EXHIBIT ARWA-603

LOWER AMERICAN RIVER
FLOW MANAGEMENT STANDARD

TECHNICAL MEMORANDUM

CALSIM II ASSUMPTIONS

Table of Contents

List of Figures

List of Tables

List of Acronyms

2006 FMS	2006 Lower American River Flow Management Standard
AF	acre-feet
AFRP	Anadromous Fish Restoration Program
ARG	Lower American River Group
ARI	American River Index
ATSP	Automated Temperature Selection Procedure
B120	Bulletin 120, Water Conditions in California
B2IT	(b)(2) Interagency Team
BO	Biological Opinion
CDEC	California Data Exchange Center
CDFW	California Department of Fish and Wildlife
cfs	cubic feet per second
CNRFC	California-Nevada River Forecast Center
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CWT	coded-wire tags
D-893	State Water Resources Control Board Decision 893
Delta	Sacramento-San Joaquin River Delta
DWR	California Department of Water Resources
EID	El Dorado Irrigation District
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EOD	End-of-December
EOM	End-of-May
FRI	Four Reservoir Index
iCPMM	Iterative Coldwater Pool Management Model
IFII	Impaired Folsom Inflow Index

MAF	million acre-feet
M&I	Municipal and Industrial
MFP	Middle Fork Project
Modified FMS	Modified Lower American River Flow Management Standard
MRR	Minimum Release Requirement
NMFS	National Marine Fisheries Service
OCAP	Operating Criteria and Plan
PCWA	Placer County Water Agency
RDPA	redd dewatering protective adjustments
Reclamation	U.S. Department of Interior, Bureau of Reclamation
RST	rotary screw trap
SMUD	Sacramento Metropolitan Utility District
SRA	shaded riverine aquatic
SRI	Sacramento River Index
SWP	State Water Project
SWRCB	State Water Resources Control Board
TAF	thousand acre-feet
UARP	Upper American River Project
UIFR	Unimpaired Inflow to Folsom Reservoir
USFWS	U.S. Department of Interior, Fish and Wildlife Service
Water Forum	Sacramento Water Forum
WOMT	Water Operations Management Team
WYTD	water-year-to-date
YOY	young-of-the-year

1 Introduction

CalSim II, a water resources planning model, is used by the Water Forum to evaluate the environmental and water supply benefits and impacts of each Water Forum alternative. A comparative analysis of benefits will also be used to support alternatives evaluation. This chapter describes CalSim II and its application in operations studies for the Water Forum.

1.1 WRIMS

CalSim II is a particular application of the Water Resources Integrated Modeling System (WRIMS). WRIMS is generalized water resources software developed by the California Department of Water Resources (DWR) Bay-Delta Office. WRIMS is entirely data driven and can be applied to most reservoir river basin systems. WRIMS represents the physical system (reservoirs, streams, canals, pumping stations, etc.) by a network of nodes and arcs. The model user describes system connectivity and various operational constraints using a modeling language known as Water Resources Simulation Language (WRESL). WRIMS subsequently simulates system operation using optimization techniques to route water through the network based on mass balance accounting. A mixed integer programming solver determines an optimal set of decisions in each monthly time step for a set of user-defined priorities (weights) and system constraints. The model is described by DWR (2000) and Draper et al. (2004). The Water Forum used the WRIMS graphical user interface (GUI) version WRIMS 2.0 (20131230) to run all of the scenarios. WRIMS uses an optimization engine, the XA solver, developed and distributed by Sunset Software Technology; the Water Forum used XA16 for all simulations.

1.2 CalSim II

CalSim II was jointly developed by the U.S. Department of the Interior, Bureau of Reclamation (Reclamation), and DWR for performing planning studies related to CVP and SWP operations. The primary purpose of CalSim II is to evaluate the water supply reliability of the CVP and SWP at current and future levels of development (e.g., 2015, 2035), with and without various assumed future facilities, and with different modes of facility operations. Geographically, the model covers the drainage basin of the Delta, CVP and SWP deliveries to the Tulare basin, and SWP deliveries to the San Francisco Bay Area (Bay Area), Central Coast, and Southern California. CalSim II typically simulates system operations for an 82-year period using a monthly time step. The model assumes that facilities, land use, water supply contracts, and regulatory requirements are constant over this period, representing a fixed level of development. The historical flow record of October 1921 to September 2003, adjusted for the influence of land use changes, upstream flow regulations, and potentially climate change, is used to represent the possible range of water supply conditions. Results from a single simulation may not necessarily correspond to actual system operations for a specific month or year, but are representative of general water supply conditions over the modeled period of record. Model results are best interpreted using various statistical measures such as long-term or year-type averages. CalSim II can be used in either a comparative or an absolute mode. The comparative mode consists of comparing two model runs: one containing modifications representing an alternative and one that does not. Differences in certain factors, such as deliveries or reservoir storage levels, are analyzed to determine the impacts of each alternative. In the absolute mode, results of a single model run, such as the amount of delivery or reservoir levels, are considered directly. Model assumptions are generally believed to be more reliable in a comparative mode than in an absolute mode. All of the assumptions are the same for baseline and alternative model runs, except assumptions regarding the action, and the focus of the analysis is on the differences in the results. For the purposes of the Water Forum, CalSim II modeling output is used in the comparative mode rather than in the absolute mode.

2 General Assumptions

This section documents both the version of CalSim II the Water Forum is basing its modeling on, and the general modifications that the Water Forum made to CalSim II.

2.1 CalSim II Version

The Water Forum reviewed CalSim II models publicly available at the time of the start of this study. Options available were:

- DWR's The State Water Project Final Delivery Capability Report (DCR) 2015 (DWR, 2015) included
    - Existing Fremont weir and control gates.
    - Draft logic for the updated Allocation Settlement Agreement for four North-of-Delta contractors: Butte, Yuba, Napa and Solano.
- Reclamation's January 2015 Benchmark Simulation
    - Notched Fremont Weir operations and control gates.
    - Existing contract-specific SWP water allocation for all North-of-Delta contractors.

After careful review and comparison of the available CalSim II models, the Water Forum selected Reclamation's January 2015 Benchmark as the basis for evaluation of Water Forum alternatives. This version of CalSim II was the most recent publicly available model from either DWR or Reclamation at the time this study commenced, therefore, it was considered the best base from which to develop the models used for analyses of the Water Forum Modified Flow Management Standard (Modified FMS).

Reclamation subsequently published its Coordinated Long Term Operation of the Central Valley Project and State Water Project Final Environmental Impact Statement (LTO FEIS) (Reclamation 2015) that was largely identical to the January 2015 Benchmark, except it included assumed climate change and sea level rise, whereas the January 2015 Benchmark included hydrology and sea levels consistent with current climactic conditions. The Water Forum determined that the climate change representation used in the LTO FEIS for the American River was inappropriate for use in evaluating effects of Water Forum alternatives for the following reasons:

- As described in Section 3.1.3, the Water Forum used updated American River watershed hydrology developed by PCWA that better represents operations of PCWA's Middle Fork Project (MFP) and SMUD's Upper American River Project (UARP). A climate change version of the updated hydrology was not available.
- The LTO FEIS climate change representation included a modification of CalSim II hydrologic inputs based on a timeseries of basin-specific scalar multipliers developed through downscaling of climate change models. The American River hydrologic inputs used in CalSim were downstream from the MFP and UARP; modifying the hydrologic output from these two projects to represent climate change is inappropriate since it would ignore any sort of re-operation of the upstream projects in response to climate change, and would not appropriately represent those projects operations to meet their existing regulatory requirements under the climate change scenario. Accordingly, it was inappropriate to apply Reclamation's climate change scaling factors to the updated PCWA hydrology.

Following the LTO FEIS, Reclamation published a biological assessment (BA) of the California WaterFix in January 2016 (Reclamation, 2016). The No Action Alternative model for the BA is similar to the LTO FEIS except some refinements in the North Delta diversion bypass for the Bay-Delta Conservation Plan/California WaterFix and turning off the San Joaquin River Restoration operations.

The Water Forum modified the model base run to improve the model's representation of the Water Forum members' specific interests. This report documents the Water Forum-specific modifications to the Reclamation's January 2015 Benchmark CalSim II model base run.

2.2 System-Wide Assumptions

Table 1 summarizes assumptions for the CalSim II models developed for Reclamation's January 2015 Benchmark, and the primary changes to these assumptions for modeling the Water Forum's alternatives, including the baseline/no action alternative of the 2006 Flow Management Standard (2006 FMS) and the Modified FMS.

Table 1. Comparison of CalSim II modeling assumptions for January 2015 USBR Benchmark and Water Forum Alternatives.

	January 2015 USBR Benchmark	Base Case (2006 Flow Management Standard)	Modified Flow Management Standard
Planning horizon[a]	Year 2030	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Period of simulation	82 years (1922-2003)	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
HYDROLOGY			
Inflows/Supplies	Historical	Historical, with updates from PCWA	Same as Base Case
Climate Change	None	None	Same as Base Case
Level of development	Projected 2030 level[c]	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
DEMANDS, WATER RIGHTS, CVP and SWP CONTRACTS			
Sacramento River Region (excluding American River)			
CVP[d]	Land-use based, full buildout of contract amounts	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
SWP (FRSA)[e]	Land-use based, limited by contract amounts	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Non-project	Land-use based, limited by water rights and SWRCB Decisions for Existing Facilities	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Antioch Water Works	Pre-1914 water right	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Federal refuges[f]	Firm Level 2 water needs	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Sacramento River Region—American River[g]			
Water rights (including settlement contracts)	Year 2025, full water rights	Year 2030, modified to reflect PCWA deliveries to San Juan Water District, City of Roseville, and Sac Suburban Water District. Also includes Water Forum Dry-Year Actions.	Same as Base Case
CVP	Year 2025, full contracts, including Freeport Regional Water Project	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
San Joaquin River Region[h]			
Friant Unit	Limited by contract amounts, based on current allocation policy	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Lower Basin	Land-use based, based on district level operations and constraints	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark

	January 2015 USBR Benchmark	Base Case (2006 Flow Management Standard)	Modified Flow Management Standard
Stanislaus River[i]	Land-use based, Revised Operations Plant and NMFS BO (June 2009) Actions III.1.2 and III.1.3[v]	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
San Francisco Bay, Central Coast, Tulare Lake and South Coast Regions (CVP and SWP project facilities)			
CVP[d]	Demand based on contract amounts	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
CCWD[j]	195 TAF/year CVP contract supply and water rights	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
SWP[e,k]	Demand based on Table A amounts	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Article 56	Based on 2001-2008 contractor requests	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Article 21	MWD demand up to 200 TAF/month from December to March subject to conveyance capacity, Kern County Water Agency demand up to 180 TAF/month, and other contractor demands up to 34 TAF/month in all months, subject to conveyance capacity	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
North Bay Aqueduct (NBA)	77 TAF/yr demand under SWP contracts, up to 43.7 cfs of excess flow under Fairfield, Vacaville, and Benicia Settlement Agreement	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Federal refuges[f]	Firm Level 2 water needs	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
FACILITIES			
Systemwide	Existing facilities	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Sacramento River Region			
Shasta Lake	Existing, 4,552 TAF capacity	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Red Bluff Diversion Dam	Diversion dam operated with gates out all year, NMFS BO (June 2009) Action I.3.1[v]; assume permanent facilities in place	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Colusa Basin	Existing conveyance and storage facilities	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Lower American River	Hodge criteria for diversion at Fairbairn	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark

	January 2015 USBR Benchmark	Base Case (2006 Flow Management Standard)	Modified Flow Management Standard
Upper American River[g,l]	PCWA American River Pump Station	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Lower Sacramento River	Freeport Regional Water Project[n]	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Fremont Weir	Notched weir operations	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
San Joaquin River Region			
Millerton Lake (Friant Dam)	Existing, 520 TAF capacity	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Lower San Joaquin River	City of Stockton Delta Water Supply Project, 30-mgd capacity	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Delta Region			
SWP Banks Pumping Plant (South Delta)	Physical capacity is 10,300 cfs but 6,680 cfs permitted capacity in all months up to 8,500 cfs during Dec. 15 through Mar. 15 depending on Vernalis flow conditions; additional capacity of 500 cfs (up to 7,180 cfs) allowed for July through Sept. for reducing impact of NMFS BO (June 2009) Action IV.2.1 Phase II[v] on SWP[w]	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
CVP C.W. Bill Jones Pumping Plant (Tracy Pumping Plant)	Permit capacity is 4,600 cfs in all months (allowed for by the Delta-Mendota Canal-California Aqueduct Intertie)	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Upper Delta-Mendota Canal Capacity	Existing plus 400 cfs Delta-Mendota Canal-California Aqueduct Intertie	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
CCWD Intakes / Los Vaqueros Reservoir	Los Vaqueros existing storage capacity, 100 TAF, existing pump locations, AIP included[p]	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
San Francisco Bay Region			
South Bay Aqueduct (SBA)	SBA rehabilitation, 430 cfs capacity from junction with California Aqueduct to Zone 7 Water Agency diversion point	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
South Coast Region			
California Aqueduct East	Existing capacity	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark

	January 2015 USBR Benchmark	Base Case (2006 Flow Management Standard)	Modified Flow Management Standard
Branch			
REGULATORY STANDARDS			
North Coast Region			
Trinity River			
Minimum flow below Lewiston Dam	Trinity EIS Preferred Alternative (369-815 TAF/year)	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Trinity Reservoir end-of-September minimum storage	Trinity EIS Preferred Alternative (600 TAF as able)	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Sacramento River Region			
Clear Creek			
Minimum flow below Whiskeytown Dam	Downstream water rights, 1963 Reclamation Proposal to USFWS and NPS, predetermined CVPIA 3406(b)(2) flows[q], and NMFS BO (June 2009) Action I.1.1[v]	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Upper Sacramento River			
Shasta Lake end-of-September minimum storage	NMFS 2004 Winter-run Biological Opinion, (1900 TAF in non-critically dry years), and NMFS BO (June 2009) Action I.2.1[v]	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Minimum flow below Keswick Dam	SWRCB WR 90-5, predetermined CVPIA 3406(b)(2) , and NMFS BO (June 2009) Action I.2.2[v]	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Feather River			
Minimum flow below Thermalito Diversion Dam	2006 Settlement Agreement (700/800 cfs)	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Minimum flow below Thermalito Afterbay outlet	1983 DWR, DFW Agreement (750-1,700 cfs)	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Yuba River			
Minimum flow below Daguerre Point Dam	Operations under Lower Yuba River Accord[r]	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
American River			

	January 2015 USBR Benchmark	Base Case (2006 Flow Management Standard)	Modified Flow Management Standard
Minimum flow below Nimbus Dam	American River Flow Managements Standard as required by NMFS BO (June 2009) Action II.1[v]	American River Flow Managements as required by NMFS BO (June 2009) Action II.1[v], as modified by the Water Forum	Modified Flow Managements Standard
Minimum Flow at H Street Bridge	SWRCB D-893	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Lower Sacramento River			
Minimum flow near Rio Vista	SWRCB D-1641	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
San Joaquin River Region			
Mokelumne River			
Minimum flow below Camanche Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (100-325 cfs)	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Minimum flow below Woodbridge Diversion Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (25-300 cfs)	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Stanislaus River			
Minimum flow below Goodwin Dam	1987 Reclamation, DFW agreement, and flows required for NMFS BO (June 2009) Action III.1.2 and III.1.3[v]	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Minimum dissolved oxygen	SWRCB D-1422	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Merced River			
Minimum flow below Crocker-Huffman Diversion Dam	Davis-Grunsky (180-220 cfs, Nov.-Mar.), and Cowell Agreement	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Minimum flow at Shaffer Bridge	FERC 2179 (25-100 cfs)	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Tuolumne River			
Minimum flow at Lagrange Bridge	FERC 2299-024, 1995 (Settlement Agreement) (94-301 TAF/yr)	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Updated Tuolumne River	New Don Pedro operations	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
San Joaquin River			
San Joaquin River below Friant Dam/ Mendota Pool	San Joaquin River Restoration-full flows, not constrained by current canal capacity[u]	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark

	January 2015 USBR Benchmark	Base Case (2006 Flow Management Standard)	Modified Flow Management Standard
Maximum salinity near Vernalis	SWRCB D-1641	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Minimum flow near Vernalis	SWRCB D-1641, and NMFS BO (June 2009) Action IV.2.1[v]	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Sacramento River – San Joaquin Delta Region			
Delta Outflow Index (Flow and Salinity)	SWRCB D-1641 and USFWS BO (Dec. 2008) Action 4	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Delta Cross Channel gate operation	SWRCB D-1641 with additional days closed from Oct. 1 – Jan. 31 based on NMFS BO (June 2009) Action IV.1.2[v] (closed during flushing flows from Oct. 1 – Dec. 14 unless adverse water quality conditions)	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
South Delta exports (Jones Pumping Plant and Banks Pumping Plant)	SWRCB D-1641, Vernalis flow-based export limits Apr. 1 – May 31 as required by NMFS BO (June 2009) Action IV.2.1[v] (additional 500 cfs allowed for July – Sept. for reducing impact on SWP)[w]	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Combined Flow in OMR	USFWS BO (Dec. 2008) Actions 1 through 3 and NMFS BO (June 2009) Action IV.2.3[v]	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
OPERATIONS CRITERIA: RIVER-SPECIFIC			
Sacramento River Region			
Upper Sacramento River			
Flow objective for navigation (Wilkins Slough)	NMFS BO (June 2009) Action I.4[v]; 3,500 – 5,000 cfs based on CVP water supply condition	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
American River			
Folsom Dam flood control	Variable 400/670 flood control diagram (without outlet modifications)	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Feather River			
Flow at Mouth of Feather River (above Verona)	Maintain DFW/DWR flow target of 2,800 cfs for Apr. through Sept. dependent on Oroville inflow and	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark

	January 2015 USBR Benchmark	Base Case (2006 Flow Management Standard)	Modified Flow Management Standard
	FRSA allocation		
San Joaquin River Region			
Stanislaus River			
Flow below Goodwin Dam[i]	Revised Operations Plant and NMFS BO (June 2009) Action III.1.2 and III.1.3[v]	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
San Joaquin River			
Salinity at Vernalis	Grasslands Bypass Project (full implementation)	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
OPERATIONS CRITERIA: SYSTEMWIDE			
CVP water allocation			
Settlement/Exchange	100 percent (75 percent in Shasta critical years)	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Refuges	100 percent (75 percent in Shasta critical years)	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Agriculture Service	100 percent-0 percent based on supply, South-of-Delta allocations are additionally limited due to D-1641, USFWS BO (Dec. 2008) and NMFS BO (June 2009) export restrictions[v]	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Municipal & Industrial Service	100 percent-50 percent based on supply, South-of-Delta allocations are additionally limited due to D-1641, USFWS BO (Dec. 2008) and NMFS BO (June 2009) export restrictions[v]	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
SWP water allocation			
North of Delta (FRSA)	Contract specific	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
South of Delta (including North Bay Aqueduct)	Based on supply; equal prioritization between Ag and M&I based on Monterey Agreement; allocations are additionally limited due to D-1641 and USFWS BO (Dec. 2008) and NMFS BO (June 2009) export restrictions[v]	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
CVP-SWP coordinated operations			

	January 2015 USBR Benchmark	Base Case (2006 Flow Management Standard)	Modified Flow Management Standard
Sharing of responsibility for in-basin-use	1986 Coordinated Operations Agreement (FRWP EBMUD and 2/3 of the North Bay Aqueduct diversions considered as Delta Export; 1/3 of the North Bay Aqueduct diversion as in-basin-use)	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Sharing of surplus flows	1986 Coordinated Operations Agreement	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Sharing of total allowable export capacity for project-specific priority pumping	Equal sharing of export capacity under SWRCB D-1641, USFWS BO (Dec. 2008) and NMFS BO (June 2009) export restrictions[v]	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Water transfers	Acquisitions by SWP contractors are wheeled at priority in Banks Pumping Plant over non-SWP users; Lower Yuba River Accord included for SWP contractors[w]	Same as January 2015 USBR Benchmark but also includes PCWA Transfer to EBMUD	Same as Base Case
Sharing of total allowable export capacity for lesser priority and wheeling-related pumping	Cross Valley Canal wheeling (max of 128 TAF/year), CALFED ROD defined Joint Point of Diversion (JPOD)	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
San Luis Reservoir	San Luis Reservoir is allowed to operate to a minimum storage of 100 TAF	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
CVPIA 3406(b)(2)[v,q]			
Policy Decision	Per May 2003 Department Decision:	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Allocation	800 TAF, 700 TAF in 40-30-30 dry years, and 600 TAF in 40-30-30 critical years as a function of Ag allocation	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Actions	Predetermined upstream fish flow objectives below Whiskeytown and Keswick Dams, non-discretionary NMFS BO (June 2009) actions for the American and Stanislaus Rivers, and NMFS BO (June 2009) and USFWS BO (Dec. 2008) actions leading to	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark

	January 2015 USBR Benchmark	Base Case (2006 Flow Management Standard)	Modified Flow Management Standard
	export restrictions[v]		
Accounting	Releases for non-discretionary USFWS BO (Dec. 2008) and NMFS BO (June 2009)[v] actions may or may not always be deemed (b)(2) actions; in general, it is anticipated that, accounting of these actions using (b)(2) metrics, the sum would exceed the (b)(2) allocation in many years; therefore no additional actions are considered and no accounting logic is included in the model [q]	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
WATER MANAGEMENT ACTIONS			
Water Transfer Supplies (long-term programs)			
Lower Yuba River Accord[w]	Yuba River acquisitions for reducing impact of NMFS BO export restrictions[v] on SWP	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Phase 8	None	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
Water Transfers (short-term or temporary programs)			
Sacramento Valley acquisitions conveyed through Banks Pumping Plant[x]	Post-analysis of available capacity	Same as January 2015 USBR Benchmark	Same as January 2015 USBR Benchmark
PCWA Transfer to EBMUD	None	Transfer of PCWA Water Forum Mitigation Water to EBMUD	Same as Base Case

[a.] These assumptions were developed under the direction of the DWR and Reclamation in 2010. Only operational components of 2008 USFWS and 2009 NMFS BOs as of the demarcation date of No Action Alternative and the No action Alternative assumptions are included. Restoration of at least 8,000 acres of intertidal and associated subtidal habitat in the Delta and Suisun Marsh required by the 2008 USFWS BO and restoration of at least 17,000 to 20,000 acres of floodplain rearing habitat for juvenile winter-run and spring-run Chinook Salmon and Central Valley Steelhead in the Yolo Bypass or suitable areas of the lower Sacramento River required by the NMFS 2009 BO are not included in the No Action Alternative assumptions because environmental documents of projects regarding these actions were not completed as of the publication date of the Notice of Preparation/Notice of Intent (February 13, 2009).

[b.] footnote removed

[c] The Sacramento Valley hydrology used in the No Action Alternative CalSim II model reflects 2020 land-use assumptions associated with Bulletin 160-98. The San Joaquin Valley hydrology reflects draft 2030 land-use assumptions developed by Reclamation. Development of Future-level projected land-use assumptions are being coordinated with the California Water Plan Update for future models.

[d] CVP contract amounts have been updated according to existing and amended contracts as appropriate. Assumptions regarding CVP agricultural and M&I service contracts and Settlement Contract amounts are documented in the Delivery Specifications attachments.

[e] SWP contract amounts have been updated as appropriate based on recent Table A transfers/agreements. Assumptions regarding SWP agricultural and M&I contract amounts are documented in the Delivery Specifications attachments.

[f] Water needs for Federal refuges have been reviewed and updated as appropriate. Assumptions regarding firm Level 2 refuge water needs are documented in the Delivery Specifications attachments. Refuge Level 4 (and incremental Level 4) water is not analyzed.

[g] Assumptions regarding American River water rights and CVP contracts are documented in the Delivery Specifications attachments. The Sacramento Area Water Forum agreement, its dry year diversion reductions, Middle Fork Project operations and "mitigation" water is not included.

[h] The new CalSim II representation of the San Joaquin River has been included in this model package (CalSim II San Joaquin River Model, Reclamation, 2005). Updates to the San Joaquin River have been included since the preliminary model release in August 2005. The model reflects the difficulties of ongoing groundwater overdraft problems. The 2030 level of development representation of the San Joaquin River Basin does not make any attempt to offer solutions to groundwater overdraft problems. In addition a dynamic groundwater simulation is not yet developed for the San Joaquin River Valley. Groundwater extraction/recharge and stream-groundwater interaction are static assumptions and may not accurately reflect a response to simulated actions. These limitations should be considered in the analysis of results.

[i] The CalSim II model representation for the Stanislaus River does not necessarily represent Reclamation's current or future operational policies. A suitable plan for supporting flows has not been developed for NMFS BO (June 2009) Action 3.1.3.

[j] The actual amount diverted is operated in conjunction with supplies from the Los Vaqueros project. The existing Los Vaqueros storage capacity is 100 TAF. Associated water rights for Delta excess flows are included.

[k] Under No Action Alternative, it is assumed that SWP Contractors demand for Table A allocations vary from 3.0 to 4.1 million acre-feet (MAF)/year. Under the No Action Alternative, it is assumed that SWP Contractors can take delivery of all Table A allocations and Article 21 supplies. Article 56 provisions are assumed and allow for SWP Contractors to manage storage and delivery conditions such that full Table A allocations can be delivered. Article 21 deliveries are limited in Wet years under the assumption that demand is decreased in these conditions. Article 21 deliveries for the NBA are dependent on excess conditions only, all other Article 21 deliveries also require that San Luis Reservoir be at capacity and that Banks Pumping Plant and the California Aqueduct have available capacity to divert from the Delta for direct delivery.

[l] PCWA American River pumping facility upstream of Folsom Lake is included in both the Existing and No Action Alternative No Action Alternative. The diversion is assumed to be 35.5 TAF/Yr.

[m] footnote removed

[n] footnote removed

[o] footnote removed

[p] The CCWD AIP is an intake at Victoria Canal that operates as an alternate Delta diversion for Los Vaqueros Reservoir. This assumption is consistent with the future no-project condition defined by the Los Vaqueros Enlargement study team.

[q] CVPIA (b)(2) fish actions are not dynamically determined in the CalSim II model, nor is (b)(2) accounting done in the model. Since the USFWS BO and NMFS BO were issued, the Department of Interior has exercised its discretion to use (b)(2) in the Delta by accounting some or all of the export reductions required under those biological opinions as (b)(2) actions. It is therefore assumed for modeling purposes that (b)(2) availability for other Delta actions will be limited to covering the CVP's VAMP export reductions. Similarly, since the USFWS BO and NMFS BO were issued, the Department of Interior has exercised its discretion to use (b)(2) upstream by accounting some or all of the release augmentations (relative to the hypothetical (b)(2) base case) below Whiskeytown, Nimbus, and Goodwin as (b)(2) actions. It is therefore assumed for modeling purposes that (b)(2) availability for other upstream actions will be limited to covering Sacramento releases, in the fall and winter. For modeling purposes, predetermined time series of minimum instream flow requirements are specified. The time series are based on the Aug. 2008 BA Study 7.0 and Study 8.0 simulations which did include dynamically determined (b)(2) actions.

[r] The Lower Yuba River Accord is assumed to be implemented for Existing and No Action Alternative No Action Alternative. The Yuba River is not dynamically modeled in CalSim II. Yuba River hydrology and availability of water acquisitions under the Lower Yuba River Accord are based on modeling performed and provided by the Lower Yuba River Accord EIS/EIR study team.

[s] footnote removed

[t] footnote removed

[u] SJR Restoration Water Year 2010 Interim Flows Project are assumed, but are not input into the models; operation not regularly defined at this time

[v] In cooperation with Reclamation, National Marine Fisheries Service, U.S. Fish and Wildlife Service, and California Department of Fish and Wildlife, the Department of Water Resources has developed assumptions for implementation of the USFWS BO (Dec. 15, 2008) and NMFS BO (June 4, 2009) in CalSim II.

[w] Acquisitions of Component 1 water under the Lower Yuba River Accord, and use of 500 cfs dedicated capacity at Banks Pumping Plant during July through Sept., are assumed to be used to reduce as much of the impact of the April through May Delta export actions on SWP contractors as possible.
[x] Only acquisitions of Lower Yuba River Accord Component 1 water are included.

3 Water Forum Assumptions

The Water Forum made additional modifications to the CalSim II logic to reflect the specific interests of the Water Forum. Water Forum assumptions are in two categories: (1) Water Forum assumptions applicable to all Water Forum alternatives; and (2) Water Forum assumptions applicable specific alternatives. These assumptions are further described below.

3.1 Assumptions for All Water Forum Alternatives

The following assumptions are applicable to all Water Forum alternatives. The coding within CalSim II is identical for all Water Forum alternatives for each of these elements.

3.1.1 Dry-Year Procedure Demand Reductions

The Water Forum Agreement provides for dry-year procedures that describe demand reductions that purveyors would implement if the forecasted March through November Unimpaired Inflow into Folsom Reservoir (Mar-Nov UIFR) is within a certain range. The Mar-Nov UIFR is the sum of forecasted 50% exceedance unimpaired American River flow at Folsom Dam for March through September plus 60 TAF to represent in flows during October and November. The UIFR values are saved in a lookup table, UIFR.table.

There are dry-year procedures concerning several purveyors. Their dry-year diversions in excess of their 1995 levels and cutbacks based on the hydrologic condition and associated indices and thresholds described in the Water Forum Agreement. The Mar-Nov UIFR is used as the primary index in the Water Forum Agreement for determining the current year's hydrologic condition according to the following hydrologic definitions.

- Wet/average Years occur when the projected Mar-Nov UIFR is greater than 950 TAF.
- Drier Years occur when the projected Mar-Nov UIFR is less than 950 TAF.
- Driest Years (also known as Conference Years) occur when the projected Mar-Nov UIFR is less than 400,000 acre-feet. Conference years are those years during which diverters and others will meet and confer to determine how best to meet demands and protect the lower American River.

In "Drier Years," the terms included within the Water Forum Agreement indicate that purveyors would reduce diversions from Folsom Reservoir and the lower American River according to Figure 1. In real-world circumstances, in some cases as with the City of Folsom, the total reductions could be allocated differently among various purveyors as a result of other terms of the Water Forum Agreement. For modeling purposes, however, the Water Forum modified the Demands70.wresl file in CalSim II to reflect the dry year procedures' reductions in American River purveyors' demands.

For the majority of American River water supply purveyors, indicated reductions in demand due to dry-year procedures were applied to water rights supplies;[1] CVP water-service contract deliveries were reduced only according to CVP shortage policies. However, after reviewing model output, SJWD (SJWD, 2015) and the City of Folsom (Folsom, 2015) indicated they would prefer that reductions due to the Dry-Year Procedures be applied to their CVP water-service contract supplies rather than to their water rights. While not discussed with the City of Roseville, a similar rationale was applied to their supplies; Roseville's CVP water-service contract supplies were reduced prior to their PCWA supplies. In situations where there were inadequate CVP supplies to cover the dry-year shortages, water right supplies were reduced after CVP water-service contract supplies had been fully reduced. Dry-year reductions were applied on a March-February basis, to align with the CVP contract year.

[1] Water rights supplies include supplies under settlement contracts between the United States and senior water-right holders.

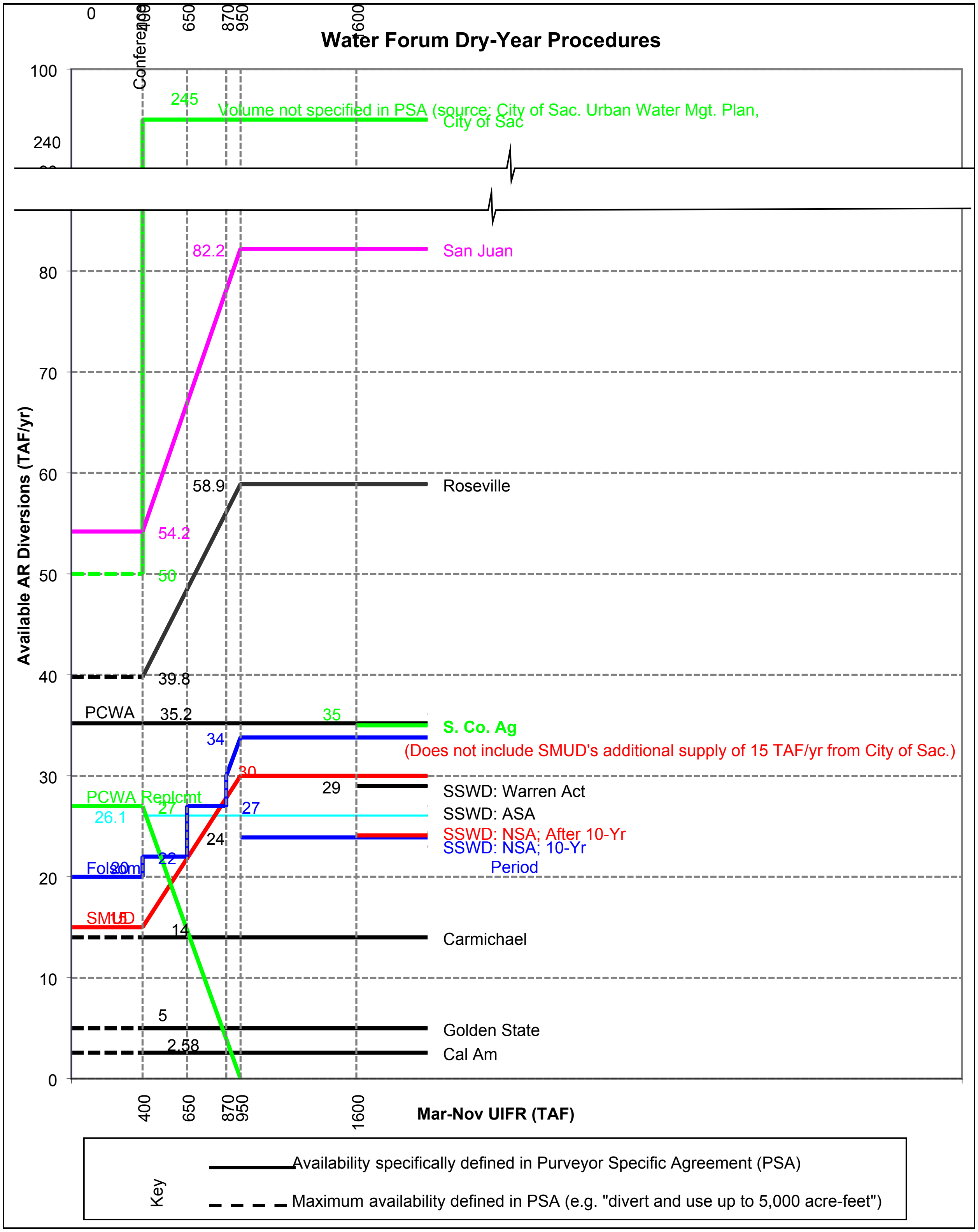

Figure 1. American River Water Forum Dry Year Procedures

3.1.2 Water Supply Demands

The Water Forum modified the demands in CalSim II's 2020D09ESV.dss file to represent input from Water Forum members. PCWA provided timeseries for deliveries to several purveyors, PCWA, the City of Roseville, San Juan Water District, and Sacramento Suburban Water District; for these purveyors, the Water Forum modified both the annual volume and the monthly delivery pattern in the 2020D09ESV.dss file to reflect PCWA's modeling. Table 2 shows the Water Forum's assumptions for diversion demands for American River purveyors.

Table 2. Water Supply Diversion Demands for American River Purveyors

Description	CalSim II node	Reclamation January 2015 Benchmark	Water Forum Alternatives
UPSTREAM OF FOLSOM RESERVOIR			
Placer County Water Agency (American River Pump Station)	D300	65,000	70,000[6a,6b,20]
FOLSOM RESERVOIR			
Sacramento Suburban Water District (PCWA Contract)	D8A	0	24,000[6a,6b,17,23]
City of Folsom	D8B	34,000	34,000[1]
Water Rights (incl. settlement contracts)		27,000	27,000
CVP Water-Service Contract		7,000	7,000
Folsom State Prison	D8C	5,000	5,000
San Juan Water District		82,200	73,660
PCWA Contract	D8D	25,000	16,460[6a,6b,24]
Water Rights (incl. settlement contract)	D8E	33,000	33,000[1]
CVP Water Service Contract	D8E	24,200	24,200[1]
El Dorado County Water Agency	D8I	0	15,000[1,9]
El Dorado Irrigation District	D8F	24,550	24,550[1]
Water Rights		0	17,000
CVP Water-Service Contract		7,550	7,550
City of Roseville	D8G	62,000	62,000[1,21]
PCWA Contract		30,000	30,000[6a,6b,21,25]
CVP Water-Service Contract		32,000	32,000
Placer County Water Agency (CVP Water-Service Contract)	D8H	35,000	35,000[6b,22]
FOLSOM SOUTH CANAL			
Southern California Water Co.	D9AA	5,000	5,000
California Parks and Recreation	D9AB	5,000	5,000[1]
SMUD	D9B	45,000	45,000[1,10]
Water Rights		15,000	15,000
CVP Water-Service Contract		30,000	30,000
FROM BELOW NIMBUS DAM TO H STREET			
Sacramento Suburban Water District	D302B	0	0
Carmichael Water District	D302C	12,000	12,000
City of Sacramento	D302A	230,000	105,446[7]
SACRAMENTO RIVER BELOW THE AMERICAN RIVER CONFLUENCE			
City of Sacramento	D167A	81,800	105,446[7,15,19]
Sacramento County Water Agency		77,600[2]	90,000[28]
Sac River Diversion CVP Water-Service Contract (Fazio)	D167B	10,000[11]	12,350[29]
Freeport CVP (From SMUD, and Fazio Balance)	D168C	35,000[16]	32,650[30]
Other Water Supplies	D168C	14,800[2]	14,800[31]
Appropriative Water Rights	D168C	17,800[2]	71,000[31]
EBMUD	D168B	133,000[5]	133,000[5,14]

[1] When the CVP Contract quantity exceeds the quantity of the Diversion Limit minus the Water Right (if any), the diversion modeled is the quantity allocated to the CVP Contract (based on the CVP contract quantity shown, times the CVP M&I allocation percentage) plus the Water Right (if any), but with the sum limited to the quantity of the Diversion Limit

[2] SCWA targets 68 TAF of surface water supplies annually. The portion unmet by CVP contract water is assumed to come from two sources as follow:

> "Other" water- derived from transfers and/or other appropriated water, averaging 14.8 TAF annually but varying according remaining unmet demand.

Delta "excess" water- averages 17.8 TAF annually, but varies according to availability. SCWA is assumed to divert excess flow when it is available, and when there is available pumping capacity.

[3] Footnote removed

[4] Footnote removed

[5] EBMUD CVP diversions are governed by the Amendatory Contract, stipulating:

(1) 133 TAF maximum diversion in any given year
(2) 165 TAF maximum diversion amount over any 3 year period
(3) Diversions allowed only when EBMUD total storage drops below 500 TAF
(4) 155 cfs maximum diversion rate

[6a] Annual MFP deliveries are described in the time series data provided by PCWA on 2/3/2015. Annual MFP deliveries never exceed 120 TAF per the current PCWA and USBR contract.

[6b] Annual CVP delivery is described in the time series data provided by PCWA on 2/3/2015. Annual CVP delivery never exceeds 35 TAF and the water is used to meet PCWA, Roseville, San Juan, and/or Sac Suburban demand, as needed.

[7] Total demand provided by Jim Peifer from the City of Sacramento on 3/20/2013. Demand split evenly between Fairbairn and Sac River plants . Assumes total consumptive demand will be met with surface water and groundwater. Total consumptive demand includes 160,100 acre feet of retail demand and 60,062 acre feet of wholesale and wheeling demand. Source is table 13 and 15 of City of Sacramento 2010 Urban Water Management Plan.

[8] Footnote removed

[9] From Tom Gohring based on discussions with EDCWA

[10] From Paul Olmstead from SMUD on 5/16/13

[11] Receives water from City of Sacramento, included in City's demand volume

[14] Timeseries of demands was provided by EBMUD on 6/11/2014

[15] City of Sacramento demand diverted from the Sacramento River Water Treatment Plant is assumed to be met from Sacramento's Sacramento River and American River entitlements.

[16] SCWA receives water from two CVP contracts; a SMUD transfer (20 TAF) and PL 101-514 (15 TAF).

[17] 29.0 TAF of SSWD demand from American River Pump Station is accounted for in PCWA pump station because SSWD does not have a long term Warren Act Contract

[18] Footnote removed

[19] Water Forum Modeling includes updated demands for City of Sacramento in addition to revised coding allowing Fairbairn shortages to be diverted at Sac. River Plant.

[20] The 70 TAF of water includes 35.5 TAF, consistent with the Water Forum Agreement, and an additional 35 TAF that, in the Water Forum Agreement, was originally anticipated as coming from the Sacramento River (this is a conservative assumption for modeling purposes).

[21] Roseville's demand is limited to 54.9 TAF per the Water Forum Agreement, PCWA contract water is used to meet remaining demand after Roseville's CVP supply (max 32 TAF) is exhausted each year.

[22] PCWA has a certified CEQA document for the ARPS that includes an annual diversion total of 35,500 AF.

[23] SSWD's contract with PCWA is for 29 TAF, but their demand is being modeled as 24 TAF

[24] SJWD's contract with PCWA is for 25 TAF. SJWD's demand in Placer County is being modeled as 16,460 AF

[25] Roseville's contract with PCWA is for 30 TAF

[26] Footnote removed

[27] Footnote removed

[28] SCWA targets 90 TAF per year in wet years, and 33.75 TAF in dry years

[29] SCWA takes 12,350 AF of their 15 TAF Fazio contract from the City of Sacramento's diversion. The balance is diverted at Freeport

[30] SCWA receives a portion of their supply from transfers, this averages around 14.8 TAF per year annually but varying according remaining unmet demand.

[31] SCWA has an appropriative water right for 71 TAF/year from the Freeport WTP. In modeling, their water right is only available when the Delta is in excess conditions.

3.1.3 PCWA Hydrology

PCWA has provided the Water Forum with hydrology representing PCWA's modeling of PCWA's Middle Fork Project (MFP), developed to support PCWA's planning activities, and PCWA's re-run of the Sacramento Metropolitan Utility District's (SMUD) Upper American River Project (UARP). The PCWA MFP hydrology has timeseries for the following parameters:

1) Middle Fork American River flow above PCWA's American River Pump Station (ARPS) – Included as part of CalSim II arc I300

2) ARPS diversions – Included as monthly pattern and annual volume for CalSim II arc D300
3) Exports from the Bear River watershed to Folsom Reservoir through the Newcastle Powerhouse – Included as part of CalSim II arc I300
4) Transferrable MFP releases for EBMUD (further discussed below).
5) South Fork American River flow to Folsom Reservoir – Included as part of CalSim II arc I8.
6) Local inflows to Folsom Reservoir. Reservoir – Included as part of CalSim II arc I8.
7) PCWA water right diversions from Folsom Reservoir to City of Roseville, San Juan Water District, Sacramento Suburban Water District, and the Placer County Water Agency – Included as monthly patterns and annual volumes for CalSim arc D8.
8) EBMUD diversions at the Freeport Regional Water Project including PCWA transfers – Included as part of CalSim II arc D168.

The Water Forum modified the CalSim II input file, 2020D09ESV.dss, to reflect these timeseries.

3.1.4 PCWA Transfer to EBMUD

As previously mentioned, as part of its Water Forum purveyor-specific agreement, PCWA has agreed to release a block of water for the benefit of the American River below Nimbus Dam as a form of mitigation for the effects of the MFP on the lower American River. PCWA has negotiated a transfer agreement with EBMUD for the purchase of PCWA's mitigation water[2]. The PCWA-to-EBMUD transfer is intended to be in addition to CVP releases from Nimbus Dam to meet the Minimum Release Requirement (MRR) from Nimbus Dam, and it is not intended to be a part of the CVP's water supply calculation considering storage in Folsom Reservoir. PCWA provided both a timeseries for the transfer's inflow to Folsom Reservoir and its release and subsequent rediversion from the Freeport Regional Water Project. PCWA's transfer to EBMUD was represented in CalSim II in a new file, PCWA_EBMUD_Trans.wresl, which is only included in CalSim II's cycle 11 (Transfers_Stage1), and is referenced in mainCONV_SA.wresl. As a result of differences between inflows and releases, the Water Forum's CalSim II logic includes a separate storage volume for the PCWA transfer that acts in parallel with general storage in Folsom Reservoir. Similarly, the transfer volume is simulated as an additional increment of flow in the American River below Nimbus Dam when operations dictate Nimbus Dam releases to meet the MRR. The incremental volume of PCWA transfer was introduced to the lower American River in the continuity equation for node 9 in the continuity.wresl file. To further ensure the PCWA transfer was not included in DWR and

[2] PCWA and EBMUD have a memorandum of understanding (MOU) declaring their intent to complete a long-term transfer once all regulatory approvals have been received. In the interim, another MOU gives EBMUD the first right of refusal for any PCWA's dry-year mitigation water available for transfer on an annual basis.

Reclamation's Coordinated Operations Agreement (COA) accounting, the file ReOpsVarDefine.wresl was modified to add the PCWA transfer to the Folsomwh1 goal.

The transfer flow is reflected in American River flow below Nimbus Dam, and in the Sacramento River between the American River and the Freeport Regional Water Project; downstream from the Freeport Regional Water Project, Sacramento River flows are the same as if there was no transfer.

Additionally, EBMUD provided a timeseries for Mokelumne River outflow to the Delta, reflecting EBMUD's operations with the PCWA transfer. That timeseries, I504, was added to the 2020D09ESV.dss input file.

3.1.5 Retraining of the Water Supply Index – Delivery Index Curves

CalSim II uses a relationship between available water supply and delivery volume as part of its water supply allocation process. This relationship is defined for the CVP and SWP in a pair of lookup tables relating a water supply index (WSI) to a delivery index (DI). the wsi_di_cvp_sys.table and wsi_di_swp.table. CalSim II includes a process for retraining these relationships using the WRIMS GUI to include changes to system operations in CalSim II's allocation decision process. The Water Forum retrained the WSI-DI relationship as part of its revisions for the 2006 FMS simulation and used those same relationships for the Modified FMS simulation.

3.1.6 Other Modifications to CalSim II

The Water Forum made additional, minor, modifications to the CalSim II logic. These modifications generally are considered to be code cleanup.

- The Hst_base.wresl file was modified to include the calculation of the H Street minimum required flow (HMin) that was previously in the NimbusHistMinQ.wresl file
- The code to include the NimbusHistMinQ.wresl file was commented out in the NOD.wresl file
- The AMERICAN_PRJ_WR.table file was modified to set the PCWASac diversion value to 0.00 cfs to ensure no PCWA diversions from the Sacramento River from the proposed River Ark project.
- The Res_Info.table file was modified to set the storage for Black Butte Lake (S42) to 0 TAF, with 0 acres of surface area, and 0 cfs release capacity at the bottom end of its area-storage-release curve.

3.2 Assumptions for the 2006 Flow Management Standard Alternative

The Water Forum used the majority of the logic implementing the 2006 FMS within Reclamation's January 2015 Benchmark. This section describes the changes that were made to the FMS for use in Water Forum alternatives. All of these changes were made to the FMStandard.wresl file.

3.2.1 Off-Ramp Condition Logic

An "Off-Ramp Condition" applies if Folsom Reservoir storage is forecasted to fall below 200 TAF in any of the following 12 months. The year-round Off-Ramp Condition is reassessed each month, but continues in effect until Folsom Reservoir storage exceeds 200 TAF and is predicted to remain above 200 TAF for the following 12 months.

Off-Ramp Minimum Flow Requirements are:

- From January 1 through September 15, no less than 250 cfs between Nimbus Dam and the mouth of the lower American River
- From September 16 through December 31, no less than 500 cfs between Nimbus Dam and the mouth of the lower American River

Due to challenges in forecasting operations in portions of the year, the Water Forum's implementation of the off-ramp condition into Reclamation's January 2015 Benchmark varied according to the time of the year.

All of the off-ramp condition forecasts assumed average historical monthly evaporation volumes, specific to each forecast period, as part of the depletion calculation. Historical monthly average evaporation was computed from daily data from CDEC for Folsom Reservoir for October 1, 1975 through September 30, 2015.

3.2.1.1 March through September

Between March and September, Reclamation can forecast, with reasonable certainty, monthly inflow volumes to Folsom Reservoir and Lake Natoma, water supply diversions from Folsom Reservoir and Lake Natoma, evaporation from Folsom Reservoir, and the MRR for the lower American River. Accordingly, the Water Forum assumed perfect foresight for these parameters to forecast, the end-of-month storage for each month between the current month and the end of September.

3.2.1.2 October through February

For the October through February months, performing a long-term forecast is much more speculative. There is quite a bit of uncertainty regarding reservoir inflows during this time, which affects Reclamation's contract water supply allocations, in addition to reservoir storage. Moreover, there is uncertainty regarding the MRR due to changes in FMS indices between September and October (October through December MRRs are based on end-of-September reservoir storages), and in January and February due to changes in the Sacramento River Index forecasts. Accordingly, between October and February, the end-of-month storage is forecasted only for the current simulation month.

3.2.1.3 Application of Off-Ramp Forecasts

In Reclamation's January 2015 Benchmark modeling, if forecasted storage dropped below 200 TAF in any month, the MRR was reduced to the applicable California State Water Resource Control Board (SWRCB) Decision 893 (D-893) flow requirement. The Water Forum modified this rule to reduce the MRR to a flow that would result in a minimum storage of 200 TAF or the applicable D-893 flow requirement, whichever was greater. Prior to the Water Forum's change, an oscillation in MRR between the D-893 flow requirement and the FMS requirement if the forecasted storage was close to 200 TAF occurred on occasion. By making the change, the off-ramp MRR was much more stable. The changes were made to the FMStandard.wresl file.

3.3 Assumptions for the Modified Flow Management Standard Alternative

The Water Forum has developed a Modified Flow Management Standard (Modified FMS) alternative to provide greater protection of the American River basin water resources for water supply and environmental purposes while maintaining a level of benefits equivalent to those provided by the FMS to resources outside of the American River basin. This alternative includes a method for allocating releases from Folsom Reservoir to maintain a water supply reserve in storage.

The Modified FMS alternative has six elements that are represented in CalSim II: (1) Hydrologic indices (the Sacramento River Index and American River Index); (2) a set of MRR curves; (3) an end-of-May Folsom Reservoir storage requirement; (4) an end-of-December Folsom Reservoir storage requirement; (5) steelhead and Chinook salmon redd dewatering protection; and (6) a two-day pulse flow in March. CalSim II logic implementing these changes was saved in a new file, FMStandard.wresl, which replaced the FMStandard.wresl file previously used for the FMS alternative. The mainCONV_SA.wresl file was then modified to reference the FMStandard.wresl file in cycles 6 through 11. Each of the Modified FMS elements is described below.

3.3.1 Hydrologic Index Calculation

The Modified FMS uses two hydrologic indices to determine MRRs. The first, the Sacramento River Index (SRI) is identical to the SRI used under the existing FMS. The second, the American River Index (ARI), is a new index developed by the Water Forum for the Modified FMS.

3.3.1.1 Sacramento River Index

The Modified FMS uses the SRI to determine the MRR for January. The SRI is published each year in December, January, February, March, April, and May around the first of each month. The SRI January 1 forecast is the first publicly available hydrologic forecast from DWR for the water year. While its early publication each year before the majority of precipitation typically occurs implies a lack of accuracy, the SRI is a reasonable representation of conditions at the time of its publication and is computed using a consistent methodology each year, so it is a reasonable index for use in computing the January MRR. The SRI is the sum of the historical and forecasted unimpaired flow (in millions of acre-feet) for the water year at:

- The Sacramento River above Bend Bridge
- The Feather River at Oroville
- The Yuba River at Smartsville
- The American River below Folsom Reservoir

Reclamation's January 2015 Benchmark simulation included a timeseries for the SRI; the Modified FMS uses the SRI timeseries already included in Reclamation's January 2015 Benchmark simulation, it is stored as a timeseries in the 2020D09ESV.dss file.

3.3.1.2 American River Index

The Modified FMS uses the ARI to determine the MRRs for February through December. The ARI is intended to represent the water available for use from the American River; it is computed by subtracting Folsom Reservoir spills to date from the forecasted water year American River unimpaired flow at Folsom Dam.

The Water Forum's approach for determining spill volume and implementing the ARI are described subsequent to the forecast methodology description.

Forecasts of Unimpaired American River Flow at Folsom Dam

The unimpaired American River flow at the Folsom Dam portion of the ARI was determined assuming perfect foresight, and uses historical full natural flows for the American River at Folsom from CDEC as a surrogate for forecasted water year unimpaired flow. The unimpaired American River at Folsom Dam values are stored in a lookup file, AR_B120.table.

Folsom Reservoir spills

The total volume of spills is computed each timestep between February and May by adding up simulated Folsom Reservoir releases greater than 8,000 cfs between the October 1 and the previous month. 8,000 cfs was used as the threshold for identifying spills because 8,000 cfs is the maximum capacity of the Folsom Power Plant, and the Water Forum assumed any releases above the powerhouse capacity would be for flood management.

Implementation of the ARI

The ARI is recomputed each month between February and May by subtracting the Folsom Reservoir spills from the forecasted water year inflow. The May ARI value is the final value for the year and is used through the end of December.

3.3.2 Minimum Release Requirement Calculation

The MRRs are determined using values of the ARI and SRI and an MRR implementation curve. Figure 2 shows a general MRR implementation curve, showing the relationship between the appropriate hydrologic index and the MRR.

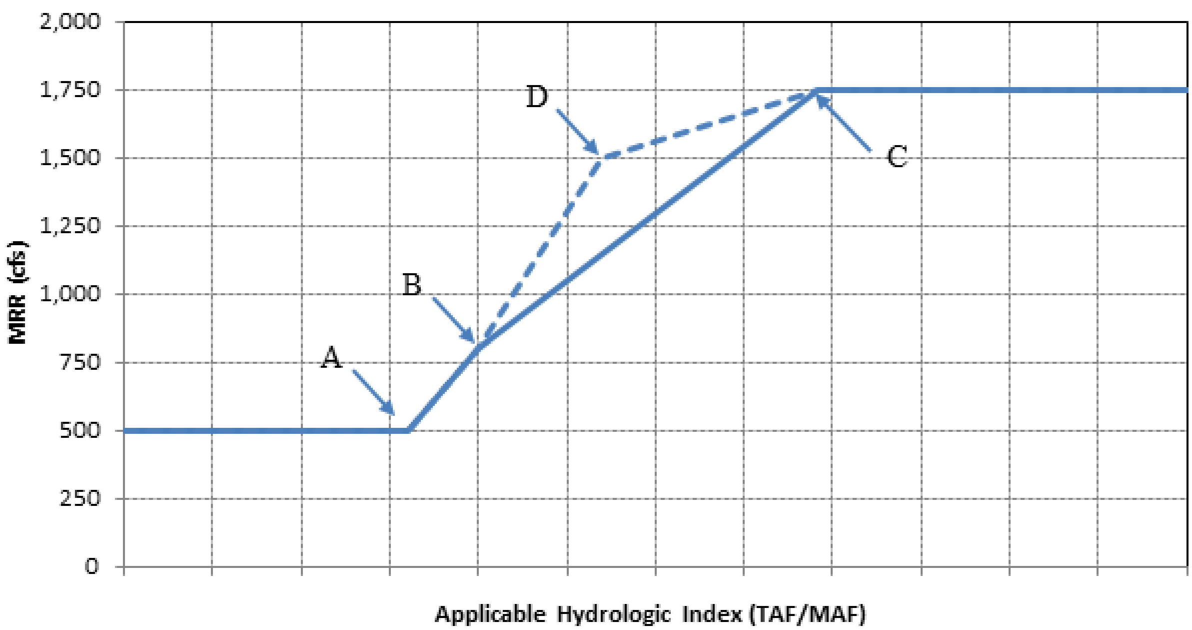

Figure 2. General Relationship between Applicable Hydrologic Index and Minimum Release Requirement

Table 3.3-1 summarizes the relationships between points A, B, and C shown in Figure 2. The MRR for index values between points B and C are linearly interpolated between the values specified by points B and C. The MRR value specifies the minimum release, but does not preclude releases of flows above the MRR. The monthly relationship between index value and MRR is in a lookup file, MRR_Schedule.table.

Table 3. Summary of Relationship between Hydrologic Index and MRR

<table>
<tr><th rowspan="2">Months</th><th rowspan="2">Hydrologic Index Used</th><th colspan="2">Point A</th><th colspan="2">Point B</th><th colspan="2">Point C</th></tr>
<tr><th>Index Value (TAF)</th><th>MRR Value (cfs)</th><th>Index Value (TAF)</th><th>MRR Value (cfs)</th><th>Index Value (TAF)</th><th>MRR Value (cfs)</th></tr>
<tr><td>Jan</td><td>SRI</td><td>5,500</td><td rowspan="3">500</td><td>7,800</td><td rowspan="3">800</td><td>11,500</td><td>1,750</td></tr>
<tr><td>Feb – Mar</td><td rowspan="2">ARI</td><td rowspan="2">800</td><td rowspan="2">1,000</td><td>1,958</td><td>1,750</td></tr>
<tr><td>Apr – Jun</td><td>2,210</td><td>1,500</td></tr>
</table>

Jul – Sep						1,958	1,750
Oct				1,500		1,914	1,500
Nov-Dec						2,210	2,000

The July through September curve includes a point D, corresponding to an ARI of 1,200 TAF and an MRR of 1,500 cfs.

3.3.3 End-of-May Storage Requirement

The Modified FMS includes an end-of-May (EOM) storage requirement for Folsom Reservoir that varies based on the ARI amount. The required storage is determined in February with the initial computation of ARI, and then is updated each month as the ARI is recomputed.

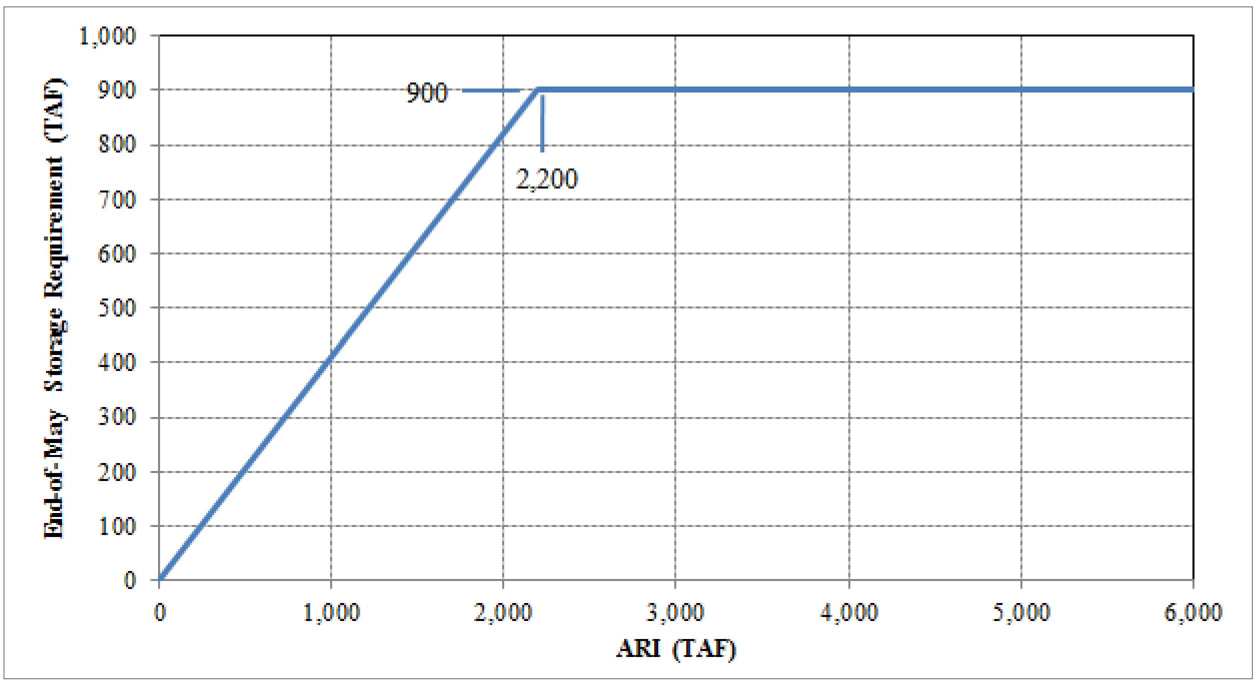

Figure 3. Relationship between ARI and End-of-May Storage Requirement

The Water Forum's CalSim II logic for computing operations to meet the EOM storage requirement includes the determination of the monthly storage needed at the end of each month between the current month, starting in February, and the end of May with the following requirements:

- Meet the MRR each month (based on the current month's ARI value)
- Provide Folsom Reservoir and Lake Natoma water supply diversions
- Cover monthly evaporation

The relationship between ARI and the EOM storage requirement is defined in the table, EOMay_Target.table. Each month between February and May, the required storage to ensure the end-of-May storage requirement is met is computed using the following equation

$$S_{Required} = S_{EOM} - I_{cum} + Del_{cum} + Evap_{cum} + MRR_{cum}$$

Where:

$S_{Required}$ = the required end-of-current month storage to meet the EOM storage requirement

S_{EOM} = the EOM storage requirement

I_{cum} = the cumulative inflow volume from the end of the current month through the end of May. The Water Forum assumed there would be perfect foresight for Folsom Reservoir and Lake Natoma inflows through the end of May from arcs I8, I300, and I9. (TAF)

Del_{cum} = Cumulative water supply deliveries between the end of the current month and the end of May, assuming full water rights and current CVP M&I allocations from arcs D8, D300, and D9. (TAF)

$Evap_{cum}$ = Cumulative evaporation between the end of the current month and the end of May. (TAF)

MRR_{cum} = Cumulative MRR volume between the end of the current month and the end of May. (TAF)

Evaporation was estimated through a regression relating the end of the previous month's storage to the cumulative evaporation from the following month through the end of May. For example, the end-of-February target storage calculation would ensure adequate storage to meet March through May evaporation, and would be based on the end-of-January storage. Table 4 shows the coefficients used to forecast cumulative evaporation.

Table 4. Cumulative Evaporation Coefficients

	End-of-Month Storage Used	Coefficient
March-May Evaporation (for end-of-February storage target)	January	0.025931
April-May Evaporation (for end-of-March storage target)	February	0.017356
May Evaporation (for end-of-April storage target)	March	0.010753

For example, to compute the April through May evaporation for purposes of determining the end-of-March storage target, the equation would be:

$$Evap_{Apr\text{-}May} = 0.017356 * S_{Feb}$$

Where

$Evap_{Apr\text{-}May}$ = April through May evaporation volume (TAF)

S_{Feb} = End-of-February Folsom Reservoir Storage (TAF)

Using similar assumptions and the end-of-month storage from the previous month, the end-of-current-month storage was also computed in each timestep. The current month's end-of-month storage is computed using the equation,

$$S_{Forecasted} = S_{prev} - I + Del + Evap + MRR$$

Where:

$S_{Forecasted}$ = the forecasted end-of-current month storage

S_{prev} = the previous month's end-of-month storage

I = The current month's inflow volume. The Water Forum assumed perfect foresight for Folsom Reservoir and Lake Natoma inflows from arcs I8, I300, and I9.

Del = The current month's water supply deliveries from Folsom Reservoir and Lake Natoma assuming the current CVP water-service allocation and full water right supplies from arcs D8, D300, and D9.

Evap = The current month's evaporation, based on a regression relating the end-of-previous month's storage to current month's evaporation, shown in Table 5.

MRR = The current month's MRR volume

Table 5. Coefficients for Computing Current Month's Evaporation

Month	End-of-Month Storage Used	Coefficient
February	January	0.002118
March	February	0.004316
April	March	0.006575
May	April	0.008712

For example, to compute the March evaporation for purposes of determining the end-of-March storage target, the equation would be:

$$Evap_{Mar} = 0.004316 * S_{Feb}$$

Where

$Evap_{Mar}$ = March evaporation volume (TAF)

S_{Feb} = End-of-February Folsom Reservoir Storage (TAF)

The difference between the current month's forecasted end-of-month storage and the current month's required end-of-month storage is the target storage volume for the current month. After computing the current month's target storage volume, the allowable release volume was converted to a maximum allowable flow, and a penalty of 1,300 was applied in CalSim II for releases exceeding the maximum allowable flow. Using a penalty on flows exceeding the maximum allowable flow, rather than a hard constraint, allowed some operational flexibility when downstream demands required release from Folsom Reservoir. All of the EOM storage requirement logic is contained in the FMStandard.wresl file.

3.3.4 End-of-December Storage Requirements

Similar to the EOM storage requirement, the Modified FMS also includes an end-of-December (EOD) storage requirement. Except for in EOD storage requirement exemption years, as defined in Section 3.3.1.3, the Water Forum has identified 300 TAF as the end-of-December Folsom Reservoir storage requirement. EOD storage requirement exemption years use an EOD requirement of 230 TAF rather than 300 TAF.

The Water Forum's CalSim II logic for identifying the maximum allowable release to meet the EOD storage requirement computes the monthly storage needed at the end of each month between the current month, starting in June, and the end of December with the following requirements:

- Meet the MRR each month
- Cover monthly evaporation
- Provide Folsom Reservoir and Lake Natoma water supply diversions

The Water Forum assumed there would be perfect foresight for Folsom Reservoir and Lake Natoma inflows from CalSim II arcs I8, I300, and I9 through the end of September. Inflows to Folsom Reservoir and Lake Natoma in October, November, and December were assumed to be the 90% exceedance volume of the CalSim II period of record inflows for October through December from arcs I8, I300, and I9. Analysis of the CalSim II inflow data indicated the 90% exceedance inflow volume for the period of record was 175.79 TAF, corresponding to 1933. The monthly breakdown of the 90% inflow volume is as follows:

- October – 58.68 TAF
- November – 55.41 TAF

- December – 61.70 TAF

Each month between June and December, the end-of-month storage to ensure the EOD storage requirement will be met is computed using the following equation

$$S_{Required} = S_{Dec} - I_{cum} + Del_{cum} + Evap_{cum} + MRR_{cum}$$

Where:

$S_{Required}$ = the required end-of-current month storage required to meet the end-of-December required storage.

S_{Dec} = the end-of-December storage requirement

I_{cum} = the estimated cumulative inflow volume from the end of the current month through the end of December, as described above.

Del_{cum} = estimated cumulative water supply deliveries between the end of the current month and the end of December assuming full water rights and current CVP M&I water-service allocations for deliveries from arcs D8, D300, and D9.

$Evap_{cum}$ = estimated cumulative evaporation between the end of the current month and the end of December.

MRR_{cum} = estimated cumulative MRR volume between the end of the current month and the end of December.

Evaporation was estimated through a regression relating the end of the previous month's storage to the cumulative evaporation from the following month through the end of December. Table 6 shows the coefficients used to forecast cumulative evaporation.

Table 6. Cumulative Evaporation Coefficients

	End-of-Month Storage Used	Coefficient
July-December Evaporation (for end-of-June storage target)	May	0.030047
August-December Evaporation (for end-of-July storage target)	June	0.020304
September-December Evaporation (for end-of-August storage target)	July	0.013903
October-December Evaporation (for end-of-September storage target)	August	0.007751
November-December Evaporation (for end-of-October storage target)	September	0.003367
December Evaporation (for end-of-November storage target)	October	0.001303

For example, to compute the August through December evaporation for purposes of determining the end-of-July storage target, the equation would be:

$$Evap_{Aug\text{-}Dec} = 0.020304 * S_{Jun}$$

Where

$Evap_{Aug\text{-}Dec}$ = August through December evaporation volume (TAF)

S_{Jun} = End-of-June Folsom Reservoir Storage (TAF)

Using similar assumptions and the end-of-month storage from the previous month, the end-of-current-month storage was also computed in each timestep. The current month's end-of-month storage is computed using the equation,

$$S_{Forecasted} = S_{prev} - I + Del + Evap + MRR$$

Where:

$S_{Forecasted}$ = the forecasted end-of-current month storage

S_{prev} = the previous month's end-of-month storage

I = The current month's inflow volume. The Water Forum assumed perfect foresight for Folsom Reservoir and Lake Natoma inflows.

Del = The current month's water supply deliveries from Folsom Reservoir and Lake Natoma assuming the current CVP allocation and full water right supplies.

Evap = The current month's evaporation, based on a regression relating the end-of-previous month's storage to current month's evaporation, shown in Table 7.

MRR = The current month's MRR volume

Table 7. Coefficients for Computing Current Month's Evaporation

Month	End-of-Month Storage Used	Coefficient
June	May	0.009442
July	June	0.012246
August	July	0.011374
September	August	0.009190
October	September	0.006103
November	October	0.002793
December	November	0.001541

For example, to compute the July evaporation for purposes of determining the end-of-July storage target, the equation would be:

$$Evap_{Jul} = 0.012246 * S_{Jun}$$

Where

$Evap_{Jul}$ = March evaporation volume (TAF)

S_{Jun} = End-of-June Folsom Reservoir Storage (TAF)

The difference between the current month's forecasted end-of-month storage and the required end-of-month storage for the current month is used to compute a maximum release for the current month, and a penalty of 1,300 was applied in CalSim II for releases exceeding the maximum allowable flow. Using a penalty on flows exceeding the maximum allowable flow, rather than a hard constraint would allow some operational flexibility when downstream demands required release from Folsom Reservoir in excess of the MRR.

The Modified FMS does not prescribe a release pattern to releases above the MRR CalSim II makes decisions about releases each period. The maximum release rate is made in one particular month, and storage in that month would be drawn down to the minimum necessary to meet the end-of-December requirement, subsequent months' calculations would indicate a penalty on any flow above the MRR. All of the EOD storage requirement logic is in FMStandard.wresl.

3.3.4.1 End-of-December Storage Requirement Exemptions

The Water Forum included an exemption to the 300 TAF EOD requirement based on the predicted March through November unimpaired inflow to Folsom Reservoir (UIFR), computed using the median forecast for March through September unimpaired inflow to Folsom Reservoir plus 60 TAF, to account for persistent dry conditions for one- two- three-, and four-year droughts. All four drought exceptions use the cumulative UIFR volume to determine if the EOD storage for a year is required to be 300 TAF or a lower requirement of 230 TAF. The cumulative UIFR volume is the sum of the prior one, two, or three years' March through November UIFR and the current year's forecasted UIFR. Table 8 specifies the UIFR amount required for an EOD exemption for each duration. An exemption to the 300 TAF EOD requirement would occur whenever at least one of the four volumes is less than the applicable amount. Each year's UIFR is defined in CalSim II in a lookup table, UIFR.table.

Table 8. Cumulative March through November unimpaired inflow (TAF) to Folsom Reservoir for 300 TAF EOD exemptions for one-, two-, three-, and four-year drought persistence scenarios.

	Cumulative March – November UIFR (TAF)
1-Year Dry-Year Volume	400
2-Year Dry-Year Volume	1,200
3-Year Dry-Year Volume	2,700
4-Year Dry-Year Volume	4,400

These volumes were determined based on a review of historical UIFR volumes for 1901 through 2015. The two-, three-, and four-year definitions were selected to ensure the driest two-, three-, and four- year periods on record would be categorized as EOD exception years.

3.3.5 Redd Dewatering Protections

Redd dewatering protective adjustments (RDPAs) were imposed on the MRR to limit potential redd dewatering due to reductions in the MRR during the January through May period. The RDPAs would limit the amount the MRR can be reduced during this period. Two RDPAs were included: (1) the Chinook salmon RDPA in January; and (2) the steelhead RDPA in February through May. After calculation of the index-based MRR (as determined by the appropriate hydrologic index, SRI or ARI) the RDPA-based MRR would be calculated. The MRR with the higher value, the index-based MRR or the RDPA-based MRR, would determine the final MRR. RDPAs would limit the amount of dewatering due to a reduction of the MRR, not the actual river release (which often would be higher than the MRR) and, as such, would not always minimize dewatering impacts to the same extent. The logic for each of these protections is in the CalSim II file, FMStandard.wresl. Each of the species has protective operations built into CalSim II, those operations are discussed below.

3.3.5.1 Fall-Run Chinook Salmon

The Water Forum's fall-run Chinook salmon redd dewatering protection is based on limiting the reductions in MRR between the December and January or February.

The fall-run Chinook salmon RDPA-based MRR is computed by multiplying the December ARI-based MRR by 0.7, representing a maximum 30% reduction in MRR from December to both January and February. If the Chinook salmon RDPA-based MRR for January is less than the SRI-based MRR for January, or the ARI-based MRR for February, then the SRI-based MRR for January or ARI-based MRR for February would be used. Otherwise, the Chinook salmon RDPA-based MRR would be used.

3.3.5.2 Steelhead

The steelhead RDPA would use the MRR from January and February to control MRR reductions in February through May to limit the potential dewatering of steelhead redds due to a reduction in the MRR.

First the January MRR would be used to set the minimum allowable MRR in February through May based upon Table 3.3-9. In some instances the MRR may increase from January to February. If the February MRR is higher than the January MRR, then the February MRR would be used to set the minimum MRR for March through May based upon Table 9. If the steelhead RDPA-based MRR is less than the index-based MRR, then the index-based MRR would be used. If the January or February MRR are in between the values provided in Table 9 the steelhead RDPA-based MRR would be interpolated between the nearest values. This table is contained in a file called, AmerSteelhead.table.

Table 9. Steelhead RDPA-based February through May MRR.

MRR_{Jan} or MRR_{Feb} (cfs)	Steelhead RDPA-Based MRR for February-May (cfs)
≤700	500
800	520
900	580
1,000	640
1,100	710
1,200	780
1,300	840
1,400	950
1,500	1,030
1,600	1,100
1,700	1,180
1,800	1,250

3.3.6 March Pulse Flows

The Water Forum has included a pulse flow in March to provide a biological cue for fall-run Chinook salmon to begin exiting the American River. A pulse flow would be triggered if the MRR in March, after calculation of the redd dewatering protections, is between 1,000 cfs and 1,500 cfs. The pulse flow magnitude is assumed to be either 3 times the MRR or 4,000 cfs, which ever would be less. The pulse flow is assumed to be a 2-day pulse in March followed by a 500-cfs-per-day ramp down to the original MRR. Since CalSim II is a monthly model, the volume of the pulse flow is computed and then converted to a monthly average flow. The subsequent MRR for April, May, and June is reduced from the ARI-based MRR by an equivalent volume as the pulse flow, distributed evenly across the three months, so the total MRR volume between March and June is not affected by the pulse. The resulting March through May MRRs reflecting the pulse flow are compared to the redd dewatering protection flows; the greater of the two flows is the controlling MRR. The March Pulse Flow logic is contained in the CalSim II file, FMStandard.wresl.

4 References

California Department of Water Resources (DWR). 2000. CALSIM Water Resources Simulation Model. Modeling Support Branch, Bay-Delta Office. Sacramento, California. http://modeling.water.ca.gov/hydro/model/index.html

___________. 2015. The State Water Project Final Delivery Capability Report 2015. State of California, Natural Resources Agency. July 2015.

___________. 2015. California Data Exchange Center (CDEC). http://cdec.water.ca.gov/cgi-progs/queryCSV?station_id=AMF&dur_code=M&sensor_num=65&start_date=1900/10/01&end_date=2015/01/31. Accessed February 20, 2015

City of Folsom. 2015. Personal communication from Marcus Yasutake on March 31, 2015

Draper, A.J., A. Munévar, S. Arora, E. Reyes, N. Parker, F. Chung, and L. Peterson (Draper et al.). 2004. CALSIM: A generalized model for reservoir system analysis. Journal of Water Resources Planning and Management, ASCE, 130(6).

U.S. Department of Interior, Bureau of Reclamation (Reclamation). 2015. Coordinated Long-Term Operation of the Central Valley Project and State Water Project, Final Environmetnal Impact Statement. Mid-Pacific Region, Bay-Delta Office. November 2015

San Juan Water District (SJWD). 2015. Personal communication from Shauna Lorance on February 18, 2015

U.S. Department of Interior, Bureau of Reclamation (Reclamation). 2016. Biological Assessment for the California WaterFix. January 2016.