CalLite

Central Valley Water Management Screening Model (Version 1.00R)

User's Guide

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California Department of Water Resources

and

United States Bureau of Reclamation

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Section 1

1 Introduction

California is experiencing unprecedented pressures on its water resources and water infrastructure. Recent issues such as the Sacramento-San Joaquin Delta ecological crisis, court-mandated cutbacks due to endangered species concerns, and southwest drought have combined with longer-term issues such as population growth and climate change to create a tenuous water supply picture in California. Various state, federal, and regional planning processes are considering significant changes to California water management to improve water supply reliability, protect fisheries and enhance ecosystems, and improve water quality.

In 2007, the California Department of Water Resources (DWR) and U.S. Bureau of Reclamation (Reclamation) embarked on the development of a rapid, interactive screening model for Central Valley water management. DWR and Reclamation identified the need for a tool that bridges the gap between more detailed system models managed by these agencies and policy/stakeholder demand for rapid and interactive policy evaluations. The newly developed screening model, named CalLite, simulates the hydrology of the Central Valley, reservoir operations, State Water Project (SWP) and Central Valley Project (CVP) operations and delivery allocation decisions, Delta salinity responses to river flow and export changes, and habitat-ecosystem indices. CalLite simulates water conditions in the Central Valley over an 82-yr planning period in under 5 minutes and allows interactive modification of a variety of water management actions including new conveyance facilities, offstream storage reservoirs, groundwater management programs, demand management, and river and Delta channel flow and salinity targets. In addition, CalLite can simulate observed or possible future hydrologic regimes to represent climate change impacts. The screening tool is designed to assist in the screening of a variety of water management options and for use in a variety of stakeholder processes for improved understanding of water system operations and future management.

This documentation describes the development, structure, and use of the CalLite model. The first several sections of this documentation provide the general context and role of screening models in California water planning and outline the objectives in the development of CalLite. The modeling platform and model representation of the physical system are then described, including a discussion of the differences between CalLite and CALSIM II. This discussion is followed by a description of the hydrology and system operations included in the CalLite model, and is supported by a detailed hydrology development appendix. Several unique methods for incorporating variable hydroclimate and demand conditions in the CalLite model are then described. While CalLite is not a direct emulation of the CALSIM II model, comparisons between the two models simulated under similar assumptions is provided along with a discussion of results. A number of future water management actions, ranging from Delta regulatory criteria to improved conveyance and storage to demand management, have been included in the CalLite model and are described in this manual. Finally, this documentation includes a discussion of limitations with the CalLite model and associated data sets and provides future directions that are being considered by DWR and Reclamation.

While CalLite simulates the hydrology and operations over much of the same geographic area as the CALSIM II model, there are several features in the CalLite screening model that are unique and are highlighted here. These innovative features or capabilities permit a range of analyses to be conducted that are distinct from those that can be reasonably performed in existing system models. These features are highlighted here and documented further in the appropriate sections of this report.

- ***Rapid runtime and interactive interface***

  CalLite simulates monthly water conditions in the Central Valley over an 82-yr planning period in less than 5 minutes and allows interactive access to simulation controls and results. While short runtimes are not a benefit in of itself, they do allow many more alternatives or trials to be explored, and are necessary for any reasonable analysis of uncertainty. Interactive controls and output displays allow the CalLite model to be accessible to a broader user-base.

- ***Delta requirements and facility controls***

  CalLite incorporates a flexible approach for allowing user-selection and specification of Delta requirements to be implemented in simulations. A menu of existing and potential future Delta requirements has been developed. Alternatively, CalLite users may specify alternative values for various controls. Of particular note, the Delta controls allow for inclusion and specification of Old and Middle River (OMR) and QWEST flow restrictions.

- ***Demand management options***

  CalLite currently incorporates both "current" and "future" levels of demand as established by the CALSIM II Common Assumptions process. However, an option also exists for user-specified SWP and CVP south of Delta demands. This capability allows for exploration of demand management in the export area.

- ***Future water management options***

  Future water management actions involving new conveyance facilities, off-stream storage reservoirs, on-stream reservoir enlargements, and groundwater management programs are incorporated as prototype implementations in the current version of CalLite. The following programs have been included in a basic form in CalLite, but can be expanded in the future: (1) Shasta Reservoir enlargement, (2) North-of-Delta Offstream Storage (NODOS), (3) Sacramento Valley conjunctive use, (4) Los Vaqueros Reservoir enlargement, (5) Isolated Facility with Hood Bypass Requirement, (6) Temperance Flat Reservoir (7) Fremont Weir Diversion and (8) Banks Pumping Plant. Note that storage implementations are place holder in this release and will be updated in the future version.

- ***Hydrologic uncertainty and climate change***

  CalLite incorporates several unique hydrologic simulation capabilities. In its standard form of simulation, CalLite utilizes the 1922-2003 historic hydrology in sequence (beginning with 1922) for projected future conditions. Alternative methods include Monte-Carlo re-sampling of the observed hydrology similar to that used in short-term position analyses and long-term Colorado River modeling, a paleoclimate mapping method utilizing reconstructed hydrologic sequences over the past 1,000 years, and climate change scenarios utilizing hydrological "perturbation" factors. Each of these methods leads to greater understanding of hydrologic uncertainty and system responses.

- ***Forecast-based delivery allocation decision-making***

  Reclamation initiated an effort to develop a forecast-based method for determining contractor annual allocations. CalLite includes an option (Forecast-based Allocation Model) to use this procedure or the traditional water supply index-demand index procedures. The forecast-based allocation procedure spawns a "submodel" for each month for each project during the allocation decision-making period (Jan-May) to maximize allocations over the remainder of year under constraints of storage carryover targets and system regulations. This procedure has been designed to better mimic Reclamation and DWR actual forecast procedures. Forecast-based Allocation Model (FAM) is described in more detail in Appendix M, however this option is currently not available to users.

Section 2

2 California Water Planning and Role of Screening Models

Many existing computer models are applied for California water planning and management. The capabilities of these models cover a wide range of analysis categories: hydrology, system operations, hydraulics/hydrodynamics, water quality, lake and river temperature, groundwater, ecosystems, agricultural water use, fish mortality, economic optimization, and others. Due to the complex nature of California's Central Valley water resources system, each of these existing models is necessarily detailed in order to capture specific system responses. These tools are vital to the understanding of physical processes and play a critical role in California water planning.

A typical application of these models in a water management setting is as follows: (1) policymakers are faced with water management problems and request technical support, (2) technical teams are formed and develop a list of studies to be performed, (3) modeling teams develop simulations for specific resource areas, and (4) results of these model simulations are processed, analyzed, and summarized for policymakers and stakeholders. This process is generally repeated several times until the questions have been framed properly and sufficient information has been developed to make informed decisions.

Many of the problems (and solutions) facing California water today, however, are ill-defined and require greater exploration of the decision space and causal relationships. Often existing tools are not well-suited for exploratory analysis due to issues such as long runtimes, lack of multi-disciplinary dynamic linkages, inability for non-modeler stakeholders to perform simulations, and lack of immediate graphical responses to specified management scenarios. It was under this guise that the concept of CalLite was conceived.

CalLite serves a unique purpose in California water management. The tool bridges the gap between more detailed system models managed by DWR and Reclamation and policy/stakeholder demand for rapid and interactive policy evaluations. CalLite incorporates the most important dynamic system responses and simplifies, or aggregates, those of less importance for the problem at hand. CalLite is not a replacement for existing models, but rather is informed by the data and results of existing models and allows users to explore the future water management actions, improve understanding, and support more stakeholder-involved decision-making. CalLite allows screening of a suite of alternatives to identify a smaller subset to be incorporated into more detailed models. In this sense, CalLite becomes part of a portfolio of analytical tools that range in complexity and stakeholder accessibility. This role of screening models is depicted in Figure 2-1.

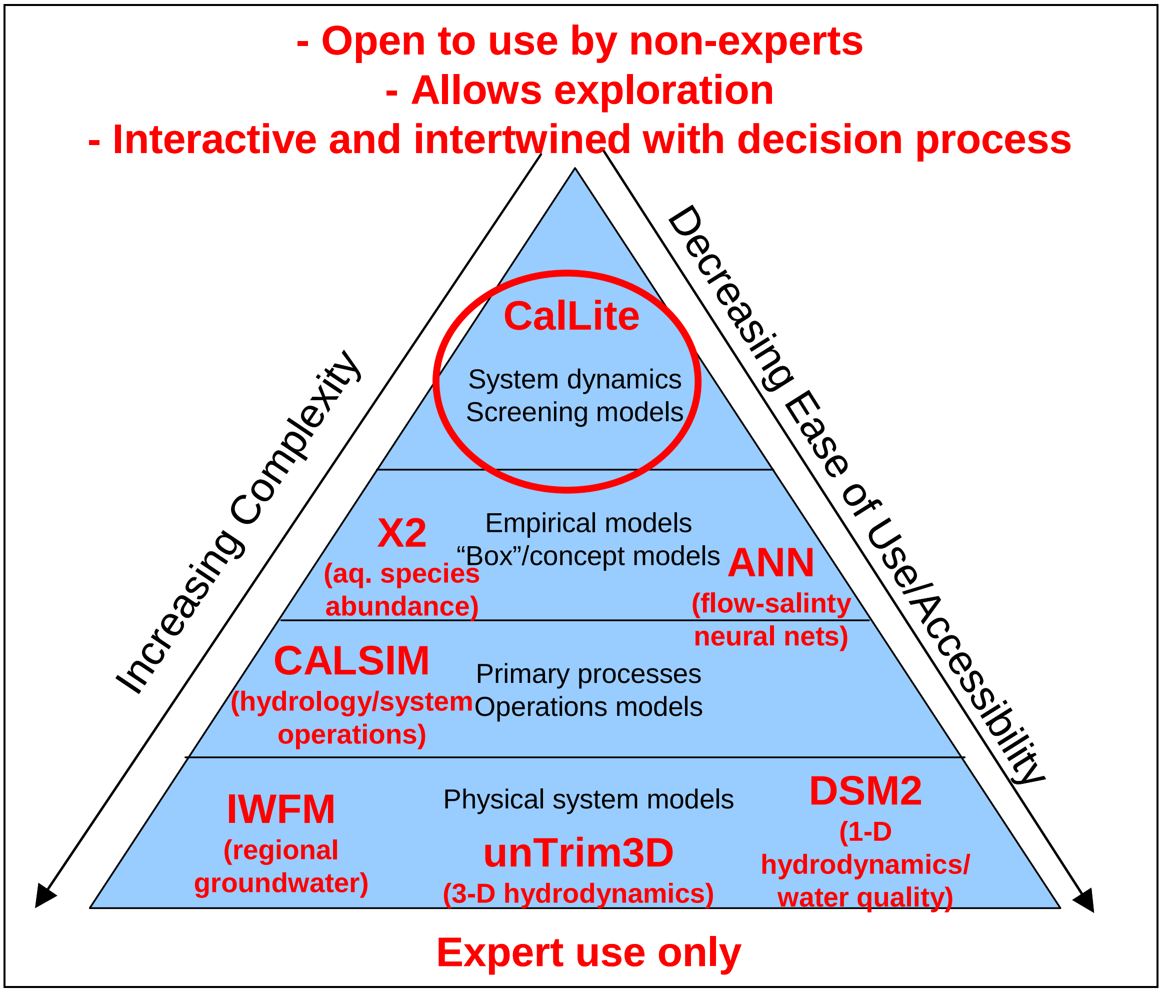

Figure 2-1. Conceptual diagram of the relationship between the CalLite screening model and other existing tools managed by Reclamation, DWR, and others

Section 3

3 Model Development Objectives

DWR and Reclamation identified the need for a simplified version of the monthly planning model of the Central Valley's water systems to rapidly evaluate alternative operations or facilities at a screening level. As discussed previously, the overall vision for CalLite is to serve as a tool that bridges the gap between more detailed system models and policy/stakeholder demand for rapid and interactive policy evaluations. The philosophy carried through the model development was to distill the complex system into the core elements to allow for coarse exploration of water management actions. The existing hydrology and operations model, CALSIM II (Munévar and Chung 1999, Draper et. al. 2004), was used to provide aggregated hydrology and guidance on system operating rules. However, the tool is designed to support stakeholder engagement and education, and is not simply a reduced version of the existing CALSIM II model. The key requirements for the development of CalLite tool were to:

1) allow simulation of the Central Valley system over an 82-yr planning horizon using a monthly time-step in under 5 minutes,
2) incorporate key facilities, regulations, system operating parameters, and sharing agreements for the Central Valley system,
3) embed existing Artificial Neural Networks for Sacramento-San Joaquin Delta flow-salinity relationships, and to
4) accommodate flexible changes to system configuration, operations, and other assumptions for interactive stakeholder session.

In addition to the stated requirements above, it is believed that CalLite can serve to educate stakeholders and decision-makers on system operations, variability, and responses to management changes. Interactive capabilities were encouraged as much as possible to allow for this type of educational feedback.

Section 4

4 Modeling Platform

The CalLite screening model has been developed within a generalized system dynamics modeling platform named GoldSim. DWR and Reclamation reviewed two broad categories of modeling platforms for potential use in the development of CalLite. The platforms reviewed ranged from existing generalized river basin modeling tools to a broad array of system dynamics platforms.

Overall, the evaluation was based on the ability of the modeling platform to best achieve the objectives set forth at the initiation of the CalLite scoping. However, specific modeling requirements critical to realistic simulation of the Central Valley system were identified early on in the development process. Amongst the most important criteria were:

1. the ability to customize operating rules or simulation procedures,
2. the ability to transfer information with existing external dynamic link libraries (DLLs) such as the flow-salinity artificial neural networks,
3. the ability to simulate SWP-CVP water sharing agreements such as the Coordinated Operations Agreement (COA),
4. the ability to iterate within a time-step to solve non-linear problems and perform pseudo-optimization,
5. the ability to create submodels for subsystem partitioning or forecast-based decision-making, and
6. the ability to perform probabilistic simulation for use in either position analyses, climate change studies, or stochastic simulations.

Other factors that were considered important were the ability of the platform to understand time and units, data exchange between other programs or spreadsheets, and handling of array constructs.

A summary of the modeling platforms reviewed as part of the CalLite development is shown in Table 4-1. Simple prototype models were tested in many of the platforms listed in the table to better evaluate model platform capabilities. The model platform evaluation, however, should not be considered entirely exhaustive, but provided a good sampling of the state of modeling tools and capabilities. The rapid growth in the system dynamics field in the last two decades has created several new and more functional modeling platforms, such as Extend and GoldSim. Newer generation models such as AnyLogic provided advanced features like real-time Java translation and web-based JavaApplet features, but were found to score lower in ease of use and would be less transparent. River-basin specific models such as WRIMS (the CALSIM II-engine), RiverWare, WEAP, HEC-ResSim, and MIKE Basin were also evaluated. While the intrinsic water resources features of many these were considered valuable, it was believed that these modeling platforms did not provide enough flexibility for the purposes of a screening model with primary purposes being operational strategy screening and dynamic user controls of complex regulatory restrictions.

While it was believed that CalLite could have been developed under a number of platforms, the inherent stochastic and iteration (looping) features of GoldSim were viewed favorably. The GoldSim system dynamics software enables simulation of complex processes through a build-up of simple object relationships, incorporates Monte-Carlo stochastic methods, and includes dynamic, interactive user interfaces. A “player” version of the CalLite model can be distributed at no cost to stakeholders. Limitations with the GoldSim modeling platform include inability to create reusable object libraries and a rather crude “scenario” manager. The GoldSim software was seen to have an aggressive research and development focus and has been very responsive to developer input.

GoldSim is part of a class of graphical, object-oriented computer modeling platforms that can be broadly described as system dynamics modeling software. System dynamics is a methodology for studying and managing complex systems, such as a water management system, a business, a mine, or the atmosphere. The system dynamics approach involves the description of relationships between system components (flows, storages, deliveries, salinity, etc in the case of CalLite) and a chain of causes, effects, and feedback. GoldSim, and its application for CalLite, is a system “simulation” model that unravels the cause-effect logic chain and solves for water allocation based on rules incorporated in the model. For example, reservoir storage is linked to flood control limits, reservoir releases are linked to inflows at the next downstream node, and diversion requirements and minimum instream flows at that node in turn drive the releases from the upstream reservoir. This simple process is repeated for each river system to form a network of water fluxes or a “system”. The simulation of the system is driven by a deterministic solution of the logic chain; meaning that for each time step the solution is simply a very long sequence of algebraic equations. This solution differs from the current simulation approach in CALSIM II in which the solution is driven by a priority-based allocation over a connected network using an “optimization” solver. Both approaches can yield the same or very close results for the same network, but the system dynamics provides greater flexibility for unstructured systems.

Table 4-1 Summary of evaluation of possible modeling platforms for the Central Valley screening model

	Generic System Dynamics Models					River Basin Specific Models					
Evaluation Features	**GoldSim**	**PowerSim**	**Extend**	**Stella**	**AnyLogic**	**WRIMS**	**RiverWare**	**WEAP**	**HEC-ResSim**	**MODSIM**	**MIKE BASIN**
Implicit Water Resource Capabilities	2	1	1	1	1	3	4	3	4	3	3
Deterministic Simulation	2	2	2	2	2	2	**4**	2	2	2	2
Stochastic Simulation	**4**	3	3	2	3	1	1	1	1	1	1
Optimization	3	3	3	2	2	2	2	1	1	1	2
Customization	3	3	3	3	**4**	4	3	2	2	2	3
Re-Usable Objects/Libraries	1	1	4	1	4	1	2	1	1	1	1
Iteration	**4**	1	1	1	2	2	2	1	1	1	1
Data Exchange (including spreadsheets)	**4**	3	3	3	3	2	3	3	2	2	3
External Functions	**4**	**4**	**4**	1	3	2	2	1	1	1	2
Callable from Other Models	1	2	2	1	3	1	2	1	1	1	1
Graphics/Animations	3	3	3	2	4	2	3	3	3	2	3
Arrays	**3**	2	2	2	2	1	1	1	1	1	1
Submodels and Layering	**4**	1	1	1	1	1	1	1	1	1	1
Equations Documented?	1	2	1	1	1	1	1	1	1	1	1
Scenario Analysis	2	2	2	2	2	2	2	2	2	2	2
Time/Units	**4**	**4**	1	1	1	2	3	3	3	2	3
Web Capabilities	1	2	2	1	4	1	1	1	1	1	1
Graphical Interface	4	4	3	2	3	2	3	3	3	2	3
Ease of Implementation	4	4	2	2	2	2	3	3	3	2	3
User Base	--	--	--	--	--	--	--	--	--	--	--
GIS Linkage	2	1	2	1	2	1	1	3	2	1	4
Availability of Player Version	4	4	4	4	4	1	1	1	1	1	1
Cost	2	2	2	2	2	2	2	2	2	2	2
Customer Service	**3**	2	2	2	2	2	2	2	2	2	2

1 = Does not contain 2 = Contains 3 = Does well 4 = Does very well

Section 5

5 Model Representation of the Physical System

CalLite represents the Central Valley water resource system based on a simplified network. The simplified network was developed based on experience from Central Valley Project/State Water Project (CVP/SWP) operators and planners in terms of criteria that tend to control project operations. Once these controls were agreed upon and the level of spatial complexity was determined, aggregation of the planning-level hydrology from the existing CALSIM II model was developed to match that of the CalLite model. The relationship between the CALSIM II hydrology and assumptions was maintained with that of CalLite through automated databases. This linkage was desired so that the two models, the simplified CalLite and the more complex CALSIM II, could synchronize hydrology as changes are made to both models in the future. The physical system is shown in Figure 5-1 and the resulting CalLite network is shown in Figure 5-2.

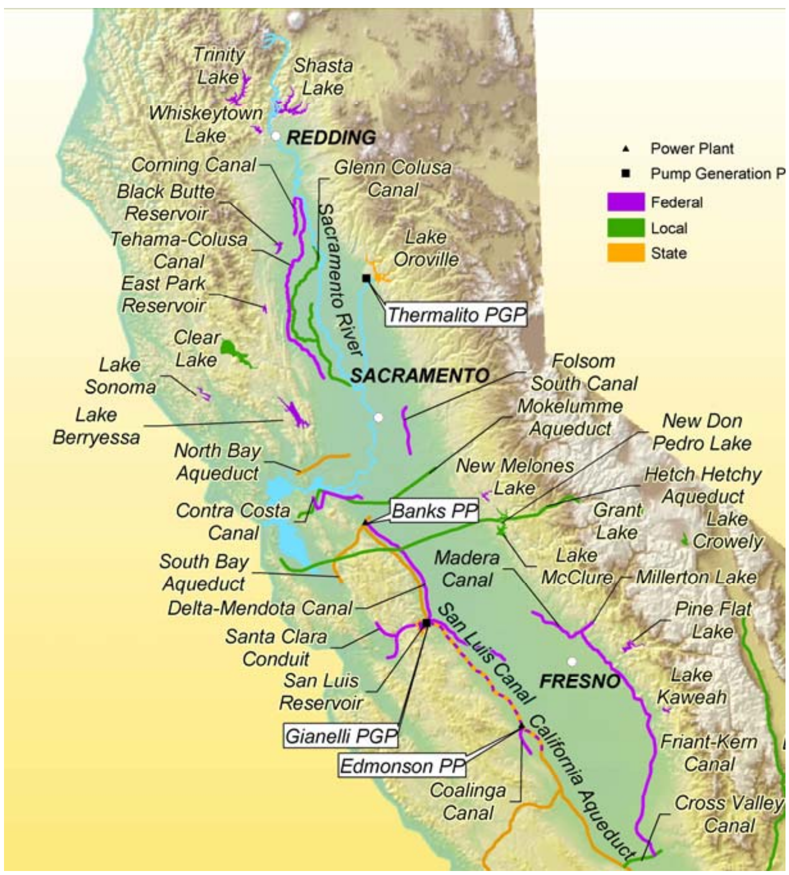

Figure 5-1. Geographic extent and general location of SWP and CVP facilities simulated in CalLite

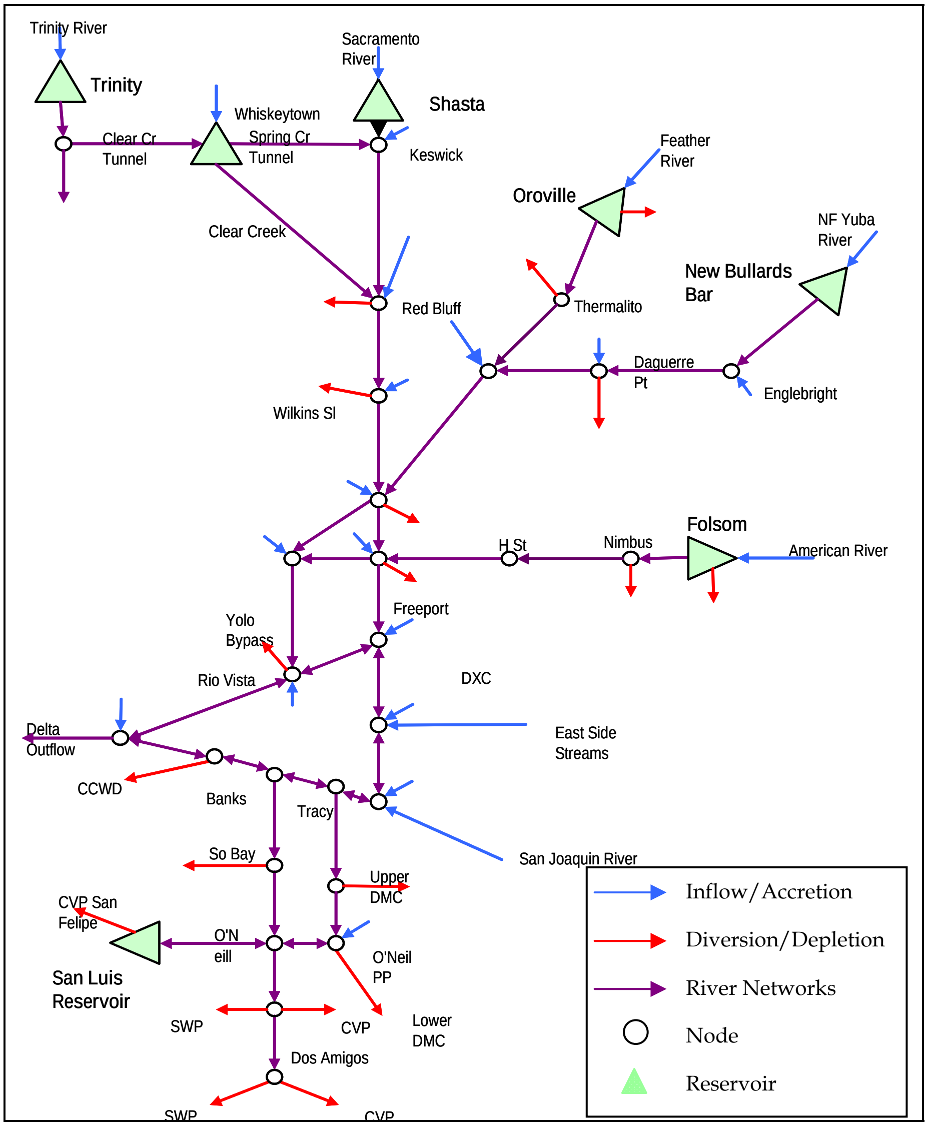

Figure 5-2. Representation of CalLite network and interactive schematic

5.1 River Basins Incorporated

The CalLite screening model incorporates a simplified version of the CALSIM II schematic as the basis for the system configuration and identifying operational constraints. CalLite incorporates the hydrology and operation of the Trinity River, Sacramento River, Feather River, Yuba River, American River, and the Sacramento-San Joaquin Delta in the main model. The hydrology and operations of the San Joaquin River and its tributaries, the Fresno River, Chowchilla River, Merced River, Tuolumne River, Stanislaus River, and Calaveras River are currently packaged into a separate CalLite model at this point in the development. This San Joaquin stand-alone model is undergoing review and refinement by Reclamation and should be considered a draft implementation. The main version of the CalLite screening model utilizes an input of the net flow at Vernalis. The hydrology of the Sacramento Valley and the Delta and treatment of SWP and CVP demands are described in detail in Appendix B. The San Joaquin Basin hydrology development and the current state of operations in that basin are described in Appendix C. Finally, the simulation of water facility operations in the Yuba River basin is described in Appendix D.

5.2 Major Storage and Conveyance Facilities

All major storage and conveyance facilities included in the CALSIM II model are also incorporated in CalLite. The facilities included in the model are listed in Table 4-1 and shown graphically in Figure 5-2 (schematic). The configuration of the Delta, Delta Mendota Canal, California Aqueduct, and San Luis Reservoir remains largely consistent with that in the full CALSIM II model, but the extent is limited to aggregate demands south of Dos Amigos pumping plant.

5.3 Sacramento Valley Hydrology Aggregation

Hydrologic inputs for the major reservoirs were applied identical to that of the CALSIM II model. However, the valley floor hydrologic accretions and depletions were aggregated to match the reduced CalLite schematic. The hydrology and water management in the Sacramento and San Joaquin Valleys is extremely complex as water is diverted from the rivers, applied to agricultural and urban areas, and often reused before being returned to the river through drainage networks. Since the current focus of CalLite is to explore valley-wide and cross-Delta water management actions, much of the valley floor hydrologic/drainage network was simplified. In CalLite, CVP and SWP contractor diversions are simulated dynamically and water is allocated to these users based on an allocation scheme, but non-project diversions were assumed to be fixed to that from the CALSIM II model. These simplifications led to a significant reduction in the complexity of the network. All hydrology for the both CalLite and CALSIM II models are specified on a monthly basis for an 82-yr planning period. Appendix B describes the hydrology development for CalLite in detail.

5.4 South of Delta Export Area Demand Aggregation

As discussed previously, the representation of the Delta Mendota Canal (DMC), California Aqueduct, and San Luis Reservoir is also largely consistent with that in the full CALSIM II model, but spatial extent and contractor diversity are simplified. Demands and deliveries to SWP and CVP south of Delta contractors have been aggregated to a few super-delivery points. These locations are Upper DMC, Lower DMC, South Bay, O'Neill, San Luis Reservoir, Joint Reach, and Dos Amigos. All south of Delta diversions occur at these seven locations. In addition, the number of contractors has been aggregated to reduce spatial and delivery allocation complexity. For the CVP, contractors are aggregated into Agricultural, Municipal, Refuge, and Exchange types. For the SWP, contractors are aggregated in Agricultural, Municipal-MWD, and Municipal-Others.

Table 5-1 Major facilities and constraints included in the CalLite screening model

Storage Facilities	Conveyance Facilities	Operational/Regulatory Constraints
Sacramento Basin		
Trinity Lake	Clear Creek Tunnel	Trinity River Minimum Flows
Whiskeytown Lake	Spring Creek Tunnel	Keswick Fish Flows
Shasta Lake	Trinity River	Red Bluff Minimum Flows
Lake Oroville	Sacramento River	Navigation Control Point
Folsom Lake	Feather River	Feather River Minimum Flows
Bullards Bar	American River	Nimbus Minimum Flows
Englebright Lake	Yuba River	American River Min Flows @ H St
	Yolo Bypass	Rio Vista Minimum Flows
		Lower Yuba/Daguerre Pt Controls
CVP / SWP South-of-Delta		
CVP San Luis Reservoir	California Aqueduct	San Luis Operations
SWP San Luis Reservoir	Delta Mendota Canal	CA Aqueduct Capacity Restrictions
	San Luis Pumping Plant	DMC Aqueduct Restrictions
	Dos Amigos Pumping Plant	Delivery Allocation Procedure
San Joaquin River Basin (Phase 1A)		
None	San Joaquin River at Vernalis	Upstream operations implicit in the boundary condition flow at Vernalis
San Joaquin River Basin (Phase 1B)		
Millerton Lake	San Joaquin River	Maximum salinity near Vernalis (D1641)
Hensley Lake	Fresno River	Minimum flow near Vernalis (D-1641 and VAMP)
Eastman Lake	Chowchilla River	Minimum flow below Goodwin (1987 USBR/DFG agreement)
Lake McClure	Merced River	
New Don Pedro Reservoir	Tuolumne River	
New Melones Reservoir	Stanislaus River	
Sacramento-San Joaquin Delta		
None	Delta Cross-Channel	Delta Cross-Channel Gate Operation
	Tracy Pumping Plant	SWRCB D-1641 Standards
	Banks Pumping Plant	VAMP

Section 6

6 Regulatory Constraints

The current version of the CalLite screening model includes level of development, regulatory, and demand assumptions that are consistent with those described in the Common Assumptions Existing Conditions study (Ver 9A). These regulatory constraints are summarized in Table 5-1 and discussed in the relevant sections of facility operations below. To be consistent with efforts currently being considered for Delta solutions, the base Delta standards and restrictions are currently set to those described in D-1641. Implementation of these standards and operations to satisfy the requirements are identical to that applied in CALSIM II. However, Delta requirements can be modified by the user through the “Regulations” control on the interface. Most other regulatory requirements such as flood control levels and minimum instream flow requirements can also be modified by the user by modifying the “CalLite_ControlInput.xls” file. This file is read by the model at runtime and establishes most of the regulatory controls. Details regarding the Delta regulatory constraints are in the subsequent sections.

Section 7

7 Simulated Operations of Existing Facilities

While many aspects of the actual Central Valley water resources system were simplified for implementation in the CalLite screening model, complexity was added in areas of critical interest. The main areas in which greater detail was provided were (1) aspects governing operation and control of Delta facilities, water quality, channel flows, and ecosystem indicators; and (2) delivery allocation procedures for the CVP and SWP.

7.1 Upstream Reservoirs and Operations

The operations of facilities are consistent with those described in the Common Assumptions V9A study and are not described separately here. However, a list of the operational criteria, summarized from the Common Assumptions documentation, is included below. Greater detail is provided where the facility operation differs from that included in CALSIM II.

7.1.1 CVP Reservoirs and Operations

7.1.1.1 Trinity Reservoir

- Flood Control – Safety of Dams
- Fish and Wildlife Requirements on the Trinity River
- Transbasin Exports

7.1.1.2 Whiskeytown Reservoir

- Hydropower Operations (Clear Creek Tunnel-Spring Creek Tunnel)
- Fish and Wildlife Requirements on Clear Creek

7.1.1.3 Shasta and Keswick Reservoir Operations

- Flood Control
- Fish and Wildlife Requirements on the Sacramento River
- Minimum Flow for Navigation – Wilkins Slough
- Hydropower Operations

7.1.1.4 Folsom/Natoma Reservoir Operation

- Flood Control
- Fish and Wildlife Requirements on the American River
- Hydropower Operations

7.1.1.5 Trinity-Shasta-Folsom Balancing

The balancing of storage between Trinity, Shasta, and Folsom reservoirs in CalLite deviates from the CALSIM II rules. During early 2007, a review of Reclamation's forecasts for 2000-2005 was performed for the explicit purpose of developing Shasta and Folsom Reservoir monthly storage targets that better reflects actual CVO practice. As implemented in CalLite, guide levels, derived from the 2000-2005 forecast information, are selected in each April and May based on the total Shasta plus Folsom storage. These levels guide the storage balancing for the remainder of the year by determining what proportion of the CVP storage withdrawals should come from each reservoir. Since Trinity Reservoir is largely balanced with Shasta Reservoir though import tables, it is only called upon for Delta requirements when Shasta and Folsom storage is insufficient. Work will continue with CVO to review these rules and month-by-month drawdown criteria.

7.1.1.6 NOD-San Luis Storage Balancing

CVP North of Delta storage is balanced with storage in San Luis Reservoir using the same San Luis rule curve criteria established and applied in CALSIM II.

7.1.2 SWP Reservoirs and Operations

7.1.2.1 Oroville/Thermalito Reservoirs and Operations

- Flood Control
- Fish and Wildlife Requirements on the Feather River
- Hydropower Operations

7.1.2.2 Oroville-San Luis Storage Balancing

Oroville storage is balanced with storage in San Luis Reservoir using the same San Luis rule curve criteria established and applied in CALSIM II. An update rule curve was provided by DWR OCO and added to the model. An option of switching back and forth to the CALSIM II version is also provided.

7.1.3 Non-SWP/CVP Reservoirs

7.1.3.1 New Bullards Bar and Englebright

New Bullards Bar and Englebright Reservoirs on the Yuba River have been included in the CalLite model version. New Bullards Bar is operated for power production through the New Colgate Powerhouse, for flood control, and for Daguerre Point demands. Englebright Reservoir is operated a run-of-the-river debris dam and thus does not store significant quantities. Englebright is simulated as a non-storage node in CalLite. Details on the operation of New Bullards Bar or the Yuba River system are provided in Appendix D Yuba River Screening Model Documentation.

7.2 Delivery Allocation Decision-Making

Delivery allocations for the CVP and SWP are implemented with three options. The first option incorporates the WSI-DI logic that is included in the current CALSIM II model. This logic develops an allocation decision for system-wide CVP and SWP deliveries based on water in storage, forecasts of usable inflow, and storage carryover targets. The allocations for the CVP Water Right, Exchange, and Settlement contractors and SWP Feather River Service Area contractors are dependent on reservoir inflow criteria. South-of-Delta delivery allocations for the CVP are based on water in CVP San Luis storage plus projections of available water for export prior to low point. This is similar to the current procedure used in the CALSIM II model.

As a second option, Reclamation has embarked on embedding a revised CVP delivery allocation process in the CalLite model that more closely represents the forecast-based procedures used in reality. A “Sub-model” procedure has been developed to search for the allowable delivery allocation while satisfying target carryover storage levels in Shasta, Folsom, and CVP San Luis. This submodel is activated during each month of the allocation period. More detail on this approach is included in the subsequent section, Innovative Features.

A third option is being developed to enter user-specified allocation values for each project to enhance comparison of different alternatives under the same operating conditions.

7.3 Coordinated Operations Agreement

The Coordinated Operations Agreement (COA) assigns responsibility for releases for in-basin uses or apportions available water for export to the CVP and SWP depending on the hydrologic conditions. In the case that stored water must be withdrawn from reservoirs to meet in-basin uses (including Delta requirements), the responsibility for releases is shared 75%/25% between the CVP and SWP, respectively. Under conditions in which unstored water is available for export (greater than in-basin uses and Delta requirements), the water is shared 55%/45% between the CVP and SWP, respectively. If one party cannot use all of its share of water under the COA, the other party is permitted to use the “unused” share.

The COA is implemented in the CalLite screening model through an iterative process. First, all reservoirs are operated to meet their reservoir-specific upstream needs which may consist of flood control, instream flows, diversion requests, temperature-related flows, and others. No Delta requirements or exports are included in this iteration. The amount of Delta outflow is then compared to that needed for requirements and, if a shortfall exists, the responsibility for each party is computed. If there is excess water in the Delta then the share of available water for export for each party is computed. Second, the project reservoirs are re-operated to make releases for any shortfall in the Delta outflow or Rio Vista flow requirement. Additional releases may be made from project reservoirs to support the target exports for each project. Under conditions of excess Delta outflow, the available water for export for each party is compared to available export capacity for each party. If any party’s available water for export exceeds the maximum export capacity, then the difference is allocated to the other party. This process is repeated until all COA and Delta constraints are fully satisfied.

7.4 Delta and Export Operations

7.4.1 Delta Requirements and Export Controls

Delta requirements and export controls are largely implemented in a fashion similar to CALSIM II. Due to the importance and scrutiny of these requirements and operational control, a brief fact sheet is provided with a focused discussion on each of the Delta requirements. This fact sheet is provided in Appendix K and is summarized in the subsection, Innovative Features.

7.4.2 Tracy Exports

Exports at Tracy Pumping Plant are governed by the need to meet demands on the Delta Mendota Canal and San Luis Unit, desired storage levels for CVP San Luis, availability of CVP water for export in the Delta, regulatory limits, and physical capacity of the pumping plant and the conveyance facilities. The target pumping level is determined by a CVP south of Delta demand which includes demands from both contractors and for maintaining CVP San Luis target storage levels. Export limits due to regulatory controls then serve as a maximum on total project exports. In the current CalLite version the allowable export curtailments are shared 50/50 between the SWP and the CVP. A minimum pumping of 800 cfs (600 cfs when total CVP NOD storage is less than 1500 taf) is applied for health and safety requirement.

7.4.3 Banks Exports

Exports at Banks Pumping Plant are subject to many of the same controls as Tracy: demands on the California Aqueduct, desired storage levels for SWP San Luis, availability of SWP water for export in the Delta, regulatory limits, and physical capacity of the pumping plant and the conveyance facilities. The target pumping level is determined by the SWP south of Delta demand which includes demands from both contractors and for maintaining SWP San Luis target storage levels. Export limits due to regulatory controls then serve as a maximum on total project exports. In the current CalLite version the allowable export curtailments are shared 50/50 between the SWP and the CVP. A minimum pumping of 300 cfs is applied for health and safety requirement.

7.5 South of Delta Operations

7.5.1 CVP Delivery Allocations

7.5.1.1 Delivery allocations

As discussed above, overall CVP delivery allocations are made through either the water supply index approach or the new forecast allocation submodel process. This allocation, or delivery target, is specified as the delivery of the sum of all CVP contractor categories. A separate process, identical to that in CALSIM II, performs the assignment of water to specific contractor types. In order to allocate water to specific contractor categories, however, a tiered reduction scheme is first employed so that contractor allocations match the overall delivery allocations. Agricultural, Municipal and Industrial, Refuge, and Exchange contractor demands are then satisfied at the appropriate delivery location.

7.5.1.2 Cross-Valley Canal deliveries

Cross –valley canal contractor deliveries are determined by the available capacity at Banks Pumping Plant and the California Aqueduct, limited by the CVP SOD Agricultural water service allocations. In the current version of CalLite, cross-valley canal deliveries are not simulated.

7.5.2 SWP Delivery Allocations

7.5.2.1 Table A Allocations

As with the CVP, overall SWP delivery allocations are made through either the water supply index approach or the new forecast allocation submodel process. This allocation, or delivery target, is specified as the delivery of the sum of all SWP Table A contractor categories. Any reductions to Table A allocations that is required to match with the overall SWP delivery target is shared in proportion to the Table A entitlement of the contractor category. CalLite aggregates demands from the 29 SWP contractors in Agricultural, Municipal and Industrial – MWDSC, and Municipal and Industrial – Other contractors.

7.5.2.2 Article 56 Deliveries

Article 56 deliveries refer to SWP contractor deliveries that were allocated in the previous year, but were stored in SWP storage before being delivered in the current year. SWP contractors sometimes defer taking the allocated water in some wetter years in the hopes that the delivery of water in the subsequent year would prove more beneficial. CalLite incorporates an accounting scheme for the Article 56 water in storage and provides this for delivery in the subsequent year. However, CalLite does not track the ownership of Article 56 water and deliveries.

7.5.2.3 Article 21 Deliveries

Article 21 deliveries are made by the SWP when excess water is available in the Delta, SWP San Luis storage is full, SWP Table A and Article 56 deliveries have been satisfied, and Banks Pumping Plant has available capacity for additional pumping. The delivery of Article 21 water in CalLite is simulated by allowing Banks pumping up to San Luis storage maximum plus Article 21 demands. All Article 21 deliveries are assumed to be taken at San Luis Reservoir.

7.5.3 San Luis Reservoir Operations

The operational objective of the San Luis Reservoir for both projects is to maximize storage in the early spring to help meet the high water demands in the late spring, summer, and early fall. The fill operation generally occurs December through April while the drawdown period is generally May through November. The projects generally rely upon winter and spring flows in the Delta to fill San Luis, however, they will make storage withdrawals from upstream reservoirs during this period to ensure that there is sufficient water in San Luis to meet future demands and storage targets. The operation of the CVP, due to greater constraints on upstream reservoirs and limited Tracy Pumping Plant capacity, generally limits the ability to significantly control San Luis storage during the fill period; exports are maximized until CVP San Luis is full or upstream storage is limited. During the fill cycle, San Luis rule curves for both the SWP and CVP are applied for each project based on available upstream storage and initial allocation, per CALSIM II assumptions. As in CALSIM II, rule curves are used to balance north of Delta supplies with San Luis storage.

Section 8

8 Innovative Features

While CalLite simulates the hydrology and operations over much of the same geographic area as the CALSIM II model, there are several features in the CalLite screening model that are unique and are highlighted here. These innovative features or capabilities permit a range of analyses to be conducted that are distinct from those that can be reasonably performed in existing system models.

- ***Rapid runtime and interactive interface***

  CalLite simulates monthly water conditions in the Central Valley over an 82-yr planning period in less than 5 minutes and allows interactive access to simulation controls and results. While short runtimes are not a benefit in of itself, they do allow many more alternatives or trials to be explored, and are necessary for any reasonable analysis of uncertainty. Interactive controls and output displays allow the CalLite model to be accessible to a broader user-base.

- ***Delta requirements and facility controls***

  CalLite incorporates a flexible approach for allowing user-selection and specification of Delta requirements to be implemented in simulations. A menu of existing and potential future Delta requirements has been developed. Alternatively, CalLite users may specify alternative values for various controls. Of particular note, the Delta controls allow for inclusion and specification of Old and Middle River (OMR) and QWEST flow restrictions.

- ***Demand management options***

  CalLite currently incorporates both "current" and "future" levels of demand as established by the CALSIM II Common Assumptions process. However, an option also exists for user-specified SWP and CVP south of Delta demands. This capability allows for exploration of demand management in the export area.

- ***Future water management options***

  Future water management actions involving new conveyance facilities, off-stream storage reservoirs, on-stream reservoir enlargements, and groundwater management programs are incorporated as prototype implementations in the current version of CalLite. The following programs have been included in a basic form in CalLite, but can be expanded in the future: (1) Shasta Reservoir enlargement, (2) North-of-Delta Offstream Storage (NODOS), (3) Sacramento Valley conjunctive use, (4) Los Vaqueros Reservoir enlargement, (5) Isolated Facility with Hood Bypass Requirement, (6) Temperance Flat Reservoir (7) Fremont Weir Diversion and (8) Banks Pumping Plant. Note that storage implementations are place holder in this release and will be updated in the future version.

- ***Hydrologic uncertainty and climate change***

  CalLite incorporates several unique hydrologic simulation capabilities. In its standard form of simulation, CalLite utilizes the 1922-2003 historic hydrology in sequence (beginning with 1922) for projected future conditions. Alternative methods include Monte-Carlo re-sampling of the observed hydrology similar to that used in short-term position analyses and long-term Colorado River modeling, a paleoclimate mapping method utilizing reconstructed hydrologic sequences over the past 1,000 years, and climate change scenarios utilizing hydrological "perturbation" factors. Each of these methods leads to greater understanding of hydrologic uncertainty and system responses.

- ***Forecast-based delivery allocation decision-making***

  Reclamation initiated an effort to develop a forecast-based method for determining contractor annual allocations. CalLite includes an option (Forecast-based Allocation Model) to use this procedure or the traditional water supply index-demand index procedures. The forecast-based allocation procedure spawns a "submodel" for each month for each project during the allocation decision-making period (Jan-May) to maximize allocations over the remainder of year under constraints of storage carryover targets and system regulations. This procedure has been designed to better mimic Reclamation and DWR actual forecast procedures. Forecast-based Allocation Modeling (FAM) is described in more detail in Appendix M (this option is currently not available to users).

In the sections that follow, the hydroclimate simulation capabilities, demand options, Delta regulatory options, and the forecast-based allocation model are described in more detail. The future water management actions are described in a subsequent stand-alone section.

8.1 Hydroclimate Simulation Capabilities

As alluded to in the Innovative Features section of this documentation, there are several key innovative features that separate CalLite from CALSIM II or other Central Valley water management tools. A significant amount of effort was put towards enhancing the ability to evaluate system performance under a range of possible hydrologic futures. This section describes CalLite's capabilities to simulate operations under the observed hydrologic traces, climate change futures, as well as alternative samplings of observed and paleoclimate information. Note that this version of CalLite does not provide user interface to use all these options except those scenarios described in DWR (2006) report.

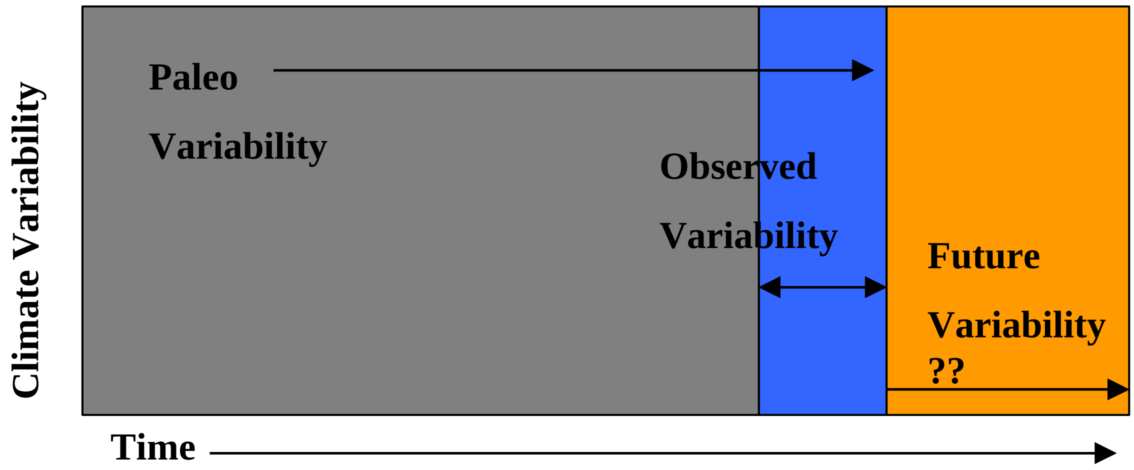

Figure 8-1. Hydrologic variability: past, present, and future

8.1.1 Direct Observed Hydrology

The traditional approach toward assessing future hydrology is to make the assumption that the historical observed hydrologic conditions and sequence are reasonable for use in projecting future water availability and management. This is the approach that is used in the CALSIM II model and in most analyses of water supply planning in the United States. CalLite incorporates the same direct observed hydrology as that used in the CALSIM II model. This hydrology is based on monthly observed flows from October 1922 through September 2003. Under the direct observed hydrology option, the 82-year simulated hydrologic sequence is identical to that observed.

8.1.2 Index Sequential Method

The Index Sequential Method (ISM), a technique commonly applied to Colorado River simulation (Reclamation 2004), also involves the use of the historic observed hydrology. However, the ISM involves simulation of multiple traces from the observed data sets. Not only is the historic sequence (Oct1922-Sep2003 in this case) simulated, but also N traces based on different starting year indices. For example, trace #2 would incorporate hydrology starting with 1923, trace #3 with 1924, trace #4 with 1925, and so on. In order to keep the length of the simulation equivalent for each trace, the hydrology would wrap-around once the end of the sequence is encountered. For example, trace #2 would sample starting years of 1923, 1924, 1925, …, 2003, and wrap-around for 1922. In planning mode the ISM would involve 82 different sequences of an 82-year simulation. Long-range planning in the Central Valley has commonly used a fixed level of development and fixed facilities to represent a static future. That is, the simulation represents only one point in time. Under this planning mode, the ISM does not necessarily provide additional information.

However, under more dynamic futures the ISM can provide a sense of the hydrologic uncertainty and system risk. SWP and CVP operators often perform "position" analyses in which the state of the system (storage, salinity, etc) is set to current conditions and multiple futures (using the historic observed flows) are simulated. This methodology can be viewed as a short duration simulation under the ISM. In CalLite, the user can select the simulation duration and the number of realizations. The example shown below in Figure 8-2 and

Figure 8-3 used a duration of 1 year and 50 realizations. The statistics for Shasta storage over this year as shown in Figure 8-3 are a standard output of the GoldSim software when probabilistic results are displayed.

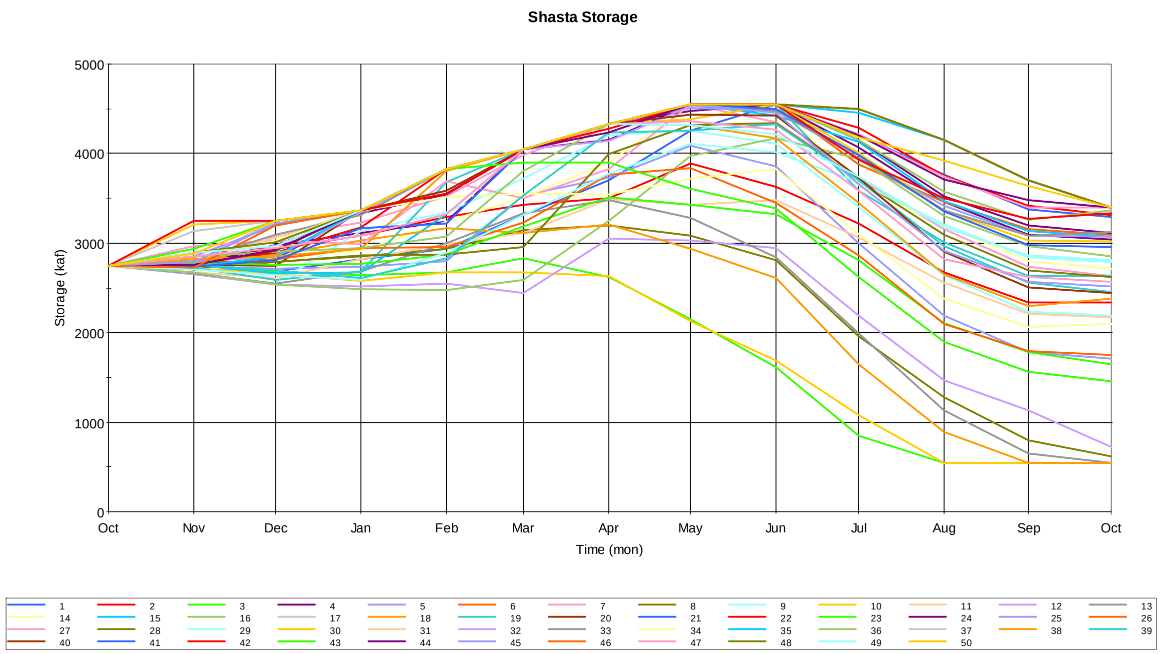

Figure 8-2. Example Shasta storage results using the Index Sequential Method or "Position Analysis" approach

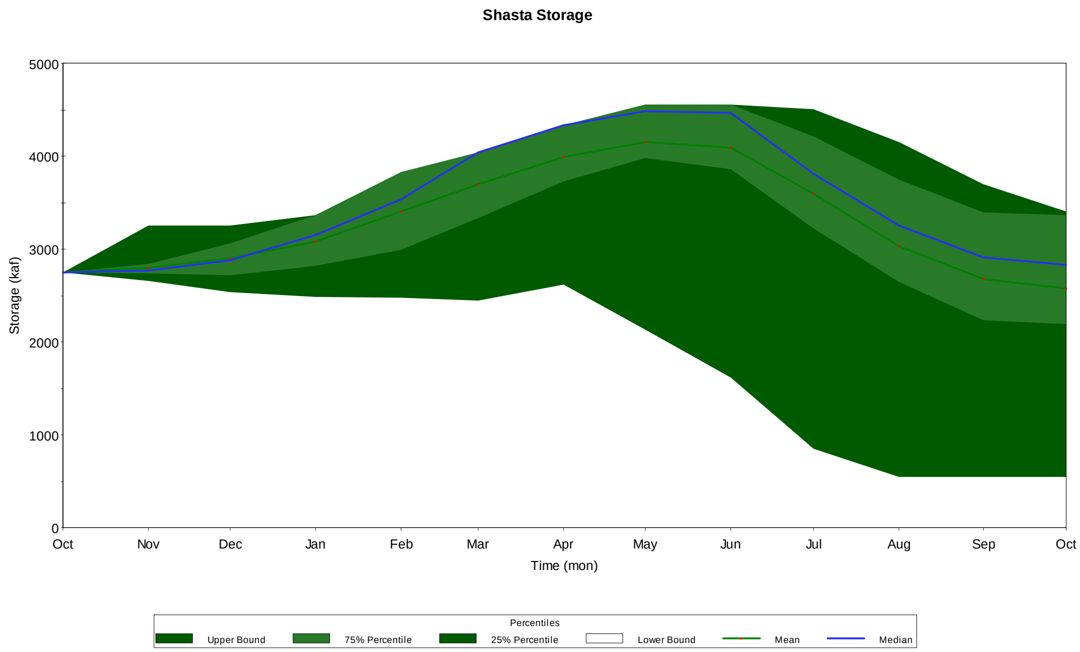

Figure 8-3. Example Shasta storage statistical results using the Index Sequential Method or "Position Analysis" approach

8.1.3 Climate Change Scenarios

DWR has been at the forefront of incorporating climate change in water resources planning and management. DWR published their first report "Progress on incorporating climate change into management of California's water resources" in 2006 in which the potential hydrologic changes of various climate scenarios were analyzed and incorporated into water resources simulation models. The methods of these analyses are described in DWR (2006) and further detailed in Ejeta et. al. (2008). The CalLite screening model incorporates these hydrological "perturbation" factors for each of the major inflow locations to describe potential changes to the runoff volumes and patterns due to various warming scenarios. Currently, the emission scenarios A2 and B1 (Intergovernmental Panel on Climate Change 2000) combined with simulation by GFDL and PCM general circulation models are utilized to create four climate change scenarios. In CalLite, the user can select whether to run only one climate change scenario or whether to run the direct observed in combination with all four climate change scenarios as realizations. In Figure 8-4 below, the latter option was selected such that 5 realizations were simulated. The first realization represents the direct observed hydrology and realizations 2 through 5 represent climate change scenarios.

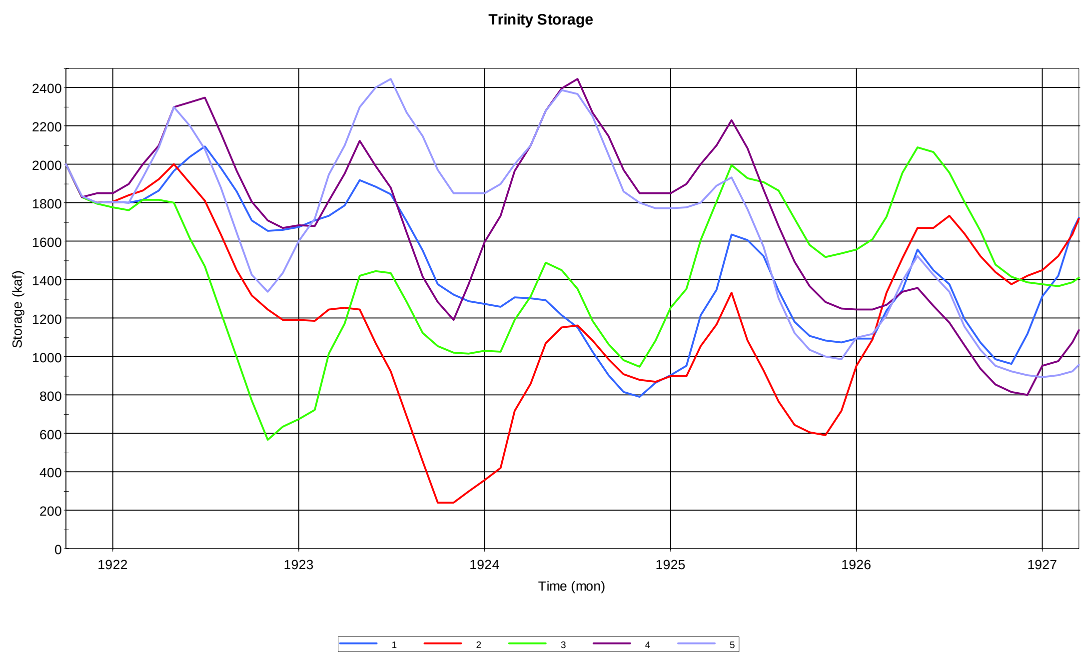

Figure 8-4. Example Trinity storage results under observed historical hydrology and four climate change futures

8.1.4 Paleoclimate Sampling

While climate change scenarios provide an insight into potential future changes to the hydrologic regime (and estuary hydrodynamics and water quality), a broader retrospective view of hydrologic variability can also provide insights into system performance and vulnerability. A paleoclimate perspective will be included in CalLite for these purposes and is currently under development. Meko et. al. (2001) developed Sacramento and Feather River annual flow reconstructions based on tree-rings for A.D. 869 through 1977. This 1,000-plus year reconstruction provides a measure of the past hydrologic variability beyond that observed from river gage measurements (less than 100 years). A mapping approach has been developed in CalLite to randomly sample multiple 82-yr periods (Monte Carlo method) from this reconstructed record and simulate system performance under a risk-based approach. Monthly patterns are applied based on the nearest observed annual runoff. Figure 8-5 below depicts random sampling of period from the paleoclimate reconstruction.

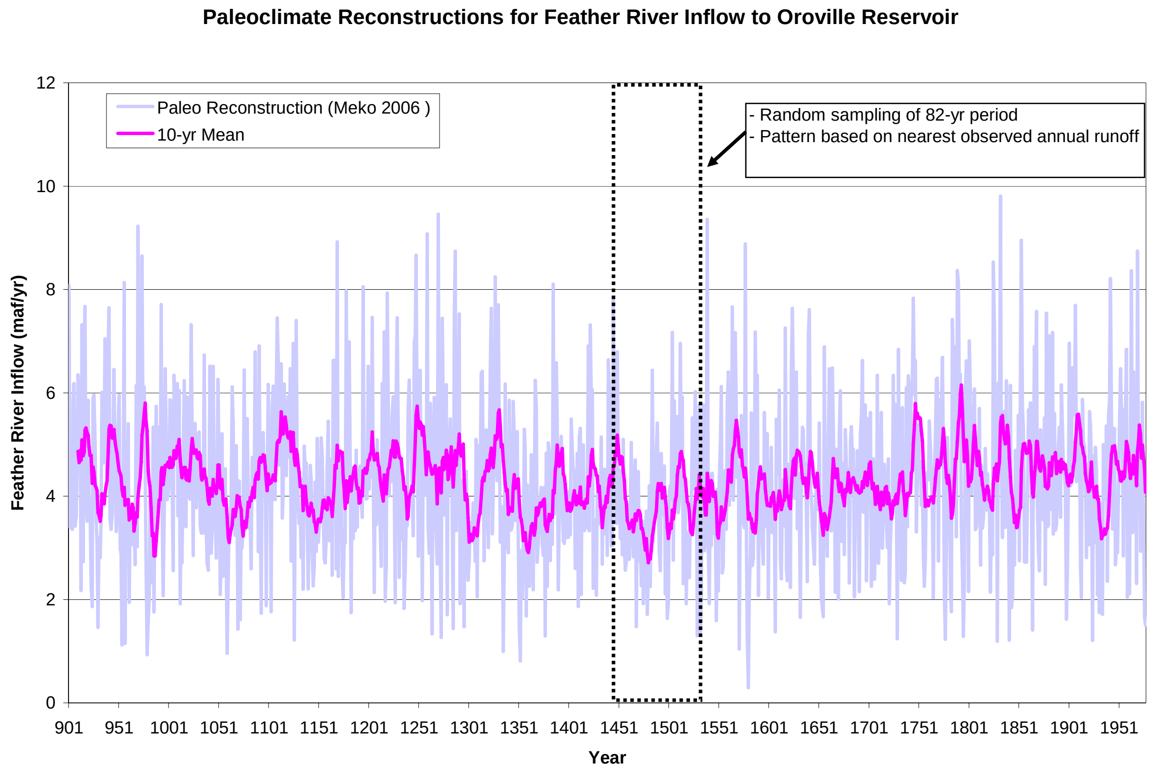

Figure 8-5. Paleoclimate reconstructions for the Feather River from A.D. 901 to 1977 as developed by Meko et al (2006) and CalLite method for sampling from this record

8.1.5 Sea Level Rise

Increased temperatures cause thermal expansion of the ocean and melt polar ice caps resulting in an increase sea level. Historical data for the later part of last century seem to validate this theory. Observed data along the pacific coast shows a change in the amplitude over the same period. Five different sea level scenarios are included in the CalLite model. Quantifying the impacts of these 5 sea level scenarios in CalLite are under construction.

8.2 Demand Options

To increase the flexibility of CalLite as a screening tool, the user is allowed to choose from three different demand options for both CVP and SWP. These three options are 2005 level, Future level, or user-defined as shown in Figure 8-6. Pre-defined data sets are included for 2005 and Future level demands. For the SWP, the 2005 level include a variable annual demand between 3.3 MAF to 4.2 MAF. The Future level for the SWP is assumed to be Full Table A entitlement demand per assumptions in the Common Assumptions future level studies. For the CVP, contractor demands are specified at full contract amounts for both the 2005 and Future level.

The third option is user-defined demand values (in TAF) up to Full Table A amounts. Under this option, the user selects the projected demand levels for SWP Agricultural, M&I-MWDSC, and M&I-Other contractors. Demand patterns (fractional) are assumed to be the same as the Future level patterns. Under this option, however, Article 21 and 56 deliveries are set to zero in order to avoid continued delivery of the these categories when Table A demands are reduced. Similarly, for the CVP, the user selects projected demand levels for CVP Agricultural, M&I, and Refuge contractors. However, deliveries to Water Right or Exchange contractors are not permitted to be modified.

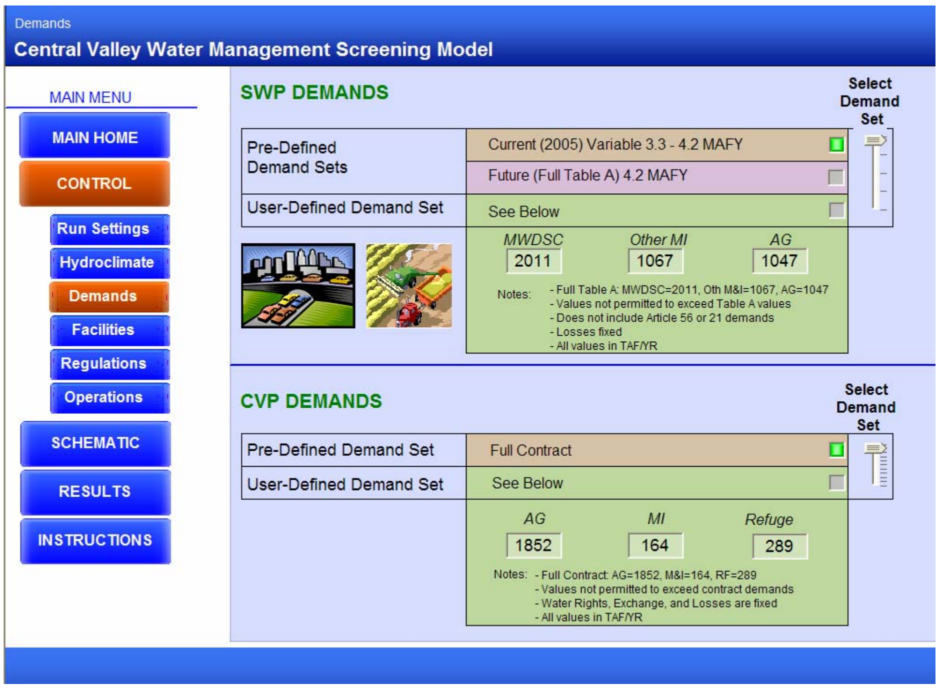

Figure 8-6. "Demands" dashboard for specification of annual SWP and CVP demand levels

8.3 Delta Regulatory Controls

The implementation of Delta regulatory controls and associated operations has been a focal point of the CalLite development. The regulatory controls in CalLite allow users to specify requirements for interior Delta flows, minimum river flows, Delta outflows, export restrictions, and salinity objectives. Figure 8-7 shows the location of the Delta regulatory controls incorporated in the CalLite model.

The methodology used in the implementation of Delta regulatory controls is generally similar to that used in the CALSIM II model. However, in the CalLite model, the user can switch requirements on or off, specify Decision 1641 requirements, or specify new values for these requirements. These user selections are specified through a dashboard (user-interface) as shown in Figure 8-8. If the user chooses to customize the constraints, then the "Assumptions" button links to an external spreadsheet for input (CalLite_ControlInput.xls). This ability to rapidly switch between Delta requirements is an innovation that does not exist in other models and allows for screening of regulatory benefits and impacts.

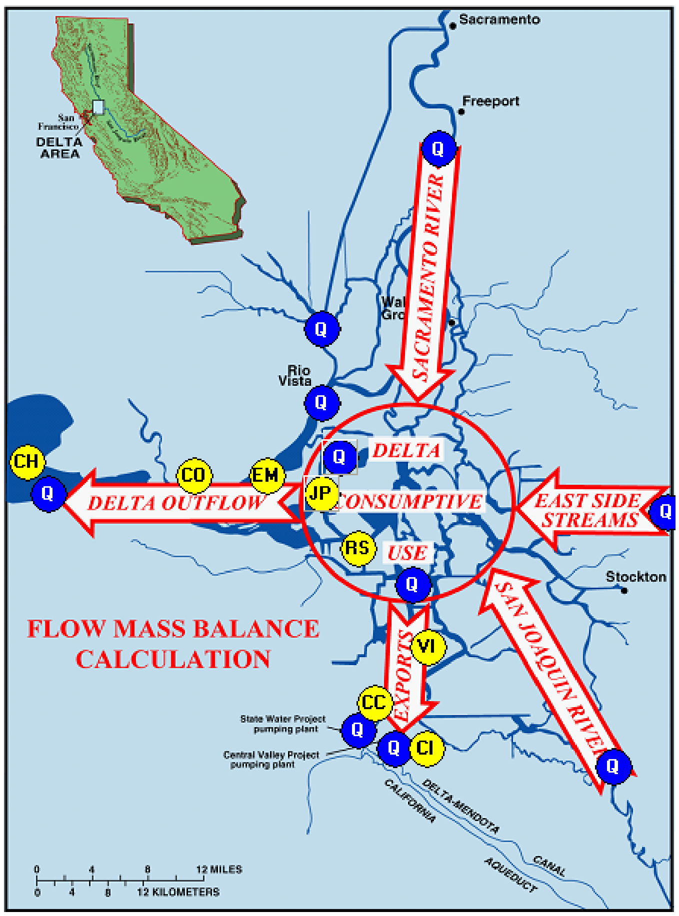

Figure 8-7. CalLite Delta regulatory control locations

The main Delta regulatory controls included in the CalLite model are:

- Old and Middle R minimum flows (or max negative flows)
- Delta Cross Channel gate position
- San Joaquin R near Jersey Point minimum flow
- Sacramento R at Rio Vista minimum flow
- Minimum Delta outflow
- X2 requirements
- Export-inflow ratio
- VAMP export restrictions
- Export –San Joaquin River Inflow Ratio
- Salinity standards at Emmaton, Jersey Pt, Rock Slough, and Collinsville

Appendix K includes detailed documentation of the main Delta regulatory controls, assumptions, and method of implementation.

Figure 8-8. Delta Regulatory Control dashboard in CalLite

8.4 Forecast-based Allocation Model

As mentioned previously, Reclamation has embarked on embedding a revised CVP delivery allocation process in the CalLite model that more closely represents the forecast-based procedures used in reality. “Sub-models” are spawned from the planning model every March, April, and May to produce a forecast-based delivery allocation (Figure 8-9). The forecast-based allocation “submodels” project CVP reservoir storage conditions both upstream and downstream of the Delta from the current month through the end of September of the current year. Target storages are specified based on the current state (planning model state) of the system and the “submodel” optimizes contractor allocations subject to these targets. Allocations for two projects are then passed back to the planning model to simulate the current month with the specified allocation. This process is repeated for each month until the final allocation is established in May. This method is consistent with the general approach applied by project operators. Forecast-based Allocation Model is explained in more detail in Appendix M.

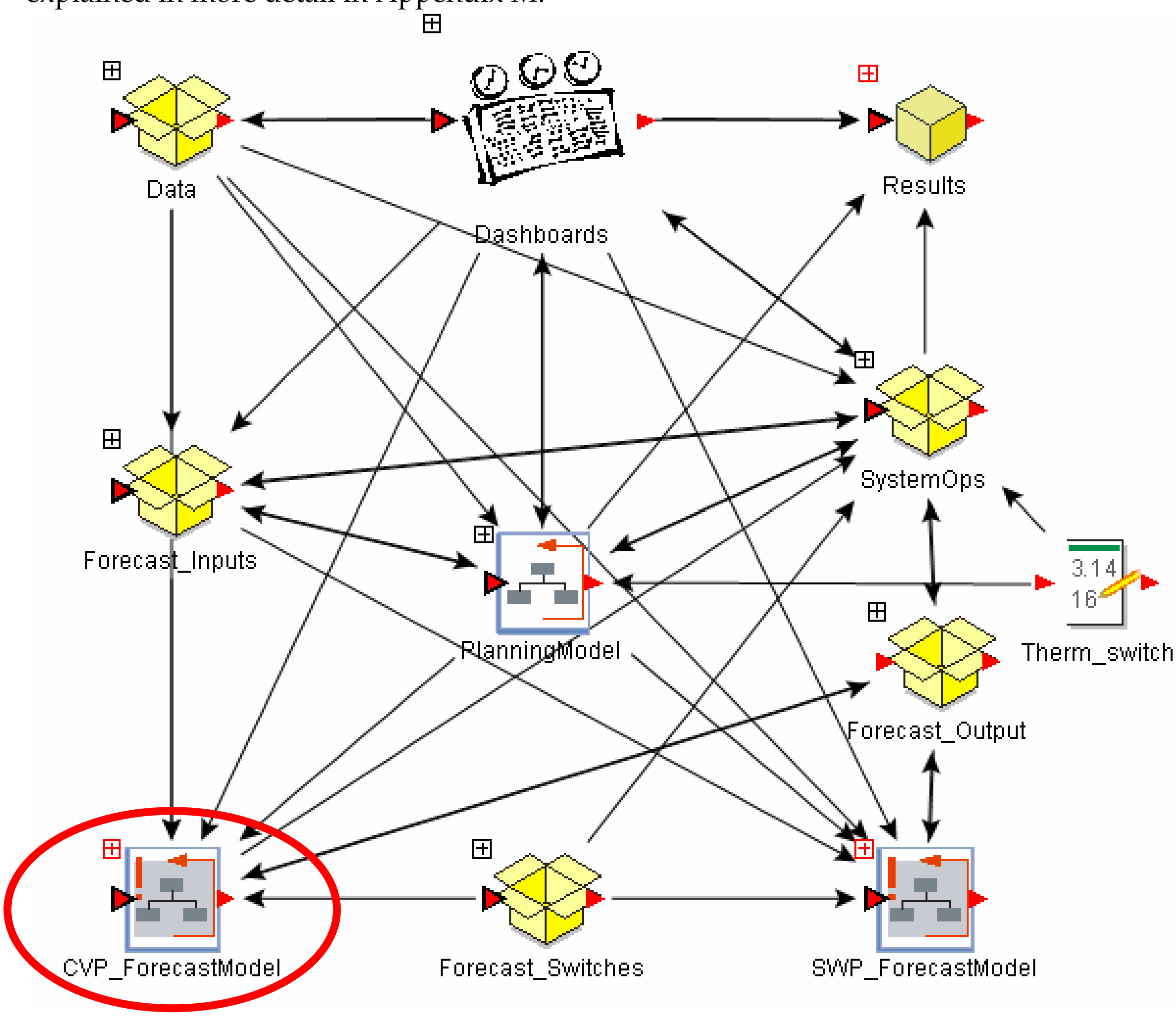

Figure 8-9. Screenshot of Forecast-based allocation model and relationship to Planning model

Section 9

9 Incorporation of Future Water Management Actions

One major impetus for the development of CalLite was to provide the capability to simulate a wide range of future water management actions. The current version of CalLite includes options for implementing demand management in the San Joaquin Valley and Southern California, adding new conveyance in the Delta, providing additional fishery and ecosystem protection through salinity and flow management, augmenting or adding new surface storage, and implementing conjunctive use operations in the Sacramento Valley. Specifically, the following future storage and conveyance facilities are in CalLite: Shasta Enlargement, North of Delta Offstream Storage (NODOS), Sacramento Valley Conjunctive Use program, Los Vaqueros Enlargement, Isolated Facility with Hood Bypass, Temperance Flat Reservoir, Fremont Weir Diversion and Banks Pumping Plant. CalLite includes only skeletal implementations of these facilities and should be considered draft. These options are considered an initial range of future facilities, and these will be refined and others added based on agency and stakeholder need. Each of these storage and conveyance programs is described in detail in Appendices.

CalLite users control which options to include in the scenario by selecting from a menu (Figure 9-1), then specifying the details of the parameters for the individual facility (Figure 9-2 as an example).

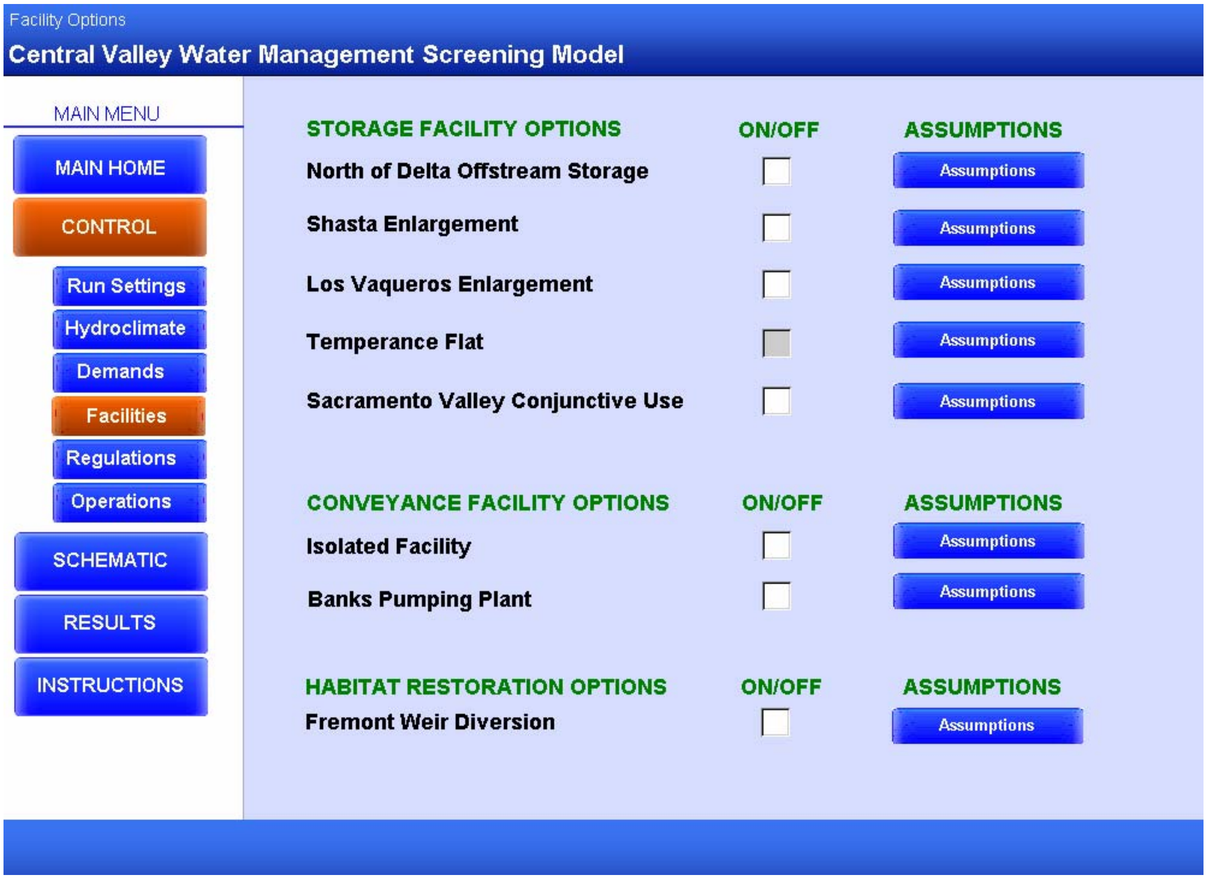

Figure 9-1. CalLite dashboard for triggering new Storage or Conveyance facilities

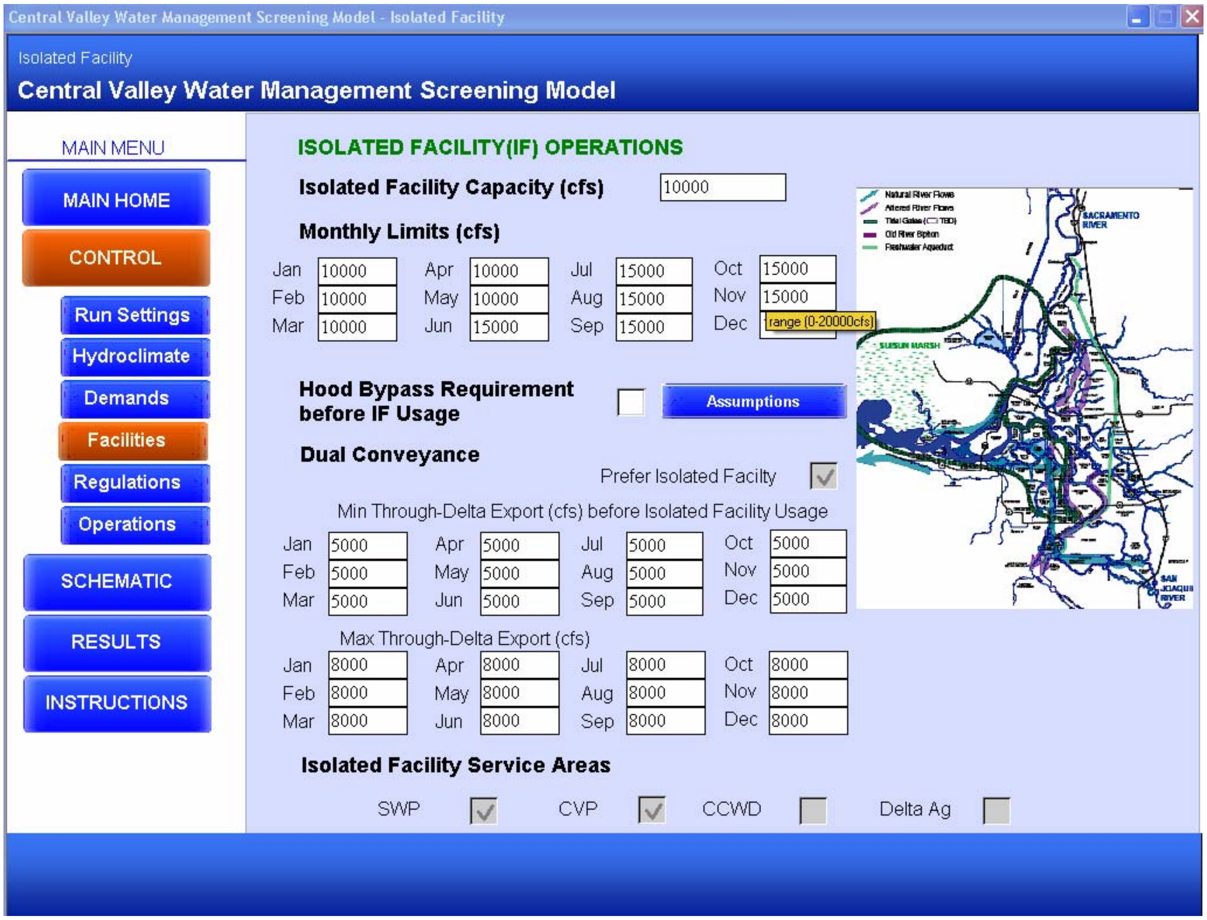

Figure 9-2. Example CalLite dashboard for specifying Storage and Conveyance facility assumptions (Isolated Facility with Hood Bypass shown)

Section 10

10 Graphical User Interface, Input Controls and Available Outputs

The CalLite model is configured with a graphical user interface that serves as the primary entry point for most users. When working with the "Player" version of CalLite, users will have access to the user interface and associated exposed controls. The user interface is comprised of a number of linked interactive screens or "dashboards" as shown in Figure 10-1. The "Main" dashboard simply provides the entryway to the "Control", "Schematic", "Results", or "Instructions" dashboards. The functionality of each of these is briefly described below.

Figure 10-1. "Main" dashboard of CalLite

The "Control" dashboard permits specification of run settings, SWP/CVP demand levels, hydroclimate settings, regulations, and whether to include new storage or conveyance facilities (Figure 10-2). Each of the buttons provides access to a more specific control dashboard. For example, under the "Regulations" dashboard, the user can specify which Delta regulations to include and the desired level of Delta regulations (Figure 10-3 and Figure 10-4). In this case, the user-controlled information is held in an Excel spreadsheet and combined Old and Middle flow criteria are established by filling in the table values.

Figure 10-2. "Control" dashboard of CalLite

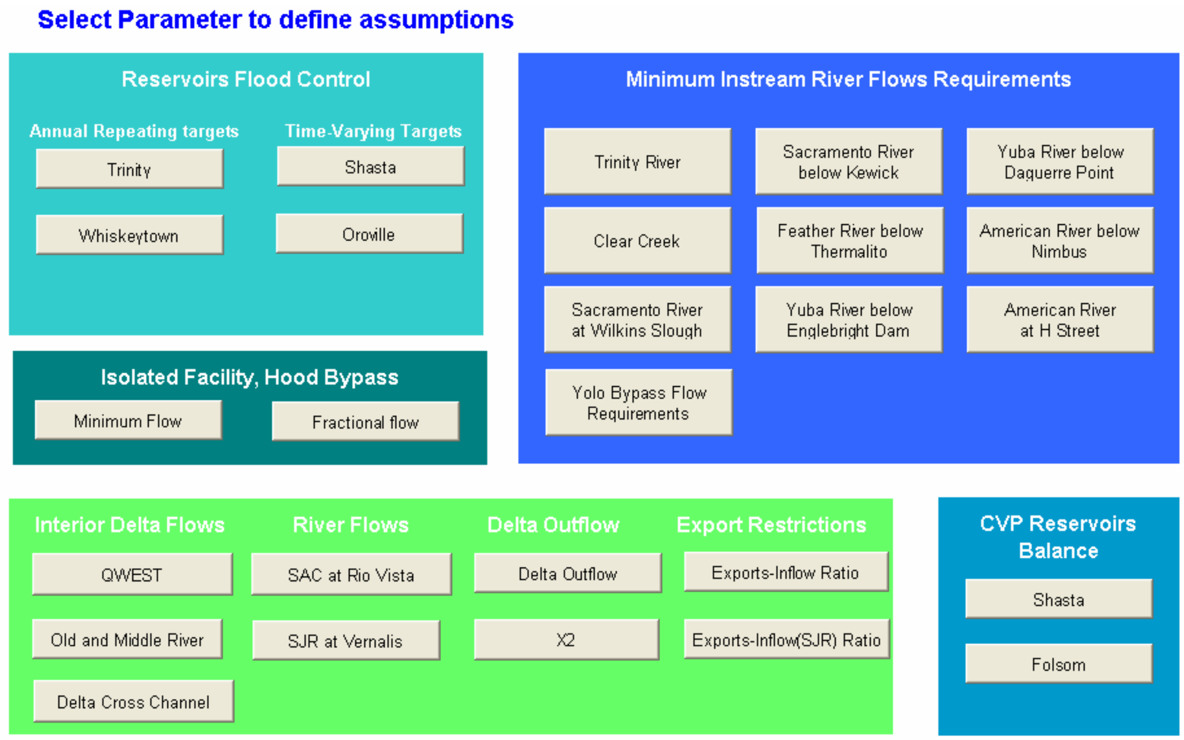

Figure 10-3. Regulatory input controls in "CalLite_ControlInput.xls"

Interior Delta Flows

QWEST = San Joaquin River near Jersey Point minimum flows

Month	W	AN	BN	D	C
Jan	-3000	-3000	-3000	-3000	-3000
Feb	0	0	0	0	0
Mar	0	0	0	0	0
Apr	0	0	0	0	0
May	0	0	0	0	0
Jun	0	0	0	0	0
Jul	-1000	-1000	-1000	-1000	-1000
Aug	-3000	-3000	-3000	-3000	-3000
Sep	-3000	-3000	-3000	-3000	-3000
Oct	-3000	-3000	-3000	-3000	-3000
Nov	-3000	-3000	-3000	-3000	-3000
Dec	-3000	-3000	-3000	-3000	-3000

Return to Control

Save & Exit

OMR = Combined Old and Middle River minimum flows

Month	W	AN	BN	D	C
Jan	-5000	-5000	-5000	-5000	-5000
Feb	-5000	-5000	-5000	-5000	-5000
Mar	-5000	-5000	-5000	-5000	-5000
Apr	-5000	-5000	-5000	-5000	-5000
May	-5000	-5000	-5000	-5000	-5000
Jun	-5000	-5000	-5000	-5000	-5000
Jul	-99999	-99999	-99999	-99999	-99999
Aug	-99999	-99999	-99999	-99999	-99999
Sep	-99999	-99999	-99999	-99999	-99999
Oct	-99999	-99999	-99999	-99999	-99999
Nov	-99999	-99999	-99999	-99999	-99999
Dec	-99999	-99999	-99999	-99999	-99999

Return to Control

Save & Exit

Figure 10-4. Example tables for QWEST and Old and Middle River requirements

The "Schematic" dashboard simply provides access to two different schematic types. The main schematic is that shown in Figure 5-2 and allows interactive access of reservoir storages and river flows. The Delta schematic is a zoomed-in version of the schematic with access to river flows, salinity, and Delta pumping as shown in Figure 10-5.

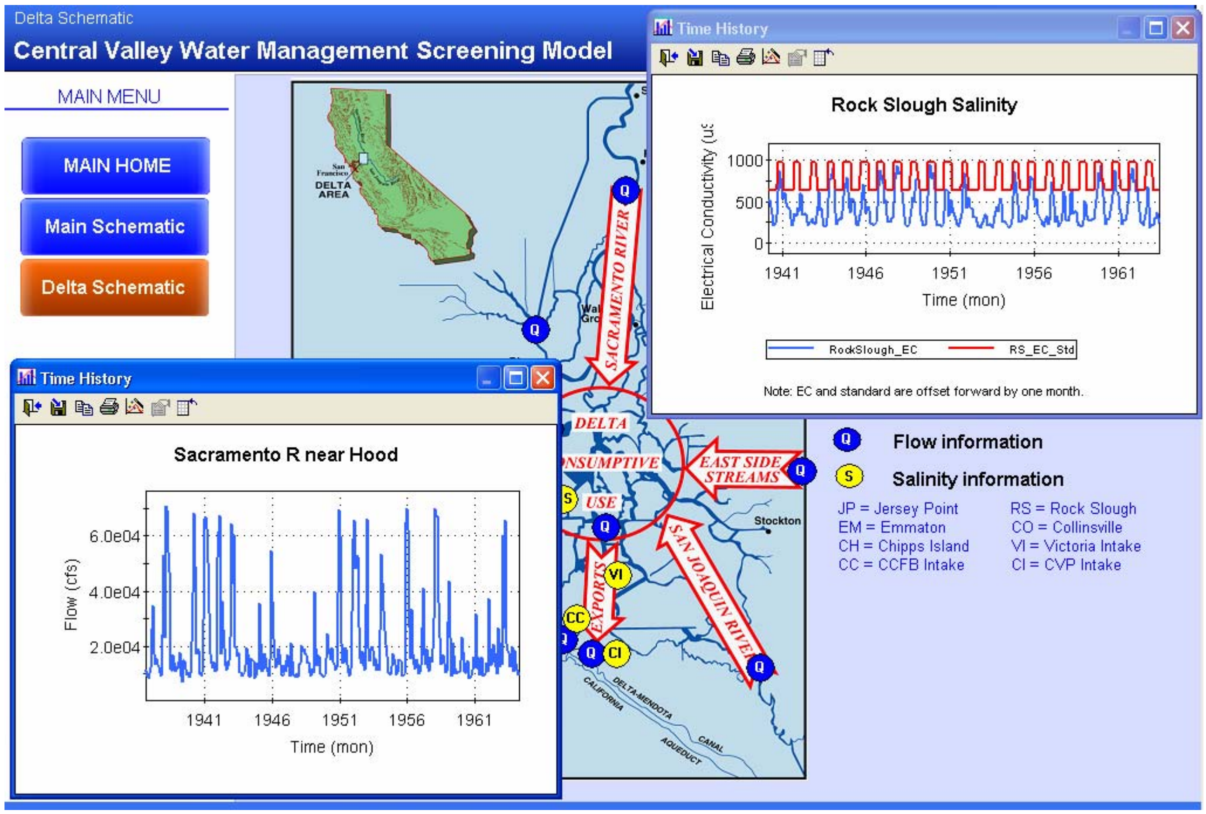

Figure 10-5. Example Delta schematic and dynamic salinity and reservoir operation results

The "Results" dashboard provides access to key simulation results for the current simulation under "Current" button (Figure 10-6) as well as cross-scenario result comparisons "Comparative Button"(Figure 10-7) . The results that are currently included were designed to capture the most critical system responses, but it is recognized that this dashboard may always been in some state of flux. The dashboard also provides buttons for compiling the annual Delta balances or water year type averages.

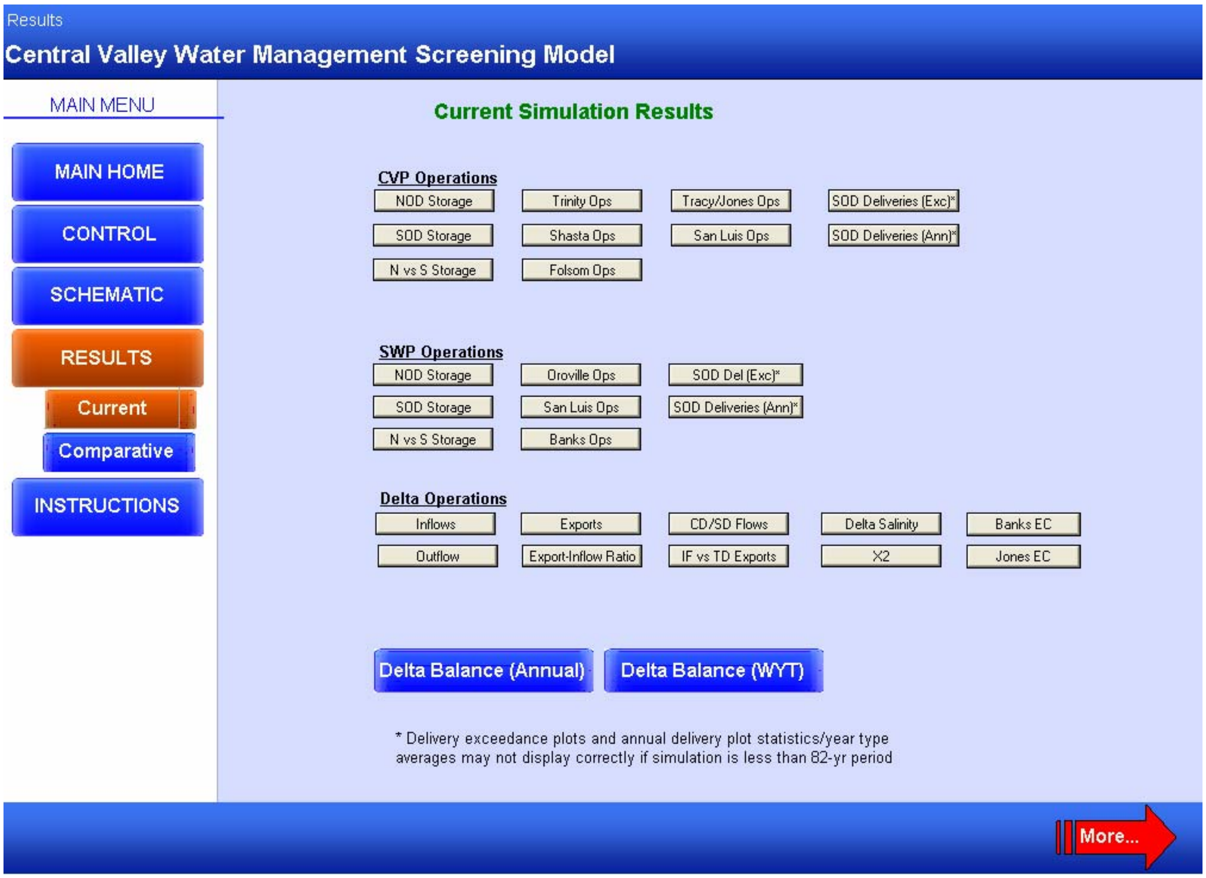

Figure 10-6. "Current"Results dashboard of CalLite

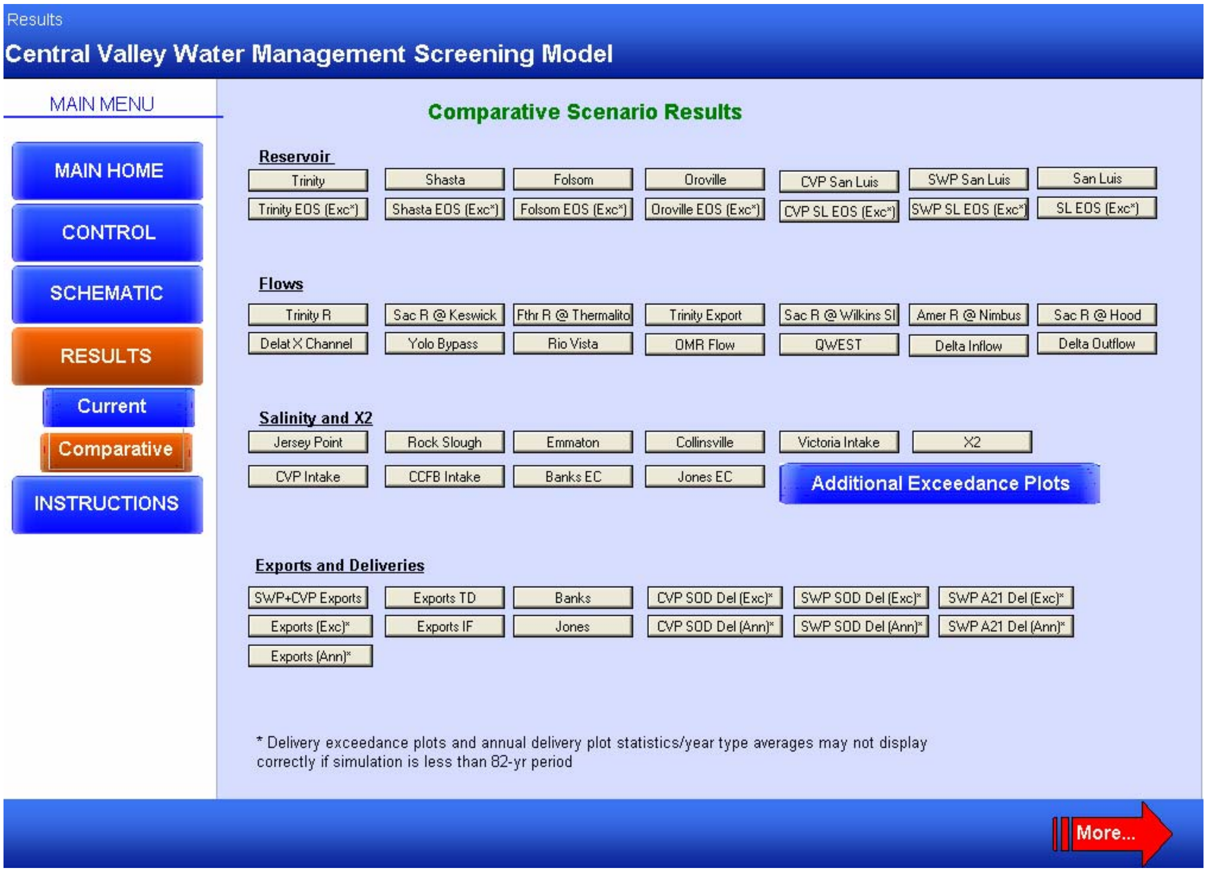

Figure 10-7. "Comparative"Results dashboard of CalLite

Section 11

11 Comparisons to CALSIM II Model Simulations

In order to better understand the differences between CalLite and CALSIM IIII and the degree in which the approximations included in CalLite affect the key system results, the two models were compared for 2005 and 2030 level simulations. Since the hydrology and demand sets in CalLite were developed from the Common Assumptions Common Model Package (CMP) version 9A, comparisons of CalLite and CALSIM II were also performed for these study versions. While the hydrology and demands should be approximately equivalent in both models, it should be recognized that CalLite was not merely developed as a replication of CALSIM II operating rules. For example, CalLite has differing rules for balancing of Shasta and Folsom storage. In other words, we do not expect an exact match of results between CalLite and CALSIM II. Rather, the comparisons were performed to evaluate whether the relative system performance was similar between models and whether any gross omissions occurred. In fact, earlier versions of these comparisons did point to differences in minimum instream flow requirements that have subsequently been resolved.

The comparisons that follow show the system-wide flow summary for both CalLite and CALSIM II for both the long-term 82-year period and the critical drought periods of 1929-1934 and 1987-1992. Note that the CalLite model results were taken from earlier internal version which is slightly different from the released version (1.00R) in terms of rule curves, balancing curves and so on. Storage time series and end-of-September exceedance plots are also provided for all major reservoirs simulated in the system. Delta mass balances, X2 position, and Rock Slough EC are also compared. Finally, SWP and CVP contractor allocations are compared between CalLite and CALSIM II. Assumptions of the base studies for 2005 and 2030 level of developments are presented in Appendix O.

11.1Comparisons to 2005 Base CALSIM II Simulations

Table 11-1. System-wide flow summary between CalLite and CALSIM II simulations (taf/yr)

	1922-2003			1929-1934			1987-1992		
	CalLite	CALSIM II	Diff	CalLite	CALSIM II	Diff	CalLite	CALSIM II	Diff
River Flow									
Trinity R blw Lewiston	692	707	-15	411	411	0	472	472	0
Trinity Export	549	539	10	335	356	-21	429	448	-19
Clear Cr blw Whiskeytown	42	45	-3	33	33	0	38	38	0
Sacramento R @ Keswick	6296	6285	11	3946	4024	-78	4597	4639	-42
Sacramento R @ Wilkins Slough	6694	6685	9	3969	4032	-62	4896	4946	-50
Feather R blw Thermalito	3168	3187	-19	1578	1637	-59	1627	1658	-31
American R blw Nimbus	2520	2522	-2	1362	1328	34	1222	1199	23
Delta Inflow	**21970**	**21959**	**11**	**9906**	**9934**	**-28**	**10754**	**10745**	**9**
Sacramento R @ Hood	16237	16226	11	8214	8242	-28	9384	9374	9
Yolo Bypass	1926	1926	0	110	110	0	130	130	0
Mokelumne R	666	666	0	202	202	0	140	140	0
San Joaquin R d/s Calaveras	3141	3141	0	1381	1381	0	1100	1100	0
Delta Outflow	**14906**	**14849**	**56**	**5044**	**5100**	**-55**	**5535**	**5624**	**-89**
Required	5566	5575	-9	4090	4092	-2	3912	4126	-214
Delta Diversions	**5988**	**6038**	**-50**	**3602**	**3579**	**22**	**3888**	**3796**	**92**
Banks SWP	3311	3384	-72	1891	1943	-52	1947	1959	-13
Banks CVP	0	78	-78	0	18	-18	0	31	-31
Tracy	2677	2576	100	1711	1618	92	1941	1806	135
SWP SOD Deliveries	**3269**	**3233**	**36**	**1860**	**1847**	**13**	**1929**	**1874**	**55**
Table A	2730	2726	4	1630	1527	103	1722	1691	31
Article 21	245	216	29	133	223	-89	30	5	25
Article 56	293	290	3	96	97	-1	177	179	-1
CVP SOD Deliveries	**2723**	**2770**	**-46**	**1647**	**1604**	**43**	**1943**	**1889**	**53**

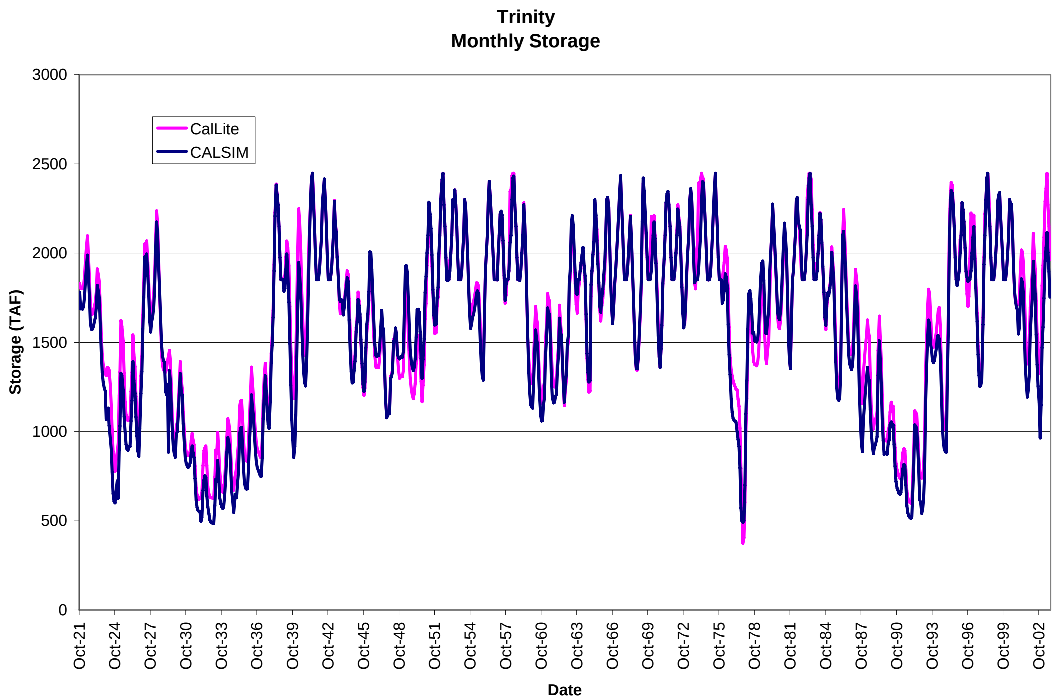

Figure 11-1. Trinity Reservoir storage for CalLite and CALSIM II existing level simulations

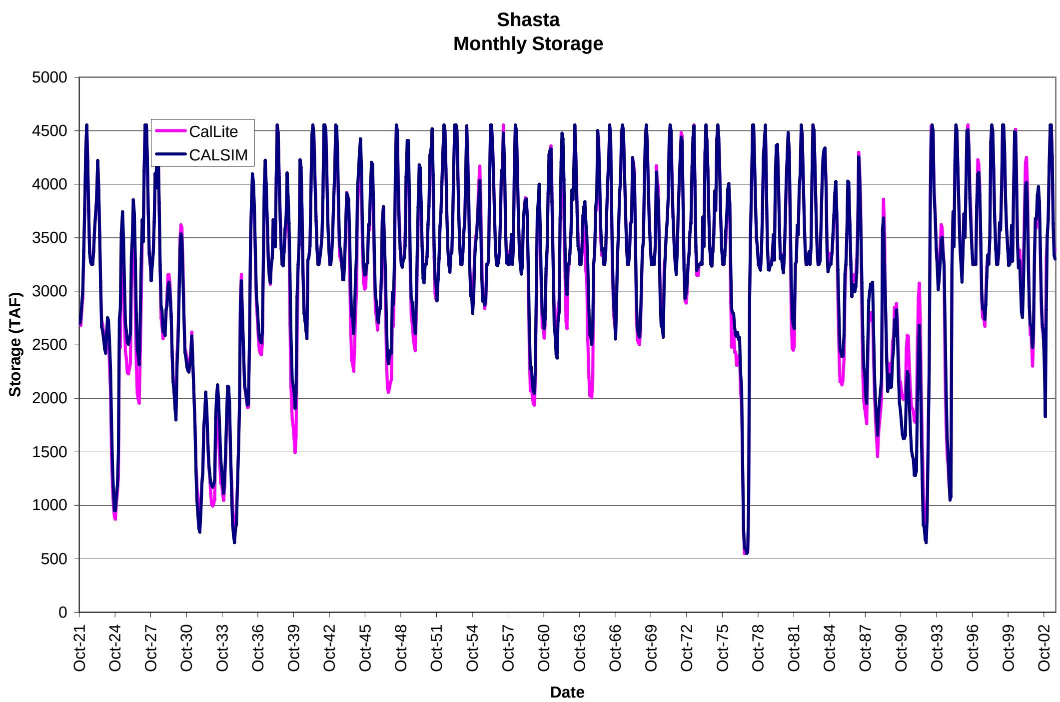

Figure 11-2. Shasta Reservoir storage for CalLite and CALSIM II existing level simulations

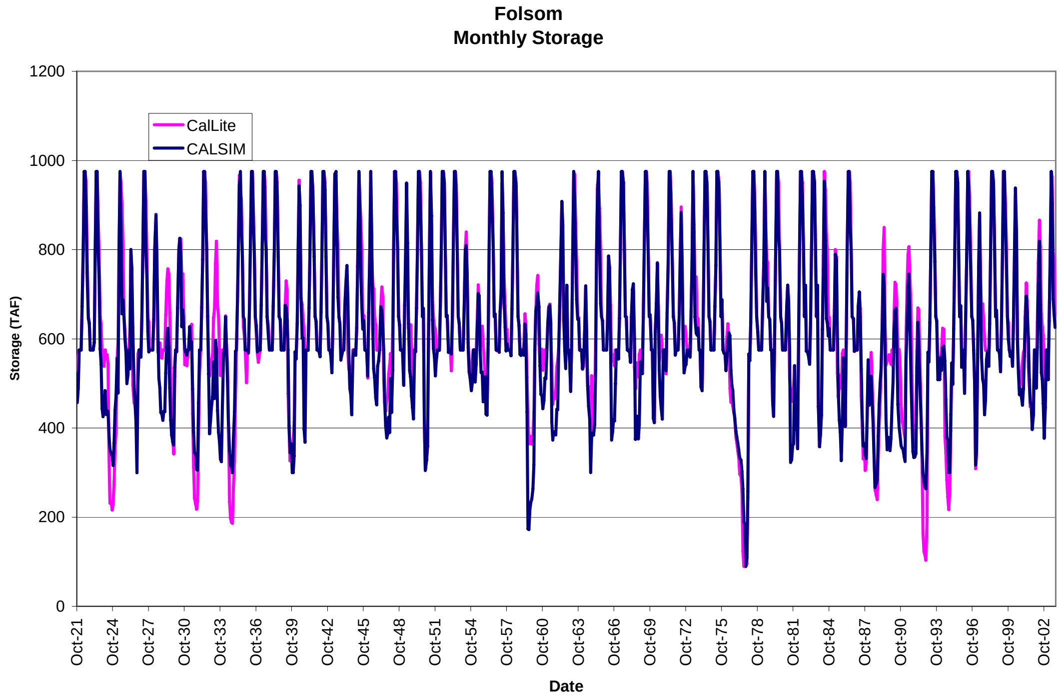

Figure 11-3. Folsom Reservoir storage for CalLite and CALSIM II existing level simulations

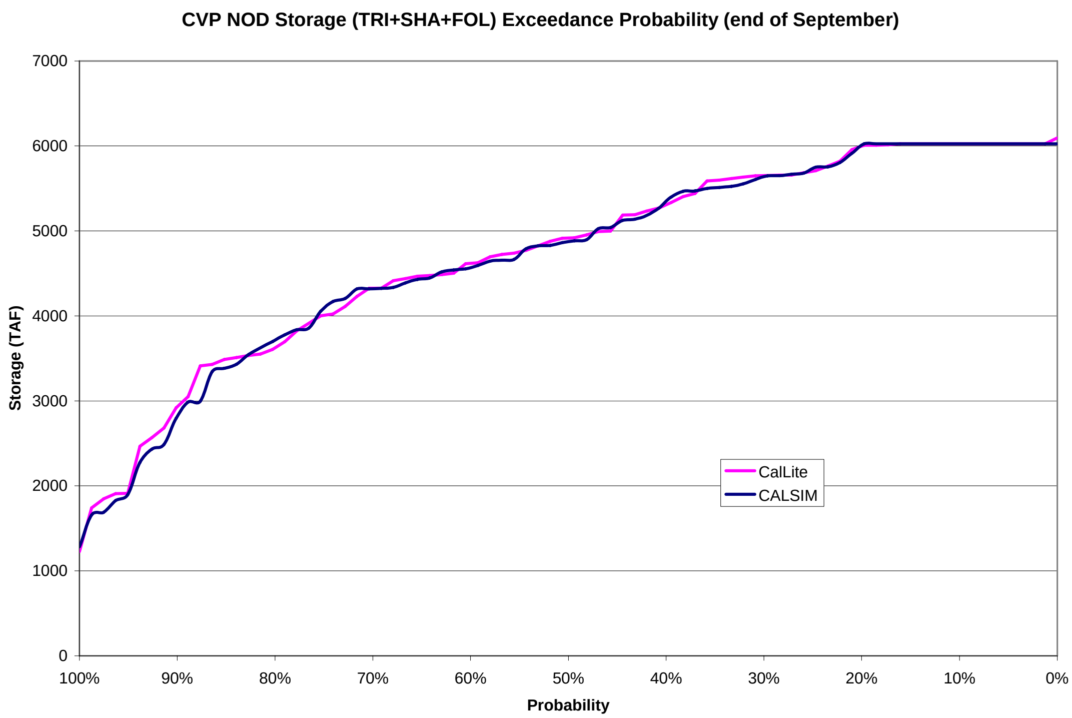

Figure 11-4. CVP north-of-Delta end of September storage exceedance probability for CalLite and CALSIM II existing level simulations

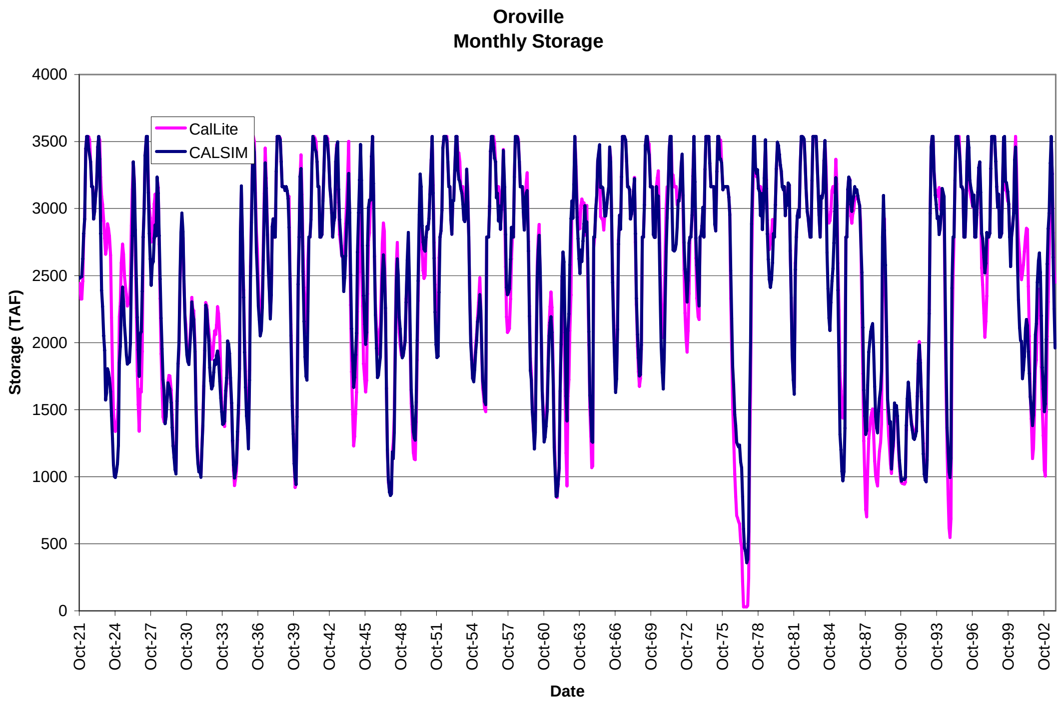

Figure 11-5. Oroville Reservoir storage for CalLite and CALSIM II existing level simulations

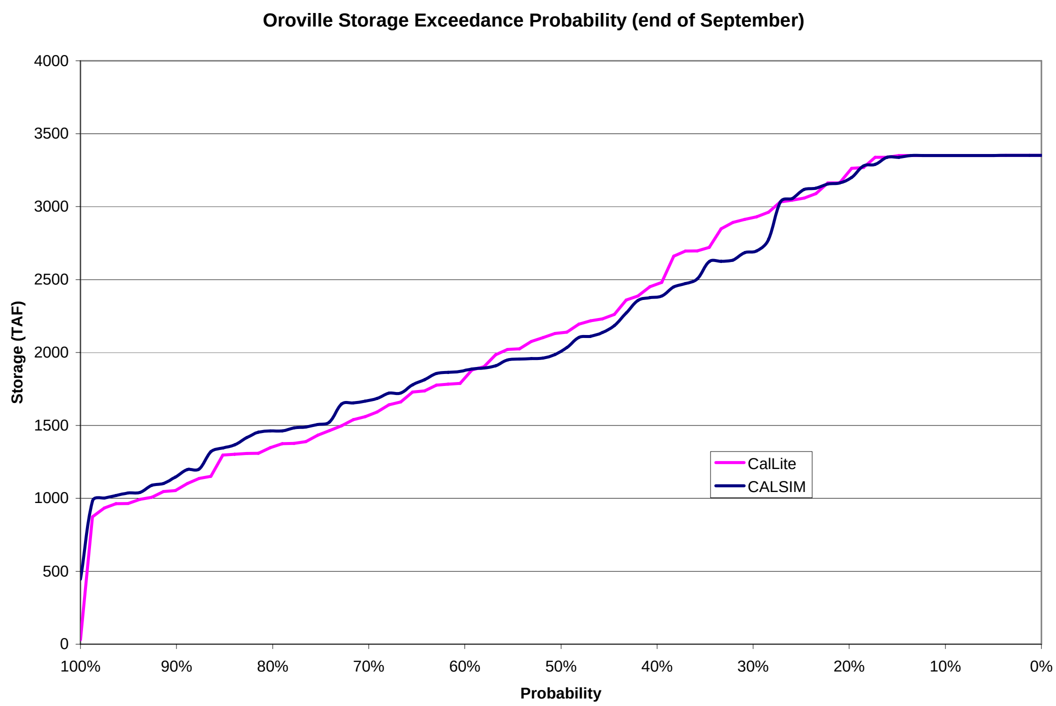

Figure 11-6. Oroville end of September storage exceedance probability for CalLite and CALSIM II existing level simulations

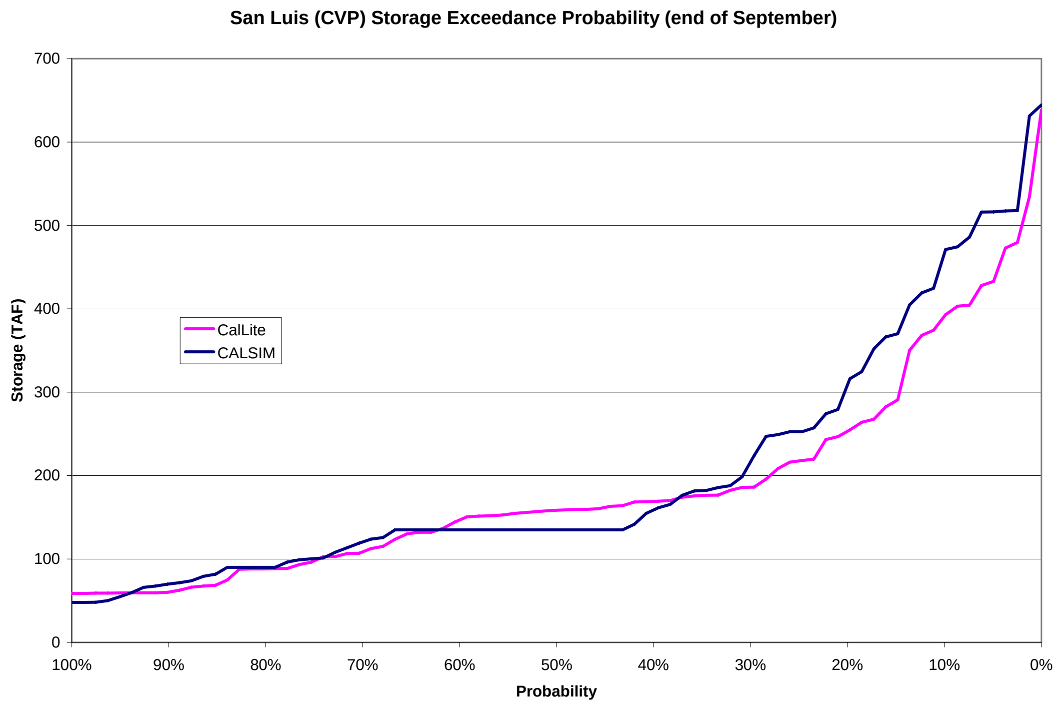

Figure 11-7. CVP San Luis end of September storage exceedance probability for CalLite and CALSIM II existing level simulations

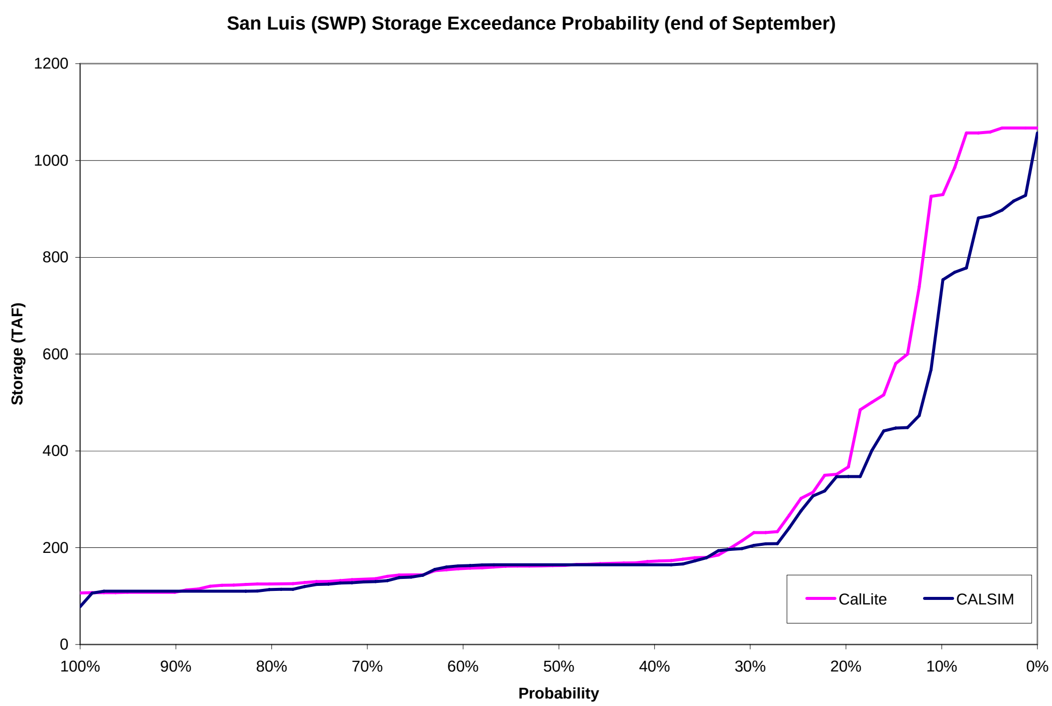

Figure 11-8. SWP San Luis end of September storage exceedance probability for CalLite and CALSIM II existing level simulations

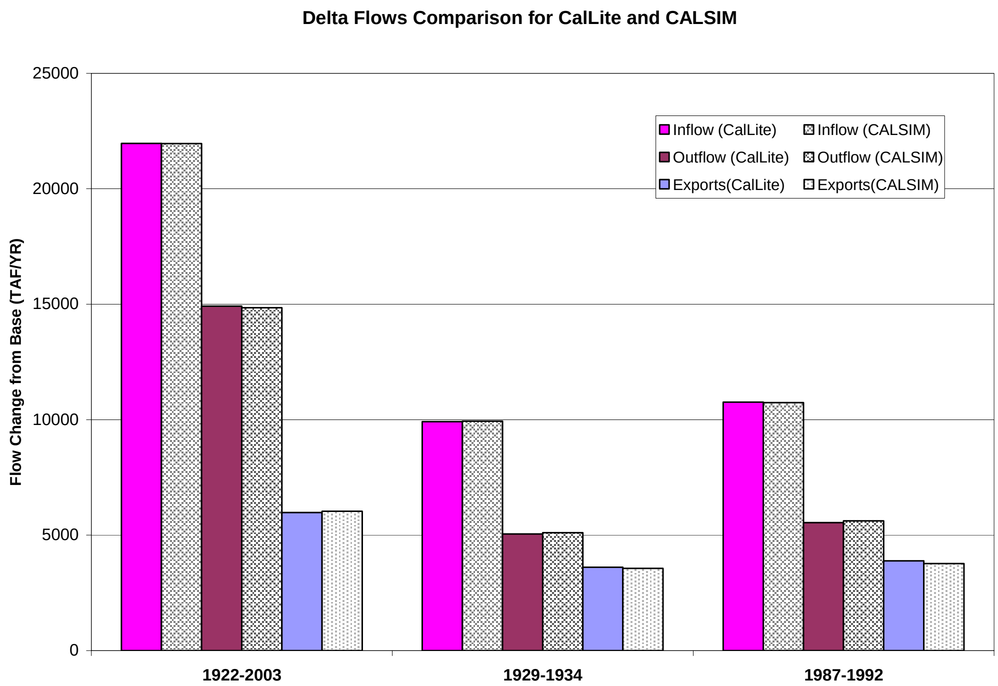

Figure 11-9. Period average Delta flows for CalLite and CALSIM II existing level simulations

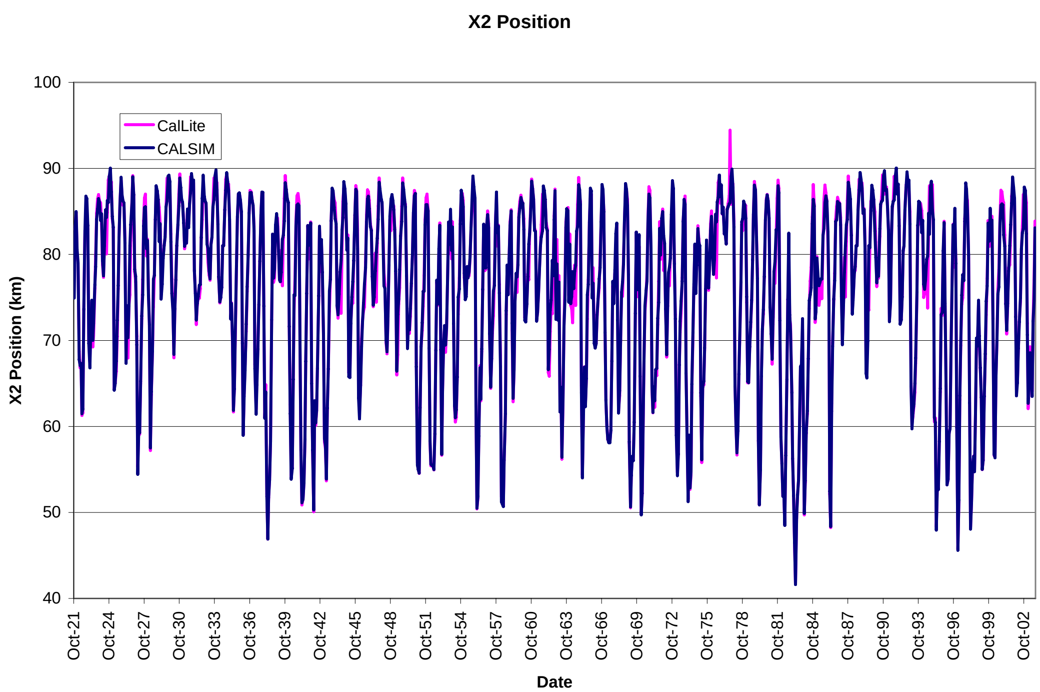

Figure 11-10. X2 position for CalLite and CALSIM II existing level simulations

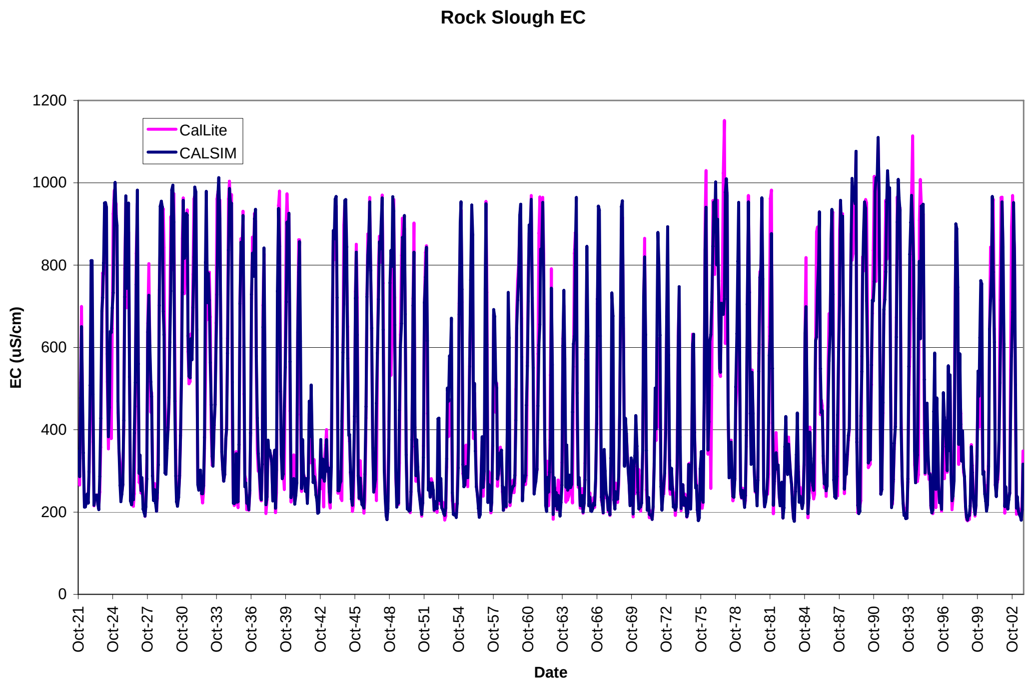

Figure 11-11. Old River at Rock Slough salinity for CalLite and CALSIM II existing level simulations

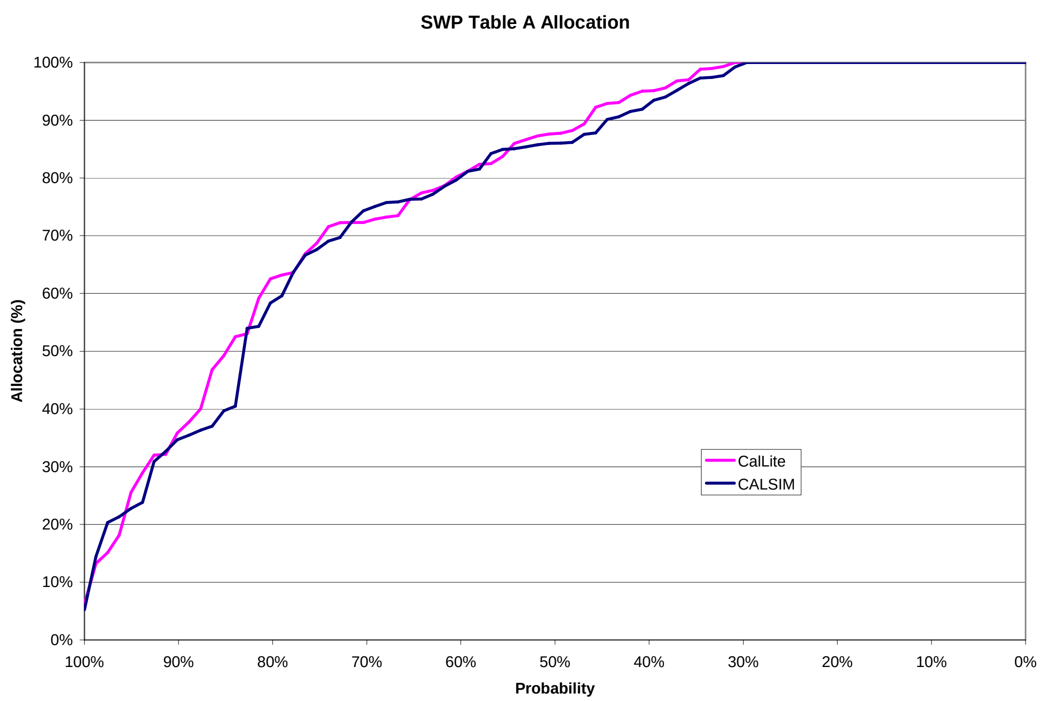

Figure 11-12. SWP Table A allocation exceedance probability for CalLite and CALSIM II existing level simulations

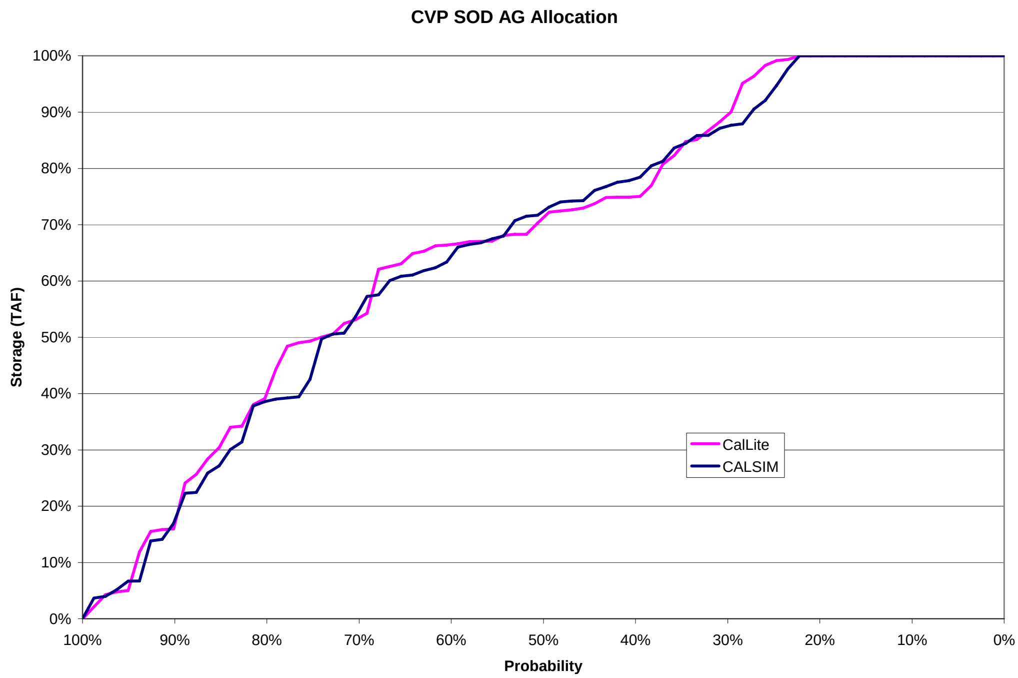

Figure 11-13. CVP south-of-Delta agricultural water contractor allocation exceedance probability for CalLite and CALSIM II existing level simulations

11.2 Comparisons to 2030 Base CALSIM II Simulations

Table 11-2. System-wide flow summary between CalLite and CALSIM II simulations (taf/yr)

	1922-2003			1929-1934			1987-1992		
	CalLite	CALSIM II	Diff	CalLite	CALSIM II	Diff	CalLite	CALSIM II	Diff
River Flow									
Trinity R blw Lewiston	690	703	-13	411	411	0	472	472	0
Trinity Export	552	541	11	335	350	-14	425	445	-20
Clear Cr blw Whiskeytown	42	45	-3	33	33	0	38	38	0
Sacramento R @ Keswick	6302	6287	16	3951	4000	-48	4602	4614	-12
Sacramento R @ Wilkins Slough	6672	6650	21	3969	3988	-18	4876	4882	-6
Feather R blw Thermalito	3161	3175	-14	1587	1622	-35	1624	1646	-22
American R blw Nimbus	2371	2373	-2	1241	1208	33	1118	1094	23
Delta Inflow	**21907**	**21893**	**14**	**9897**	**9850**	**47**	**10733**	**10694**	**39**
Sacramento R @ Hood	16217	16194	23	8237	8190	47	9380	9342	39
Yolo Bypass	1913	1922	-9	117	117	0	136	136	0
Mokelumne R	666	666	0	206	206	0	155	155	0
San Joaquin R d/s Calaveras	3111	3111	0	1337	1337	0	1062	1062	0
Delta Outflow	**14764**	**14778**	**-14**	**5058**	**4971**	**87**	**5504**	**5576**	**-72**
Required	5571	5566	4	4090	4094	-4	3914	3894	20
Delta Diversions	**6043**	**6013**	**30**	**3569**	**3607**	**-38**	**3891**	**3777**	**114**
Banks SWP	3379	3342	37	1869	1946	-77	1960	1941	20
Banks CVP	0	82	-82	0	22	-22	0	33	-33
Tracy	2664	2589	75	1700	1639	61	1931	1803	128
SWP SOD Deliveries	**3338**	**3322**	**16**	**1835**	**1869**	**-34**	**1946**	**1904**	**42**
Table A	3023	3029	-7	1657	1655	2	1846	1806	40
Article 21	207	155	52	144	163	-19	33	4	29
Article 56	108	138	-30	34	51	-18	67	94	-27
CVP SOD Deliveries	**2713**	**2786**	**-73**	**1636**	**1646**	**-10**	**1929**	**1889**	**40**

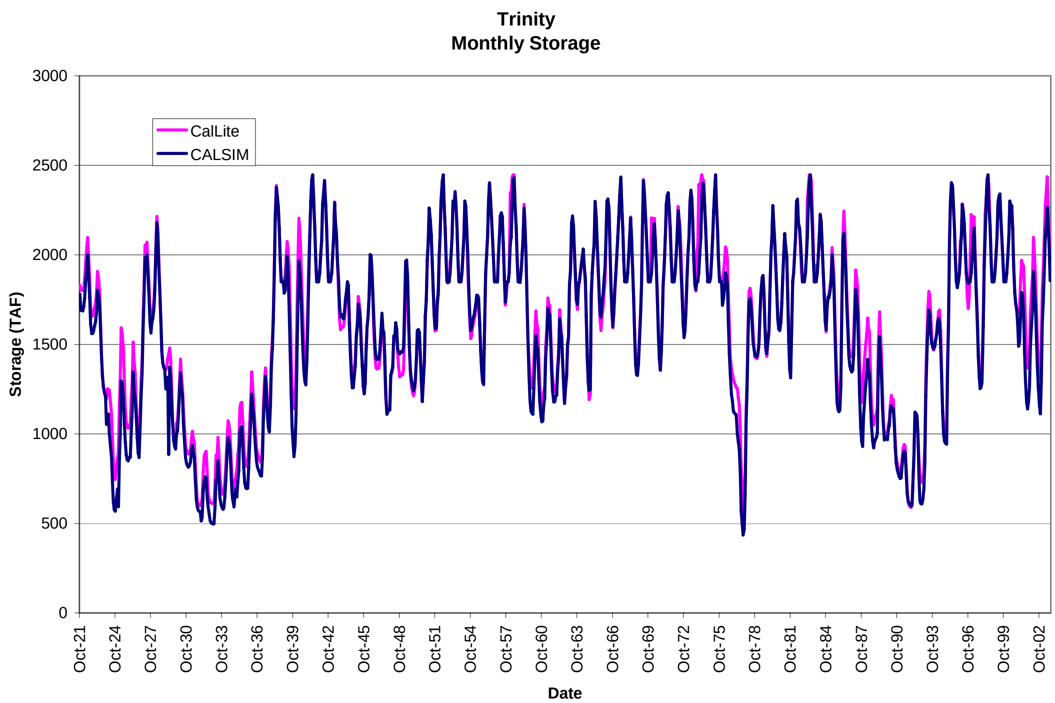

Figure 11-14. Trinity Reservoir storage for CalLite and CALSIM II future level simulations

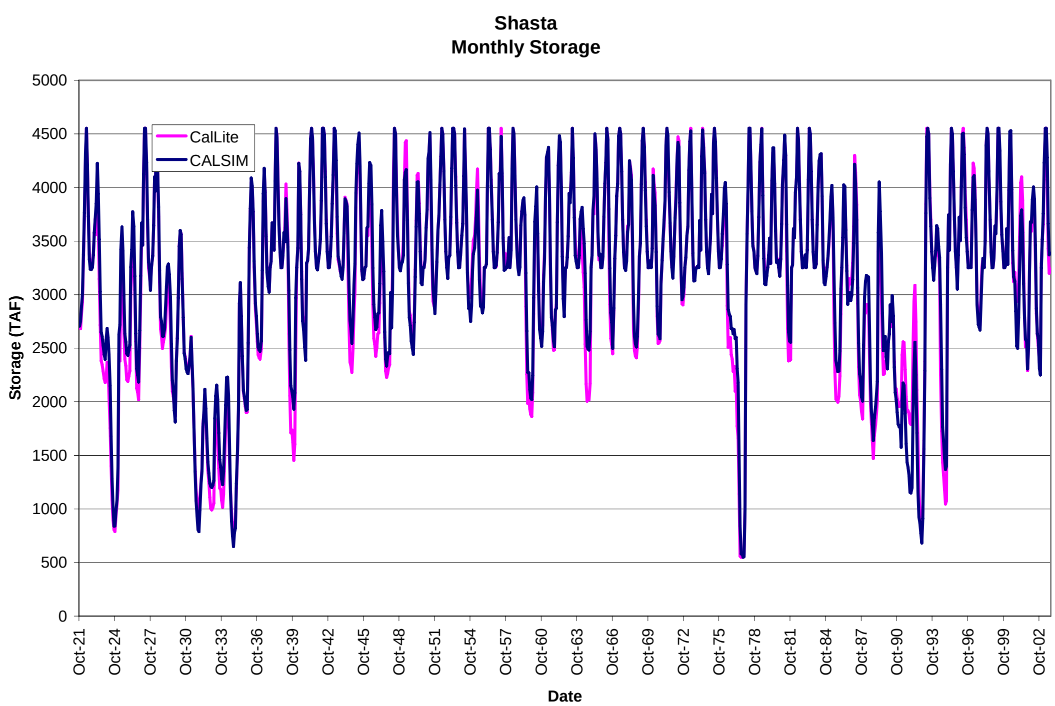

Figure 11-15.. Shasta Reservoir storage for CalLite and CALSIM II future level simulations

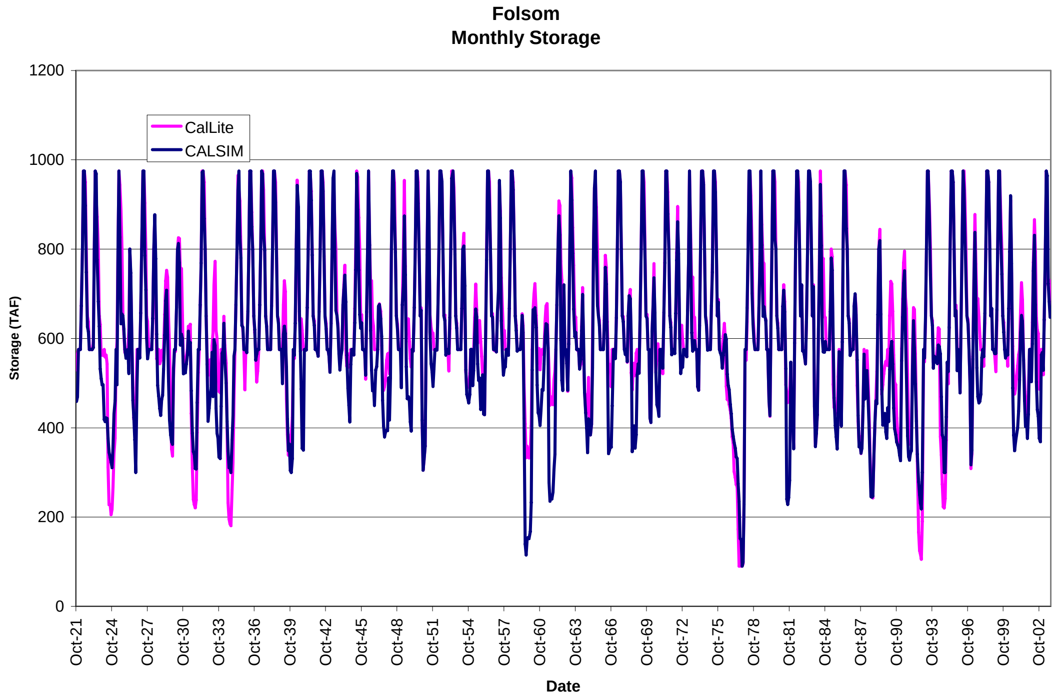

Figure 11-16. Folsom Reservoir storage for CalLite and CALSIM II future level simulations

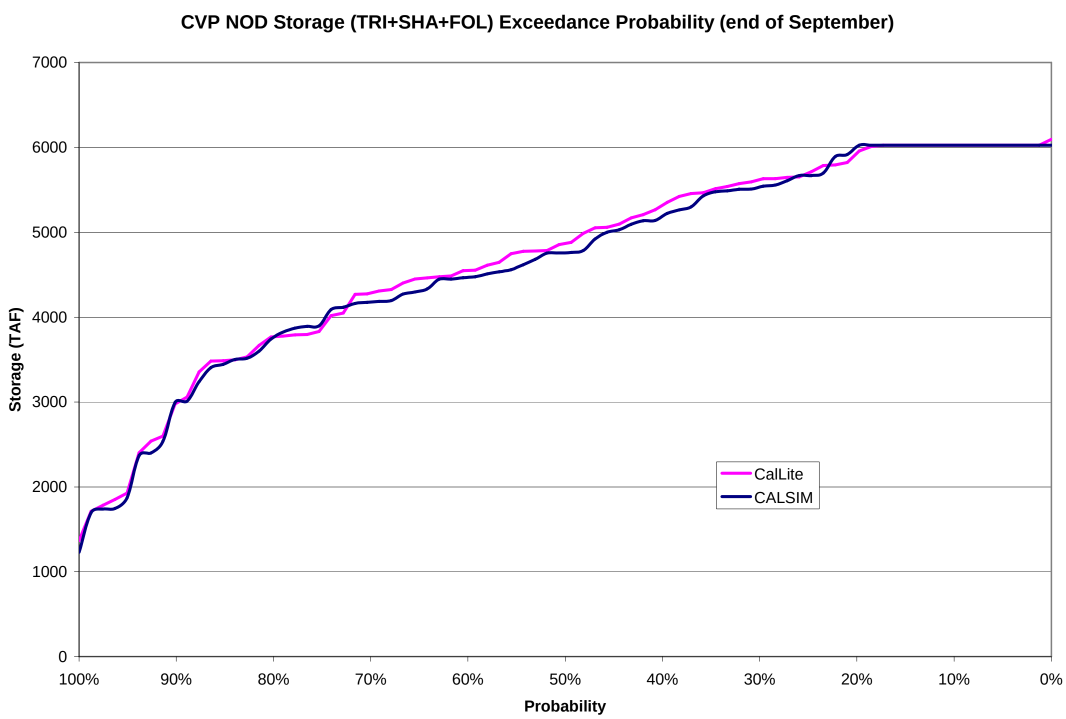

Figure 11-17. CVP north-of-Delta end of September storage exceedance probability for CalLite and CALSIM II future level simulations

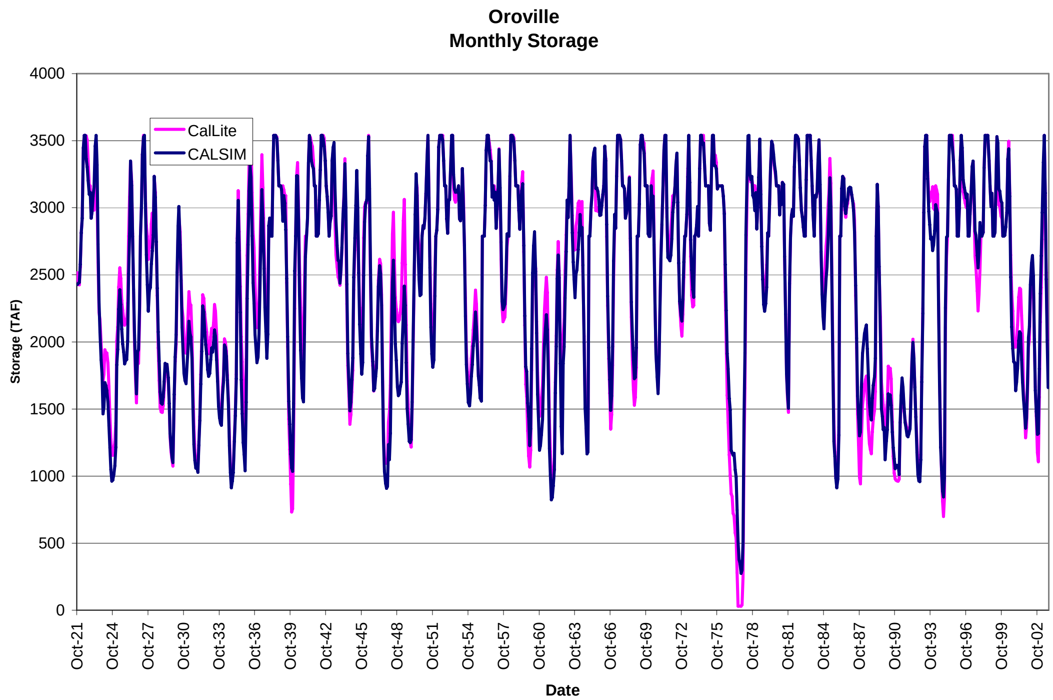

Figure 11-18. Oroville Reservoir storage for CalLite and CALSIM II future level simulations

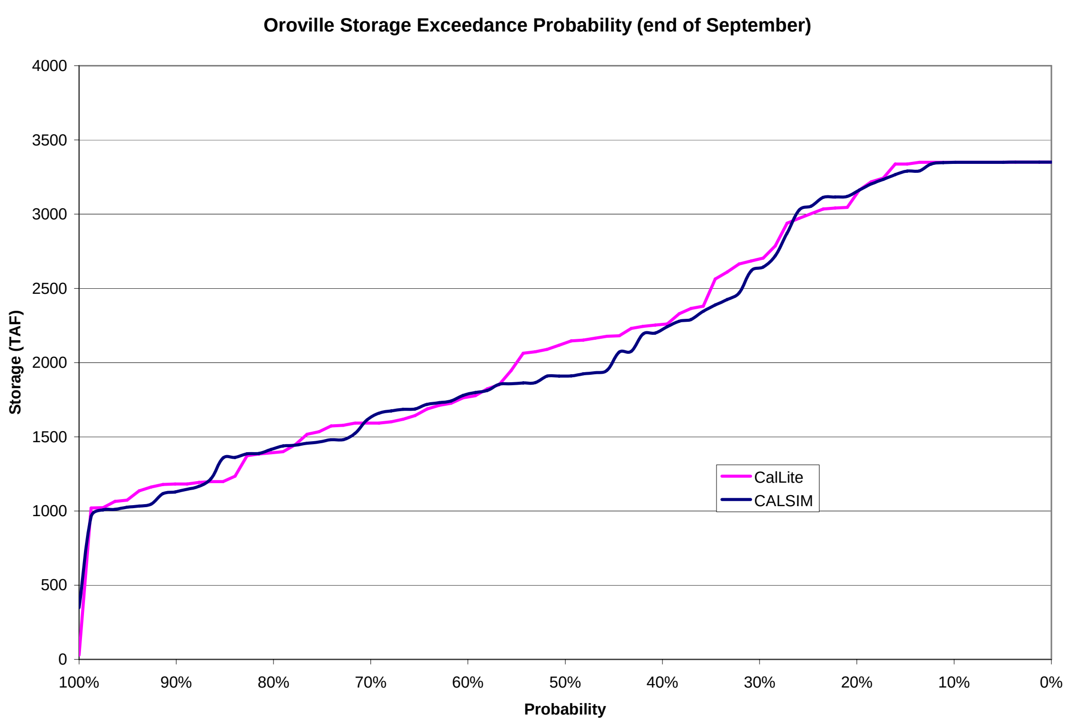

Figure 11-19. Oroville end of September storage exceedance probability for CalLite and CALSIM II future level simulations

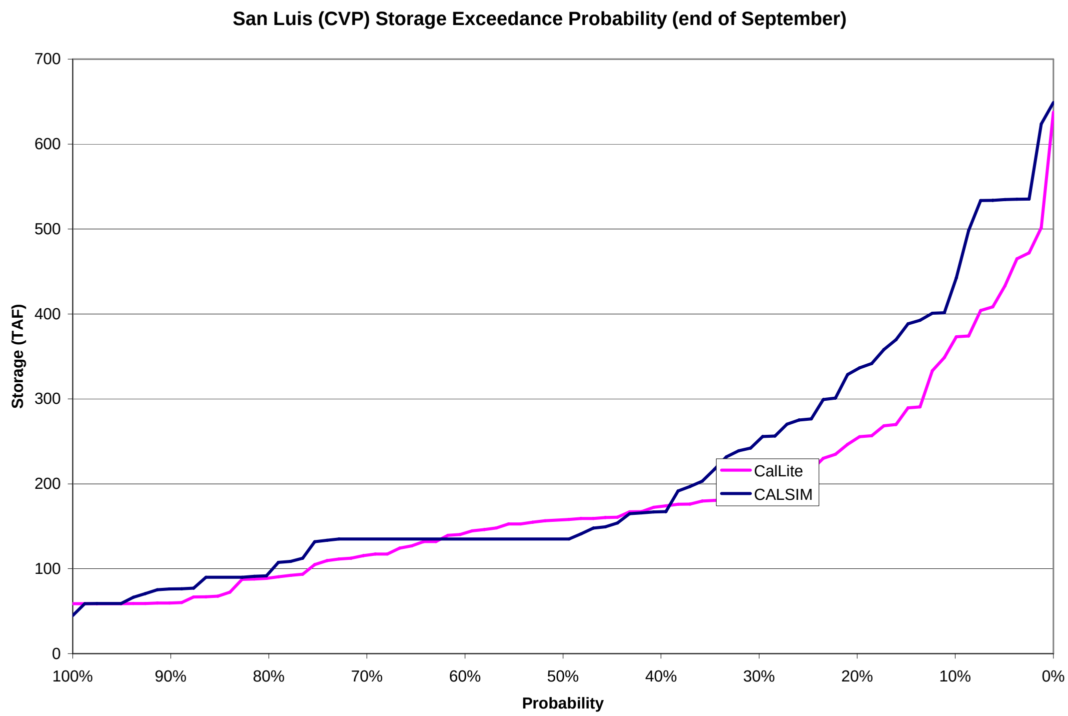

Figure 11-20. CVP San Luis end of September storage exceedance probability for CalLite and CALSIM II future level simulations

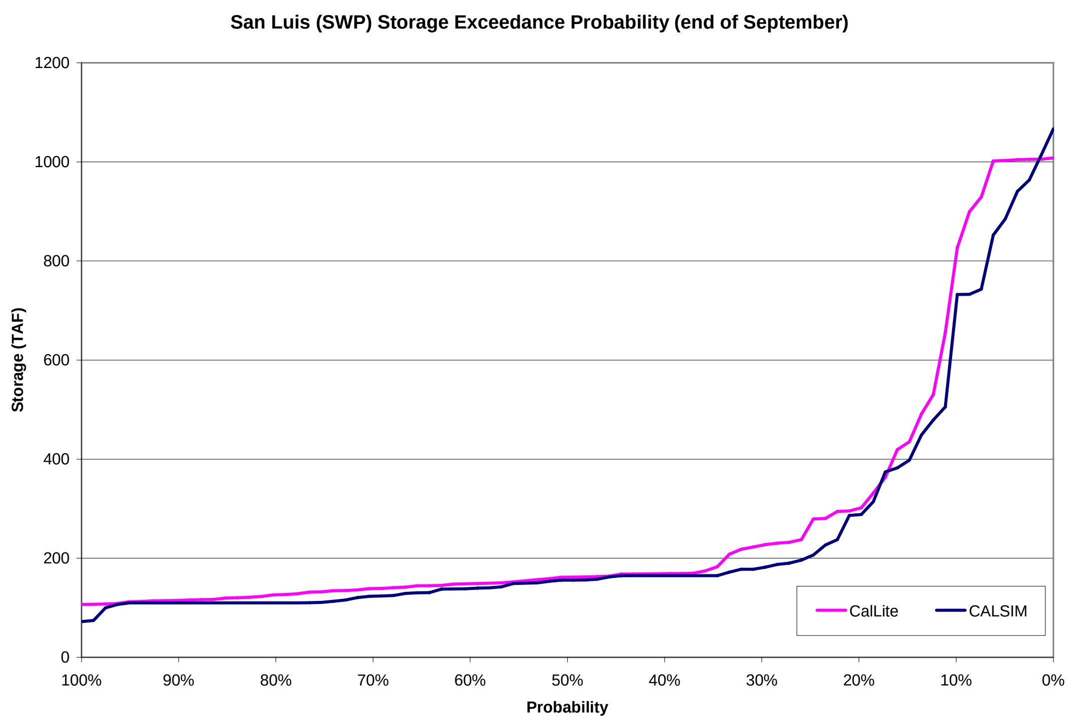

Figure 11-21. SWP San Luis end of September storage exceedance probability for CalLite and CALSIM II future level simulations

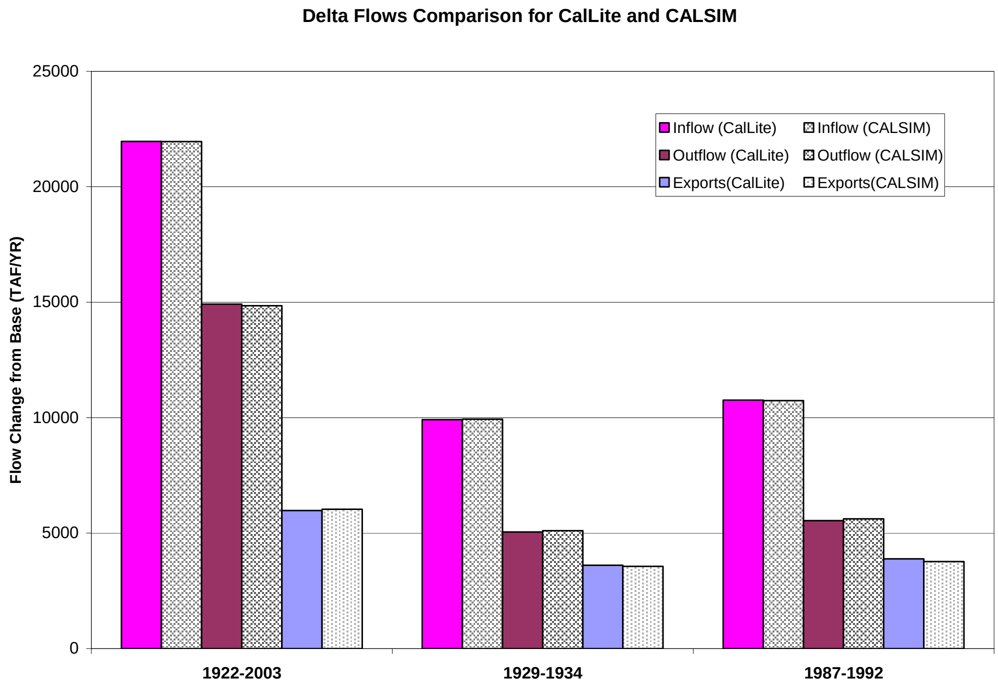

Figure 11-22. Delta period average flows for CalLite and CALSIM II future level simulations

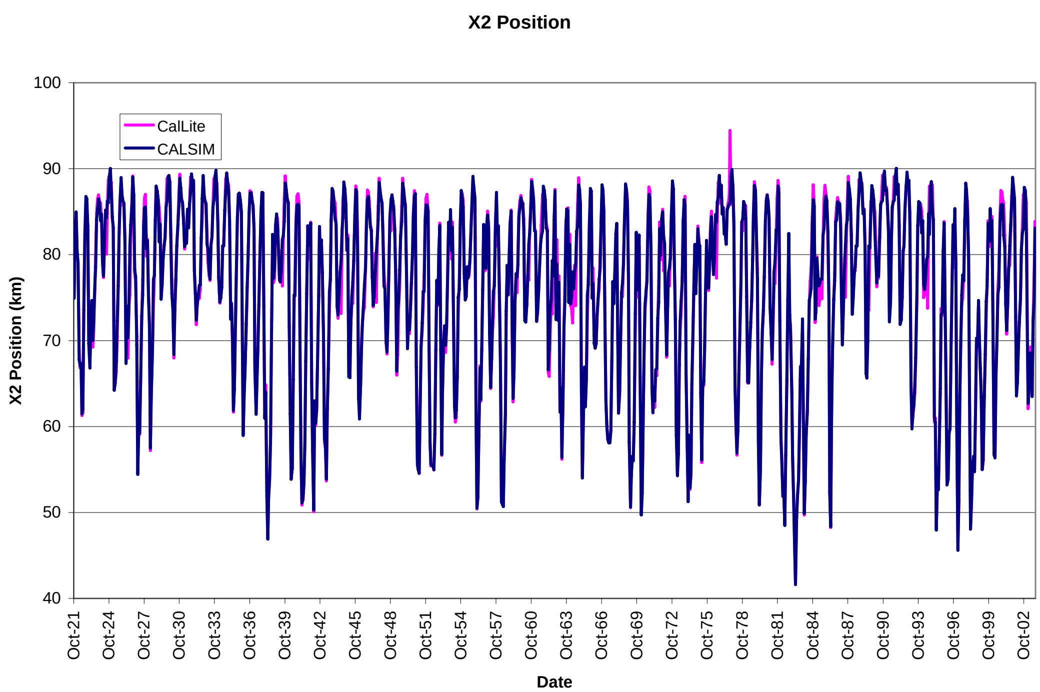

Figure 11-23. X2 position for CalLite and CALSIM II future level simulations

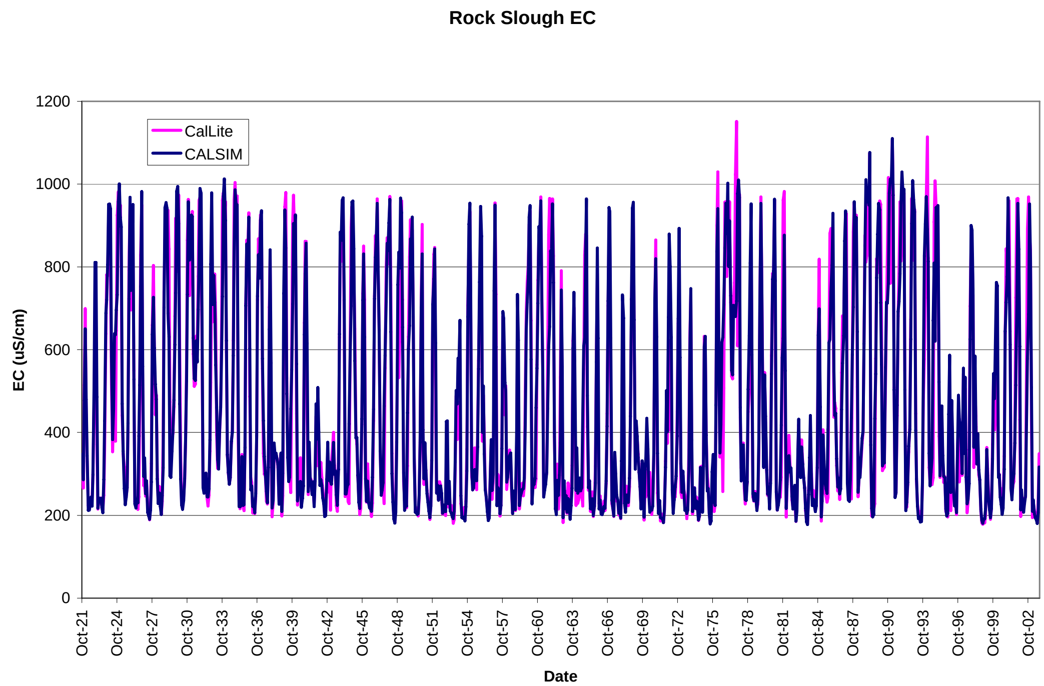

Figure 11-24. Old River at Rock Slough salinity for CalLite and CALSIM II future level simulations

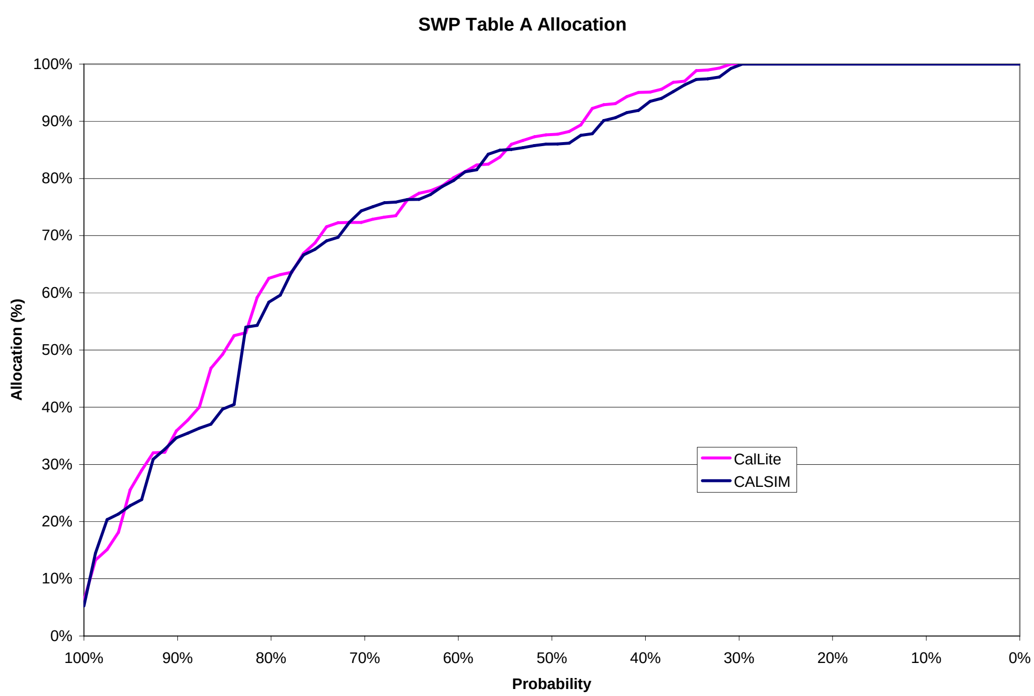

Figure 11-11-25. SWP Table A allocation exceedance probability for CalLite and CALSIM II future level simulations

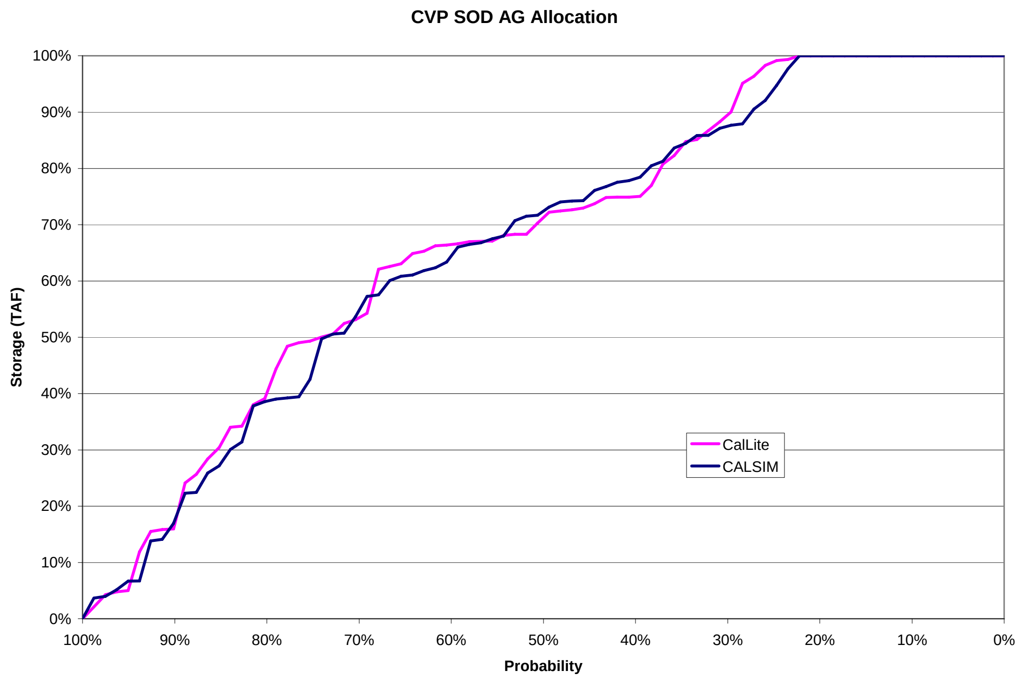

Figure 11-26. CVP south-of-Delta agricultural water contractor allocation exceedance probability for CalLite and CALSIM II future level simulations

11.3 Comparison of CALSIM II vs CalLite Results

The comparisons above provide an encouraging result for the CalLite model. Long-term average Delta flows differed by less than 1%, reservoir releases differed by less than 1%, SWP and CVP deliveries differed by less than 2%, and individual project exports differed by less than 2%. During the 1929-1934 and 1987-1992 dry periods, these differences between the CalLite and CALSIM II results were less than 3% for all of the same parameters listed above.

CalLite simulated CVP storage shows a good match with that simulated by CALSIM II. Differences are noted, however, in the balancing of Trinity, Shasta, and Folsom storage. This is predominately due to the changes in relative guide curves provided by CVO as compared to those incorporated in CALSIM II. CalLite tends to have higher storage in Trinity and Folsom Lakes and lower storage in Shasta Lake. But when viewed as total CVP storage the model results are virtually undistinguishable. Similarly, CalLite reproduces the overall storage trend and frequency of storage conditions for Oroville and it can be said the models compare well. Some greater drawdown in Oroville is detected in the 1976-1977 critical period and also in the 1987-1992 period in the CalLite model. These differences appear to be caused by higher SWP calls for Delta water during the first couple of months entering these drought periods. Simulated San Luis storage in CalLite for both the SWP and CVP match the results of CALSIM II very well. The fact that the end-of-September values are very close to that in CALSIM II indicates that both models are “pushing” delivery allocations to a similar degree. This can also be seen by the very good match of delivery allocations to SWP and CVP contractors.

Delta flows and exports drive the results for X2 and salinity conditions. The X2 position results from CalLite also compare well to those in CALSIM II. The one exception is that in 1977. In this year, CalLite storage levels in upstream reservoirs fall to dead, or near dead, pools in Shasta, Folsom, and Oroville. Because no additional water could be taken out of storage for Delta requirements, the X2 and salinity requirements could not be satisfied. Salinity comparisons at various stations in the Delta indicate that the ANNs were implemented correctly and respond identically to the external boundary conditions.

Section 12

12 Model and Data Limitations

The CalLite model is intended as a screening model for Central Valley water management. As designed, CalLite is a simplified model and much of the complexity of the system has been aggregated. CalLite captures the most prominent aspects of the Central Valley hydrology and system operations, but simulated hydrology and water management within specific sub-basins has limited detail. The following is a list of model limitations that should be considered when applying the CalLite model for Central Valley water management screening.

- Monthly time step hydrology and operations cannot simulate smaller temporal-scale phenomenon
- Simplified system in representation of hydrology in Sacramento and San Joaquin valleys
- Non-dynamic hydrologic interactions with return flows and surface water – groundwater interactions
- California Aqueduct, SWP terminal reservoirs, and associated losses and capacity limits downstream of Dos Amigos are not simulated
- Cross Valley Canal deliveries are not simulated in the current version, but will be added in the future
- Only D-1641 requirements and operations are simulated; CVPIA (b)(2) and EWA operations are not simulated

Section 13

13 On-Going/Future Developments

Reclamation and the DWR have developed a rapid, interactive screening model for Central Valley water management. The CalLite screening tool serves a unique purpose in California water management. The tool bridges the gap between more detailed system models managed by DWR and Reclamation and policy/stakeholder demand for rapid and interactive policy evaluations. CalLite simulates current and future water management options and allows policymakers and stakeholders to gain greater understanding of the system responses. CalLite simulates the 82-yr planning horizon in less than 5 minutes, is adaptable to changing stakeholder needs, and is accessible to non-modeling stakeholders. It is therefore believed that this screening model will serve as a policy evaluation tool, educational tool, and eventually lead to more informed decision-making and more robust water management.

DWR and Reclamation intend to apply the CalLite model as part of interactive sessions associated with current SWP and CVP operations and long-term Delta planning. It is anticipated that several additional features will be added to the Delta operations and storage investigations based on stakeholder input. DWR is currently in the process of adding ANNs that include sea level rise scenarios and can be combined with the existing climate change scenarios related to changes in runoff. Reclamation is currently refining the methodology for delivery allocation to include consistent forecast information with that used by USBR CVO and DWR DCO and this revision is expected to better mimic allocation procedures on an annual basis.

In addition to these near-term CalLite refinements, DWR and Reclamation expect to utilize the CalLite and CALSIM II models conjunctively. As CalLite is used in more and more interactive sessions with operators and stakeholders, it may eventually include operations and features that should be transferred to the more detailed CALSIM II model. Similarly, the development and refinement of the CALSIM II model will continue to support many planning efforts and periodically the hydrology and operating criteria in CalLite may need to be “re-synchronized” if applicable. It is recommended that a review of the two models be performed annually, or at significant release points, to determine whether revisions to either model are warranted.

Finally, while the CalLite model is a simplified screening model of the Central Valley water resource system, the modeling platform could permit loose integration with a number of more detailed models of specific resource areas. The current integration with the flow-salinity ANNs is a good example. In this example, the hydrodynamics and water quality response of the DSM2 model is loosely coupled to CalLite through the use of the neural networks. Other models, or response functions based on these models, could be coupled to allow simulation of groundwater conditions (C2VSIM), power generation, consumption, and greenhouse gas emissions (LTGEN), salmon life-cycle and mortality analysis, and regional economics (LCPSIM). The GoldSim platform allows rather seamless integration with dynamic link libraries (DLLs), permits submodels to be simulated at different time steps than the primary model, and allows these submodels or containers to be activated or deactivated based on user-defined or system conditions. While these additional modules would increase the runtime of the CalLite model, it is believed that these capabilities could be selected on an as-needed basis thus allowing for greater complexity and feedback processes when required, but still retain the “light” capabilities for most analyses.

Section 14

14 References

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Appendix A CalLite Quick Start User's Guide

CalLite

Central Valley Water Management Screening Model (Version 1.00R)

Quick Start User's Guide

July 2008

Introduction

This brief write-up describes the main features and general use of the prototype version of the Central Valley Water Management Screening Model (CalLite). The U.S. Bureau of Reclamation (Reclamation) and Department of Water Resources (DWR) were seeking a simplified version of the current planning model that could be used to rapidly evaluate alternative operations or facilities at a screening level. To this end, CH2M HILL evaluated several approaches and various modeling platforms that would satisfy the requirements of both Reclamation and DWR and which would accommodate the system complexity most efficiently. The GoldSim modeling environment was selected as the most suitable platform for the development of a screening model of Central Valley operations and an initial version of a screening model, named CalLite, has been developed. This version of CalLite, described herein, contains the most significant functionality of a larger, more complex planning model, such as CALSIM II, but is simplified in its spatial and hydrologic detail. Despite the simplifications included in CalLite, the model results correlate very well to those of a comparable CALSIM II study. The power of a screening model such as CalLite is the ability to rapidly simulate system operations and to incorporate changes with relative ease. The current version of CalLite simulates system operations on a monthly basis for the full 82-yr period of record in less than 5 minutes, incorporates a linked planning-forecast model structure, allows probabilistic simulation, and incorporates dynamic graphical displays of results from either independent scenario simulations or Monte Carlo analyses. The current version emulates the operations and hydrology of an existing (Year 2005) and future (Year 2030) level of developments. The model can be run with stand-alone D-1641 or user defined Delta regulations. CalLite shows considerable promise as a tool for bridging the gap between more detailed planning models and agency and stakeholder demand for a rapid screening tool. It should be noted that a tool such as CalLite should be customized for each suite of problems to allow for greater applicability and interaction from stakeholders.

Modeling Approach

GoldSim is a powerful platform for developing and dynamically simulating and visualizing complex relational models. While many dynamic simulation modeling tools are available and have been used over the past decades, GoldSim appears to be one of the few that has been principally applied to water and environmental problems and is fully-integrated with capabilities for uncertainty-risk assessments. Models are graphically developed. Objects, which can be used to represent water resource components such as reservoirs, rivers, pump stations, or rules/regulations, are inserted onto a palette and assigned attributes. As more and more objects are added and relational equations entered, an influence diagram, or relationship network is drawn. The entire model of the Central Valley system was developed in such a fashion. Objects can then be grouped into various levels of hierarchy to better organize and understand model component interaction.

CalLite was developed with GoldSim Pro Version 9.60 (SP4). The GoldSim Player software is required to run the model, make data input changes, and/or review results. The model structure and equations, however, cannot be modified with the Player software. The GoldSim Player version is available free-of-charge from http://www.goldsim.com.

The Central Valley system representation incorporated in CalLite is shown in Figure A-1. Experience in simulating Central Valley Project (CVP) and State Water Project (SWP) system operations has shown that the system is often controlled by a few identifiable system constraints. The basic hydrology included in the model is identical to the 2005 and 2030 LOD hydrology used in the Common Assumptions Common Model Package version 9A. All major storage and conveyance facilities included in CALSIM II are also included in the screening tool. Aggregation of river accretions and depletions in the Sacramento Valley was performed so that the net effect on project operations would be similar to the more detailed approach. For example, all accretions and non-CVP depletions between Keswick and Wilkins Slough were aggregated into a single flow addition or removal at the downstream locations. The San Joaquin Valley hydrology and operations are not dynamically simulated at this point, but the net flow at Vernalis serves as the boundary condition for CalLite. The configuration of the Delta, Delta Mendota Canal, California Aqueduct, and San Luis Reservoir are largely consistent with that in the full CALSIM II model, but the southern extent is limited to Dos Amigos pump station. The Yuba system, focusing on operations of New Bullards Bar and Englebright Reservoirs, was added at the request of Reclamation.

The major facilities and operational/regulatory constraints included in the screening model are listed in Table A-1. The screening model has been developed to transfer information both in the downstream and upstream directions. In general, all mass balance calculations are performed in the downstream direction. Reach inflows are determined from boundary flows or reservoir releases. Diversions are removed from the water balance, local accretions are added, and the resulting balance becomes outflow. However, in order to trigger the upstream facility to operate for a downstream requirement, information must flow upstream. For example, the flow requirement at Wilkins Slough must be translated into a release requirement at Shasta/Keswick and depends on the accretions and depletions between the two locations. Thus, for nearly all reaches and reservoirs there are upstream, as well as downstream, information flows. Water from reservoirs will always be released for downstream demands or instream flow requirements unless reservoir minimum storage levels or conveyance limitations are reached. At this point, the simulation will short the allocation of water in the following order: (1) exports above a minimum level, (2) Delta outflow requirements, and (3) upstream flow requirements.

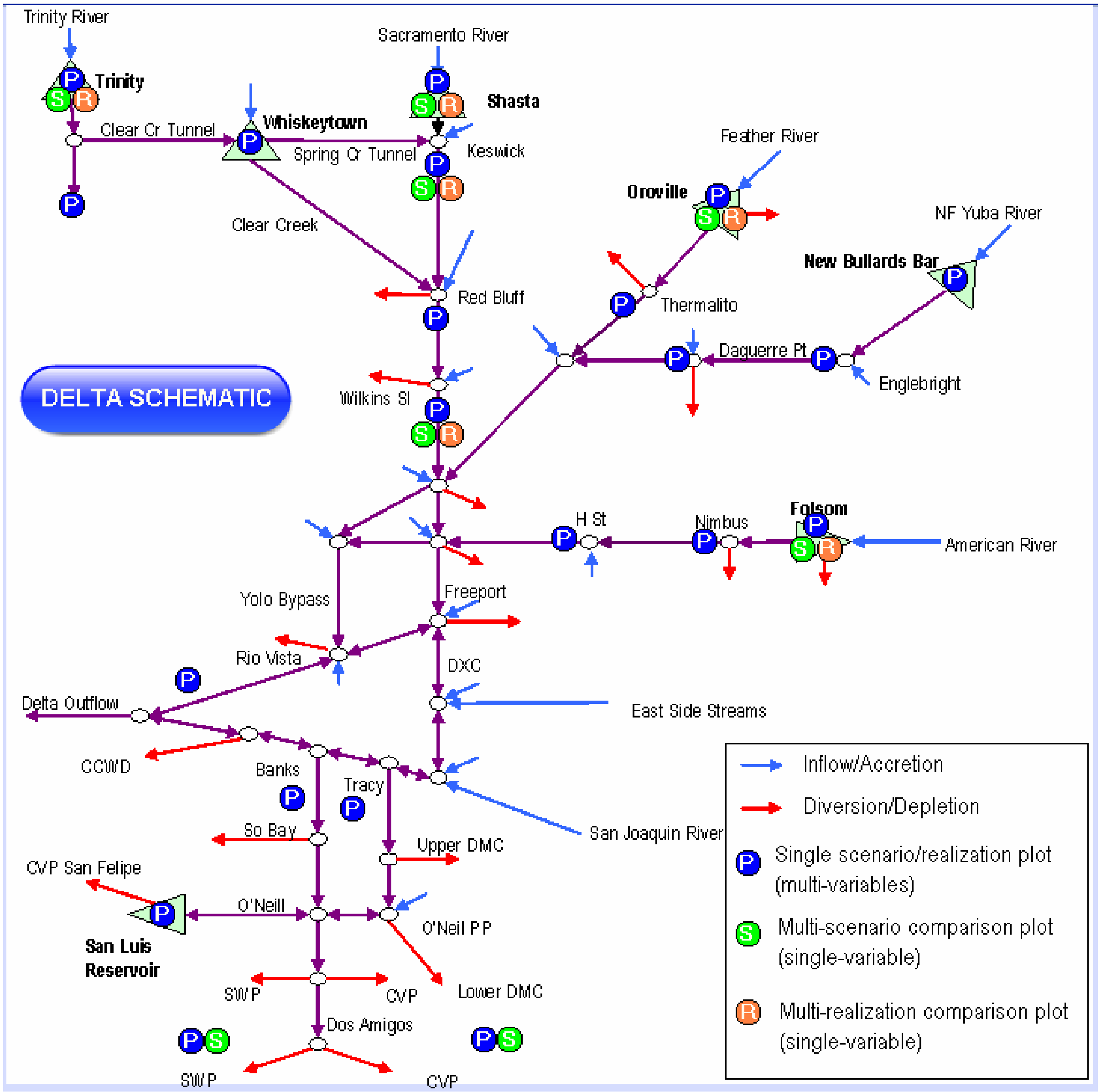


Figure A-1. System representation included in CalLite

Table A-1. Major facilities and constraints included in CalLite

Storage Facilities	Conveyance Facilities	Operational/Regulatory Constraints
Sacramento Basin		
Trinity Lake Whiskeytown Lake Shasta Lake Lake Oroville Folsom Lake Bullards Bar	Clear Creek Tunnel Spring Creek Tunnel Trinity River Sacramento River Feather River American River Yuba River Yolo Bypass	Trinity River Minimum Flows Keswick Fish Flows Keswick Temp Surrogate Releases Red Bluff Minimum Flows Navigation Control Point Feather River Minimum Flows Nimbus Minimum Flows American River Min Flows @ H St Rio Vista Minimum Flows Lower Yuba/Daguerre Pt Controls
CVP / SWP South-of-Delta		
CVP San Luis Reservoir SWP San Luis Reservoir	California Aqueduct Delta Mendota Canal San Luis Pumping Plant Dos Amigos Pumping Plant	San Luis Operations CA Aqueduct Capacity Restrictions DMC Aqueduct Restrictions Delivery Allocation Procedure
San Joaquin River Basin		
None	San Joaquin River at Vernalis	Upstream operations implicit in the boundary condition flow at Vernalis
Sacramento-San Joaquin Delta		
None	Delta Cross-Channel Tracy Pumping Plant Banks Pumping Plant	Delta Cross-Channel Gate Operation SWRCB D-1641 Standards VAMP

Understanding the Prototype Model

This section provides a step-by-step guide for navigating, running, and viewing results from CalLite. After establishing a basic understanding of the GoldSim software, highlights of key functionality of the model are illustrated.

Getting Started

1. Obtain the GoldSim Player software version 9.60 from www.goldsim.com.
2. Download the model from http://baydeltaoffice.water.ca.gov/modeling/hydrology/CalLite/index.cfm and install the model.
3. Once the Player is installed on your computer, you should be able to simply double-click on the CalLite-player model file (CalLite_v1.00R.gsp) to start the program Another way of opening the model would be to run the GoldSim Player by clicking Start|Programs|GoldSim Player 9.60. From the Player menu choose “Open Model” and select the CalLite_v1.00R.gsp file.
4. At this point, you should see the CalLite Main Home dashboard as shown in Figure A-2.

5. Note that there are some features that are still under development. The grayed-out areas are placeholders for future controls inputs but are inactive in the current version.

Figure A-2. CalLite Main Home dashboard and GoldSim Run Controller

Running the Model

1. The CalLite-player model will automatically open to the system dashboard and can be run through the GoldSim Run Controller displayed as a separated window. The Run Controller cannot be minimized or otherwise removed from the screen. Pressing Run on the run controller will initiate. . The total runtime should be 4-5 minutes, for 82-yr simulation from Oct 1921 – Sep 2003, depending on computer and system. The model may take a few seconds to begin the simulation as input data is read from an Excel spreadsheet. Close all Excel files prior running CalLite as some information is exchanged between GoldSim and Excel and data corruption could occur.
2. The progress of the simulation is tracked on the controller and the simulation can be paused or stepped-through (in time-step intervals).
3. After the simulation is complete, you should see a “Simulation Complete” message. Click “OK” on this message box.

Viewing Results
There are three ways of viewing results:
Through the interactive Main and Delta schematics
Through the "Results" page
Through an external spreadsheet "CalLite_results.xls" which is updated after each simulation.

1. On the Main Home window, click on the "Schematic" button. The schematic image will be displayed and on the screen you will see many small "P" (for plot) buttons for various system results. Click on any of these to see the model results for the last simulation. All reservoirs have storage plots and key river/aqueduct locations have flow plots. In some cases, several plots may be available at the same location. The "R" button provides links to plots that may contain multiple realizations if the model was run in a probabilistic fashion (i.e. climate change realizations). The "S" button provides links to plots that contain multiple scenarios as specified by the user.

2. On the Main Home window, click on the "Results" button. Under "Results", there are two sub-buttons: "Current" and "Comparative". The buttons on this dashboard will display system-wide results and can be customized in future releases to better suit agency or stakeholder needs. Currently, the available buttons are:
    a. "Current" dashboard displays results for the last (or the latest) simulation. CVP, SWP and Delta operations buttons present a set of graphs to show the main parameters outputs. Also, using the upper bottoms of the graphs window, you can display a data set window with the same features as previously described (Figure A-3).
    The Delta Balance button will display a data set window that could be either manipulated by copying selected cells (using the mouse, select an area and then click on the upper copy button and then paste it in a blank spreadsheet file) or by saving (using the upper save button) the whole data set as a text file which then could be converted into a spreadsheet file. You can also use the upper buttons of the data set window to create a graph, choose a particular chart style, and print as well.
    b. "Comparative "dashboard displays result for different scenarios. Note that user can choose up to 5 scenarios. A set of display alternatives will be shown for reservoir storage, river flows, salinity, export and deliveries.
    c. Lower right corner shows "More .." button to link to another dashboard to display results for different water management actions.
3. Under the CalLite folder, click on an Excel file named CalLite_Results.xls and view the results. The model flickers at the end of the simulation because a set of model results are automatically configured to write out to the Excel file. Also, Excel files included under "ResultComparison" folder can be linked to this output and used to compare results between a specified Base (or an alternative) and the most recent CalLite simulation.

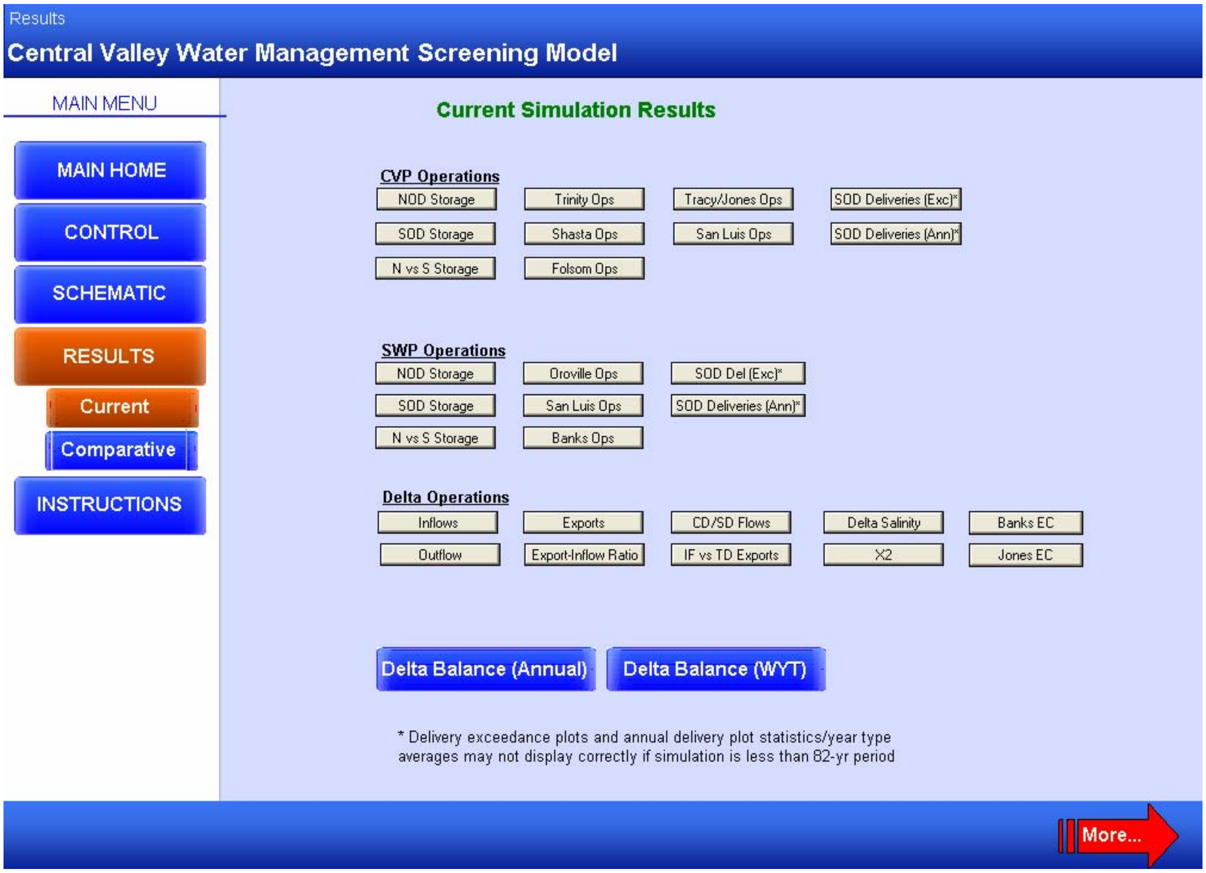


Figure A-3. CalLite Results dashboard view

<u>Viewing Results during the Simulation</u>

1. Results can be viewed as the model is being simulated. Simply pause the simulation, open the result plot of interest, and restart the simulation. The results will automatically update on the plot.
2. The user can also step through the simulation time-step by time-step using the "T" button on the Run Controller.

Controlling Model Parameters

Back on the Main Home dashboard (Figure A-2), you will see a "Control" button which leads to various system parameters for controlling the simulations. CalLite version 1.00R model allows the user to modify run settings, hydroclimate conditions and scenario demands (Figure A-4). The facilities used for the operation of the system and the implementation of regulations standards and operation criteria are additional dashboards that will be activated in future release of CalLite.

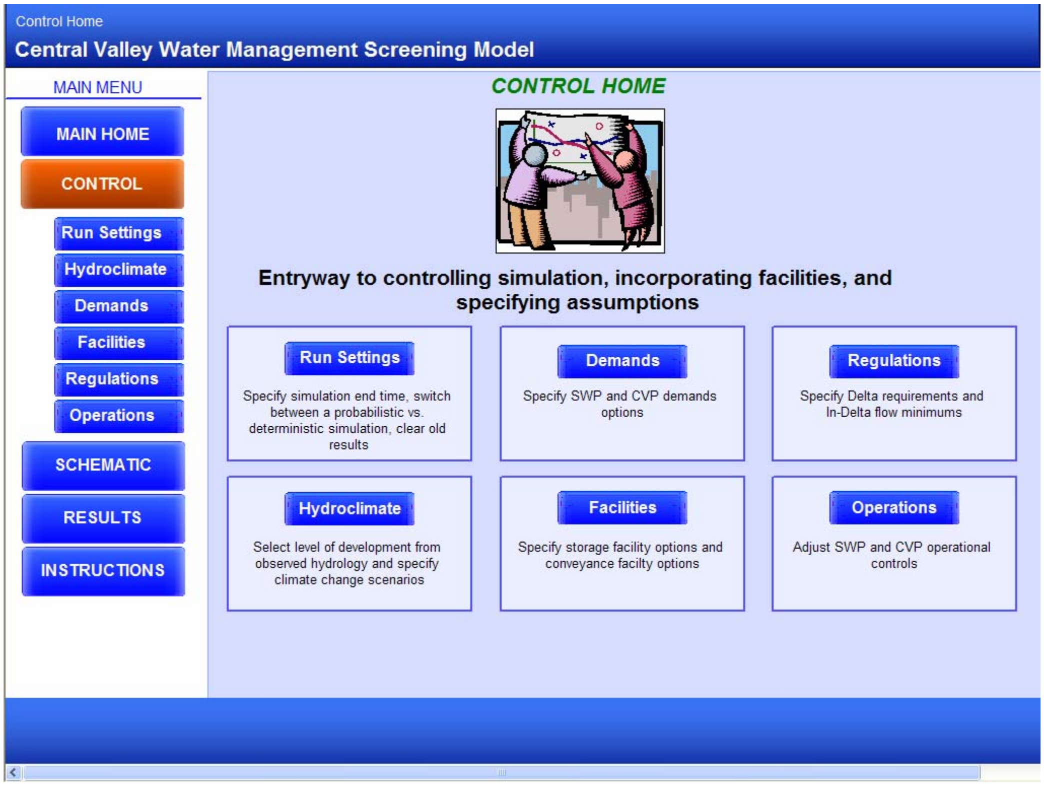


Figure A-4. CalLite Control dashboard

Navigating and changing input controls

1. Input controls are locked while the model is in Result Mode which can be identified by a green square in the status of the GoldSim Run Controller window. To change inputs you must first reset the model by pressing the reset button in this window. Doing this will destroy previous results in the model root memory, but it will not destroy the scenario results that have been stored. Note that the scenario results can not be displayed before a new run is done after resetting.
2. To navigate within the dashboard you can use the right hand buttons on the Run Controller window in order to go to a specific dashboard or to go to the previous or next one by using the arrows button.

Simulation and scenario settings

Simulation period: The simulation period can be set by the user by changing the end month or year within the range October 1, 1921 to September 2003.

Deterministic vs. Probabilistic: CalLite has been configured to illustrate how multiple realizations can be incorporated within a single simulation. GoldSim contains a full-featured Monte Carlo package that allows multiple realizations to be simulated. The realizations could represent forecasted inflows, uncertain demands, or more simply different desired flow regimes. Within the current release of CalLite, realizations are used to sequentially simulate the model through five possible climate scenarios. On the “Run Settings” Dashboard, click on the “Deterministic vs. Probabilistic” button. This provides access to the

Monte Carlo settings. Select the "Deterministic" option unless you wish to simulate all five (5) hydroclimate options by selecting all realizations.

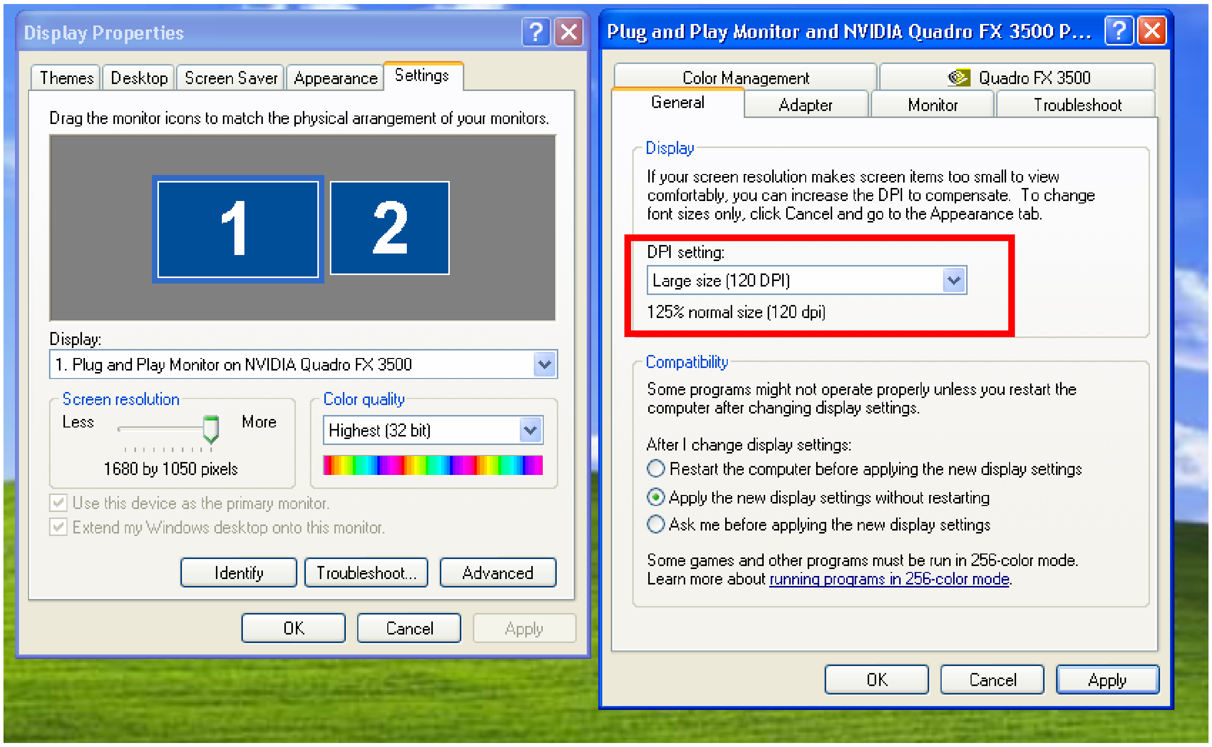
The Scenario Settings: CalLite will currently save histories of specific variables for up to five (5) individual scenario simulations. The user must specify the scenario number prior to simulation. At the end of simulation these results are saved externally to an Excel file (CalLite_ScenResults.xls) and internally within GoldSim results elements. To view GoldSim stored results, used needs to check boxes on the dashboard. On the other hand, CalLite will display all results stored in Excel file. User can set a new scenario number, change the demand, and/or hydroclimate assumptions to develop a new scenario. Certain plots have been configured to allow the results of five scenarios to be plotted together.

Scenario Log: CalLite transfers the user input for each scenario to a spreadsheet that is included with the package (UserInputSummary.xls).

Known Limitations with CalLite v1.00R

The following items are known limitations with the current version of the model. These have been identified and logged, but have not able to be corrected at this time.

1. CalLite is intended as a "screening tool," and as such, several simplifications have been necessary. In rare instances, the iterative COA process may not converge, i.e., the system constrains may not be fully satisfied after the number of iterations has reached the predefined maximum iteration number in CalLite, which may lead to inaccurate results. For greater accuracy, or after alternatives have been defined in detail, it is recommended to perform evaluations using the full CALSIM II model.
2. CalLite is currently configured to simulate a D-1641 regulatory environment, but does not include CVPIA (b)(2) or EWA operations.
3. This version of GoldSim (engine behind CalLite model) works fine with Windows XP operating system. However, GoldSim creates some warnings during software installation with Windows Vista operating system as Vista does not allow writing files in system32 folder. It is fine to ignore these warnings.
4. If you have the following settings of your desktop, you may have problem seeing the dashboard (distorted font). To fix the problem, change larger size to normal size (indicated below in red box).



5. Scenario results are stored either in Excel or in GoldSim elements. Excel results are post processed but GoldSim element results are not. Users can clear excel scenario results. But users can not clear scenario results stored in GoldSim elements. To overwrite results stored in GoldSim elements, new scenarios must be run.

Accessing Documentation and Help

This document can be accessed directly from CalLite GUI by clicking on the Quick Start Guide link on the "Instructions" dashboard. This document is designed to provide the highlights and a quick guide on the basic use of the model. The GoldSim Player provides a guide on the use of the software, and can be accessed by clicking the help button on the GoldSim Run Controller. As further enhancements are made to the current version of CalLite, a more comprehensive version of this document may be produced in the future.

For technical questions regarding CalLite, please contact: CalLitesupport@water.ca.gov

CalLite Run Instructions

After installing the CalLite software, double click on the CalLite application icon on your desktop.
To change any control parameters or options, user must press "reset" button on Run Controller if highlighted.

Base Run:

1. Run Settings:
    a. Simulation Period: Specify within the time period of 10/1/1921 - 10/1/2003
    b. Deterministic vs. Probabilistic: check deterministic simulation
    c. Scenario Setting: Press "Clear Scenario History" (if you plan to compare with another run), Remember to **save and close Excel**
    d. Enter "1" in the "Save Selected Results as Scenario No" box
2. Hydroclimate:
    a. Select "direct observed hydrology" (by scrolling the vertical sliding bar)
3. Demands:
    a. Select "Current (2005) Variable…. "
4. Regulation:
    a. Use default check boxes for D-1641 regulations
5. Press the "Run" button on the Run Controller. A message will notify you when the run is complete. Click "OK."
6. Explore results on Schematic by click "P" buttons and/or the buttons on "current" Results page (under "Current Simulation Results").

Scenario Setting: (Climate Change)

1. Run Settings:
    a. Scenario Setting: Put "2" in the box as this will be second scenario to compare with Scenario1 (Base run).
2. Hydroclimate:
    a. Select a model and scenario (e.g., GFDL and A2) (by scrolling the vertical sliding bar).
3. Run the simulation (Run Controller).
4. Go to Results ->Comparative and click on the buttons (under the heading"Comparative Scenario Results") to compare the results between scenarios.
5. You can also compare results on the Schematic page by clicking the "S" buttons.

Realization Runs: (To run all climate change scenarios to run on in batch mode)

1. Run Settings:
    a. Deterministic vs. Probabilistic: check probabilistic simulation.
2. Hydroclimate:
    a. Check "All (as Realizations)."
3. Run the simulation.
4. Compare results on Schematic by clicking the "R" buttons and/or the left side buttons on the Results page.

Appendix B Hydrology Development Documentation

The purpose of this appendix is to provide information regarding the assumptions and development of the hydrology for use in the CalLite model.

General Approach

CalLite is designed to provide quick answers for “what if?” scenarios. Its hydrology depends on major simplifications and assumptions as it is to fit to a simplified schematic of the Central Valley water systems (Figure B-1). The model is designed to give comparative results to DWR’s CALSIM II model, although operational logic may differ considerably. Therefore CALSIM II schematic is used as the starting point for CalLite hydrology development.

The major reservoirs of the Central Valley (Shasta, Trinity, Whiskeytown, Oroville, New Bullards Bar, Folsom, and San Luis) are included in CalLite as they are simulated in CALSIM II. CalLite nodes were identified as controlling locations on the CALSIM II schematic (e.g. locations where minimum flow requirements are enforced). CALSIM II hydrology between those identified points is then aggregated to match CalLite nodes. Diversions pertinent to a segment in CALSIM II are then simulated as diversions from the relevant CalLite node. CVP/SWP project demands are simulated dynamically in CalLite as they are dependent on other operational rules, whereas non-project demands are included as timeseries that are computed from companion CALSIM II study.

All other inflows, system losses/gains (such as groundwater-surface water interaction), and return flows are included as “local inflow” at respective nodes. A free-body diagram is delineated between CALSIM II’s nodes and the net accretion / depletion calculated within that free-body diagram is identified as a “local inflow” in CalLite. If the net flows contributing to a segment result in a net depletion rather than accretion, then the “local inflow” may have negative values.

Modeled Level of Development

The current CalLite hydrology has been developed using the CALSIM II 2005 and 2030 LOD hydrology. For any other user defined study, the tool is designed in a way that the user can easily switch to a different level of development. CalLite source data spreadsheet that comes with the package is linked to CALSIM II DV and SV files. Once the user refers to a different CALSIM II study, most data fields are updated automatically. There are a few sheets that are not dynamically linked (CVP & SWP SOD demands, for example) and they are highlighted with detailed explanation about how to update them in CalLite. The CalLite input hydrology spreadsheet is linked to the source data spreadsheet and the values will be updated automatically once the user chooses to do so. The CalLite model updates all linked hydrology input whenever a simulation is performed.

Rim Basin Inflows

Rim basin inflows use hydrology developed for the 2005 or 2030 LOD CALSIM II study. Inflows to North-of-Delta reservoirs are equal to the equivalent CALSIM II input flows. Inflows to the Delta from Eastside streams and the San Joaquin River are equal to equivalent CALSIM II output flows. Inflows to the model are shown in Table 1 along with the CALSIM II flow record used for each inflow.

Table B-1. Model Inflow Locations and Corresponding CALSIM II Flows

Location	CALSIM II Flow Arc(s)
Trinity Reservoir Inflow	I1
Whiskeytown Reservoir Inflow	I3
Shasta Reservoir Inflow	I4
Oroville Reservoir Inflow	I6
Folsom Reservoir Inflow	I8
Inflow to Delta from Eastside Streams	C504
Inflow to Delta from San Joaquin River	C639 + C508
Note: Inflows do not include inflow to New Bullards Bar Reservoir. Please see section below for discussion of Yuba hydrology and operations.	

Local Inflows

Local inflows are also based on 2005 or 2030 LOD CALSIM II hydrology. Local inflows are computed by summing CALSIM II inflows and outflows at each CalLite node. Each node corresponds to a reach in the CALSIM II model network and the local inflow at each node is equal to the sum of CALSIM II inflows and outflows to the corresponding reach. Any diversions that are included in CalLite (CVP and SWP deliveries, Sacramento Weir diversions, and non-project deliveries) are removed from the local inflows. The following figures and tables illustrate CalLite hydrology development reach by reach.

Upper Sacramento River

The Upper Sacramento River representation in CalLite includes Trinity, Shasta, and Whiskeytown Reservoirs and Lewiston Lake, Keswick Dam, and Red Bluff Diversion Dam (RBDD) as nodes. Lewiston Lake is simulated as a node with Trinity River exports embedded in. It is connected to Whiskeytown Lake via Clear Creek Tunnel. Whiskeytown Lake is then connected to the downstream node (Red Bluff) through Clear Creek and to the Keswick Reservoir through Spring Creek Tunnel. Trinity River exports are transferred into the Keswick reservoir through the two tunnels. All five nodes discussed thus far have the same schematic representation as CALSIM II, therefore the free-body diagrams that delineate these nodes include only the local inflows relevant to each node. The next node downstream is the Red Bluff node, since it is the diversion point of Tehama Colusa Canal (TCC) and the Corning Canal. The free-body diagram extends from downstream of Whiskeytown Lake and Keswick Dam (C3 and C5 arcs in CALSIM II) to RBDD (node 112). The diagram also includes TCC and Corning Canal so that all demands are lumped at the Red Bluff node in CalLite. Upper Sacramento River representation is illustrated in Figure B-2 and the local inflow calculations are provided in Table B-2.

Table B-2. Upper Sacramento River local inflow calculation

Feature	**Inflow**	**Diversion***	**Local Inflow**
Reservoirs			
Shasta	I4		
Trinity	I1		
Whiskeytown	I3		
Nodes (labeled)			
Red Bluff		Diversion to DSA 58	C112-C5-C3+D104_PRJ+D112+D173B_StCr-L172-C17502A-C17502B
Keswick			C5-D3-C4
Lewiston			I100
*All diversions constrained by contract allocation and consumptive use requirements			

Colusa Basin

Wilkins Slough was selected as the controlling node since it has the Navigation Control Point minimum instream flow requirements and it is a suitable location to lump Colusa Basin demands. As seen in Figure B-3, the free-body diagram includes all of the Glenn Clousa Canal (GCC) Irrigation District demands. Moulton, Colusa, and Tisdale weirs remain within the free-body diagram of the reach and are not modeled in CalLite. Table B-3 represents the local inflow calculations within the Colusa Basin representation in CalLite.

Table B-3. Colusa Basin local inflow calculation

Feature	**Inflow**	**Diversion***	**Local Inflow**
Nodes (labeled)			
Red Bluff		Diversion to WBA 4--Corning Canal, WBA 4--Kirkwood, WBA7N, WBA7S	See worksheet "CVOSM Upper Sac"
Wilkins Slough / Navigation Control Pt		Diversions to WBA 8NN, WBA 8NS, WBA 8S, and DSA 15	C129-C112+D114+D122A+D122B+D129

		Eastside, Sacramento Wildlife Refuge, and Colusa/Delevan Refuges	A+D128+I180+I182+R181A+R181B +R182A+R182B+C17502A+C17502 B+R18302-L143-C18302
*All diversions constrained by allocation and consumptive use requirements			

Lower Sacramento River

The Lower Sacramento River representation includes Sacramento River- Feather River and Sacramento River – American River confluences as well as the Yolo Bypass. The Fremont and Sacramento Weirs are simulated dynamically and divert water to the Yolo Bypass depending on river flows and rating curves as in CALSIM II. Figure B-4 illustrates the Lower Sacramento River representation and Table B-4 represents related local inflow calculations.

Table B-4. Lower Sacramento River local inflow calculation

Feature	Inflow	Diversion*	Accretions
Nodes (labeled)			
SacFeather		Diversion to Yolo Bypass	C160-C129-C223+D160
SacAmerican		Diversions to Yolo Bypass, West Sacramento, DSA 65 Settlement Contractors, City of Sacramento, DSA 70 Settlement Contractors, and SCWA	C168-C160-C303+D166A+D162_PRJ +D163_PRJ+D165+D167
Yolo Bypass			C156
*All diversions (except bypass diversions) constrained by allocation and consumptive use requirements			

Feather River

The Feather River representation in CALSIM II is scaled down to four nodes in CaLite: Lake Oroville, Thermalito Complex, Feather River – Yuba River confluence and Feather River – Sacramento River confluence. The minimum instream flow requirement below Thermalito is applied at both Thermalito and Feather River - Yuba River confluence. Figure B-5 and Table B-5 summarize the Feather River representation and hydrology calculations in CalLite.

Table B-5. Feather River local inflow calculation

Feature	Inflow	Diversion*	Local Inflow
Reservoirs			
Oroville	I6	Diversion to Palermo Canal	
Nodes (labeled)			

Thermalito		Diversions to Western Canal, Joint Board, Butte County, Thermalito ID, Gray Lodge, and Butte Sink Duck Clubs	C203 -C6 +D201 +D202 +D7A +D7B
YubaFeather		Diversions to Yuba City, Feather WD, and misc. FRSA	C223 -C203 -C230 +D204 +D206A +D206B +D206C
*All diversions constrained by allocation and consumptive use requirements			

Yuba River

New Bullards Bar Reservoir, Englebright, and Daguerre Point were selected as CalLite nodes since they are the controlling locations on the Yuba River. North Yuba minimum instream flow requirements and the power release requirements are included in the New Bullards Bar node. Englebright Dam is simulated as a node rather than a reservoir since it operated primarily as a debris dam and not for seasonal or long-term carryover storage. Both Englebright and Daguerre Point nodes have minimum instream flow requirements. Figure B-6 and Table B-6 summarize the Yuba River representation in CalLite.

Table B-6. Yuba River local inflow calculation

Feature	**Inflow**	**Diversion**	**Local Inflow**
Reservoirs			
New Bullards Bar	I31+C251+D252		
Nodes (labeled)			
Englebright			C37-C31-D31
DaguerrePt		Diversion to YCWA	C231-C37

American River

Folsom Lake, Lake Natoma, and H Street comprise the three nodes on the American River. Folsom is included as a reservoir since its operation is simulated dynamically in CalLite, while Lake Natoma (Nimbus Dam) primarily serves as a regulating reservoir for downstream demands and minimum instream flow requirements and is simulated as a node. H Street node in CalLite represents nodes 301, 302, and 303 of CALSIM II model (Figure B-7). City of Sacramento diversions are included within this node. While the project demands are modeled dynamically, non-project (water rights) demands are included as time series from CALSIM II. Both demand types are excluded from local inflow calculations (Table B-7).

Table B-7. American River local inflow calculation

Feature	Inflow	Diversion*	Local Inflow
Reservoirs			
Folsom	I8+C300	Diversions to City of Folsom, Folsom Prison, SJWD, EID, and City of Roseville	
Nodes (labeled)			
Nimbus		Diversions to SCWC/ACWC and CA Parks and Rec	C9-C8+D309A
H St		Diversions to City of Sacramento, Carmichael WD, and Arcade WD	C303-C9+D302
*All diversions constrained by allocation and consumptive use requirements			

The Sacramento - San Joaquin River Delta

The Delta is expressed in two layers. Within the general system schematic, "Eastside" and "San Joaquin" nodes represents boundary conditions of the model where inflows from San Joaquin River and the Eastside streams are used as timeseries from CALSIM II. The Exports node represents Jones and Banks Pumping Plants and their related operations. The "Delta" node contains net Delta flow, X2, and salinity calculations.

The second layer consists of a more detailed schematic including Hood, Delta Cross Channel, Central Delta, San Joaquin River at Delta, South Delta, Rio Vista (West Delta), and the South Delta and Rio Vista confluence. Rio Vista has the minimum instream requirements and all other nodes provide a basis for detailed operations development. Table B-8 represents the local inflow calculations within the Delta node where Figure B-8 illustrates the Delta node in CalLite.

Table B-8. Delta local inflow calculation

Feature	**Inflow**	**Diversion***	**Local Inflow**
Nodes (labeled)			
DXC			C400-C168
North Delta		Diversions to NBA	C404-C401A-C157+D403B+D403C
West Delta			C406-C405-C408
Central Delta	C504		C413-C414
South Delta	C644		C410-C411, C412-C644-D415
*Does not include SOD diversions			

Delta – San Luis Reservoir

Upper Delta Mendota Canal and California Aqueduct are modeled as the"Upper DMC" and "South Bay" nodes respectively (Figure B-9). There are no minimum instream flow requirements in the South of the Delta; however these locations are critical in terms of grouping the CVP and SWP South of Delta demands. Therefore there is no local inflow calculation for these nodes.

San Luis Reservoir – Dos Amigos

San Luis Reservoir, O'Neill Forebay, O'Neill Pumping Plan, Joint Reach, and Dos Amigos nodes represent the critical nodes further south of the Delta that are used to model San Luis operations and South of the Delta deliveries for both CVP and SWP (Figure B-9 and Figure B-10).

Demands—North of Delta

North-of-Delta project demands are also based on 2005 and 2030 LOD CALSIM II hydrology. Consistent with the CALSIM II approach, deliveries are constrained by CVP and SWP allocations and by land use-based diversion requirements for the hydrologic planning area. Table B-9 shows North-of-Delta model nodes and CALSIM II demand timeseries used to represent project demands at each node. The table also shows the DSA land use-based diversion requirement associated with each demand timeseries.

Table B-9. Model Nodes, Demands, and Land Use-Based Constraints

Model Node	Corresponding CALSIM II Demand(s)	DSA Land Use-Based Diversion Requirement
Red Bluff		
	DEM_D112B_PAG	DSA 10
	DEM_D112A_PAG	DSA 12
	DEM_D104_PMI	DSA 58
	DEM_D104_PAG	DSA 58
	DEM_D104_PSC	DSA 58
Wilkins Sl.		
	DEM_D117A_PSC	DSA 10
	DEM_D114_PSC	DSA 12
	DEM_D122_PSC	DSA 12
	DEM_D128_PSC	DSA 15
Oroville		
	DEM_D6_PWR	DSA 69
Thermalito		
	DEM_D7A_PWR	DSA 69
	DEM_D7B_PWR	DSA 69
	DEM_D202_PWR	DSA 69
	DEM_D7A_PAG	DSA 69
	DEM_D7B_PAG	DSA 69
	DEM_D201_PMI	DSA 69
	DEM_C216B_PRF	DSA 69
	DEM_C220A_PRF	DSA 69
Yuba-Feather		

Model Node	Corresponding CALSIM II Demand(s)	DSA Land Use-Based Diversion Requirement
Confluence		
	DEM_D204_PMI	DSA 69
	DEM_D206A_PAG	DSA 69
	DEM_D206B_PAG	DSA 69
Folsom		
	ALLOC_D8B_OMI	DSA 70
	ALLOC_D8B_IMI	DSA 70
	ALLOC_D8C_OMI	DSA 70
	ALLOC_D8C_IMI	DSA 70
	ALLOC_D8D_OMI	DSA 70
	ALLOC_D8D_IMI	DSA 70
	ALLOC_D8E_OMI	DSA 70
	ALLOC_D8E_IMI	DSA 70
	ALLOC_D8F_OMI	DSA 70
	ALLOC_D8F_IMI	DSA 70
	ALLOC_D8G_OMI	DSA 70
	ALLOC_D8G_IMI	DSA 70
Natoma		
	ALLOC_D9AA_OMI	DSA 70
	ALLOC_D9AA_IMI	DSA 70
	ALLOC_D9AB_OMI	DSA 70
	ALLOC_D9AB_IMI	DSA 70
	ALLOC_D9A_PLS	DSA 70
H Street		
	ALLOC1_D302A_OMI	DSA 70
	ALLOC1_D302A_IMI	DSA 70
	ALLOC_D302B_OMI	DSA 70
	ALLOC_D302B_IMI	DSA 70
	ALLOC_D302C_OMI	DSA 70

Model Node	Corresponding CALSIM II Demand(s)	DSA Land Use-Based Diversion Requirement
	ALLOC_D302C_IMI	DSA 70
Sacramento/American Confluence		
	ALLOC1_D167A_OMI	DSA 70
	ALLOC1_D167A_IMI	DSA 70
	ALLOC_D167B_OMI	DSA 70
	ALLOC_D167B_IMI	DSA 70
	ALLOC_D162A_PSC	DSA 70
	ALLOC_D162B_PSC	DSA 70
	ALLOC_D162C_PSC	DSA 70
	DEM_D163_PSC	DSA 65
	DEM_D165_PSC	DSA 65

Demands—South of Delta

State Water Project Demands

Twenty-nine agencies have contracts for a long-term water supply from the State Water Project totaling about 4.2 million acre-feet annually, of which about 4.1 million acre-feet are for contracting agencies with service areas south of the Sacramento-San Joaquin Delta. About 70 percent of this amount is the contract entitlement for urban users and the remaining 30 percent for agricultural users. Implementation of these demands in CalLite is similar to CALSIM II, however, the contractors are grouped into three types: agricultural (Ag), Metropolitan Water District's municipal and industrial demands (MWD), and other municipal and industrial demands (OTH) (Table B-10); similar to older versions of the CALSIM II model.

Table B-10. SWP Contractors as simulated in CalLite

IDD[1]	DemArc[2]	IDC[3]	Type	Contractor	CalLite Demand Node
1	D810	1	MI	ALAMEDA COUNTY FC&WCD-ZONE 7	SouthBay
2	D813	1	MI	ALAMEDA COUNTY FC&WCD-ZONE 7	SouthBay
3	D814	2	MI	ALAMEDA COUNTY WD	SouthBay
4	D877	3	MI	ANTELOPE VALLEY-EAST KERN WA	Dos Amigos
5	D868	4	AG	CASTAIC LAKE WA	Dos Amigos
6	D896	4	MI	CASTAIC LAKE WA	Dos Amigos
7	D204	5	MI	CITY OF YUBA CITY	Feather
8	D883	6	MI	COACHELLA VALLEY WD	Dos Amigos
9	D201	7	MI	COUNTY OF BUTTE	Feather

10	D847	8	AG	COUNTY OF KINGS	Dos Amigos
11	D25	9	MI	CRESTLINE-LAKE ARROWHEAD WA	Dos Amigos
12	D884	10	MI	DESERT WA	Dos Amigos
13	D849	11	AG	DUDLEY RIDGE WD	Dos Amigos
14	D846	12	AG	EMPIRE WEST SIDE ID	Dos Amigos
15	D851A	13	MI	KERN COUNTY WA	Dos Amigos
16	D851	13	AG	KERN COUNTY WA	Dos Amigos
17	D859	13	AG	KERN COUNTY WA	Dos Amigos
18	D863	13	AG	KERN COUNTY WA	Dos Amigos
19	D867	13	AG	KERN COUNTY WA	Dos Amigos
20	D879	14	MI	LITTLEROCK CREEK ID	Dos Amigos
21	D27	15	MWD	METROPOLITAN WDSC	Dos Amigos
22	D851B	15	MWD	METROPOLITAN WDSC	Dos Amigos
23	D885	15	MWD	METROPOLITAN WDSC	Dos Amigos
24	D895	15	MWD	METROPOLITAN WDSC	Dos Amigos
25	D899	15	MWD	METROPOLITAN WDSC	Dos Amigos
26	D881	16	MI	MOJAVE WA	Dos Amigos
27	D403B	17	MI	NAPA COUNTY FC&WCD	Delta
28	D802A	18	AG	OAK FLAT WD	O'Neill
29	D878	19	MI	PALMDALE WD	Dos Amigos
30	D886	20	MI	SAN BERNARDINO VALLEY MWD	Dos Amigos
31	D887	21	MI	SAN GABRIEL VALLEY MWD	Dos Amigos
32	D888	22	MI	SAN GORGONIO PASS WA	Dos Amigos
33	D869	23	MI	SAN LUIS OBISPO COUNTY FC&WCD	Dos Amigos
34	D870	24	MI	SANTA BARBARA COUNTY FC&WCD	Dos Amigos
35	D815	25	MI	SANTA CLARA VALLEY WD	SouthBay
36	D403C	26	MI	SOLANO COUNTY WA	Delta
37	D848	27	AG	TULARE LAKE BASIN WSD	Dos Amigos
38	D28	28	MI	VENTURA COUNTY WPD	Dos Amigos
39	D29	28	MI	VENTURA COUNTY WPD	Dos Amigos

[1]: Demand ID

[2]: Demand Arc in CALSIM II

[3]: Contractor ID

Central Valley Project Demands

CVP demands are currently also based on 2005 and 2030 LOD CALSIM II hydrology and consistent with the CALSIM II approach. Table B-11 summarizes the contractors, their types and the CalLite node at which they are applied.

Table B-11. CVP south of Delta contractors as simulated in CalLite

Contractors	Location (CALSIM II)	Type	CalLite Demand Node
Plainview WD	Upper DMC	Ag	Upper DMC
Tracy, City of	Upper DMC	Mi	Upper DMC
Banta Carbona ID	Upper DMC	Ag	Upper DMC
West Side ID	Upper DMC	Ag	Upper DMC

Davis WD	Upper DMC	Ag	Upper DMC
Del Puerto WD	Upper DMC	Ag	Upper DMC
Hospital WD	Upper DMC	Ag	Upper DMC
Kern Canon WD	Upper DMC	Ag	Upper DMC
Salado WD	Upper DMC	Ag	Upper DMC
Sunflower WD	Upper DMC	Ag	Upper DMC
West Stanislaus WD	Upper DMC	Ag	Upper DMC
Mustang WD	Upper DMC	Ag	Upper DMC
Orestimba WD	Upper DMC	Ag	Upper DMC
Patterson WD Water Rights	Upper DMC	Wr	Upper DMC
Patterson WD	Upper DMC	Ag	Upper DMC
Foothill WD	Upper DMC	Ag	Upper DMC
Quinto WD	Upper DMC	Ag	Upper DMC
Romero WD	Upper DMC	Ag	Upper DMC
Centinella WD	Upper DMC	Ag	Upper DMC
Losses	Upper DMC	Loss	Upper DMC
Exchange Contractors	DMC Downstream from O'Neill	Ex	O'Neill_PP
Panoche WD	DMC Downstream from O'Neill	Ag	O'Neill_PP
San Luis WD	DMC Downstream from O'Neill	Ag	O'Neill_PP
Broadview WD	DMC Downstream from O'Neill	Ag	O'Neill_PP
Laguna WD	DMC Downstream from O'Neill	Ag	O'Neill_PP
Eagle Field WD	DMC Downstream from O'Neill	Ag	O'Neill_PP
Mercy Springs WD	DMC Downstream from O'Neill	Ag	O'Neill_PP
Oro Loma WD	DMC Downstream from O'Neill	Ag	O'Neill_PP
Widren WD	DMC Downstream from O'Neill	Ag	O'Neill_PP
Grasslands via CCID	DMC Downstream from O'Neill	Ref	O'Neill_PP
Los Banos WMA	DMC Downstream from O'Neill	Ref	O'Neill_PP
Kesterson NWR	DMC Downstream from O'Neill	Ref	O'Neill_PP
Freitas - SJBAP	DMC Downstream from O'Neill	Ref	O'Neill_PP
Salt Slough - SJBAP	DMC Downstream from O'Neill	Ref	O'Neill_PP
China Island - SJBAP	DMC Downstream from O'Neill	Ref	O'Neill_PP
Volta WMA	DMC Downstream from O'Neill	Ref	O'Neill_PP
Grassland via Volta Wasteway	DMC Downstream from O'Neill	Ref	O'Neill_PP
Westlands WD (incl. Barcellos)	Mendota Pool	Ag	O'Neill_PP
Fresno Slough WD	Mendota Pool	Ag	O'Neill_PP
James ID	Mendota Pool	Ag	O'Neill_PP
Traction Ranch/F&G	Mendota Pool	Ag	O'Neill_PP
Tranquillity ID	Mendota Pool	Ag	O'Neill_PP
Hughes, Melvin	Mendota Pool	Ag	O'Neill_PP
R.D. 1606	Mendota Pool	Ag	O'Neill_PP
Exchange Contractors	Mendota Pool	Ex	O'Neill_PP
Sch. II W.R.. -	Mendota Pool	Wr	O'Neill_PP
Sch. II W.R.. - James ID	Mendota Pool	Wr	O'Neill_PP
Sch. II W.R.. - Traction Ranch	Mendota Pool	Wr	O'Neill_PP
Sch. II W.R.. - Tranquility I	Mendota Pool	Wr	O'Neill_PP
Sch. II W.R.. - Hughes, Melvin	Mendota Pool	Wr	O'Neill_PP
Sch. II W.R.. - R.D. 1606	Mendota Pool	Wr	O'Neill_PP

Sch. II W.R.. - Dudley	Mendota Pool	Wr	O'Neill_PP
Grasslands WD	Mendota Pool	Ref	O'Neill_PP
Los Banos WMA	Mendota Pool	Ref	O'Neill_PP
San Luis NWR	Mendota Pool	Ref	O'Neill_PP
Mendota WMA	Mendota Pool	Ref	O'Neill_PP
West Gallo - SJBAP	Mendota Pool	Ref	O'Neill_PP
East Gallo - SJBAP	Mendota Pool	Ref	O'Neill_PP
Losses	Mendota Pool	Loss	O'Neill_PP
San Benito County WD MI	San Felipe	Mi	San Luis
San Benito County WD AG	San Felipe	Ag	San Luis
Santa Clara Valley WD PMI	San Felipe	Mi	San Luis
Santa Clara Valley WD PAG	San Felipe	Ag	San Luis
Pajaro Valley Wtr Mgmt Agency	San Felipe	Ag	San Luis
San Luis Interim	San Luis Unit (Joint Reach)	Ag	Joint Reach
Westlands WD	San Luis Unit (Joint Reach)	Ag	Joint Reach
San Luis WD	San Luis Unit (Joint Reach)	Ag	Joint Reach
Panoche WD	San Luis Unit (Joint Reach)	Ag	Joint Reach
Pacheco WD	San Luis Unit (Joint Reach)	Ag	Joint Reach
Grasslands WD	San Luis Unit (Joint Reach)	Ag	Joint Reach
CA, State Parks and Rec	San Luis Unit (Joint Reach)	Ag	Joint Reach
Affonso/Los Banos Gravel Co.	San Luis Unit (Joint Reach)	Ag	Joint Reach
Avenal, City of	San Luis Unit (Joint Reach)	Mi	Joint Reach
Coalinga, City of	San Luis Unit (Joint Reach)	Mi	Joint Reach
Huron, City of	San Luis Unit (Joint Reach)	Mi	Joint Reach
Loss	San Luis Unit (Joint Reach)	Loss	Joint Reach
Ducor ID	Cross Valley Canal	Ag	Dos Amigos
Hope Valley	Cross Valley Canal	Ag	Dos Amigos
Fresno, County of	Cross Valley Canal	Ag	Dos Amigos
Hills Valley ID	Cross Valley Canal	Ag	Dos Amigos
Kern-Tulare ID	Cross Valley Canal	Ag	Dos Amigos
Lower Tule River ID	Cross Valley Canal	Ag	Dos Amigos
Pixley ID	Cross Valley Canal	Ag	Dos Amigos
Rag Gulch WD	Cross Valley Canal	Ag	Dos Amigos
Tri-Valley WD	Cross Valley Canal	Ag	Dos Amigos
Tulare, County of	Cross Valley Canal	Ag	Dos Amigos
Kern NWR	Cross Valley Canal	Ref	Dos Amigos
Pixley NWR	Cross Valley Canal	Ref	Dos Amigos

HYDROLOGY FIGURES

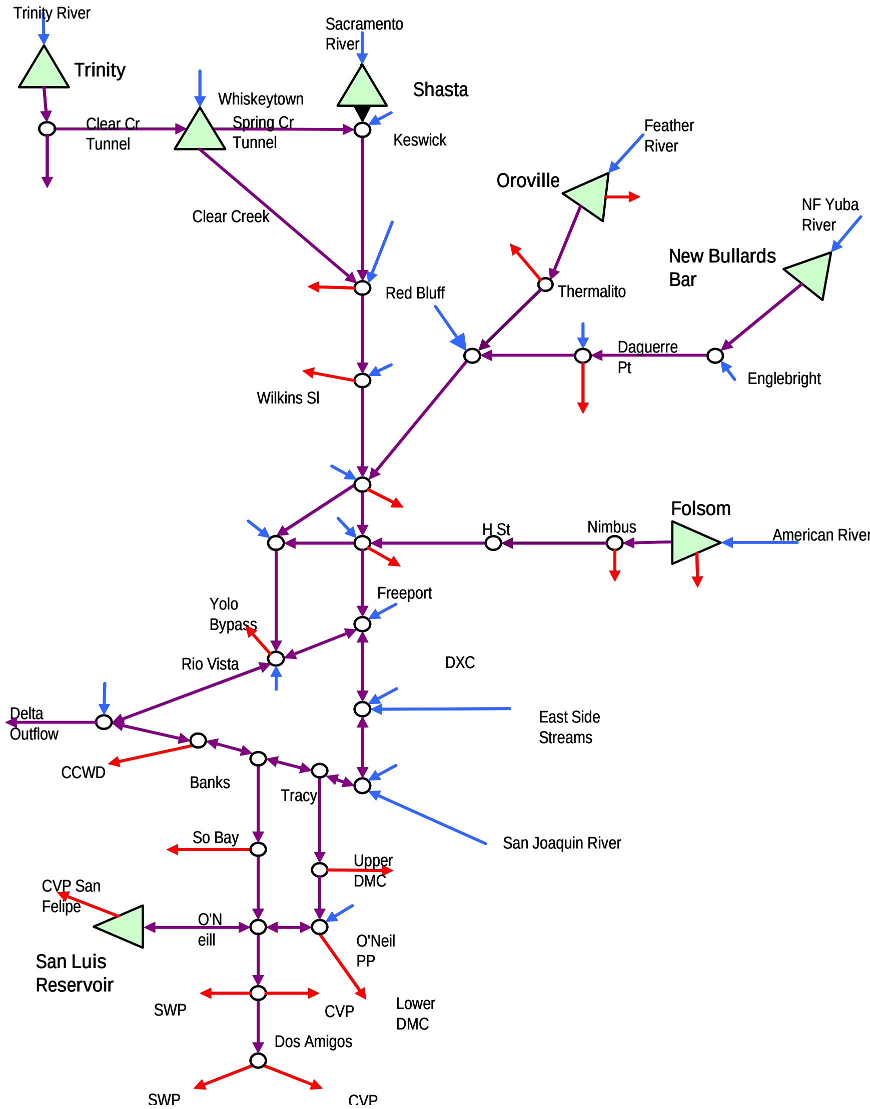


Figure B-1. CalLite schematic

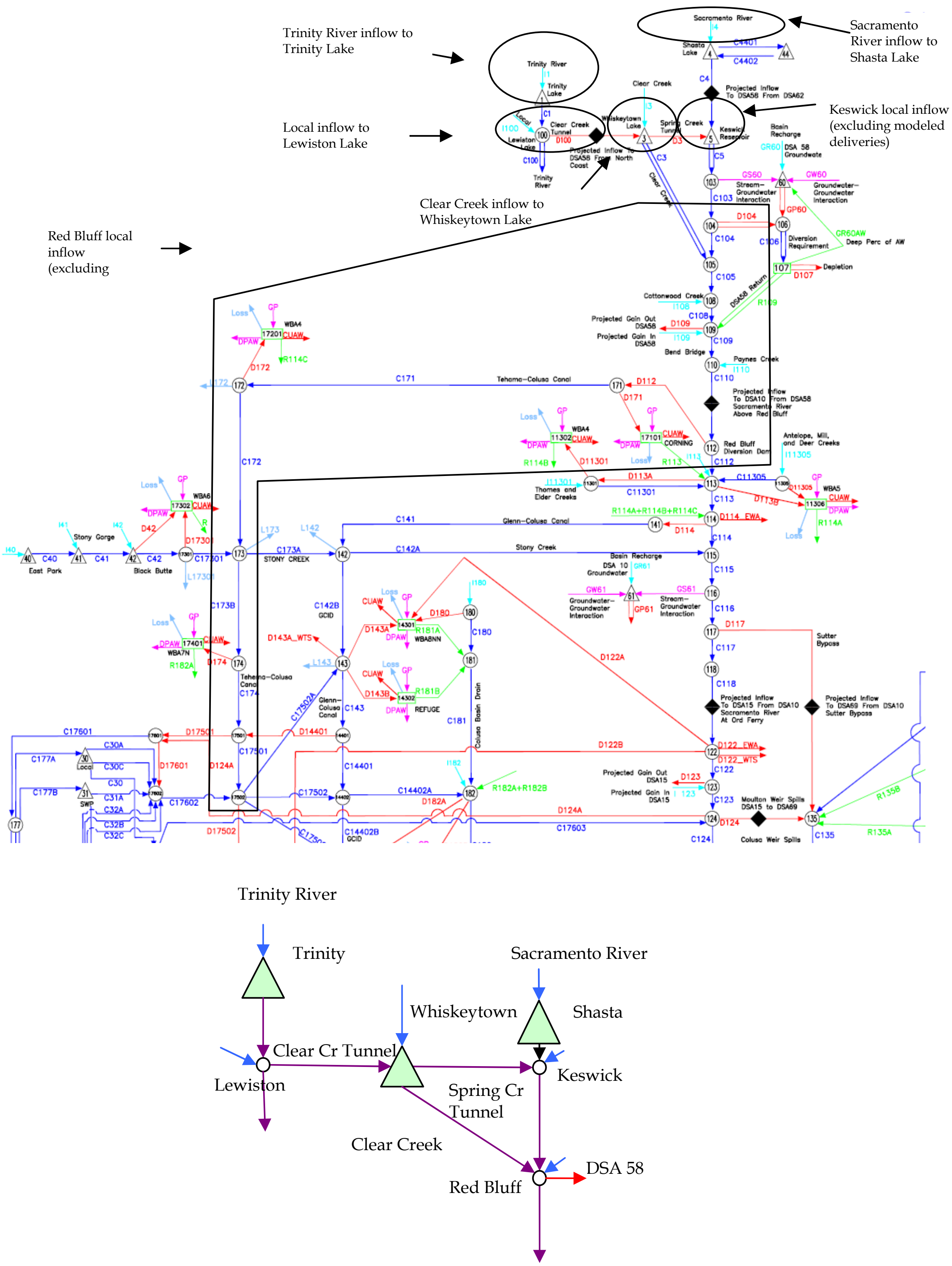


Figure B-2. CalLite Upper Sacramento River representation

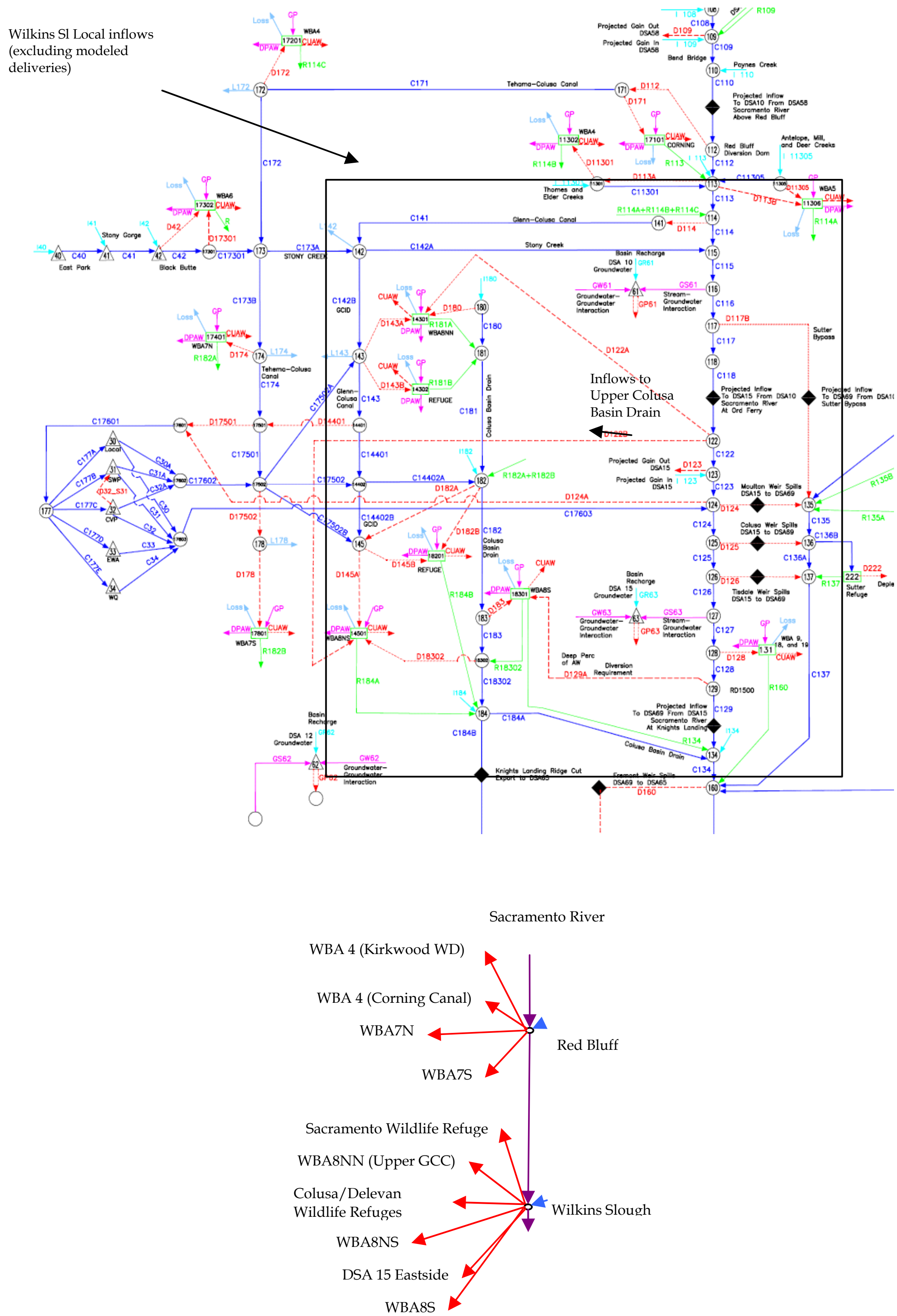


Figure B-3. CalLite Colusa Basin representation

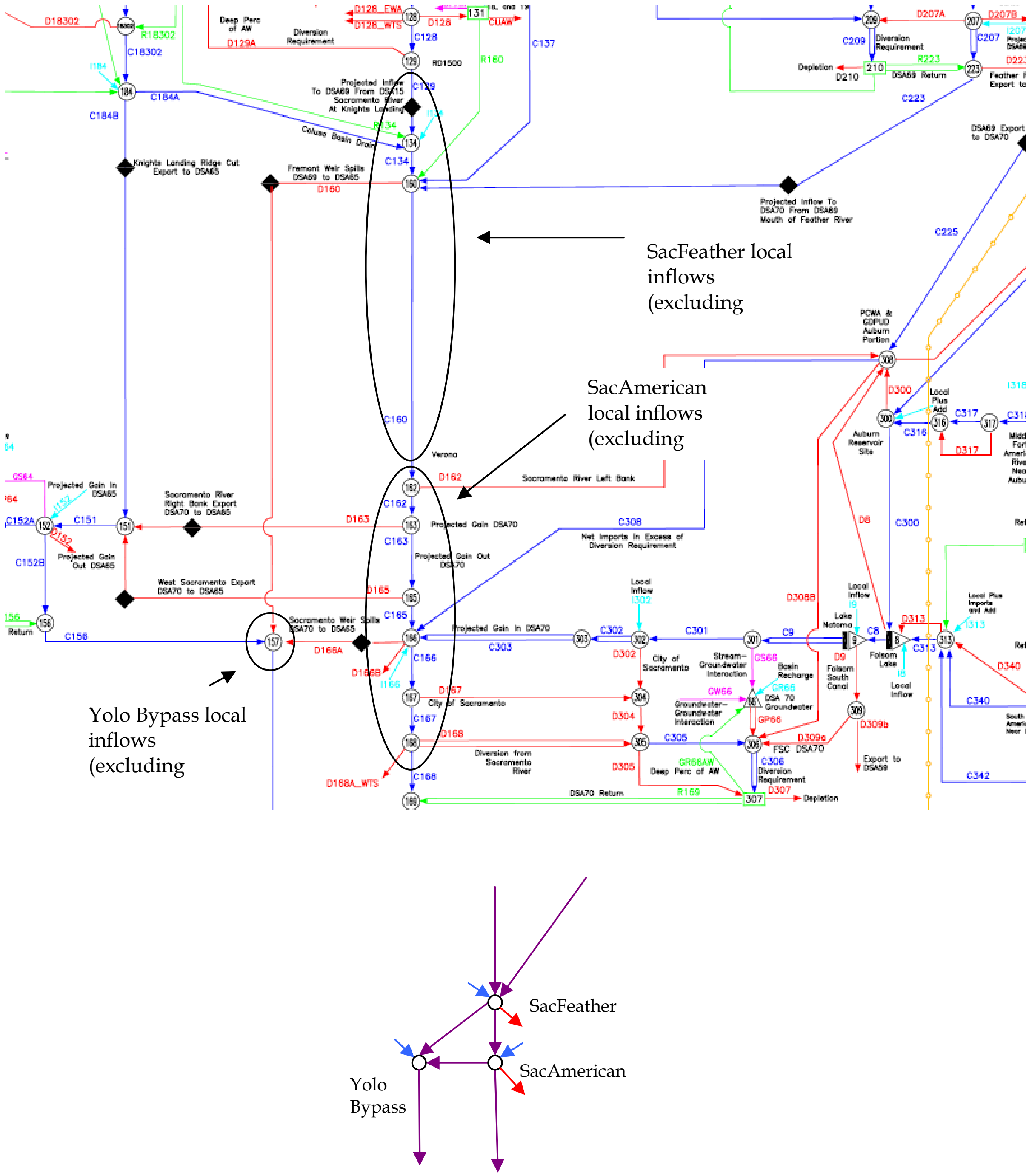


Figure B-4. CalLite Lower Sacramento River representation

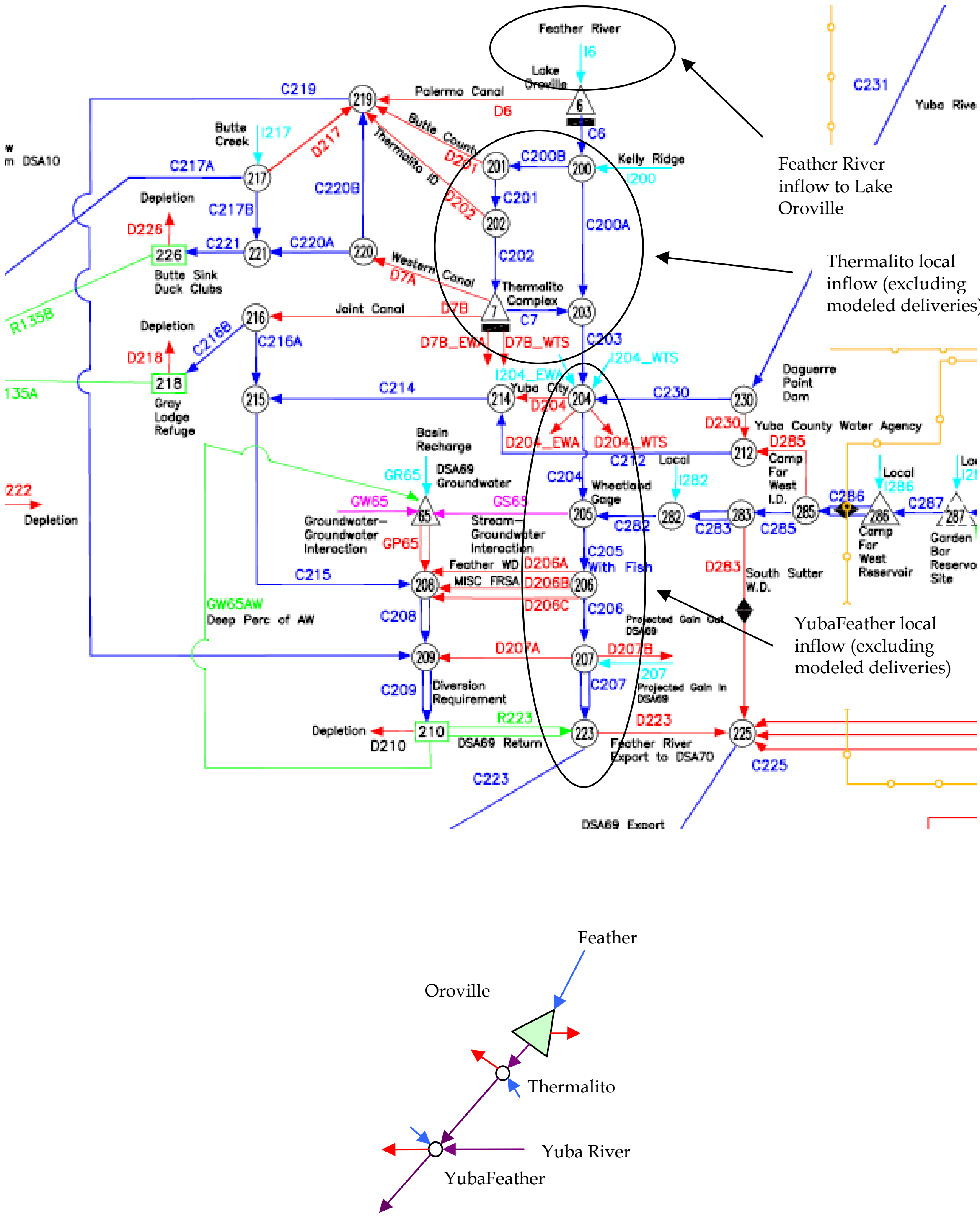


Figure B-5. CalLite Feather River representation

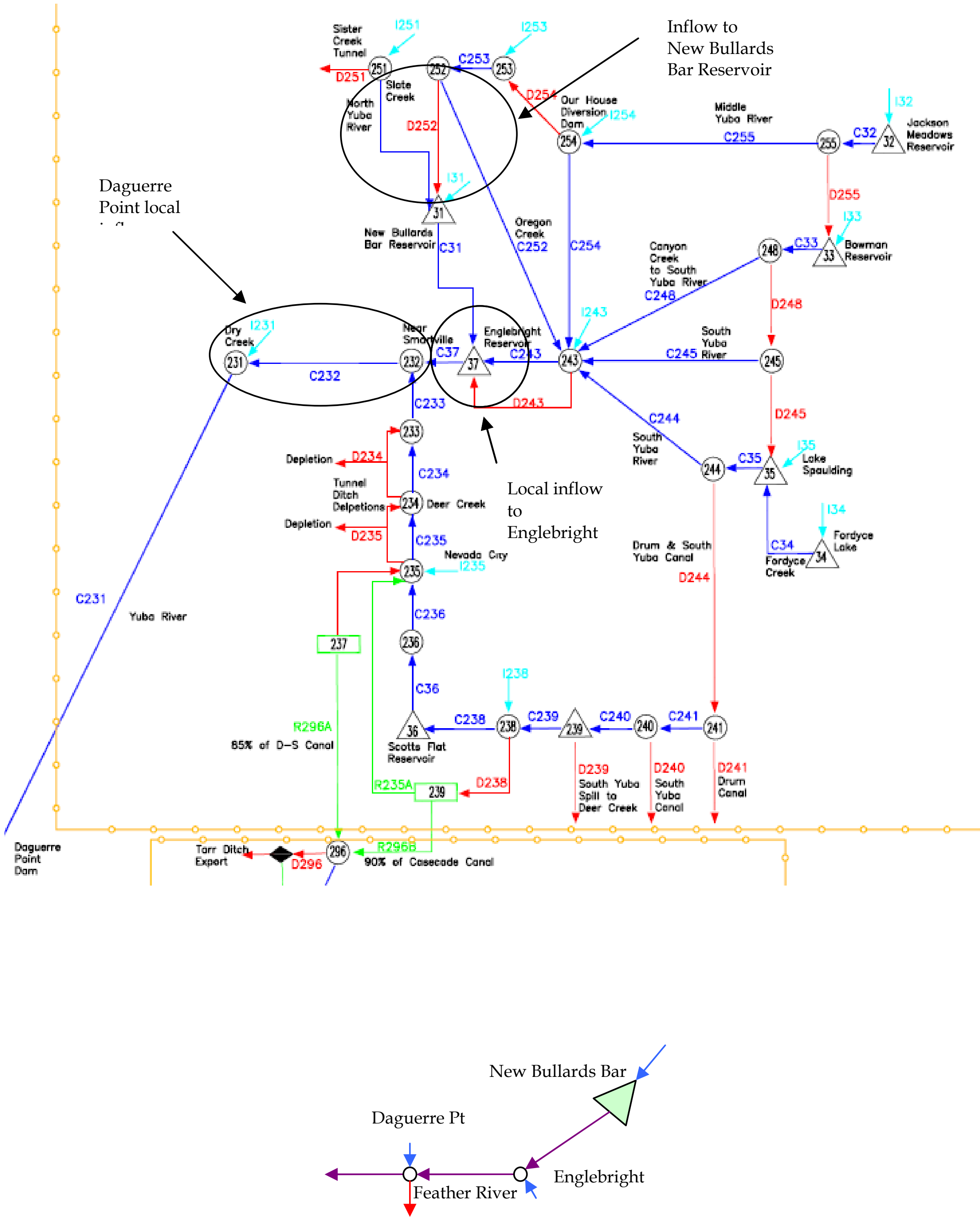


Figure B-6. CalLite Yuba River representation

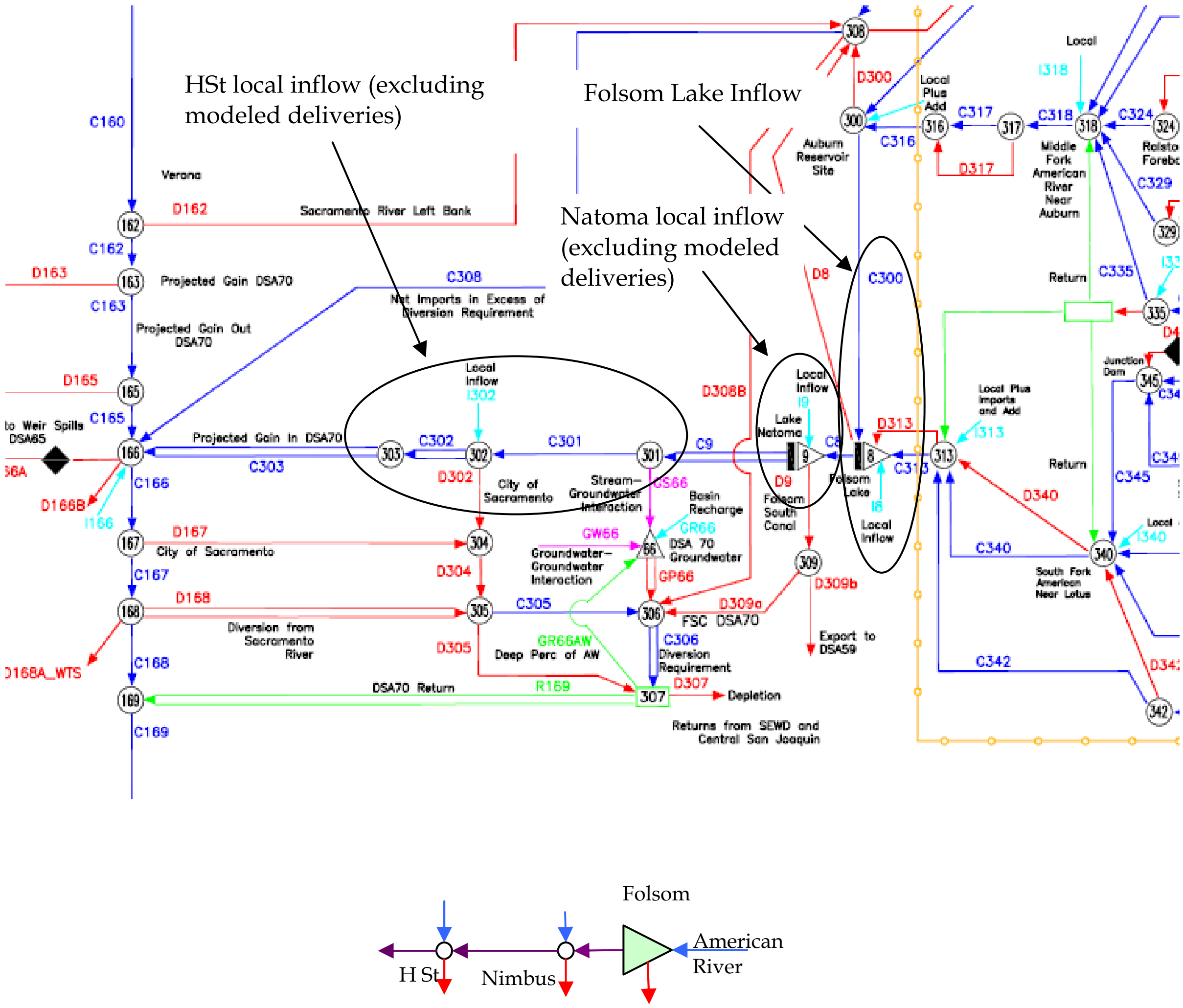


Figure B-7. CalLite American River representation

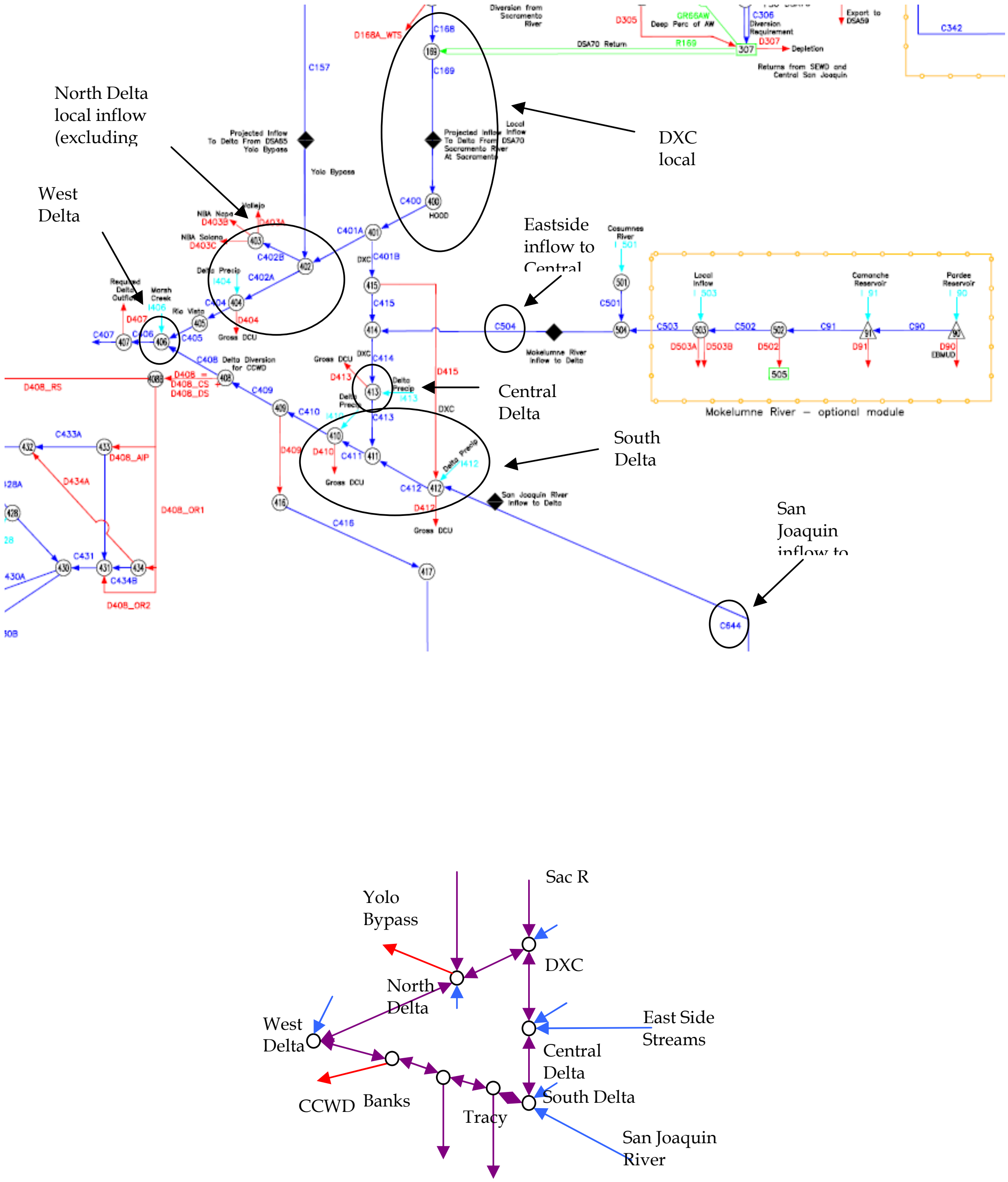


Figure B-8. Delta representation and local inflow calculation

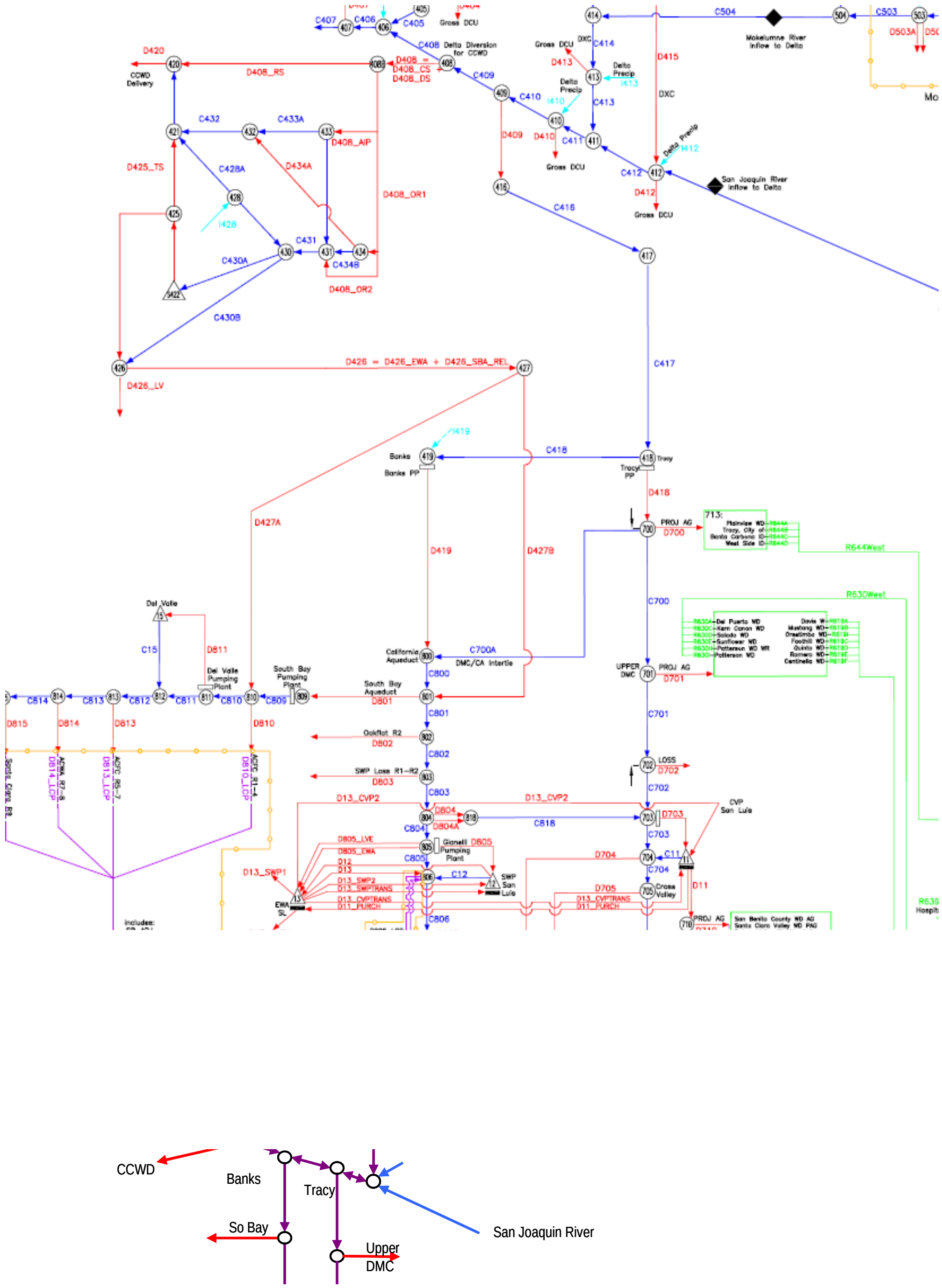


Figure B-9. CalLite representation from Delta to San Luis

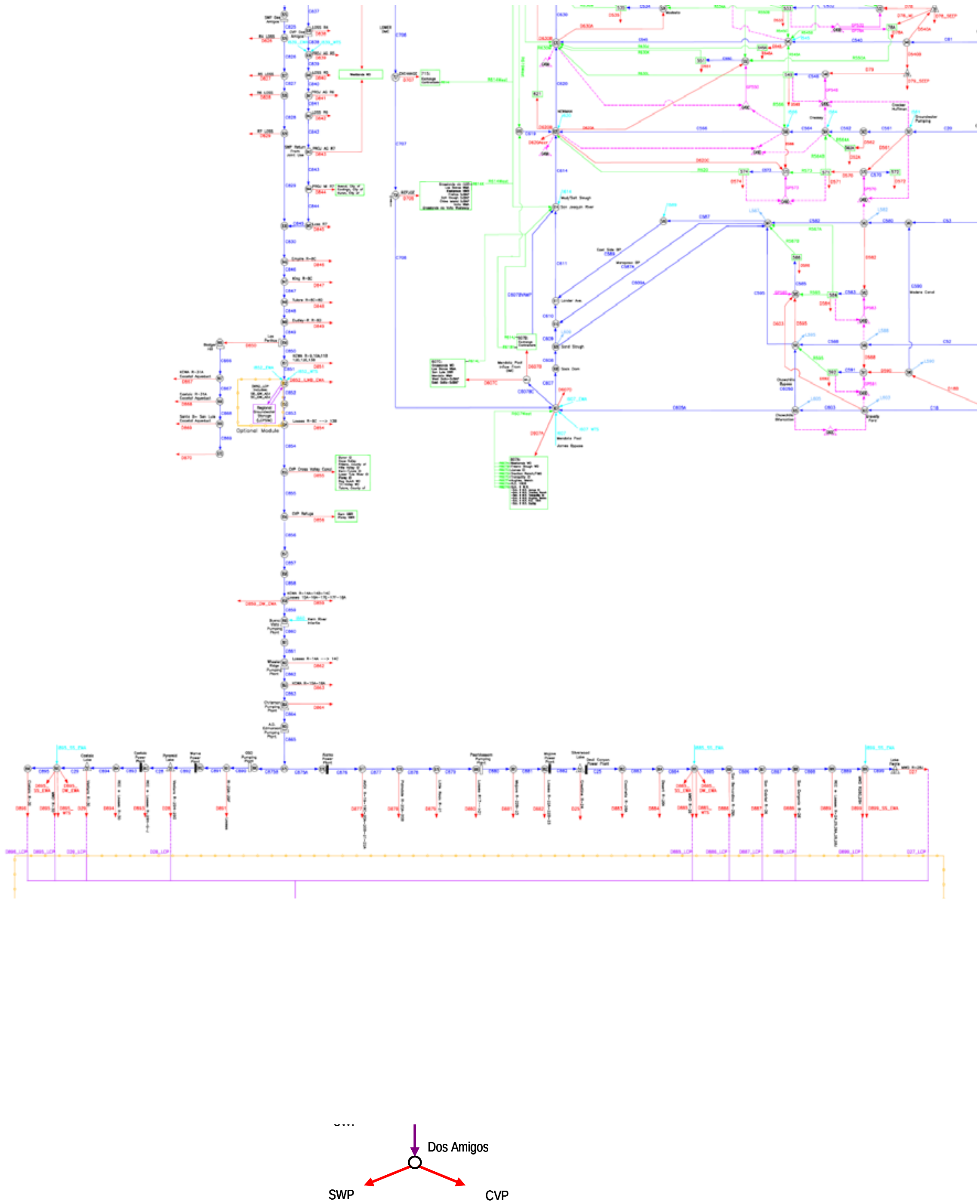


Figure B-10. CalLite representation beyond Dos Amigos

Appendix C San Joaquin River Module Development

The purpose of this document is to provide information about the stand-alone CalLite model of the San Joaquin Basin (SJR).

Introduction

At this point of development, the screening model developed for the San Joaquin River system is a draft implementation and is undergoing review and refinement by Reclamation. Yet, it provides a strong foundation for enabling a more comprehensive model in the future.

The CalLite SJR module, as with the main CalLite screening model, is designed to provide quick answers for "what if?" scenarios and to provide user friendly, fast computations within an acceptable model error bound. Likewise, the hydrology development of the CalLite SJR model follows the same general approach as the main CalLite screening model.

In this appendix, the general approach followed for the representation of the physical SJR system into a screening model is described first. Second, the Millerton Lake operation simulated in the model is described in more detail. Finally, a comparison with CALSIM II is provided.

General Approach and Hydrology Assumptions

The CalLite SJR model schematic is based on the CALSIM II San Joaquin Model. As with the main CalLite model, the hydrology and operations have been simplified to the most critical factors. The CALSIM II schematic was used as the starting point for the CalLite SJR hydrology development; its nodes other than reservoirs were determined by those locations that tend to control reservoir operations, or exist as either confluence points or diversion points on the CALSIM II schematic.

In Figure C-1 the aggregated CALSIM II nodes are delineated according to the CalLite hydrology and schematic definition. CALSIM II hydrology nodes between those identified points are then aggregated to match CalLite nodes. Therefore, the CalLite hydrology, as in the main screening model, is fully-dependent on companion CALSIM II hydrology. The aggregation process results in the calculation of a net accretion / depletion that includes all inflows, deliveries, and system losses except demands and flows that could be dynamically modeled. This accretion/depletion is identified as a "local inflow" in CalLite at every node where aggregation took place. If the net flows end up as depletion, the "local inflow" may have negative values. Table C-1 summarizes local inflow calculations and Figure C-2 illustrates CalLite simplified representation of the San Joaquin River water based on these hydrological assumptions.

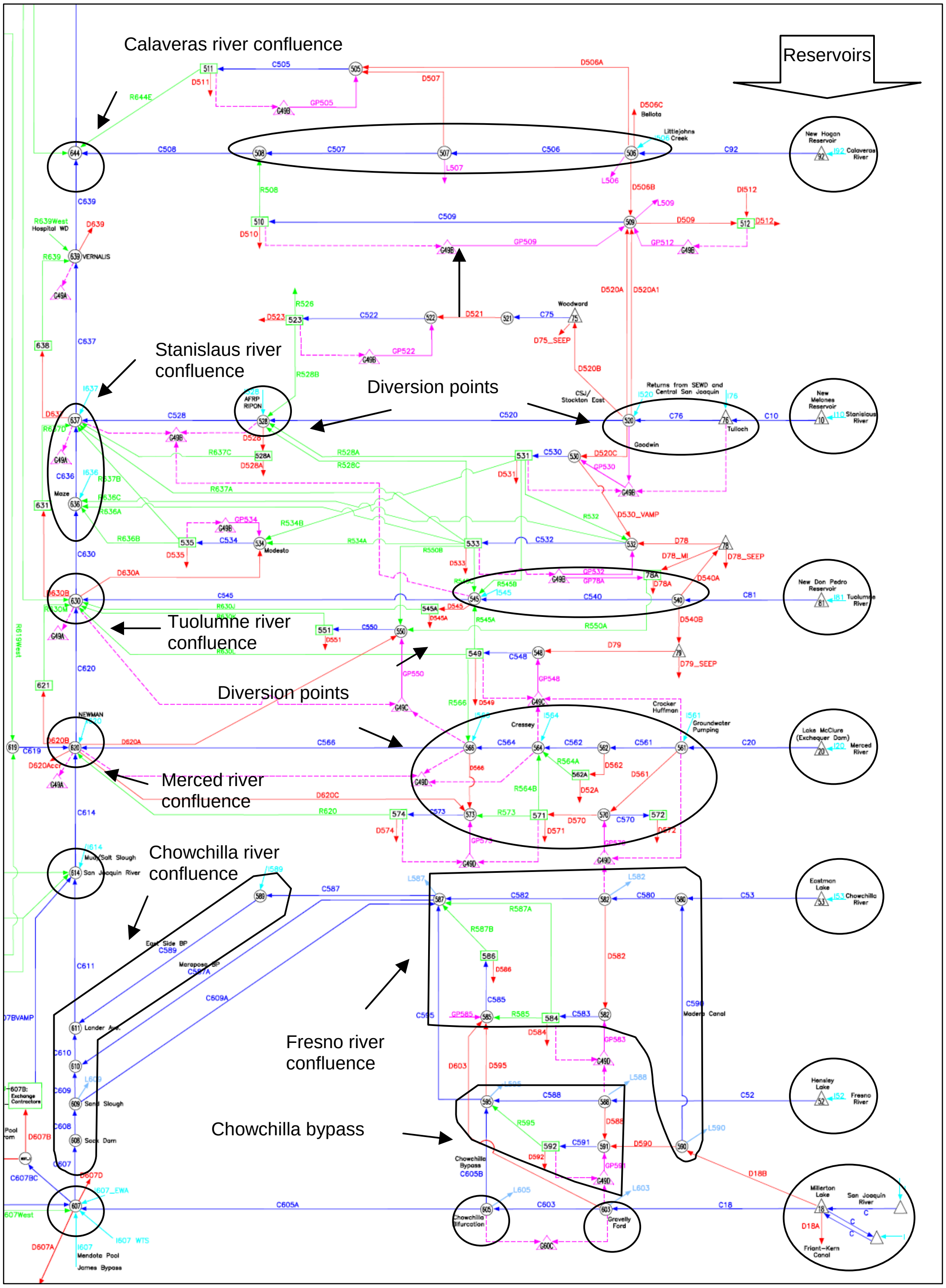


Figure C-1 Node selection and hydrology aggregation for the CalLite model from the CALSIM II schematic

San Joaquin tributaries Rivers included in the model are: Fresno, Chowchilla, Merced, Tuolumne, Stanislaus, and Calaveras Rivers. Major reservoirs in the system such as Millerton Lake, Hensley Lake, Eastman Lake, Lake McClure, New Don Pedro, New

Melones, and New Hogan Dams are included in the model. Currently, Millerton Lake operations are modeled dynamically including its diversions. In all other reservoirs, downstream diversions are fixed to that simulated in CALSIM II, but minimum flows and other reservoir operations are simulated dynamically. The Pulse, VAMP, and Dissolved Oxygen flow needs are included in the water quality flow release and minimum stream flow requirements. Time series related to water quality flow release requirement (i.e. VAMP, DO) and minimum stream flows target are used to estimate the outflow release goals. The water quality requirements are applied as an outflow request in the New Melones, New Don Pedro and McClure reservoirs and as an outflow request downstream Calaveras River node. On the other hand, the minimum stream inflows were applied along the Stanislaus, Tuolumne, Merced and Fresno Rivers.

Table C-1 Hydrology aggregation assumptions and computations

Feature	Inflows	Accretions	Diversions
Reservoirs			
Millerton[1]	I18		D18A+D18B
Hensley	I52		
Eastman	I53		
McClure	I20		
New Don Pedro	I81		D540A+D540B
New Melones	I10		
New Hogan	I92		
Nodes (labeled)			
GravellyFord (Node 603)		C603-C18+D603	D603
ChowchillaByfurcation (Node 605)		C605A+C605B-C603	
ChowchillaBypass (Node 595)		C595-C52-C605B+D595+D588	D595+ D588
MendotaPool (Node 607)[2]	C708	C607-C605A-C708+D607A+D607B+D607C+D607D	D607A+D607B + D607C+D607D
LanderAve (Node 611)		C611-C607-C587-C587A	
ChowchillaRiver (Node587)		C587+C587A-C609A-C53-C595+D582	D582
MudSaltSl (Node 614)		C614-C611	
SJRMerced (Node 620)		C620-C614-C566+D620A+D620B+D620 c	D620A+D620B + D620 c
MercedRiver (Node 566)		C566-C20+D561+D562+D566	D561+D562+D566
SJRTuolumne (Node 630)		C630-C620-C545+D630A+D630B	D630A+D630B
ToulumneRiver (Node 545)		C545-C81+D545+D540A+D540B	D545
SJRStanislaus (Node 637)		C637-C630-C528+D637	D637
RIPON (Node 528)		C528-C520+D528	D528
GoodwinTulloch (Node 520)		C520-C10+D520A+D520A1+D520B+D520 c	D520A+D520A1+D520B+D520 c
Vernalis (Node 639)		C639-C637+D639	D639
SJRCalaveras (Node 644)		C644-C639-C508	
CalaverasRiver (Node 507)		C508-	D506A+D506B

		C92+D506A+D506B+D506C+D507	+ D506C+D507

NOTES: All inflows, accretions and diversions (except from Millerton) are assumed the same as CALSIM II (1). Diversions are modeled dynamically. (2). The C708 CALSIM II time series was considered as an inflow in this node

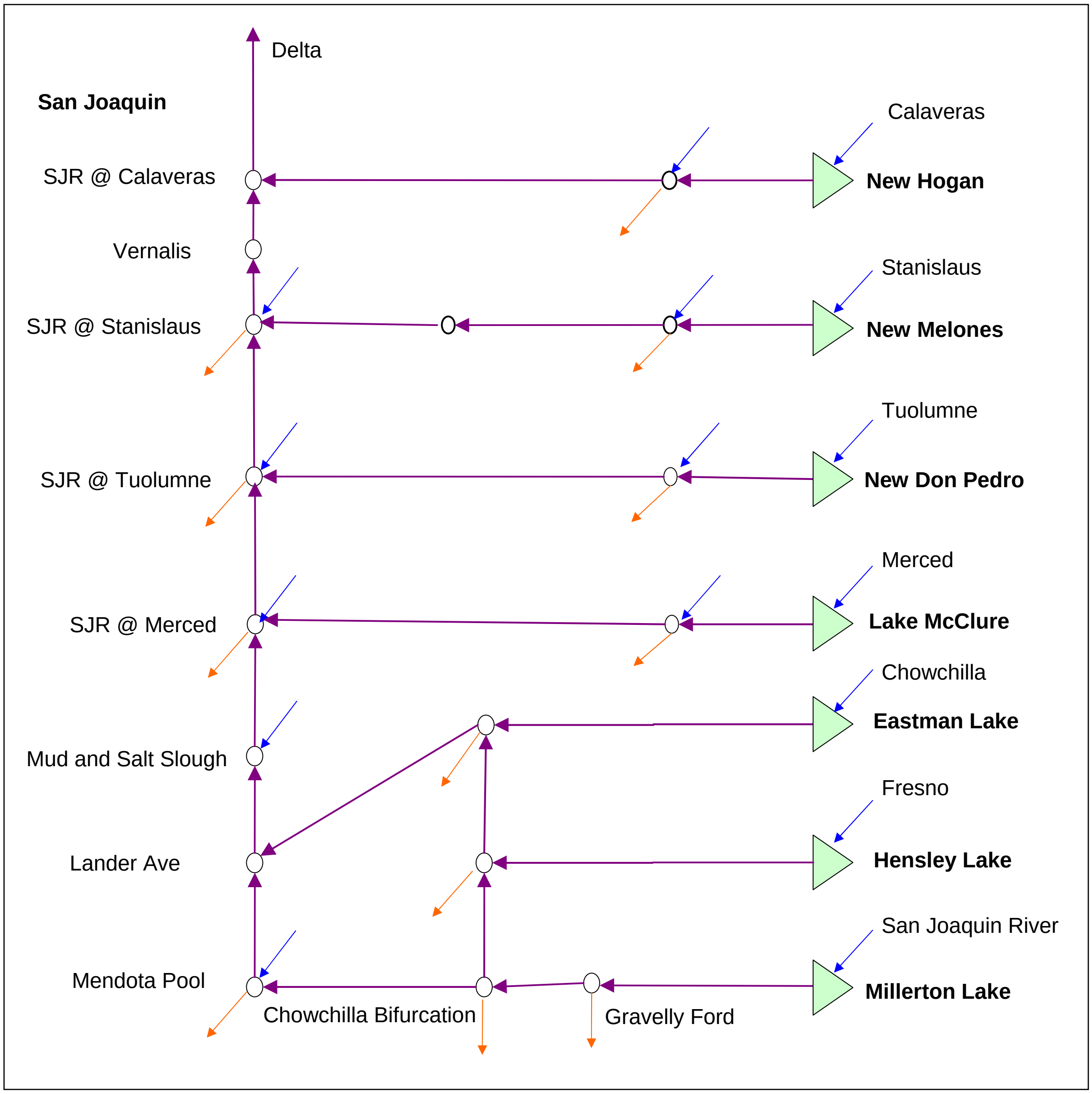


Figure C-2. CalLite schematic of the San Joaquin river basin

Facility and Regulatory Operations

Millerton Lake

Millerton Lake (Friant Dam) is operated for flood control, conservation storage, diversions to the Madera and Friant-Kern Canals, and recreational uses. Millerton Lake water is delivered to approximately one million acres of agricultural lands within Fresno, Kern, Madera, and Tulare Counties. Regulatory operations of Millerton Lake in CalLite follow CALSIM II logic.

Flood Control Operations

As in CALSIM II, at any given time Millerton Lake storage is identified to be within one of three zones: within the conservation space, within the rain-flood space, or within the conditional space. No releases are required in the conservation space, where water stored in rain-flood space needs to be removed as quickly as possible. In the conditional space, releases are required if irrigation demand is exceeded and the release amount is determined based on forecasted runoff, available upstream space and forecasted irrigation demand.

The required rain-flood space required by each month is presented in Table C-2. In those months where more than 85,000 AF is needed, available space in Mammoth Pool Reservoir (up to 85 TAF), which is just upstream, can be credited towards the flood space volume. Mammoth Pool storage is provided as a timeseries (as in CALSIM II), and the remaining logic is built dynamically in CalLite.

Table C-2. Millerton Lake Rain-flood Space (1,000 AF)*

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
85	170	170	170	42	0	0	0	0	0	0	0

* Space in excess of 85,000 AF can be replaced by an equal amount in Mammoth Pool

From February through June, the reservoir is in the conditional space state. The release is calculated using a logic that depends on forecasted inflows, demands and losses and it is updated every month during this time period. At each month, reservoir inflow (perfect foresight), average evaporation losses, minimum instream flow requirements, combined Madera and Friant-Kern Canal losses, and estimated deliveries (at maximum) throughout June are used and amount of water that needs to be spilled through June is calculated. Once a total volume is obtained, the spill amount for each month is calculated using Friant flood control release pattern.

The flood control release made for a given month is the greater of the computed rainflood release or the conditional space release.

Minimum Instream Flows

In CALSIM II, a minimum downstream release of 116,700 AF is estimated based on the historical records; and is spread throughout the year (Table C-3). These amounts of water account for water necessary to maintain diversions by riparian and contractor users below Friant Dam to a location near Gravelly Ford. The same approach is followed in CalLite and Table C-3 values are used.

Table C-3. Millerton Lake estimated minimum instream flows (1,000 AF)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
10.1	7.4	6.7	4.5	5.0	6.6	9.0	10.9	12.9	14.4	15.7	13.4

Canal Losses

CALSIM II canal losses that were developed through a comparison of historical water deliveries and canal diversions are used in CalLite. Canal losses are calculated monthly and added to the diversion requirement from Friant Dam. These canal losses are shown in Table C-4 and Table C-5.

Table C-4. Friant-Kern Canal Losses (1,000 AF)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
5	4	1	1	2	3	4	5	6	7	7	6

Table C-5. Madera Canal Losses (1,000 AF)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
0	0	0	0	0	0	0	2	3	4	3	0

Return Flows

There are no directly associated return flows with the Friant-Kern and Madera Canal deliveries.

Demand Allocations

The annual allocation is estimated by summing the total water available from storage and inflow and subtracting requirements and losses. The remainder is the water available for delivery. There are two types of deliveries from Millerton Lake: Class 1 and Class 2 contractors. Class1 contractors have priority in receiving their contract amounts. If the annual volume is less than the full Class 1 contract amount, Class 1 is set to the annual volume of available water and Class 2 is not allocated any water. If the annual volume is greater than the Class 1 contract amount, Class 1 is set to full contract amount and the remainder (after the flood release) is allocated to Class 2, up to the full Class 2 contract amount.

Class 1 allocation is capped at 800 TAF, where Class 2 maximum delivery is 1400 TAF. The allocation procedure starts with Class 1 contractors considering water supply from March through September (contract calendar starts in March). The process is updated every month through June according to the Class 1 amount delivered and the remaining supply. Class 2 allocation is done after subtracting forecasted spills through June from the remaining water supply. This logic is consistent with CALSIM II model, which is based on historical data.

Delivery

Annual water deliveries for the Friant Division are determined in March of each year and updated monthly through June. Similar to CALSIM II approach, a forecasted volume of water supply is distributed into monthly deliveries to the Friant-Kern and Madera Canals using a relationship between monthly deliveries and forecasted water supply availability. First, allocated Class 1 and Class 2 deliveries are shared between Friant-Kern and Madera Canal contractors. Friant-Kern Canal contractors represent 82% of the Class 1 and 75% of the Class 2 waters. Similarly, Madera Canal contractors represent 18% of Class 1 and 25% of Class 2 waters. Then, the pattern of total water deliveries and the pattern of Class 1 deliveries are established. Finally, Class 2 delivery pattern is obtained by taking the difference in total monthly and the Class 1 delivery at that month at the two conveyance facilities. Delivery patterns that are used in this model are obtained from CALSIM II, which is based on historical data. The total and Class 1 delivery patterns are shown in Figure C-3 and Figure C-4.

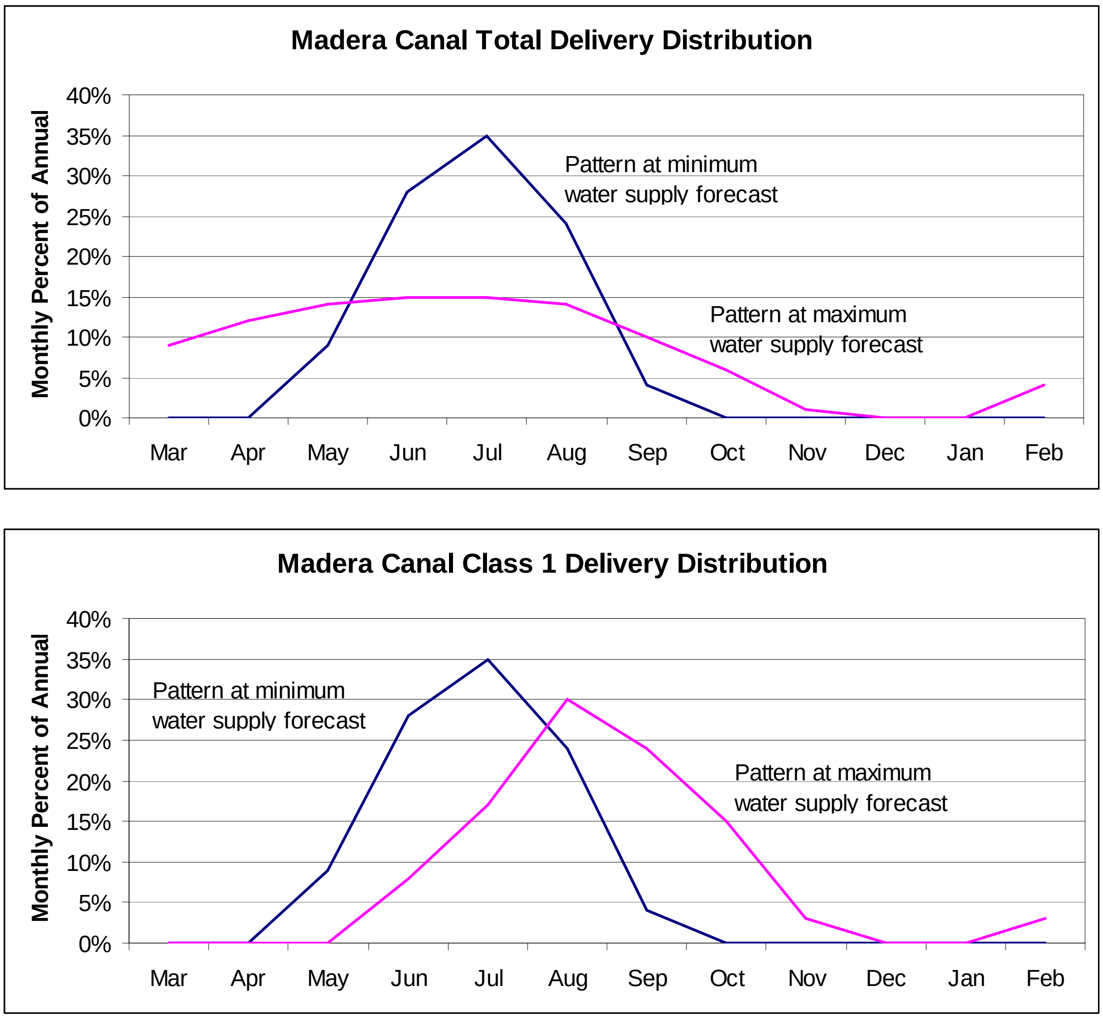
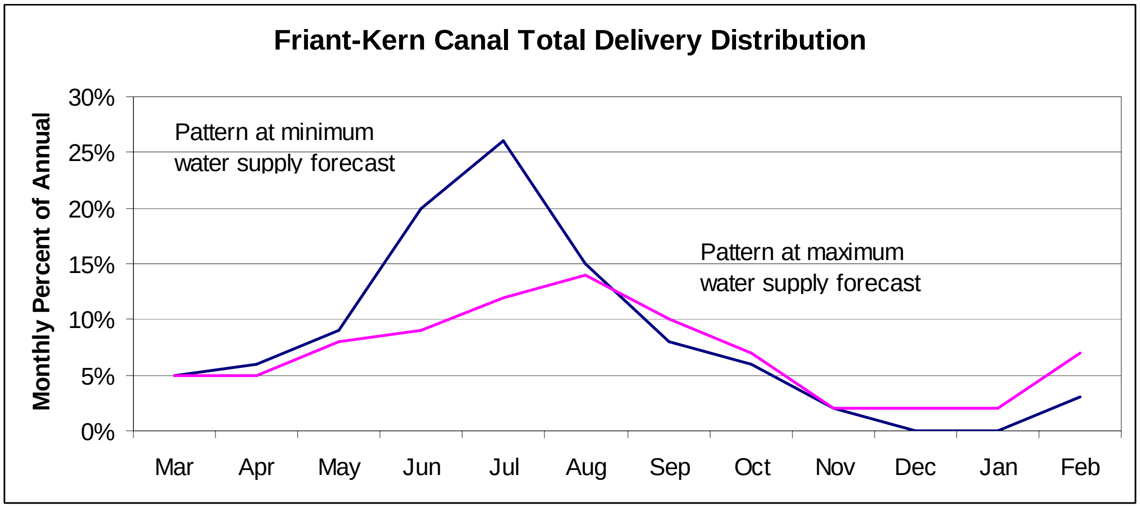


Figure C-3. Madera Canal contractor annual delivery distribution as a total (top) and Class 1 contracts (bottom)



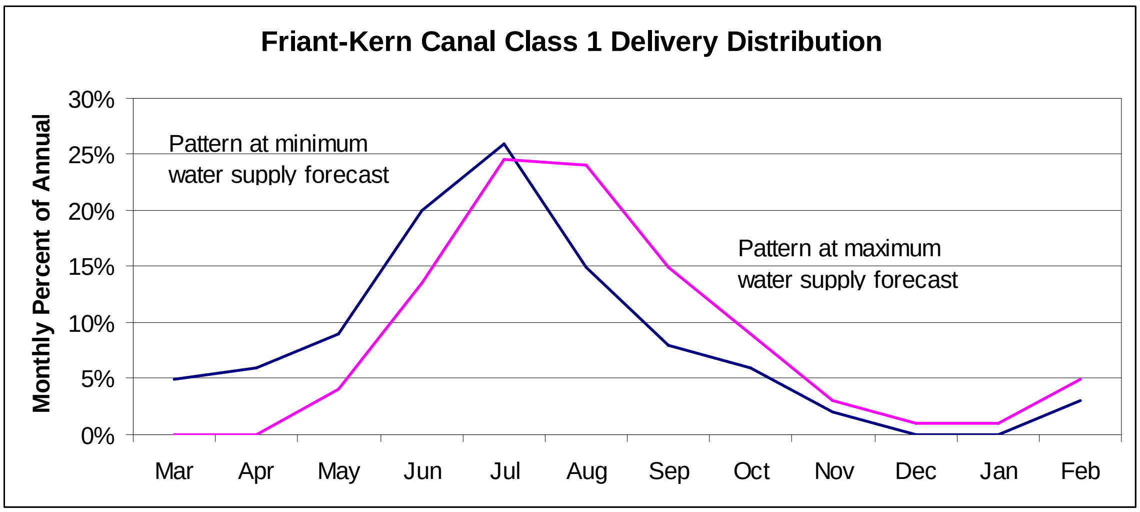


Figure C-4. Friant-Kern Canal contractor annual delivery distribution as a total (top) and Class 1 contracts (bottom)

Delivery Adjustments

There are two adjustments made to deliveries after initial allocations are made with the delivery logic. One is based on wetness in the Tulare Lake Basin and the other is based on flood control releases from Friant.

If flood flows are available in the Tulare Lake Basin tributaries, Friant-Kern delivery amount from Friant Dam is reduced. Tule River wetness index is used as an indicator. If the wetness index is greater than 41 TAF, the delivery is reduced by the excess amount (only 41 TAF is delivered from Friant).

If flood flows are available in Millerton Lake, then both Friant-Kern and Madera Canal deliveries are increased. Additional deliveries are capped at the capacity limits for both canals. As in CALSIM II, the model assumes an increased demand for water when Friant is spilling. For Friant-Kern Canal, only one of the adjustments is active at a time.

In addition to the adjustments explained above, during flood or snowmelt spills, approximately 7% of the spill goes to the Madera Canal (and then to the Fresno and Chowchilla Rivers).

Comparison to CALSIM II Model Simulations

Table C-6. San Joaquin basin system-wide flow summary between CalLite and CALSIM II simulations (taf/yr)

	1922-2003			1929-1934		
Reservoirs outflow (TAF)	**CalLite**	**CALSIM II**	**Diff**	**CalLite**	**CALSIM II**	**Diff**
Millerton	378	372	-6	118	118	-1
Hensley	79	79	0	40	40	0
Eastman	65	65	0	28	28	0
McClure	945	944	-1	610	601	-10
NewDonPedro	655	656	1	152	150	-2
NewMelones	1023	1024	2	760	780	20
NewHogan	141	141	0	53	53	0
San Joaquin River flows (TAF)						
GravellyFord	262	256	-6	2	1	-1
ChowchillaBifurcation	236	230	-6	1	0	-1
MendotaPool	139	137	-2	1	0	-1
LanderAve	491	484	-7	91	91	-1
MudSaltSl	754	747	-7	327	326	-1
Merced confluence	1164	1155	-9	428	400	-27
Tuolumne confluence	2066	2057	-9	813	784	-29
Stanislaus confluence	3061	3054	-7	1400	1391	-9
Vernalis	3034	3027	-7	1371	1362	-9
Calaveras confluence	3148	3141	-7	1389	1381	-9
Tributary river flows (TAF)						
Fresno River (downstream Chowchilla Bypass)	162	156	-6	10	10	0
Chowchilla river	296	291	-5	4	4	0
Merced River	506	504	-2	214	188	-26
Tuolumne River	870	871	1	375	373	-2
Stanislaus River (downstream RIPON)	561	563	2	275	295	20
Calaveras River	114	114	0	19	19	0

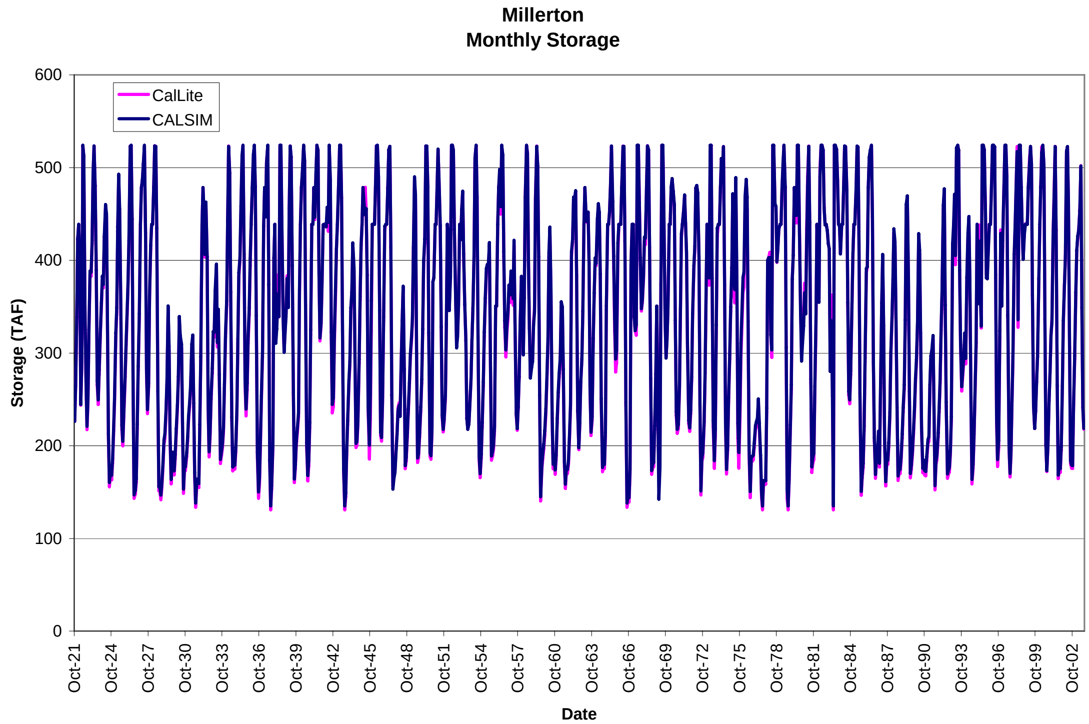


Figure C-5. Millerton Lake storage for CalLite and CALSIM II existing level simulations

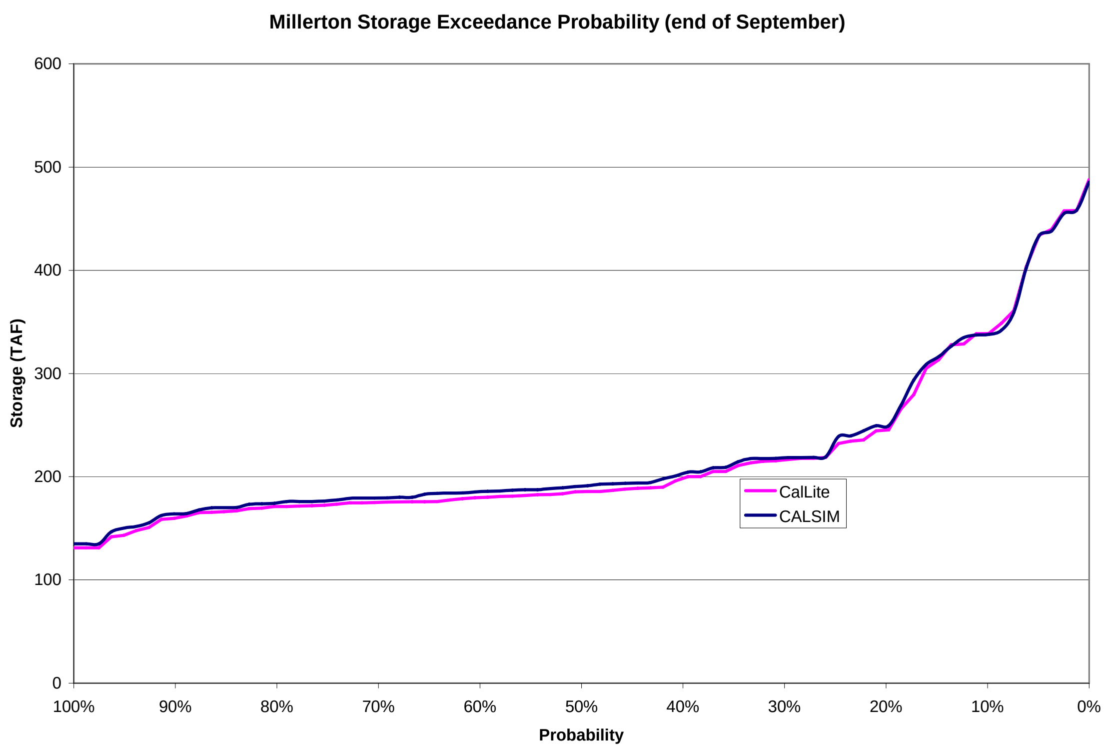


Figure C-6. Millerton Lake end of September storage exceedance probability for CalLite and CALSIM II existing level simulations

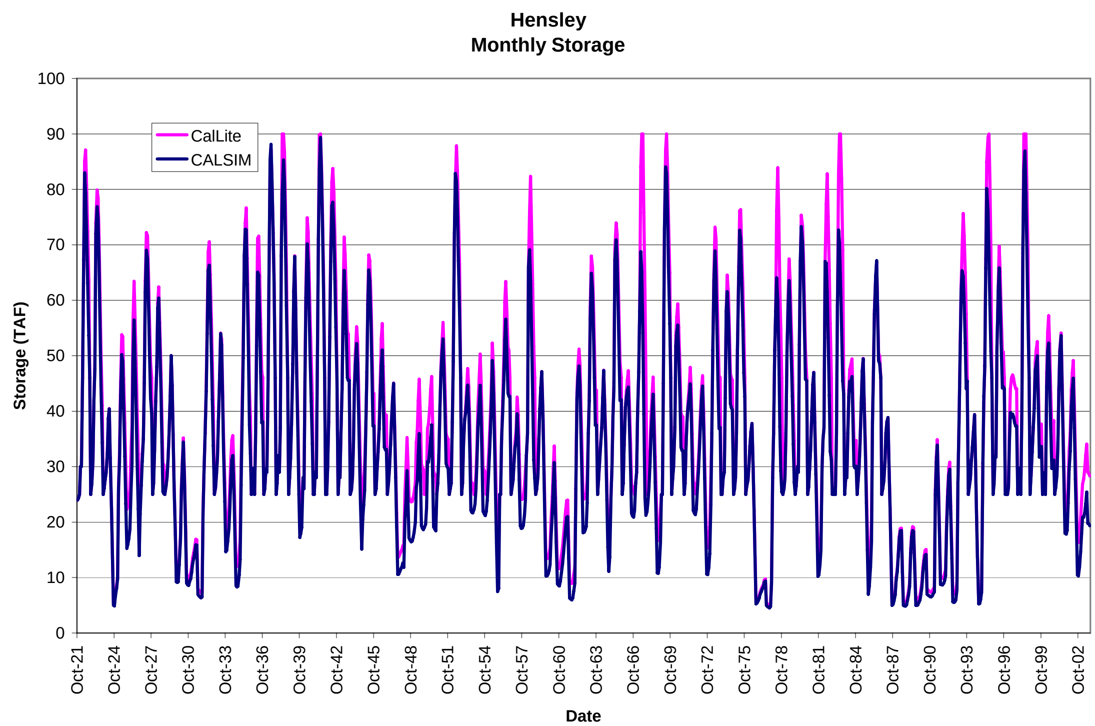


Figure C-7. Hensley Lake storage for CalLite and CALSIM II existing level simulations

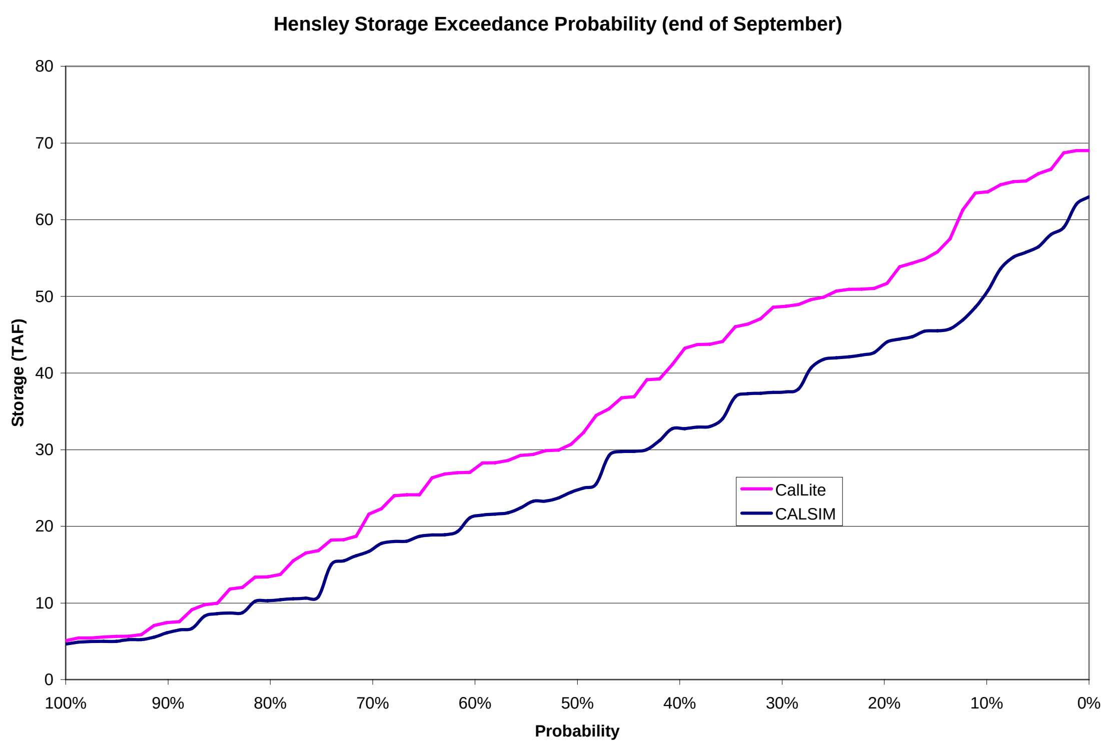


Figure C-8. Hensley Lake end of September storage exceedance probability for CalLite and CALSIM II existing level simulations

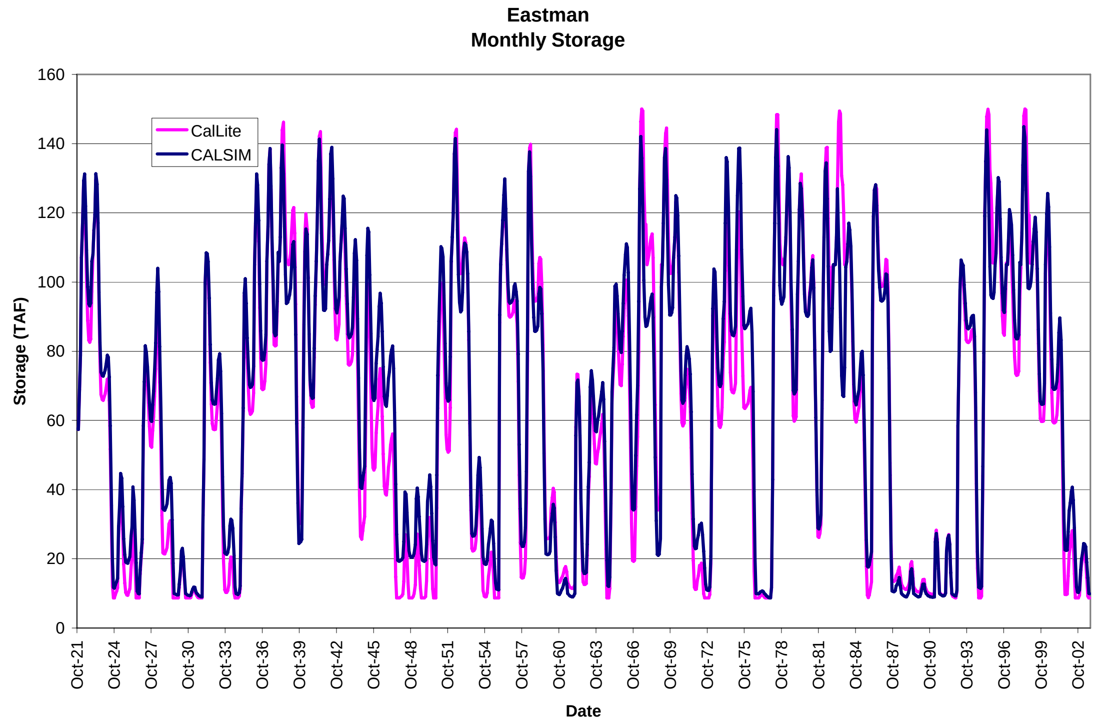


Figure C-9. Eastman Lake storage for CalLite and CALSIM II existing level simulations

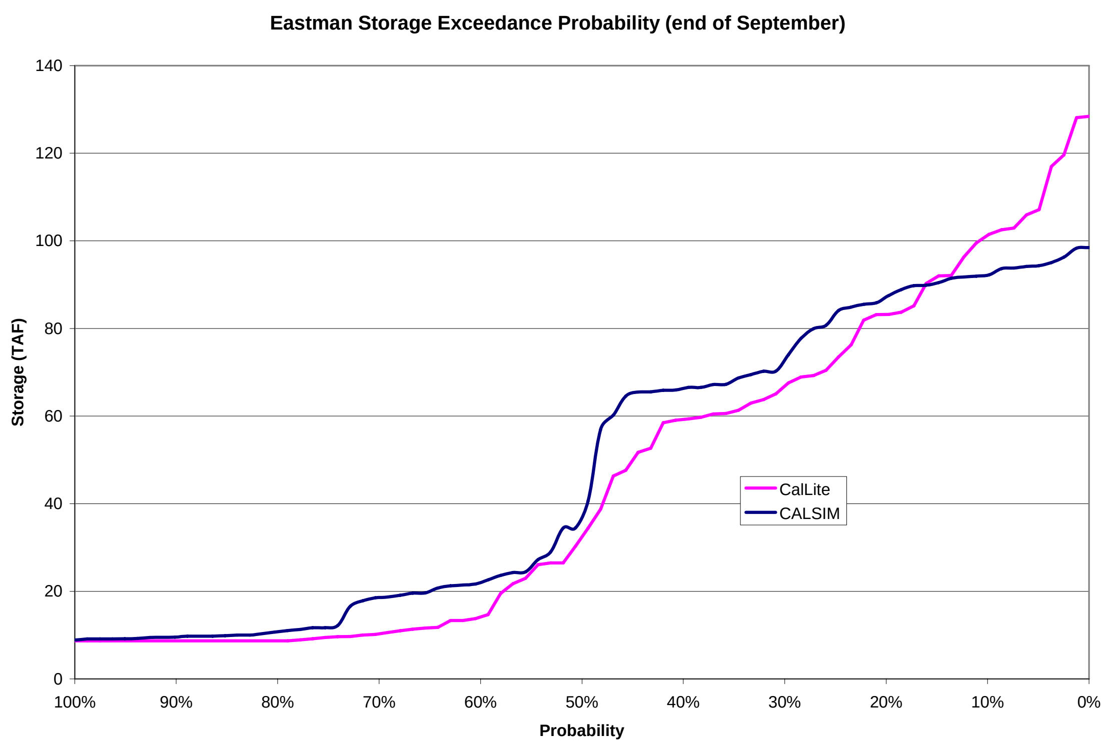


Figure C-10. Eastman Lake end of September storage exceedance probability for CalLite and CALSIM II existing level simulations

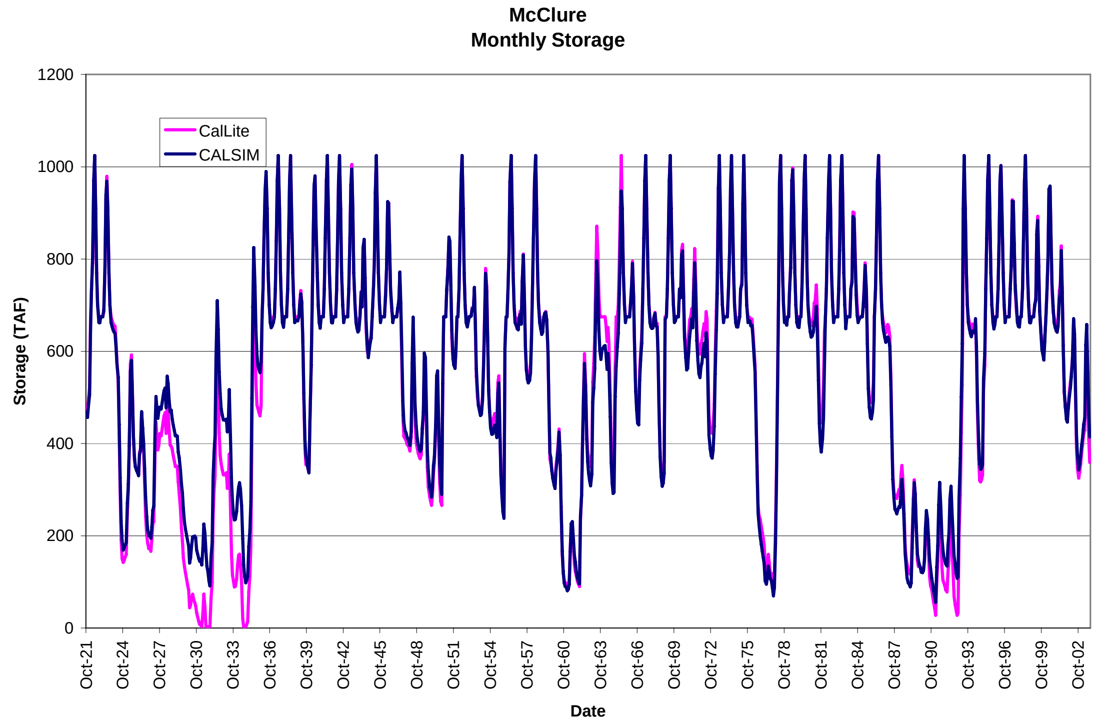


Figure C-11. Lake McClure storage for CalLite and CALSIM II existing level simulations

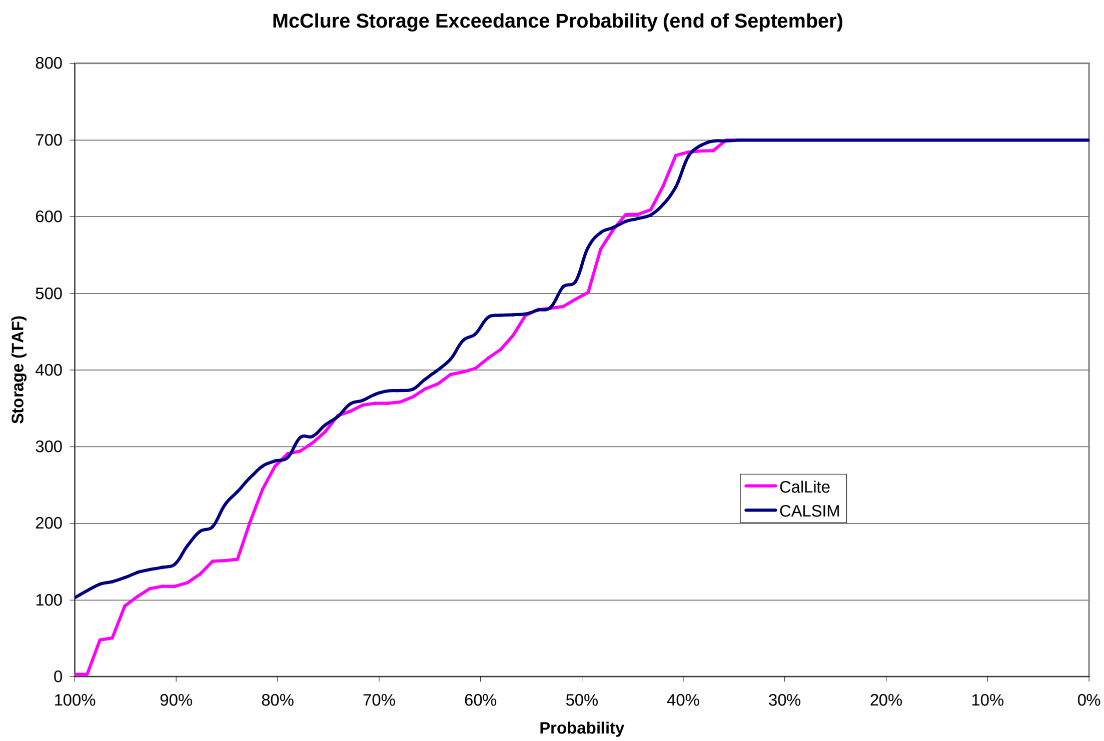


Figure C-12. Lake McClure end of September storage exceedance probability for CalLite and CALSIM II existing level simulations

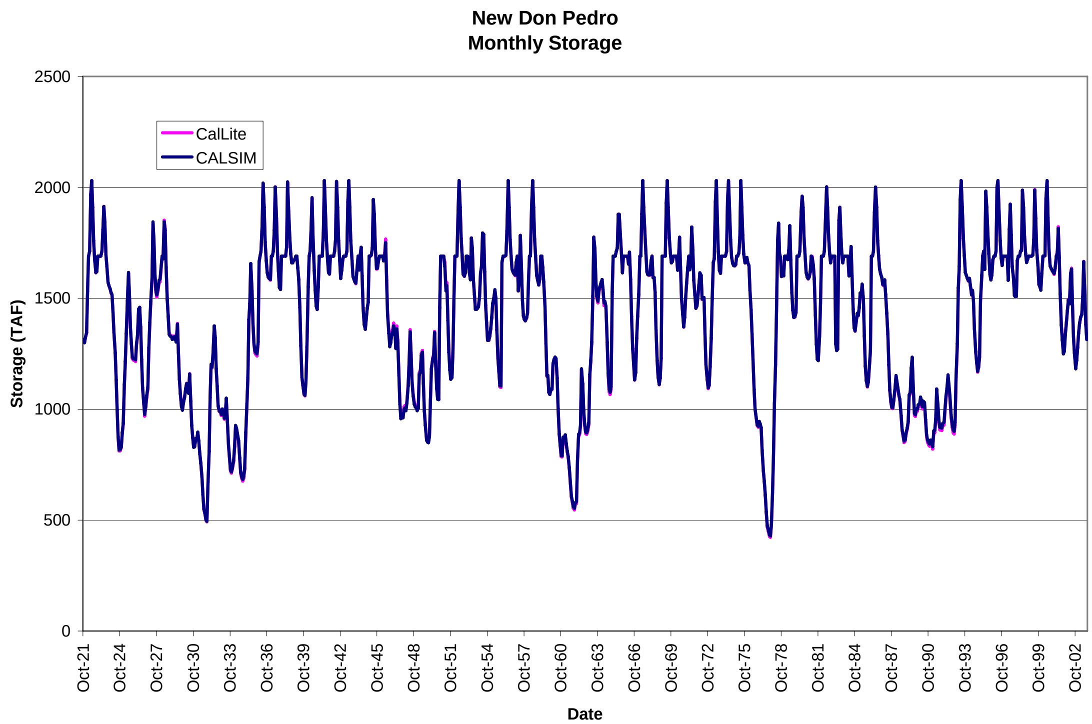


Figure C-13. New Don Pedro Reservoir storage for CalLite and CALSIM II existing level simulations

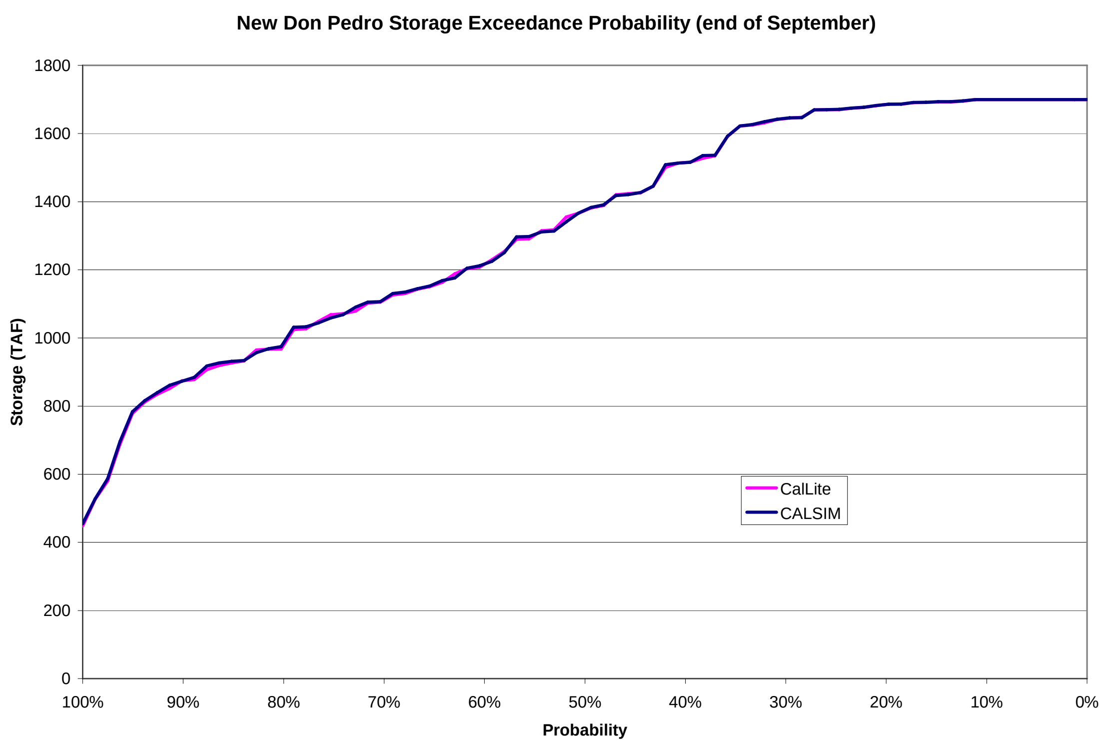


Figure C-14. New Don Pedro Reservoir end of September storage exceedance probability for CalLite and CALSIM II existing level simulations

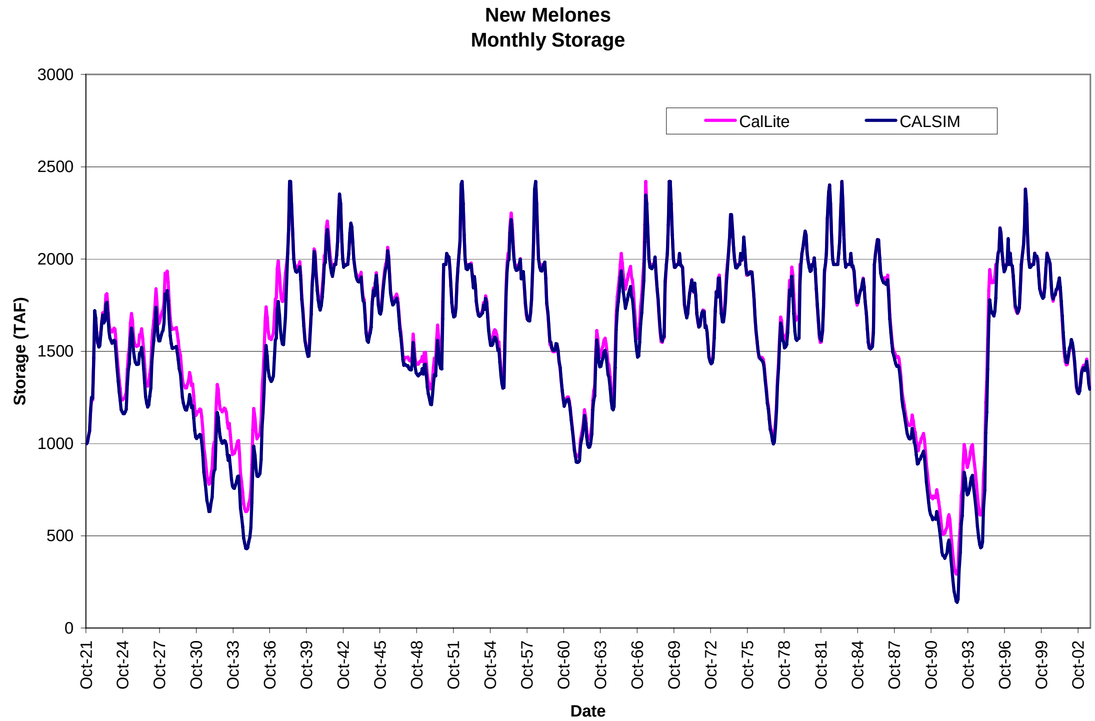


Figure C-15. New Melones Reservoir storage for CalLite and CALSIM II existing level simulations

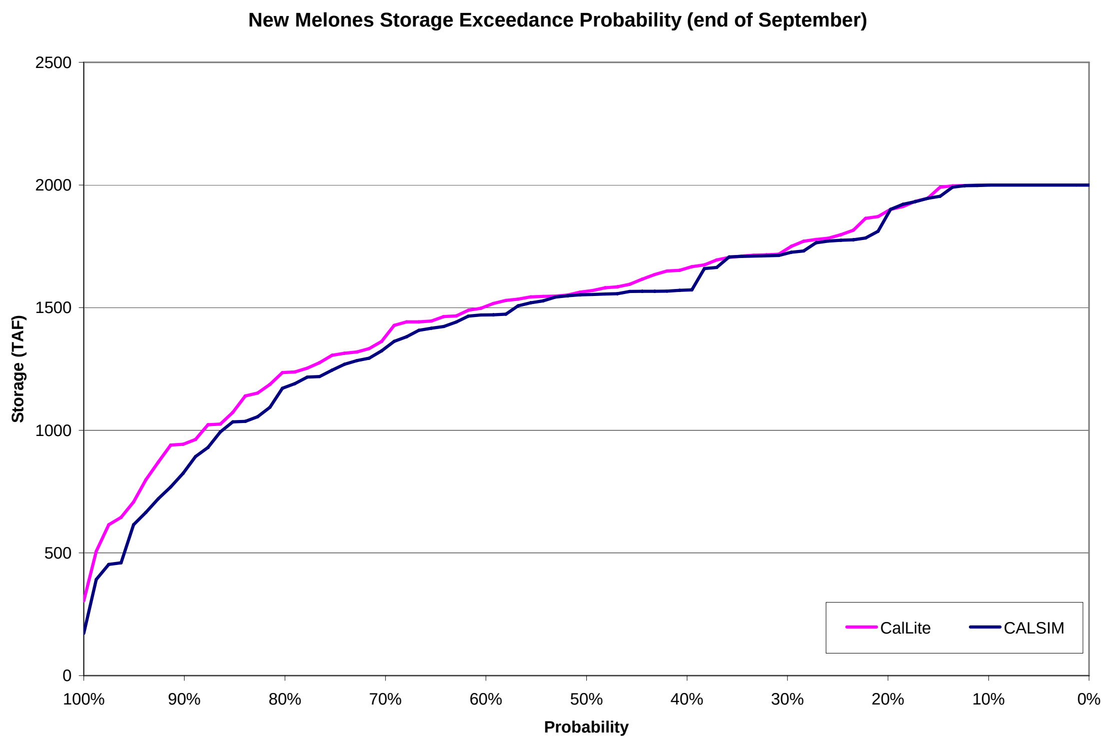


Figure C-16. New Melones Reservoir end of September storage exceedance probability for CalLite and CALSIM II existing level simulations

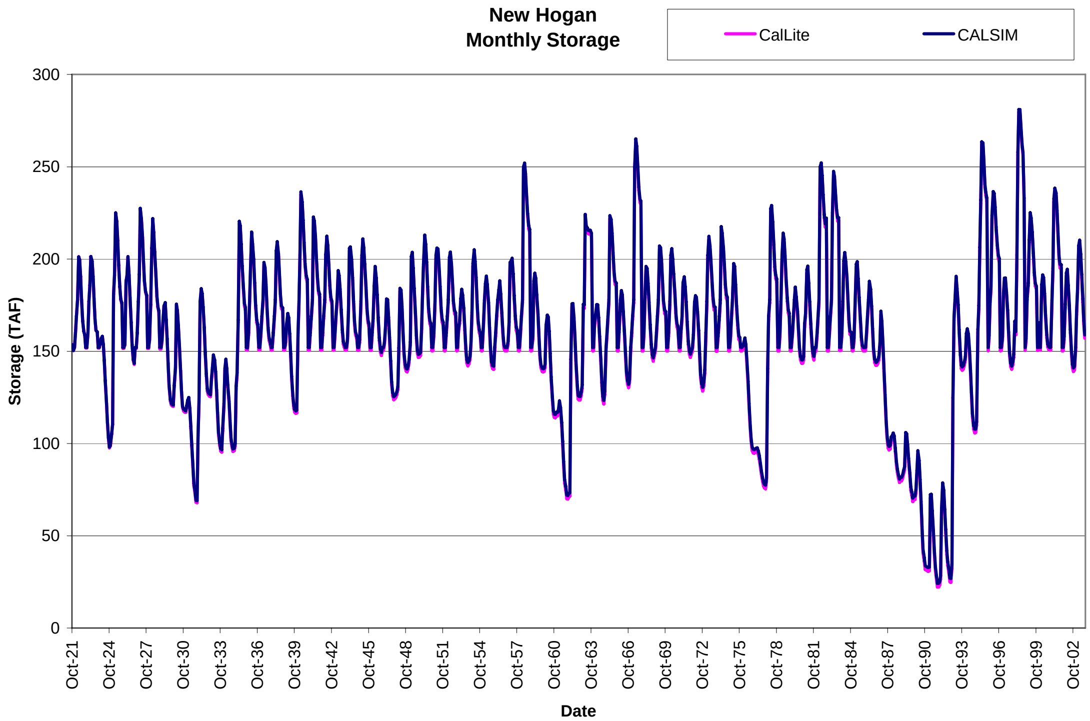


Figure C-17. New Hogan Reservoir storage for CalLite and CALSIM II existing level simulations

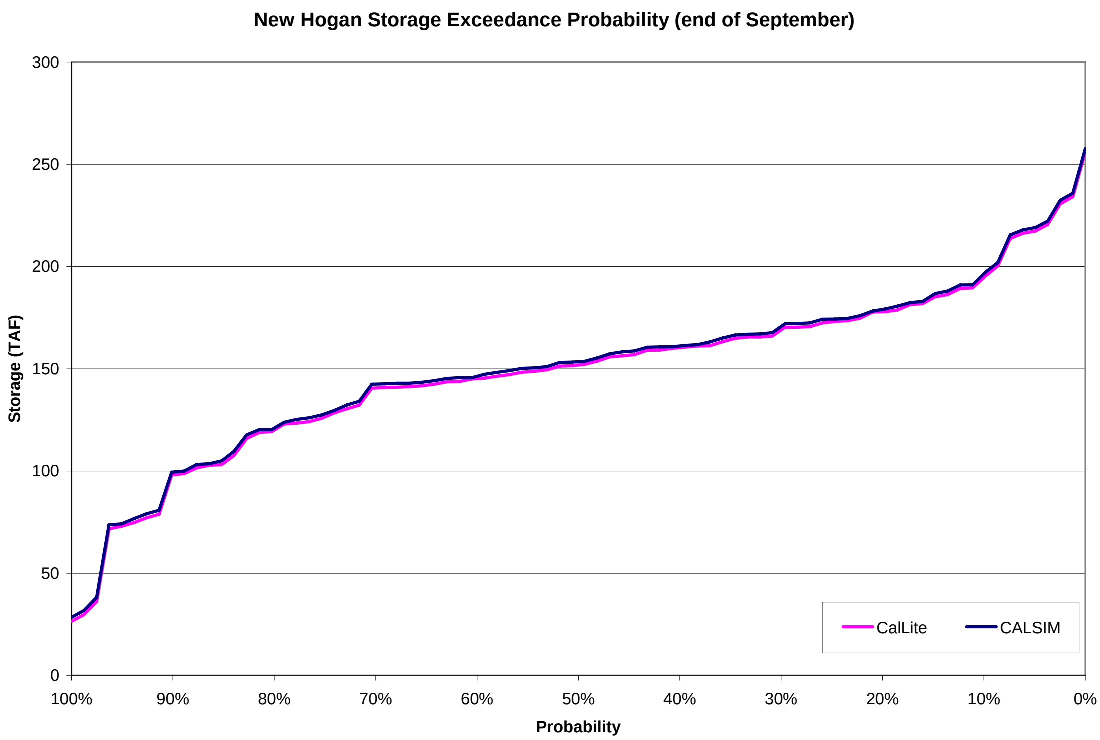


Figure C-18. New Hogan Reservoir end of September storage exceedance probability for CalLite and CALSIM II existing level simulations

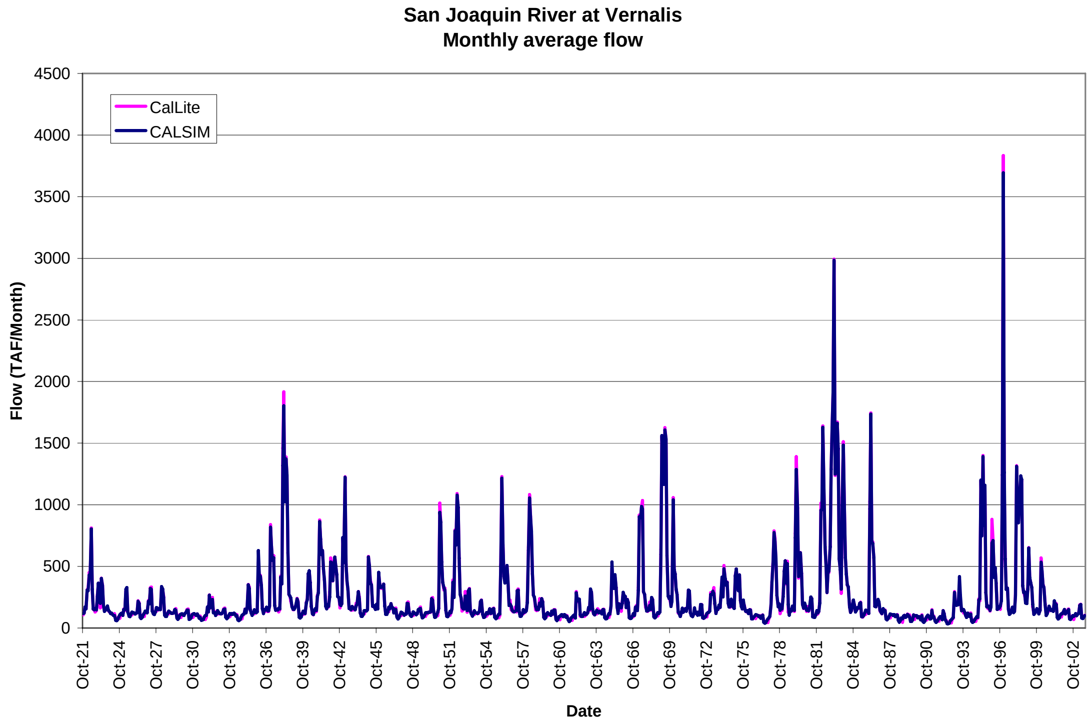


Figure C-19. San Joaquin River at Vernalis flow for CalLite and CALSIM II existing level simulations

Appendix D Yuba River Module Development

This appendix describes the Yuba River Basin representation that is implemented in the CalLite screening model. The representation is primarily based on DWR's CALSIM II model of the Yuba River system. However, some operating criteria were taken from the HEC-5 model of the Yuba River Basin developed by the Yuba County Water Agency (YCWA).

DWR is currently in the process of updating the CALSIM II model to conform to operating criteria and flow requirements agreed to as part of the Proposed Lower Yuba River Accord. When the revised CALSIM II model is released, this representation should be updated.

Model Overview

The CalLite representation includes the lower portion of the Yuba River Basin, from New Bullards Bar Reservoir to the confluence of the Yuba and Feather Rivers, including New Bullards Bar Reservoir, Englebright Reservoir, and Daguerre Point. New Bullards Bar Reservoir is operated for flood control; power; to satisfy demands at Daguerre Point Dam; and to meet instream flow requirements below New Bullards Bar, Englebright, and Daguerre Point dams. Englebright Reservoir operations are not simulated because the reservoir's active storage is small in comparison to average annual inflows. The only consumptive demand included in the model is the diversion at Daguerre Point Dam.

A schematic of the representation is shown in Figure D-1.

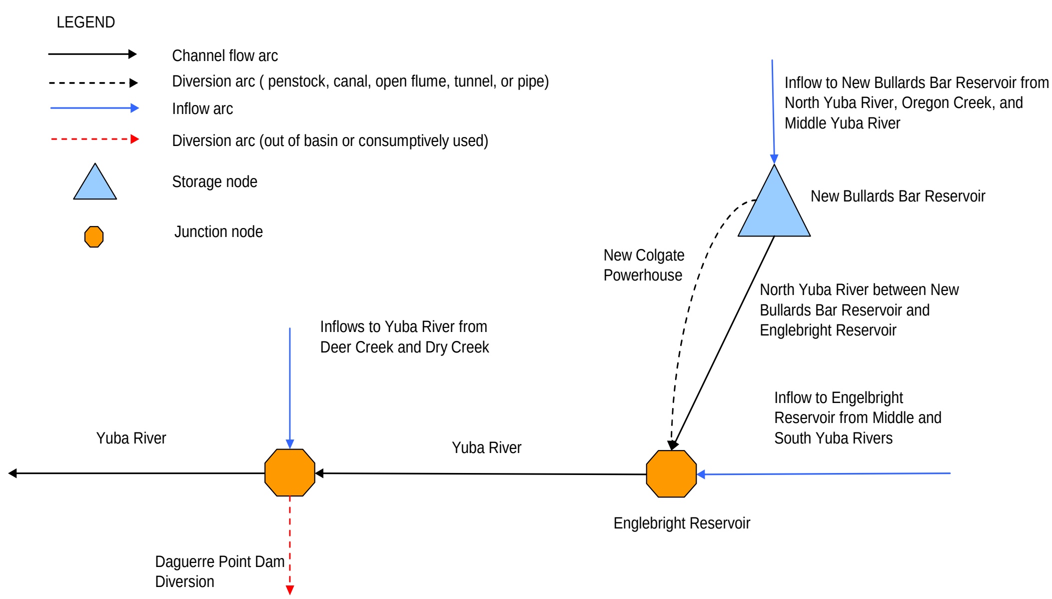


Figure D-1. Schematic representation of the Yuba River implementation in CalLite

Model Assumptions

Hydrology, demand assumptions, major regulatory constraints, and operating criteria are outlined in the following sections.

Hydrology

Inflows have been developed from the CALSIM II Yuba model. In some cases, inflows are taken directly from CALSIM II input timeseries data. In other cases, inflows are based on CALSIM II output. The CALSIM II Yuba model simulates the Yuba River system in greater detail than the representation proposed here, so many inflows are based on outflows generated by the representation of the upper Yuba system in the CALSIM II model.

Table D-1 lists CALSIM II arcs that are used to develop each of the inflows in the representation.

Table D-1. Inflow locations for CalLite Yuba River model and computation based on CALSIM II flows (based on DWR CALSIM II Yuba model)

Inflow	CALSIM II Flows
Inflow to New Bullards Bar Reservoir	I31 + C251 + D252
Inflow to Englebright Reservoir	C243 + R37A
Inflow to Yuba River from Deer Creek and Dry Creek	C233 + I231

The flows used to develop the above inflows are taken from the present (2005) level of development CALSIM II Yuba study. A future (2020) level of development study also exists. Although inflows are the same in both studies, outflows are different because of different demand assumptions.

Demand Assumptions

The only consumptive diversion in the model is the diversion at Daguerre Point Dam. The model uses the appropriate level of demand depending on the user-specified demand option. The existing level of development CALSIM II Yuba study uses demands that are increased in March and April of drier years. The CALSIM II Yuba documentation does not define a threshold for the transition to higher or lower demands. The increased March-April demands are also used in the HEC-5 model. The HEC-5 model documentation states that the choice of demands is based on unimpaired flow of the Yuba River and that higher demands are used in Below Normal, Dry, and Critical years. Because instream flow requirements used in this model are based on a new North Yuba Index developed as part of the Lower Yuba Accord, the choice of whether to use increased demands at Daguerre Point will also depend on the North Yuba Index. The increased March-April demands are used when the North Yuba Index is equal to 3, 4, 5, or 6, while the lower demands are used when the index is equal to 1 or 2. Although North Yuba Index values 3, 4, 5, and 6 do not correspond exactly to Below Normal, Dry, and Critical years as defined for Yuba River unimpaired inflows, the approximation is reasonably close for this application. Table 2 lists monthly demands at Daguerre Point Dam and corresponding North Yuba Index values.

The CALSIM II Yuba model uses reduced demands at Daguerre Point Dam from March 1976 to February 1978. The model documentation does not explain the basis for the reduced demands, which are not used in any other years. The reduced level demands for 1976 and 1977 are not used in the CalLite model because it is anticipated that dry-year demands can be managed through delivery allocation decisions. The monthly demands at Daguerre Point Dam are show in Table D-2.

Table D-2. Monthly demands at Daguerre Point Dam (cfs)

Month	North Yuba Index = 1 or 2	North Yuba Index = 3, 4, 5, or 6
October	309	309
November	175	175
December	85	85
January	7	7
February	7	7
March	24	49
April	239	310
May	981	981
June	935	935
July	1063	1063
August	892	892
September	302	302

Delivery Cutback Decision

The CalLite model reduces deliveries at Daguerre Point Dam if forecasted April-September supplies indicate that end-of-September carryover storage targets for New Bullards Bar Reservoir can not be met.

The model uses a carryover storage target of 600 TAF during each year of the simulation period. The CALSIM II Yuba model uses a 600 TAF carryover target in all but five years of the simulation period. The carryover targets used in the CALSIM II Yuba model are taken from a pre-processed set of carryover targets used in the YCWA HEC-5 model. The HEC-5 targets are developed to provide sufficient supplies to meet 100% of instream flow requirements and 50% of demands at Daguerre Point Dam. These targets are capped at 600 TAF. Because these targets are based on outdated instream flow requirements from the 1965 DFG-YCWA agreement and are equal to 600 TAF in all but five years, a decision was made to use 600 TAF throughout the simulation period. This decision should be reviewed if new targets are developed as part of the updated CALSIM II Yuba model.

The model determines whether a delivery cutback is required using an approach based on the approach used in the CALSIM II Yuba model. At the beginning of each April, the model forecasts April-September supplies and determines the required reduction at Daguerre Point, if any, using the following procedure:

Net April-September demand on New Bullards Bar Reservoir storage is estimated as follows:

$$NetDemand = \sum_{i=April}^{September} NetDemand_i$$

Where

$$NetDemand_i = \max(DaguerrePtDemand_i + EnglebrightDemand_i + NewBullardsBarDemand_i)$$

Where

$$DaguerrePtDemand_i = \max(DaguerrePtDiversionDemand_i + DaguerrePtInstreamDemand_i - DaguerrePtInflow_i - EnglebrightInflow_i, 0) - NewBullardsBarInflow_i$$

$$EnglebrightDemand_i = \max(EnglebrightInstreamDemand_i - EnglebrightInflow_i, 0) - NewBullardsBarInflow_i$$

$$NewBullardsBarDemand_i = NewBullardsBarInstreamDemand_i + NewBullardsBarMinimumPowerDemand - NewBullardsBarInflow_i$$

New Bullards Bar inflow is excluded from the maximum function in the Daguerre Point and Englebright computations because New Bullards Bar inflow can be diverted to storage and used to satisfy demands later in the April-September period. In other words, if New Bullards Bar inflow exceeds all demands in a particular month, the net demand for that month will be negative and will be subtracted from total demand for the April-September period to account for the availability of water diverted to storage in New Bullards Bar Reservoir.

Supply available from New Bullards Bar Reservoir is determined by subtracting the carryover target from March New Bullards Bar storage.

If April-September demand is greater than supply available, then the difference is the delivery cutback amount.

The delivery cutback percentage is determined by dividing the delivery cutback amount by the April-September demand. The delivery cutback percentage can not be greater than 50%.

The delivery reduction is applied from April through March of the following year. The reduction is applied through March because the carryover target is designed to supply 50% of demands at Daguerre Point Dam; if it is anticipated that end-of-September storage will be at the minimum carryover amount, then it is reasonable to continue the delivery cutback until the cutback percentage is determined again the following April.

Major Regulatory Constraints

The major regulatory constraints in the representation are instream flow requirements below Englebright Dam and below Daguerre Point Dam. A small instream flow requirement below New Bullards Bar Dam is also included. All instream flow requirements are based on instream flow requirements in the CALSIM II Yuba model.

CALSIM II Yuba model documentation provides no explanation for the basis of flow requirements used at Englebright Dam and Daguerre Point Dam. The minimum flow requirements are interpreted to be based on flow requirements in the proposed Lower Yuba River Accord. The proposed Lower Yuba River accord would implement minimum flow standards based on a new North Yuba Index, which has six levels referred to as “flow schedule year types”. Minimum flows and North Yuba Index levels are given in Table D-3.

Table D-3. Minimum instream flow requirements below Englebright Dam (cfs)

Minimum Instream Flow Requirements below Englebright Dam (CFS)

Source: DWR CALSIM II Yuba model (corresponding North Yuba Index Flow Schedule values from interpretation of CALSIM II Yuba input, Lower Yuba Accord environmental documentation)

Month	North Yuba Index Flow Schedule Year Type = 1, 2, 3, or 4	North Yuba Index Flow Schedule Year Type = 5 or 6
October	700	600
November	700	600
December	700	550
January	700	550
February	700	550
March	700	550
April	350	300
May	--	--
June	--	--
July	--	--
August	--	--
September	700	500

Appendix E Isolated Facility Modeling and Hood Bypass Flow Requirement Option Documentation

Program Description

The Isolated Facility (IF) program would involve the construction of a peripheral aqueduct with an intake on the Sacramento River and an isolated connection at the SWP and CVP pumping facilities. The new facilities would include state-of-the-art positive barrier fish screens on the Sacramento River near Hood or Clarksburg, a peripheral aqueduct and associated conveyance facilities (i.e. pumps and siphons) that would traverse from the new intake facility along the Sacramento River along a southerly-alignment adjacent to, and west of, Interstate 5, terminal facilities that would allow discharge into the Clifton Court Forebay (CCF), and an intertie between CCF and Jones Pumping Plant.

Various facility sizes are under consideration, but diversion rates to be considered are likely to be in the range of 5,000 to 15,000 cfs. Generally, a dual conveyance configuration, involving possible diversions at both the new IF and the existing south Delta channels, has been discussed as the most promising. However, operation of the IF exclusively has been considered in some forums.

An option exists where the user can apply a minimum flow requirement at Hood. This would limit IF diversions to a specific percentage of the amount of flow at Hood that exceeds the minimum requirement.

Program Core Elements

The following core elements are included in the IF program:

- Diversion on the Sacramento River near Hood (0 – 20 kcfs)
- Isolated aqueduct with connection to CCF
- Intertie between CCF and Jones Pumping Plant
- Diversion limits, bypass requirement flows (at Hood) may be used to cap diversions
- Minimum south Delta pumping may be specified prior to use of IF diversion
- Maximum south Delta pumping may be specified prior to use of IF diversion
- Water may be delivered to both SWP and CVP

Options Considered

For the purposes of the screening model implementation, the following options are considered:

- Diversion options: 0 – 20,000 cfs (variable)
- Minimum south Delta pumping options: 0 – 15,000 cfs (variable)
- Maximum south Delta pumping options: 0 – 15,000 cfs (variable)
- Banks capacity options: 0 cfs to 10,300 cfs through the Banks Pumping Capacity Option (See Appendix L)
- **Hood Bypass flow requirement** : Caps IF diversion to a user-defined percentage of the amount of Hood flow above a user-defined required minimum flow at Hood (See Figure E-3)

Schematic Representation

The schematic representation in CalLite involves a diversion at Hood and a tie-in at CCF. The general alignment is shown in Figure E-1, and a markup of the CalLite network is shown in Figure E-2.

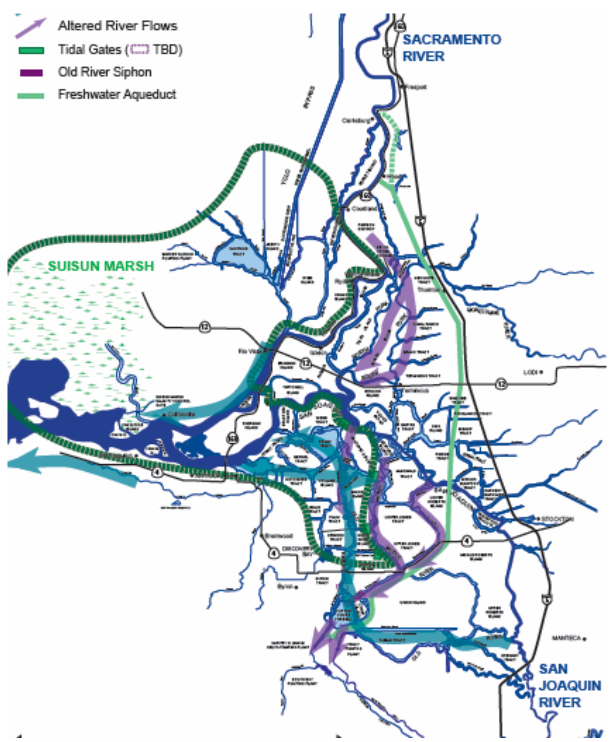


Figure E-1. General location of Isolated Facility program features

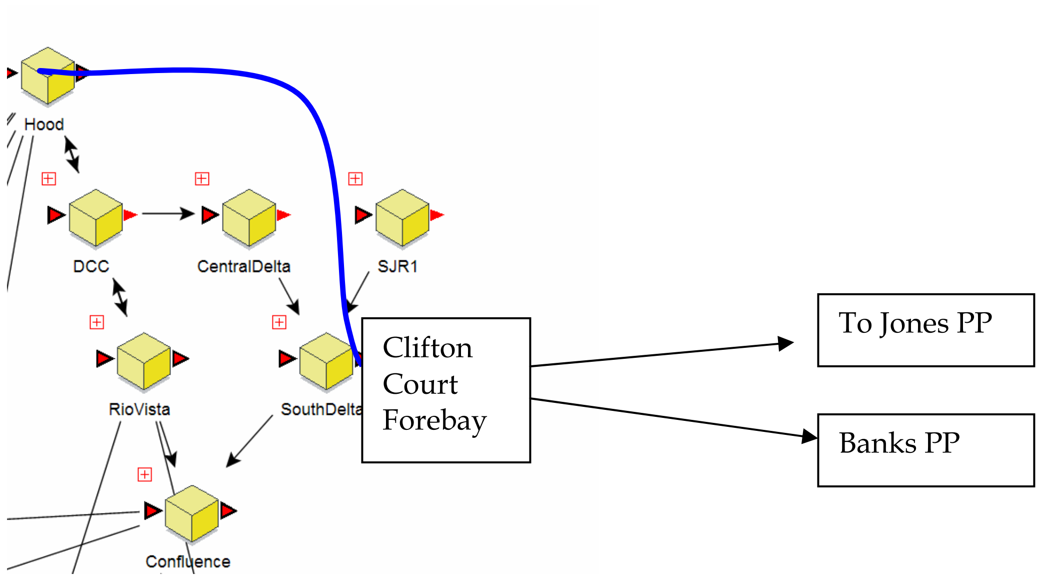


Figure E-2. CalLite schematic representation of Isolated Facility program

Facility Operations

IF Diversions

- Maximum available diversion determined by considering both the maximum rates provided by the user and the flow upstream of the DCC needed for Rio Vista (with consideration of DCC gate position)
- IF diversions will always be preferred after satisfaction of minimum south Delta pumping
- Available diversion capacity will be shared 50/50 between SWP and CVP (when this option is triggered), but actual diversions will be strictly governed by COA sharing

Hood Bypass requirement option (See Figure E-3)

- When checked, user defines a minimum flow requirement at Hood for each month and water year type. Hood diversion through IF is capped by to a fraction (also user-defined) of the flow at Hood that is above the minimum requirement (See Figure E-4)

Banks and Tracy Exports

- Banks PP physical capacity will limit the IF diversion, not the permitted CCF diversion
- Salinity at CCF is a blend of Sacramento River quality at Hood (~125 uS/cm) and Old River at CCF quality (regression based on Old River at Rock Slough quality). Jones PP

quality is a blend of the CCF quality and the quality at OR at Tracy (regression based on Old River at Rock Slough quality).

Integration with SWP/CVP System

As implemented, the Isolated Facility is considered an SWP/CVP project and is directly integrated into the Coordinated Operations Agreement and project operational decisions.

User Input and Output Requirements

Table E-1 shows the user input and output requirements for the Isolated Facility program implementation in CalLite. Note that the outputs only represent additional displays that are not included in the base model.

Table E-1. Input Controls and Output Displays for the Isolated Facility Program

Input Control	**Output Displays**
Max physical diversion capacity	Total IF vs TD diversion rates
Max permissible monthly diversion capacity	SWP IF vs TD diversion rates
Min south Delta pumping before IF use	CVP IF vs TD diversion rates
Max through-Delta pumping	Delta Inflows
Hood Bypass minimum flow requirement (If Hood Bypass Option checked and "Assumptions" control used)	X2
IF Diversion fraction of flow above Hood requirement (If Hood Bypass Option checked and "Assumptions" control used)	CD/SD Flows
	Exports
	Delta Outflow
	Delta Salinity

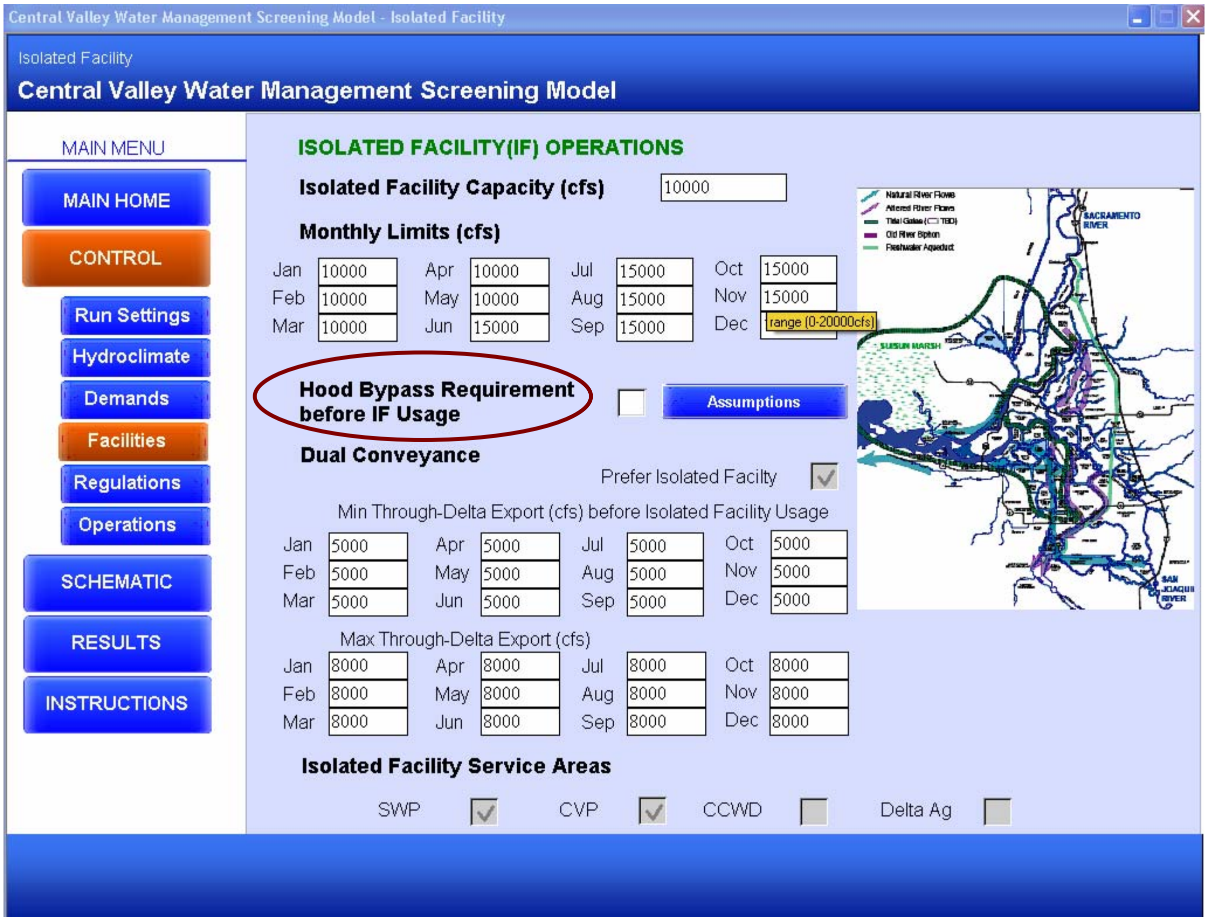


Figure E-3. Preliminary dashboard of controls for the Isolated Facility (the Hood Bypass flow requirement option is indicated above)

Limitations

Isolated Facility implementation in CalLite at this point is similar to that for CALSIM II. Limitations will also be similar: monthly time step, unknown fish screen efficiency, unknown diversion capability, and currently unknown operating restrictions on the diversion rates.

Minimum Hood Bypass Flow Requirement (cfs)

	Water Year Type				
Month	**W**	**AN**	**BN**	**D**	**C**
Jan	10000	10000	10000	10000	10000
Feb	10000	10000	10000	10000	10000
Mar	10000	10000	10000	10000	10000
Apr	10000	10000	10000	10000	10000
May	10000	10000	10000	10000	10000
Jun	10000	10000	10000	10000	10000
Jul	10000	10000	10000	10000	10000
Aug	10000	10000	10000	10000	10000
Sep	10000	10000	10000	10000	10000
Oct	10000	10000	10000	10000	10000
Nov	10000	10000	10000	10000	10000
Dec	10000	10000	10000	10000	10000

Max Hood Diversion Fraction of Flows Above Min Bypass Flow Requirement

	Month											
Qsac (cfs)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
0	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
5000	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
5001	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
10000	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
10001	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
15000	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
15001	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
30000	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
30001	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
100000	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
200000	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
999999	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33

Figure E-4. User-defined minimum flow requirements at Hood and fraction of flow at Hood above the minimum requirement used to limit IF diversions (if Hood Bypass option checked and "Assumptions" control used)

Comparison Data Sets

While a number CALSIM II model simulations have been developed recently for the DWR and for the BDCP process, they commonly include a number of changes that are independent with the Isolated Facility (i.e. Old and Middle River criteria, export-inflow ratios, salinity standards, etc). We identified three simple sensitivity studies from DWR that are the most suitable for comparison. These studies included the existing 6,680 cfs Banks PP capacity along with three sizes of an isolated conveyance canal transferring water from Hood to the CCF. The three sizes of an Isolated Facility are 5,000 cfs, 10,000 cfs, and 15,000 cfs.

Figure E-5 below shows an absolute comparison of total export changes between CalLite IF and CALSIM II IF studies over the 1922 – 2003 period (5 kcfs, 10 k cfs and 15 kcfs IF capacities) . Figure E-6 illustrates the relative difference in total exports (compared with a base case without IF) for CalLite and CALSIM II over the long-term average period of 1922-2003 for all three IF capacities. Figure E-7 compares the relative export changes that occur over the 1929-1934 drought period. While we have not verified that all assumptions are consistent between the two studies, simulations by both models show similar magnitude and trends of increased export with various IF sizes. Both models produce the expected trend of increasing total exports with larger IF sizes. The water supply increases would be significantly larger, but the Banks PP capacity is limiting further increases at the larger IF sizes. During the 1929-34 drought period, CalLite produces the expected trends of increasing water deliveries with larger IF capacities, although this trend is not apparent in the CALSIM II simulations.

The CalLite and CALSIM II simulations show a similar shift in the usage of the Isolated Facility diversion versus the south Delta pumps. Under a dual Isolated Facility-south Delta operation, the IF is preferred over south Delta pumping as long as capacity and Delta controls allow. Figure E-8 presents an example time series plot of the CalLite results of south Delta diversions (labeled as "TD"), IF diversions, and total diversions from the Delta. In this lower IF capacity scenario (5 kcfs), one can see that the IF is commonly at its capacity before any addition pumping occurs from the south Delta. In this scenario, diversions from the south Delta and the IF are nearly equal. As the IF sizes are increased, a greater percentage is provided by the IF and the dependence on the south Delta diversions is reduced. These trends and a comparison between CalLite and CALSIM II simulations are shown in Figure E-9.

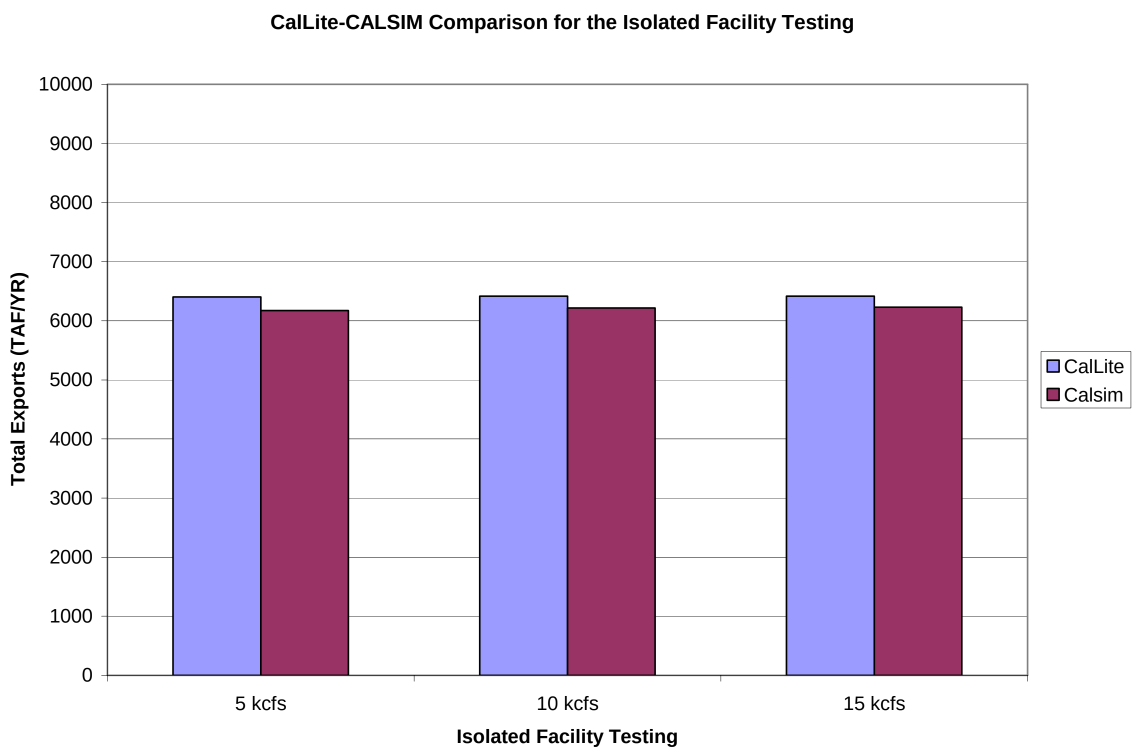


Figure E-5. Comparison of long-term average export changes between CalLite and CALSIM II for varying Isolated Facility capacities (absolute changes)

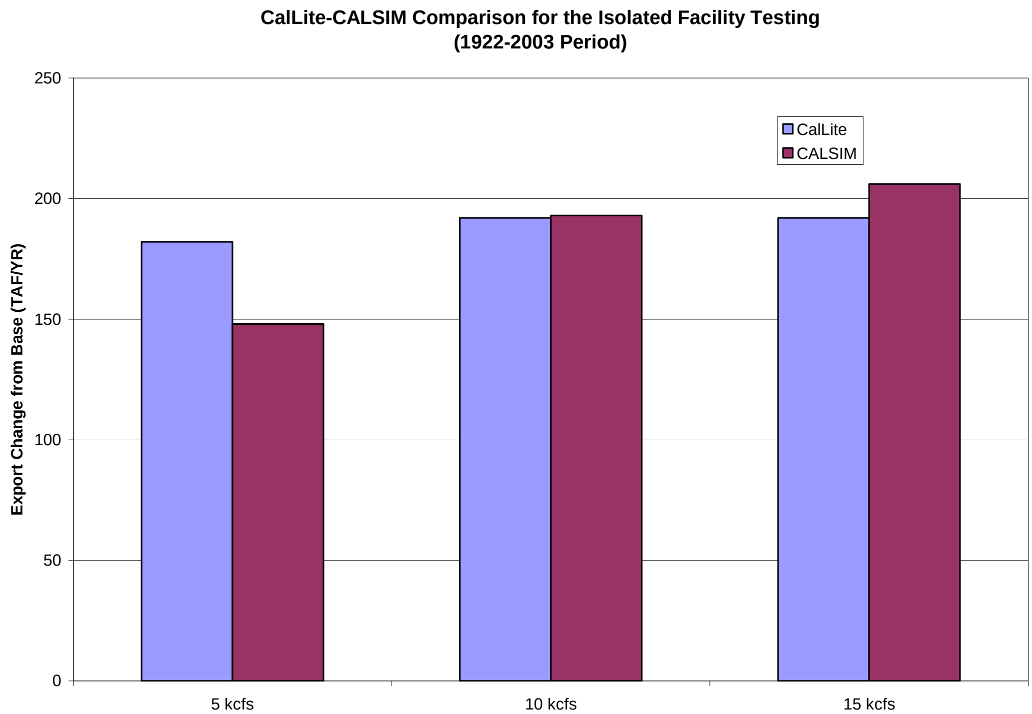


Figure E-6. Comparison of long-term average export changes between CalLite and CALSIM II for varying Isolated Facility capacities (relative to the respective CalLite and CALSIM II base case without IF)

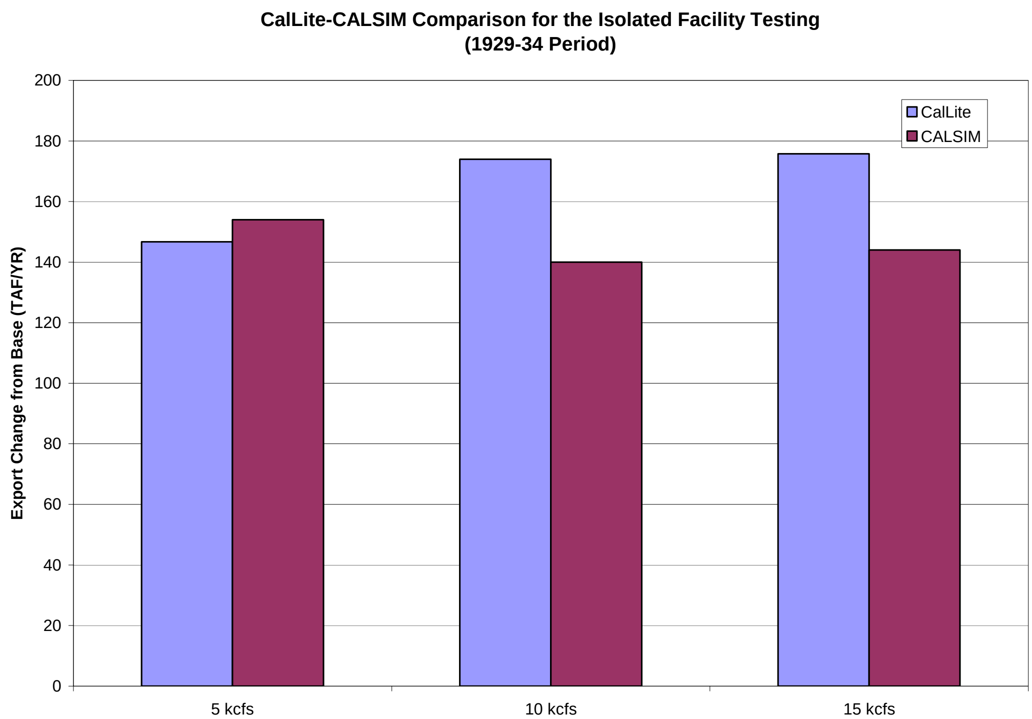


Figure E-7. Comparison of dry period average export changes between CalLite and CALSIM II for varying IF capacities (relative change to a base case without IF)

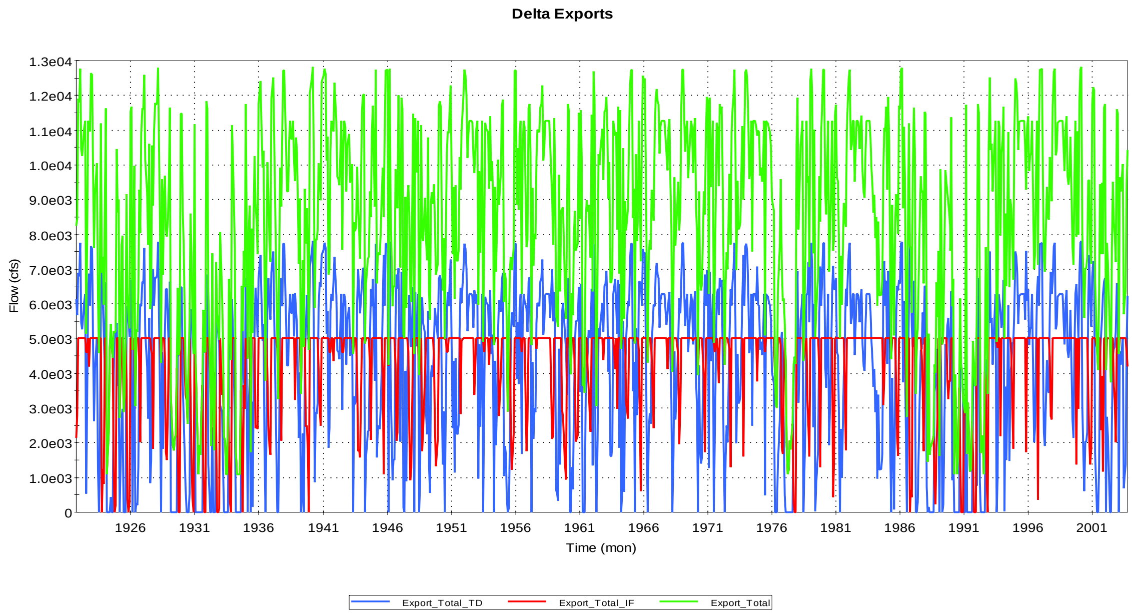


Figure E-8. CalLite results of Delta diversions through the Isolated Facility (red) and south Delta (blue) for the 5,000 cfs Isolated Facility capacity

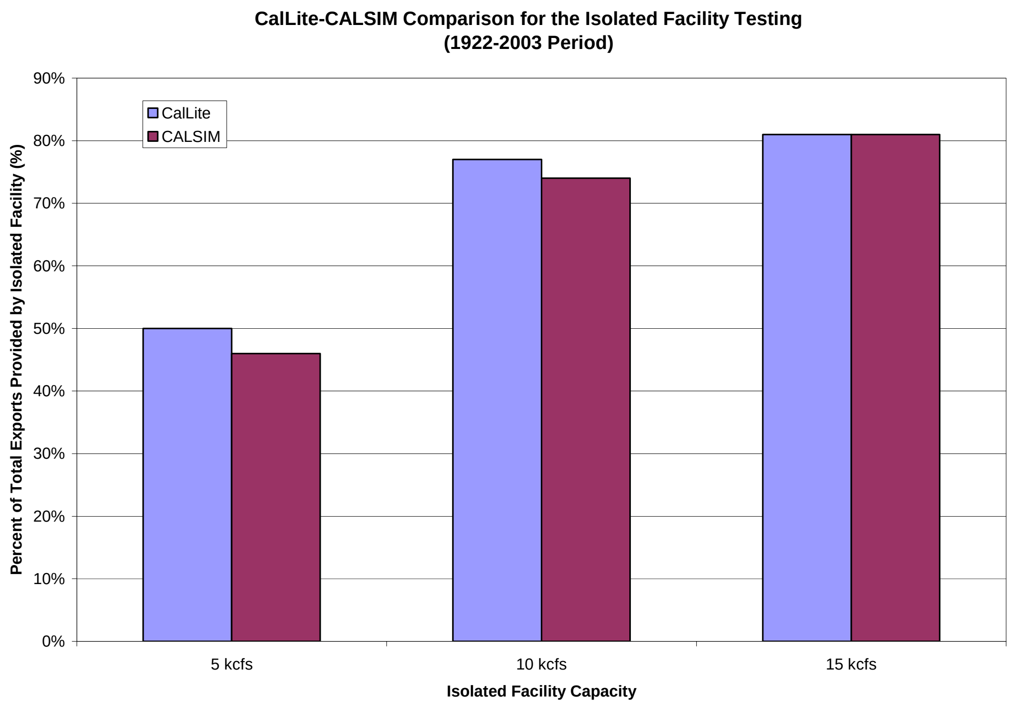


Figure E-9. Comparison of CalLite and CALSIM II results of percent of total exports provided by the Isolated Facility for varying Isolated Facility capacities

Appendix F North of Delta Offstream Storage Modeling Documentation

Program Description

NODOS (commonly referred to as “Sites” Reservoir), is a proposed offstream storage facility that is approximately 1.8 million acre-feet in capacity. Located 10 miles west of Maxwell, in northern Colusa and southern Glenn counties, NODOS has the potential to provide (along with benefits to local demands and to the environment through Delta outflow augmentation and ecosystem restoration in the upper Sacramento River) an increase in water supply reliability to SWP and CVP contractor deliveries (Figure F-1). In this model representation in CalLite, NODOS will be used initially to provide supply reliability for SWP and CVP only. This was done mainly for reasons of modeling expediency. This depiction was not meant to represent the full range of benefits possible through NODOS.

Program Core Elements

The NODOS program will include the following core elements:

- Storage capacity of 1.8 million ac-ft.
- Diversion to NODOS through Tehama-Colusa Canal (2,100 cfs capacity)
- Diversion to NODOS through Glenn-Colusa Irrigation District Canal (1,800 cfs capacity)
- Diversion to NODOS and releases to Sacramento River from New Pipeline (2,000 cfs capacity)
- Diversions to NODOS limited to Delta surplus conditions and excess NCP flows
- Diversions to NODOS also limited if resulting flow below GCID canal intake falls below a set level (default is 4,000 cfs)
- NODOS modeled as two separate reservoirs (SWP and CVP components designated as “NODOS SWP” and “NODOS CVP” respectively)
- Equal fill priority for SWP and CVP
- NODOS releases to provide supply reliability to SWP and CVP
- Dead pool storage of 150 TAF

Options Considered

For the purposes of the screening model implementation, the following options are considered:

- Total NODOS storage capacity can range from a minimum of 150 TAF (dead storage) to a maximum of 3,000 TAF
- Adjustable percentage of project share of NODOS storage capacity
- New Pipeline capacity can vary from a minimum of 0 cfs to a maximum of 2,000 cfs
- TC Canal capacity can very between 0 cfs and 2,100 cfs
- GCID Canal capacity can range between 0 cfs and 1,800 cfs
- Adjustable GCID minimum flow requirement for diversion to NODOS
- Diversion trigger to NODOS SWP based on Oroville storage between 0 TAF and 3,558 TAF (maximum Oroville capacity)
- Diversion trigger to NODOS CVP based on Shasta storage between 0 to 4,552 TAF (maximum Shasta capacity)

These options can be set by the user through the dashboard for NODOS facility assumptions (See "User Input and Output Requirements").

Schematic Representation

The schematic representation of NODOS is shown in Figure F-2. The schematic depicts the storage facility ("Sites Reservoir") along with three major conveyances used to divert into it from the Sacramento River. The Tehama-Colusa (TC) Canal draws its water near Red Bluff. The Glenn-Colusa Irrigation District (GCID) Canal diverts river water near Hamilton. The New Pipeline Canal both diverts from and releases to the Sacramento River several miles north of Maxwell (as shown in Figure F-1).

The CalLite model schematic of NODOS differs somewhat from the general representation described above. Both TC and GCID canals originate from a container (node) designated as "Red Bluff." They are treated however, as individual canals and are operated by separate rules. New Pipeline Canal in CalLite connects with the Sacramento River at a container labeled as "Wilkins Slough." These alterations were necessary since CalLite utilizes aggregated hydrology to represent the system.

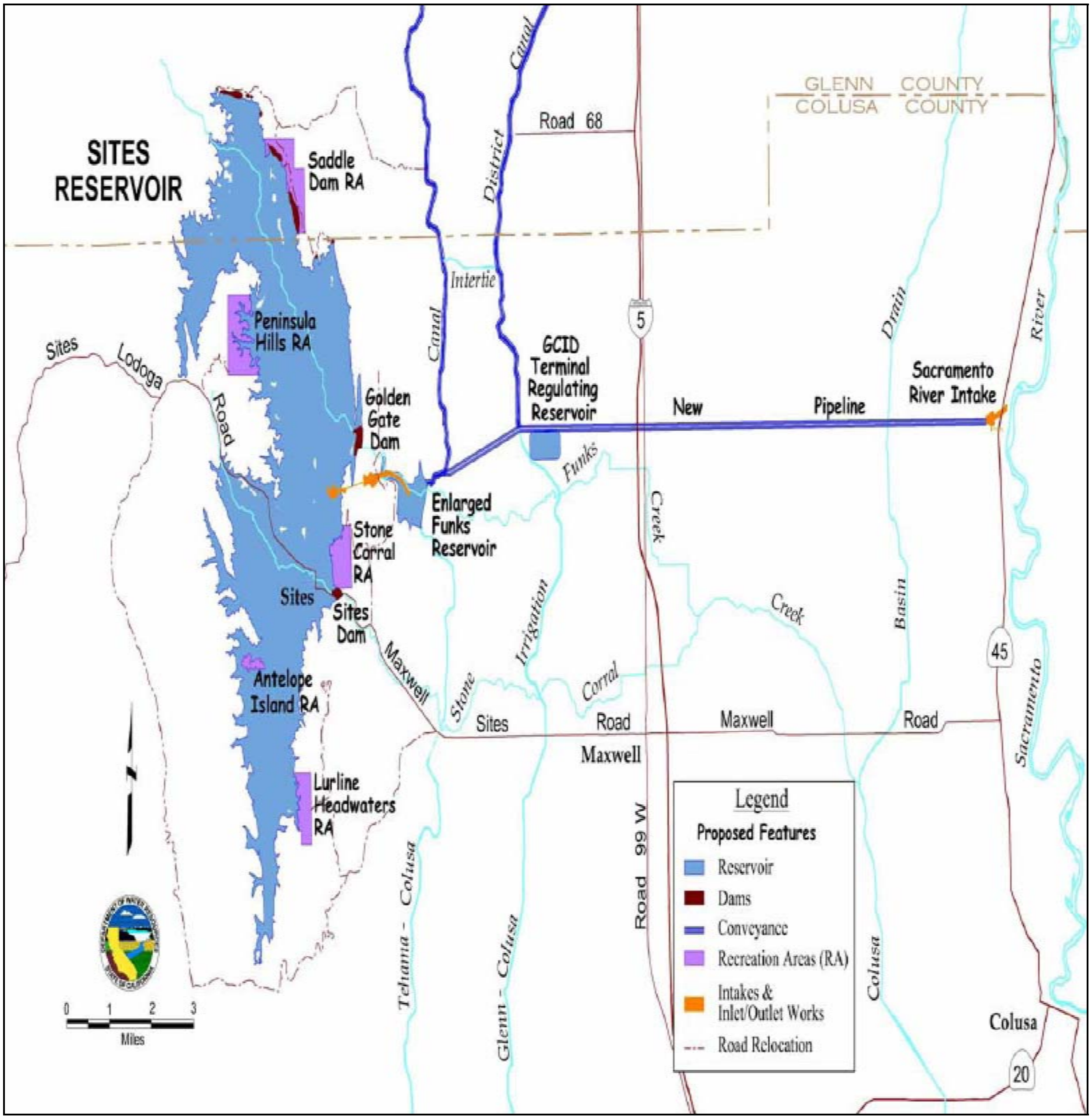


Figure F-1. General location of NODOS program features

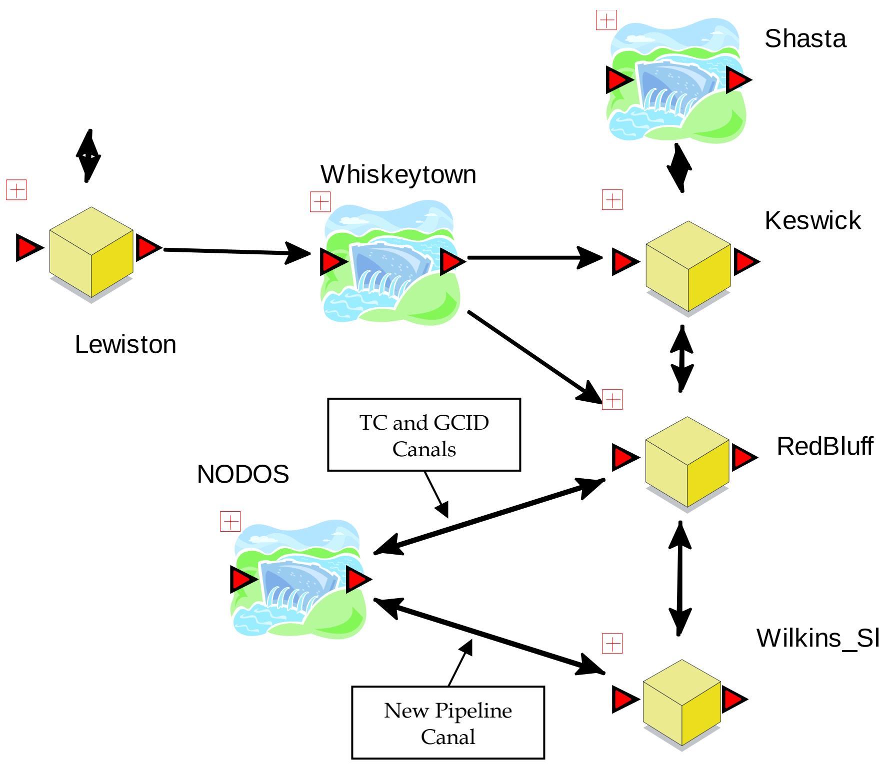


Figure F-2. CalLite schematic representation of NODOS program

Facility Operations

Many of the facility parameters were identified previously and are specified by the user through the options available. However, some core functionality is embedded in to the model structure to ensure proper operations. These operations are listed below:

NODOS Diversions

- Diversions to NODOS through TC and GCID canals will take place during the months of November and March
- Diversion to NODOS through New Pipeline can take place year-round
- Diversions to NODOS limited to Delta excess and NCP excess conditions
- TC and GCID diversions limited when resulting downstream flow of GCID intake goes below 4,000 cfs

NODOS Storage Operations

- NODOS SWP and NODOS CVP components share equal fill priority

NODOS Releases

- Release made to provide supply reliability to SWP and CVP.
- Priority of release shared between NODOS SWP and NODOS CVP.

Integration with SWP/CVP System

NODOS is considered an SWP/CVP project and is directly integrated into COA and operational decisions.

User Input and Output Requirements

Table F-1 shows the proposed user input and output requirements for the NODOS program implementation in CalLite. Note that the outputs only represent additional displays that are not included in the base model. The NODOS input options dashboard is shown in Figure F-3. Figure F-4 shows the dashboard for output displays (NODOS is at the top left corner).

Table F-1. Input Controls and Output Displays for the Isolated Facility Program

Input Control	**Output Displays**
NODOS maximum storage capacity	NODOS Storage
Project share percentage of NODOS storage	NODOS Inflow
GCID Canal diversion capacity	NODOS releases
TC Canal diversion capacity	NODOS diversions
New Pipeline diversion capacity	Flow below Red Bluff
Minimum flow requirement before diversion to NODOS (below Red Bluff)	Flow below Wilkins Slough
Oroville storage trigger for NODOS SWP releases	Comparison of Oroville and NODOS SWP storages
Shasta storage trigger for NODOS CVP releases	Comparison of Shasta and NODOS CVP storages

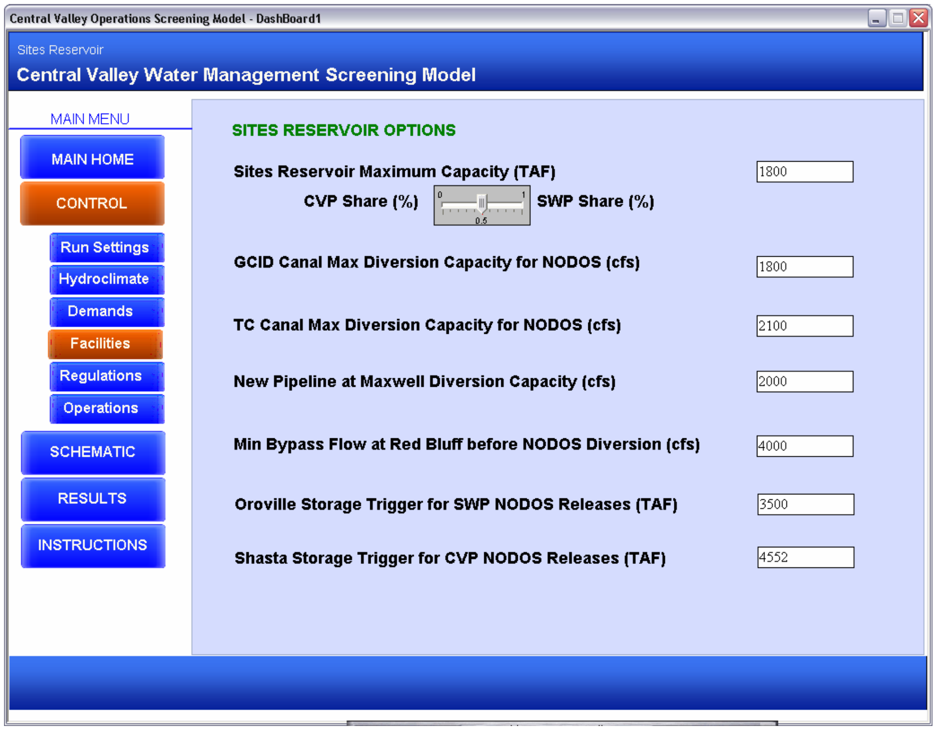


Figure F-3. NODOS Facility Input Options

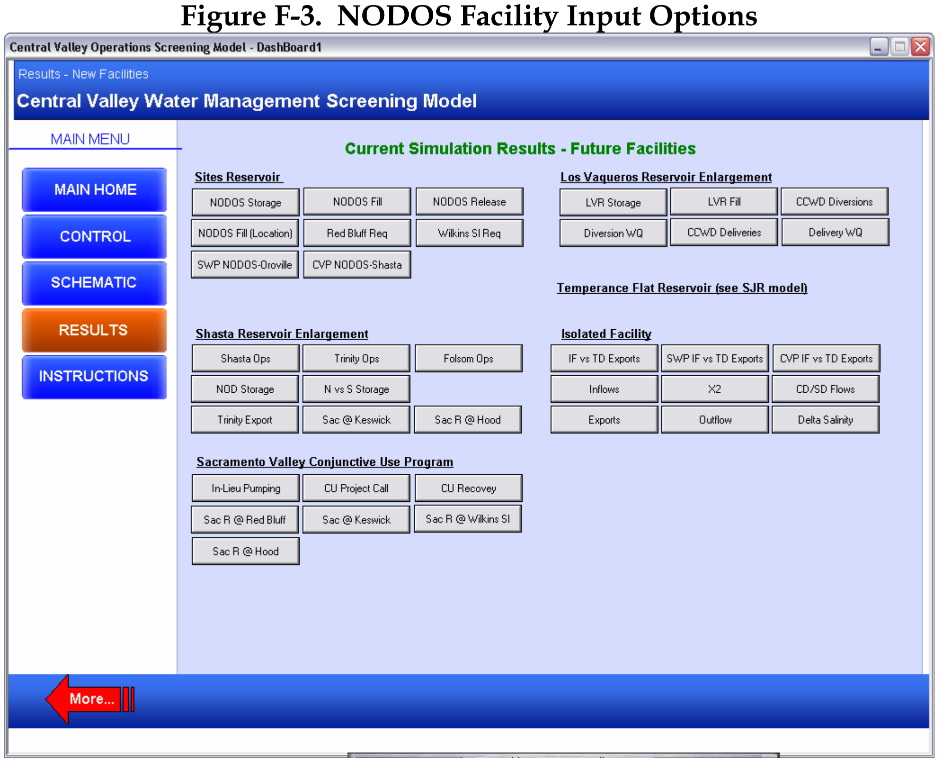


Figure F-4. Output Displays (NODOS is at top left corner)

Limitations

NODOS has the capability of providing local (TCCA and GCID) supply reliability, but this can only be implemented in CalLite after a more detailed representation of Colusa Basin hydrology is incorporated. The current model utilizes NODOS exclusively for project water supply reliability.

Comparison Data Sets

The initial NODOS implementation in CalLite ignored operations for local beneficiaries due to the consolidation of much of the Colusa Basin hydrology. Comparative Data sets were thus not compiled for NODOS because there were not comparable companion CALSIM II studies.

Appendix G Shasta Lake Enlargement Modeling Documentation

Program Description

The primary objectives of the alternatives identified in the Shasta Lake Water Resources Investigation (SLWRI) are (1) increase survival of anadromous fish populations in the Sacramento River primarily upstream from the Red Bluff Diversion Dam; and, (2) increase water supplies and water supply reliability for agricultural, municipal and industrial, and environmental purposes to help meet future water demands, with a focus on enlarging Shasta Dam and Reservoir.

The Shasta Dam enlargement alternatives under consideration include dam raises of 6.5-feet (256 TAF), 12.5-feet (443 TAF), and 18.5-feet (634 TAF).

Program Core Elements

The following core elements are included in the CALSIM II SLWRI:

- Shasta Dam enlargement alternatives as defined
- Increased Shasta storage identified as a component of the Central Valley Project (CVP) for water supply operation and b2 accounting

CalLite representation of SLWRI excludes CVPIA (b)(2) requirements since the model is currently constructed for D1641 level of requirements.

Options Available in the Model

For the purposes of the screening model implementation, three Shasta Dam enlargement alternative dam raises of 6.5-feet (256 TAF), 12.5-feet (443 TAF), and 18.5-feet (634 TAF) are considered. Banks capacity options (6,680 cfs and 8,500 cfs) considered in CALSIM II SLWRI studies are not explicitly included in CalLite.

Schematic Representation

Unlike the additional storage element in CALSIM II representation (S44), schematic representation in CalLite includes a single reservoir with increased capacity.

Facility Operations

To ensure proper operation of the enlarged reservoir; storage-area and storage-elevation curves have been modified; and the target storage level has been adjusted by the user-defined increased storage to ensure that the same flood control space is preserved in Shasta Reservoir. Once these modifications are activated, Shasta Reservoir functions as the original reservoir element and enlargement volumes operate as an additional storage component of the CVP.

Trinity import adjustments are needed to re-balance the Trinity with the increase in Shasta storage.

Integration with SWP/CVP System

The Shasta enlargement options are considered a component of the CVP as Shasta storage and are directly integrated into COA, water supply indices, operational decisions, etc. CALSIM II WSI-DI curves with the enlarged Shasta options are incorporated into CalLite.

Comparison Data Sets

Comparative CALSIM II model simulations for the Shasta enlargement option were obtained from Reclamation. However, a direct comparison is not possible since the CALSIM II study includes CVPIA (b)(2) regulations, while the CalLite is based on D1641 regulations. Therefore test scenarios were developed for each of the options outlined above and comparisons were made against the respective CALSIM II and CalLite no project scenarios. Table G-1, Figure G-1, and Figure G-2 illustrate the summary of results. This type of comparison provides a relative comparison of the incremental benefits simulated in the CALSIM II and CalLite studies. However, as shown in Table G-1, the simulated changes in system flows in CalLite are virtually identical to those simulated in CALSIM II; providing a strong verification that the CalLite implementation and model respond in a similar fashion to that in CALSIM II.

Table G-1. Results comparison between two CalLite studies of Shasta 18.5 ft raise versus no raise (Alt & Base). Values are for long term average (1922-2003) and are in taf/yr

	1922-2003			1929-1934			1987-1992		
	Alt	Base	Diff	Alt	Base	Diff	Alt	Base	Diff
River Flow									
Trinity R blw Lewiston	693	692	1	411	411	0	472	472	0
Trinity Export	550	549	1	333	335	-3	420	429	-9
Clear Cr blw Whiskeytown	42	42	0	33	33	0	38	38	0
Sacramento R @ Keswick	6279	6296	-18	4001	3946	55	4651	4597	54
Sacramento R @ Wilkins Slough	6660	6694	-34	4015	3969	46	4943	4896	47
Feather R blw Thermalito	3168	3168	0	1605	1578	26	1650	1627	23
American R blw Nimbus	2520	2520	-1	1366	1362	4	1222	1222	0
Delta Inflow	**21936**	**21970**	**-34**	**9982**	**9906**	**76**	**10824**	**10754**	**70**
Sacramento R @ Hood	16224	16237	-13	8290	8214	76	9453	9384	70
Yolo Bypass	1905	1926	-21	110	110	0	130	130	0
Mokelumne R	666	666	0	202	202	0	140	140	0
San Joaquin R d/s Calaveras	3141	3141	0	1381	1381	0	1100	1100	0
Delta Outflow	**14816**	**14906**	**-89**	**5052**	**5044**	**8**	**5509**	**5535**	**-26**
Required	5567	5566	1	4090	4090	0	3914	3912	2
Delta Diversions	**6037**	**5988**	**49**	**3669**	**3602**	**67**	**3982**	**3887**	**95**
Banks SWP	3325	3311	14	1917	1891	26	1966	1947	20
Banks CVP	0	0	0	0	0	0	0	0	
Tracy	2712	2677	36	1752	1711	41	2016	1941	75
SWP SOD Deliveries	**3002**	**2993**	**9**	**1795**	**1770**	**26**	**1777**	**1762**	**15**
Table A	2747	2730	16	1655	1630	25	1736	1722	14
Article 21	238	245	-8	135	133	1	30	30	0
Article 56	18	17	0	6	6	0	11	11	0
CVP SOD Deliveries	**2766**	**2723**	**42**	**1696**	**1647**	**49**	**1991**	**1943**	**48**

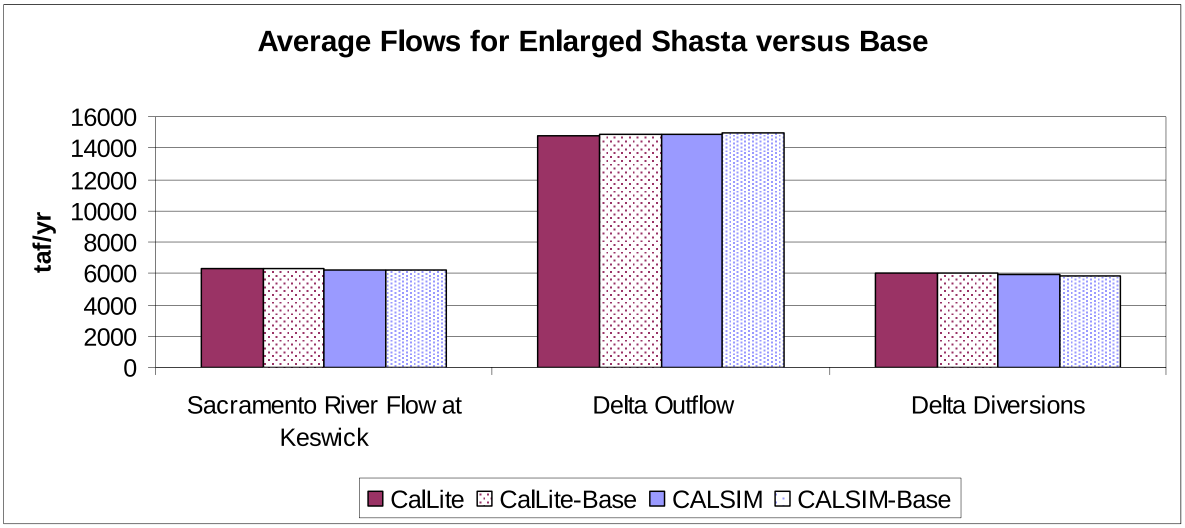


Figure G-1. CalLite and CALSIM II simulated Sacramento River flow, Delta outflow, and Delta diversions

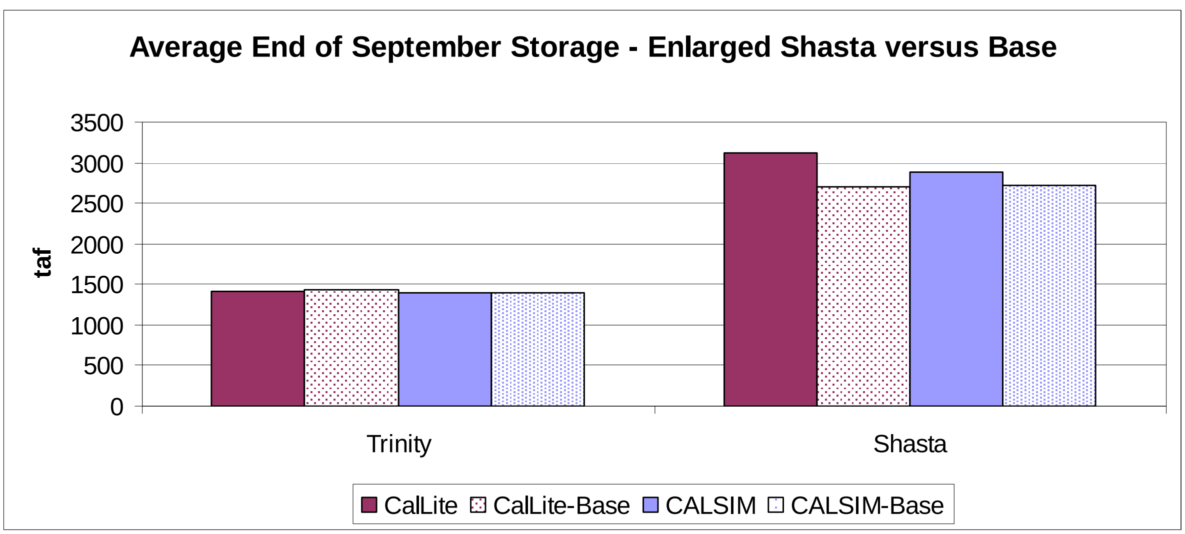


Figure G-2. CalLite and CALSIM II simulated average end of September storage in Trinity Lake and Shasta Lake

User Input and Output Requirements

The user is provided with a check box to turn on/off the SLWRI options. If turned on, the user has three more check boxes representing three enlargement alternatives to choose from. Once the user selects a new size, all the related inputs are activated within the model.

Limitations

Limitations of the SLWRI implementation in CalLite include exclusion of CVPIA (b)(2) requirements and possible differences with CALSIM II study due to simplified model schematic.

Appendix H Sacramento Valley Conjunctive Use Modeling Documentation

Program Description

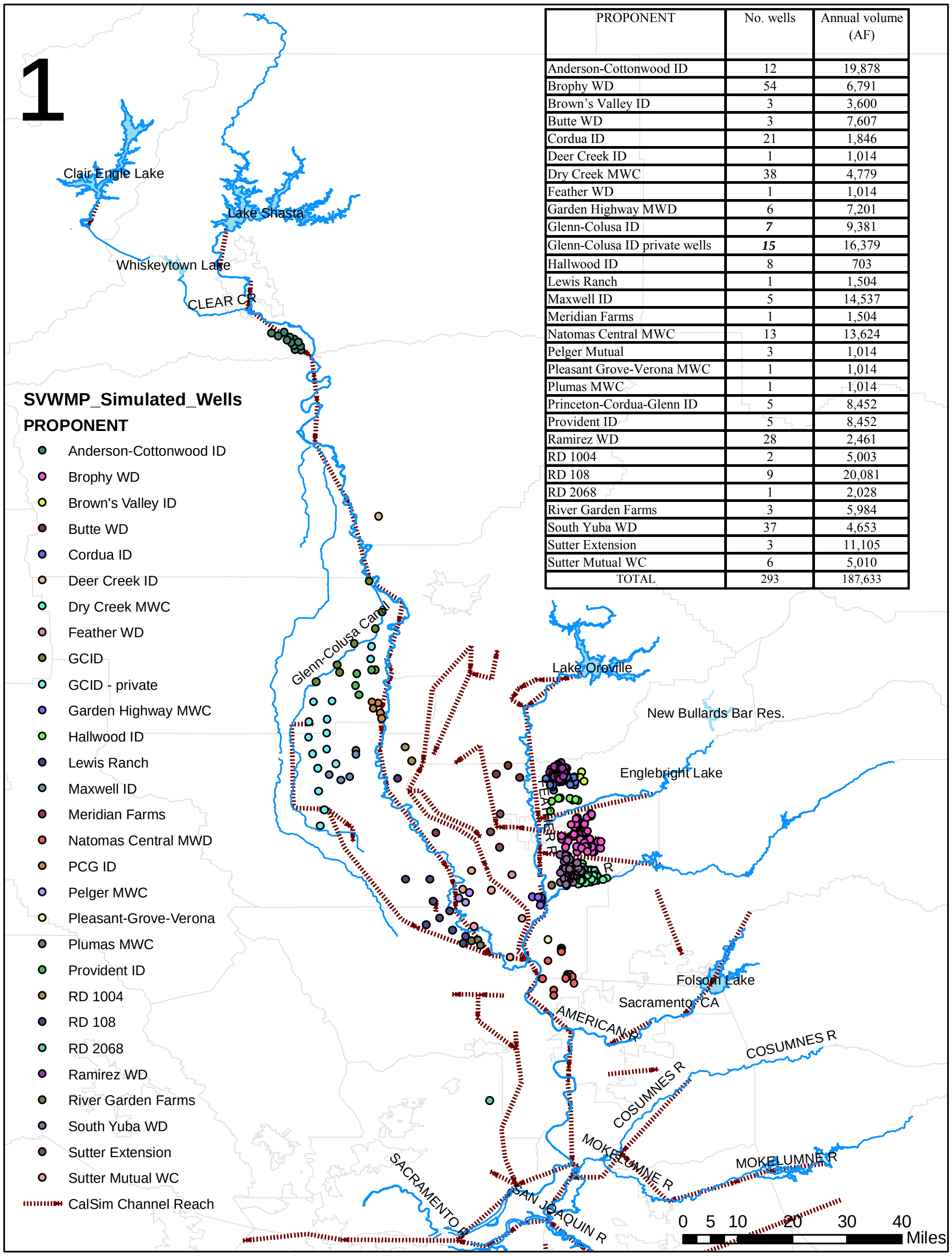
The conjunctive use program in the Sacramento Valley will forego surface water diversions from the Sacramento River and its tributaries for the months June through October in non-wet years, as identified by the Sacramento River Index, and replace this water by operating groundwater pumps. The Sacramento Valley Water Management Program (SVWMP), includes 29 proponents as shown in Figure H-1, proposes pumping of 173 TAF/year of groundwater in stead of surface water diversion that will meet water flow requirements to the Sacramento-San Joaquin Delta in non-wet years.

Twenty nine (29) participants in the program have been identified in Table H-1 to provide annual pumping contribution of 188 TAF/year. The pumping volume supplied from these wells is greater than the specified pumping volume of 173 TAF/year for the SVWMP program; further refinement of the wells is required. For the CalLite implementation as a preliminary study, the groundwater pumping is scaled down to 173 TAF.

Program Core Elements

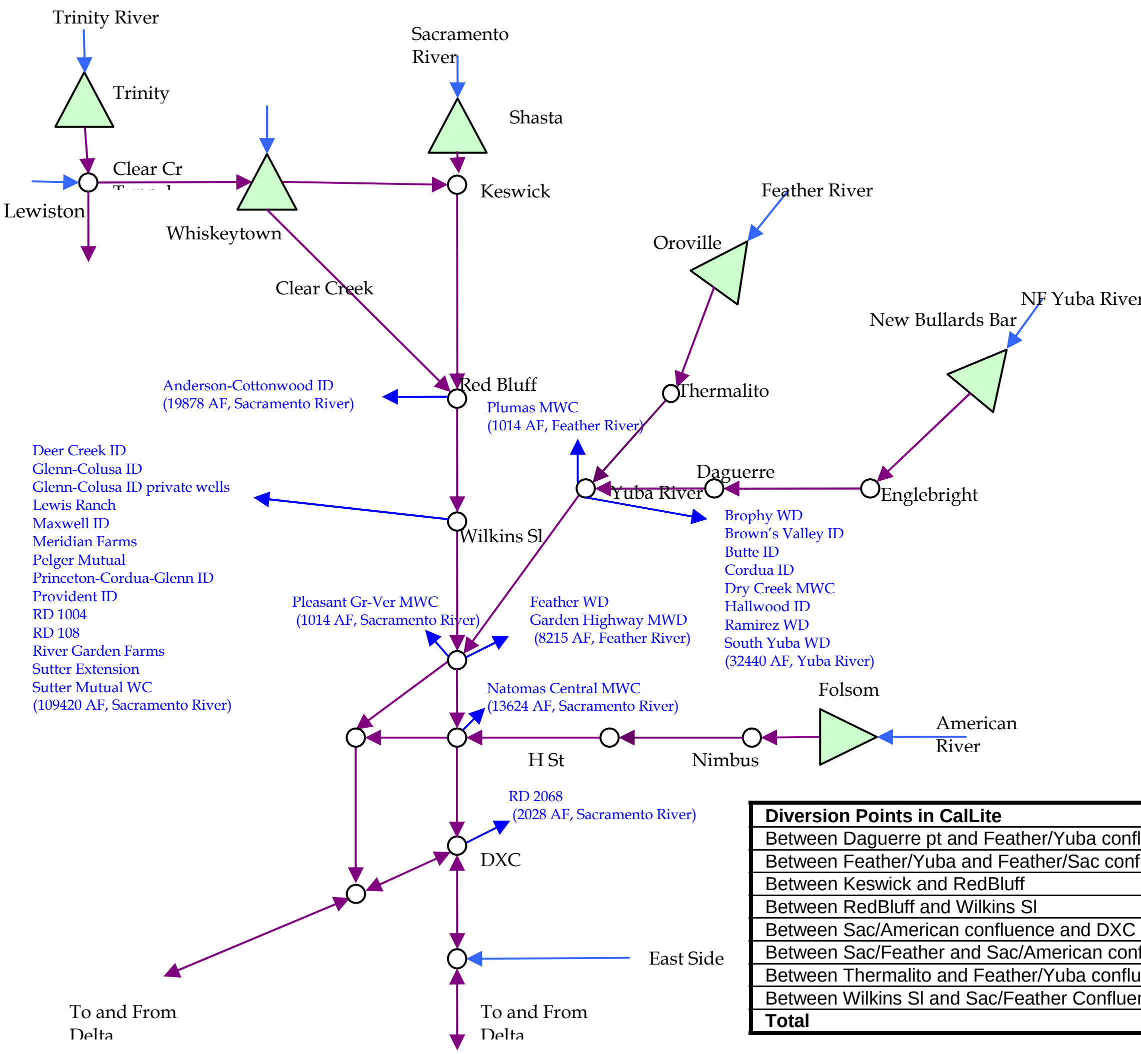
The following core elements are included in the Conjunctive Use program:

- Annual project call for water based on State Water Project (Table A) and Central Valley Project (South of Delta – Agriculture) allocations
- Imposes less diversion from the Sacramento River and its tributaries dependent upon groundwater withdrawal
- Period from June to October
- Uses reduction factor to upstream flow in Sacramento river due to altered surface water and groundwater interaction for groundwater pumping to estimate available flow downstream



PROPONENT	No. wells	Annual volume (AF)
Anderson-Cottonwood ID	12	19,878
Brophy WD	54	6,791
Brown's Valley ID	3	3,600
Butte WD	3	7,607
Cordua ID	21	1,846
Deer Creek ID	1	1,014
Dry Creek MWC	38	4,779
Feather WD	1	1,014
Garden Highway MWD	6	7,201
Glenn-Colusa ID	***7***	9,381
Glenn-Colusa ID private wells	***15***	16,379
Hallwood ID	8	703
Lewis Ranch	1	1,504
Maxwell ID	5	14,537
Meridian Farms	1	1,504
Natomas Central MWC	13	13,624
Pelger Mutual	3	1,014
Pleasant Grove-Verona MWC	1	1,014
Plumas MWC	1	1,014
Princeton-Cordua-Glenn ID	5	8,452
Provident ID	5	8,452
Ramirez WD	28	2,461
RD 1004	2	5,003
RD 108	9	20,081
RD 2068	1	2,028
River Garden Farms	3	5,984
South Yuba WD	37	4,653
Sutter Extension	3	11,105
Sutter Mutual WC	6	5,010
TOTAL	293	187,633

Figure H-1. Spatial distribution of Conjunctive Use program proponents



Diversion Points in CalLite	Curr. GW (af)	Scaled GW (af)
Between Daguerre pt and Feather/Yuba confluence	32440	29852
Between Feather/Yuba and Feather/Sac confluence	8215	7559
Between Keswick and RedBluff	19878	18292
Between RedBluff and Wilkins Sl	109420	100690
Between Sac/American confluence and DXC	2028	1866
Between Sac/Feather and Sac/American confluence	13624	12537
Between Thermalito and Feather/Yuba confluence	1014	933
Between Wilkins Sl and Sac/Feather Confluence	1014	933
Total	187633	172662

Figure H-2. CalLite schematic representation of Conjunctive Use program.

Table H-1. Sacramento Valley Water Management Agreement proponents and quantity of water to be made available.

		Groundwater Withdrawal, Annual Volume (AF)				
Diversion Points in CalLite	PROPONENT	Deer Cr.	Feather	Sacramento	Yuba	Total
Between Daguerre pt and feather/Yuba confluence						
	Brophy WD				6791	6791
	Brown's Valley ID				3600	3600
	Butte WD				7607	7607
	Cordua ID				1846	1846
	Dry Creek MWC				4779	4779
	Hallwood ID				703	703
	Ramirez WD				2461	2461
	South Yuba WD				4653	4653
Between Feather/Yuba confluence and Feather/Sac confluence						
	Feather WD		1014			1014
	Garden Highway MWD		7201			7201
Between Keswick and RedBluff						
	Anderson-Cottonwood ID			19878		19878
Between RedBluff and Wilkins Sl						
	Deer Creek ID	1014				1014
	Glenn-Colusa ID			9381		9381
	Glenn-Colusa ID private wells			16379		16379
	Lewis Ranch			1504		1504
	Maxwell ID			14537		14537
	Meridian Farms			1504		1504
	Pelger Mutual			1014		1014
	Princeton-Cordua-Glenn ID			8452		8452
	Provident ID			8452		8452
	RD 1004			5003		5003
	RD 108			20081		20081
	River Garden Farms			5984		5984
	Sutter Extension			11105		11105
	Sutter Mutual WC			5010		5010
Between Sac/American confluence and DXC						
	RD 2068			2028		2028
Between Sac/Feather Confluence and Sac/American confluence						
	Natomas Central MWC			13624		13624
Between Thermalito and Feather/Yuba confluence						
	Plumas MWC		1014			1014
Between Wilkins Sl and Sac/Feather Confluence						
	Pleasant Grove-Verona MWC			1014		1014
Grand Total		1014	9229	144950	32440	187633

Options Considered

For the purposes of the screening model implementation, the following options are considered:

- Diversion options: Groundwater withdrawal amount or percentage
- Reduction factor: Percentage of forgone surface water diversion that is available in the Delta and rate for further reduction for subsequent years of groundwater withdrawal
- Recovery period: number of consecutive years to fully recover the basin

Schematic Representation

Foregone surface water, in lieu of groundwater pumping, between two nodes in CalLite schematic is added to the downstream of each node.

Proposed Facility Operations

Figure H-2 depicts the diversion points in CalLite and aggregated annual groundwater withdrawal of program participant. Due to groundwater pumping and hence altered surface water and groundwater interaction, foregoing surface water at upstream will not be the same amount in Sacramento River and its tributaries at the downstream that eventually flows into Delta. Another important factor if the conjunctive use program operated several years in succession, the groundwater storage declines that may cause higher surface water loss to ground water. Through internal communication at DWR (Bob Niblack) and memo (from Charles F. Brush), simplified reduction (Figure H-4) and recovery functions are developed. In Figure H-4 obtained from the memo for a period of1976-1981, 85%of pumped water reaches Freeport after full recovery and reduces 4% in subsequent years. It is also reported in the memo that the aquifer takes 3 to 6 years to fully recover. In CalLite we assume 4 years on average to fully recover.

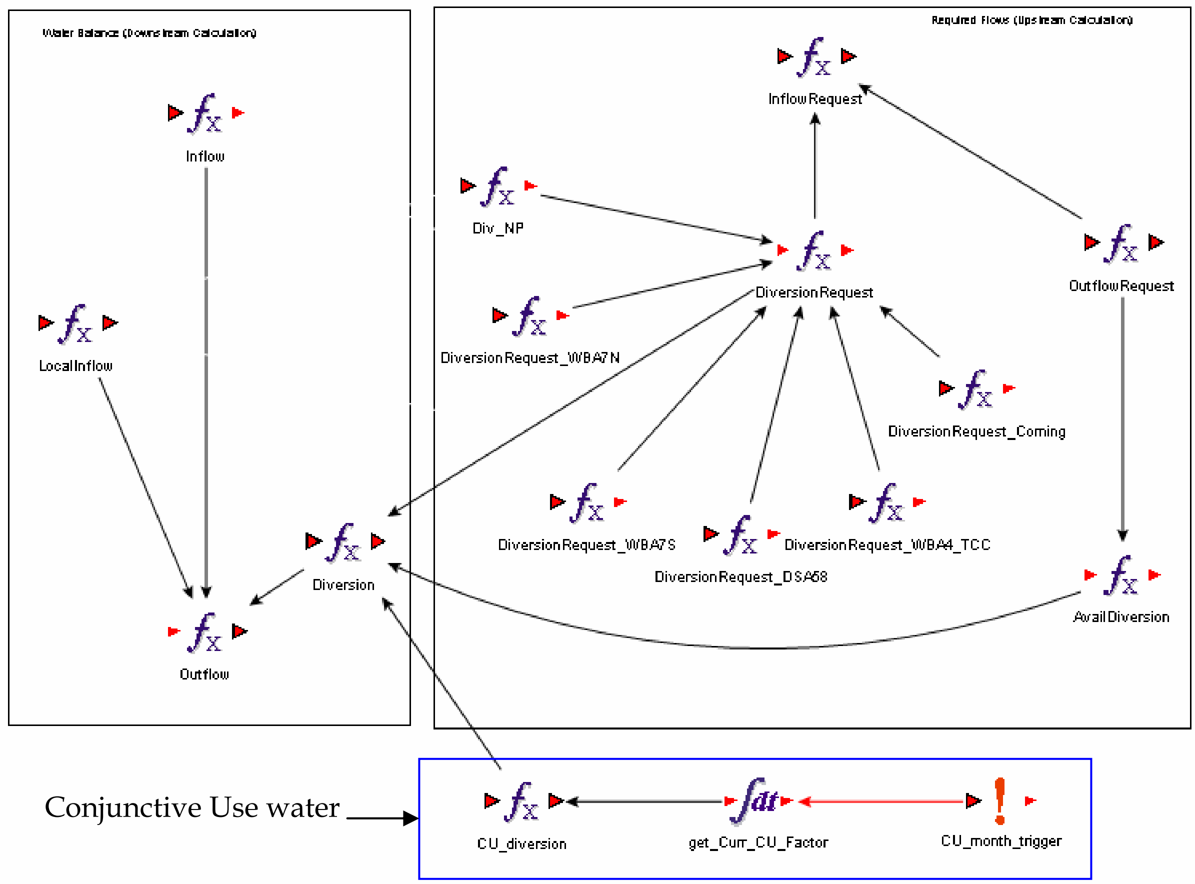


Figure H-3. Example conjunctive use implementation in CalLite

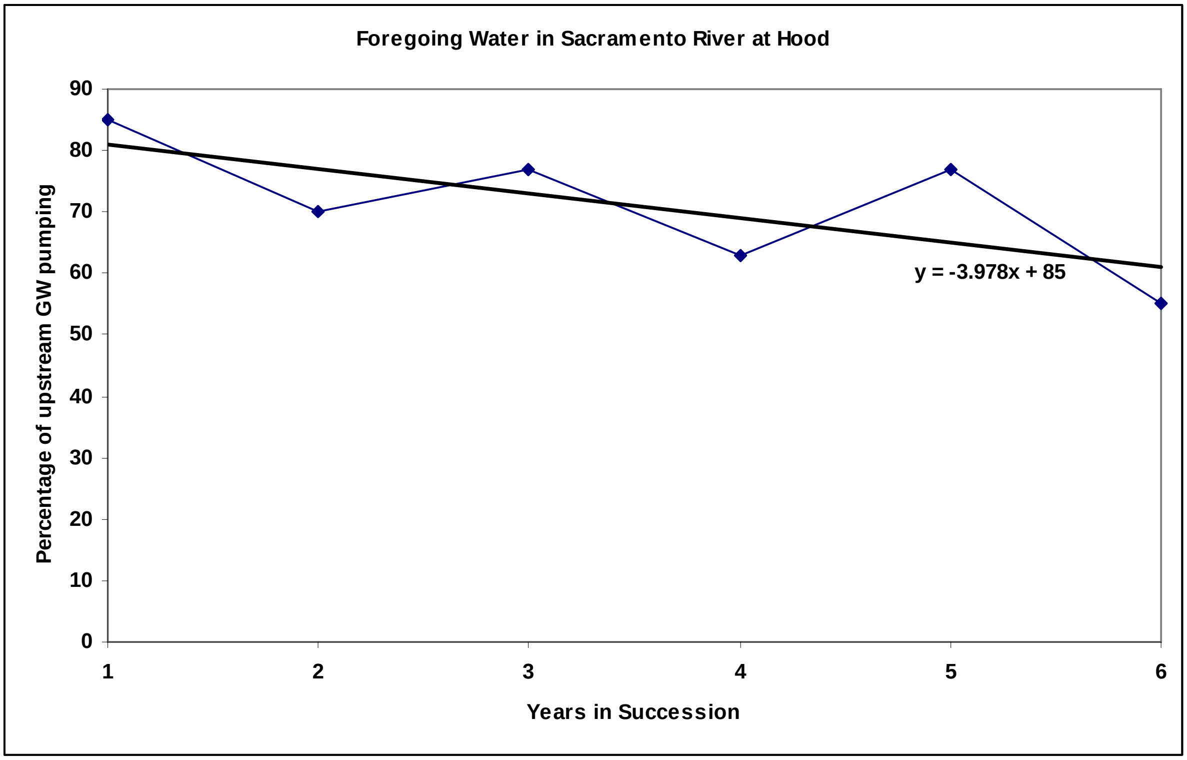


Figure H-4. . Percentage of surface water produced from upstream groundwater pumping that is available in the Sacramento River at Hood

Integration with SWP/CVP System

The Conjunctive Use program is considered an SWP/CVP project and will be directly integrated into the Coordinated Operations Agreement (COA) and operational decisions.

Comparison Data Sets

Currently no CALSIM II study is available to compare the results obtained from the simulation. However, an attempt is made to compare between CalLite with Conjunctive Use program and CalLite base. In Table H-3, higher inflows into Delta and deliveries to South of Delta clearly indicate the presence of Conjunctive Use program, as expected, especially during drought periods (1929-1934 and 1987-1992).

User Input and Output Requirements

User Input and Output Requirements Table H-2 shows the proposed user input and output requirements for the Conjunctive Use program implementation in CalLite. Note that the outputs only represent additional displays that are not included in the base model.

Table H-2. Input Controls and Output Displays for the Conjunctive Use Program

Input Control	Output Displays
Groundwater withdrawal percentage	Available water in Sacramento River at Hood
Fraction of water reaching Hood	Total Conjunctive Use program triggered
Reduction factors	
Recovery period	
SWP Allocation (Table A)	
CVP Allocation (SOD-AG)	

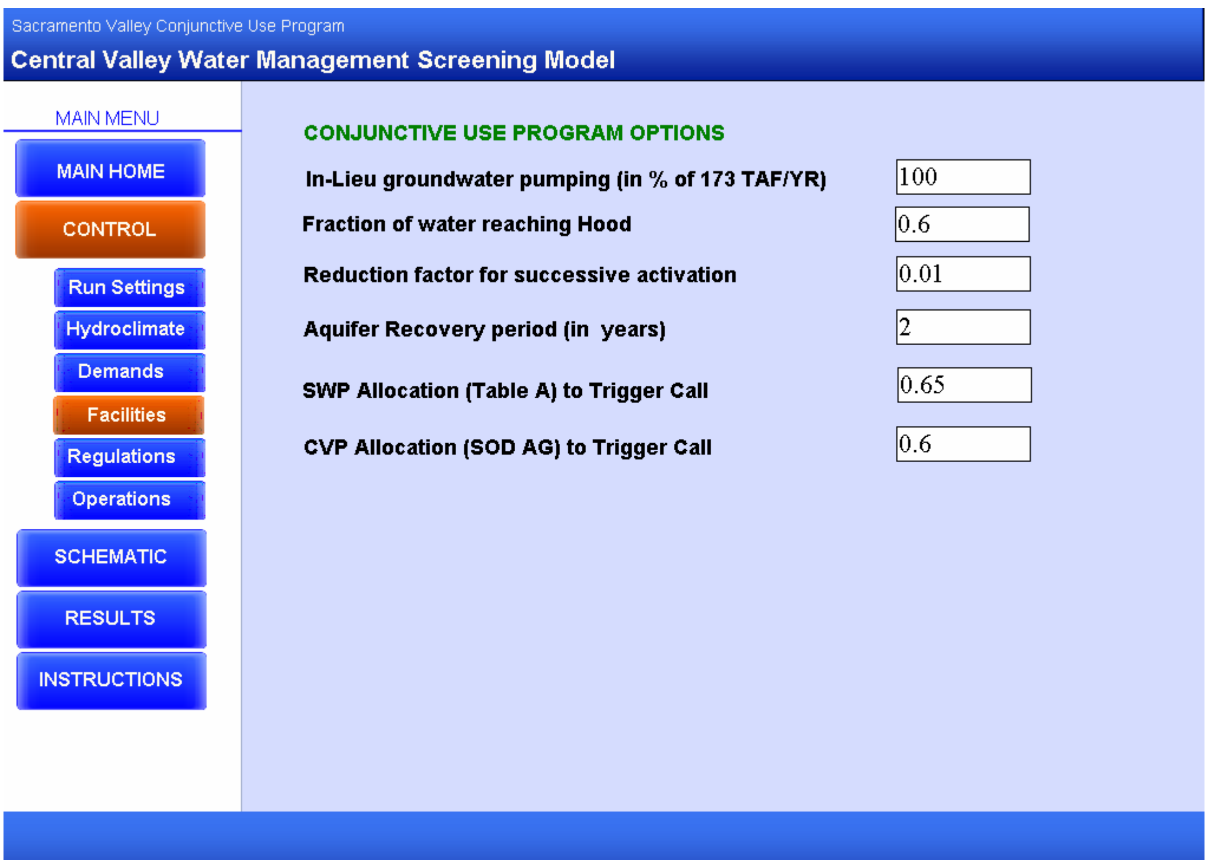


Figure H-5. CalLite dashboard for Conjunctive Use program elements

Limitations

Refined groundwater withdrawal information would represent the program accurately. Simplified reduction and recovery functions were used. In future update, user should be allowed to choose from to forego surface water in Sacramento River or to store water in the upstream reservoirs.

Table H-3. Results comparison between two CalLite studies of Conjunctive Use program scenario and the base scenario (Alt & Base)

	1922-2003			1929-1934			1987-1992		
	Alt	**Base**	**Diff**	**Alt**	**Base**	**Diff**	**Alt**	**Base**	**Diff**
River Flow									
Trinity R blw Lewiston	692	692	1	411	411	0	472	472	0
Trinity Export	549	549	-1	331	335	-4	425	429	-4
Clear Cr blw Whiskeytown	42	42	0	33	33	0	38	38	0
Sacramento R @ Keswick	6295	6296	-1	3935	3946	-11	4574	4597	-23
Sacramento R @ Wilkins Slough	6713	6694	19	4040	3969	71	4927	4896	31
Feather R blw Thermalito	3168	3168	0	1574	1578	-4	1619	1627	-8
American R blw Nimbus	2520	2520	0	1356	1362	-6	1219	1222	-3
Delta Inflow	**21996**	**21970**	**26**	**9998**	**9906**	**92**	**10797**	**10754**	**43**
Sacramento R @ Hood	16263	16237	26	8312	8214	98	9431	9384	47
Yolo Bypass	1926	1926	0	103	110	-6	126	130	-4
Mokelumne R	666	666	0	202	202	0	140	140	0
San Joaquin R d/s Calaveras	3141	3141	0	1381	1381	0	1100	1100	0
Delta Outflow	**14921**	**14906**	**15**	**5086**	**5044**	**41**	**5497**	**5535**	**-38**
Required	5565	5566	-1	4088	4090	-2	3911	3912	-1
Delta Diversions	**5994**	**5988**	**6**	**3652**	**3602**	**50**	**3968**	**3887**	**80**
Banks SWP	3317	3311	6	1925	1891	34	1979	1947	32
Banks CVP	0	0	0	0	0	0	0	0	0
Tracy	2677	2677	0	1726	1711	16	1989	1941	48
SWP SOD Deliveries	**3000**	**2993**	**7**	**1802**	**1770**	**32**	**1798**	**1762**	**36**
Table A	2737	2730	6	1662	1630	32	1757	1722	35
Article 21	246	245	0	134	133	0	30	30	0
Article 56	17	17	0	6	6	0	11	11	0
CVP SOD Deliveries	**2729**	**2723**	**6**	**1666**	**1647**	**19**	**1985**	**1943**	**42**

Appendix I Los Vaqueros Reservoir Enlargement Modeling Documentation

Program Description

The Los Vaqueros Enlargement (LVE) program involves the expansion of the Los Vaqueros Reservoir (LVR), and expansion of the existing San Joaquin Old River Pumping Plant and planned construction of the Alternate Intake on Middle River. The project goals include the development of long term Environmental Water Account (EWA) supplies and to provide water supply reliability to Bay Area M&I customers. This capability has not been implemented in the CalLite model. This representation of the LVE program is intended to demonstrate the flexibility of the implementation of complex diversion and blending operations within the Goldsim Modeling environment.

Program Core Elements

The following core elements are included in the LVE program:

- LVR maximum capacity of 500 TAF
- Increase diversion capacity at the Old River Pumping plant to 420 cfs
- Use the planned Alternate intake on Middle River of 250 cfs
- Use existing Rock Slough pumping Intake of 350 cfs
- Maximum target chloride at CCWD delivery of 65 mg/L
- Improve water quality and reliability of deliveries to CCWD customers
- Water may be delivered to the East Bay M&I water providers , and Delta Agricultural users (not yet implemented)

Options Considered

For the purposes of the screening model implementation, the following options are to be considered:

- LVR storage capacity: 100 – 500 TAF
- Diversion from Rock Slough: 0 – 500 CFS
- Diversion from Old and Middle river: 250 - 670 CFS
- Maximum target chloride at CCWD delivery: 40-200 mg/L

Schematic Representation

The schematic representation in CalLite will involve multiple diversions at the Delta, pipelines, a transfer facility, and an offstream reservoir enlargement. The general project location is shown in Figure I-1 and a markup of the CalLite network is shown in Figure I-2.

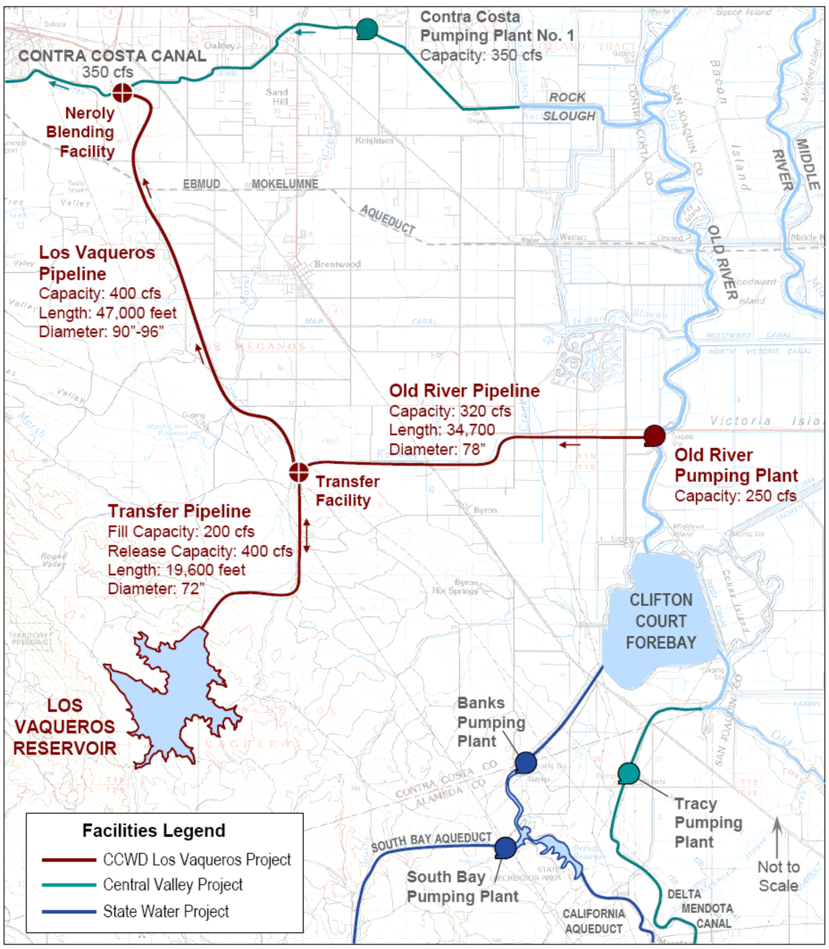


Figure I-1. General location of Los Vaqueros Enlargement program features

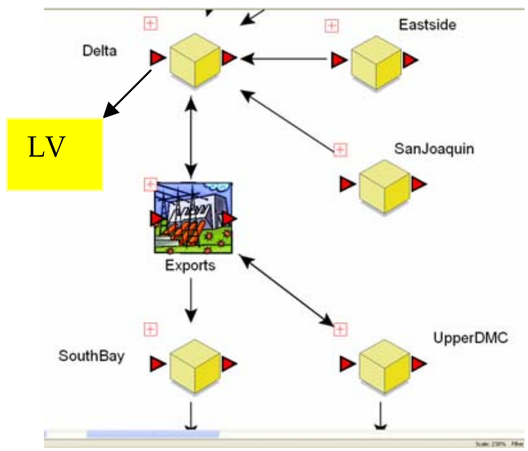


Figure I-2. CalLite schematic representation of the Los Vaqueros Enlargement

Facility Operations

The facility parameters and implemented operations are listed below:

<u>LVE Diversions</u>

- CCWD contract amount 195 TAF
- CCWD total demands are as follows: 149 TAF /year Wet , 157 TAF/year Above Normal , 162 TAF /year Below Normal, 175 TAF/ Year Dry, 184 TAF /year Critical
- CCWD water transfers base on year type : 1 TAF /year Wet , 11 TAF/year Above Normal, 31 TAF /year Below Normal, 39 TAF/ Year Dry, 73 TAF /year Critical
- Water Quality constraints on diversions must be below 50 mg/L Chloride at Rock Slough, Old River and Victoria canal at AIP (Uses DSM2 output ROLDO24, ROLD034, 229_3048). This requires ANN DLL functionality.

Integration with SWP/CVP System

The LVE project under the D1641 regulatory environment will be considered a Bay Area water supply reliability program due to no EWA implementation in the current version of CalLite. This program has not been implemented into CalLite, however.

Verification Data Sets

Verification CALSIM II model simulations are not available for the D1641 regulatory environment with Alternative Intake Project (AIP), therefore no verification data sets are currently available.

User Input and Output Requirements

Table I-1 shows the user input and output requirements for the LVE program implementation in CalLite. Note that the outputs only represent additional displays that are not included in the base model.

Table I-1. Input Controls and Output Displays for the Isolated Facility Program

Input Control	**Output Displays**
LVR maximum capacity	Old and Middle River diversions
CCWD AIP diversion capacity	LVR Storage
CCWD Old River diversion capacity	Diversion Water Quality
CCWD Rock Slough diversion capacity	CCWD Deliveries
CCWD target chloride at delivery	CCWD Delivery Water Quality

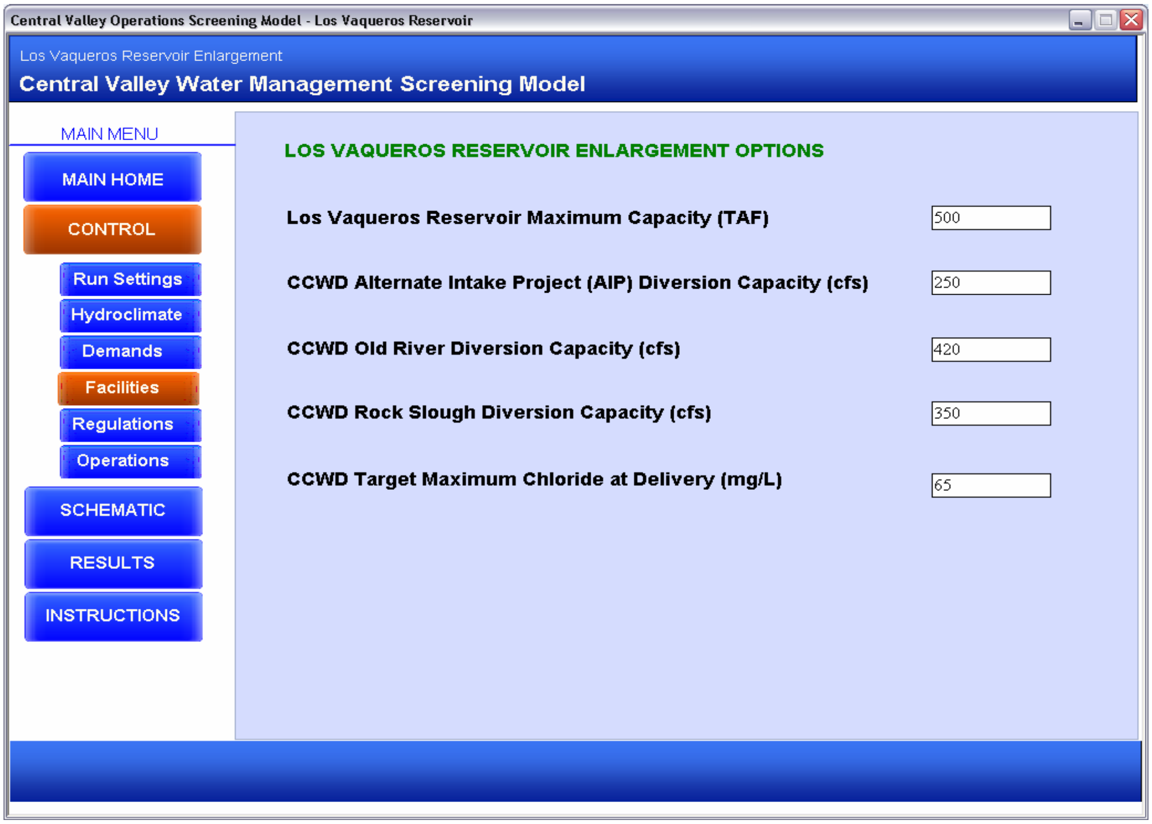


Figure I-3. The Los Vaqueros Reservoir Enlargement option dashboard

Limitations

Implementation at this point is reduced from that for CALSIM II. Since specific components of the LVE expansion, such as AIP are in Future-with-Project model studies of CALSIM II the implementation is limited to demonstrative value.

Appendix J Increased Storage in the Upper San Joaquin River Watershed Modeling Documentation

Program Description

As outlined in the CALFED ROD, additional storage in the upper San Joaquin River watershed "…would be designed to contribute to the restoration of and improve water quality for the San Joaquin River and facilitate conjunctive water management and water exchanges that improve the quality of water deliveries to urban communities." The increase in storage was proposed to come from the enlargement of Millerton Lake or the development of a new upstream reservoir. Millerton Lake is located on the San Joaquin River in the foothills of the Sierra Nevada north of Fresno. Note that this version of the model does not include this module to run CalLite.

Screening Model Representation

Millerton Lake's existing storage capacity is 524 TAF. Two proposed dam locations upstream of Millerton would add 690 TAF or 1,260 TAF to Millerton's existing capacity on the Upper San Joaquin River. As such, the screening model provides three options to the user: a base simulation with the 524 TAF Millerton Lake (Base), a study simulation with an increase in Upper San Joaquin River Storage (USJRS) of 690 TAF (TF1), or a study simulation with an increase in USJRS of 1,260 TAF (TF2). An USJRS screening model schematic is shown in Figure J-1.

Aside from storage capacity, all facility operations logic was embedded in the model. This includes allocation and delivery logic for the Friant Division. Class 1, Class 2, and Section 215 deliveries were made to Friant water users using the same delivery and allocation logic found in CALSIM II. Deliveries to Friant water users were diverted from Millerton Lake through the Madera and Friant-Kern Canals. Appropriate canal capacity constraints were included. Some simplifications of were made regarding response of groundwater pumping to increased allocation in the Madera Canal service area.

Three types of reservoir releases were represented in the screening model. The first is the minimum release necessary to meet local demand between Friant Dam and Gravelly Ford including in-stream losses. Second, snowmelt releases are scheduled when anticipated snowmelt exceeds available storage and forecast deliveries through June 1. Lastly, flood releases are made to maintain flood pool capacity. Seasonal flood pool sizing remains consistent with CALSIM II regardless of user specified reservoir capacity.

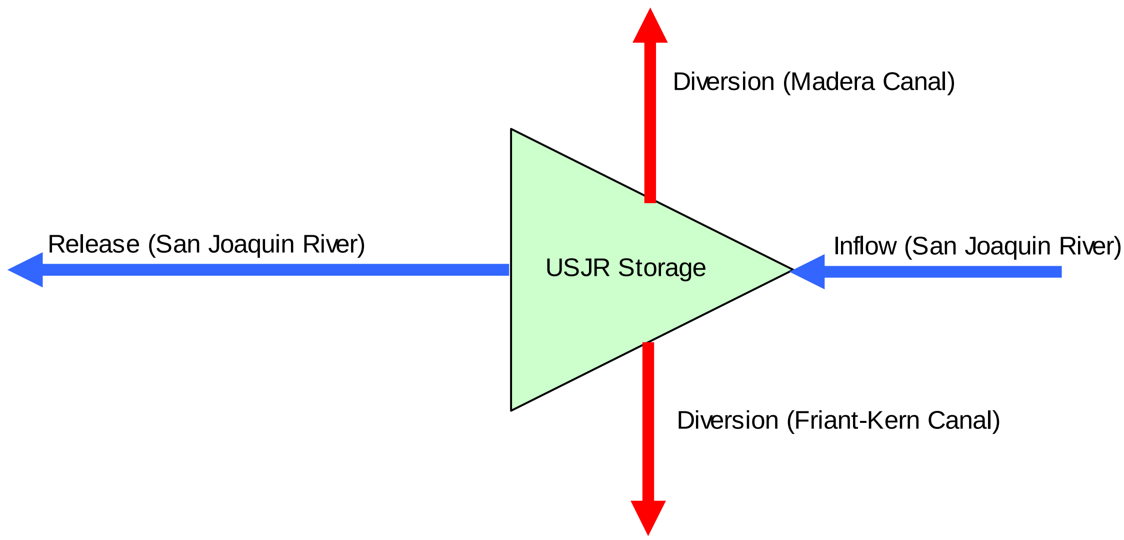


Figure J-1. CalLite schematic representation of Upper San Joaquin River storage

Modeling of USJRS Operations in CalLite

This section provides the necessary details to approximate CALSIM II operations of USJRS in CalLite, and states key outputs for describing the system

Reservoir Inflow

- Inflow to USJRS was a timeseries input in the state variable DSS file (I18)

Flood Pool Calculation

- Monthly flood pool pattern was maintained for all storage scenarios. CALSIM II lookup table Friant-FC-Limits was altered to represent flood pool capacity instead of maximum monthly storage capacity.
- Available capacity at Mammoth Pool included as difference between maximum Mammoth pool capacity (120 TAF) and monthly storage. Mammoth Pool storage kept in state variable DSS file with name mammoth_storage.

Canal Capacities

- Friant-Kern Canal has 5000 cfs diversion capacity from USJRS.
- Madera Canal has 1250 cfs diversion capacity from USJRS.

Minimum Reservoir Release

- Minimum monthly release from Millerton Lake for downstream diversions and associated channel losses is defined in lookup table Upper_SJR_losses under column “inc” by contract_month where March is month 1.

Class 1, Class 2, and Section 215 Allocations and Deliveries

- Water supply forecasts are made March through June. This is the sum of forecasted inflows and presently available storage reduced by forecasted evaporation, minimum flow releases, and canal losses. All forecasted information is contained in lookup tables or the state variable DSS file.
- Class 1 allocations have highest priority with a maximum annual allocation of 800 TAF. From March through June Class 1 allocations for the remainder of the contract year are the minimum of the water supply forecast of the difference between the maximum annual allocation (800 TAF) and Class 1 water already delivered in the current contract year.
- Class 2 allocations secondary to Class 1 and are dependent on forecasted snowmelt releases and past flood flow releases. Forecasted snowmelt releases will be described in more detail below. In March, the Class 2 allocation is the minimum of the maximum annual allocation (1400 TAF) and the difference between the water supply forecast and Class 1 allocations plus forecasted snowmelt releases. For the remainder of the contract year, Class 2 allocations are altered to reflect unexpected flood releases and changes in the snowmelt release forecast.
- Monthly Friant-Kern and Madera canal losses are defined in lookup table Friant_canal_losses.
- Total and Class 1 delivery patterns are defined monthly using lookup tables. Class 2 monthly delivery patterns are determined by the difference between the two.
- Section 215 deliveries are delivered when the Tule wetness index is less than 41, snowmelt or flood spills are forecasted, and capacity is available in the canals.

Spill Forecasting and Releases

- Snowmelt release forecasts are made February through June and are based on forecasted inflows, available storage capacity, forecasted deliveries and minimum releases and forecasted evaporation. Four lookup tables contain snowmelt release patterns.
- Flood releases are made to preserve flood pool capacity. Each time-step, a monthly flood release forecast is made for purposes of allocating Section 215 water. Seven percent of flood releases flow down the Madera Canal. This is capped by Madera canal capacity.

Key Output

1. Upper San Joaquin River Storage.
2. Friant-Kern and Madera Canal deliveries
3. USJRS releases.

Verification Data Sets

The three USJRS screening model scenarios were verified by comparing CalLite results with to CALSIM II. For the purpose of this appendix, we'll compare the Base and TF2 USJRS operations. Figure J-2 shows Millerton Lake storage operations for both models. There is very little deviation. Figure J-3 compares exceedance probability plots for USJRS releases. Again, the differences are very small. Friant-Kern Canal delivery exceedance probability plots are shown in Figure J-4, and exceedance plots for Madera Canal deliveries are shown in Figure J-5. CALSIM II and CalLite results compare well in both cases.

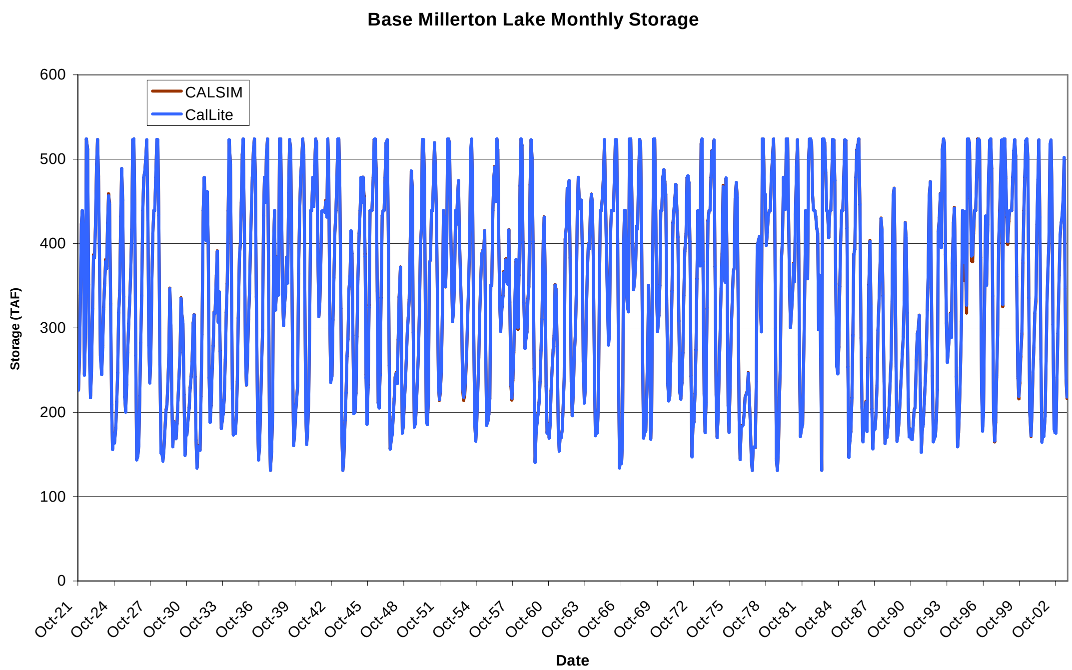


Figure J-2. Comparison of CalLite and CALSIM II Base scenario USJRS

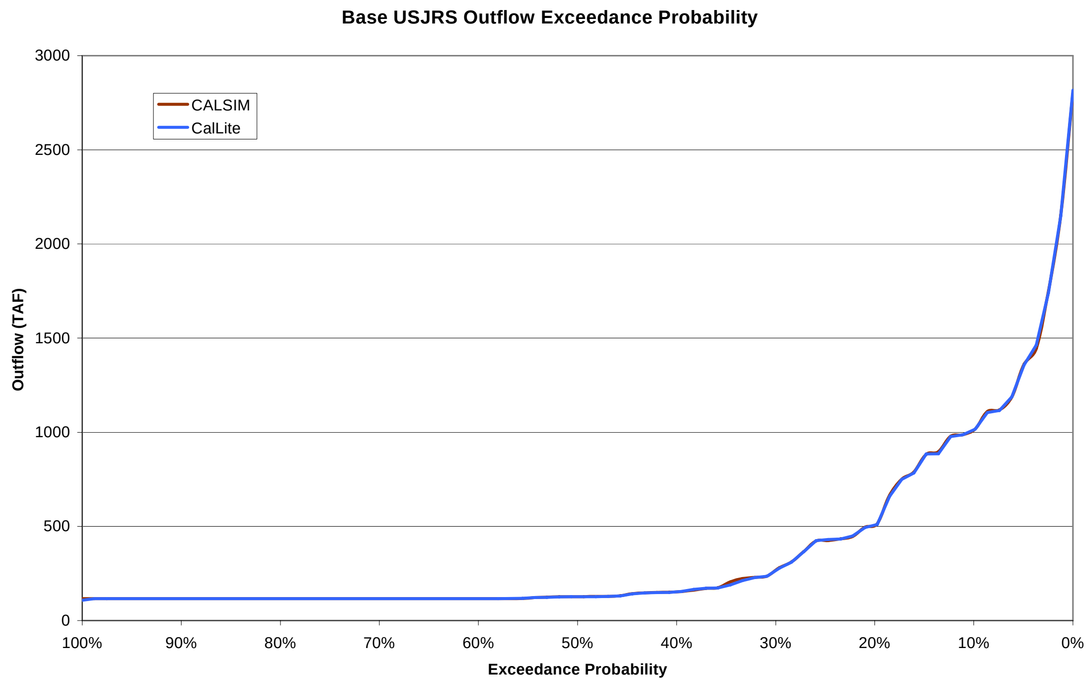


Figure J-3. Comparison of Base scenario USJRS outflow exceedance probability

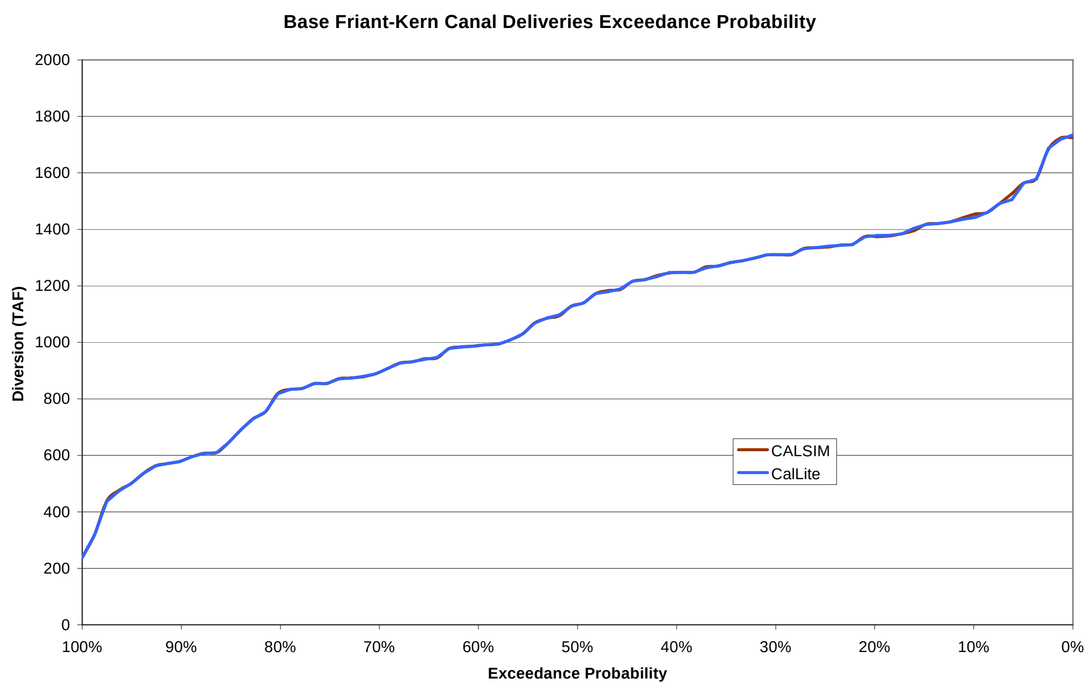


Figure J-4. Comparison of Base scenario Friant-Kern Canal delivery exceedance probability

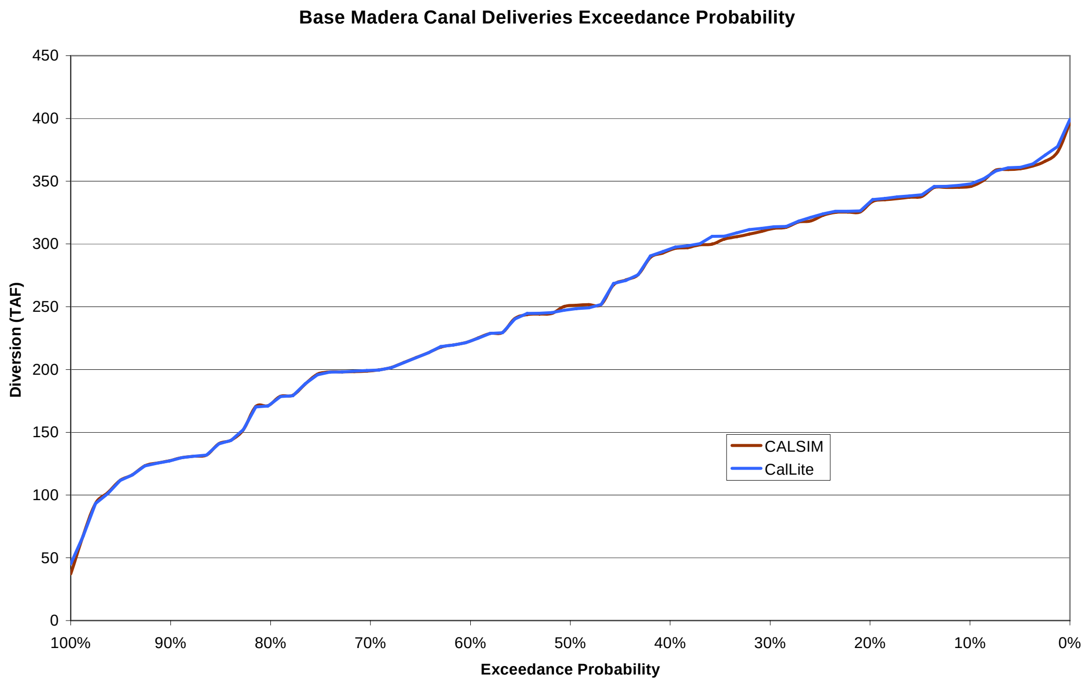


Figure J-5. Comparison of Base scenario Madera Canal delivery exceedance probability

For the TF2 scenario, USJRS is plotted in Figure J-6. Note that with increased storage the reservoir now fills to approximately 1.8 MAF. Looking back at Figure J-2, the reservoir in the Base scenario filled to a maximum of 524 TAF. As for the CalLite versus CALSIM II comparison in scenario TF2, reservoir storage tracks closely with minor differences. Figure J-7, Figure J-8, and Figure J-9 show exceedance plots for USJRS outflow, Friant-Kern deliveries, and Madera deliveries respectively. CALSIM II and CalLite results compare closely in all four figures. The differences seen could be caused by some of the screening model simplifications. In CALSIM II, Millerton and the proposed upstream reservoir are modeled as separate reservoirs with different storage-area curves; in the screening model the reservoirs are combined with an estimated storage-area curve. Because of this, there are differences in evaporation. Also, Madera Canal service area operations are simplified in CalLite which causes small changes in USJRS operations overall.

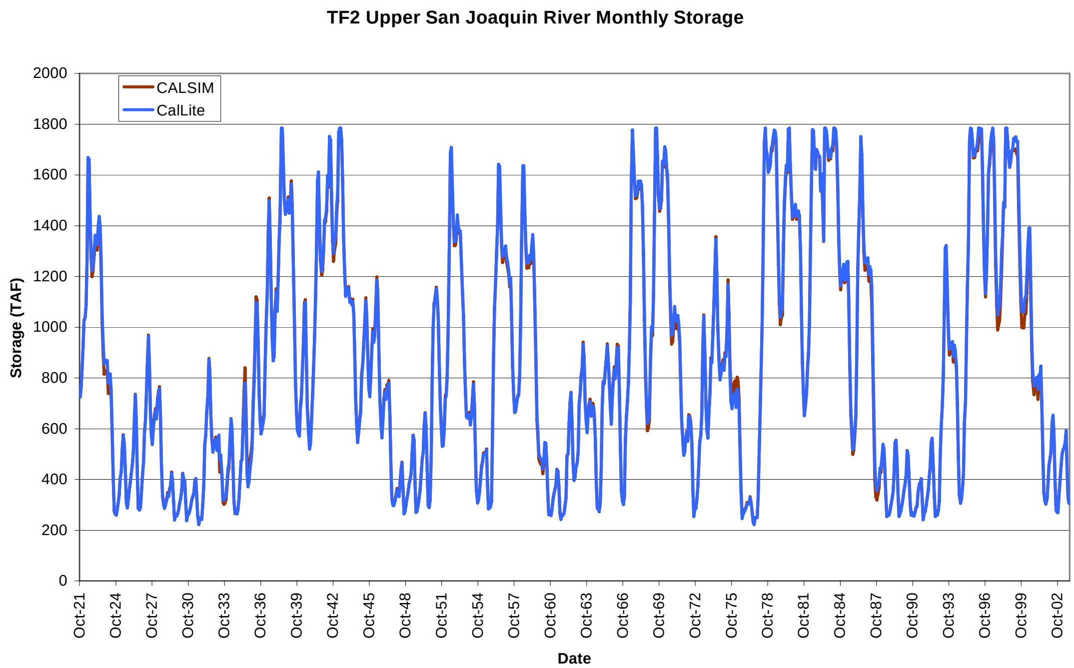


Figure J-6. Comparison of CalLite and CALSIM II TF2 scenario USJRS

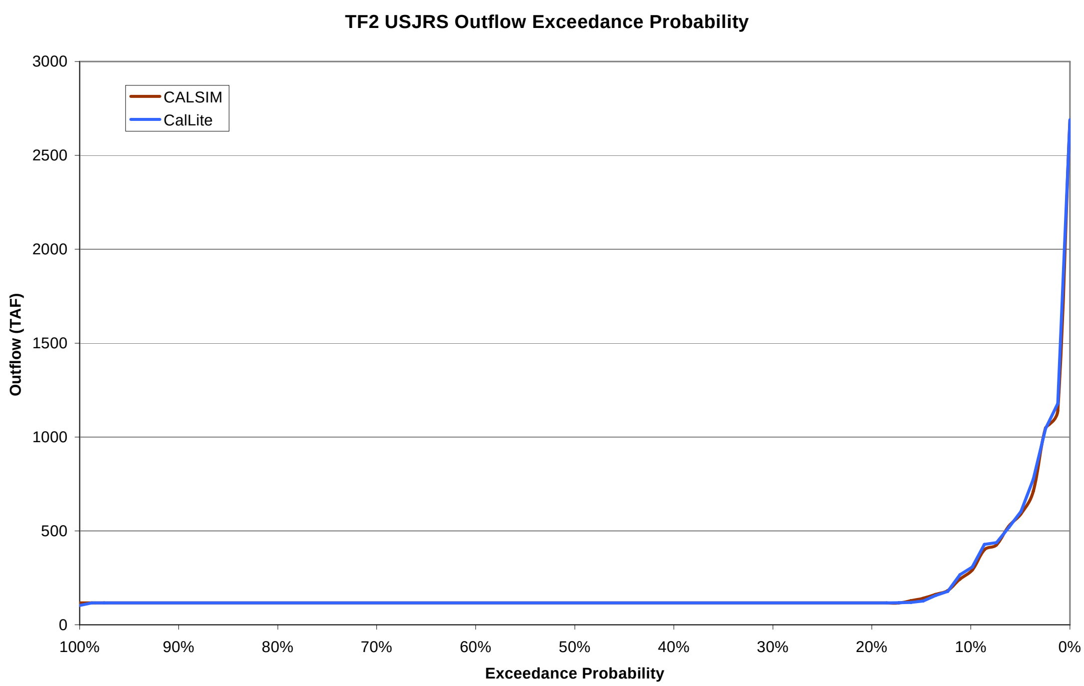


Figure J-7. Comparison of TF2 scenario USJRS outflow exceedance probability

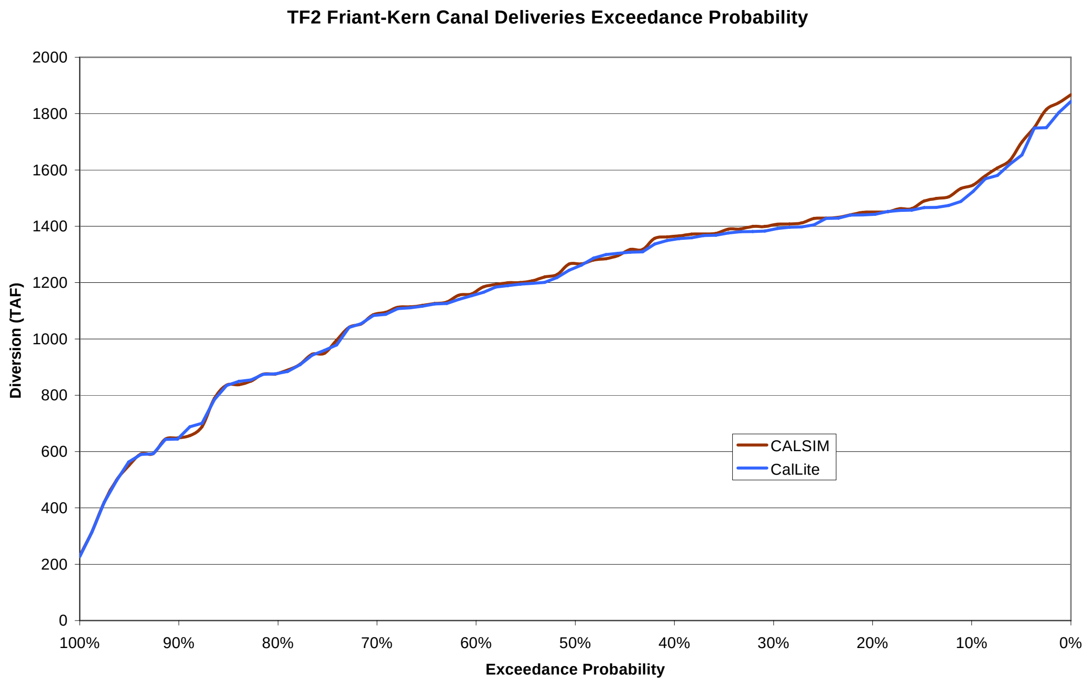


Figure J-8. Comparison of TF2 scenario Friant-Kern Canal delivery exceedance probability

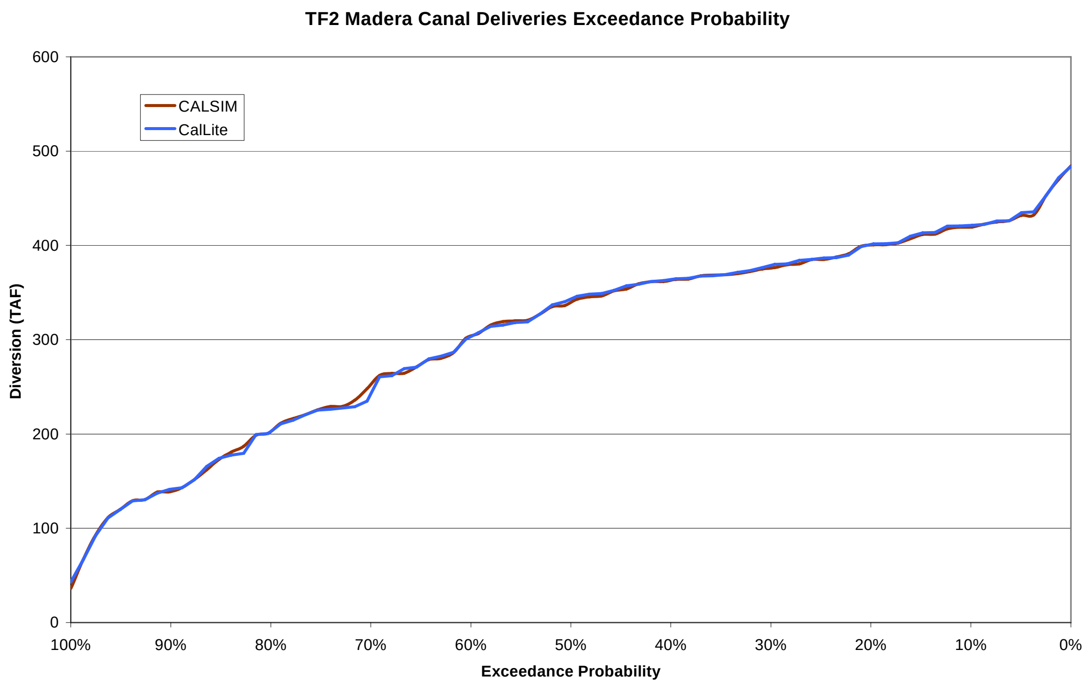


Figure J-9. Comparison of Base scenario Madera Canal delivery exceedance probability

Limitations

Because of the limited scope of the USJRS screening model, measured benefits are limited to water supply reliability within the Friant Division along the eastern San Joaquin Valley. Measuring impacts downstream of the USJRS project would require integrating San Joaquin River Basin operations with the Sacramento – San Joaquin Delta operations and corresponding CVP and SWP exports. Reductions in snowmelt releases and flood flows to the San Joaquin River could result in higher demand for CVP water at the Mendota Pool. Also, USJRS operations will impact flow and water quality at Vernalis which, in turn, can affect CVP and SWP Delta operations. None of this was accounted for in the screening model. Furthermore, Madera Canal operations in CalLite are dependent on CALSIM II II output. This required CALSIM II output to be generated for all three scenarios in CalLite. If a fully dynamic representation of USJRS operations is desired in CalLite, it will require dynamic Madera Irrigation District and Chowchilla Water District operations.

Appendix K Delta Regulatory Controls Modeling Documentation

This brief fact sheet describes the implementation of Delta regulatory controls into the CalLite model. The regulatory controls in CalLite allow users to specify requirements for interior Delta flows, minimum river flows, Delta outflows, export restrictions, and salinity objectives. Figure K-1 shows the location of the Delta regulatory controls incorporated in the CalLite model.

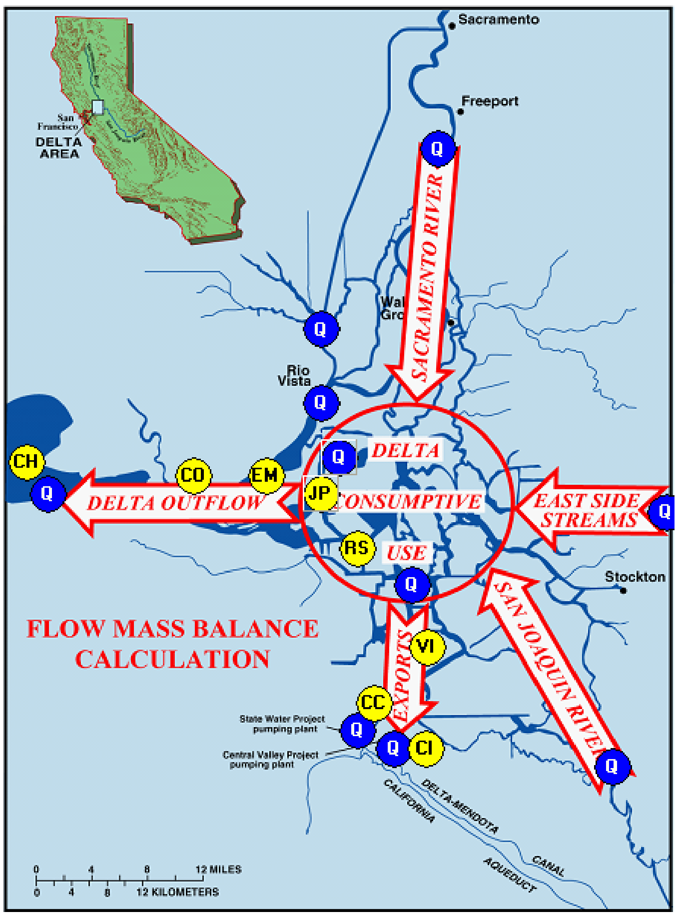


Figure K-1. CalLite Delta regulatory control locations

The methodology used in the implementation of Delta regulatory controls is generally similar to that used in the CALSIM II model. However, in the CalLite model, the user can switch requirements on or off, specify Decision 1641 requirements, or specify new values for these requirements. These user selections are specified through a dashboard (user-interface) as shown in Figure K-2. If the user chooses to customize the constraints, then the "Assumptions" button links to an external spreadsheet for input (CalLite_ControlInput.xls).

The sections that follow describe the main Delta regulatory controls, assumptions, and method of implementation. The main controls are:

- Old and Middle R minimum flows (or max negative flows)
- Delta Cross Channel gate position
- San Joaquin R near Jersey Point minimum flow
- Sacramento R at Rio Vista minimum flow
- Minimum Delta outflow
- X2 requirements
- Export-inflow ratio
- VAMP export restrictions
- Export-inflow ratio based on San Joaquin River inflow to the Delta
- Salinity standards at Emmaton, Jersey Pt, Rock Slough, and Collinsville

Figure K-2. Delta Regulatory Control dashboard in CalLite

NOTE: San Joaquin River at Vernalis minimum flow target is currently not implemented in the model.

River Flows

Sacramento River at Rio Vista Minimum Flow

This minimum flow for the Sacramento River at Rio Vista is specified by month and water year type. If natural flow is insufficient to meet the requirement, additional flow is provided through releases from CVP and SWP reservoirs. Calculations of additional releases account for upstream loss of water through the DCC and Georgianna Slough, depending on gate position.

San Joaquin River at Vernalis Minimum Flow

Currently, the CalLite model does not have an integrated San Joaquin River model. A separate stand-alone San Joaquin River model is used to provide input to this model. Thus, the minimum flow requirement at this location is not currently implemented.

Delta Outflow

Minimum Net Delta Outflow (NDO)

This minimum net Delta outflow is specified by month and water year type. If natural flow is insufficient to meet the requirement, additional flow is provided through releases from CVP and SWP reservoirs. Calculation of total required Delta outflow considers the NDO flow requirement and the X2 required outflows described below.

X2 Requirements

X2 is a measure of the distance (in km) from Golden Gate Bridge of 2 parts per thousand chloride. The X2 position is estimated using the regression model developed Jassby et. al. (1995) relating current X2 position to net Delta outflow and antecedent X2 position.

$$X2^{t} = 122.2 + 0.3278 * X2^{t-1} - 17.65 * \log(Q^{t})$$

When operated under D-1641 standards, the required outflow is calculated using a day-weighting scheme to account for the number of days in each month required at Roe Island, Chipps Island, and the Confluence. When customized standards are desired, the user enters desired monthly average X2 position by month and water year type. When customized standards are desired, the user selects the months that will have user-defined X2. Once these months are selected, the user enters desired monthly average X2 position by month and water year type. For all the months that are not selected to be modified by the user, CalLite assumes D1641 standards.

Interior Delta Flows

San Joaquin River near Jersey Point (QWEST)

The San Joaquin River flow near Jersey Point, often called QWEST, is often used as an indicator of flow reversals in the lower San Joaquin River. Some have proposed minimum flow requirements based on QWEST to sustain transport flows in the westward direction. QWEST is calculated using the mass balance equation reported in IEP's DAYFLOW database. This equation approximates QWEST as the sum of all of the eastside streams including the San Joaquin River plus the calculated cross transfer flow (flow through Georgiana Slough and the Cross Channel) minus sixty five percent of the net channel depletions minus total pumping exports:

$$Q_{WEST} = Q_{SJR} + Q_{CSMR} + Q_{Mokelume} + Q_{Misc} + Q_{XGEO} - 0.65 * (Q_{GCD} + Q_{PREC}) - Q_{EXPORT} - Q_{MISDV}$$

where:

Q_{SJR} = San Joaquin River flow at Vernalis,

Q_{CSMR} = Cosumnes River flow,

$Q_{Mokelume}$ = Mokelumne River flow,

Q_{Misc} = Miscellaneous inflows including Calaveras River,

Q_{XGEO} =Delta cross-channel and Georgianna Slough flow,

Q_{GCD} =Delta gross channel depletions,

Q_{PREC} =Delta precipitation,

Q_{EXPORT} =Exports at SWP Banks, CVP Jones, Contra Costa WD, and North Bay Aqueduct, and

Q_{MISDV}=Miscellaneous diversions.

QWEST restrictions in the CalLite model are translated into a maximum export restriction through solution of the DAYFLOW equation. Export capacity under QWEST controls are currently shared equally between the SWP and CVP. In some circumstances, the QWEST target cannot be solely satisfied through export reductions. In these cases, exports are specified as zero, but no additional flow is provided through the San Joaquin River or through the DCC.

Old and Middle River combined flow (OMR)

Combined Old and Middle River flows restrictions are proposed as a means for reducing flow reversals in these channels and limiting Delta smelt entrainment at the SWP and CVP export facilities.

Four regression equations are available for use in approximating the OMR flows. The first, recently developed by Paul Hutton (2007), has calibrated on historic flow conditions as well as a full range of hydrodynamic simulation results using the DSM2 model. This equation relates OMR flow to south Delta diversions (including CCWD and Delta Island channel depletions) and Vernalis flow. The equation includes differing coefficients depending on Vernalis flow, head of Old River barrier (HORB) operation, and Grant Line Canal (GLC) barrier operation as shown below. This equation is reported to be the most accurate of the four, but no independent analysis has been performed.

$$Q_{OMR}\text{ (cfs)} = A * Q_{Vernalis} + B * Q_{South\ Delta\ Diversions} + C$$

$$\text{Where: } Q_{South\ Delta\ Diversions} = Q_{CCF} + Q_{Jones} + Q_{CCWD} + Q_{South\ Delta\ NCD}$$

HORB	**GLC Barrier**	**Vernalis (cfs)**	**A**	**B**	**C**
Out	Out	< 16,000	0.462	-0.911	120
Out	Out	16,000-28,000	0.681	-0.940	-2982
Out	Out	> 28,000	0.634	-0.940	-1654
Out	In	All	0.405	-0.940	183
In (Spring)	Out/In	All	0.079	-0.940	73
In (Fall)	Out/In	All	0.259	-0.940	-9

The three other regression equations for OMR are based on older analysis by DWR and the USGS and relate OMR flow to SWP/CVP exports and Vernalis flow. These equations include differing coefficients for OMR flow based on Vernalis flow, and the USGS2 equation includes a further adjustment for the HORB operation.

$$Q_{OMR}\text{ (cfs)} = A * Q_{Vernalis} + B * Q_{export} + C$$

$$\text{Where: } Q_{export} = Q_{CCF} + Q_{Jones}$$

OMR Eqn	**Vernalis (cfs)**	**A**	**B**	**C**
DWR	All	0.58	-0.913	0
USGS1	All	0.4486	-0.7695	-590
USGS2	<10,000 cfs (w/ barriers)	0	-0.8219	-365
USGS2	<10,000 cfs (w/o barriers)	0	-0.8738	1137
USGS2	>10,000 cfs	0.7094	-0.7094	-4619

As with the QWEST, OMR restrictions in the CalLite model are translated into a maximum export restriction through solution of the equations above. Export capacity under OMR controls are currently shared equally between the SWP and CVP. In some circumstances, the OMR target cannot be solely satisfied through export reductions. In these cases, exports are specified as zero, but no additional flow is provided through the San Joaquin River.

Delta Cross Channel (DCC)

Operation of the Delta Cross Channel (DCC) assists in transferring fresh water from the Sacramento River across the Delta (DWR 1993). Flow from the Sacramento River into the DCC is controlled by two radial arm gates located at the Sacramento River end of the DCC. These gates can be opened and closed depending on water quality, flood protection, and fish protection requirements. Historically during periods of high salinity the DCC gate has been opened, and during periods of low salinity the DCC gate has been closed. The USBR and DWR have been operating the DCC in accordance with D-1641 since its establishment.

The operation of the DCC in CalLite is simulated as the fraction of the month that the gate remains open. Under either D-1641 or user-specified operation, the number of days “open” are specified and a fraction is computed internally depending on the number of days in the month.

The flow through the DCC and Georgianna Slough are estimated based on the regression equations that relate DCC+GEO flow to upstream Sacramento River flow and gate position.

$$Q_{dcc+geo\_open} = 0.293*Q_{sac}+2090 \text{ cfs (DCC gates open)}$$

$$Q_{dcc+geo\_closed} = 0.133*Q_{sac}+829 \text{ cfs (DCC gates closed)}$$

The diversion from Sacramento River to the Central Delta is then calculated as:

$$Q_{dcc+geo\_open}*DCC\_FractOpen+Q_{dcc+geo\_closed}*(1-DCC\_FractOpen)$$

The DCC impact on salinity is considered in the Artificial Neural Network (ANN) flow-salinity models.

Export Limits

Maximum exports are based on conveyance restrictions, VAMP export limits, export-inflow (EI) ratio, and salinity controls. In addition, as discussed above the QWEST and OMR restrictions are translated into export maximums. The VAMP and EI ratio limits can be modified by the user and are discussed here.

Export-Inflow Ratio

EI ratio restrictions limit the combined export rate of the SWP and CVP to a specified percentage of the total Delta inflow. The EI ratio values are used to set a maximum export flow in the model. When D-1641 standards are specified the February value is computed based on the January eight river index, while all other months have a specific maximum EI ratio. When user-defined values are specified, all months have specific maximum ratios. If EI ratio limits total project exports, the export capacity is shared equally between the SWP and CVP. Unused share of the export capacity by one party can be used by the other party.

Export- San Joaquin River Inflow Ratio

A user defined E/I ratio based on San Joaquin river at Vernalis is built in the model and works similar to what has been explained in the above section. Since San Joaquin River is not simulated dynamically in Cal-Lite, this implementation only serves as a cap on the maximum allowable exports from the Delta. It has no affect in increasing Delta inflows.

Vernalis Adaptive Management Program (VAMP) Export Limits

SWP and CVP exports are commonly restricted during the VAMP window of April 15 – May 15 to a combined rate of the maximum of 1500 cfs or the flow at Vernalis. As with other export limits, the available export capacity is shared equally between the SWP and CVP.

Salinity

The salinity at Sacramento River at Collinsville, Sacramento River at Emmaton, San Joaquin River at Jersey Point, Old River at Rock Slough are estimated in the CalLite model through implementation of the most recent ANNs developed by DWR (1995). The ANNs receive input of boundary flows, DCC gate position, exports, and tides to estimate salinity (electrical conductivity) at each of these locations. Through a linkage to the external ANNs, the CalLite model can both simulate the monthly and 14-day average salinity in the forward direction, and approximate the maximum export for a given maximum salinity in the reverse direction. The maximum export capacity is once again shared equally between the SWP and CVP. The CalLite model allows the user to turn on and off specific standards, but the ability to specify new standards is not currently enabled.

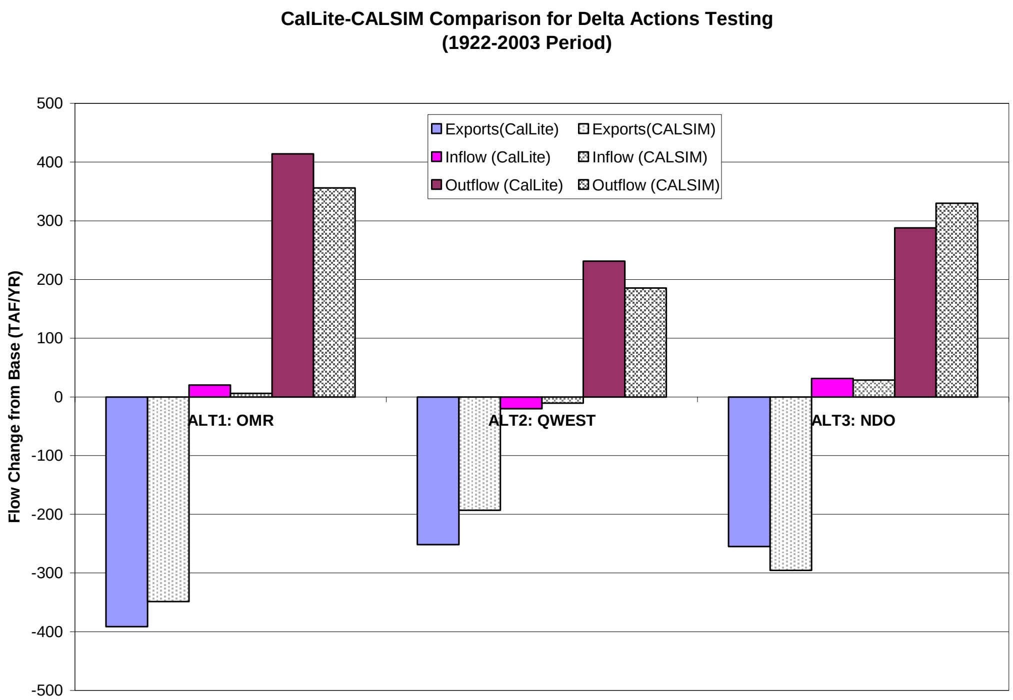


Figure K-3. Comparison of Delta flow changes between CalLite and CALSIM II for the 1922-2003 period for various Delta actions

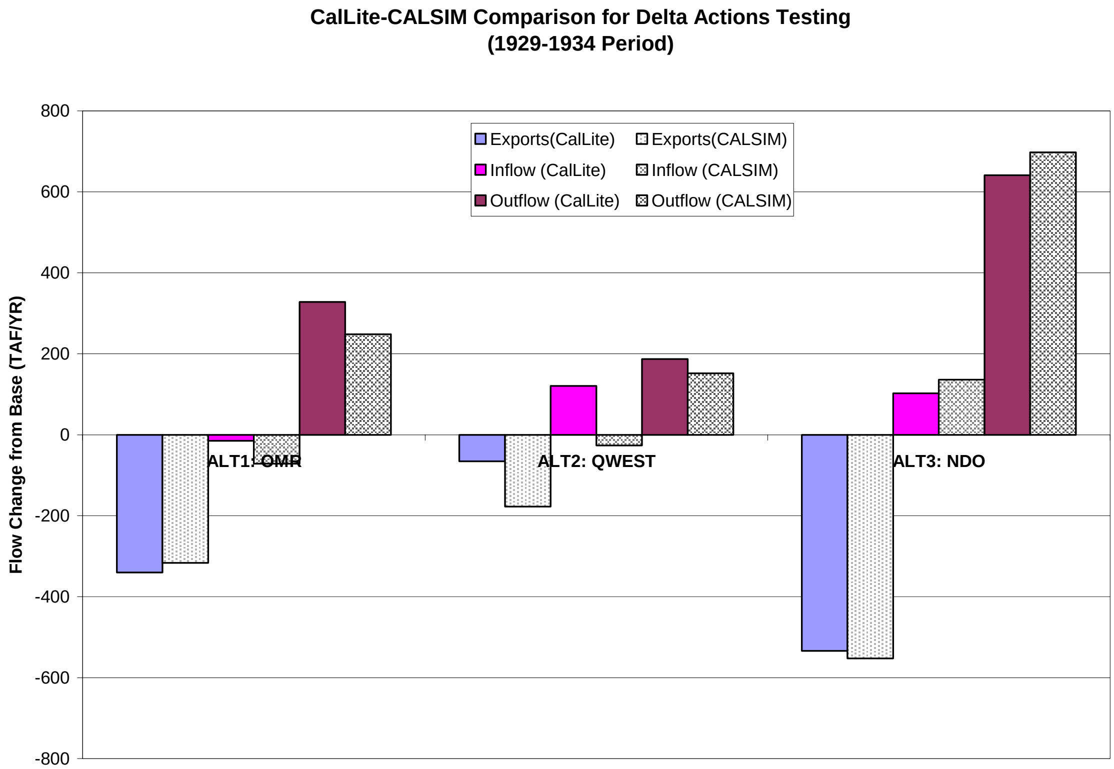


Figure K-4. Comparison of Delta flow changes between CalLite and CALSIM II for the 1929-1934 period for various Delta actions

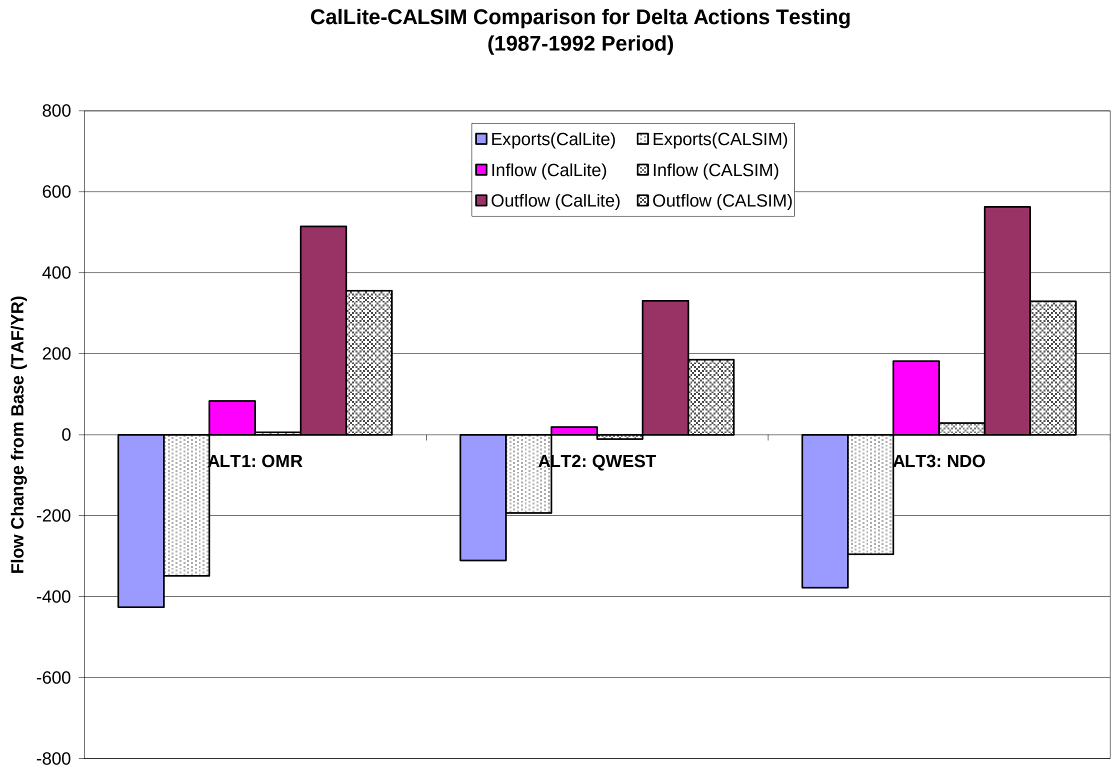


Figure K-5. Comparison of Delta flow changes between CalLite and CALSIM II for the 1987-1992 period for various Delta actions

References

Department of Water Resources, 1995. Methodology for flow and salinity estimates in the Sacramento-San Joaquin Delta and Suisun Marsh. Sixteenth annual progress report to the State Water Resources Control Board.

Hutton, 2007. OMR Flow Model Section 6, ROUGH DRAFT. September 28. 2007

Jassby AD, Kimmerer WJ, Monismith SG, Armor C, Cloern JE, Powell TM, Schubel JR, Vendlinski TJ. 1995. Isohaline position as a habitat indicator for estuarine populations. Ecological Applications 5:272-289.

Appendix L Banks Pumping Plant Capacity Options

Program Description

This facility has been implemented to provide user options to choose monthly varying pumping capacity at Banks Pumping Plant. Note that CalLite applies the existing permit, by default, if users do not check the Banks Pumping Plant facility option on the dashboard. Users can choose between 0 cfs to 10300 cfs (physical capacity) for a particular month. In addition, users can limit the south Delta flow to the existing permit. In other words, the Clifton Court Forebay (CCF) intake can be limited to existing permit. In such case, additional water may come through an isolated facility, if selected, to meet user defined pumping capacity.

Options Considered

The following core elements and/or options are included at the Banks Pumping Plant:

- Pumping capacity can vary from shut down (0 cfs) to physical capacity (10300 cfs)
- Pumping capacity can vary monthly
- Clifton Court Forebay (CCF) intake can be limited to the existing permit

Facility Operations

As mentioned earlier, by default, CalLite applies existing permitted capacity for pumping through Banks Pumping Plant. In that permit, year around capacity is 6680 cfs except from December 15 – March 15 when 1/3 San Joaquin River flow can be added to 6680 cfs up to 8500 cfs. User defined pumping capacity is applied if the Banks Pumping Plant facility option is activated on the dashboard.

Users have the option to limit the Clifton Court Forebay (CCF) intake to existing permit, even though if Banks Pumping Plant is checked as shown in the Figure L-1. If pumping capacity is higher than the existing permit, additional water may come from an isolated facility, if selected.

Integration with SWP/CVP System

As implemented, the Banks Pumping Plant is considered part of SWP project and is directly integrated into the Coordinated Operations Agreement and project operational decisions.

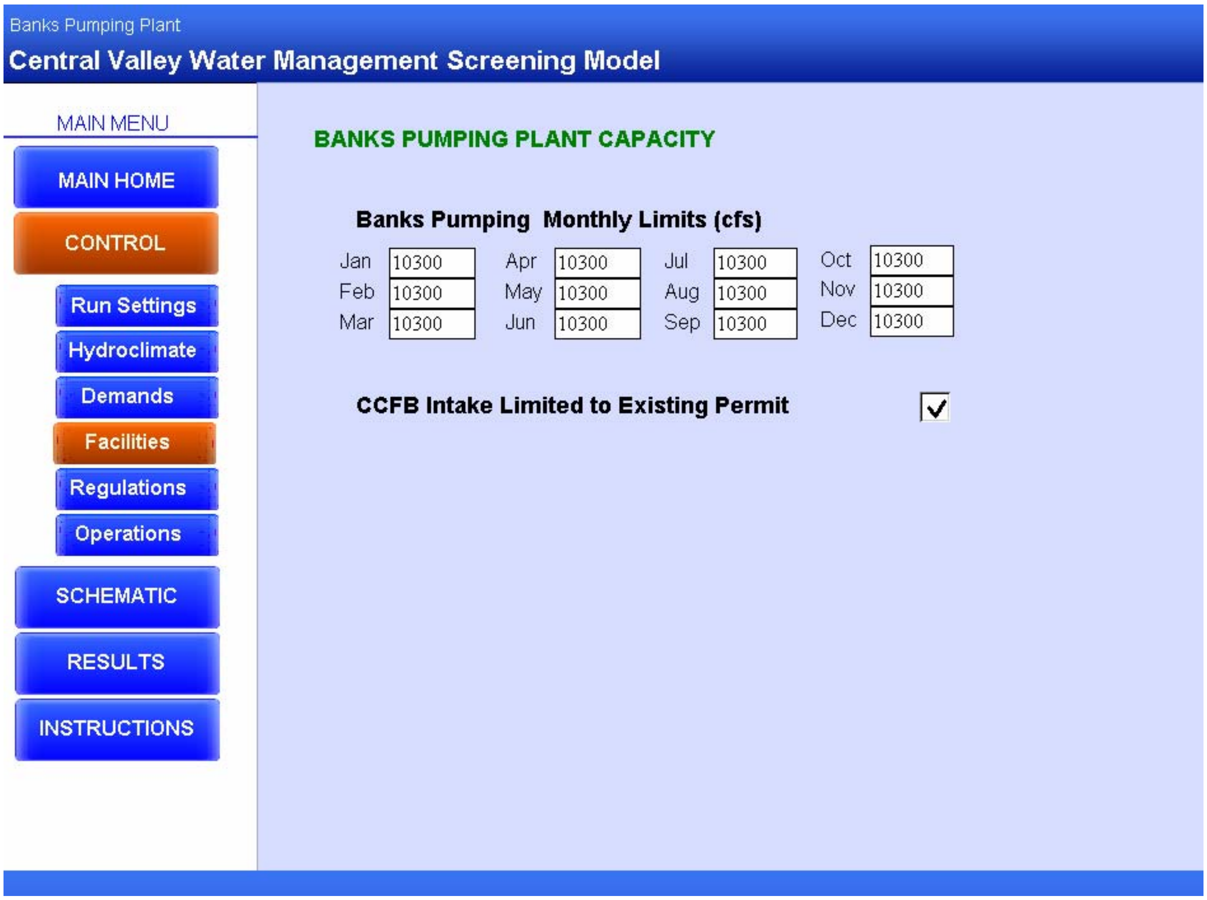


Figure L-1. Banks Pumping Plant dashboard with user options

Appendix M Forecast Allocation Modeling Documentation

Introduction

In an effort to better mimic Reclamation and DWR actual forecast procedures, the CalLite screening model includes an option to use a forecast-based method for determining contractor annual allocations from the Central Valley Project (CVP) and State Water Project (SWP) instead of the traditional water supply index-demand index procedures. The forecast-based allocation procedure includes two "sub-models", one for each project (CVP and SWP), that are activated each month during the allocation decision-making period (Jan-May) to maximize allocations over the remainder of year under constraints of storage carryover targets and system regulations (Figure M-1). This document summarizes the development of these two models.

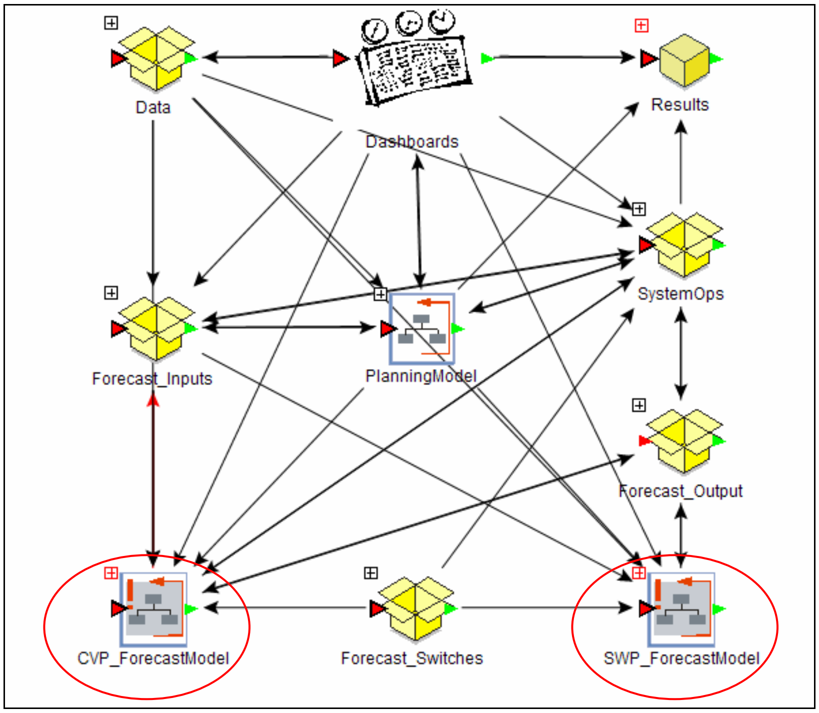


Figure M-1. CVP and SWP forecast sub-models in CalLite

Methodology

The forecast-based allocation "sub-models" project CVP and SWP reservoir storage conditions both upstream and downstream of the Delta from the current month through the end of September of the current year. Target storages are specified based on the current state (planning model state) of the system. The "sub-model" maximizes contractor allocations subject to these targets.

The delivery allocation process incorporates a bisection search method that begins with 100% and 0% allocations and then narrows down the delivery allocation targets until storage conditions are satisfied. This information is then passed back to the planning model to simulate the current month with the specified delivery target. This process is repeated for each month until the final allocation is established in May. This method is consistent with the general approach applied by project operators.

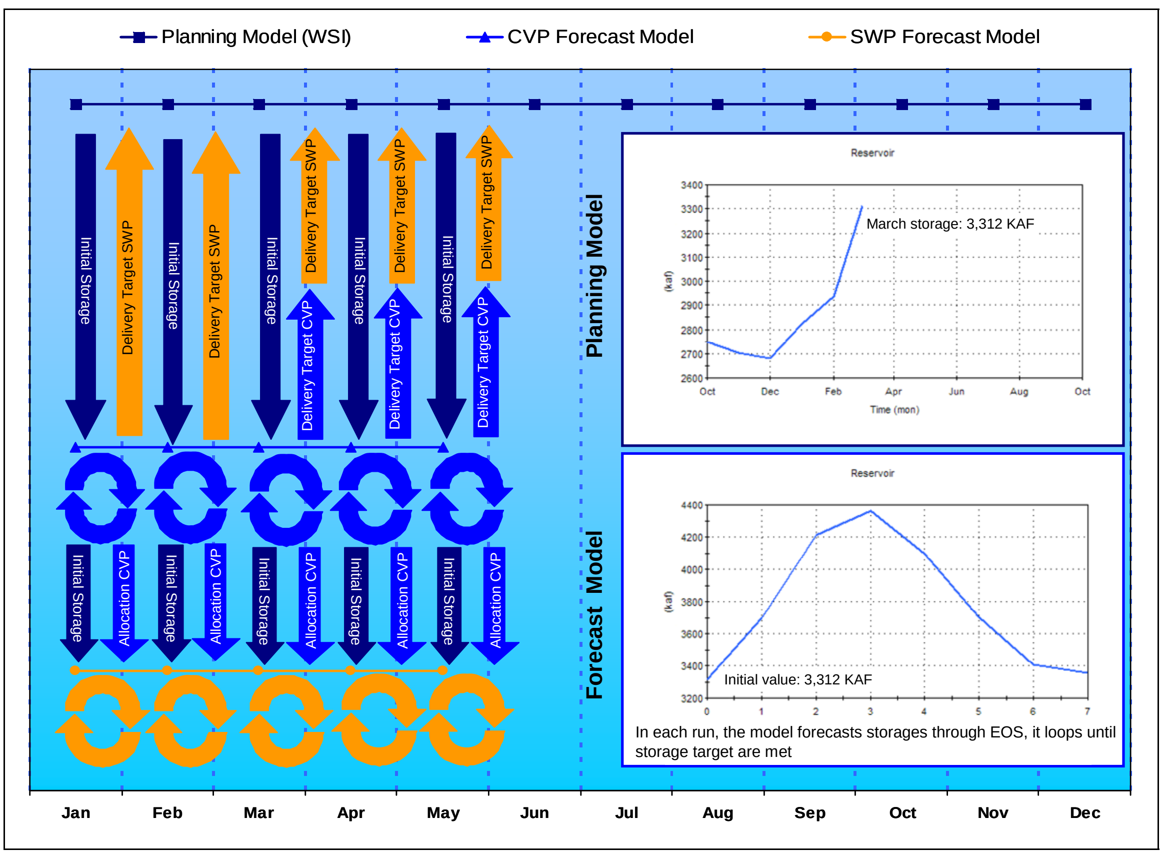


Figure M-2. Forecast sub-models and planning model interactions

Sub-models and planning model interaction

In Figure M-2, the interaction between forecast sub-models and the main model (or planning model) is represented as well as the interaction among sub-models themselves. As mentioned previously, the delivery allocation decision-making takes place during the period from January through May. At the beginning of each one of these months, the planning model provides the initial storage for all reservoirs and end of September target levels for the Oroville, Shasta, and Folsom reservoirs to the sub-models (dark blue arrows). The main model pauses while the allocation decision-making process is performed in the sub-models. The end of September storage targets are estimated from the planning model and used as looping conditions in the sub-models. The following considerations were used specifying storage targets:

Storage targets for Shasta and Folsom: the target storage level is defined based on the total Shasta plus Folsom storage. Guide levels are selected in March, April, and May and provide the storage targets through September. The minimum September targets for Shasta range between 1200 TAF and 1900 TAF and between 200 TAF and 550 TAF for Folsom.

Storage targets for Oroville: As recommended by DWR OCO, the previous September storage and the SWP allocation is used to estimate the storage target as follows:

> 1000 TAF + SWP_Allocation * 0.5 * max(previous September Storage – 1000 TAF, 0 TAF)

Storage targets for San Luis: the target storage for San Luis reservoir is set in terms of a defined low point in August. For the SWP San Luis this value is 55 TAF and for the CVP is 45 TAF.

After each monthly forecast process from January through May, the SWP sub-model provides the delivery target to the planning model (orange arrow) which is then used to estimate the individual SWP contractor allocations (delivery percentages from total contractor demand). During May, the planning model does not permit reduction in SWP allocation. Likewise, the CVP sub-model provides the delivery target to the planning model with two delivery targets only from March through May (light blue arrow): one for the system-wide CVP allocation and another for the South of Delta CVP allocation. Both sub-models are activated in January through May although the CVP sub-model output is only used by the planning model from March through May to be consistent with CVP allocation processes.

CVP and SWP sub-models interaction

Interaction between the sub-models is required since the allocation search process proceeds in sequential order for either the SWP or CVP. The same network and hydrology is used in both sub-models but the value for the contractor's allocation that is not being calculated is specified from the results of the other sub-model. The CVP sub-model simulation is computed first, and provides the allocation values for use in the SWP sub-model simulation. For the CVP simulation process, the sub-model uses the previous month SWP allocation target. This interaction is applied if both models are switched ON but it can vary depending on the user-defined allocation settings. Possible variants are:

Case 1: only one sub-model ON: if either one of the sub-model is running, the project contractor's allocation that is not being simulated is assumed to be 100%
Case 2a: both sub-models switched OFF: when the dynamic allocation process is switched OFF, then the WSI-DI process is utilized
Case 2b: both sub-models switched OFF: when the allocation rule is set to "fixed" allocation, there is no interaction between sub-models and the allocation values are input through the input control file.

Forecast sub-models looping process

The sub-models use a looping process, based on the bi-section method, to determine the allocation delivery assuring that the maximum possible allocation takes place subject to an end of September storage target.

Settlement and Exchange contractors' allocations are NOT subject to the allocation process described above. As determined in their contracts, there are no reductions except for a 25% in Shasta critical years. There are cases when the North of Delta storage targets can not be satisfied even after allocations are set to zero. However, if the looping process determines that CVP or SWP allocations are zero (based on Shasta or Oroville storage) AND San Luis reservoir storage levels are above its target (for both CVP and SWP), then south-of Delta allocations may be increased to utilize the San Luis storage above 100 TAF in storage. This adjustment takes place at the end of the looping process when estimating the delivery target.

The optimization looping process uses the bisection method approach which requires control parameters defined in the *Forecast_Inputs* container. The allocation control parameters, starting maximum and minimum book-ends are defined as well as the maximum allowed difference among these. The smaller the closure term is, the more accurate allocation estimation will be but more looping time will be required. The looping process varies between CVP and SWP sub-models:

CVP Forecast Model. In the CVP two different delivery targets and allocations are estimated: one for system-wide allocations and another for South of Delta (SOD). The SOD allocation is limited to the system allocation, except when the allocation is zero and the SOD gets adjusted. In order to fulfill this condition the following criteria was considered in the bisection method implementation:

- The storage target for NOD reservoirs is first met assuming the same allocation for SOD and using Shasta target as the reference
- If the storage target for SOD is not met at this estimated allocation, the looping process continues to reduce more the SOD allocation and the NOD or system allocation is kept constant. The San Luis CVP storage target is used as a reference.

In order to reduce run-time, the case for 100% and meeting both storage targets -NOD and SOD-, and the case of 0% allocation and NOT meeting either one of the storage targets are tested during the first and second loop respectively.

SWP Forecast Model. In the SWP only one delivery target is estimated and that is for SOD. However, the allocation optimization is estimated as a function of Oroville (NOD) and San Luis SWP (SOD) storage targets. Also, as in the CVP sub-model, in order to save running time, the cases of 100% allocation and 0% are tested at the beginning of the looping process.

Representation of physical system

The network used in the sub-models is a simplification of the network developed for the CalLite planning model. As can be observed in Figure M-3, the number of nodes in the network used in the Forecast sub-models is significantly smaller than in the planning model. However, the missing nodes from the planning model are aggregated in the ones that are represented in this network as summarized in Table M-1.

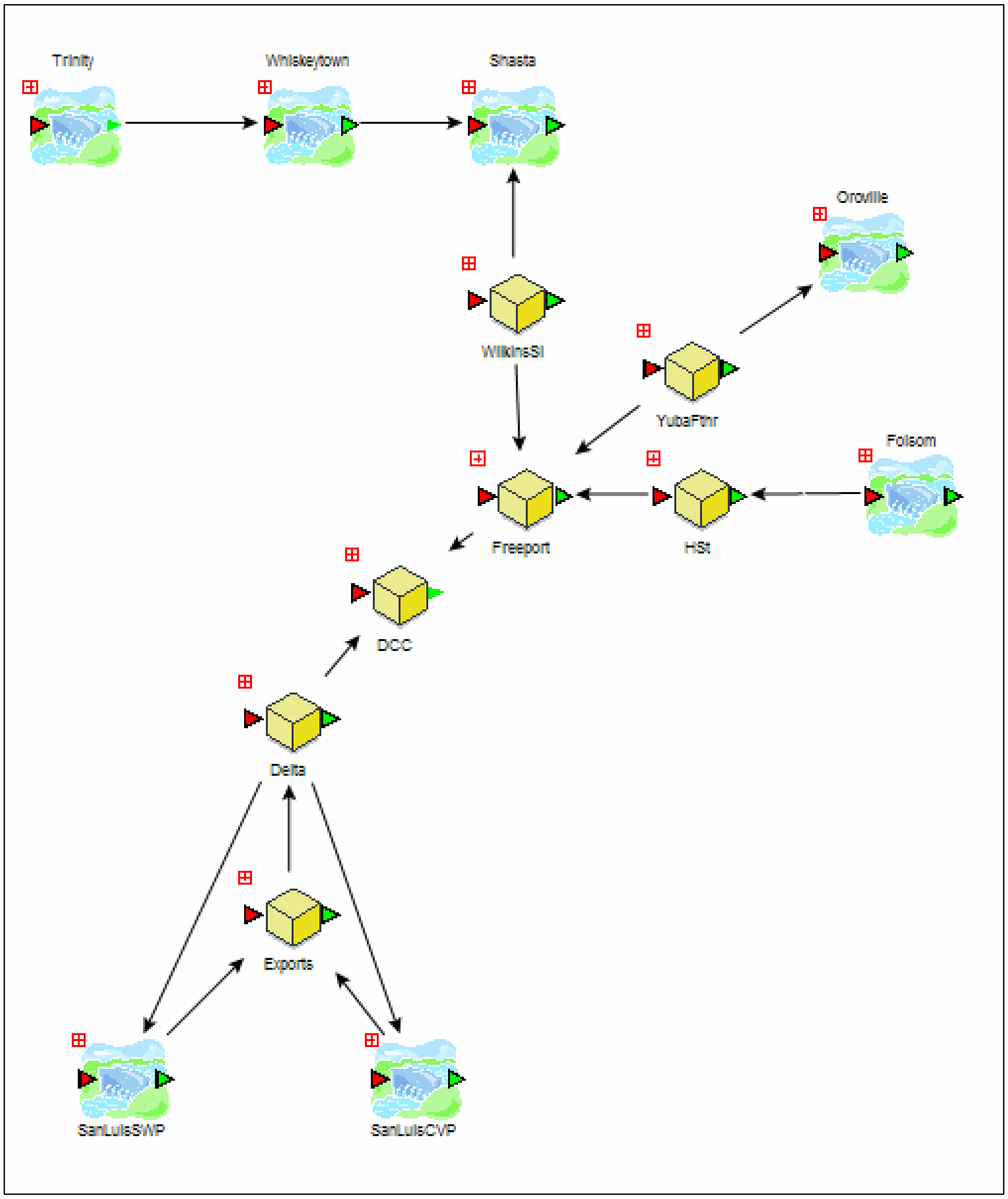


Figure M-3. CVP and SWP sub-models network

The Delta Cross Channel (DCC) node was included only to estimate a more accurate QWEST flow and does not have an impact on the hydrology since the flow through the DCC and Georgiana Slough is available downstream.

Table M-1. Forecast model nodes aggregation of Planning model nodes

Forecast Model	Planning Model
WilkinsSl	RedBluff
	WilkinsSl
Folsom	Folsom
	Natoma
HSt	HSt
Freeport	SacFthr
	SacAmer
	YoloBypass
Oroville	Oroville
YubaFthr	Thermalito
	New Bullards
	Englebright
	Daguerre Point
	YubaFthr
Delta	Delta
SanLuisCVP	San Luis
SanLuisSWP	

Major Storage and Conveyance Facilities

Figure M-3 shows the major storage and conveyance facilities included in the sub-model. The following operations simplifications, compared to the planning model, are considered:

- Evaporation in reservoirs in neglected
- Flood targets in Trinity, Shasta, Oroville and Folsom are monthly average matrix values instead of a time series targets
- COA is implemented through a single-step calculation, rather than the looping process in the planning model
- Shasta upstream requests for Keswick are defined based on a monthly basis according to the existing storage
- Wilkins Slough minimum flow of 5000 cfs target is considered without relaxation as incorporated in the planning model
- Oroville upstream requirement to meet the Feather fiver minimum flow is set at a constant value of 1,700 cfs
- Folsom upstream outflow requests to meet Nimbus requirements are triggered by American river flows level forecast

Project and Non-Project Demands

The project demands are specified as monthly constant values corresponding to the maximum demand for each contractor type. As mentioned previously, to estimate the actual demand, an allocation factor is applied based on the allocation that is being simulated. The non-project demands are included as a time series as in the planning model. In **Error! Reference source not found.**, a detailed description of the project and non-project demands is described for the CVP. The diversion points for CVP are: Wilkins Slough, Freeport, Folsom and San Luis storage. In these locations the delivery target is estimated.

Table M-2. Central Valley project (CVP) and non-project demands

Location	Project Demand	Demand matrix and allocation factors used	Non-project demands
WilkinsSl (2,525 TAF)	WBA 4 Corning WBA 4 TCC WBA 7N WBA 7S DSA 58 WBA 8NN WBA 8N GCID WBA 8NS WBA 8S DSA 15 EAST Sac Refuge Colusa Delevan	AverageDemMatrix_CVP SC: AllocCVP_SC RF,AG,MI: AllocCVP*	DEL_WilkinsSl DEL_RedBluff
Folsom (98 TAF)	DSA 70 Folsom DSA 70 Natoma	AverageDemMatrix_CVP2 MI_CON: AllocCVP*	DEL_Folsom DEL_Nimbus
HSt			DEL_HSt
Freeport (242 TAF)	DSA 65 DSA 70 SacAmer	AverageDemMatrix_CVP2 SC: AllocCVP_SC MI_CON: AllocCVP*	DEL_SacAmer
SanLuisCVP (3,374 TAF)	Demands_CVP_UDMC Demands_CVP_LDMC Demands_CVP_MP Demands_CVP_SF Demands_CVP_JU1 Demands_CVP_JU2	JamesBypassDeliv (when max) AverageDemMatrix_CVP_SD EX: AllocCVP_EX WR: 1 RF,AG,MI: AllocCVP_SOD*	

NOTES: * Only contractor demand considered in the MI

M-3 presents the detailed list of the SWP project and non-projects demands that are included. SWP South-of-Delta demand patterns based on percent allocation are included for better estimation of deliveries at both those nodes.

Table M-3. State Water Project (SWP) and non-project demands

Location	Project Demand	Demand matrix and allocation factors used	Non-project demands
Oroville (18 TAF)	DSA 69 Oroville	AverageDemMatrix_SWP_ND, WR: 1	
YubaFthr (281,008 TAF)	DSA 69 Therm DSA 69 YubaFthr	AverageDemMatrix_SWP_ND WR: 1 RF, OMI, IMI: AllocSWP*	
Delta (94 TAF)	DelivSWP_NoBay	AverageDemMatrix_SWP_SD; OTH: AllocSWP*; LOSS: 1; INT: 0	DEL_NoDelta DEL_CCWD
SanLuisSWP (5,164 TAF)	DemSWP_BanksSoBay DemSWP_SoBayONeill DemSWP_ONeillDosAmigos DemSWP_ONeillJointUse DemSWP_JointUseTerm	AverageDemMatrix_SWP_SD MWD,OTH,AG: AllocSWP* LOSS:1 INT: 0	

NOTES: * Only contractor demand considered in the MI

Hydrology

Forecasted hydrology, provided by DWR, is used as inflows to reservoirs and downstream locations. The only exception of use the forecasted hydrology is the Freeport node for which reasonable forecasts could not be obtained.

The forecast inflows and local inflows are selected annually depending on the month the forecast model is running and according to a defined exceedance percentile. For the CVP, the 90th percentile is used. For the SWP, the 99th percentile is used from January through March and 90th for the remaining months.

Delta regulatory constraints synchronization

The Delta regulations are synchronized with the planning model and applied similarly in the forecast sub-models. User-specified controls are transferred to the forecast model for more accurate allocation decision-making. The regulations that are included in the forecast model are:

- Delta Outflow: Minimum Net Delta Outflow (NDO) and X2 Requirements
- Interior Delta Flows: QWEST and OMR
- Exports limits: EI ratio and EI San Joaquin river ratio

Appendix N Fremont Weir Diversion Modeling Documentation

Program Description

The Yolo Bypass is a flood basin that receives floodwaters from the Sacramento River, Cache Creek, the Knight's Landing Ridge Cut, Willow Slough, and Putah Creek. The floodwater in the Yolo Bypass water rejoins the Sacramento River a few miles upstream of Rio Vista. Fremont Weir is a low, concrete barrier at the north end of the Yolo Bypass, close to the confluence of the Sacramento, Sutter Bypass and Feather Rivers, through which overflow waters of the Sacramento River, Sutter Bypass, and the Feather River are released into the Yolo Bypass. Fremont Weir's two-mile overall length marks the beginning of the Yolo Bypass, as shown in Figure N-1. Currently, the elevation of the crest of Fremont Weir is 33.5 feet and the design capacity of the weir is 343,000 cfs.

Figure N-1. Fremont Weir in a satellite image

In order to enhance fish and wildlife habitat in the Yolo Bypass, modifications have been proposed for the Fremont Weir so that water can be released to the Yolo Bypass basin during a specified number of months even when the water surface in the Sacramento River is below the current weir crest. In this release of the CalLite, simulations can be done for the proposed Fremont Weir under various scenarios in order to satisfy the flow requirement for the fish and wildlife habitat. Various combinations of diversion scenarios are under consideration, but diversion rates to be considered are likely to be in the range of 1,000 to 30,000 cfs.

Program Core Elements

The following core elements are included in the Yolo Bypass habitat restoration program:

- Diversion at Fremont Weir
- Diversion at Sacramento Weir
- Local inflows to Yolo Bypass basin

Diversion at Fremont Weir can be activated even the water surface in Sacramento River is below the current Fremont Weir crest, i.e. the total flow in the Sacramento River is less than 62000 cfs. The Yolo Bypass Habitat Requirement trigger is defined as the summation of the Fremont Weir diversion, the Sacramento Weir diversion, and the local inflows from Cache Creek, the Knight's Landing Ridge Cut, Willow Slough, and Putah Creek.

Options Considered

For the purposes of the screening model implementation, the following options are considered:

- Monthly Minimum Yolo Bypass Flow triggers for each water-year type (user-specified)
- Months while diversion trigger are activated (combination of Feb, Mar, Apr and May)
- Switch of release from storage if required (on/off)

Schematic Representation

Figure N-2 shows the schematic representation of the Yolo Bypass facility in CalLite. The three program core elements are defined in three CalLite nodes: the SacFeather node represents the Sacramento River and Feather river confluence with Fremont Weir; the SacAmerican node represent the Sacramento River and American River confluence with Sacramento Weir; and the Yolo Bypass node represent the Yolo Bypass basin which receives water from Fremont Weir, Sacramento Weir and the local tributaries.

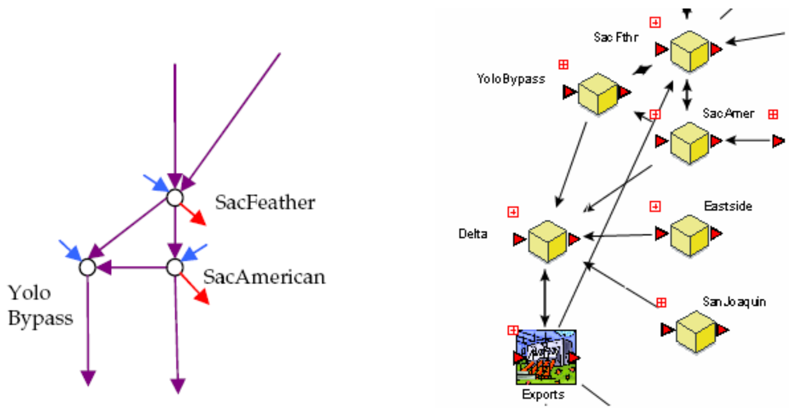


Figure N-2. CalLite schematic representation of Yolo Bypass Facility

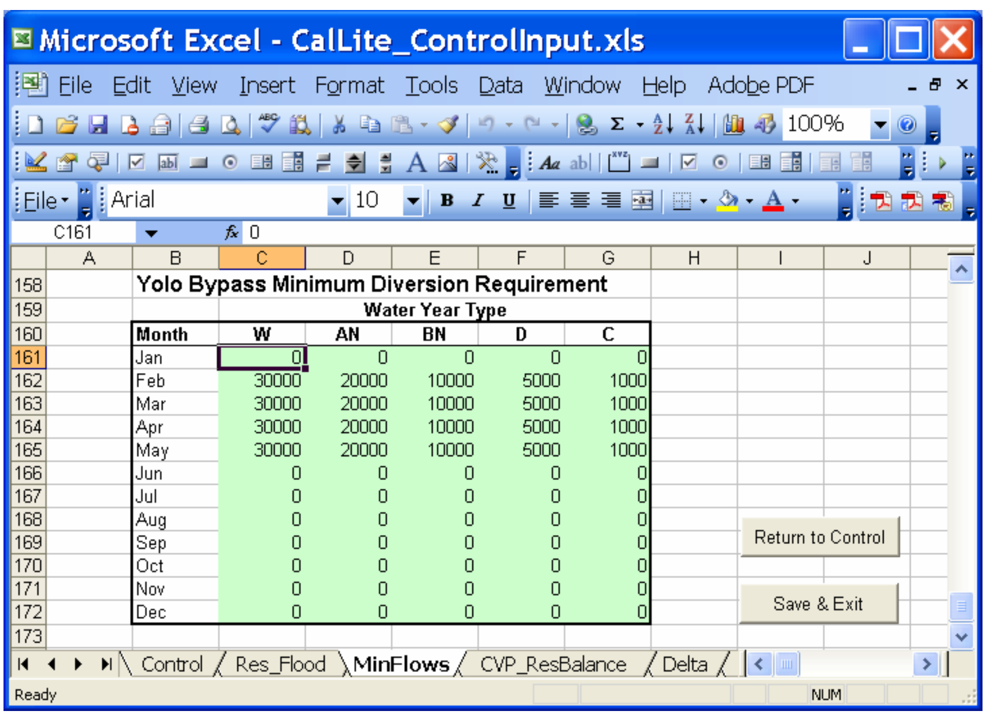
Integration with SWP/CVP System

As implemented, the Fremont Weir Diversion is considered a part of SWP/CVP projects and is directly integrated into the project operational decisions.

User Input and Output Requirements

Figure N-3 and Figure N-4 show the user controls and parameters for the Yolo Bypass facility in CalLite. After having clicked the Assumptions button in the CalLite dashboard shown in Figure N-3, users can specify the triggers of monthly Yolo Bypass minimum habitat flow requirement based on water-year type in the "CalLite_ControlInput.xls" as shown in Figure N-4. The triggers can be activated for the months of February, March, April and May. There is also an option of asking release from storage if required.

Figure N-3. CalLite dashboard of controls for the Fremont Weir Facility



Month	W	AN	BN	D	C
Jan	0	0	0	0	0
Feb	30000	20000	10000	5000	1000
Mar	30000	20000	10000	5000	1000
Apr	30000	20000	10000	5000	1000
May	30000	20000	10000	5000	1000
Jun	0	0	0	0	0
Jul	0	0	0	0	0
Aug	0	0	0	0	0
Sep	0	0	0	0	0
Oct	0	0	0	0	0
Nov	0	0	0	0	0
Dec	0	0	0	0	0

Figure N-4. CalLite Excel spreadsheet of Yolo Bypass Minimum Diversion Requirement for the Fremont Weir Facility

Limitations

Yolo Bypass facility implementation in CalLite is similar to the implementation that has been added to CALSIM II recently. Limitations will also be similar: monthly time step, and currently unknown operating restrictions on the diversion rates.

Comparison Data Sets

Two simple sensitivity studies using CalLite and CALSIM II with varying Yolo bypass habitat flow requirements have been carried for comparison. For both studies, the Yolo bypass minimum diversion requirement is set as 30000 cfs for wet-years, 20000 cfs for above-normal-years, 10000 cfs for 10000 cfs for below-normal-years, 5000 cfs for dry-years, and 1000 cfs for critical-years, as shown in Figure N-4. The first study assumes the diversion trigger will be activated for the months of February and March, and the second one assume the diversion trigger will be activated for the months of April and May. In the both scenarios, the option of asking release from storage if required is selected.

Figure N-5 and Figure N-6 below show a comparison of the export changes simulated by CalLite and those simulated by CALSIM II over the long-term average period of 1922-2003 and also over the 1929-1934 drought period.

Results from CalLite and CALSIM II indicate that there is no significant impact on the Delta diversion with the activation of the Fremont Weir diversion triggers for February and March for both the long-term average period of 1922-2003 and the 1929-1934 drought period. When the Fremont Weir diversion triggers are activated for April and May, both models produce the expected decreasing total Delta diversion during the two periods although the magnitudes of the decreasing produced by CalLite is small in comparison with the decreasing produced by CALSIM II simulation.

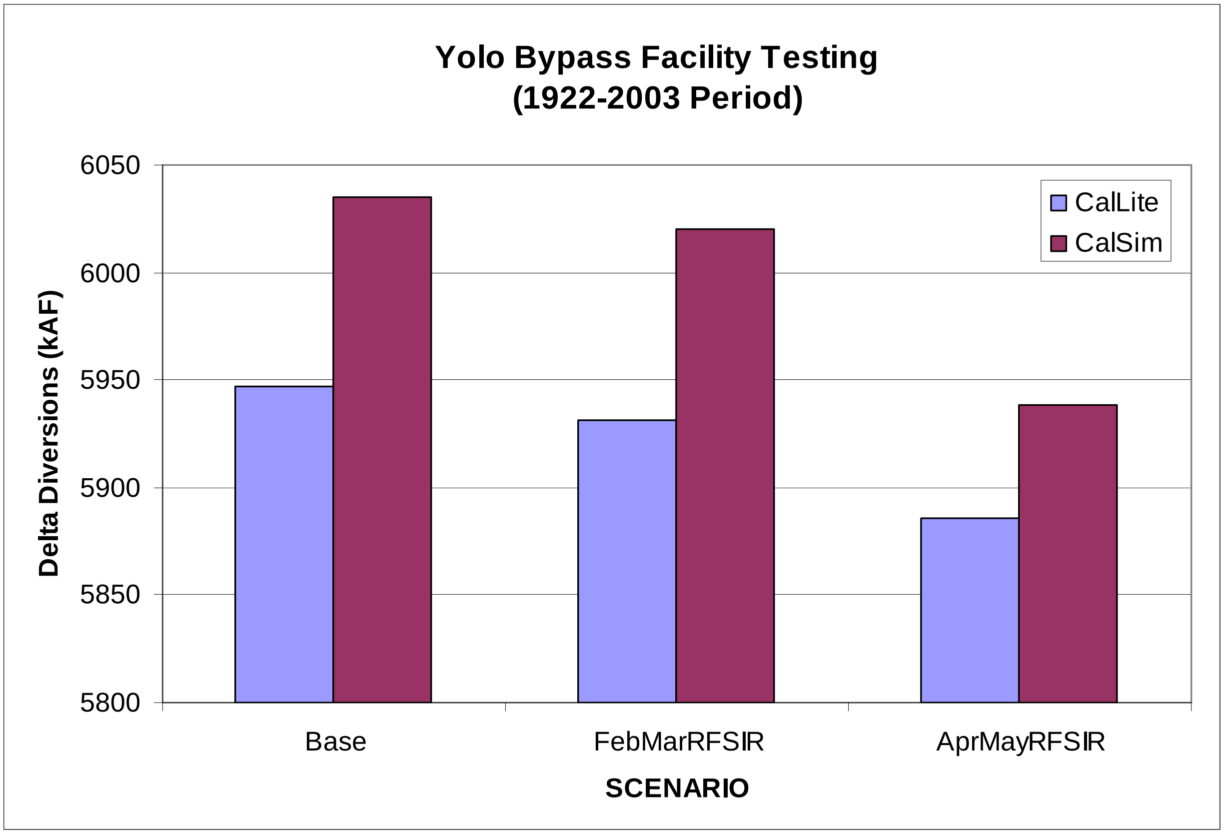


Figure N-5. Comparison of long-term average export changes between CalLite and CALSIM II for varying Yolo Bypass Habitat Flow Requirements

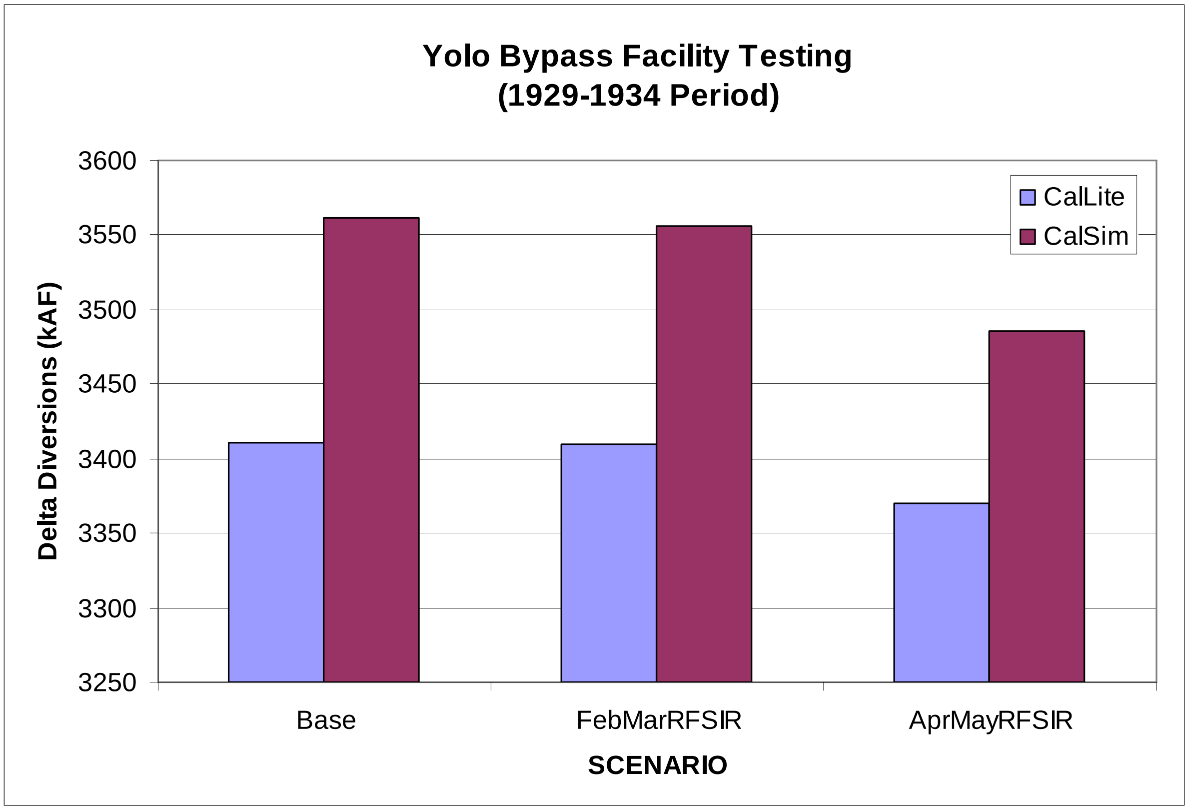


Figure N-6. Comparison of dry period average export changes between CalLite and CALSIM II for varying Yolo Bypass Habitat Flow Requirements

Appendix O Base assumptions comparison between CALSIM II and CalLite

This appendix lists the base model Common Assumptions (Common Model Package of CALSIM II Version 9A) and compares that with CalLite base model.

		CALSIM II Current Conditions	CalLite Current Conditions	CALSIM II Future Conditions	CalLite Future Conditions
		Common Assumptions 2005 Level-of-Development V9A	**CalLite 2005 LOD**	**Common Assumptions 2030 Level-of-Development V9A**	**CalLite 2030 LOD**
"Same" indicates an assumption from a column to the left					
Planning horizon		2005	Same	2030	Same
Period of Simulation		82 years (1922-2003)	Same	Same	Same
HYDROLOGY					
Level of development (Land Use)		2005 level	Same	2030 level	Same
Sacramento Valley					
(excluding American R.)					
	CVP	Land-use based, limited by contract amounts	Same	CVP Land-use based, Full build out of CVP contract amounts	Same
	SWP (FRSA)	Land-use based, limited by contract amounts	Same	Same	Same
	Non-project	Land-use based	Same	Same	Same
	Federal refuges	Firm Level 2	Same	Firm Level 2 water needs	Same
American River			Same		
	Water rights	2001	Same	2005	Same
	CVP (PCWA American River Pump Station)	No project	Same	CVP (PCWA modified)	Same
San Joaquin River[h]			Same		
	Friant Unit	Limited by contract amounts, based on current allocation policy	Same	Same	Same

	Lower Basin	Land-use based, based on district level operations and constraints	Same	Same	Same
	Stanislaus River	New Melones Interim Operations Plan	Same	Same	Same
South of Delta			Same		
	(CVP/SWP project facilities)	CVP Demand based on contracts amounts	Same	Same	Same
	Contra Costa Water District	124 TAF/yr	Same	195 TAF CVP contract supply and water rights	Same
	SWP Demand - Table A	Variable 3.0-4.1 MAF/Yr	Same	Full Table A	Same
	SWP Demand - Article 21 demand	Up to 134 TAF/month December to March, total of other demands up to 84 TAF/month in all months	Same	Up to 314 TAF/month from December to March, total of demands up to 214 TAF/month in all other months	Same
	Federal refuges	Firm Level 2	Same	Firm Level 2 water needs	Same
FACILITIES					
Systemwide		Existing facilities	Same	Same	Same
Sacramento Valley					
	Red Bluff Diversion Dam	No diversion constraint	Same	Diversion Dam operated July - August (diversion constraint)	Same
	Colusa Basin	Existing conveyance and storage facilities	Same	Same	Same
	Upper American River	No project	Same	PCWA American River pump station	Same
	Sacramento River Water Reliability	No project	Same	American/Sacramento River Diversions	Same
	Lower Sacramento River	No project	Same	Freeport Regional Water Project	Same

Delta Region					
	SWP Banks Pumping Plant	South Delta Improvements Program Temporary Barriers, 6,680 cfs capacity in all months and an additional 1/3 of Vernalis flow from Dec 15 through Mar 15.	Same	South Delta Improvements Program Permanent Barriers (Stage 1). 6,680 cfs capacity in all months and an additional 1/3 of Vernalis flow from Dec 15 through Mar 15	Same
	CVP C.W. Bill Jones (Tracy) Pumping Plant	4,200 cfs + deliveries upstream of DMC constriction	Same	4,600 cfs capacity in all months (allowed for by the Delta-Mendota Canal–California Aqueduct Intertie)	Same
	City of Stockton Delta Water Supply Project	No project	Same	Delta Water Supply Project - total demands 85 TAF/yr	Same
	Contra Costa Water District	Existing pump locations	Same	Alternate Intake Project (AIP)	Same
South of Delta					
(CVP/SWP project facilities)					
	South Bay Aqueduct (SBA)	Existing capacity 300 cfs	Same	SBA Rehabilitation: 430 cfs capacity from junction with California Aqueduct to Alameda County FC&WSD Zone 7 diversion point	Same
REGULATORY STANDARDS					
Trinity River					
	Minimum flow below Lewiston Dam	Trinity EIS Preferred Alternative (369-815 TAF/year)	Same	Same	Same
	Trinity Reservoir end-of-September minimum storage	Trinity EIS Preferred Alternative (600 TAF as able)	Same	Same	Same
Clear Creek					

	Minimum flow below Whiskeytown Dam	Downstream water rights, 1963 USBR Proposal to USFWS and NPS, and USFWS discretionary use of CVPIA 3406(b)(2)	Same	Same	Same
Upper Sacramento River					
	Shasta Lake	SWRCB-WR 1.9 MAF end of Sep. storage target in non-critical years	Same	Same	Same
	Minimum flow below Keswick Dam	Flows for SWRCB WR 90-5 temperature control, and USFWS discretionary use of CVPIA 3406(b)(2)	Same	Same	Same
Feather River					
	Minimum flow below Thermalito Diversion Dam	1983 DWR, DFG Agreement (600 cfs)	Same	2006 Settlement Agreement (700 / 800 cfs)	Same
	Minimum flow below Thermalito Afterbay outlet	1983 DWR, DFG Agreement (750-1,700 cfs)	Same	Same	Same
Yuba River					
	Minimum flow below Daguerre Point Dam	D-1644 Interim Operations	Embedded Model that approximates the Lower Yuba River Accord (LYRA)	D-1644 Interim Operations	Embedded Model that approximates the Lower Yuba River Accord (LYRA)
American River					
	Minimum flow below Nimbus Dam	SWRCB D-893 (see Operations Criteria), and USFWS discretionary use of CVPIA 3406(b)(2)	Same	Same	Same

	Minimum Flow at H Street Bridge	SWRCB D-893	Same	Same	Same
Lower Sacramento River					
	Minimum flow near Rio Vista	SWRCB D-1641	Same	Same	Same
Mokelumne River					
	Minimum flow below Camanche Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (100-325 cfs)	Same	Same	Same
	Minimum flow below Woodbridge Diversion Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (25-300 cfs)	Same	Same	Same
Stanislaus River					
	Minimum flow below Goodwin Dam	1987 USBR, DFG agreement, and USFWS discretionary use of CVPIA 3406(b)(2)	Same	Same	Same
	Minimum dissolved oxygen	SWRCB D-1422	Same	Same	Same
Merced River					
	Minimum flow below Crocker-Huffman Diversion Dam	Davis-Grunsky (180-220 cfs, Nov-Mar), Cowell Agreement	Same	Same	Same
	Minimum flow at Shaffer Bridge	FERC 2179 (25-100 cfs)	Same	Same	Same
Tuolumne River					
	Minimum flow at Lagrange Bridge	FERC 2299-024, 1995 (Settlement Agreement) (94-301 TAF/year)	Same	Same	Same
San Joaquin River					
	Maximum salinity near Vernalis	SWRCB D-1641	Same	Same	Same

	Minimum flow near Vernalis	SWRCB D-1641, and Vernalis Adaptive Management Plan per San Joaquin River Agreement	Same	Same	Same
Sacramento River–San					
Joaquin River Delta					
	Delta Outflow Index (Flow and Salinity)	SWRCB D-1641	Same	Same	Same
	Delta Cross Channel gate operation	SWRCB D-1641	Same	Same	Same
	Delta exports	SWRCB D-1641	Same	Same	Same
OPERATIONS CRITERIA: RIVER-SPECIFIC					
Upper Sacramento River					
	Flow objective for navigation (Wilkins Slough)	3,250 - 5,000 cfs based on CVP water supply condition	Same	Same	Same
American River					
	Folsom Dam flood control	Variable 400/670 flood control diagram (without outlet modifications)	Same	Same	Same
	Flow below Nimbus Dam	Discretionary operations criteria corresponding to SWRCB D-893 required minimum flow	Same	Same	Same
	Sacramento Area Water Forum Mitigation Water	Mitigation water is not implemented	Same	Same	Same
Stanislaus River					
	Flow below Goodwin Dam	1997 New Melones Interim Operations Plan	Same	Same	Same

San Joaquin River					
	Salinity at Vernalis	D1641	Same	Same	Same
OPERATIONS CRITERIA: SYSTEMWIDE					
CVP water allocation					
	CVP Settlement and Exchange	100% (75% in Shasta critical years)	Same	Same	Same
	CVP refuges	100% (75% in Shasta critical years)	Same	Same	Same
	CVP agriculture	100%-0% based on supply (South-of-Delta allocations are reduced due to D-1641 and 3406(b)(2) allocation-related export restrictions)	Same	Same	Same
	CVP municipal & industrial	100%-50% based on supply (South-of-Delta allocations are reduced due to D-1641 and 3406(b)(2) allocation-related export restrictions)	Same	Same	Same
SWP water allocation					
	North of Delta (FRSA)	Contract specific	Same	Same	Same
	South of Delta (including North Bay Aqueduct)	Based on supply; equal prioritization between Ag and M&I based on Monterey Agreement	Same	Same	Same
CVP-SWP coordinated operations					

	Sharing of responsibility for in-basin-use	1986 Coordinated Operations Agreement (FRWP EBMUD and 2/3 of the North Bay Aqueduct diversions are considered as Delta Export, 1/3 of the North Bay Aqueduct diversion is considered as in-basin-use)	Same	Same	Same
	Sharing of surplus flows	1986 Coordinated Operations Agreement	Same	Same	Same
	Sharing of Export/Inflow Ratio	Equal sharing of export capacity under SWRCB D-1641; use of CVPIA 3406(b)(2) restricts only CVP and/or SWP exports	Same	Same	Same
	Sharing of export capacity for lesser priority and wheeling related pumping	Cross Valley Canal wheeling (max of 128 TAF/year), CALFED ROD defined Joint Point of Diversion (JPOD)	Not modeled	Same	Not Modeled

Appendix P CalLite Utilities

CalLite package includes several supporting spreadsheets:

CalLite Monthly Comparison Spreadsheets

Monthly comparison spreadsheets are designed to view and compare model results from two different scenarios in a monthly table format. A system water balance summary is provided in a tabular format as well as timeseries and exceedance plots for each facility and key parameter in the model. In order to upload results of each simulation, the user simply needs to point to the results summary spreadsheet through MS Excel.

CalLite vs CALSIM II Monthly Comparison Spreadsheets

In a similar format to spreadsheets described above, these spreadsheets are designed to compare CalLite results to a companion CALSIM II model results. The user needs to import CALSIM II results through HEC-DSS utility and point CalLite results as described above.

User Input Summary Spreadsheet

CalLite saves the selections that user makes in the GUI and saves it in a summary spreadsheet. It is intended to help the user keep a log of different scenarios.

CalLite Control Input Spreadsheet

As described in preceding sections, this spreadsheet holds the user defined inputs. Model uploads user input from this spreadsheet each time a scenario is run. It is important to note that only the user-specified parameters that are selected through the GUI will be uploaded.

CalLite Facility Control Spreadsheet

This spreadsheet provides the operation control for reservoirs, Delta, exports and so on for the current simulation. Users can obtain information about the controlling parameter of the system for each time step.