Cost Allocation Study Analysis to Address the Water Supply Purpose of the Central Valley Project

Hydrology Analysis for Sizing Storage Facilities for the Single Purpose of Water Supply

The Central Valley Project (CVP) serves multiple purposes, and each CVP facility (i.e. dam, canal, pumping plant, power plant, diversion facility, etc…) may serve one or several project purposes. The Cost Allocation Study (CAS) is charged with determining the apportionment of each project facility among different project purposes. This document will present information about the hydrology analysis used to calculate the portion of storage facilities that is used for the water supply purpose.

For the most part, conveyance and pumping facilities serve only the water supply purpose, so 100% of their costs can be apportioned as such. Storage facilities, on the other hand, typically serve additional multiple purposes – i.e. flood control, power, recreation. CVP reservoirs with a water supply purpose include Friant, New Melones, Trinity, Shasta, Whiskeytown, Folsom, Nimbus, and San Luis.

A key element of CAS analysis is single-purpose facility sizing. Conceptually, this answers the question "what size reservoir is required if the only purposed it needs to serve is water supply"? Any given reservoir is built to serve multiple purposes because this is more cost effective than building multiple reservoirs, each with a unique purpose. Single-purpose sizing analysis ignores all other purposes for the facility in question and calculates operations as if water supply is its sole function. For a multi-purpose storage facility, the size that is required to satisfy a single purpose is typically smaller than the full actual size of the reservoir.

Single-purpose vs Single-facility scenarios. Because of geographical considerations in the CVP, single-facility scenarios have limited applicability – i.e. Shasta cannot provide water to American River contractors. A matrix of multiple-facility scenarios, with conservation storage shifted between Trinity, Shasta, and Folsom, will be analyzed to determine a range of sizing options and associated cost results.

The CVP Water Supply Purpose is the project's capability to deliver water. CVP water deliveries are made to meet demands in the Agricultural, M&I, and Refuge

sectors, both north and south of the delta. The CVP has made water deliveries throughout its history, and historical records define past water supply purpose capacity. But the historical record reflects an ever-evolving scenario of project capacity, irrigated acreage, land management, demand, and regulatory environment. Water supply capacity under static current or future operating conditions can be depicted through modeling. Two cornerstones to the analysis for this study are that modeled deliveries 1) implicitly reflect a specific set of system regulations and 2) that they also reflect a specific level of development (land use, population) which determines input hydrology (inflow and demand).

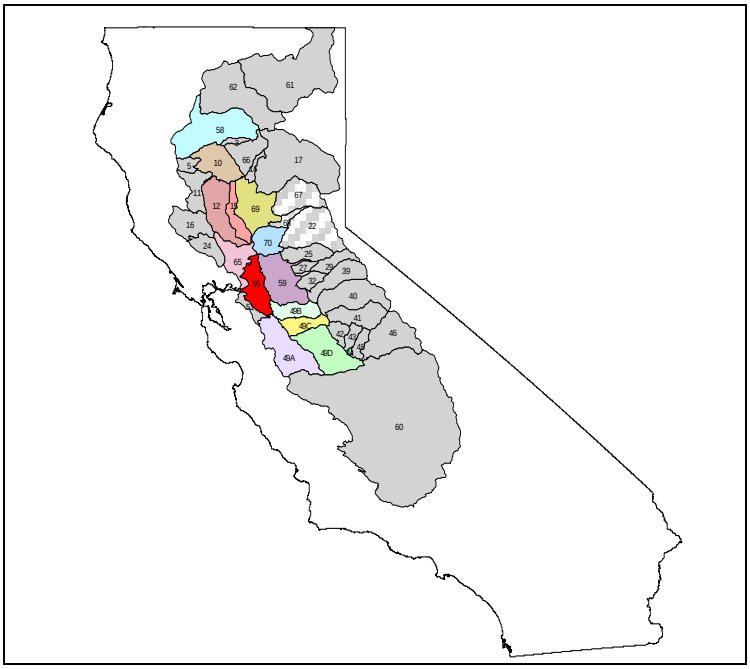
Two models will be used for the water supply purpose analysis in the CAS.

- CalSim2 model results will represent delivery capability. CalSim2 studies reflect both a particular regulatory environment and a particular level of development – the two critical elements for defining water supply delivery.
- A new storage sizing model will be developed to determine the reservoir storage that is required solely to meet the deliveries determined by the CalSim2 model.

Developed and jointly maintained by the California Department of Water Resources and the Bureau of Reclamation, CalSim2 is a monthly timestep planning model which evaluates the water supply reliability of the CVP/SWP. It does this at a defined level of development, with a defined set of facilities, under a defined set of regulatory criteria. CalSim2 has been the subject of two academic peer reviews and sees ongoing development and improvement through its application to a broad range of system planning studies. A substantial user community includes other state and federal agencies, water users, NGO's, and consultants. Studies that have used CalSim2 since its introduction in 2002 include OCAP, CALFED, DWR's delivery reliability reports, numerous storage investigations, climate change sensitivity studies, San Joaquin River Restoration, the DMC/CAA Intertie EIS, and the Bay Delta Conservation Plan. Extensive documentation on CalSim2 is available separately. Some key concepts are described briefly below.

CalSim2 uses input data for inflows and demands that reflects a particular level of land-use development, developed in the following manner. The historical data set for gaged flows, irrigated acreage, and land use is modified to remove all of the effects of historical operations – diversions, return flows, groundwater pumping, deep percolation, storage operations, evapotranspiration – to calculate a "native condition". Upon this basis, current or future land-use assumptions are projected, and the native hydrology is "re-impaired" to define demand and calculate runoff under these conditions. The resulting hydrology trace does implicitly assume that precipitation would occur in the same amount at the same places as it did historically. The unimpairment and re-impairment calculations are all done at a Depletion Study Area (DSA) scale, with rim inflows, local accretions, land use, and demand aggregated at that level. Figure 1 shows the delineation of DSA's in the central valley floor and rim watersheds.

Figure 1 – Depletion Study Area Delineation



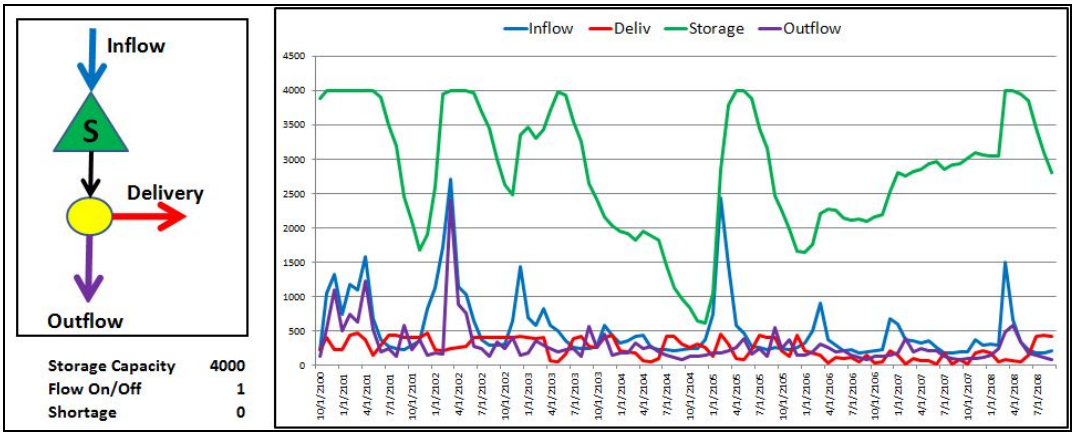
In addition to fundamental hydrology, water user contracts, the project allocation process, and system operations criteria are also key elements to the model's depiction of water supply delivery. In the DSA's north of the delta, consumptive use demands are based on land use, while contract allocations limit surface water delivery. South of the delta, demands in CalSim2 are represented as the full contract amounts, but deliveries are limited to the contract allocations. CVP allocations are affected by project storage, forecasted inflows, environmental regulations, contractual commitments, demands, and conveyance constraints. Operations criteria guide and constrain operations of both the Central Valley Project and State Water Project. Criteria currently represented in CalSim2 studies includes SWRCB D-1641, Biological Opinion RPA's, CVPIA 3406(b)(2) actions, the Coordinated Operations Agreement, flood control rules, San Joaquin River Restoration Agreement releases from Friant Dam, and many other specific agreements and operations.

The Single Purpose Facility Sizing Model will use schematic network representation of the CVP/SWP system similar to that used in CalSim2 but with some major simplifications. Hydrology inputs will be the same as CalSim2 hydrology – rim inflows and accretions/depletions reflecting the available water under a specific level of development. CVP surface water deliveries and exports will be *fixed* to the diversions which are the results of a CalSim2 run. SWP and Non-Project operations (reservoir releases, deliveries, exports) will also be fixed to ensure that the model uses CVP resources to address CVP demands.
The sizing model will not explicitly represent *any* system regulations. The reason for this is that a set of regulatory criteria are already *implicitly reflected* in the fixed deliveries and exports – both CVP and SWP/NP. These deliveries were determined by the CalSim2 model under allocations that were affected by the system regulations. All that the sizing model needs to do is determine how much

conservation storage is necessary to meet these CVP deliveries. Single-reservoir scenarios (i.e. only Trinity or only Shasta) can be tested, but as pointed out earlier it is anticipated that these will have limited success. A matrix of multiple-reservoir scenarios will be developed where each scenario can collectively provide conservation storage that will supply the prescribed CVP delivery/export need.

A small, simple example can demonstrate the concepts used in the sizing model. The example network (Figure 2) has one storage reservoir (green triangle). The outflow is a surrogate for regulatory criteria, which includes both a flow standard and flood control (release requirement and spill). Two runs of this example model will be presented. The first run will show a normal operation, representing the role that CalSim2 will play in the CAS analysis. The second run will show what happens when regulatory criteria is removed and the reservoir is sized to just meet the fixed delivery.

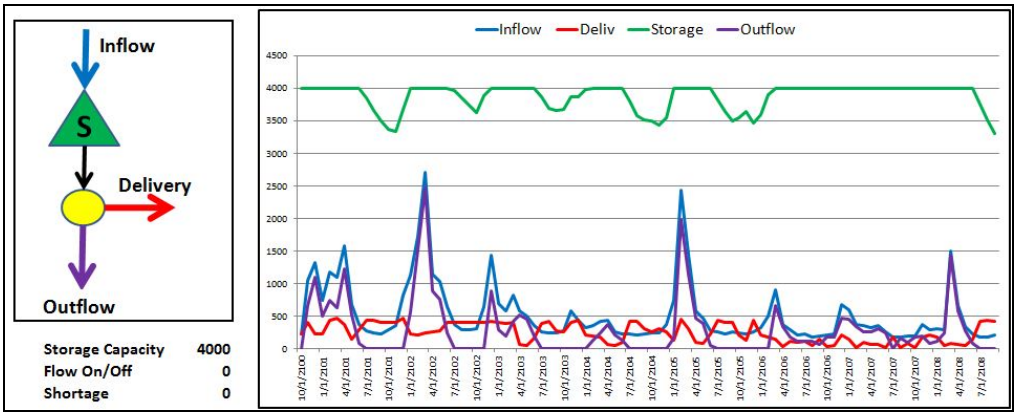
Figure 2 – Normal Operations in Demo Model



Normal operations results are shown in Figure 2. The reservoir has a capacity of 4 taf, and inflow (the blue line) shows seasonal and inter-annual variability. Flow requirements and spill are captured in the outflow (the purple line). The reservoir storage output is shown by the green line - outflow spikes due to spill whenever the storage hits maximum capacity, and storage declines over time as conservation pool is used for delivery and required outflow through a low-inflow period. Deliveries (the red line) vary, reflecting an allocation process. The plot shows the simple system operating through a range of water supply conditions, utilizing the storage in the reservoir to serve multiple purposes.

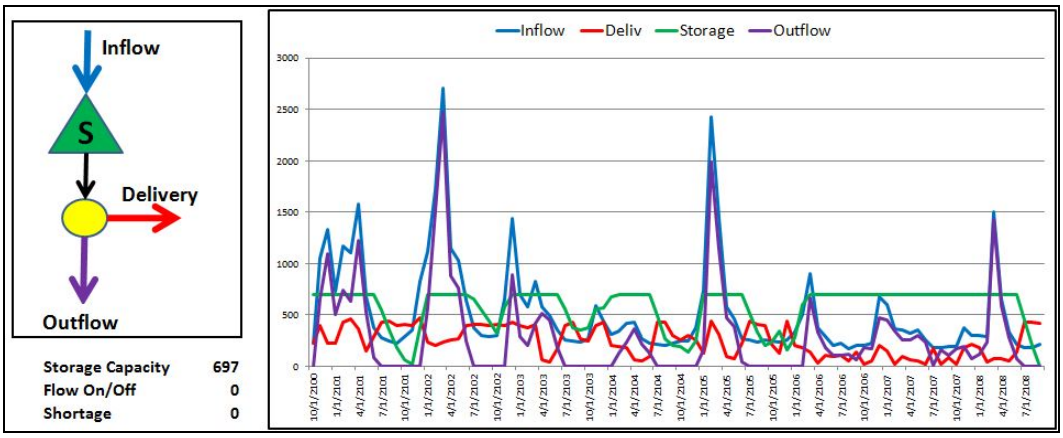
Figure 3 shows the operation that results if the regulatory requirement is removed. The model is no longer obligated to make releases for flows downstream. The reservoir does still spill when it fills up. Deliveries are fixed to the results from the Normal Operations run and they are always met – sometimes by inflow simply passing through the full reservoir, and sometimes by a combination of inflow and storage release. The largest dip in the storage pool determines the maximum conservation storage that was actually necessary to fully satisfy the deliveries.

Figure 3 – Sizing Model run with Full Size Reservoir



Clearly, the full reservoir size of 4000 af is not required to meet the delivery needs. When reservoir capacity is set to 697 af, there is exactly sufficient storage to satisfy the water supply delivery of the system at all times through the period of record. This is the single-purpose reservoir size for the water supply purpose. The operation is shown in Figure 4.

Figure 4 – Sizing Model Run with Single-Purpose-Sized Reservoir



In summary, the analysis goal for the Cost Allocation Study is to size CVP reservoirs to meet the water supply purpose of the Central Valley Project. CVP delivery capacity at a consistent level of development must be depicted by modeling that reflects demands and hydrology at that level of development and under specific regulatory criteria. CalSim2 will be used to depict these operations and deliveries. A new sizing model will be developed to determine a matrix of system storage conditions that can meet the CVP water supply purpose.