Appendix 22D
Urban Water Supply Economics Modeling

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APPENDIX 22D
Urban Water Supply Economics Modeling

22D.1 Introduction

Economic impacts, including benefits and costs, occur with changes in amount of municipal and industrial (M&I) water supply. For areas served by the State Water Project (SWP) and Central Valley Project (CVP) in California, these impacts are estimated using the Least Cost Planning Simulation Model (LCPSIM) and the Other Municipal Water Economics Model (OMWEM). These models were developed by the Department of Water Resources (DWR) for use in planning and impact studies related to water supply for SWP and CVP contractors. LCPSIM is used to estimate the benefits of changes in the water supply for M&I purposes in the urban areas of the San Francisco Bay – South and the South Coast regions. OMWEM covers other affected SWP and CVP delivery regions.

22D.2 Least Cost Planning Simulation Model

22D.2.1 Description

LCPSIM estimates economic benefits and other impacts of changes in urban water supply using a simulation/optimization framework. The model takes annual water supplies over a hydrologic period as input and estimates how local storage operations, conservation, recycling, transfers, contingency shortage and other local management will work together to minimize total economic costs of water acquisition and distribution and shortage. The value of available supply from a proposed project can be determined from the change it produces in this least-cost mix of demand and supply measures and shortages. The reduction in all costs associated with a water supply increment is the benefit of the increment.

Data has been developed to use LCPSIM for the two largest urban water use areas in the State. The South Coast model corresponds to the DWR South Coast Hydrologic Study Area. The San Francisco Bay – South model was expanded somewhat beyond the DWR South Bay Planning Study Area boundary to include all customers served by Contra Costa Water District (CCWD), the Santa Clara Valley Water District, Alameda County Water District, and Alameda County Zone 7. As a result, it includes all Bay Area SWP and CVP M&I users.

For each model area, several model data versions have been developed corresponding to carefully defined “development conditions” that describe the level of demands and facilities in place to manage supplies. Development conditions are normally defined and named according to a recent or future year. The assumptions for each development condition are selected according to local plans for demands, facilities and operations, and they include what is allowed and required for the type of study at hand; for example, NEPA/CEQA or federal Principles and Guidelines (P&Gs). Like CALSIM II, LCPSIM provides a distribution of results that reflect the development condition as well as hydrologic variability over the hydrologic period.

LCPSIM has been developed and applied for more than 25 years. Model development began in 1985 as a means to provide a systematic evaluation of projects and programs in the context of existing and forecasted regional water management. It has been used since 1990 to evaluate urban reliability benefits for DWR planning and environmental impact documents. It was also used for the CALFED Water

Management Strategy Evaluation Framework (2002). The model has been updated almost continuously since then as planning assumptions have changed.

An LCPSIM review group consisting of DWR and Bureau of Reclamation (Reclamation) staff, economics-engineering consultants, and water agency staff was convened in July 2004 and met periodically for over a year. The review group issued its final report in October 2005. The review found that "LCPSIM can provide usable information on economic benefits for use in surface storage evaluations," but noted some qualifications. These qualifications included regular modifications and refinements and additional work on the San Francisco Bay – South model. A number of changes to LCPSIM were made in response to the group's input. The San Francisco Bay – South model was revised and improved as recommended, and periodic updates have been made to water use efficiency costs and adoption rates, recycling costs, water transfer costs, and other data and assumptions.

LCPSIM was designed to be data-driven in order to easily represent different analytical circumstances without changing the model code. For example, adding a line of parameters to the carryover storage input text file is all that is necessary to create a new carryover storage operation. If unique situations require recoding, the source has been written with an emphasis on modularity to facilitate different analytical needs.

22D.2.1.1 Interactions with Other Models

The model has important interactions with other models. In particular, CALSIM II, DWR's project operations model for the SWP and the CVP, is used to estimate SWP and CVP supplies which are inputs into LCPSIM. CALSIM II and LCPSIM both currently operate over the 1922 to 2003 hydrologic period. CALSIM II deliveries are driven by specified target delivery quantities that the model tries to meet based on available inflows and storage on the SWP and CVP systems for each year of hydrology used. An existing linkage tool has been developed to translate CALSIM II delivery output to a corresponding LCPSIM input file.

LCPSIM model requires annual water supply estimates from other sources such as the Colorado River Aqueduct (CRA), the Los Angeles (LA) Aqueduct, the Mokelumne Aqueduct and the Hetch-Hetchy system. These inputs are provided by annual time series provided by local agencies. The State maintains databases and models that estimate and forecast urban water demands. These demands, including detailed forecasts of conservation savings, provide input to LCPSIM.

The Characterization and Quantification (C&Q) process provides inputs directly to LCPSIM and indirectly, through CALSIM II. The C&Q process obtains demand and conservation information from other processes such as the Water Plan and provides information on base use, or adopted, conservation as well as quantities and costs of conservation options. Similarly, the C&Q process provides baseline recycling estimates and the costs and amounts of recycling options. The C&Q process is used to document water transfer assumptions including detailed evaluations of water rights transfers, long-term temporary transfers, and the cost and availability of short-term temporary transfers.

LCPSIM output can be used as part of the input to regional economic analysis using the IMPLAN model. LCPSIM can estimate changes in water supply, treatment, and distribution costs within M&I regions, and these changes can be provided to IMPLAN. Increases in regional water supply costs reduce disposable income of water consumers to spend elsewhere in the local economy.

22D.2.1.2 LCPSIM Model Theory

LCPSIM simulates economically efficient regional water use in that the total cost of supply and demand management is minimized. This feature is critical for unbiased benefits estimation because it means that new water supplies will always replace the lowest-cost increment of shortage or regional long-term water supply and demand management options available in any year. Total cost is the sum of two costs: 1) the cost of long-term reliability augmentation, and 2) the cost of shortage. The latter includes shortage contingency measures such as water market transfers and is inversely related to the former.

Figure 22D-1 shows the relationship between shortage costs and reliability augmentation costs, and it shows their least-cost combination. At the least-cost point, the cost of additional reliability augmentation is more than the reduction in shortage costs, but the cost savings from less reliability augmentation is less than the additional shortage cost.

The addition of new water supplies to this mix will reduce the total cost of shortage and reliability augmentation. That is, the new total cost curve will be lower than the curve in Figure 22D-1. At the new equilibrium, costs of shortage and reliability augmentation will both be less and the least cost point will lie to the left of the point in Figure 22D-1.

In LCPSIM, the cost of additional supply reliability and the cost of shortages affect the level of the use of long-term conservation measures beyond those included in the base use values. This is because the economic optimization logic used in LCPSIM depends on comparing the marginal cost of regional long-term conservation measures, the marginal cost of regional long-term supply augmentation measures and the marginal expected cost of shortages. Quantity demanded is therefore a function of the overall regional economic efficiency of water management.

22D.2.1.3 Types of Water Demands and Uses

Water demands are separated into four categories: priority uses, base use, deliveries for contingency conservation affected use, and interruptible use deliveries. For the 2009, 2025, and 2060 development conditions, the South Coast LCPSIM includes between 4 and 6 million acre feet (MAF) of demand, respectively, with another 1 to 1.6 MAF in the San Francisco Bay – South model.

- Priority Uses: Some uses are assumed to be required before supplies are available for allocation to urban demands. These uses are non-interruptible agricultural use, environmental use, and conveyance losses. Environmental use and conveyance losses are aggregated from local DWR Detailed Analysis Unit (DAU) studies. The net supply needed to meet these uses is obtained by reducing by the regional reuse that occurs in the process of applying water for these purposes.

- LCPSIM uses a forecast of irrigated acreage, forecasted average applied water use, and a time series file of annual variation from average crop ETAW (Evapotranspiration of Applied Water) to generate time series agricultural use data. Information on annual crop water use variation comes from a simulation model of unit crop ETAW that was developed to create a historical agricultural water use pattern for the 1922 to 2003 hydrologic period by water year (September through October). A reuse factor from the parameter file is used to generate the annual net agricultural use data used by LCPSIM.

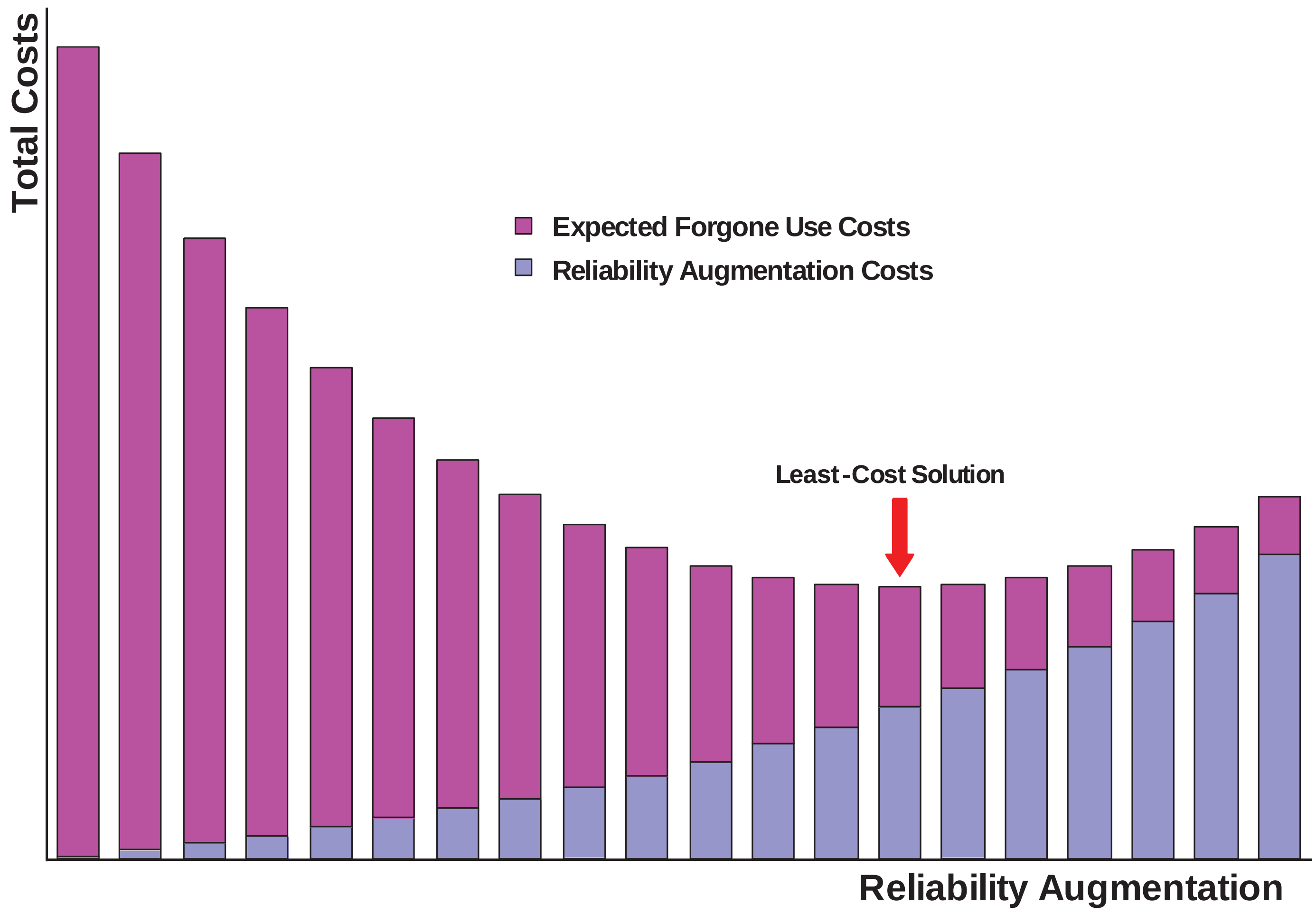

FIGURE 22D-1
The Effect of Increasing Reliability on Total Costs
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- Base Use Demands: The demand sequence for non-interruptible urban deliveries is developed from a forecasted quantity demanded for the development condition (e.g., 2025) being investigated. The annual interior and average annual exterior urban demand quantities are calculated using the interior and exterior urban demand share values. Interior demand is assumed to have the same value for all years. Exterior use is separated into two components, a fixed component, which is assumed to have the same value for all years, and a variable component, which is assumed to be directly proportional to the ETAW for each year.
- A simulation model of urban turfgrass water use was developed to allow the creation of an annual ETAW variation time series for the 1922 to 2003 hydrologic period by water year (September through October). A variable exterior use component time series demand is generated using this time series and the average variable exterior demand. Adding the variable exterior demand time series to the sum of the fixed exterior demand component and interior demand produces the total urban applied water demand sequence.
- Because the demand sequence consists of applied water quantities, they must be converted to net quantities for use in the mass balance logic. All of the variation in total applied water demand is assumed to arise from exterior applied water use. While the regional reuse associated with interior use is consequently constant, reuse associated with exterior applied water use varies from year to year.
- Contingency Conservation Affected Use. Contingency conservation affected use is that amount of non-interruptible use which can be expected to be eliminated on a short-term basis in response to programs such as drought alerts and conservation advice in the media, local agency water-waster patrols and alternate-day watering rules, etc.
- Interruptible Demands. The interruptible component of demand for the South Coast was developed from information contained in the annual financial reports of the Metropolitan Water District of Southern California (MWDSC). This component is held constant for the hydrologic period and the quantity specified assumes that other sources of supply will not be used in-lieu. No interruptible delivery program was assumed for the San Francisco Bay – South.

22D.2.1.4 Types of Water Supplies

- Regional Yield Supply. Some supplies such as desalination, recycling, and recovery of native groundwater can be assumed to be available at the same level (defined by the development condition) every year of the hydrologic period. These water supplies include some within-region surface supplies and groundwater supplies exclusive of carryover operations. Annual supplies vary according to historical precipitation and local storage conditions.
- Import Supply Time Series. Annual deliveries from projects which import water from outside the region including the SWP, federal CVP service contracts, and regional projects. SWP and CVP deliveries are developed using CALSIM II.
- In the San Francisco Bay – South region, the CVP service contract delivery sequence represents CVP deliveries through the San Felipe Division to Santa Clara Valley Water District (SCVWD), to Contra Costa Water District (CCWD) and through the new Freeport diversion, to East Bay Municipal Utility District (EBMUD). Annual time series of deliveries through the Mokelumne Aqueduct and the Hetch-Hetchy system are also included. These time series are developed from modeling done by the

East Bay Municipal Utility District (Mokelumne Aqueduct) and the San Francisco Water Department (Hetch-Hetchy Aqueduct).

- For the South Coast region, federal deliveries made through the CRA, transfers and exchanges through the CRA, and the LA Aqueduct deliveries from the Owens Valley are included. LA Aqueduct deliveries are from modeling studies from the Los Angeles Department of Water and Power. CRA deliveries are based on the recent Quantification Settlement Agreement.
- Local Supply Time Series. Annual supplies available to the regions are included as annual quantities over the hydrologic period being represented (e.g., the 82 years represented by the period 1922 to 2003).
- Water Transfers. Water transfers are generally 1) permanent, as in water rights transfers, 2) long-term temporary, or 3) short-term temporary. In general, permanent and long-term temporary transfers are modeled in CALSIM II and temporary short-term (annual) transfers are modeled in LCPSIM. Some temporary transfers are included as fixed amounts within the CRA time series.

These four supply types are used, managed and stored as described below.

22D.2.1.5 Annual Water Supply Operations

This section describes how LCPSIM operates water supplies to meet demands and other uses on an annual basis. Operations are described in general order of their priority as supplies are reduced relative to demand. Modeled operations include deliveries to users, deliveries to and from carryover storage, water transfers, and shortage event-related conservation and water allocation programs.

Operations in Excess Conditions

Excess conditions exist when supplies are more than enough to meet the sum of current consumptive demand plus available carryover storage space and/or put capacity. The amount of supply remaining after carryover storage delivery constraints are considered is used to estimate how planned SWP operations might be reduced in specific years compared to the target deliveries set in CALSIM II.

- SWP Reallocated Water: The SWP and CVP water deliveries used by LCPSIM are generated by the CALSIM II project operations model. The CALSIM II deliveries are driven by specified target delivery quantities which it tries to meet based on available inflows and storages on the SWP and CVP systems for each year of the hydrology used. Because these targets are set independently of LCPSIM, an economically efficient water management plan can produce a level of reliance on regional supply and conservation measures which can result in the target deliveries for a region having been set too high for the wetter years. In these years, the capacity for deliveries to carryover storage can be exceeded, either because the volume to be stored exceeds the available space or the annual put rate is insufficient.
- This “excess” supply is assigned to the SWP because it is assumed by LCPSIM to be the marginal supplier. Provisions of the Monterey Agreement require that excess SWP supplies be offered for sale to other SWP Table A contract holders. If a portion of the SWP supply available to a region exceeds both current quantity demanded and available carryover storage constraints, a time series file of the excess quantities can be generated by LCPSIM for that region and used to augment SWP deliveries to other urban regions or agricultural users, or the target deliveries in CALSIM II can be reset.

- Local Storage Operations. Surplus conditions exist when supplies are more than enough to meet current consumptive demand but less than the sum of current consumptive demand and carryover storage delivery constraints. Water supply surplus to demand for current consumptive use is allocated to ground or surface storage. Deliveries to carryover storage are constrained by annual put ceilings and available carryover storage capacity after adjusting for put efficiencies (if less than 100 percent).

Regional Ground and Surface Carryover Storage

The general types of regional storage modeled in LCPSIM are:

- Banked Groundwater. A banking arrangement may involve an agreement between water agencies in two different regions of the State, for example, allowing one agency to operate a specified portion of the other agency's groundwater storage capacity (e.g., the agreement between the Santa Clara Valley Water District and the Semitropic Water Storage District). The stored water would be water that would otherwise be delivered for use under contract or water right but is stored for later delivery for use during shortage events.
- Puts involving groundwater storage can be accomplished by injection wells, spreading basins, or in-lieu deliveries (water users normally pumping groundwater are switched to surface water supplies). Conversely, takes from groundwater storage either can be accomplished by groundwater pumping or by switching water users who normally take surface water to groundwater pumping, allowing the now unused surface supplies to be delivered elsewhere. SWP project deliveries direct to San Joaquin Valley groundwater storage are also supported in LCPSIM. The stored water is then made available for delivery in subsequent years.
- Regional Carryover Storage. This may be conjunctive use storage that is physically located within the region or it may be located outside of the region (e.g., MWDSC's Lake Mead Project). Storage that uses a federal contract service conveyance facility (e.g., the CRA) is constrained by the conveyance capacity available (federal contract deliveries are given priority).
- Reserve Storage. In the South Coast Region, SWP terminal reservoir storage in the South Coast Region can be used for shortage management per contractual agreement. LCPSIM can place strict rules on the use and refill of this storage (i.e., the last to be used and the first to be refilled).
- SWP Carryover. If storage is available in San Luis Reservoir, SWP contractors can elect to have a portion of their SWP supply stored for delivery in the following year. The stored quantity is always assumed to be used to augment SWP deliveries. Available San Luis storage is determined using a file of time series data generated by CALSIM II.

Regional Ground and Surface Carryover Storage Characteristics

Carryover storage operations can involve storage capacities within the region or external to the region. Information entered into LCPSIM for individual carryover storage operations includes the capacity which can be operated, the initial fill, the annual put capacity, the annual take capacity, the conveyance facilities which will be used for puts and takes, any losses associated with storage operations, the on-site unit cost of the put and take operations, and whether one or more storage operations operate the same physical storage space.

The carryover storage element of the basic water management simulation algorithm was developed from information published by agencies within the study regions as well as discussions with their staff. This information was used to estimate the average amount of groundwater basin and reservoir storage capacities available for the purpose of storing currently available water for use in future years. The carryover storage capacities are the amounts over and above the capacities needed for regional intra-year operations. In the same manner, annual rate ceilings for deliveries to carryover storage (puts) and withdrawals from carryover storage (takes) were developed.

By default, LCPSIM uses take-capacity-to-stored-supply ratios to dynamically set put and take priorities. The put and take priorities for each storage operation are dynamically set by calculating the ratio of the stored supply to the take capacity for each storage operation for each annual time step. This ratio is then used to assign relative priorities for that time step: the lower the ratio, the lower the take priority and the higher the put priority. This strategy is designed to maximize supply availability from carryover storage when the desired deliveries to users exceed the supply available from other sources. Alternatively, these priorities can be set statically for each storage operation based on entries in the carryover storage data file.

Statically based priorities, in general, assume that when carryover supplies are needed to meet desired deliveries, water is preferentially taken from surface storage carryover supplies as opposed to groundwater storage carryover supplies. When supplies are available for refilling carryover storage, the supplies are preferentially used for groundwater storage carryover operations as opposed to surface storage carryover operations.

LCPSIM can trigger water market transfers to refill depleted carryover storage. These transfers can be triggered when the amount of stored supply is less than the available take capacity. The trigger can be set in LCPSIM parameter file as a percentage of take capacity. Dynamically set put priorities are always used for water market transfers made to replenish depleted carryover storage.

Operations in Deficit Conditions

Deficit conditions exist when imported plus local supplies are not enough to meet priority uses and demand including interruptible deliveries. If the supply from the sources other than carryover storage is less than desired deliveries to users, this balance can be achieved by deliveries from carryover storage, or by reducing use, or both. Deliveries from carryover storage are constrained by the annual take ceilings and the amount of stored water available.

Takes from carryover storage are constrained in LCPSIM to amounts accrued from puts in previous periods, with an allowance for a specified initial fill. LCPSIM has the capability of simulating groundwater bank take constraints based on either quantity limits for consecutive takes (e.g., Arvin-Edison WSD) or on percentage cutbacks in SWP Table A deliveries (e.g., Semitropic WSD, Mojave WA). The rules for simulating these constraints are stored as LCPSIM data files.

Takes from carryover can also be constrained by a hedging function within the model. This hedging function can be assigned to any or all carryover operations but only on a total capacity basis. Figure 22D-2 depicts the functional form used.

From the example function shown, if the amount in storage is 50 percent of the total storage capacity of the operations selected to be hedged and 25 percent of the stored amount is needed to meet demand, 90 percent of the needed amount will be supplied. If 75 percent of the stored amount is needed, 70 percent of the needed amount will be made available. Three input parameters affect this function, the storage capacity ratio at which hedging is employed and two parameters which affect the absolute and relative slopes of the curves which relate quantity needed to quantity supplied.

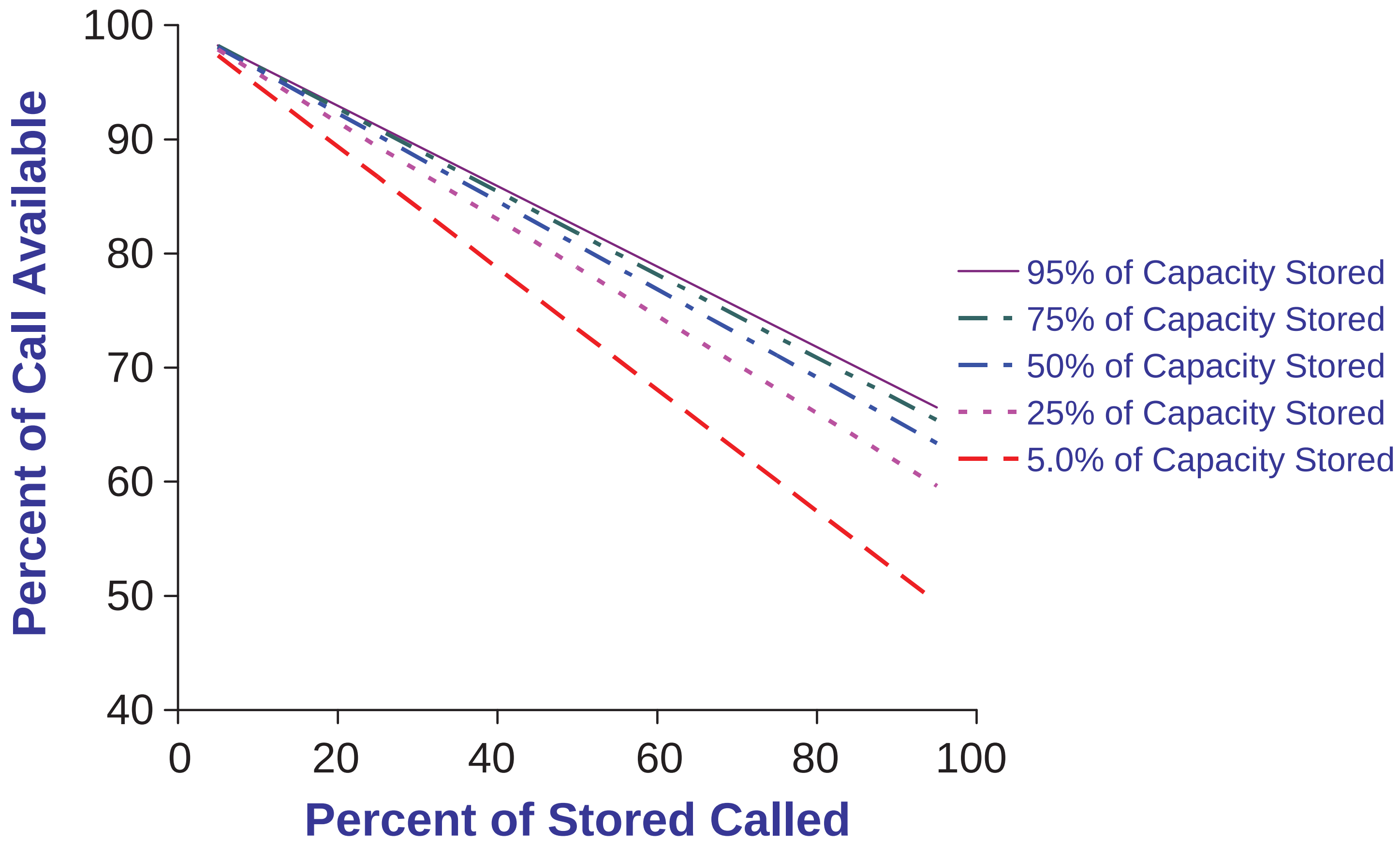

FIGURE 22D-2
LCPSIM Hedging Function Example
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Take constraints set in the carryover storage data file for reservoir storage can also be used to represent a specific hedging strategy. LCPSIM also accepts water bank take constraint rules based on either reducing the allowed take in consecutive-year take situations (e.g., Arvin-Edison WSD banking program) or on the project delivery received by the bank operator as a percentage of their contract full-delivery quantity (e.g., Semitropic WSD and Mojave WA banking programs).[1]

Curtailment of Interruptible Deliveries

The economic losses assigned to users of interruptible supplies are assumed to be limited to the cost of that supply in accordance with their usual water rate. Interruptible program deliveries are assumed to be cut back along with non-interruptible deliveries but at a higher rate relative to non-interruptible cutbacks. The unit value of the losses incurred by interruptible supply customers in a current year is the same as the unit price paid for that supply. This is based on the assumption that the price reflects the value of that supply discounted for unreliability by knowledgeable users of that source of supply.

Contingency Conservation Measures

Examples of contingency conservation measures include; alternate day watering regulations, water waster patrols, emergency water pricing programs, and intensive public education campaigns. A specified reduction in quantity demanded can be expected upon implementation of a program which includes such measures. The model assumes that such a program is instituted whenever there is a shortage in available water supplies compared to current quantity demanded or in response to low carryover storage availability. An agency cost of implementing the contingency conservation programs is included.

The contingency conservation program allows supplies which would have been directed to this category of use to be allocated elsewhere. Figure 22D-3 shows the function used to implement this logic. The “take call ratio” relates desired deliveries to supply. The capacity use ratio relates the total amount of capacity available to store carryover supplies to the total amount of water in carryover storage. Both of these ratios are input parameters to LCPSIM.

Contingency Water Market Transfers

If current year supplies and withdrawals from carryover storage are insufficient to meet the quantity demanded the ability of annual water market transfers to augment current year supply is simulated. Water market transfers are modeled using constraints as well as costs by source. These constraints include conveyance capacity, carriage water and other conveyance losses. Conveyance of other supplies, including withdrawals from carryover storage, is given priority. Also, transfers are limited by a consideration of potential third party impacts and amounts historically made available.

Water transfer costs vary by year type. The information used to develop these costs considered actual transfer prices as well as shadow prices from the Statewide Agricultural Production (SWAP) model. Unit water purchase costs from each source are adjusted upward by their respective conveyance losses and augmented by their respective conveyance costs. The unit purchase costs from any source can be specified as coefficients of a quadratic function, representing a unit cost that increases linearly as the amount used is increased. Quantities available from each source are constrained by the applicable conveyance capacities. The quadratic programming solution which minimizes the sum of the forgone

[1] Arvin-Edison’s MWDSC take limit is reduced for each consecutive year for which a take is made. Semitropic’s MWDSC take limit is equal to the bank’s pumpback capacity plus the product of MWDSC’s percentage share of the bank and Semitropic’s SWP Contract Table A delivery after subtracting Semitropic’s reserved amount of that allocation: Pumpback Capacity + Share of Bank * ((Table A Allotment * Percentage of Table A Delivered) - Reserved Table A).

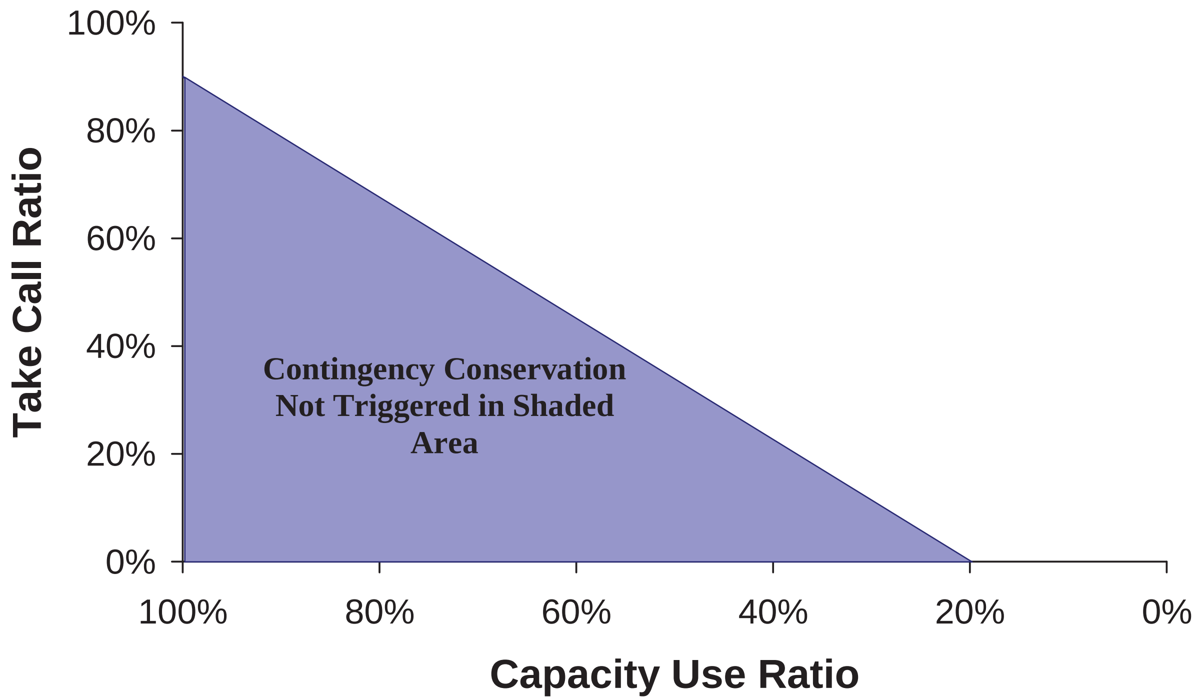

FIGURE 22D-3
Trigger Function for Contingency Conservation
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use-related costs and losses and the minimized costs of transfers at alternative transfer quantities is used to determine the quantity transferred to reduce forgone use.

Water market transfer options are input into LCPSIM in terms of the quantity available from a specified source, the cost obtaining the water at the source, what facilities will be used to convey the transferred water, any losses during conveyance (e.g., carriage water for transfers involving the Delta), and any constraints on the frequency of use of the transferred water from that source. System conveyance capacity constraints and delivery efficiency factors for water market transfers in the form of time series files generated by CALSIM II or other system models can be used by LCPSIM. LCPSIM can use such files for transfers from the either Sacramento Valley, the San Joaquin Valley, or both.

Identification of the conveyance facility is needed to determine what capacity remains for moving the water to be transferred and to determine the conveyance cost. If the conveyance facility is a federal service contract facility that is used to convey exchanged SWP Table A contract deliveries then the aqueduct capacity for transfers is increased during those years when Table A deliveries are cut back. For example, MWDSC delivers Colorado River water to Desert Water Agency and Coachella Valley Water District through the CRA in exchange for their SWP contact deliveries.

Frequency of use constraints can be used to represent the need to respect the potential for serious third-party impacts. These constraints are specified by source and are in the form of a limit on the maximum amount of water that may be transferred during consecutive years and in terms of the maximum quantity to be made available over a 10-year period.

Simulated water market transfers include not only those made for shortage event management but also those made to augment carryover storage.

Shortage Modeling and Forgone Use Costs

A shortage event is the most direct consequence of water service system unreliability. LCPSIM estimates how new water supplies and management reduce the frequency, magnitude, and duration of shortage. Shortage is the difference between the quantity of current consumptive use and the supply available for use. The model uses a shortage loss function derived from contingent valuation studies and water agency shortage allocation strategies to value the forgone use.

LCPSIM includes a number of steps used to determine the management, amount, allocation and costs of shortage. Conservation and rationing operations are instituted 1) during shortage events or 2) when the total carryover storage quantity available is of serious concern.

Rationing

In LCPSIM, “rationing” is shorthand for a water allocation method designed to minimize the overall economic costs of a shortage by “balancing” the costs of forgone use among customer classes. The allocation method in LCPSIM is intended to mimic water agencies by maintaining provisions for exemptions due to serious adverse economic impacts, especially for businesses. Above a specified threshold level, compared to single-family residential users, multi-family residential customers are assumed forgo use at a lower rate, commercial users are assumed to forgo use at an even lower percentage rate, and industrial customers are assumed to forgo use at the lowest percentage rate. Above the specified threshold level, water use for the purpose of maintaining large landscaping is assumed to be curtailed at a greater percentage rate than single-family residential use.

LCPSIM logic accounts for the assumption that interior use is cut back at a lower rate than exterior use during shortage events and that the associated reuse factors differ. Because recycling options affect fixed reuse, this also has to be taken into account in calculating the overall annual reuse quantities needed to related applied water supply availability to net water supply availability. The effect of the adoption of conservation options on the relationship between a shortage in supply and the availability of applied water is also taken into account in the determination of economic losses.

Forgone Use Allocation

Forgone use resulting from rationing is allocated among the different user classes represented in the model; industrial users, commercial and governmental users, single family and multifamily residential users, and large landscape users.

This allocation is determined by input parameters for users not classified as single family residential. These parameters represent the respective fractions of the single family residential percentage of use forgone that will be allocated to them. For example, a parameter value of 25 percent for industrial users means that these users will be held to a forgone use equal to 25 percent of the percentage use forgone by single family residential users. This results in the single family residential users forgoing use, in percentage terms, larger than the overall forgone use. This effect can be moderated by specifying that deliveries to large landscape irrigators will be curtailed at a greater percentage rate compared to single family residential users. An input parameter determines the level of overall forgone use at which this allocation takes effect. This is intended to represent strategies used by water agencies to protect businesses and institutions from serious economic damage and job loss during shortage events. Some water agencies have explicit water allocation rules. Other agencies have hardship exemption programs that have a similar result.

Forgone Use Cost Function

The forgone use loss function assigns economic losses to forgone use. The loss function is input into LCPSIM either as:

- A polynomial function which relates a percentage forgone use to a total cost of that forgone use or
- A constant price elasticity of demand function.

Because the loss function is intended to approximate willingness-to-pay at the water user level, it is driven by the availability of applied water. For this reason, the net water supply availability generated by the mass-balance logic must be converted to applied water supply availability. This is done by adding reuse back to the net water supply.

LCPSIM has the ability to use a polynomial loss function. This functional form has the advantage of allowing “threshold effects” to be modeled. The intuition is that the inconvenience of dealing with water agency policies during shortage events (e.g., alternate day watering and gutter flooder regulations, water waster patrols, etc.) is perceived as a hardship over and above the value associated with the amount of water no longer available for use. Depending on how this phenomenon is specified as a polynomial, it can result in a loss function in which, at higher shortage values, associates a higher marginal value of supply at lower forgone use levels than at higher shortage levels. If this is the case, it is important to evaluate the model results to ensure that the model solves within the range of shortages where this is not considered an issue. The polynomial loss specification can also accommodate a linear cost function (i.e., polynomial of degree one).

The ability to use a constant price elasticity of demand function is also provided as an alternative, more conventional, means of deriving the shortage loss function. It has the advantage of using just three parameters that are readily available; the retail water price, the retail quantity, and the elasticity of demand. Because it is likely to assign much higher loss values to the larger shortage events, the CPED function can result in more regional reliability options being brought online, reducing the number of small shortage events compared to the use of a linear or polynomial function even though it may assign comparatively lower loss values to smaller shortages.

The loss function includes the marginal value of water to users for the no shortage condition. This is done by setting the intercept of the loss function equal to the variable component of the retail price of water. To avoid double counting, all costs are considered from perspective of the water user; any changes in costs or income to water purveyors resulting from changes in operations costs or from reduced water sales due to shortages are assumed to be passed on as water user costs or cost savings.

Demand elasticity can help to inform or validate forgone use loss functions. The steeper the demand function, the more that shortage costs increase with shortage amount. A 1996 elasticity study done for DWR Bulletin 160-98 found an average elasticity of -0.16 for urban residential users. In 1990, estimated price elasticities of demand for single-family, multifamily and non-residential users were -0.195, -0.163 and -0.159, respectively. A demand hardening factor of 52 percent by 2010 resulted in 2010 elasticities of -0.101, -0.085 and -0.083, respectively, with elasticities of -0.064, -0.054 and -0.052 by 2020. For the CPED shortage cost function, LCPSIM currently assumes a demand elasticity of -0.101 in 2009, and -0.064 in 2025 and 2060.

For comparison, the CPED function with the elasticity value of -0.10 is used to estimate the forgone use losses and results are compared to losses estimated by the polynomial function in Tables 22D-1 and 22D-2 below. Average willingness to pay per unit water for the CPED function is lower at small shortage levels but more at large shortage levels.

Table 22D-1
Example Polynomial Loss Function Values
Urban Water Supply Economics Modeling

Forgone Use	Willingness to Pay to Avoid Event		
	Acre-Foot Use/Year/Household		
	0.75	0.65	0.55
0%	$0	$0	$0
5%	$49	$43	$36
10%	$145	$126	$106
15%	$278	$241	$204
20%	$439	$380	$322
25%	$618	$535	$453
30%	$804	$697	$590
35%	$990	$858	$726

Table 22D-2
Example CPED Loss Function Values
Urban Water Supply Economics Modeling

Forgone Use	Willingness to Pay to Avoid Event Acre-Foot Use/Year/Household		
	0.75	0.65	0.55
0%	$0	$0	$0
5%	$29	$25	$22
10%	$79	$69	$58
15%	$166	$144	$122
20%	$323	$280	$237
25%	$618	$535	$453
30%	$1,194	$1,034	$875
35%	$2,376	$2,059	$1,742

Consecutive Shortage Events

When they occur, the calculated forgone use costs can be increased by a specified percentage amount to reflect the more severe consequences of consecutive shortage events. This effect falls off as a power function of the number of years between events and does not apply if the next loss event follows by more than 2 years. The default inputs do not increase foregone use costs.

Demand Hardening

Long-term demand management measures that are adopted by water users can have a demand hardening effect. Although they can increase reliability by reducing the size, frequency and duration of shortage events, they can make these events relatively more costly when they do occur. A hardening factor can be set in LCPSIM to simulate this effect. If conservation decreases demand by a specific percentage then the economic impact of forgone use of a specified size is computed as if the forgone use was greater, based on the hardening factor. Hardening is computed from the ratio of the quantity of use reduction due to conservation to total quantity of use prior to that reduction and expressed as a percentage. This percentage is then multiplied by a percentage specified as a LCPSIM input parameter (the demand hardening adjustment factor) to get a forgone use adjustment factor. This factor is used to adjust the quantity of forgone use before the loss function is applied. For example, if pre-adjustment forgone use is 10 percent, the demand hardening percentage is 20 percent, and the demand hardening adjustment factor is 50 percent, then forgone use is increased to 11 percent for the purposes of determining economic losses.

Long-Term Conservation and Supply Options

LCPSIM includes the potential for cost-effective long-term conservation or local supply augmentation. Information on individual regional water management options used by LCPSIM includes: the amount available from that that option, the unit annualized capital and O&M cost of that option, and the type of option. The unit cost of any option can be specified as coefficients of a quadratic function, representing a unit price that increases linearly as the amount used is increased.

The type of option is used to determine how the option would affect the mass balance. Options such as ocean water desalting augment supply, conservation options decrease applied water demand, and recycling options augment reuse. With one exception, these options are assumed to provide a fixed level of supply enhancement or demand reduction each year.

The type of option is also used to determine either the cost of regional potable water and wastewater treatment and distribution, or, in the case of conservation, that these costs don't apply. To determine the effect of conservation on wastewater treatment costs, interior and exterior conservation options are identified separately. If a recycling option has a dedicated distribution system (e.g., "purple pipe"), the capital and operations and maintenance costs of that system must be included in the option data file as the cost of that option. The regional potable water treatment and distribution costs would not apply.

The applied water that is "lost" to surface return flows and deep percolation can help meet applied water demand through reuse. Conservation options, by definition, reduce this loss and, therefore reduce this source of applied water. To account for this, the option file includes percentage values to account for the effect of reuse on the ability of water conservation options to reduce the need for regional supplies (i.e., net demand) and on the cost of achieving that reduction. For example, exterior use conservation options which support the same plants (i.e., same ETAW) but reduce return flows and deep percolation will have a different effect on the need for regional supplies compared to conservation options which substitute different, lower water using plants. Conservation options which reduce the amount of deep percolation are credited with their associated pumping cost savings in LCPSIM, reducing their effective cost.

The exception to fixed nature of the options used by LCPSIM is exterior conservation. The value in the main parameter file that sets the share of exterior use that is unaffected by ETAW is also used to separate the effect of exterior use conservation into a fixed component and a variable component. The variable component is assumed to be directly proportional to the amount of exterior use in any year and is intended to capture the effect of actions which, for example, reduce the amount of water applied through better irrigation management.

Information about the potential quantities and costs of permanent options are largely from DWR's Water Plan process and are reviewed and selected within the C&Q process. Most water conservation opportunities are based on the Water Use Efficiency Comprehensive Evaluation. Recycling opportunities are based on a review of planned and potential projects. In both cases, amounts to include for a future development condition are included as regional fixed yield supplies, and this amount is subtracted from existing opportunities to obtain the remainder available as an option at the future development condition date.

Carryover Storage Augmentation Option

LCPSIM offers a limited ability to augment carryover storage capacity as an option. Only one existing carryover storage operation can be selected to be augmented. The augmentation assumes that annual put and take capacities are increased in proportion to the size of the augmentation. Information on which carryover storage operation is to be augmented and the cost of adding storage capacity to that operation is entered along with the data entered for the other regional management options.

Operations Cost Accounting

The economic costs and losses related include regional water management operations costs. These costs include SWP conveyance costs to the region, conveyance costs on other affected aqueducts supplying the region, and regional potable water and wastewater treatment and distribution costs. Conveyance costs include the cost of wheeling transferred water. The costs are from the perspective of statewide economic efficiency, generally compatible with a national accounting perspective, and are lifecycle costs whenever possible. Conservation option costs are adjusted to reflect any in-home energy costs savings which accrue to the user.

Unit costs of aqueduct conveyance, regional potable water and wastewater treatment and distribution costs are entered as LCPSIM parameters. Per-capita costs to regional water agencies for managing rationing programs, along with the forgone use threshold at which it assumed a rationing program will be instituted, are also inputs. Costs and maximum quantities of options including water transfers are input.

22D.2.1.6 Solution Method and Smoothing

LCPSIM uses several methods to find its least-cost solution over an entire hydrologic period. Quadratic programming algorithms are used to 1) find the least cost way of obtaining an increment of regional long-term option use, and 2) find the minimized cost of water market transfers at alternative transfer quantities and compare cost of water transfers to the value of transfers in terms of the amount of shortage avoided to identify the economically efficient quantity to transfer. The quadratic objective function can relate the amount of option use to the total cost of that amount of option use. For a particular level of option use, the options are assumed to be implemented in manner that minimizes the cost of achieving that level of use when both annualized capital and O&M costs and regional potable water and wastewater treatment and distribution costs are considered. Because quadratic option costs can be entered, a particular level of use may be achieved by implementing less than the total amount specified as being available from any one option.

The Priority-Weighted Mass-Balance Constrained Linear Optimization is used to find the least cost combination of long-term water management options, shortage contingency measures (including water market transfers), and shortages. A mass balance constraint is used to assure that supplies equal uses, but how this balance is achieved is set by assigning priority weights that affect how the water is moved. Storage operations are a critical component of the mass-balance logic. As was noted, priorities for take and refill are dynamic, depending on the status of the entire system, and are set to ensure maximum potential use of available supplies. The algorithm maximizes quantities weighted by priorities subject to the imposed system constraints.

The model water balance logic is used to balance water use with water supply, simulating regional water management operations. Using the mass-balance logic requires that the demand data, which are applied water quantities, be converted to net quantities by accounting for regional reuse. Reuse is either fixed (e.g., recycling) or variable (e.g., in-region pumping of deep percolation). In LCPSIM, variable reuse arises primarily from deep percolation of exterior urban use (e.g., residential landscaping and public parks). The other variable source is interior urban wastewater that is deep percolated from septic tanks. For this conversion, interior use is assumed to be constant and any year-to-year variation in total use is assumed to arise from variation in exterior use due to weather (e.g., temperature and effective precipitation).

Because of the complicated nature of multiple interacting supply sources and management decisions, one solution can be a local optimum that does not necessarily reflect the best least-cost result. Therefore, the model is run for a range of option use around the minimum point to obtain a curve whose variation reflects the variety of local optima. This curve is fit using regression and the minimum on this curve is used as the estimate of total costs.

The order of the polynomial smoothing function can be set by the model user based on the user's view of the trade-off between minimizing the rate of change in the slope of the function (i.e., a smoother function) and a function which is less smooth but more closely follows the path of the points (i.e., maximizes the goodness of fit). If LCPSIM user feels that, on average, the real world operations would be unlikely to duplicate the results of the threshold-based operating criteria incorporated in the model, then fitting the model-generated points too closely would be likely to bias the model results.

Selecting the starting and ending regional option use points for the simulation can also affect the results of smoothing. Adjusting the range of option availability is another trade-off that the user may make to exclude or include information that may or may not be useful for identifying an optimal solution point.

22D.2.1.7 Results Format

Figure 22D-4 shows results regarding amount of water supply and water storage over years of the hydrologic sequence. This type of output provides insights into the conditions that lead to different types of operations and storage. The hydrologic period includes two long-term droughts. In the South Coast region, these two periods account for most of the shortage costs.

22D.2.1.8 National Cost-Benefit Analysis with LCPSIM

LCPSIM was developed to provide state-level cost-benefit analyses for proposed SWP storage facilities. LCPSIM is used to find the economically efficient (i.e., least-cost) management strategy for the reservoir alternatives being considered, including the no-project alternative. The reduction in total regional costs when each with-project alternative is compared to the no-project alternative is the regional economic benefits ascribable to that alternative.

These benefits could then be used in a separable costs, remaining benefits (SC-RB) cost allocation analysis to determine the project costs allocable to that region. Comparing the allocated costs to the regional benefits for each alternative provides the benefit-cost ratio or the net benefits for that alternative, as appropriate.

In 2005, LCPSIM Review Group found that

> "in considering every aspect of the model, has determined that the model should be able to provide economic benefits information accurate enough for an economic benefits analysis of urban water supply from the perspective of the State or nation."

This finding was subject to several qualifications, including:

- Subject to some appropriate modification and refinements;
- Not appropriate for individual local water supply agencies, benefits not suitable for allocating costs among M&I users;
- Assumptions and results should be compared to local agency data and updated accordingly

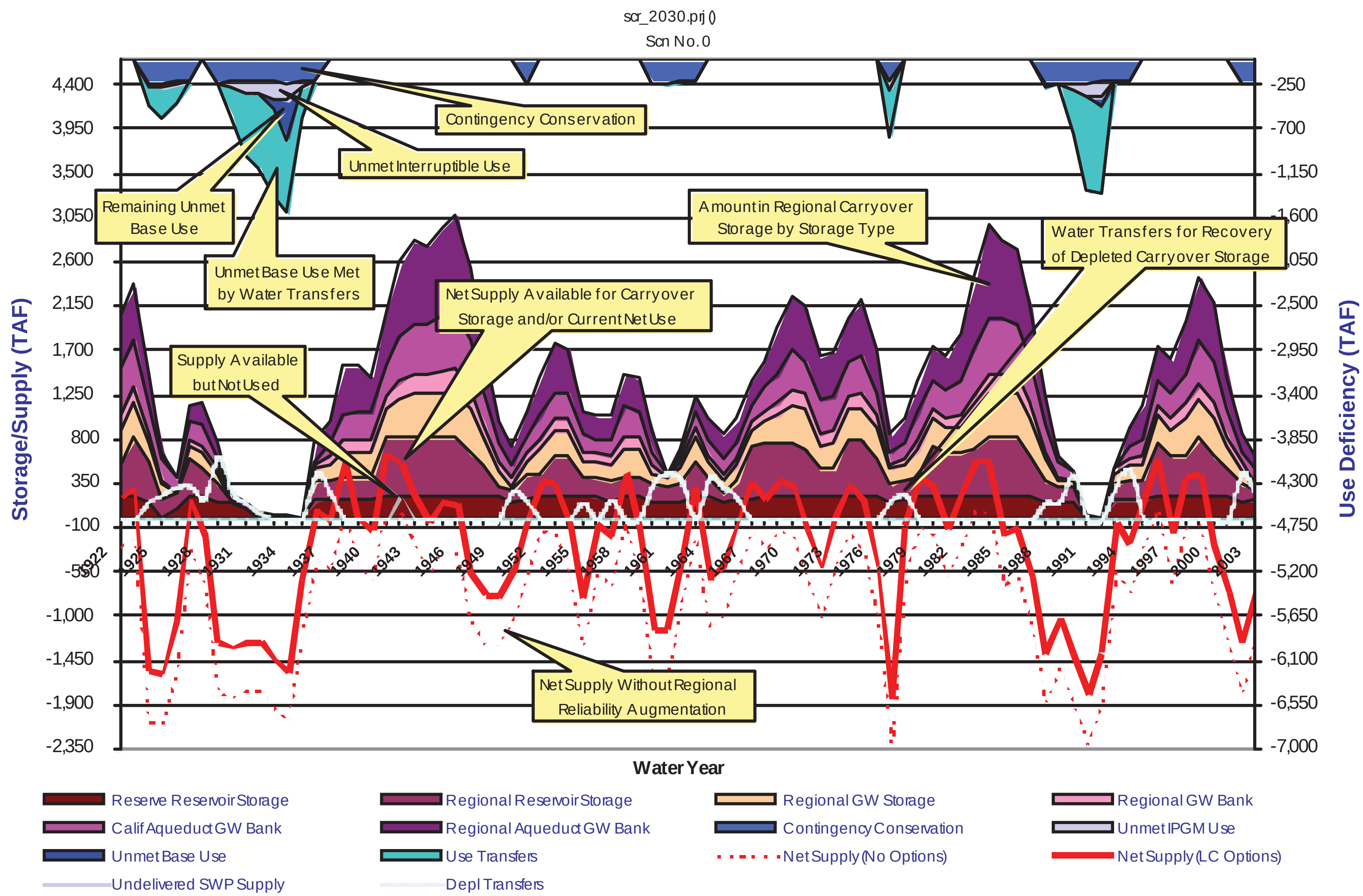

FIGURE 22D-4
Example Operations Trace Screen
Sites Reservoir Project EIR/EIS

- An expert group should be convened to evaluate the operation and results of any LCPSIM application proposed as a basis for benefits estimates
- Regular updating

A check of LCPSIM assumptions might be appropriate before use for national benefits analysis. In particular, some LCPSIM costs were developed using real discount rates and prices that should be adjusted for a national analysis.

Economic benefits from LCPSIM are computed at specifically identified development conditions. The model thereby conforms to CALSIM II hydrologic output which is also generated for specific development conditions and is tied to target deliveries and upstream depletions tied to those levels, rather than over a period of time.

National benefit-cost analysis requires a planning horizon analysis. Results from multiple development conditions can be used to develop planning horizon analyses as required by the P&Gs (U.S. Water Resources Council, 1983). Each year of the planning horizon corresponds to the development condition for that year. The needs of a planning horizon analysis can be met by LCPSIM by using LCPSIM results from two or more development conditions. The necessary information for years not modeled by LCPSIM can be obtained by interpolating between the two sets of LCPSIM results and extrapolating beyond. Information on specific planned events in the planning horizon might be used to design LCPSIM runs with specific facilities in place for desired years of the planning horizon.

22D.2.1.9 LCPSIM Parameters

Tables 22D-3 and 22D-4 list parameters specific to the San Francisco Bay – South and South Coast models, respectively. Recent changes to LCPSIM are also listed in Table 22D-5.

TABLE 22D-3
LCPSIM Inputs: San Francisco Bay Region–South
Urban Water Supply Economics Modeling

	Baseline
Planning horizon	2009, 2025 and 2060
Demarcation date	February 13, 2009[a]
Period of simulation	82 years (1922-2003)
Dollars	2007
Regional Supplies	
Local	
Average local surface supply	38 TAF/year for all levels of development
Average local groundwater supply	203 TAF/year for all levels of development
Imported	
Hetch-Hetchy Aqueduct deliveries	Annual time series from SFPUC PEIR Study WSIP1LT[b]
Mokelumne Aqueduct deliveries	Annual time series from EBMUD Freeport Regional Water Project EIS/EIR With Project EBMUDSIM study #6292[b]
SWP deliveries	Annual time series from CALSIM II simulation[c]
CVP deliveries	Annual time series from CALSIM II simulation
Water Management Actions (CALFED)	
Local recycling[a]	41 TAF/year for 2009 and 51 TAF/year for 2025 and 2060, respectively

	Baseline
Desalination[a]	0 TAF/year for all levels of development
Transfers	
San Joaquin Valley	Single-year transfers as determined through interaction with CALSIM II at acquisition cost of $325, $385, and $517 per AF[d,e] for 2009, 2025, and 2060, respectively
Sacramento Valley	Single-year transfers as determined through interaction with CALSIM II at acquisition cost of $197, $243, and $345 per AF[d,e] for 2009, 2025, and 2060, respectively
Regional Base Operations Cost	
Distribution cost	$24, $36, and $52 per AF for 2009, 2025, and 2060, respectively from CALFED, 1999
Treatment cost	$98, $99, and $100 per AF for 2009, 2025, and 2060, respectively from CALFED, 1999
Cost of Reuse and Deep Percolation	$30, $44, and $68 per AF for 2009, 2025, and 2060, respectively from Electricity Price Forecasts (DWR)
SWP Aqueduct Conveyance	
Groundwater bank	$35, $50, and $78 per AF for 2009, 2025, and 2060, respectively from Electricity Price Forecasts (DWR)
Regional conveyance	$60, $86, and $134 per AF for 2009, 2025, and 2060, respectively from Electricity Price Forecasts (DWR)
CVP Conveyance	
Groundwater bank	$0/AF
Regional conveyance	$59, $85, and $132 per AF for 2009, 2025, and 2060, respectively from Electricity Price Forecasts (DWR)
Annual Regional Base Use	
Urban demand target	1,085, 1,234, and 1,636 TAF/year for 2009, 2025, and 2060, respectively
Regional Demand Reductions	
Conservation	67, 142, and 167 TAF/year for 2009, 2025, and 2060, respectively from CALFED, 2006
Precipitation	Four station average annual rainfall 1884-2003 from National Weather Service[f]
Agricultural use	30 TAF/year for all levels of development from DWR Water Portfolio (on-farm applied water) 1998-2005
Environmental use	5 TAF/year for all levels of development from DWR Water Portfolio (managed wetlands) 1998-2005
Regional Reliability Management Options	
Conservation	108 TAF/year interior and 163 TAF/year exterior increasing in cost up to $1,800/AF for 2025 and 90.0 TAF/year interior and 156 TAF/year exterior increasing in cost up to $1,800/AF for 2060
Water recycling	72 TAF/year for all levels of development increasing in cost from $738 to $4,245/AF for 2025 and from $760 to $4,276/AF for 2060
Desalination	134 TAF/year for all levels of development at $1,527/AF for 2025 and $1,692/AF for 2060
Regional Ground and Surface Carryover Storage	
Groundwater spreading operations	30 TAF of storage, put limit of 30 TAF/year and take limit of 10 TAF/year
California Aqueduct groundwater banking operations	565 TAF of storage, put limit of 178 TAF/year, and take limit of 130 TAF/year from MWDSC

	Baseline
Arvin-Edison Project delivery constraint[g]	155 TAF of Table A allotment, 22 TAF of reserve Table A, 56% share of the bank, and 0 TAF base take available
Shortage Management Strategy	
Contingency conservation campaign	10.0 % of net urban demand target[h,i] for 2009 and 5.0% for 2025 and 2060
Point at which transfers to depleted carryover storage are triggered	80% of each facility's annual take capacity
Shortage allocation rule cut ratio	Industrial user 25%, commercial user 50%, multi-family residential 60%, landscape user 200%[i,k]
Demand hardening factor	52, 33, and 25%[i,l] in 2009, 2025, and 2060, respectively
Rationing program threshold	80% non-interruptible shortage triggers rationing cost of $0.50/person[i]
Take call ratio for using contingency conservation	100% call on available carryover to meet net delivery with conservation reduction[i]
Capacity use ratio for using contingency conservation	20% of capacity[i,m]
Threshold for shortage allocation	Below a 95.0% level of shortage, all users will experience the same percentage reduction[i]
Inverse power function exponent for loss value adjustment	Inverse power function of 1.0[i,n]
Regional urban population	5,982, 6,674, and 8,529 thousand in 2009, 2025, and 2060, respectively from DWR
Industrial customer size (% of total use)	2.7, 2.3, and 1.8% of total use in 2009, 2025, and 2060, respectively from WEAP Current Trends (DWR)
Commercial customer size (% of total use)	22.5, 23.8, and 25.1% of total use in 2009, 2025, and 2060, respectively from WEAP Current Trends (DWR)
Landscape customer size (% of total use)	9.1, 8.5, and 7.9% of total use in 2009, 2025, and 2060, respectively from WEAP Current Trends (DWR)
Multi-family residential customer size (% of total use)	21.5, 21.4, and 21.2% of total use in 2009, 2025, and 2060, respectively from WEAP Current Trends (DWR)
Economic Loss Function	
Polynomial loss function[o]	$830 (intercept), coefficients b_1 = 22,269, b_2 = -14,693, b_3 = -3,148 for 2009; $1,037 (intercept), coefficients b_1 = 21,994, b_2 = -14,782, b_3 = -3,149 for 2025; $1,688 (intercept), coefficients b_1 = 2,1093, b_2 = -1,5069, b_3 = -3,150 for 2060 from MWDSC, 2005

[a]A detailed description of the assumptions selection criteria and policy basis used is included in the Technical Memorandum: Characterization and Quantification of Water Management Actions (DWR)

[b]Time series extrapolated to 2003 using average value for water year type

[c]In the San Francisco Bay Region–South turnback from Table A and Article 21 are allocated to South Coast SWP water in LCPSIM.

[d]These values may change contingent on revisions to Mann and Hatchett, 2006

[e]Transfers costs are the average between Below Normal, Dry, and Critical year types. The cost shown is acquisition cost; delivered cost is higher because of Delta salinity and other operational losses.

[f]Historical rainfall records starting in 1883 are used to create a stochastic sequence for the hydrologic study period to estimate urban demand targets.

[g]The take limit for MWDSC from Arvin Edison is reduced for each consecutive year for which a take is made.

[h]Shortage management strategies were developed using MWDSC, 1999.

[i]A specified reduction in use can be expected upon implementation of a contingency conservation program that includes such measures as increased watering regulations, increased water waste patrols, emergency water pricing programs, and intensive public education campaigns. Contingency measures to meet shortages are implemented only after shortages exceed 5% of total urban use.

[j]If storage falls below this threshold, transfers are implemented to augment storage. Sacramento River Region, San Joaquin River Region, and Tulare Lake Region transfers can be used for this purpose.

[k]User shortage percentage limited to X% of overall shortage percentage.

[l]Percentage increase in conservation (compared to base use levels) makes shortages effectively larger by 50% times the percentage increase in conservation.

[m]Limit on the fraction of carryover storage capacity filled before triggering contingency conservation.

[n]Adjustments to losses are made for shortage events with up to two intervening non-threshold years to account for residual damages.

[o]This model element assigns economic loss to foregone use.

Source: Information in the table was interpreted from various published and unpublished reports and mathematical modeling exercises. Some of this information is sensitive in nature and should be interpreted in the appropriate context. For further information regarding the information included here, please contact the California Department of Water Resources, Economic Analysis Section, Section Supervisor.

TABLE 22D-4
LCPSIM Inputs: South Coast Region
Urban Water Supply Economics Modeling

	Future Baseline
Planning horizon	2009, 2025, and 2060
Demarcation date	February 13, 2009[a]
Period of simulation	82 years (1922-2003)
Dollars	2007
Regional Supplies	
Local	
Average local surface supply	257 TAF/year for all levels of development
Average local groundwater supply	1,160 TAF/year for all levels of development
Imported	
LA Aqueduct deliveries	Annual time series provided by LADWP
Colorado River Aqueduct deliveries	1,050, 955, and 847 TAF/year[b] from MWDSC, 2005 and model output from Metropolitan's IRPSIM
SWP deliveries	Annual time series from CALSIM II simulation[c]
Colorado River Aqueduct capacity	1,200 TAF from MWDSC, 2005
Water Management Actions (CALFED)	
Local recycling[a]	318 TAF/year for 20099 and 345 TAF/year for 2025 and 2060
Desalination[a]	1 TAF/year for 20099 and 57 TAF/year for 2025 and 2060
Transfers	
Colorado River transfers	Net Aqueduct Capacity (TAF) available at acquisition cost of $340, $398, and $565 in 2009, 2025, and 2060, respectively
San Joaquin Valley transfers	Single-year transfers as determined through interaction with CALSIM II at acquisition cost of $325, $385, and $517 per AF[d,e] for 2009, 2025, and 2060, respectively
Sacramento Valley transfers	Single-year transfers as determined through interaction with CALSIM II at acquisition cost of $197, $243, and $345 per AF[d,e] for 2009, 2025, and 2060, respectively
Regional Base Operations Cost	
Distribution cost	$24, $36, and $52 per AF for 2009, 2025, and 2060, respectively from CALFED, 1999
Treatment cost	$98, $99, and $100 per AF for 2009, 2025, and 2060, respectively from CALFED, 1999

	Future Baseline
Cost of Reuse and Deep Percolation	$30, $44, and $68 per AF for 2009, 2025, and 2060, respectively from Electricity Price Forecasts (DWR)
SWP Aqueduct Conveyance	
Groundwater bank	$35, $50, and $78 per AF for 2009, 2025, and 2060, respectively from Electricity Price Forecasts (DWR)
Regional conveyance	$155, $225, and $347 per AF for 2009, 2025, and 2060, respectively from Electricity Price Forecasts (DWR)
East Branch conveyance	$242, $350, and $542 per AF for 2009, 2025, and 2060, respectively from Electricity Price Forecasts (DWR)
Colorado River Aqueduct conveyance	
Groundwater bank	$81, $118, and $182 per AF for 2009, 2025, and 2060, respectively from Electricity Price Forecasts (DWR)
Regional conveyance	$102, $147, and $147 per AF for 2009, 2025, and 2060, respectively from Electricity Price Forecasts (DWR)
Annual Regional Base Use	
Urban demand target	4,236, 4,943, 6,008 TAF/year in 2009, 2025, and 2060, respectively
Regional Demand Reductions	
Conservation	211, 463, 650 TAF/year in 2009, 2025, and 2060, respectively
Precipitation	Ten station average annual rainfall 1884-2004 from National Weather Service[f]
Agricultural use	772, 652, 389 TAF/year in 2009, 2025, and 2060, respectively from DWR
Environmental use	34 TAF/year for all levels of development from DWR Water Portfolios (managed wetlands) 1998-2005
Regional Reliability Management Options	
Urban conservation	392 TAF/year interior and 380 TAF/year exterior increasing in cost up to $2,000/AF for 2025 and 286 TAF/year interior and 299 TAF/year exterior increasing in cost up to $2,000/AF for 2060
Water recycling	973 TAF/year for all levels of development increasing in cost from $692 to $2,470/AF for 2025 and from $723 to $2,501/AF for 2060
Desalination	280 TAF/year for all levels of development increasing in cost from $1,577 to $2,583/AF for 2025 and from $1,743 to $2,583/AF for 2060
Regional Ground and Surface Carryover Storage	
Reservoir operations	807 TAF of storage, put limit of 786 TAF/year, and take limit of 385 TAF/year from MWDSC
Groundwater storage	2,437 TAF of storage, put limit of 772 TAF/year, and take limit of 495 TAF/year from MWDSC
Colorado River Aqueduct groundwater banking operations	1,400 TAF of storage, put limit of 240 TAF/year in 2009 and 400TAF/year in 2025 and 2060 and a take limit of 396 TAF/year from MWDSC
Semitropic Project Delivery Constraint[g]	155 TAF of Table A allotment, 22 TAF of reserve Table A, 35% share of the bank, and 31.5 TAF base take available
Shortage Management Strategy	
Contingency Conservation Campaign	5.0% of net urban demand target[h,i]
Point at which transfers to depleted carryover storage are triggered	80% of each facility’s annual take capacity

	Future Baseline
Shortage allocation rule cut ratio	Industrial user 25%, commercial user 50%, multi-family residential 60%, landscape user 200%[i,k]
Demand hardening factor	52, 33, and 25%[i,l] in 2009, 2025, and 2060, respectively
Rationing program threshold	80% non-interruptible shortage triggers rationing cost of $0.50/person[i]
Take call ratio for using contingency conservation	100% call on available carryover to meet net delivery with conservation reduction[i]
Capacity use ratio for using contingency conservation	20% of capacity[i,m]
Threshold for shortage allocation	Below a 95.0% level of shortage, all users will experience the same percentage reduction[i]
Inverse power function exponent for loss value adjustment	Inverse power function of 1.0[i,n]
Interruptible program delivery cutoff point	At 35% non-interruptible shortage level
Regional urban population	20,314, 23,435, and 28,076 in 2009, 0225, and 2060, respectively from DWR
Industrial customer size (% of total use)	2.6, 2.2, and 1.7% of total use in 2009, 2025, and 2060, respectively from WEAP Current Trends (DWR)
Commercial customer size (% of total use)	25.4, 25.5, and 25.6% of total use in 2009, 2025, and 2060, respectively from WEAP Current Trends (DWR)
Landscape customer size (% of total use)	5.8, 5.5, and 5.1% of total use in 2009, 2025, and 2060, respectively from WEAP Current Trends (DWR)
Multi-family residential customer size (% of total use)	16.9% of total use in 2009 and 2025 and 16.8% in 2060 from WEAP Current Trends (DWR)
Economic Loss Function	
Polynomial loss function[o]	$830 (intercept), coefficients b_1 = 22,269, b_2 = -14,693, b_3 = -3,148 for 2009; $1,037 (intercept), coefficients b_1 = 21,994, b_2 = -14,782, b_3 = -3,149 for 2025; $1,688 (intercept), coefficients b_1 = 2,1093, b_2 = -1,5069, b_3 = -3,150 for 2060 from MWDSC, 2005a

[a]A detailed description of the assumptions selection criteria and policy basis used is included in the Technical Memorandum: Characterization and Quantification of Water Management Actions (DWR).

[b]Colorado River Aqueduct deliveries consists of base appointment (550 TAF/year) + All American Canal and Coachella Canal lining (94 TAF/year) + Imperial Irrigation District Transfer Water to San Diego County Water Authority (200 TAF/year) + Palo Verde Irrigation District (25 TAF/year) + Imperial Irrigation District/MWDSC conservation program (85 TAF/year) – Quantification Settlement Agreement (20 TAF/year) – Coachella Valley Water District (35 TAF/year) – 47 CRW present perfected rights.

[c]In the San Francisco Bay Region–South, turnback from Table A and Article 21 is allocated to South Coast SWP water in LCPSIM.

[d]These values may change contingent on revisions to the Mann and Hatchett, 2006.

[e]Transfers costs are the average between Below Normal, Dry, and Critical year types. The cost shown is acquisition cost; delivered cost is higher because of Delta salinity and other operational losses.

[f]Historical rainfall records starting in 1883 are used to create a stochastic sequence for the hydrologic study period to estimate urban demand targets.

[g]The take limit for MWDSC from Semitropic is equal to the bank's pumping capacity (base take available) plus the product of MWDSC's percentage share of the bank and Semitropic's SWP Contract Table A delivery after subtracting Semitropic's reserved amount of that allocation.

[h]Shortage management strategies were developed using MWDSC, 1999.

[i]A specified reduction in use can be expected upon implementation of a contingency conservation program that includes such measures as increased watering regulations, increased water waste patrols, emergency water pricing programs, and intensive public education campaigns. Contingency measures to meet shortages are implemented only after shortages exceed 5% of total urban use.

[j]If storage falls below this threshold, transfers are implemented to augment storage. Sacramento River Region, San Joaquin River Region, and Tulare Lake Region transfers can be used for this purpose.

[k]User shortage percentage limited to X% of overall shortage percentage.

[l]Percentage increase in conservation (compared to base use levels) makes shortages effectively larger by 50% times the percentage increase in conservation.

[m]Limit on the fraction of carryover storage capacity filled before triggering contingency conservation.

[n]Adjustments to losses are made for shortage events with up to two intervening non-threshold years to account for residual damages.

[o]This model element assigns economic loss to foregone use.

Source: Information in the table was interpreted from various published and unpublished reports and mathematical modeling exercises. Some of this information is sensitive in nature and should be interpreted in the appropriate context. For further information regarding the information included here, please contact the California Department of Water Resources, Economic Analysis Section, Section Supervisor.

Table 22D-5
LCPSIM Model Revisions
Urban Water Supply Economics Modeling

Version	Update
97.0.0	Removes the general interior and exterior conservation effectiveness parameters from parameter file and uses an added column to the option file to input conservation effectiveness parameters for the individual conservation options.
96.8.0	Improves the logic for calculating applied water shortages in the LC Increment Results display and for testing for exceeding the limit for the effect of exterior conservation on reuse.
96.7.0	Adds code to constrain market transfers to include the effect of Mojave WA banking operations on aqueduct capacity.
96.6.2	Corrects aqueduct conveyance capacity constraint for transfers.
96.6.1	Changes net use output in View LC Increment Results display to shortage adjusted net use.
96.6.0	Corrects the calculation of the effect of variable exterior applied use on net use and the calculation of the contribution of reuse to the availability of applied water.
96.5.2	Gives the user a warning that the use of local options will be truncated when the number of increments exceeds the existing program limit of 201 increments. The user is asked to increase the increment size or reduce the range.
96.5.1	Corrects LC Increment Results output display error.
96.5.0	Adds the ability to manage a Mojave WA water bank for MWDSC.
96.4.0	Fixes calculation of applied water shortage for multi-family residential use.
96.3.0	Zeros out option increment size and use range parameters when all quantities in option file are zero (e.g., existing conditions). Corrects an array initialization bug that introduced an error when making a single iteration (i.e., existing condition) run after making a multiple iteration (i.e., future condition) run without first exiting and restarting LCPSIM.
96.2.0	Fixes calculation of average net supply in the LC Increment Results display. Fixes reporting of SWP energy use when iteration is not used (e.g., existing conditions).
95.5.0	Incorporates a parameter to reduce the cost of conservation by the avoided groundwater pumping cost associated with reusing that portion of the conserved water which would have gone to deep percolation.
95.4.2	Corrects the display of the incremental option costs when the “View Cost Curve/Base Balance” menu item is selected.
95.4.1	Displays a warning and won’t allow the user to enter an end point option use quantity greater than the sum of the regional option quantities.

Version	Update
95.3.6	Fixes a dynamic storage operation logic bug that creates a priority assignment error when storage operations have a zero balance. Changes summary output to display the use of regional options broken out into three categories: supply/reuse augmentation, average net demand reduction, and average applied demand reduction.
95.3.1	Corrects a problem that prevented the water market transfer cost-benefit QP from being correctly set up for the solver when the use of QP logic is selected for evaluating transfers.
95.2.0	Incorporates a parameter which sets the weight given to the fixed component of urban exterior use conservation as compared to the conservation component which is assumed to vary in proportion to urban exterior use. Corrects logic used to calculate effect of the adoption of conservation options on reuse.
95.0.1	Fixes a bug that occurred when project data files are changed and the project was not reloaded before running.

22D.3 Other Municipal Water Economics Model (OMWEM)

There are a large number of urban areas outside of the south bay and south coast that receive SWP or CVP supplies but are not included in LCPSIM. The Other Municipal Water Economic Model (OMWEM) estimates economic benefits of changes in SWP and CVP supplies in these areas. The model includes CVP M&I supplies north of Delta, CVP and SWP supplies to the Central Valley and the Central Coast south of Santa Clara County, and SWP supplies or supply exchanges to the desert regions east of the South Coast. Ten providers who use SWP water and eight providers who use CVP water are included. CVP contractors on the American River are currently not included. The model includes some agricultural use that could not be separated from urban use. All of this agricultural water use is not included in SWAP or other common assumptions economic models.

22D.3.1 Description

Each of the eighteen service areas in OMWEM are independent each other so their benefits are additive, but they are all analyzed in a similar way. The 2005 Urban Water Management Plans (UWMPs), where available, provided water demand and supplies for recent and future development conditions. The UWMP data were often inadequate, so other local water supply planning documents were used. Most UWMPs included demand forecasts from 2005 to 2025 at 5-year increments, and supply forecasts for 2005 and 2025.

Table 22D-6 provides SWP Table A, CVP contract amounts, and demand forecasts used to develop water balance. The model includes about 828,000 AF of SWP Table A or CVP M&I contract. The model allows the user to input a selected year for analysis, either 2009 or 2025. Interpolation is used where needed to develop demand and supply estimates for 2009 and 2025. Total 2009 demand in OMWEM is about 1.3 million acre-feet (MAF) of which about 400,000 AF is agricultural and turf irrigation in Coachella Valley and 86,000 AF is irrigation in San Benito County and Mojave Water Agency. Demand is estimated to increase to 1.564 MAF by 2025.

Table 22D-6
Agencies Included in OMWEM, their SWP and CVP Contract Amounts, 2009 and 2025 Demand Forecast
Urban Water Supply Economics Modeling

SWP Service Areas	SWP Table A, AF	2009 Demand, AF/YR	2025 Demand, AF/YR	Notes
Antelope Valley – East Kern Water Agency	141,400	99,656	107,599	UWMP 2025
Coachella Valley Water District	133,100	505,178	625,567	Includes about 300 TAF ag water; SWP supply is CRA water by exchange with MWDSC
Crestline – Lake Arrowhead Water Agency	5,800	4,300	6,100	UWMP 2025
Desert Water Agency	54,000	54,400	70,400	SWP is CRA water by exchange
Mojave Water Agency	75,800	112,580	124,100	Demand includes 12,500 of ag water. Table A includes 25 TAF bought from Berrenda Mesa
San Luis Obispo County FCWCD	8,447	5,258	6,350	See note 1
County of Santa Barbara FCWCD and Central Coast Water Agency	62,039	63,136	76,255	Sum of individual demand estimates Table A includes SLO transfer
Kern County Water Agency (SWP) ID #4	134,600	43,704	52,785	Demand from 2005 UWMP
Napa County FCWCD	29,025	25,565	30,877	Estimated from 2020 and 2050 forecasts
Solano County Water Agency	47,756	254,806	255,106	Lake Berryessa is major supply
TOTAL SWP	691,967	1,168,581	1,355,139	
CVP Service Areas	CVP contract, AF	2009 Demand, AF/YR	2025 Demand, AF/YR	Notes
City of Redding	27,140	27,940	36,000	2025, Table 36 and 37 in 2005 UWMP
City of Shasta Lake and Shasta CWA	5,422	4,240	8,100	Future demand assumed double current
City of West Sacramento	23,600	20,770	29,120	Page 4-2 UWMP
San Benito County	43,800	42,530	89,345	Includes 74,880 ag, 3,000 losses. 2022, GW EIS/R
City of Tracy	20,000	19,620	28,200	See Note 2.
City of Avenal	3,500	3,500	3,500	Assumed demand = contract
City of Coalinga	10,000	10,000	12,000	Assumed demand = contract
City of Huron	3,000	3,000	3,000	Assumed demand = contract
TOTAL CVP	136,462	131,600	209,265	
TOTAL SWP and CVP	828,429	1,300,181	1,564,404	

Notes:

SWP serves Morro Bay, Pismo Beach, Oceano CSD, many small users. Current demand and growth unknown, for most SWP Table A amount assumed to be demand

2005 UWMP includes Tracy M&I contract, other CVP contracts 58% reliable, 10,000 is SCSWSP pre-1914.

For each service area, water supply benefits are avoided costs of shortage or other supplies. The model mimics LCPSIM but with a more simple representation of supplies, supply options, shortage and shortage costs. Data on water supply costs are from local planning documents, where available. In many cases, water transfers are assumed to be the marginal supply. Water transfer costs are obtained from studies conducted for DWR (Mann and Hatchett, 2006 and 2007). The evaluation of M&I water supply changes in the San Joaquin Water Delivery Region is based on the availability and cost of groundwater. Additional water supply for M&I use is assumed to replace groundwater pumping.

Table 22D-7 shows other baseline supplies in the 2009 average condition, and Table 22D-8 shows these supplies in the 2009 dry condition. These supplies in the future condition are not appreciably different. Table 22D-9 shows the marginal cost of new supplies in the average condition.

Table 22D-7
Other Water Supplies, Average Condition, Primarily from 2005 UWMPs, Acre-feet per Year
Urban Water Supply Economics Modeling

SWP Table A holder	Surface water	Natural Ground Water	Other Ground Water	Recycled Water	Transfers	Other
Antelope Valley – East Kern Water Agency	0	0	0	0	0	0
Coachella Valley Water District	310,800	102,380	0	21,519	0	800
Crestline – Lake Arrowhead Water Agency	433	0	0	0	0	0
Desert Water Agency	2,740	7,250	11,810	5,370	0	0
Mojave Water Agency	0	65,500	0	0	0	0
San Luis Obispo County FCWCD	1,199	1,900	0	0	0	0
County of Santa Barbara FCWCD and CCWA	31,777	16,449	14,300	1,800	0	8,909
Kern County Water Agency (SWP) ID #4	0	0	0	0	0	0
Napa County FCWCD	20,914	0	0	0	0	3,105
Solano County Water Agency	207,350	0	0	0	0	0
TOTAL SWP	575,213	193,479	26,110	28,689	0	12,814
CVP Contract Holder						
City of Redding	0	19,000	0	0	0	0
City of Shasta Lake and Shasta CWA	0	0	0	0	0	0
City of West Sacramento	0	0	0	0	0	0
San Benito County	0	49,925	0	0	0	0
City of Tracy	10,000	4,400	0	0	0	6,500
City of Avenal	0	0	0	0	0	0
City of Coalinga	0	0	0	0	0	0
City of Huron	0	0	0	0	0	0

SWP Table A holder	Surface water	Natural Ground Water	Other Ground Water	Recycled Water	Transfers	Other
TOTAL CVP	10,000	73,325	0	0	0	6,500
TOTAL	585,213	266,804	26,110	28,689	0	19,314

Table 22D-8
Other Water Supplies, Dry Condition, Primarily from 2005 UWMPs, Acre-feet per Year
Urban Water Supply Economics Modeling

SWP Table A holder	Surface water	Natural Ground Water	Other Ground Water	Recycled Water	Storage Depletion	Other
Antelope Valley – East Kern Water Agency	0	0	0	0	0	0
Coachella Valley Water District	310,800	102,380	0	21,519	0	800
Crestline – Lake Arrowhead Water Agency	433	0	0	0	0	0
Desert Water Agency	2,800	7,250	11,450	6,000	0	0
Mojave Water Agency	0	65,500	0	0	0	0
San Luis Obispo County FCWCD	1,199	1,900	0	0	0	0
County of Santa Barbara FCWCD and CCWA	23,603	16,449	14,300	1,800	0	0
Kern County Water Agency (SWP) ID #4	0	75,000	0	0	0	0
Napa County FCWCD	6,165	0	0	0	6,904	2,486
Solano County Water Agency	186,615	0	0	0	0	0
TOTAL SWP	531,615	268,479	25,750	29,319	6,904	3,286
CVP Contract Holder						
City of Redding	0	19,000	0	0	0	0
City of Shasta Lake and Shasta CWA	0	0	0	0	0	0
City of West Sacramento	0	0	0	0	0	0
San Benito County	0	49,925	0	0	0	0
City of Tracy	9,000	2,500	0	0	0	6,833
City of Avenal	0	0	0	0	0	0
City of Coalinga	0	0	0	0	0	0
City of Huron	0	0	0	0	0	0
TOTAL CVP	9,000	71,425	0	0	0	6,833
TOTAL	540,615	339,904	25,750	29,319	6,904	10,119

Table 22D-9
Marginal Water Supply Costs, Average Condition, 2009 and 2025
Urban Water Supply Economics Modeling

Agency	Type of Marginal Supply	Unit net Total Cost of additional supply, $ per AF per year, not delivery	
SWP		**2009**	**2025**
Antelope Valley – East Kern Water Agency	Transfer/exchange	$272	$323
Coachella Valley Water District (SWP is CRA)	Additional CRA water	$340	$398
Crestline – Lake Arrowhead Water Agency	Transfer/exchange	$272	$323
Desert Water Agency (SWP is CRA)	Additional CRA water	$340	$398
Mojave Water Agency average	Regional Aquifer Project	$233	$337
San Luis Obispo County FCWCD	Desalination	$950	$1,375
County of Santa Barbara FCWCD	Desalination	$950	$1,375
Kern County Water Agency (SWP) ID #4	Expand SWP Conj. Use	$232	$336
Napa County FCWCD	Conjunctive use	$150	$186
Solano County Water Agency	Conjunctive use	$150	$217
CVP			
City of Redding	Groundwater	$100	$145
City of Shasta Lake and Shasta CWA	Transfer/exchange	$181	$224
City of West Sacramento	Groundwater	$100	$145
San Benito County	Transfer/exchange	$272	$323
City of Tracy	Buy local water	$200	$237
City of Avenal	Transfer/exchange	$184	$218
City of Coalinga	Transfer/exchange	$184	$218
City of Huron	Transfer/exchange	$184	$218

For a water supply scenario, the model accepts CALSIM II results in term of annual water supply as input. Rather than input time series of water supply for all eighteen providers, the model can also use an annual time series of SWP or CVP supplies expressed as percent of SWP Table A or CVP contract amount available. These percentages can be applied to the SWP Table A or CVP contract amounts to obtain the annual time series of deliveries.

22D.3.1.1 Model Logic

First, for each year and each agency, demand and supply quantities are used to achieve a water balance in the average water supply condition. If supply is insufficient to meet demand in the average condition, the amount and costs of additional water supplies are calculated. If the year type is below normal or wetter, the model calculates the cost of supply based on a unit value per AF for these year types. Cost data were generally obtained from the 2005 UWMP or other provider-specific sources. The model includes separate calculations for an average condition and a dry condition.

If the year type is dry or critical, the model allows for shortfalls to be eliminated with dry/critical supply sources and with end-user shortage. The incremental amounts and costs of additional supplies and shortage needed to achieve water balance in the dry condition are estimated.

If supplies are less than demand in the dry or critical year type, and the marginal water supply for the provider is a water transfer, then end-use shortages up to 5 percent are applied first (this priority mimics LCPSIM). Then, providers can acquire dry-year supplies to eliminate shortfalls up to 50 percent. These supplies have unit costs specific to the dry and critical condition. Thereafter it is assumed that end-users must take additional shortage.

If the marginal water supply for the provider is not a water transfer, then the 5 percent end-use shortage is not required first. The provider can eliminate a shortfall of up to 50 percent of demand using the dry/critical supply, but end-user shortage is used to cope with any larger shortfalls.

The model calculates shortage costs based on a constant elasticity of demand (CED) loss function with a demand elasticity of -0.1. A description of this shortage cost function is provided by M.Cubed (2007). This shortage function generates very high costs at high shortage levels. The marginal value of water from the CED function can be capped. The current cap is set at $7,000 per acre-foot year (AFY) more than the provider's retail water price.

Two model runs are required to compare a baseline and a with-project alternative. Results from a baseline scenario are saved as values and compared to results from the with-project scenario. The cost of water supplies required to obtain water balance in the baseline, without-project alternative average condition do not influence the incremental cost of supplies in the with-project alternative. In the dry and critical

condition, however, marginal costs of shortage increase with shortage. Therefore, the marginal value of additional supplies decline as supply increases.

22D.3.1.2 Discussion of individual water users

A separate detailed accounting by agency is included for the Central Coast region served by the SWP. The main purpose of the Central Coast worksheet is to isolate water balance information for those areas served by the SWP. Most of the urban water providers in this group are too small to require an UWMP. Model information is from local and regional plans. Water balance information is provided in Table 22D-10.

For Kern County Water Agency (KCWA), demand data for areas served by the SWP are not available because much SWP water is recharged and surface water and ground water are used interchangeably. Up to 53,000 AF of treated surface water will be provided around 2025, but groundwater will be available to meet demands if surface water is short. Therefore, economic calculations for KCWA are based on alternative costs of conjunctive use supplies only.

The SWP supplies for Coachella Valley (CVWD) and Desert Water Agency are not provided from the SWP delivery system. Rather, they are provided from the Colorado River through the CRA as an exchange with MWDSC. The amounts provided from the CRA to the two agencies are roughly equivalent to the amount they would obtain if they were connected to the SWP.

Table 22D-10
2030 Water Balance Information for Central Coast SWP Service Area, from Local Sources, AF per Year
Urban Water Supply Economics Modeling

Agency	Typical Demand[a]	2030 Demand	Surface Water	Natural Ground Water	Other Ground Water	Recycled Water	Other
Santa Barbara County							
Cachuma Project Area			25,714				
Carpintera Valley WD	2,122						
City of Santa Barbara	12,960		6,063	1,304		1,200	
City of Goleta Water District		17,010		2,350		1,000	
Montecito WD		8,000					
Santa Ynez River WCD ID #1	2,405						
Other							
City of Santa Maria		24,780		12,795	14,300		8,909
City of Solvang	1,277						
La Cumbre Mutual Water Co.	1,258						
California Cities Water Co.	375						
City of Buelton	806						
City of Guadalupe	574						
Morehart Land Co	150						
Raytheon Infrared	38						
Vandenberg AFB	4,500						
TOTAL Santa Barbara	**26,465**	**49,790**	**31,777**	**16,449**	**14,300**	**2,200**	**8,909**
San Luis Obispo County*							
City of Morro Bay	1,400		whalerock	300			645
Ca Men's Colony	400		whalerock				
Co Operations Center	425		whalerock				
Cuesta College	200		whalerock				
City of Pismo Beach	2,673		896	700			
Oceano CSD	750		303	900			
San Miguelito MWC	275		lopez				
Avila Beach CSD	100		lopez				
Avila Valley MWC	20		lopez				
San Luis Coastal USD	7		lopez				
Co of SLO CSA No 16-1	100						
TOTAL San Luis Obispo	6,350		1,199	1,900			

*For most assume demand=Table A

Antelope Valley East Kern (AVEK) has agricultural and urban water use, but the two are fairly well separated. "AVEK does not have production groundwater wells and has no plans to include groundwater pumping as a water supply. In previous years AVEK has made efforts to utilize groundwater to offset imported water deficiencies. These efforts were rejected by several of the larger AVEK purveyors…" (AVEK, 2005). Since agriculture does not receive surface water there does not appear to be an opportunity to reduce agricultural use to supply water for urban use unless urban users will take groundwater. Therefore, following a drought conservations savings, AVEK is assumed to tap water transfers for its additional supplies.

The Mojave UWMP adopts the same assumptions as their 2004 Regional Water Management Plan (RWMP), called agricultural scenario 2. Under this scenario "significant decreases in agricultural consumptive use" because "agriculture will voluntarily transfer its free production allowance to non-agricultural uses in lieu of purchasing replacement water" (MWA, 2005). Under this scenario, 12,500 AF of agricultural use remain by 2030. The Mojave UWMP states that the shortfall in a dry year would be met with demand management and increased reliance on stored groundwater. Therefore, low-value crops are the first demand to be reduced in shortage. Then, groundwater pumping is used to eliminate the rest of the shortfall.

In CVWD, M&I water supplies are not separated from agriculture, but almost all M&I water use is from wells. Most of the SWP exchange water is delivered to agriculture. Canal water and recycled water are used for golf courses and other landscape irrigation. Total 2030 demand is 320,800 AF agriculture, 92,400 AF golf course and other non-potable municipal, and 231,088 domestic. The 231,088 of demand would be met with groundwater (CVWD, 2005).

CVWD does have a water shortage contingency plan, so all users would be cut back in a severe shortage. However, their analysis of Water Service Reliability shows that shortages of SWP exchange water would be met entirely with increased groundwater pumping (CVWD, 2005). However, since the basin is managed, shortages in exchange water would require additional replenishment purchases later. CVWD can place an assessment on groundwater pumping to finance water purchases for recharge. The district did purchase water from Palo Verde in the shortage caused by the initial signing of the QSA (CVWD, 2005). Therefore, to be consistent with the UWMP, the entire SWP exchange deficiency should be made up by additional purchases of water in the CRA market. CVWD does not appear to be willing to idle lower value crops even if idling would provide the water at lower cost.

The primary areas that obtain urban water from the CVP are the City of Redding, the City of West Sacramento, Tracy and San Benito County. The San Benito water use is primarily agricultural. Relatively small amounts are modeled for Shasta Lake and the San Joaquin Valley cities of Avenal, Coalinga and Huron. UWMPs were not available for these smaller water users. Demands were assumed equal to contract amounts.

22D.4 References

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