# Attachment 1 Model Assumptions

## Introduction

Benchmark models were prepared at historical (Benchmark 011721 HIST) and 2035 climate conditions (Benchmark 011721 2035CT).

Sections 2 and 3 describe the assumptions used for each model simulation. Section 4 lists references cited.

The assumptions for the model simulations for the two Benchmark models are also summarized in table format in Attachment 2 CalSim II Model Assumptions Callouts.

Detailed tabulation of delivery specifications in CalSim II are provided in Attachment 3 CalSim II Model Delivery Specifications.

Any use of results of model simulations should observe limitations of the models used as well as the limitations to the modeled Benchmarks. These results should only be used for comparative purposes. More information regarding limitations of the models used as well as the limitations to the modeled Benchmarks is included Attachment 4 Model Limitations.

## Assumptions for the Benchmark 011721 HIST

This section presents the assumptions used in developing the CalSim II simulation of the Benchmark 011721 HIST.

The Benchmark 011721 HIST represents CVP and SWP operations to comply with the 2019 Biological Opinions and the 2020 State Water Project Incidental Take Permit regulatory environment as of January 2021 under current climate conditions. This includes existing facilities and ongoing programs that existed as of January 2021. Additionally, this product includes facilities and programs that received approvals and permits by January 2021.

### CalSim II Assumptions for the Benchmark 011721 HIST

The following is a description of the assumptions listed in Attachment 2 CalSim II Model Assumptions Callouts.

#### Hydrology

##### Inflows/Supplies

The CalSim II model includes the historical hydrology with projected 2020 modifications for operations upstream of the rim reservoirs.

##### Level of Development

CalSim II uses a hydrology which is the result of an analysis of agricultural and urban land use and population estimates. The assumptions used for Sacramento Valley land use result from aggregation of historical survey and projected data developed for the California Water Plan Update (Bulletin 160-98). Generally, land use projections are based on Year 2020 estimates (hydrology serial number 2020D09E), however the San Joaquin Valley hydrology reflects draft 2030 land use assumptions developed by Reclamation. Where appropriate Year 2020 projections of demands associated with water rights and CVP and SWP water service contracts have been included. Specifically, projections of full build out are used to describe the American River region demands for water rights and CVP contract supplies, and California Aqueduct and the Delta Mendota Canal SWP/CVP contractor demands are set to full contract amounts.

CVP Settlement Contractor Consumptive Use of Applied Water (CUAW) Demands are modified to match historical annual volumes and monthly distributions, based on historical data from 2000 – 2016. The monthly distributions of annual contract amounts were also modified to match the distributions of CUAW demand.

##### Demands, Water Rights, CVP/SWP Contracts

CalSim II demand inputs are preprocessed monthly time series for a specified level of development (e.g. 2020) and according to hydrologic conditions. Demands are classified as CVP project, SWP project, local project, or non-project. CVP and SWP demands are separated into different classes based on the contract type. A description of various demands and classifications included in CalSim II is provided in the 2008 OCAP BA Appendix D (USBR, 2008a).

The detailed listing of CVP and SWP contract amounts and other water rights assumptions are included in the delivery specification tables in Attachment 3 CalSim II Model Delivery Specifications.

###### **CCWD**

Contra Costa Water District’s (CCWD) annual service area demands are met by CVP service contract deliveries and other CCWD diversions. To be consistent with CCWD’s latest modeling, the Benchmark 011721 HIST model includes in-Delta transfers to meet CCWD demands not otherwise met by CVP service contract deliveries and other CCWD diversions.

#### Facilities

All CVP-SWP existing facilities are simulated based on operations criteria under current regulatory environment.

CalSim II includes representation of all the existing CVP and SWP storage and conveyance facilities. Assumptions regarding selected key facilities are included in the callout tables in Attachment 2 CalSim II Model Assumptions Callouts.

CalSim II also represents the flood control weirs such as the Fremont Weir located along the Sacramento River at the upstream end of the Yolo Bypass (Reclamation, 2017).

The Benchmark 011721 HIST also includes the Freeport Regional Water Project, located along the Sacramento River near Freeport and the City of Stockton Delta Water Supply Project (30 mgd capacity).

A brief description of the key export facilities located in the Delta and included under the Benchmark 011721 HIST run is provided below.

The Delta serves as a natural system of channels to transport river flows and reservoir storage to the CVP and SWP facilities in the south Delta, which export water to the projects’ contractors through two pumping plants: CVP’s C.W. Jones Pumping Plant and SWP’s Harvey O. Banks Pumping Plant. Jones and Banks Pumping Plants supply water to agricultural and urban users throughout parts of the San Joaquin Valley, South Lahontan, Southern California, Central Coast, and South San Francisco Bay Area regions.

The Contra Costa Canal and the North Bay Aqueduct supply water to users in the northeastern San Francisco Bay and Napa Valley areas.

##### Fremont Weir

Fremont Weir is a flood control structure located along the Sacramento River at the head of the Yolo Bypass. To enhance the potential benefits of the Yolo Bypass for various fish species, the Fremont Weir is assumed to be notched to provide increased seasonal floodplain inundation. It is assumed that an opening in the existing weir and operable gates are constructed at invert elevation 14 feet along with two smaller openings and operable gates at invert elevation 18 feet. This structure is further described in the Yolo Bypass Salmonid Habitat Restoration and Fish Passage EIS/EIR Alternative 1.

##### CVP C.W. Bill Jones Pumping Plant (Tracy PP) Capacity

The Jones Pumping Plant consists of six pumps including one rated at 800 cfs, two at 850 cfs, and three at 950 cfs. Maximum pumping capacity is assumed to be 4,600 cfs with the 400 cfs Delta Mendota Canal (DMC) –California Aqueduct Intertie that became operational in July 2012.

##### SWP Banks Pumping Plant Capacity

SWP Banks pumping plant has an installed capacity of about 10,300 cfs. The SWP water rights for diversions specify a maximum of 10,300 cfs, but the U. S. Army Corps’ of Engineers (ACOE) permit for SWP Banks Pumping Plant allows a maximum pumping of 6,680 cfs. With additional diversions depending on Vernalis flows the total diversion can go up to 10,300 cfs during December 15 – March 15. Additional capacity of 500 cfs (pumping limit up to 7,180 cfs) is allowed to reduce impact of 2020 SWP ITP Spring Outflow Action on the SWP.

##### CCWD Intakes

The Contra Costa Canal originates at Rock Slough, about four miles southeast of Oakley, and terminates after 47.7 miles at Martinez Reservoir. Historically, diversions at the unscreened Rock Slough facility (Contra Costa Canal Pumping Plant No. 1) have ranged from about 50 to 250 cfs. The canal and associated facilities are part of the CVP; but are operated and maintained by the Contra Costa Water District (CCWD). CCWD also operates a diversion on Old River and the Alternative Intake Project (AIP), the new drinking water intake at Victoria Canal, about 2.5 miles east of Contra Costa Water District’s (CCWD) intake on the Old River. CCWD can divert water to the Los Vaqueros Reservoir to store good quality water when available and supply to its customers.

To be consistent with CCWD’s latest Los Vaqueros modeling, the Benchmark model includes updated local inflow, precipitation, and evaporation values for Los Vaqueros Reservoir.

##### Suisun March Salinity Control Gates

The Suisun Marsh Salinity Control Gates (SMSCG) are located on Montezuma Slough about 2 miles downstream from the confluence of the Sacramento and San Joaquin Rivers, near Collinsville. The objective of the SMSCG operation is to decrease the salinity of the water in Montezuma Slough. The gates control salinity by restricting the flow of higher salinity water from Grizzly Bay into Montezuma Slough during incoming tides and retaining lower salinity Sacramento River water from the previous ebb tide. Operation of the gates in this fashion lowers salinity in Suisun Marsh channels and results in a net movement of water from east to west through Suisun Marsh.

##### Red Bluff Pumping Plant

Benchmark 011721 HIST assumes that the pumping capacity at Red Bluff Pumping Plant is 2,000 cfs.

##### Hamilton City Pump Station

Benchmark 011721 HIST assumes that the pumping capacity at Hamilton City Pump Station is 3,000 cfs.

#### Regulatory Standards

The regulatory standards that govern the operations of the CVP and SWP facilities under the Benchmark 011721 HIST are briefly described below. Specific assumptions related to key regulatory standards are also outlined below.

##### D-1641 Operations

The SWRCB Water Quality Control Plan (WQCP) and other applicable water rights decisions, as well as other agreements are important factors in determining the operations of both the Central Valley Project (CVP) and the State Water Project (SWP).

The December 1994 Accord committed the CVP and SWP to a set of Delta habitat protective objectives that were incorporated into the 1995 WQCP and later, were implemented by D-1641. Significant elements in D-1641 include X2 standards, export/inflow (E/I) ratios, Delta water quality standards, real-time Delta Cross Channel operation, and San Joaquin flow standards.

##### Coordinated Operations Agreement (COA)

The CVP and SWP use a common water supply in the Central Valley of California. Reclamation and DWR have built water conservation and water delivery facilities in the Central Valley in order to deliver water supplies to project contractors. The water rights of the projects are conditioned by the SWRCB to protect the beneficial uses of water within each respective project and jointly for the protection of beneficial uses in the Sacramento Valley and the Sacramento-San Joaquin Delta Estuary. The agencies coordinate and operate the CVP and SWP to meet the joint water right requirements in the Delta.

The Coordinated Operations Agreement (COA), signed in 1986, defines the project facilities and their water supplies, sets forth procedures for coordination of operations, identifies formulas for sharing joint responsibilities for meeting Delta standards as they existed in SWRCB Decision 1485 (D-1485), identifies how unstored flow will be shared, sets up a framework for exchange of water and services between the Projects, and provides for periodic review of the agreement.

Reclamation and DWR re-negotiated COA in 2018. This model includes the new COA. The amendment stipulates a change in responsibility for making storage withdrawals to meet in-basin use (as noted in Table 1-1) and a change in export capacity when exports are constrained (Table 1-2).

Table 1-1. Sharing of Responsibility of Meeting In-basin Use

|  |  |  |
| --- | --- | --- |
|  | **CVP** | **SWP** |
| W | 80% | 20% |
| AN | 80% | 20% |
| BN | 75% | 25% |
| D | 65% | 35% |
| C | 60% | 40% |

Table 1-2. Sharing of Applicable Export Capacity When Exports Are Constrained

|  |  |  |
| --- | --- | --- |
|  | **CVP** | **SWP** |
| Balanced Water Conditions | 65% | 35% |
| Excess Water Conditions | 60% | 40% |

##### CVPIA (b)(2) Assumptions

Reclamation releases flows for Central Valley Project Improvement Act (CVPIA) 3406(b)(2) water allocation, management, and related actions (B2). The selection of discretionary actions for use of B2 water in each year was based on a May 2003 Department of the Interior policy decision. CalSim II does not dynamically account for the use of (b)(2) water, but rather assumes (b)(2) actions are achieved through NMFS BO (2019) actions.

##### Clear Creek Flows

Reclamation releases Clear Creek flows in accordance with the 1960 Memorandum of Agreement (MOA) with CDFW, and the April 15, 2002 SWRCB permit, which established minimum flows to be released to Clear Creek at Whiskeytown Dam. Reclamation operations to a minimum baseflow in Clear Creek of 200 cfs from October through May, and 150 cfs from June through September in all year types except Critical year types. In Critical years, Clear Creek base flows would be reduced below 150 cfs based on available water from Trinity Reservoir. Additional flow may be required for temperature management during the fall. A ramping rate of no more than 25 cfs per hour during nocturnal hours will be used to reduce potential stranding risks to juvenile salmonids during Whiskeytown controlled flow reductions.

In addition, Reclamation creates pulse flows for both channel maintenance and spring attraction flows. For spring attraction flows, Reclamation releases 10 Thousand Acre-Feet (TAF) (measured at the release), with daily release up to the safe release capacity (approximately 900 cfs, depending on reservoir elevation and downstream capacity), in all year-types except for Critical year-types to be shaped by the Clear Creek Implementation Team in coordination with CVO. For channel maintenance flows, Reclamation would release 10 TAF from Whiskeytown, with a daily release up to the safe release capacity, in all year-types except for Dry and Critical year-types (based on the Sacramento Valley index) to be shaped by the Clear Creek Implementation Team in coordination with CVO. Pulses would be scheduled with CVO. No channel maintenance flows would be scheduled before January 1. For each storm event that results in a Whiskeytown Gloryhole spill of at least 3,000 cfs for 3 days, Reclamation will reduce the channel maintenance flow volume for this year or the following year by 5,000 acre-feet. If two Gloryhole spills occur that meet this criterion in a year, additional channel maintenance flows would not be released in that year. In Critical years, Reclamation would release one spring attraction flow of up to the safe release capacity (approximately 900 cfs) for up to 3 days and would not release any channel maintenance flows. Reclamation could instead, or in addition, use mechanical methods to mobilize gravel or shape the channel if needed to meet biological objectives.

The Clear Creek operations, for CalSim II modeling purposes, are assumed as follows:

* Minimum flow of 200 CFS from October through May and 150 CFS from June through September in all years except critical years. Minimum flow of 150 CFS in all months in critical years (water-year type based on SWRCB D-1641 40-30-30 index).
* Spring pulse flow totaling a volume of 10 TAF in June of non-critical years. Pulse flows are in addition to minimum flow and are distributed to the whole month's average flow rate.
* 3-day Spring pulse of 900 cfs in Critical years; the other 27 days are at the base flow.
* Channel maintenance flow totaling a volume of 10 TAF in February of all years except dry and critically dry years (volume in addition to minimum flow; distributed to the whole month's average flow rate).

As CalSim II is a monthly model, ramping rates and release capacity limitations that constrain actual operations are not included. Other flow adjustments for consideration of actual storage and temperature operations are not included.

Previously modeled Clear Creek operations were removed from the CalSim II model, including CVPIA 3406(b)(2) related flows pre-processed from 2008 OCAP BA model studies and the 2009 NMFS RPA Action 1.1.1 pulse flows.

##### Upper Sacramento River

In the Benchmark 011721 HIST, SWRCB WR 90-5 requirements are included. In addition, seasonal operations for Fall flows and Spring pulse flows are included.

###### **Fall flows**

Reclamation rebuilds storage and cold water pool for the subsequent year. Maintaining releases to keep late spawning Winter-Run Chinook Salmon redds underwater may drawdown storage necessary for temperature management in a subsequent year.

If Reclamation determines reduced releases are needed to rebuild storage, targets for winter base flows (December 1 through the end of February) from Keswick would be set in October based on Shasta Reservoir end-of-September storage. Table 1-3 shows the initial schedule for Keswick Releases based on Shasta Reservoir storage condition; these would be refined through future modeling efforts as part of the seasonal operations planning.

Table 1-3 Keswick Dam Release Target Schedule based on Shasta Reservoir End-of-September Storage

|  |  |
| --- | --- |
| Shasta Reservoir  End-of-September Storage | Keswick Dam Release Target |
| ≤ 2.2 MAF | 3,250 CFS |
| ≤ 2.8 MAF | 4,000 CFS |
| ≤ 3.2 MAF | 4,500 CFS |
| > 3.2 MAF | 5,000 CFS |

For CalSim II modeling purposes, the Keswick Dam release targets were specified as weighted goals. The weighted goals cause the model to increase or decrease the flow release as the model is able to meet the target flow. The selected weights for the goals would not prevent the model from releasing water from Shasta Reservoir for CVP project regulatory environmental, flood control or water supply purposes.

###### **Shasta Spring pulse flows**

Reclamation would release spring pulse flows of up to 150 TAF in coordination with the Upper Sacramento Scheduling Team when the projected total May 1st Shasta Reservoir storage indicates a likelihood of sufficient cold water to support summer cold water pool management, and the pulse does not interfere with the ability to meet performance objectives or other anticipated operations of the reservoir. Reclamation would evaluate the projected May 1st Shasta Reservoir storage at the time of the February forecast to determine whether a spring pulse would be allowed in March and would evaluate the projected May 1st Shasta Reservoir storage at the time of the March forecast to determine whether a spring pulse would be allowed in April. Reclamation anticipates that a projected May 1st storage greater than 4 MAF provides sufficient cold water pool management for Tier 1 and may release the spring pulse if it does not impact the ability to meet project objectives. Reclamation could also determine, in coordination with the Upper Sacramento scheduling team, that while the reservoir is less than 4 MAF, there is sufficient water to do a pulse of up to 150 TAF. The Upper Sacramento Scheduling Team would determine the timing, duration, and frequency of the spring pulse within the 150 TAF volume. Wet hydrology downstream of Keswick Dam may meet the need for pulse flows without increased releases.

The spring pulse could be 0 to 2 pulses of 10,000 cfs at Sacramento River at Wilkins Slough for 3 days each, in a time when Sacramento River at Wilkins Slough flows are less than 9,000 cfs. Following the initial three-day pulse targeting 10,000 cfs at Sacramento River at Wilkins Slough, Keswick flows could reduce by no more than 15% per night for flows greater than 6,000 cfs, and no more than 200 cfs per night for flows between 4,000 and 5,999 cfs.

The determination of when to make the spring pulse in the CalSim II model depends on the forecasted May 1st storage. For modeling purposes, a rule-of-thumb was used based on water year type and the end-of February storage to estimate the storage forecast. The forecast is done in March and uses end-of previous month storage and forecasted inflows to Shasta until May. The May 1st Shasta Reservoir storage threshold of 4.1 MAF was used consistent with the storage threshold for Tier 1 in the tiered temperature management approach. The model does not consider spring pulses when the estimated May 1st Shasta storage is below 4.1 MAF. In addition, the spring pulses are limited to wet and above normal years (based on Sacramento River 40-30-30 index) as the 4.1 MAF storage threshold in below normal and drier years may not be adequate to identify conditions where the spring pulse will not adversely affect the temperature management or other obligations of the CVP. The model calculates flood control releases from Shasta Reservoir in March and April. If the flood control releases are sufficient to meet the 150 TAF pulse objective, then no additional releases are made. If not, Shasta Reservoir releases are increased to up to 75 TAF in March and then in April, up to a total of 150 TAF of pulse flow in two months.

##### Continued CALFED Agreements

The Environmental Water Account (EWA) was established in 2000 by the CALFED Record of Decision (ROD). The EWA was initially identified as a 4-year cooperative effort intended to operate from 2001 through 2004 but was extended through 2007 by agreement between the EWA agencies. It is uncertain, however, whether the EWA will be in place in the future and what actions and assets it may include. Because of this uncertainty, the EWA has not been included in the current CalSim II implementation.

One element of the EWA available assets is the Lower Yuba River Accord (LYRA) Component 1 water. In the absence of the EWA and implementation in CalSim II, the LYRA Component 1 water is assumed to be transferred to South of Delta (SOD) State Water Project (SWP) contractors to help mitigate the impact of the NMFS BO and D1641 on SWP exports during April and May. An additional 500 cfs of capacity is permitted at Banks Pumping Plant from July through September to export this transferred water.

##### Water Transfers

###### **Lower Yuba River Accord (LYRA)**

Acquisitions of Component 1 water under the Lower Yuba River Accord, and use of 500 cfs dedicated capacity at Banks PP during July – September, are assumed to be used to reduce as much of the impact of the Apr – May Delta export actions on SWP contractors as possible.

###### **Phase 8 transfers**

Phase 8 transfers are not included in the Benchmark 011721 HIST simulation.

###### **Short-term or Temporary Water Transfers**

Short term or temporary transfers such as Sacramento Valley acquisitions conveyed through Banks PP are not included in the Benchmark 011721 HIST simulation.

#### Specific Regulatory Assumptions

##### Upper Sacramento Flow Management

Model includes SWRCB WR 90-5 and NMFS BO (Oct 2019) Section 3.1 achieved as possible through other modeled actions.

##### Lower Feather Flow Management

Model includes 1983 DWR, DFG Agreement (minimum flow 750 – 1,700 cfs, depending on runoff and month).

##### Lower American Flow Management

Model includes Water Forum’s 2017 Lower American Flow Management Standard where the flows range from 500 to 2,000 cfs based on time of year and annual hydrology. Planning minimum storage is represented in CalSim with a 275 TAF end-of December storage target in Folsom.

##### Folsom Flood Control Diagram

The 2019 Folsom Water Quality Control Manual relies on daily forecasts through the flood season; monthly implementation is able to use an updated time series instead of the old SAFCA-based timeseries.

##### Delta Outflow (Flow and Salinity)

###### **SWRCB D-1641**

All Delta outflow requirements per SWRCB D-1641 are included in the Benchmark 011721 HIST simulation. Similarly, for the February through June period the X2 standard is included in the Benchmark 011721 HIST simulation.

###### **Delta Smelt Summer-Fall Habitat Action**

The Delta Smelt Habitat Action is intended to improve Delta Smelt food supply and habitat, thereby contributing to the recruitment, growth, and survival of Delta Smelt. Reclamation and DWR propose to use structured decision making to implement Delta Smelt habitat actions as described in the 2019 BiOps and 2020 SWP ITP.

The action will initially include modifying project operations to maintain a monthly average 2 ppt isohaline at 80 km from the Golden Gate in above normal and wet water years in September and October. Reclamation and DWR will also implement additional measures that are expected to achieve additional benefits. These measures include, but are not limited to:

* Suisun Marsh Salinity Control Gate (SMSCG) operations described in the Operation Criteria section of this document.
* An additional 100 TAF of Delta Outflow is provided in Wet and Above Normal water years by cutting SWP exports in June through September as described in section 8.19 of the ITP. SWP allocations have been reduced in April and May to ensure the water is gained by cutting SWP exports. No more than 40 TAF of the additional outflow is immediately used to reach X2 of 80 km in June through August. The remaining SWP export cuts is backed up into Oroville for future use. If that carryover water in Oroville is likely to spill, it can be used to augment outflow in August to reach an X2 of 80 km. Otherwise, the carryover is used the following year depending on that year’s water type as follows: the water is kept for SWP deliveries for critical water years, used for SMSCG operations in June through September for dry water years, released in May to augment Delta Outflow regardless of X2 for Below Normal water years, and used to either to meet X2 or for SMSCG operations by September for Above Normal and Wet water years.

In the Delta Smelt Habitat Action Plan, the specifics of the flow and habitat actions will be more fully defined through a structured decision making or other review process.

For CalSim II modeling purposes, the Delta Outflow action is assumed as maintaining an X2 position of 80 km in September through October of wet and above normal years (based on the 40-30-30 Sacramento River Index). A ramping up of outflow preceding the action is assumed as achieving an X2 position of 82 km for last 14 days of August. The model tries to meet Delta outflow augmentation in the fall primarily through export reductions. CVP water operations were adjusted to balance reservoir operations in response to these reductions.

##### Combined Old and Middle River Flows

Reclamation and DWR propose to operate the CVP and SWP in a manner that maximizes exports while minimizing entrainment of fish and protecting critical habitat.

Proposed OMR management is modeled as follows:

Projects operate to an OMR index no more negative than a 14-day moving average of -5,000 cfs between January 1 and June 30 except for the following conditions:

* Integrated Early Winter Pulse Protection: After December 1, and when the 3-day average turbidity is 12 NTU or greater at Old River at Bacon Island (OBI), Prisoner’s Point (PPT), and Victoria Canal (VCU), Reclamation and DWR propose to operate to -2,000 cfs of the 14-day average OMR index for 14 days. The same model index of SAC\_RI developed for the USFWS RPA Action I representation is used in the model to determine when the turbidity exceeds 12 NTU.
* Turbidity Bridge Avoidance: For January and February in any water year type, if the Turbidity trigger is reached (SAC\_RI greater than or equal to 20,000 cfs), Projects operate to 14-day average OMR Index if -2000 cfs for five days. For March through June of Wet and Above Normal years, it is assumed that there will be one event of turbidity bridge avoidance in each month (-2000 cfs for five days).
* OMR Storm-Related Flexibility: It is assumed that there may be storm-related OMR management flexibility in January and February. In wet years, it is assumed that storm events will coincide with turbidity bridge events and no OMR flexibility is modeled. In Above Normal and Below Normal years, it is assumed that there will be one opportunity in January and one opportunity in February to operate to a more negative OMR index than -5000 cfs. This is modeled as 14-day OMR index of -6,250 cfs for 6 days in each month. In dry years, it is assumed that one opportunity occurs either in January or February but not both months.
* Species-specific cumulative salvage or loss threshold: Since salvage or loss cannot be modeled in CalSim II, historic salvage data at the fish facilities at Banks and Jones Pumping Plants and fish catch data at Chipps Island trawl during water years 2010 – 2018 were analyzed. Historic salvage data provides the potential timing of triggering the 50% and 75% levels of the proposed single year loss thresholds. The Chipps Island catch data provides the migration timing and estimates for when the 95% of Winter-Run and Steelhead have migrated out of the Delta, which is the proposed offramp for the real-time OMR management for these species. Based on this historic data, the modeling used an OMR index of negative 3,500 CFS in April and May of all non-critically dry year-types when it is assumed that the 50% of the proposed single year loss thresholds for one or more of the species will be exceeded.

##### South Delta Export-San Joaquin River Inflow Ratio

From April 1 to May 31, exports are restricted by the ratio of Vernalis flow (cfs) to combined CVP and SWP exports described in the ITP 8.17. The ratio varies based on water year type as shown in Table 1-4.

Table 1-4. San Joaquin River Inflow Ratio

|  |  |
| --- | --- |
| Water Year Type | SJR I:E Ratio |
| Critically Dry | 1:1 |
| Dry | 2:1 |
| Below Normal | 3:1 |
| Above Normal | 4:1 |
| Wet | See below |

Per section 8.10 of the ITP, the SWP share to meet the SJR I:E ratio requirement is 35% in balanced Delta conditions and 40% in excess Delta conditions.

During wet water years, the reduction in SWP exports in April and May to meet the SJR I:E ratio is capped at 150 TAF. The first 30 TAF of SWP exports that would be cut because of the SJR I:E ratio can instead be exported. Then, if needed, the next 150 TAF of SWP exports in April and May will be cut to meet the SJR I:E ratio. After 150 TAF of SWP exports has been cut, there is no more need to cut SWP exports to meet the SJR I:E ratio (8.18 ITP).

There following two requirements must be met for SJR I:E ratio offramp: Delta Outflow must be greater than 44,500 cfs and flow on the San Joaquin River at Vernalis must be greater than 21,750.

The decision to carryover water under ITP 8.18 would be made based on real-time analysis, including fish monitoring, which is difficult to simulate in CalSim. Since no other actions in the ITP depends on the carryover water, this is not modeled.

Maintaining health and safety pumping standard of 1,500 cfs takes precedence over meeting the SJR I:E ratio.

##### Exports at the South Delta Intakes

Exports at Jones and Banks Pumping Plant are restricted to their permitted capacities per SWRCB D-1641 requirements. In addition, Banks Pumping Plant is subject to the 2020 SWP ITP Spring Outflow Action during April and May. Additional 500 cfs pumping is allowed to reduce impact of D1641 on SWP during the July through September period.

Under D-1641 the combined export of the CVP Tracy Pumping Plant and SWP Banks Pumping Plant is limited to a percentage of Delta inflow. The percentage ranges from 35 to 45 percent during February depending on the January eight river index and is 35 percent during March through June months. For the rest of the months 65 percent of the Delta inflow is allowed to be exported.

A minimum health and safety pumping of 1,500 cfs is assumed from January through June.

##### Delta Water Quality

The Benchmark 011721 HIST simulation includes SWRCB D-1641 salinity requirements. However, not all salinity requirements are included as CalSim II is not capable of predicting salinities in the Delta. Instead, empirically based equations and models are used to relate interior salinity conditions with the flow conditions. DWR’s Artificial Neural Network (ANN) trained for salinity is used to predict and interpret salinity conditions at the Emmaton, Jersey Point, Rock Slough, and Collinsville stations. Emmaton and Jersey Point standards are for protecting water quality conditions for agricultural use in the western Delta and they are in effect from April 1 to August 15. The EC requirement at Emmaton varies from 0.45 mmhos/cm to 2.78 mmhos/cm, depending on the water year type. The EC requirement at Jersey Point varies from 0.45 to 2.20 mmhos/cm, depending on the water year type. The Rock Slough standard is for protecting water quality conditions for M&I use for water exported through the Contra Costa Canal. It is a year-round standard that requires a certain number of days in a year with chloride concentration less than 150 mg/L. The number of days requirement is dependent upon the water year type. The Collinsville standard is applied during October through May months to protect water quality conditions for migrating fish species, and it varies between 12.5 mmhos/cm in May and 19.0 mmhos/cm in October.

##### San Joaquin River Restoration Program

Friant Dam releases required by the San Joaquin River Restoration Program are included in the Benchmark 011721 HIST. More detailed description of the San Joaquin River Restoration Program is presented in the Appendix 3A “*No Action Alternative: Central Valley Project and State Water Project Operations*” of the LTO EIS (Reclamation 2015a).

Recapture of San Joaquin River Restoration water has been simulated. Recapture does not happen in months when there is a flood release from Friant. Recapture on the San Joaquin River occurs at Patterson Irrigation District (PID), West Stanislaus Irrigation District (WSID), and Banta Carbona Irrigation District (BCID) based on the assumptions for future capacities shown in Table 1-5. Delta Recapture at Banks and Jones Pumping Plants is assessed in a new final model cycle utilizing unused capacity. Simulated Banks Pumping of Recaptured water does not occur when Banks is making cuts for ITP Actions. Any San Joaquin River Restoration water that cannot be Recaptured is released as Delta Outflow.

Table 1-5. San Joaquin River Restoration Recapture

|  |  |  |  |
| --- | --- | --- | --- |
|  | PID | BCID | WSID |
| Oct | 130 | 150 | 180 |
| Nov | 170 | 180 | 220 |
| Dec | 195 | 180 | 230 |
| Jan | 195 | 180 | 230 |
| Feb | 195 | 180 | 210 |
| Mar | 170 | 100 | 190 |
| Apr | 160 | 100 | 160 |
| May | 115 | 50 | 120 |
| Jun | 60 | 40 | 40 |
| Jul | 15 | 0 | 0 |
| Aug | 30 | 75 | 0 |
| Sep | 50 | 100 | 120 |

#### Operations Criteria

##### Fremont Weir Operations

To provide seasonal floodplain inundation in the Yolo Bypass, the 14- and the two 18-foot elevation gates are opened between November 1 and March 15. The gates would open to allow a maximum flow of 6,000 cfs when the water surface elevation in the river reaches 28 feet. The gates are operated to limit maximum spill to 6,000 cfs until the Sacramento River stage reaches the existing Fremont Weir crest elevation. When the river stage is at or above the existing Fremont Weir crest elevation, the notch gates are assumed to be closed. While desired inundation period is on the order of 30 to 45 days, gates are not managed to limit to this range, instead the duration of the event is governed by the Sacramento River flow conditions. The spills at about 21 feet river stage would be around 1,000 cfs. This operation is further described in the Yolo Bypass Salmonid Habitat Restoration and Fish Passage EIS/EIR Alternative 1.

##### Delta Cross Channel Gate Operations

Delta Cross Channel (DCC) Gates are assumed to be operated based on the proposed DCC operational changes described in Table 2 of the Delta Cross Channel Temporary Closure Final Environmental Assessment (Reclamation 2012a). However, model representation of the proposed DCC operations remain the same as the SWRCB D-1641 standards and NMFS BO Action 4.1.2 (described below), as the proposed changes cannot be captured within the CalSim model.

SWRCB D-1641 DCC standards provide for closure of the DCC gates for fisheries protection at certain times of the year. From November through January, the DCC may be closed for up to 45 days. From February 1 through May 20, the gates are closed every day. The gates may also be closed for 14 days during the May 21 through June 15 time period. Reclamation determines the timing and duration of the closures after discussion with USFWS, CDFW, and NMFS.

NMFS BO Action 3.4.1 requires gates to be operated based on the presence of salmonids and water quality from October 1 through November 30; and gates to be closed from December 1 to January 31, except for short-term operations to maintain water quality. CalSim II includes the NMFS BO DCC gate operations in addition to the D-1641 gate operations. When the daily flows in the Sacramento River at Wilkins Slough exceed 7,500 cfs (flow assumed to flush salmon into the Delta), DCC is closed for a certain number of days in a monthas described in Appendix 5A of the LTO EIS (Reclamation 2015b). During October 1 – December 14, if the flow trigger condition is such that additional days of DCC gates closure is called for, however water quality conditions are a concern and the DCC gates remain open, then Delta exports are limited to 2,000 cfs for each day in question.

##### Suisun Marsh Salinity Control Gates

###### **SWRCB D-1641**

The SMSCG are operated on an as needed basis to meet SWRCB D-1641 water quality standards in Montezuma Slough. The water quality standard includes the period between October through May. Operations are determined from data at SWRCB D-1641 compliance stations, hydrologic conditions, weather, Delta outflow, tide, fishery considerations, and other factors. The duration of gate operation may range from no use to full use for the entire October through May period.

The Benchmark 011721 HIST CalSim II considers the effect of SMSCG operations, when SMSCG is used to meet SWRCB D-1641 water quality standards in Montezuma Slough. As the CALSIM ANN was trained with SMSCG operations occurring in the months from October through February, evaluation of an SMSCG operations trigger was focused to the months of March through May. Previously versions of CALSIM had not considered gate operations during these months. Historical operations and salinity were reviewed to develop a threshold parameter and value for commencing SMSCG operations. Through this analysis, use of prior month X2 to trigger SMSCG operations was selected. SMSCG operations are triggered in March through May based on the previous months X2 value. If the previous month’s X2 is greater than the value in Table 1-6, then SMSCG operations are triggered.

Table 1-6. SMSCG X2 Triggers

|  |  |
| --- | --- |
| **Month** | **X2** |
| October | 88 |
| November | 88 |
| December | 84 |
| January | 82 |
| February | 71 |
| March | 71 |
| April | 73 |
| May | 73 |

During SMSCG operations, the net flow from east to west through the Montezuma Slough generally increases by 2,200 to 2,800 CFS, and salinity is reduced in Suisun Marsh channels. Concurrently, salinity may increase in the Sacramento River unless Delta outflow is increased to counteract the effect of the SMSCG operations. Through iterative testing with the CalSim II and DSM2 models, it was determined that Delta outflow had to be increased by 500 CFS in order to balance the potential effect of SMSCG operations on the X2 position when the X2 position is estimated to be greater than 76 km.

The CalSim II model used for the Benchmark 011721 HIST was revised to include an adjustment to Artificial Neural Network (ANN) flow-salinity calculations when the SMSCG are being operated. In the ANN calculations for X2 position, the input value for Delta outflow for the ANN was reduced by 500 CFS for months in which SMSCG was assumed to operate. In the ANN calculations for EC at the compliance locations used in CalSim II, the input value for net DICU for the ANN was increased by 500 CFS for months in which SMSCG was assumed to operate. This adjustment allows the ANN calculations in the CalSim II model to recognize the potential salinity effect of the SMSCG operations when determining reservoir releases for maintaining Delta outflow and compliance with SWRCB D-1641 and other flow-salinity related model functions. When X2 or salinity conditions control water operations, these adjustments result in an increase in Delta outflow for a given salinity condition.

Reclamation considers this revision to the CalSim II model as an approximate method for use in evaluating changes in water operations due to changes in SMSCG operations. A more complete approach would be the use of ANN models that consider SMSCG operations directly as part of the flow-salinity calculations used in CalSim II.

###### **2019 BiOps**

The Baseline considers the effect of SMSCG operations, when SMSCG is used to meet SWRCB D-1641 water quality standards in Montezuma Slough, and when SMSCG is used to achieve the goals of the Delta Smelt Habitat Action Plan. The revisions included the adjustment to Artificial Neural Network (ANN) flow-salinity calculations previously discussed.

The SMSCG operations to achieve the goals of the Delta Smelt Habitat Action Plan, for CalSim II modeling purposes, are assumed as follows: for the below normal, above normal, and wet year types, during the months June through September, if the X2 position is estimated to be greater than 76 km and 60 days of SMSCG operations have not occurred since June 1, the SMSCG are assumed to operate for the month. These assumptions represent the maximum extent of the SMSCG operations in support of the Delta Smelt Habitat Action.

###### **CDFW ITP**

Based on section 9.3.1 of the ITP, a trigger is added for SMSCG operations for 30 days in Dry water years following either a Wet, Above Normal, or Below Normal water year when the carryover water from the additional 100 TAF of Delta Outflow (Section 19.9 of the ITP) described in the Delta Smelt Habitat Action Plan is available for use.

##### Allocation Decisions

CalSim II includes allocation logic for determining deliveries to north-of-Delta and south-of-Delta CVP and SWP contractors. The delivery logic uses runoff forecast information, which incorporates uncertainty in the hydrology, and standardized rule curves (i.e. Water Supply Index versus Demand Index Curve). The rule curves relate forecasted water supplies to deliverable “demand,” and then use deliverable “demand” to assign subsequent delivery levels to estimate the water available for delivery and carryover storage. Updates of delivery levels occur monthly from January 1 through May 1 for the SWP and March 1 through May 1 for the CVP as runoff forecasts become more certain. The south-of-Delta SWP delivery is determined based on water supply parameters and operational constraints. The CVP system wide delivery and south-of-Delta delivery are determined similarly upon water supply parameters and operational constraints with specific consideration for export constraints and reservoir storage levels. The CVP south-of-Delta allocation may be increased through July if storage conditions in the Federal position of San Luis Reservoir are high enough to support an increase.

##### San Luis Operations

CalSim II sets targets for San Luis storage each month that are dependent on the current South-of-Delta allocation and upstream reservoir storage. When upstream reservoir storage is high, allocations and San Luis fill targets are increased. During a prolonged drought when upstream storage is low, allocations and fill targets are correspondingly low. For the Benchmark 011721 HIST simulation, the San Luis rule curve is managed to minimize situations in which shortages may occur due to lack of storage or exports.

##### New Melones Operations

In addition to flood control, New Melones is operated for four different purposes: minimum flows, water quality, Bay-Delta flow, and water supply.

###### **Minimum Flows**

These flows are patterned to provide fall attraction flows in October and outmigration pulse flows in spring months (April 15 through May 15 in all years), and total up to 98.9 TAF to 483.7 TAF annually depending on the hydrological conditions based on the San Joaquin 60-20-20 Index (Table 1-7 through Table 1-9). The 60-20-20 Index used in the modeling implements a 75% exceedance forecasted water year type for the months of February through April. The final water year type is used for May thorough January.

Table 1-7. Stanislaus Annual Flow Allocation

|  |  |
| --- | --- |
| **60-20-20 Index** | **Minimum Flow Allocation (TAF)** |
| Critical | 185.3 |
| Dry | 234.1 |
| Below Normal | 346.7 |
| Above Normal | 346.7 |
| Wet | 483.7 |

Table 1-8. Monthly “Base” Shaping of Minimum Flows Based on the Annual Volume

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Annual Fishery Flow Volume (TAF)** | **Monthly Base Flows (cfs)** | | | | | | | | | | | |
| **Oct.** | **Nov.** | **Dec.** | **Jan.** | **Feb.** | **Mar.** | **Apr. 1–14** | **May 16–31** | **June** | **July** | **Aug.** | **Sept.** |
| 185.3 | 577.4 | 200 | 200 | 212.9 | 214.3 | 200 | 200 | 150 | 150 | 150 | 150 | 150 |
| 234.1 | 635.5 | 200 | 200 | 219.4 | 221.4 | 200 | 500 | 284.4 | 200 | 200 | 200 | 200 |
| 346.7 | 774.2 | 200 | 200 | 225.8 | 228.6 | 200 | 1,471.4 | 1,031.3 | 363.3 | 250 | 250 | 250 |
| 483.7 | 796.8 | 200 | 200 | 232.3 | 235.7 | 1,521 | 1,614.3 | 1,200 | 940 | 300 | 300 | 300 |

Table 1-9. April 15 through May 15 “Pulse” Flows Based on the Annual Fishery Volume

|  |  |  |
| --- | --- | --- |
| **Annual Fishery Flow Volume (TAF)** | **Fishery Pulse Flows (cfs)** | |
| **April 15–30** | **May 1–15** |
| 185.3 | 687.5 | 666.7 |
| 234.1 | 1,000 | 1,000 |
| 346.7 | 1,625 | 1,466.7 |
| 483.7 | 1,212.5 | 1,933.3 |

###### **Water Quality**

Releases are made to the Stanislaus River below Goodwin Dam to meet the D-1422 dissolved oxygen content objective. Surrogate flows representing releases for dissolved oxygen requirement in CalSim II are presented in Table 1-10. The surrogate flows are reduced for critical years under the San Joaquin 60-20-20 Index. These flows are met through releases from New Melones without any annual volumetric limit.

Table 1-10. Surrogate flows representing releases for dissolved oxygen requirement in CalSim II

|  |  |  |
| --- | --- | --- |
|  | **Non-Critical Years** | **Critical Years** |
| January | 0.0 | 0.0 |
| February | 0.0 | 0.0 |
| March | 0.0 | 0.0 |
| April | 0.0 | 0.0 |
| May | 15.2 | 11.9 |
| June | 16.3 | 12.3 |
| July | 17.4 | 12.3 |
| August | 14.8 | 11.9 |
| September | 0.0 | 0.0 |
| October | 0.0 | 0.0 |
| November | 0.0 | 0.0 |
| December | 0.0 | 0.0 |

###### **Water Supply**

Water supply refers to deliveries from New Melones to water rights holders (Oakdale Irrigation District [ID] and South San Joaquin ID) and CVP eastside contractors (Stockton East Water District [WD] and Central San Joaquin Water Control District [WCD]).

Water is provided to Oakdale ID and South San Joaquin ID in accordance with their 1988 Settlement Agreement with Reclamation (up to 600 TAF based on hydrologic conditions), limited by consumptive use. The conservation account of up to 200 TAF storage capacity defined under this agreement is not modeled in CalSim II.

Water Supply-CVP Eastside Contractors

Annual allocations are determined using the San Joaquin 60-20-20 Index (using a 75% exceedance forecast for February through April) for Stockton East WD and Central San Joaquin WCD (Table 1-11) and are distributed throughout 1 year using monthly patterns.

Table 1-11. Annual allocations for Stockton East WD and Central San Joaquin WCD

|  |  |
| --- | --- |
| **60-20-20 Index** | **CVP Contractor Allocation (TAF)** |
| Critical | 0 |
| Dry | 49 |
| Below Normal, Above Normal, and Wet | 155 |

#### Non-CVP/SWP Operations

##### Yuba

The Yuba County Water Agency (YCWA) converted their operations model from a monthly timestep to a daily timestep as part of their FERC Relicensing process for a more accurate representation of Yuba River Development Project (YRDP) operations. To be consistent with YCWA’s planning model, Yuba River Development Project Model (YRDPM), the CalSim II inputs related to the Yuba River operations have been updated.

##### Mokelumne

East Bay Municipal Utility District (EBMUD) provided the timeseries input for the Mokelumne River operation from EBMUD Study #8151. This model included a planning level demand of 194 MGD for EBMUD, assumptions for upstream diversions, Water Rights Permit 10478 Mitigation Measure FISH-1, the in-stream flow requirements from the Joint Settlement Agreement (JSA) with CDFW and U.S.FWS and the Drought Management Program Guidelines from June 2020.

##### Tuolumne

1996 FERC license number 2299 requires flows based on the San Joaquin Index. The Tuolumne simulation uses the final San Joaquin Index starting in April. The Base Flows (including an attraction pulse flow Oct 1-15) as set at LaGrange are shown in Table 1-12. For the Base Flows, if the actual Index is between to San Joaquin Index values in Table 1-12, the model releases the lower flow.

Table 1-12. Tuolumne River Base Flow Requirement

|  |  |  |  |
| --- | --- | --- | --- |
| **San Joaquin Index** | **October (cfs)** | **November through May (cfs)** | **June through September (cfs)** |
| 0 | 125 | 150 | 50 |
| 1499 | 125 | 150 | 50 |
| 1500 | 125 | 150 | 50 |
| 2000 | 150 | 150 | 50 |
| 2200 | 150 | 150 | 75 |
| 2400 | 207 | 180 | 75 |
| 2700 | 215 | 175 | 75 |
| 3100 | 397 | 300 | 250 |
| 10000 | 397 | 300 | 250 |

The FERC flow requirement at La Grange also includes an Outmigration Pulse in April 15 through May 15. The Pulse Flow (shown in Table 1-13) is in addition to the Base Flow. For the Pulse Flows, if the actual Index is between to San Joaquin Index values in Table 1-13, the model releases the lower flow.

Table 1-13. Tuolumne River Pulse Flow Requirement

|  |  |
| --- | --- |
| **San Joaquin Index** | **Pulse (cfs)** |
| 0 | 92 |
| 1499 | 92 |
| 1500 | 166 |
| 2000 | 270 |
| 2200 | 306 |
| 2400 | 297 |
| 2700 | 496 |
| 3100 | 743 |
| 10000 | 743 |

The FERC flow requirement requires linear interpolation between San Joaquin Index values. The model simulates this by releasing an additional pulse in the April 15 through May 15 pulse period that is the difference between the annual FERC flows using the linear interpolation and the FERC flows that were released using the lower flow value.

##### Merced

Minimum flows on the Merced River are set at Crocker Huffman Diversion Dam and Shaffer Bridge. At Crocker Huffman, minimum flows are set according to the 1926 Cowell Agreement. Under the Cowell Agreement, flows are 100 cfs in March; 175 cfs in April; 225 cfs in May; 250 cfs from the first day in June until the natural flow of the Merced River falls below 1,200 cfs; 225 cfs flow for the next 31 days; 175 cfs flow for the next 31 days; 150 cfs for the next 30 days; and 50 cfs thereafter or the natural inflow into Lake McClure, whichever is less, through the last day of February. To be consistent with Merced Irrigation District’s FERC modeling, the minimum flow schedule in Table 1-14 was used.

Table 1-14. The Merced River’s modeled Cowell Agreement Flow Requirement

|  |  |
| --- | --- |
| **Month** | **Cowell Agreement (cfs)** |
| October | 50 or inflow |
| November | 50 or inflow |
| December | 50 or inflow |
| January | 50 or inflow |
| February | 50 or inflow |
| March | 100 |
| April | 175 |
| May | 225 |
| June | 250 |
| July | 225 |
| August | 175 |
| September | 150 |

Minimum flows at Shaffer Bridge are set in accordance with FERC license numbers 2179 and 2467 and an additional 12.5 TAF release in October based on the 2002 Merced ID and CDFW Memorandum of Understanding (MOU). When determining the FERC flow requirement, a Wet year is a year with greater than 450 TAF of inflow to Lake McClure from April through July; otherwise it is a Dry year. The flows required under the FERC license are shown by month in Table 1-15.

Table 1-15. The Merced River’s FERC minimum Flow Requirement

|  |  |  |
| --- | --- | --- |
| **Month** | **Wet (cfs)** | **Dry (cfs)** |
| October | 50.81 | 38.23 |
| November | 100 | 75 |
| December | 100 | 75 |
| January | 75 | 60 |
| February | 75 | 60 |
| March | 75 | 60 |
| April | 75 | 60 |
| May | 75 | 60 |
| June | 25 | 15 |
| July | 25 | 15 |
| August | 25 | 15 |
| September | 25 | 15 |

The Davis-Grunsky contract expired on December 31, 2017, since which time MID has ceased providing the flows.

## Assumptions for the Benchmark 011721 2035CT

This section presents the assumptions used in developing the CalSim II Model simulations of the Benchmark 011721 2035CT.

The Benchmark 011721 2035CT represents CVP and SWP operations to comply with the 2019 Biological Opinions and 2020 State Water Incidental Take Permit regulatory environment as of January 2021 under 2035CT climate conditions and 15 cm of sea level rise. The Benchmark 011721 2035CT assumptions include existing facilities and ongoing programs that existed as of January 2021. The Benchmark 011721 2035CT assumptions also include facilities and programs that received approvals and permits by January 2021.

### CalSim II Assumptions for the Benchmark 011721 2035CT

The following is a description of the assumptions listed in Attachment 2 CalSim II Model Assumptions Callouts.

#### Hydrology

##### Inflows/Supplies

Inflow hydrology representing 2035CT climate conditions. Please review the Final Environmental Impact Report for Long-Term Operation of the California SWP for details regarding development of 2035 climate hydrologic conditions (DWR, 2019).

##### Level of Development

Same as the Benchmark 011721 HIST.

##### Demands, Water Rights, CVP/SWP Contracts

Same as the Benchmark 011721 HIST.

#### Facilities

Same as the Benchmark 011721 HIST.

##### Fremont Weir

Same as the Benchmark 011721 HIST.

##### CVP C.W. Bill Jones Pumping Plant (Tracy PP) Capacity

Same as the Benchmark 011721 HIST.

##### SWP Banks Pumping Plant Capacity

Same as the Benchmark 011721 HIST.

##### CCWD Intakes

Same as the Benchmark 011721 HIST.

##### Suisun March Salinity Control Gates

Same as the Benchmark 011721 HIST.

##### Red Bluff Pumping Plant

Same as the Benchmark 011721 HIST.

##### Hamilton City Pump Station

Same as the Benchmark 011721 HIST.

#### Regulatory Standards

The regulatory standards that govern the operations of the CVP and SWP facilities are briefly described below. Specific assumptions related to key regulatory standards are also outlined below.

##### D-1641 Operations

Same as the Benchmark 011721 HIST.

##### Coordinated Operations Agreement (COA)

Same as the Benchmark 011721 HIST.

##### CVPIA (b)(2) Assumptions

Same as the Benchmark 011721 HIST.

##### Clear Creek Flows

Same as the Benchmark 011721 HIST.

##### Upper Sacramento River

Same as the Benchmark 011721 HIST.

##### Continued CALFED Agreements

Same as the Benchmark 011721 HIST.

##### Water Transfers

###### **Lower Yuba River Accord (LYRA)**

Same as the Benchmark 011721 HIST.

###### **Phase 8 transfers**

Same as the Benchmark 011721 HIST.

###### **Short-term or Temporary Water Transfers**

Same as the Benchmark 011721 HIST.

#### Specific Regulatory Assumptions

##### Upper Sacramento Flow Management

Same as the Benchmark 011721 HIST.

##### Lower Feather Flow Management

Same as the Benchmark 011721 HIST.

##### Lower American Flow Management

Same as the Benchmark 011721 HIST.

##### Folsom Flood Control Diagram

Same as the Benchmark 011721 HIST.

##### Delta Outflow (Flow and Salinity)

Same as the Benchmark 011721 HIST.

##### Combined Old and Middle River Flows

Same as the Benchmark 011721 HIST.

##### South Delta Export-San Joaquin River Inflow Ratio

Same as the Benchmark 011721 HIST.

##### Exports at the South Delta Intakes

Same as the Benchmark 011721 HIST.

##### Delta Water Quality

Same as the Benchmark 011721 HIST.

##### San Joaquin River Restoration Program

Same as the Benchmark 011721 HIST.

#### Operations Criteria

##### Fremont Weir Operations

Same as the Benchmark 011721 HIST.

##### Delta Cross Channel Gate Operations

Same as the Benchmark 011721 HIST.

##### Suisun Marsh Salinity Control Gates

Same as the Benchmark 011721 HIST.

##### Allocation Decisions

Same as the Benchmark 011721 HIST.

##### San Luis Operations

Same as the Benchmark 011721 HIST.

##### New Melones Operations

Same as the Benchmark 011721 HIST.

#### Non-CVP/SWP Operations

##### Yuba

Same as the Benchmark 011721 HIST.

##### Mokelumne

Same as the Benchmark 011721 HIST.

##### Tuolumne

Same as the Benchmark 011721 HIST.

##### Merced

Same as the Benchmark 011721 HIST.

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