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# CALFED Bay-Delta Program System Operation Modeling Plan
**August 21, 1997**

## OVERVIEW
To complete systems operations modeling for the Bay-Delta Program Programmatic Environmental Impact Report / Environmental Impact Statement (PEIR/EIS), additional DWRSIM programming modifications and DWRSIM operation studies are needed. Modeling assumptions for the Affected Environment, the No Action Alternative, and the program alternatives must be refined. Additionally, DWRSIM must be modified to allow operation of a portion of new storage to meet Ecosystem Restoration Program Plan (ERPP) flow targets and to allow acquired water to be used to make up deficiencies in these flow targets.

DWRSIM is designed to simulate operation of the SWP and CVP systems for the purposes of water supply, flood control, recreation, instream flows, power generation and Sacramento-San Joaquin Delta water quality and associated outflow requirements. Generally, the model is used to evaluate water supply opportunities for the SWP and CVP systems with various facilities and operational criteria in place. DWRSIM is not currently configured to analyze ERPP flow targets, environmental storage operations, or water transfer activities. Other necessary model changes include: 1) adding and testing code to simulate San Joaquin River tributary storage, 2) completing code to simulate in-Delta storage, and 3) incorporating 2020-level hydrology. To complete the CALFED PEIR/EIS, DWRSIM operation studies are needed for the Affected Environment, the No Action Alternative, and the three Program alternatives with multiple storage and Delta conveyance variations. Additionally, sensitivity analyses should be conducted to reflect uncertainty in assumptions that apply to the No Action Alternative and Program Alternative simulations. The simulations will focus primarily on the re-operation of surface water supply facilities and describe changes in existing and new reservoir storage operations, resulting downstream river flows, deliveries of surface water pursuant to CVP and SWP contracts, and required water acquisition quantities. Assumptions for these planned operation studies are described below.

## AFFECTED ENVIRONMENT
State Water Resources Control Board Study 1995C6F-SWRCB-469 has been used as an initial approximate description of the Affected Environment for the CALFED Draft PEIR/EIS. However, several differences exist between modeling assumptions in this study and CALFED Affected Environment assumptions. A summary description of 1995C6F-SWRCB-469 assumptions is presented below, followed by a description of assumptions that should be modified to more accurately reflect CALFED Affected Environment assumptions.

### State Water Resources Control Board Study 1995C6F-SWRCB-469
A summary description of assumptions used in State Water Resources Control Board Study 1995C6F-SWRCB-469 is presented here. A more detailed description of study assumptions is



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available on the Department of Water Resources Hydrology and Operations Section Home Page at: *http://wwwhydro.water.ca.gov/index.html.*

- **1995-Level Hydrology**. A 1995-level hydrology, HYD-C06F, is used in the 1995C6F-SWRCB-469 study. This hydrology is similar to HYD-C06B, which is described in a DWR Division of Planning June 1994 memorandum report entitled *Summary of Hydrologies at the 1990, 1995, 2000, 2010 and 2020 Levels of Development for Use in DWRSIM Planning Studies.*

- **SWP Demands**. SWP demands are varied between 3,529 taf in drier years down to 2,619 taf in the wetter years based on local wetness indices. SWP demands of San Joaquin Valley agricultural contractors are reduced in wetter years from 1,175 to 915 taf using a Kern River flow index. SWP demands of Metropolitan Water District of Southern California (MWDSC) are reduced in wetter years from 1,433 to 783 taf using a Southern California precipitation index. Deliveries to all other SWP M&I Contractors are not adjusted for a wetness index, and are set at 857 taf/year in all years.

- **CVP Demands**. CVP demands, including wildlife refuges, are set at 3,573 taf/year. CVP Delta export demands are reduced in certain wet years (in the San Joaquin River Basin) when James Bypass flows are available in the Mendota Pool. Sacramento Valley refuge demands are modeled implicitly in the hydrology through rice field and duck club operations. Level II refuge demands in the San Joaquin Valley are explicitly modeled at an assumed level of 288 taf/year.

- **Instream Requirements**.
  - ***Sacramento River*** - Sacramento River navigation control point (NCP) flows are maintained at 5,000 cfs in wet and above normal water years and 4,000 cfs in all other years with possible relaxations to 3,250 cfs. Flow objectives between 3,250 cfs and 5,500 cfs are maintained below Keswick Dam on the Sacramento River in accordance with an April 26, 1996 letter from USBR to SWRCB defining early CVPIA flow criteria.

  - ***Feather River*** - Feather River fishery flows are maintained per an agreement between DWR and the Calif. Dept. of Fish & Game (August 26, 1983) with October through March minimum flows at 1,700 cfs from and 1,000 cfs from April through September.

  - ***Yuba River*** - Yuba River minimum fishery flows below Englebright Reservoir at Smartville range between 600 cfs and 800 cfs from October 15 through February under 1993 FERC requirements. The river flows are not dynamically modeled by the DWRSIM model, but are contained in the HYD-C06F hydrology used as model input into DWRSIM. The HYD-C06F hydrology does not reflect the 1993 FERC requirements, but water supply impacts are not substantially different from those modeled in HYD-C06F.



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- ***American River*** - Flow objectives between 250 cfs and 4,500 cfs are maintained below Nimbus Dam on the American River in accordance with an April 26, 1996 letter from USBR to SWRCB defining early CVPIA flow criteria.

- ***Mokelumne River*** - Mokelumne River minimum fishery flows below Camanche Dam are per an agreement between EBMUD, U.S. Fish and Wildlife Service, and Calif. Dept. of Fish & Game (FERC Agreement 2916) with base flows ranging from 100 cfs to 325 cfs from October through June and at 100 cfs from July through September. The river flows are not dynamically modeled by the DWRSIM model, but are contained in the HYD-C06F hydrology used as model input into DWRSIM.

- ***Stanislaus River*** - Stanislaus River minimum fish flows below New Melones Reservoir range from 98 taf/year up to 302 taf/year, according to the interim agreement (dated June 1987) between the USBR and the California Department of Fish and Game.

- ***Tuolumne River*** - Tuolumne River minimum fishery flows below New Don Pedro Dam are maintained between 50 cfs and 300 cfs per an agreement between Turlock and Modesto Irrigation Districts, City of San Francisco, Dept. of Fish & Game and others (FERC Agreement 2299).

- ***Merced River*** - Merced River minimum fishery flows below Shaffer Bridge are maintained between 15 cfs and 180 cfs per an agreement between Merced Irrigation Districts, Dept. of Fish & Game and others (FERC, Davis-Grunsky).

- **Delta Standards.** Operation of CVP and SWP export facilities in the Delta are coordinated with the upstream SWP and CVP reservoirs to meet the SWRCB's May 1995 Water Quality Control Plan for the Bay-Delta (WQCP). A summary description of these assumptions are summarized below:

  - ***X2 Requirement*** - For February through June, outflow requirements are maintained in accordance with the 2.64 EC criteria (also known as X2) using the required number of days at Chipps Island (74 km) and Roe Island (64 km).

  - ***Export Limits*** - Ratios for maximum allowable Delta exports are specified as a percentage of total Delta inflow as shown in Table 1. In February, the export ratio is a function of the January Eight River Index.

**Table 1 - Export/Import Ratio (in %)**

| Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 65 | 65 | 65 | 65 | 35-45 | 35 | 35 | 35 | 35 | 65 | 65 | 65 |

Based on the WQCP, April 15 to May 15 total Delta export are limited to 1,500 cfs or 100 percent of the San Joaquin River flow at Vernalis, whichever is



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greater. Additional water is provided from the San Joaquin River upstream of its confluence with the Stanislaus, if necessary, to meet salinity and pulse flow objectives at Vernalis. Additional water requirements are shared equally between the Tuolumne (Don Pedro Reservoir) and Merced (Lake McClure) River basins. If these sources are insufficient to meet objectives at Vernalis, nominal deficiencies are applied to upstream demands. Additional releases from the Tuolumne and Merced Rivers are assumed to be of fresh water quality (50 ppm TDS). Furthermore, it is assumed that these additional releases do not incur losses between the reservoirs and Vernalis.

- ***Delta Cross Channel***. The Delta Cross Channel (DCC) is closed 10 days in November, 15 days in December and 20 days in January for a total closure of 45 days. The DCC is fully closed from February 1 through May 20 of all years and is closed an additional 14 days between May 21 and June 15.

- ***Water Quality Objectives.*** The water quality objective at Contra Costa Canal intake is maintained in accordance with the WQCP. A "buffer" was added to insure that the standard is maintained on a daily basis. Thus, DWRSIM uses a value of 130 mg/L for the 150 mg/L standard and a value of 225 mg/L for the 250 mg/L standard.

  Water quality objectives on the Sacramento River at Emmaton and on the San Joaquin River at Jersey Point are maintained in accordance with the WQCP. WQCP water quality objectives on the San Joaquin River at Vernalis are 0.7 EC in April through August and 1.0 EC in other months. These objectives are maintained primarily by releasing water from New Melones Reservoir. A cap on water quality releases is imposed per criteria outlined in an April 26, 1996 letter from USBR to SWRCB. The cap varies between 70 taf/year and 200 taf/year, depending on New Melones storage and projected inflow. The interior Delta standards on the Mokelumne River (at Terminous) and on the San Joaquin River (at San Andreas Landing) are not modeled.

  The 0.44 EC standard is maintained at Jersey Point in April and May of all but critical years. This criteria is dropped in May if the projected SRI is less than 8.1 MAF. Table 2 displays average high tide EC standards to be maintained at Collinsville for eastern Suisun Marsh salinity control. All other Suisun Marsh standards are assumed to be met through operation of the Suisun Marsh salinity control gates.

**Table 2 - EC Standards at Collinsville (in mS/cm)**

| Oct | Nov | Dec | Jan | Feb | Mar | Apr | May |
|---|---|---|---|---|---|---|---|
| 19.0 | 15.5 | 12.5 | 12.5 | 8.0 | 8.0 | 11.0 | 11.0 |

- ***Trinity River Imports.*** Trinity River minimum fish flows below Lewiston Dam are maintained at 340 taf/year for all years, based on a May 1991 letter agreement between the USBR and the U.S. Fish and Wildlife Service.



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## CALFED Affected Environment Modeling Assumptions

Several modifications to the State Water Resources Control Board Study 1995C6F-SWRCB-469 are necessary to more accurately reflect Affected Environment assumptions for the CALFED PEIR/EIS. In some cases simplifications must be made in the modeling assumptions to reflect simulation accuracy inherent to DWRSIM or because specific information on implementation of assumptions is not available. These modified assumptions and simplifications are described below.

- **Refuge Demands.** Affected Environment assumptions for the CALFED PEIR/EIS include Level II wildlife refuge demands plus 30 percent of Level IV demands. Sacramento Valley refuge demands are modeled implicitly in the hydrology (depletion analysis) developed for DWRSIM. Sacramento Valley refuges include Gray Lodge, Modoc, Sacramento, Delevan, Colusa and Sutter. Refuge demands in the San Joaquin Valley are explicitly modeled as a component of CVP demand. San Joaquin Valley refuges include Grasslands, Volta, Los Banos, Kesterson, San Luis, Merced, Mendota, Pixley and Kern. As described in the CVPIA Draft PEIS, water would be acquired from willing sellers to provide the difference in Level II and Level IV refuge demands. This water would be acquired as a first priority from reliable sources within the same geographic region as the refuges. Under this approach, no additional water would be transported through the Delta for San Joaquin Valley refuges. As a modeling assumption simplification to the Affected Environment assumptions for the CALFED PEIR/EIS, only Level II refuge demands will be modeled in DWRSIM. It will be assumed that differences in Level II and Level IV deliveries will come from nearby willing sellers, and that differences in total consumptive use and affects on system operations will be negligible. This assumption will be refined if time allows.

- **Instream Requirements.** Several discrepancies exist between CALFED Affected Environment assumptions and modeling assumptions used in 1995C6F-SWRCB-469 for instream flow requirements on the Yuba, Mokelumne, and Tuolumne Rivers, pursuant to recent FERC agreements.

  - ***Yuba River*** - CALFED Affected Environment assumptions for the Yuba River maintain that the 1993 FERC requirements are not imposed. These river flows are not dynamically modeled by the DWRSIM model, but are contained in the HYD-C06F hydrology used as model input into DWRSIM. As described in the previous summary description of 1995C6F-SWRCB-469, the HYD-C06F hydrology does not reflect the 1993 FERC requirements, so no modification in modeling assumptions is required for the CALFED Affected Environment simulation.

  - ***Mokelumne*** - CALFED Affected Environment assumptions for the Mokelumne River maintain that recent FERC requirements are not imposed. State Water Resources Control Board Study 1995C6F-SWRCB-469 includes Mokelumne River minimum fishery flows below Camanche Dam as defined in FERC Agreement 2916. The river flows are not dynamically modeled by the DWRSIM model, but are contained in the HYD-C06F hydrology used as model input into



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DWRSIM. To more accurately simulate the CALFED Affected Environment assumptions, Mokelumne River flow requirements should be modified to reflect requirements that existed prior to FERC Agreement 2916.

- ***Tuolumne River*** - CALFED Affected Environment assumptions for the Tuolumne River maintain that recent FERC requirements are not imposed. State Water Resources Control Board Study 1995C6F-SWRCB-469 includes Tuolumne River minimum fishery flows below New Don Pedro Dam as defined by FERC Agreement 2299. To more accurately simulate the Affected Environment assumptions, Tuolumne River flow requirements should be modified to reflect requirements that existed prior to FERC Agreement 2916.

- **CVPIA Flow Criteria.** CALFED Affected Environment assumptions include implementation of CVPIA (b)(2) water management actions; however, targets and an accounting system for use of the (b)(2) water have not yet been thoroughly defined. State Water Resources Control Board Study 1995C6F-SWRCB-469 includes a partial implementation of CVPIA (b)(2) water management in accordance with an April 26, 1996 letter from the USBR to the SWRCB. This letter describes upstream actions on the Sacramento and American Rivers. For the CALFED Affected Environment simulation, additional actions will be included as a surrogate for final implementation of CVPIA (b)(2). These additional actions were selected from a list of possible water management actions evaluated in the CVPIA Draft PEIS. Selection of specific actions for this surrogate approach is not intended to signify endorsement of any action by CALFED. If more definitive information on final implementation of CVPIA (b)(2) becomes available, adjustments will be made to these assumptions to the extent possible. (See Sensitivity Analyses section, later in this document, for additional planned evaluations.)

  In addition to the CVPIA flow criteria included in 1995C6F-SWRCB-469, upstream actions on the Stanislaus River (as designated in the Interim New Melones Operation Plan) and the following Delta (b)(2) water management actions from the CVPIA Draft PEIS will be incorporated in the base Affected Environment simulation:

  - ***Delta Cross Channel.*** Delta Cross Channel closed November through June, open July through October.

  - ***April-May Export Restriction***: Total CVP/SWP exports restricted during the 30-day pulse flow period from April 15 through May 15 to the following ratios of total export to flow at Vernalis for the following year types:
    1:3 below normal, dry, and critical years.
    1:4 above normal years.
    1:5 wet years.

  - ***Additional Chipps Island X2 Days.*** Additional Chipps Island X2 days required to approximate a 1962 Level of Development as described in Table 3. Existing X2 requirements are included in the table for comparison.



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**Table 3 - Chipps Island X2 Days at 1962 of Development**

| | 1962 LOD | | WQCP | |
|---|---|---|---|---|
| Previous Month 8 River Index | May | June | May | June |
| 500 | 0 | 0 | 0 | 0 |
| 750 | 0 | 0 | 0 | 0 |
| 1000 | 0 | 0 | 0 | 0 |
| 1250 | 0 | 0 | 0 | 0 |
| 1500 | 0 | 0 | 0 | 0 |
| 1750 | 1 | 0 | 0 | 0 |
| 2000 | 4 | 0 | 1 | 0 |
| 2250 | 13 | 1 | 3 | 0 |
| 2500 | 24 | 3 | 11 | 1 |
| 2750 | 29 | 7 | 20 | 2 |
| 3000 | 30 | 12 | 27 | 4 |
| 3250 | 31 | 18 | 29 | 8 |
| 3500 | 31 | 23 | 30 | 13 |
| 3750 | 31 | 26 | 31 | 18 |
| 4000 | 31 | 28 | 31 | 23 |
| 4250 | 31 | 29 | 31 | 25 |
| 4500 | 31 | 29 | 31 | 27 |
| 4750 | 31 | 30 | 31 | 28 |

- **Delta Standards.** As described in the summary description of modeling assumptions for 1995C6F-SWRCB-469, under the WQCP, April 15 to May 15 total Delta exports are limited to 1,500 cfs or 100 percent of the San Joaquin River flow at Vernalis, whichever is greater. Additional water is provided from the San Joaquin River upstream of its confluence with the Stanislaus, if necessary, to meet salinity and pulse flow objectives at Vernalis. Under CALFED Affected Environment assumptions, no additional water is to be provided from the San Joaquin River upstream of its confluence with the Stanislaus. If insufficient water is available from the Stanislaus River, the salinity and pulse flow objectives at Vernalis will not be met. To more accurately simulate the CALFED Affected Environment assumptions, this limitation in the availability of San Joaquin River water should be incorporated in the simulation.

## NO ACTION ALTERNATIVE

CALFED Benchmark Study 1995C6D-CALFED-472 served as an initial simulation of the CALFED No Action Alternative. Assumptions regarding instream flow requirements and Delta standards are similar to those summarized above for the State Water Resources Control Board Study 1995C6F-SWRCB-469. The primary difference between 1995C6D-CALFED-472 and 1995C6F-SWRCB-469 is the level of SWP and CVP demand, as described below. Several assumptions included in the 1995C6D-CALFED-472 study will require additional refinement to more accurately depict CALFED No Action Alternative assumptions. These refinements are described later in this section.

## CALFED Benchmark Study 1995C6D-CALFED-472

Assumptions for CALFED Benchmark Study 1995C6D-CALFED-472 are comparable to assumptions described above for State Water Resources Control Board Study 1995C6F-SWRCB-469, except for the level of SWP and CVP demand as described here. A more detailed description of study assumptions is available on the Department of Water Resources Hydrology and Operations Section Home Page at: *http://wwwhydro.water.ca.gov/index.html.*

- **SWP Demands**. SWP demands are assumed to be fixed at full entitlement of 4.1 maf. This corresponds to DWR's Bulletin 160-93 assumptions for 2020-level demand. MWDSC's monthly demand patterns assume an Eastside Reservoir and an Inland Feeder pipeline in accordance with a July 26, 1995 memorandum from MWDSC.

- **CVP Demands**. CVP demands, including wildlife refuges, are set at 3,766 taf/year. CVP Delta export demands are reduced in certain wet years (in the San Joaquin River Basin) when "James" bypass flows are available in the Mendota Pool. Sacramento Valley refuge demands are modeled implicitly in the hydrology through rice field and duck club operations. Level II refuge demands in the San Joaquin Valley are explicitly modeled at an assumed level of 232 taf/year. The Contra Costa Canal monthly demand pattern assumes Los Vaqueros operations in accordance with a July 11, 1994 e-mail from CCWD.

## CALFED No Action Alternative Modeling Assumptions

Several modifications to the CALFED Benchmark Study 1995C6D-CALFED-472 are necessary to more accurately reflect No Action Alternative assumptions for the CALFED PEIR/EIS. In some cases simplifications must be made in the modeling assumptions to reflect simulation accuracy inherent to DWRSIM or because specific information on implementation of assumptions is not available. These modified assumptions and simplifications are described below.

- **2020-Level Hydrology**. DWR's Hydrology Development Unit is finalizing a 2020-level hydrology for use in DWRSIM planning studies. This hydrology represents the water supply of the Central Valley (excluding Tulare Basin) available to the SWP and CVP systems at 2020-level of development. This hydrology will replace the 1995-level hydrology previously used in CALFED Benchmark Study 1995C6F-CALFED-472.

- **Variable SWP Demand**. To more accurately portray future water supply demand, a variable SWP demand function will be included in the CALFED No Action Alternative simulation. Different assumptions are made for SWP 2020-level agricultural demand and urban demand as described below:

  - ***SWP Agricultural Demand.*** San Joaquin Valley SWP agricultural demands will be reduced in wetter years to reflect an expected reduction in SWP water use due to availability of local water supply sources and local flooding that prevents agricultural production. Total SWP agricultural demands will be reduced from full contractual entitlement by 25 percent in wetter years based on a Kern River flow index. When inflow to Lake Isabella is less than 1.5 maf, agricultural demand will be set at a maximum 1,180 taf. In years when inflow to Lake Isabella exceeds



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1.5 maf, agricultural demands will be reduced to 890 taf. This logic is similar to the reduction logic used in the 1995C6F-SWRCB-469 study.

- ***SWP Urban Demand.*** In planning studies conducted for their Integrated Resources Planning process, MWDSC has assumed reduced SWP deliveries in some drier years. In these studies, full contractual entitlement deliveries are requested in most wetter years, with a portion of these supplies reserved in local storage. These local storage options include ground water conjunctive use operations and the future Eastside Reservoir. Subsequently, these local storage sources are drawn upon in when SWP supplies are reduced in drier years. MWDSC has provided CALFED with a set of annual 2020-level SWP demands, varying from a minimum of 1,460 taf to full entitlement of 2,010 taf. Remaining SWP urban demands (other than MWDSC) will be assumed at a constant 950 taf per year.

- ***Total SWP Demands.*** Combining these SWP agricultural and urban demand assumptions, total annual SWP demand is varied between a minimum of 3,480 taf and a maximum of 4,130 taf.

- **CVPIA Flow Criteria.** As with the CALFED Affected Environment Assumptions, the CALFED No Action Alternative assumptions include implementation of CVPIA (b)(2) water management actions. As described earlier, targets and an accounting system for use of the (b)(2) water have not yet been thoroughly defined. CALFED Benchmark Study 1995C6D-CALFED-472 includes a partial implementation of CVPIA (b)(2) water management in accordance with an April 26, 1996 letter from the USBR to the SWRCB. This letter describes upstream actions on the Sacramento and American Rivers. As with the CALFED Affected Environment simulation, a surrogate approach will be used to approximate final implementation of CVPIA (b)(2) for the CALFED No Action Alternative simulation. Additional upstream actions on the Stanislaus River and representative Delta actions specified in the CVPIA Draft PEIS will also be included in this surrogate approach, as described previously in the CALFED Affected Environment Modeling Assumptions section. (See Sensitivity Analyses section, later in this document, for additional evaluations.)

## PROGRAM ALTERNATIVES

System modeling of the CALFED Bay-Delta Program alternatives with multiple storage and conveyance variations is required to provide information regarding potential water supply benefits for environmental enhancements and urban and agricultural uses. To complete the CALFED PEIR/EIS, DWRSIM program modifications and operation studies are needed for the three Program alternatives with multiple storage and Delta conveyance variations. These activities include programming modifications to add new facility components and ERPP flow targets to DWRSIM along with operation studies with specific combinations of storage and conveyance facilities to represent each CALFED alternative. These operation studies will be used to represent the range of water supply benefits and impacts between the alternatives for environmental, agricultural and urban purposes.



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## DWRSIM Program Modifications for Alternative Components

Preliminary system modeling has been conducted with the DWRSIM model, including combinations of 1) isolated Delta conveyance, 2) Sacramento River tributary surface storage and 3) south of Delta off-aqueduct surface storage. A significant amount of DWRSIM coding changes and testing have taken place to simulate these alternative components. Additional evaluation of operational sensitivities is ongoing.

Several additional features must still be added to the model, including: 1) adding and testing code to simulate San Joaquin River tributary storage, 2) testing simulations of in-Delta storage, and 3) testing simulations of north and south of Delta groundwater storage. Summary descriptions and status of the alternative components included or being included into DWRSIM are summarized below:

- **New Facilities.**
  - ***Isolated Conveyance Facility.*** The isolated conveyance facility coding additions are complete with operations governed by 1) a minimum through-Delta conveyance requirement, 2) a maximum isolated conveyance ratio, 3) physical design capacity limit, and 4) export ratio restrictions.

  - ***Surface Storage.*** The Sacramento River tributary surface storage (SRTSS) facility coding additions are complete. Diversions to storage each water year not permitted until a monthly flow event target volume of a specified amount occurs at the facility's diversion point. In any month that storage releases are being made to satisfy Delta in-basin requirements, diversions to SRTSS are not permitted. Only surplus flows that are in excess of the export ratio requirement are considered for use in filling the facility.

    The south of Delta off-aqueduct storage (SDSS) facility coding is complete and is essentially linked with SWP San Luis Reservoir operations. SDSS and SWP San Luis operations are triggered by a combined south of Delta storage target.

    Coding for in-Delta surface storage (IDSS) is complete, although operation studies including this component have not been conducted. Coding for San Joaquin River tributary storage (SJRTSS) is under development. For initial Program Alternative simulations, San Joaquin tributary storage is assumed to be at the Montgomery Reservoir site with possible diversions from Merced and Tuolumne Rivers. Future simulations may incorporate a Millerton Lake expansion on the San Joaquin River. (See Sensitivity Analyses section, later in this document, for additional evaluations.)

  - ***Groundwater Storage.*** Coding for north and south of Delta ground water storage facilities is complete, although additional refinement may be necessary. Complete simulations including this component have not been conducted.

- **DWRSIM Program Modifications for ERPP Flow Targets.** Simulation of the Program Alternatives will optimize combined CVP and SWP operations and include ERPP environmental flow targets to simulate environmental benefits. As an initial policy, the



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ERPP flow targets are not interpreted as constraints to water supply diversion. Water supplies required to meet the flow targets will be developed through construction of new storage facilities or purchased from willing sellers. ERPP water used for in-stream flow targets is not to be diverted at the Delta; however, these flows will effect the Delta mass balance and influence export patterns. To accurately simulate Bay-Delta Program alternatives including ERPP actions in DWRSIM, the ERPP flows must be added to the system in each monthly time step, after simulation of SWP and CVP operations. This process is further complicated by the sharing of new facilities for environmental, agricultural, and urban purposes. The new facilities must be operated to provide for each of these purposes to the extent possible. However, shortfalls in ERPP flow must be made up through an "add water" function, to simulate acquisitions from willing sellers.

- ***ERPP Upstream Environmental Flow Targets***. The ERPP outlines many environmental flow objectives to improve the ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species. The ERPP identifies monthly and 10-day flow event targets for many of the river basins within the Bay-Delta watershed. The additional river flows targeted by the ERPP would occur through the following prioritized actions: 1) implementation of actions under consideration through the Central Valley Project Improvement Act (CVPIA) Draft PEIS, 2) releases from new environmental storage created under the CALFED Bay-Delta Program, and 3) water acquisitions from willing sellers.

  As a simplification for DWRSIM modeling, initial programming modifications and operation studies will focus on the 10-day flow event and monthly Freeport flow targets, which represent the most significant ERPP flow actions. These flow targets are shown in Table 4.

- ***Environmental Storage Operations***. As an initial assumption for CALFED Program Alternatives, the total volume of all new storage is assumed to be split among the three beneficial use sectors, such that one-third of storage is dedicated to environmental purposes, one-third to urban purposes, and one-third to agricultural purposes. In initial model runs, only portions of Sacramento River and San Joaquin River Tributary Surface Storage will be allocated for environmental purposes. Groundwater Storage, In-Delta Surface Storage, and South of Delta Off-Aqueduct Surface Storage would require transfer arrangements to serve ERPP flow targets. Operational parameters and appropriate code modifications to DWRSIM may be developed as time allows to allow simulation of these types of storage operations for environmental purposes

  In initial simulations of Program Alternatives, environmental storage will be operated to maximize average annual yield by not imposing carryover provisions.



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**Table 4 - Proposed ERPP Flow Targets**
**(in cfs)**

| Location/Time Period | Critical | Dry | Below Normal | Above Normal | Wet |
|---|---|---|---|---|---|
| **Sacramento-San Joaquin Delta Outflow** | | | | | |
| • March - 10 days | - | 20,000 | 30,000 | 40,000 | - |
| • April/May - 10 days | - | 20,000 | 30,000 | 40,000 | - |
| **Sacramento (Freeport - Between CP 137 & CP 503)** | | | | | |
| • May | - | 13,000 | 13,000 | 13,000 | 13,000 |
| **Sacramento (Knights Landing - Between CP 61 & CP 43)** | | | | | |
| • March - 10 days | - | 7,500 | 17,500 | 17,500 | - |
| **Feather (Gridley - Between CP 106 & CP 38)** | | | | | |
| • March - 10 days | - | 5,000 | 7,000 | 9,000 | - |
| **Yuba (Marysville - Additional Nodes Connected to CP 37)** | | | | | |
| • March - 10 days | - | 2,500 | 3,500 | 3,500 | - |
| **American (Nimbus Dam - Between CP 9 & CP 41)** | | | | | |
| • March - 10 days | - | 3,500 | 5,000 | 5,000 | 7,000 |
| **Stanislaus (Goodwin - Between CP 16 & CP 672)** | | | | | |
| • April/May - 10 days | - | - | 2,750 | 2,750 | 3,500 |
| **Tuolumne (La Grange - CP 662 & CP 663)** | | | | | |
| • April/May - 10 days | - | 2,750 | 3,750 | 3,750 | 5,500 |
| **Merced (Shaffer Bridge - CP 645 & CP 646)** | | | | | |
| • April/May - 10 days | - | 1,250 | 2,250 | 2,250 | 3,750 |

- ***Upstream ERPP Add Water.*** To fully meet ERPP flow targets, water acquisitions from willing sellers will be required when sufficient flow is unavailable from environmental storage releases. To model the effects of these upstream water acquisitions, new DWRSIM nodes will be added at the flow target locations identified in Table 4. Flow will be added at these control points to represent the net amount of "real water" needed to fully meet the ERPP targets. Once initial modeling results are available, an evaluation must be made of the potential for obtaining these required quantities of "real water".

- ***ERPP Delta Environmental Outflow Targets.*** The increased Delta inflow resulting from meeting Sacramento River Basin ERPP flow targets should satisfy the March Delta outflow 10-day flow target specified in Table 8. Additional water will be required, beyond the Delta inflow obtained from the San Joaquin River Basin ERPP flow targets, to meet



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the April/May Delta outflow 10-day flow target. This additional flow will be obtained from environmental storage operations in both the Sacramento River and San Joaquin River Basins and from water acquisitions from willing sellers from both basins. Water acquisitions for the ERPP Delta outflow targets will be modeled using the "add water" approach, as described previously. Flow originating from environmental storage operations and water acquisitions will be excluded as water available for export pumping.

- **Surrogate Demand for Combined CVP and SWP Operations**. A goal of system modeling for the Bay-Delta Program is to provide information on water supply opportunities under the most efficient operations. Ideally, individual CVP and SWP operations would be optimized to provide the best integrated operation, including sharing of new storage and conveyance facilities. Since this is not possible with the current modeling tools available, SWP operations must serve as a surrogate for combined SWP and CVP operation of new facilities in DWRSIM. To provide this surrogate approach, annual unmet south of Delta CVP demand will be included as a new SWP demand with a diversion point near San Luis Reservoir. Additionally, maximum wheeling of CVP flow will be allowed in SWP conveyance facilities.

## DWRSIM Operation Studies for Program Alternatives

The three CALFED Program Alternatives consist of the four common programs of ecosystem restoration, water quality, water use efficiency, and levee system integrity together with various configurations of storage and conveyance facilities. Alternative 1 uses only existing Delta channels for water conveyance, preserving the Delta common pool as currently in place. Three configurations with various south Delta modifications and one new storage configuration differentiate the variations in this alternative. Alternative 2 uses significant modifications of through Delta channels to improve water conveyance across the Delta. Combinations of four potential conveyance configurations and three new storage configurations differentiate the five variations of this alternative. Alternative 3 adds an isolated facility to the through-Delta modifications of Alternative 2. Combinations of seven potential conveyance configurations and two new storage configurations differentiate the nine variations of this alternative.

A summary description of the three Program alternatives with multiple storage and Delta conveyance variations along with the proposed DWRSIM operation studies is shown below in Table 5. The operation studies for the three Program alternatives with multiple storage and Delta conveyance variations are intended to display the range of system benefits and impacts between CALFED Alternatives with focus primarily on the re-operation of surface water supply facilities and describe changes in existing and new reservoir storage operations, resulting downstream river flows, deliveries of surface water pursuant to CVP and SWP contracts, and required water acquisition quantities.



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# Table 5 - Summary Description of Alternative Configurations

| Alternative Configuration | Delta Modifications | | | | | Storage Components (Maximum Storage Volumes in MAF) | | | | | | DWRSIM Scenario |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CVP-SWP Improvements | North Delta Modifications | South Delta Modifications | Isolated Delta Conveyance Facility (Conveyance Capacity in 1,000 CFS / Type) | Comments | North of Delta Ground Water Storage | Sacramento River Tributarty Surface Storage | San Joaquin River Tributary Surface Storage | In-Delta Surface Storage | South of Delta Ground Water Storage | South of Delta Off-Aqueduct Surface Storage | |
| 1A | | | | | | | | | | | | 1 |
| 1B | A | | | | | | | | | | | 1 |
| 1C | A | | D,E | | | 0.25 | 3.00 | | | 0.50 | 1.00 | 2 |
| 2A | A | B,C | D,E,F | | | | | | | | | 3 |
| 2B | A | B,C | D,E,F | | | 0.25 | 3.00 | 0.24 | | 0.50 | 2.00 | 4 |
| 2C | A | Special | Special | | Multiple Intakes | | | | 0.10 | | | 3 |
| 2D | A | Special | Special | | Extensive Habitat Restoration | | | | | | 2.00 | 5 |
| 2E | A | Special | Special | | Extensive Habitat Restoration | 0.25 | 3.00 | 0.24 | | 0.50 | 2.00 | 4 |
| 3A | A | C | D,E,F | 5 / Open Channel | | | | | | | | 6 |
| 3B | A | C | D,E,F | 5 / Open Channel | | 0.25 | 3.00 | 0.24 | 0.20 | 0.50 | 2.00 | 7 |
| 3C | A | C | D,E,F | 5 / Pipeline | | | | | | | | 6 |
| 3D | A | C | D,E,F | 5 / Pipeline | | 0.25 | 3.00 | 0.24 | 0.20 | 0.50 | 2.00 | 7 |
| 3E | A | C | D,F | 15 / Open Channel | | 0.25 | 3.00 | 0.24 | 0.20 | 0.50 | 2.00 | 8 |
| 3F | A | Special | Special | 15 | Chain of Lakes | 0.25 | 3.00 | 0.24 | | 0.50 | 2.00 | 8 |
| 3G | A | C | D,E,F | 5 | Deep Water Ship Channel | 0.25 | 3.00 | 0.24 | 0.20 | 0.50 | 2.00 | 7 |
| 3H | A | Special | Special | 5 / Open Channel | Extensive Habitat Restoration | 0.25 | 3.00 | 0.24 | | 0.50 | 2.00 | 7 |
| 3I | A | Special | Special | 15 / Open Channel | IF / Multiple Intakes | 0.25 | 3.00 | 0.24 | 0.20 | 0.50 | 2.00 | 8 |

**CVP-SWP Improvements**

*A* New fish screens at the Skinner Fish facility
New fish screens at the Tracy Pumping Plant Intake
Interconnection between Tracy Pumping Plant and Clifton Court Forebay

**North Delta Modifications**

*B* 10,000 cfs Screened Hood Intake

*C* Purchase of 600-foot wide alignment along Mokelumne River from I-5 to the San Joaquin River
Replacement of existing levees on one side of the existing channel with new setback levees approximately 500 feet back from the existing channel
Removal of existing levees where they obstruct the new channel and convert remaining portions into channel islands
Relocation of existing improvements displaced by the widened channel

**South Delta Modifications**

*D* Increased permitted capacity of existing export pumps to physical capacity
New Clifton Court Forebay intake structure
Operable barrier or equivalent at the head of Old River to maintain a positive flow down the San Joaquin River

*E* Flow and stage control structures on Middle River, Grant Line Canal, and Old River or other methods to control flow, stage, and south Delta salinity

*F* Channel enlargement along a 4.9 mile reach of Old River



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- **New Facility Operation Assumptions.**
Operating parameters and assumptions established for initial evaluation of the CALFED Program Alternatives include the assumptions described previously for the CALFED No Action Alternative. In addition, the following assumptions associated with operation of new facilities will be included in the appropriate simulations.

  - ***Surface and Groundwater Storage Operational Goals***. All new surface storage facilities will be operated primarily to maximize average annual deliveries to meet all beneficial uses. All new groundwater and conjunctive use facilities will be primarily operated to maximize average dry year deliveries to meet all beneficial uses.

  - ***Storage Filling and Discharge Priorities*** Filling of and discharging from new storage will be made with the following priorities (the following will be modified as necessary for consistency with local water management practices and water rights):
    1. Tributary groundwater storage facilities have first priority for filling and last priority for discharging from storage (withdrawals from groundwater basins will only be made in dry and critical years).
    2. Aqueduct groundwater storage facilities have second priority for filling and fourth priority for discharging from storage.
    3. Aqueduct surface storage facilities have third priority for filling and third priority for discharging from storage.
    4. Tributary surface storage facilities have fourth priority for filling and second priority for discharging from storage.
    5. Delta storage facilities have fifth priority for filling and first priority for discharging from storage.

  - ***Groundwater Filling and Discharge Assumptions***. Maximum storage capacity of both upstream of Delta and off-aqueduct ground water storage is assumed at 250 and 500 taf, respectively. Diversion capacity for both upstream of Delta and off-aqueduct ground water storage is assumed at 500 cfs. All in-stream flow requirements must be met before diversions to new storage are allowed. No geomorphological flow event targets are specified as a constraint to diversions for groundwater storage. Discharge capacity for both upstream of Delta and off-aqueduct ground water storage is also 500 cfs.

  - ***Sacramento River Tributary Storage Filling and Discharge Assumptions***. Maximum capacity for Sacramento River Tributary Surface Storage is assumed to be 3.0 maf. Assumed diversion and discharge capacity is 5,000 cfs. All in-stream flow requirements must be met before diversions to new storage are allowed. For new diversion points between Keswick and Chico Landing, no new diversions are allowed in any given water year until a 60,000 cfs mean daily flow event that preserves the river's natural fluvial geomorphology process has occurred at Chico Landing. (Future study will be conducted to refine the estimate of the flow needed). For the monthly time step used in modeling, a



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corresponding monthly volume of 1.5 maf at Wilkens Slough will be used as a surrogate for the 60,000 cfs mean daily flow criteria. For new diversion points at and downstream of Chico Landing, no flow event target will be used.

- ***San Joaquin River Tributary Storage Filling and Discharge Assumptions***. San Joaquin River Tributary Surface Storage will be initially modeled as a 260 taf maximum capacity off-stream reservoir located between the Merced and Toulumne Rivers. Spills in both rivers that exceed in-stream and Delta requirements would be diverted into the reservoir. Diversion capacity will be assumed at 2,000 cfs for the Merced River and 1,000 cfs for the Toulumne River. No geomorphological flow event targets are specified as a constraint to diversions. Future simulations may incorporate a Millerton Lake expansion on the San Joaquin River. (See Sensitivity Analyses section, later in this document, for additional evaluations.)

- ***In-Delta Storage Filling and Discharge Assumptions***. Maximum capacity for In-Delta Surface Storage is assumed to be 200 taf. Assumed diversion and discharge capacity is 15,000 cfs. All instream flow requirements must be met before diversions to new storage are allowed. Diversion to In Delta Storage is considered an export for export - inflow ratio calculations. Discharge from In Delta Storage is not considered in export - inflow ratio calculations.

- ***Off-Aqueduct Storage Filling and Discharge Assumptions***. Maximum capacity for Off-Aqueduct Surface Storage is assumed to be 3.5 maf. New storage is assumed to be connected to the California Aqueduct with 3,500 cfs diversion and discharge capacity.

- ***Delta Standards with Isolated Conveyance***. Delta Cross Channel closed September through June, open July through August. Isolated facilities assumed to be operated to maximize isolated conveyance year round, consistent with the need to meet south Delta water quality objectives. The minimum levels of monthly export flows taken through the south Delta export facilities are suggested as follows:

| | |
|---|---|
| October-March | 1,000 cfs |
| April-June | 0 cfs |
| July-September | 1,000 cfs |

Isolated Facilities will be studied using two separate levels of ecosystem protection:

- Existing E/I ratio
- Isolated flow is assumed to be not included in both export and inflow in E/I ratio

**Note:** *These operating parameters have been developed to provide a preliminary basis for conducting system and Delta model studies of CALFED alternatives. They do not reflect the*



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*culmination of the consensus process. A wide range of operating parameters will eventually be explored as part of the alternative evaluation process.*

*Facilities included in the Alternative configurations will be operated to provide multiple benefits for the environment, water supply reliability, and water quality improvement. Additional study will be required before CALFED can settle on the best operational mode considering the hydrology and hydraulic constraints, the size range of potential facilities, the economic allocation of costs, and the assurances needed for successful multi-benefit operations.*

## SENSITIVITY ANALYSES

Several assumptions for the CALFED Affected Environment and No Action Alternative include considerable uncertainty regarding specific implementation. Additionally, many stakeholders have voiced interest in evaluating specific variances to these policy assumptions. In response to these concerns, CALFED will endeavor to conduct sensitivity analyses to provide supporting information for stakeholder review and to be used in preparation of the PEIR/EIS. Specific issues to be addressed in these sensitivity analyses are described below.

- **CVPIA Flow Criteria**. CALFED has assumed that CVPIA, including (b)(2) water management actions, will be fully implemented in the CALFED Affected Environment description, No Action Alternative, and Program Alternatives. However, considerable uncertainty remains regarding the accounting system and targets for use of the (b)(2) water. CALFED has taken a surrogate approach to simulating full implementation of CVPIA (b)(2) by selecting specific actions to represent final CVPIA (b)(2) water management. As noted earlier, selection of specific actions for this surrogate approach is not intended to signify CALFED endorsement of any specific action.

  A June 23, 1997 letter from the U.S. Department of the Interior outlines a stakeholder process for finalizing a management plan for CVPIA Section 3406(b)(2) water. An attachment to the letter titled *Draft Proposal on the Management of Section 3406(b)(2) Water* lists various water management actions which might be implemented in the final management plan. These management actions include the upstream actions on the Sacramento, American, and Stanislaus Rivers and Delta actions which have already been included in the CALFED CVPIA Flow Criteria assumptions, as described previously. The *Draft Proposal on the Management of Section 3406(b)(2) Water* also includes proposed upstream actions for Clear Creek, various additional Delta water management actions, and a Water Reserve Account, which would reserve a portion of the (b)(2) water each year for fish-related contingencies, opportunities, and carryover.

  As priorities and triggers for these water management actions are developed through the CVPIA stakeholder process, CALFED modeling assumptions will be updated and revised to the extent possible. As time and resources permit, sensitivity runs will be conducted to evaluate the effects of additional or revised (b)(2) water management actions on the CALFED Affected Environment, No Action and Program Alternatives.

- **Trinity River Diversions.** CALFED has assumed that Trinity River flow requirements will remain unchanged within the CALFED Affected Environment description, No Action Alternative, and Program Alternatives. However, potential actions resulting from the Trinity



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River Mainstem Fisheries Restoration Study will be evaluated as a sensitivity analysis. These potential new Trinity River flow requirements are listed in Table 6.

**Table 6 - Trinity River Mainstem Fisheries Restoration Flow Requirements (in cfs)**

| Month | Wet | Above Normal | Below Normal | Dry | Critical |
|---|---|---|---|---|---|
| Oct. | 337 | 265 | 248 | 248 | 248 |
| Nov. | 480 | 373 | 364 | 364 | 364 |
| Dec. | 500 | 476 | 434 | 434 | 400 |
| Jan. | 600 | 500 | 450 | 450 | 450 |
| Feb. | 600 | 500 | 450 | 450 | 450 |
| Mar. | 663 | 587 | 494 | 494 | 494 |
| Apr. | 903 | 800 | 727 | 603 | 603 |
| May | 4048 | 3381 | 2258 | 1961 | 1768 |
| Jun. | 2875 | 1647 | 1219 | 1087 | 1082 |
| Jul. | 926 | 477 | 390 | 322 | 311 |
| Aug. | 314 | 286 | 236 | 196 | 196 |
| Sep. | 221 | 209 | 194 | 163 | 163 |

- **Demand Level.** CVP and SWP deliveries are very sensitive to the assumed demand levels in any simulation. Various CALFED agencies and stakeholders have expressed interest in operation studies that include a reduced level of south of Delta CVP and SWP demand. To capture a low end of potential CVP and SWP demand, sensitivity runs will be conducted which include a maximum south of Delta CVP demand of 2.3 maf and a total SWP demand 3.0 maf in combination with No Action Alternative assumptions and selected Program Alternative assumptions.

- **San Joaquin River Tributary Surface Storage.** San Joaquin River Tributary Surface Storage will be initially modeled as a 260 taf maximum capacity off-stream reservoir located between the Merced and Toulumne Rivers. Another possibility for increasing San Joaquin River storage is an enlargement of Millerton Lake. As time and resources permit, a 720 taf expansion of the existing Millerton Lake on the San Joaquin River will be simulated as an alternative San Joaquin River Tributary Surface Storage option.

## SUMMARY OF PROPOSED OPERATION STUDIES

In summary, the three CALFED alternative with multiple storage and Delta conveyance variations along with the Affected Environment and No Action Alternative require ten (10) DWRSIM modeling scenarios to complete the draft programmatic document, not including sensitivity operation studies. The components of the ten (10) proposed DWRSIM scenarios with different combinations storage and Delta conveyance components are outline in Table 7.

These ten (10) operation studies along with several sensitivity analysis will display the initial range of system benefits and impacts between CALFED Alternatives and describe changes in existing and new storage operations, resulting downstream river flows, deliveries of surface water pursuant to CVP and SWP contracts, and required water acquisition quantities. The operation analysis will portrayed a matrix of variable physical components and operation



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assumptions, including varying levels of CVP/SWP demand, CVPIA (b)(2) actions, and storage and conveyance facilities. The matrix will then be linked to the four common programs related to water use efficiency, water quality, levee system integrity and ecosystem restoration to measure resource areas of water supply reliability and ecosystem quality.

The draft and final PEIR/EIS process should provide additional opportunities to refine the operating rules and agreements for system operations for the No Action and Program Alternatives through sensitivity analysis. To accomplish the goal of specific operation criteria for each Program alternative, significant input, interaction and acceptance will be needed from CALFED agencies and the stakeholder community. The integration of more complete operating rules and criteria for each reservoir and conveyance facility related to the Sacramento-San Joaquin Delta system and coordinated operations to protect other beneficial uses in the Bay/Delta and its tributaries should occur during the preparation of the final PEIR/EIS.

## Table 7 - Summary Description of Proposed Planning Study Scenarios

| Operation | Component Summary Description |
|---|---|
| Existing Condition | ***469 SWRCB*** + Previous FERC (Yuba, Mokelumne, Tuolumne) + Stanislaus AFRP + No WQCP Vernalis Flows from SJTA + CVPIA (b)(2) Actions (DXC closures, Pulse Flow Export Restriction, Additional X2 Days) |
| No Action | ***472 Benchmark*** + 2020 Hydrology + Variable SWP Demand + Stanislaus AFRP + CVPIA (b)(2) Actions (DXC closures, Pulse Flow Export Restriction, Additional X2 Days) |
| Scenario 1 | ***No Action*** + ERPP targets +CVP surrogate |
| Scenario 2 | ***Scenario 1*** + SDI |
| Scenario 3 | ***Scenario 2*** + 0.2 NDGS + 3.0 SRTSS + 0.5 SDGS + 1.0 SDSS |
| Scenario 4 | ***Scenario 2*** + 0.2 NDGS + 3.0 SRTSS + 0.5 SDGS + 1.0 SDSS + (0.24 to 0.72) SJRSS |
| Scenario 5 | ***Scenario 2*** + 2.0 SDSS |
| Scenario 6 | ***Scenario 2*** + 5,000 cfs IF |
| Scenario 7 | ***Scenario 4*** + 5,000 cfs IF + 0.2 IDS |
| Scenario 8 | ***Scenario 4*** + 15,000 cfs IF + 0.2 IDS |
| Sensitivity | ***No Action*** and/or ***Selected Scenarios*** + CVPIA (b)(2) Delta Actions (*Ramping 5/15-6/1, .35 E/I ratio for July, Nov, Dec and./or Jan..*) + CVPIA (b)(2) Upstream Actions (*May 13,000 cfs @ I St., May 9,000 cfs @ Knights Landing*) + Trinity River Req. + Fixed 2.3 CVP/3.0 SWP Demand |



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