study (Report distributed)
The bathymetry study plan was part of reservoir model study plan. The Districts collected the bathymetry data in 2011. The effort consisted of joining two surfaces: one measured when the reservoir elevation was 792 feet, the other purchased IFSAR data, acquired (flown) when the reservoir elevation was 760 feet. The overlap between the two surfaces contributes to the bathymetric surface's precision.

The 2011 bathymetric surface was compared to the New Don Pedro Reservoir area-capacity curve (pre-1972). Research by TID indicates that the new Don Pedro Reservoir elevation-storage data incorporated the original elevation-storage data for the Old Don Pedro Reservoir. The two volumes were found to be within 1% of each other at elevation 830 ft and a very close match was found at all of the elevation intervals.

Model Design, Computations, and User Interface

MIKE3 is a three dimensional, time variable hydrodynamic model. The temperature structure of the reservoir was described and the items that can be varied in the model were discussed. Specific discussions included flooding and drying (how the model mesh can adapt to changes in reservoir elevation) and heat balance equations, including, air temperature, humidity, short and long wave radiation.

> Comment: Bob Hughes asked if the ground temperatures of reservoir land areas temporarily not inundated were included in the model.
>
> Response: Scott Lowe indicated they were not and that the temperature of the adjacent ground would not be expected to affect reservoir water temperatures.
>
> Comment: Chris Shutes asked about clearness information and time step used for this information. Mr. Shutes recommended that the actual solar data be provided in the report.
>
> Response: Mr. Lowe answered that monthly average cloud cover is used in the model based on local information. Daily information is not available. With respect to solar radiation, the Districts' meteorological station is collecting hourly solar radiation data. The data will be used to confirm/modify the model's internally calculated solar radiation, but solar radiation is not a direct input. However, it will be included in the report.

Data Sources and Data Collection: Meteorology, Inflow Temperatures, Reservoir Profiles

Sources of model input data consist of the following:

- Inflow and outflow – based on Project Operations Model (daily time step)
- Inflow temperature – recorded on the Tuolumne River at Indian Creek Trail and other upstream locations (hourly time step)
- Met data recorded at Don Pedro
  - Air temperature
  - Humidity
  - Wind speed and direction
- Cloud cover – from Modesto
- Reservoir bathymetry collected by CDFG and the Districts

Model Calibration

Data collected in 2011 are being used to calibrate the model. Initial calibration results were presented. Model results were shown with red triangles and observed results were blue circles.

The calibration figures also included two dark horizontal lines: (1) 830 feet, shows the reservoir's normal maximum pool; and (2) 600 feet, indicating the minimum operating pool.

Other elevations of interest include: (1) the power tunnel inlet, 535 feet at central line; (2) the diversion tunnel/outlet works inlet at approximately 350 feet; (3) the Old Don Pedro top of dam at 611 feet; 4) the spillway crest at about 596 feet; 5) the old Don Pedro Dam gates on top to raise to 604 feet. The Old Don Pedro Dam also had lower level outlet works consisting of two sets of six gates, the upper ones at about centerline 512 ft and the lower ones at about centerline of 422 ft. The Districts believe all of these gates are open.

The modelers have encountered a few inconsistencies in the data that they are in the process of evaluating. Examples of these data inconsistencies were discussed. One of the problems is that data sheets from other sources need to be reviewed to confirm the accuracy of the recorded depth measurements. In addition, it appears that some CDFG data collection sites were moved during low water, so the precise latitude and longitude where the profile was collected needs to be confirmed. The modelers are using the bottom elevations from the interpolated bathymetric surface to help check the reliability of some of the input profile data where it appears that the data collection sites were moved.

Model Validation

A detailed write-up on this topic was distributed, entitled *W&AR-03 Reservoir Temperature Model: Upstream Water Temperature and Meteorological Data Sets for Model Verification, September 2012.*

Data collected in 2012 are being used to validate the model. At the time of the run presented at this meeting, data included was only through June 2012 because that was the latest data retrieved. The validation will be completed upon receipt of all data through November 2012. The study plan (W&AR-3) stated that 2008 data would be used for model validation. Use of the 2012 data for model validation will be a variance, but is preferred because of the availability of actual inflow temperature data. The synthesized 2008 data set, however, may still be used as an additional model check if the water levels in 2008 were significantly lower than in 2012.

The Districts' two meteorological stations installed in 2010 were discussed, along with the data available from local stations.

Model Training and Access

A virtual workstation will be created that will allow external users to connect to the MIKE modeling software and run "what-if" scenarios. Access to the workstation will be provided via the existing Project website. Users will be able to use the models provided as a base to perform other simulations and then have the ability to save and/or print the results.

Next Steps

- Modelers are working with CDFG staff to resolve temperature profile data issues
- Once these data issues are resolved, the calibration will be finalized
- Once all data through November 2012 is available, the validation runs will be completed

- Model access for use by RPs will be established by the time of the ISR Meeting in January 2013
- Training will be scheduled for early-2013 (currently scheduled for January 24, 2013 in HDR's Sacramento office)

Action Items:

- Schedule model training for Relicensing Participants. Proposed dates are:
    - January 24, 2013 – River and Reservoir Model Training
    - March 20, 2013 (preliminary) – Operations and Temperature Model integration training

- The study report and graphs will provide intake structure elevations as a reference on temperature plots.

Lower Tuolumne River Temperature Model (W&AR-16)

The following topics were covered in the meeting:

- Study Plan Overview
- Reservoir Bathymetry Study
- Description, Computations, and User Interface
- Data Sources and Collection: Meteorology; Inflow Temperatures; Reservoir Profiles
- Calibration and Validation

Study Plan Overview

The study plan (W&AR-16) specifies the model platform and data acquisition requirements for the Lower Tuolumne River Temperature Model. The river model platform consists of an existing San Joaquin River basin-wide HEC-5Q model that included the lower Tuolumne River. This basin-wide model was initially developed in part under Bay-Delta funding, and was referred to as the SJR5Q model. Under direction of the 2009 FERC Order on Rehearing, this model was recalibrated using the then most-recent river temperature data and used to evaluate river temperature regimes in the lower Tuolumne River. The report was filed with FERC, after opportunity for comment, in March 2011. This report noted the need for further recalibration of the model using new data to be collected at the La Grange Dam location. The Districts prepared a study plan for accomplishing this recalibration (W&AR-16), and FERC approved the study plan with modification in the December 22, 2011 Study Plan Determination. FERC's modifications were (1) make sure the results of the temperature model would be available to the ongoing CALFED modeling efforts; (2) extend the model to the confluence of the Tuolumne River and the San Joaquin River; and (3) ensure data collected and modeling results are sufficient to calculate the 7-day average daily maximum temperature (7DADM) values.

Description, Computations, and User Interface

The original SJR5Q model of the Tuolumne River began above Don Pedro Reservoir and extended to the mouth. This Districts' river temperature model for relicensing purposes starts at the Don Pedro powerhouse. Like the original SJR5Q model, it has a 6-hour time step. The only significant outflows in the lower Tuolumne River are the Districts' diversions at La Grange Dam. The only significant inflow is Dry Creek. Accretions are not included in the model;

however, the Districts are undertaking accretion flow measurements under study W&AR-2 and may input these flows into the model once they are completed (circa February 2013).

Data Sources and Collection: Meteorology, River Temperatures, Other Data

CDFG and the Districts have been monitoring river temperatures in the lower Tuolumne River for as long as two decades at some sites. A list of monitoring sites was provided. The Districts are maintaining two meteorological stations, one near the Don Pedro Reservoir and one near RM 30. Relevant meteorological data is collected at various nearby locations as described in the attachments provided prior to the Workshop.

Model Calibration and Validation

Like the reservoir temperature model, the Districts plan to use 2011 as a calibration year and 2012 as a validation year.

An initial calibration run has been performed using the HEC-5Q model. Modeled vs. measured data are shown from 2011. Modeled data are shown in red and measured data are shown in black. The model calibration was strong with the exception that the diurnal range in temperatures varies considerably from station to station with upstream stations above RM circa 37 showing expected and predicted diurnal ranges, but farther downstream stations displaying unexpected (and not predicted) smaller diurnal ranges. In addition, the downstream stations are not consistent in displaying these more narrow ranges with measuring stations quite close to one another displaying significantly different diurnal ranges.

To better understand why the model predicted greater temperature ranges during theses months and locations, each data collection site has been visited to examine for variations in shade, substrate, flow, District vs CDFG collection, spikes associated with operational spill, and no correlation was found to explain this inconsistent and unpredicted range in diurnal variation. The Districts discussed the data with RPs and asked for any ideas in regard to explaining such data variances. A good discussion ensued but without resolution. The Districts have concluded that the data are all good and reliable and that the phenomena being observed are real and not a data anomaly. The Districts and RPs agreed that the Districts should evaluate (1) whether similar data ranges occur in other years, (2) do the accretion flow measurements indicate potential groundwater sources that may be reducing the diurnal range.

RPs also indicated that the outflow data temperature showed a relatively sudden reduction of about 2 degrees C in late 2011. The Districts indicated they believed this occurred during a full powerhouse outage that occurred in late October or early November and the low level outlet works had to be opened. The Districts agreed to confirm this and provide the dates of the event.

Districts Shifting to the HECRAS Model

The Districts proposed migrating the Lower Tuolumne River Temperature Model to the HECRAS model platform. The Districts provided their rationale for the change, including the HECRAS model is a publicly available model, it is much more user friendly, and it is completely transparent. Importantly, it performs at an hourly and even sub-hourly time step which is consistent with the RPs requests for the model and FERC's Determination. Migration to the HECRAS model is underway in order to meet the relicensing schedule.

> Comment: Mr. Shutes asked about how the HECRAS model would match up with San Joaquin model.
>
> Response: Mr. Devine answered that they are compatible and that the flows and temperature at the SJR/TR confluence can be fed directly into the SJR5Q model, or the models can be run independently. However, like with any two models, slightly different results are to be expected.

Next Steps

- Refine calibration of both models; validate models using 2012 data; review latest accretion flow results and evaluate year-to-year consistency of observed ranges in river diurnal temperatures.
- Conduct additional Workshop after final calibration/validation; conduct training session, likely in January (now set for January 24, 2013).
- Issue draft report with ISR in January 2013.

Action Items

- The Districts will provide the RPs with details of the powerhouse outage, including the dates and times.
- Bob Hughes observed that California Agencies have not used HECRAS in a FERC water rights forum yet. He will check with other CDFG staff, including Dale Stanton, and ask for suggestions and observations. (Action item complete.)
- Mike Maher will likewise check in with SWRCB staff.
- The Districts will set up a meeting/conference call with agencies to discuss the HECRAS model, if necessary. (Follow-up communication with agencies via email deemed this action item unnecessary.)