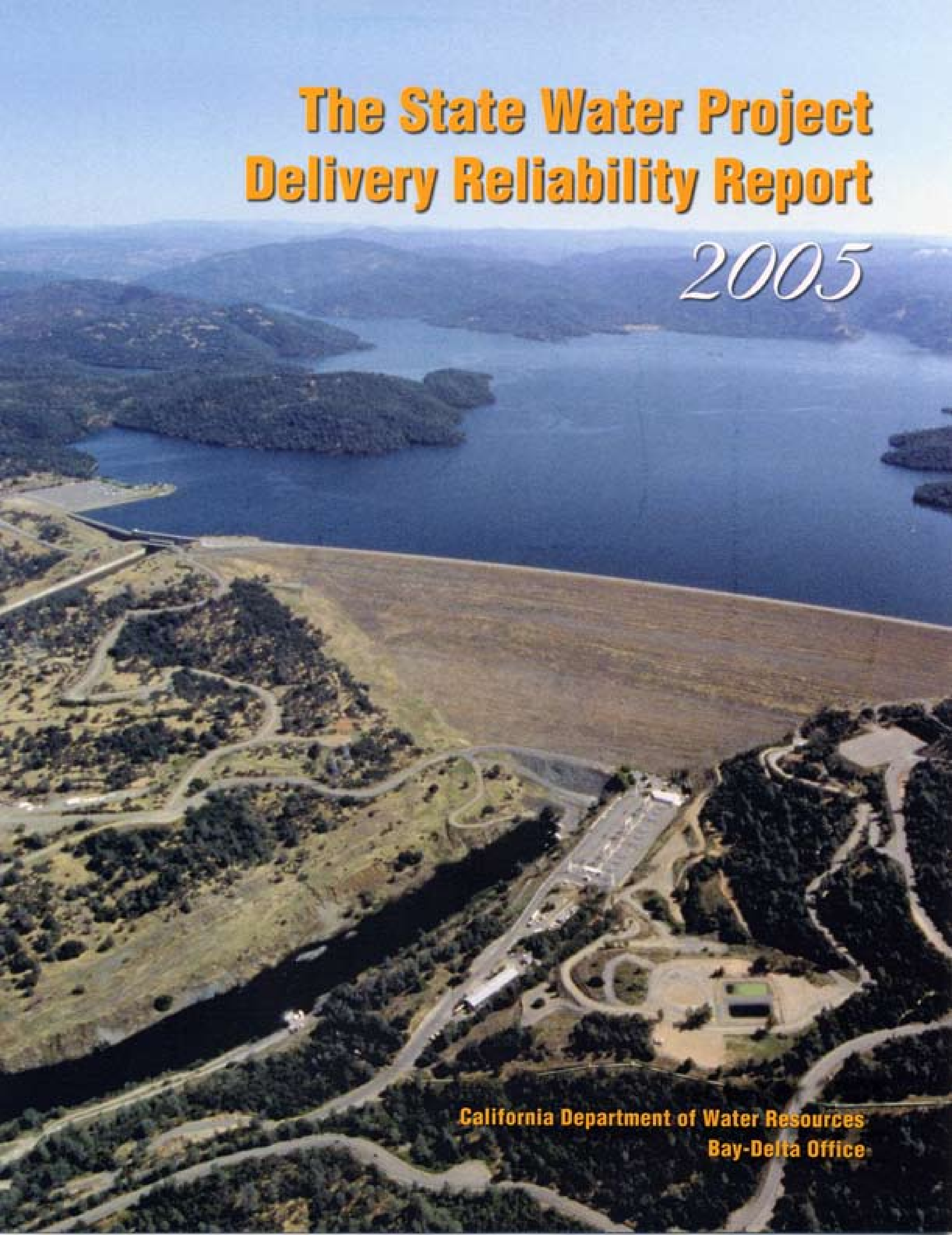
The State Water Project Delivery Reliability Report

2005



California Department of Water Resources
Bay-Delta Office

State of California
The Resources Agency
Department of Water Resources

The State Water Project Delivery Reliability Report 2005

Final

April 2006

Arnold Schwarzenegger
Governor
State of California

Mike Chrisman
Secretary for Resources
The Resources Agency

Lester A. Snow
Director
Department of Water Resources

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Foreword

The Department of Water Resources (DWR) is issuing this report to update information presented in the first report of this series, *The State Water Project Delivery Reliability Report 2002*, which was finalized in 2003 after an extensive public review. A draft of the *The State Water Project Delivery Reliability Report 2005* underwent a 30-day public review during November and December 2005. The information contained in this update was recommended by DWR in May 2005 for use by SWP water supply contractors in developing their 2005 Urban Water Management Plans.

The SWP Delivery Reliability Report 2002 and *The SWP Delivery Reliability Report 2005* are based upon analyses using a computer simulation model, CalSim II. Public criticism of this analytical approach centers on two areas: the ability of CalSim II to simulate "real world" conditions and accurately estimate SWP deliveries; and the inability of the approach to account for future uncertainties such as changes in the climate pattern or levee failure in the Delta due to flooding or an earthquake. While no model is perfect, DWR is satisfied with the degree to which CalSim II simulates actual, real-world operations of the SWP. When professional judgment is used with the knowledge of the limitations of CalSim II and the assumptions used in the studies, CalSim II is a useful tool in assessing the delivery reliability of the SWP. The studies and peer review related to CalSim II are discussed in Chapter 3 and Appendix E of this update.

Although the estimates contained in *The SWP Delivery Reliability Report 2005* are the best quantifications available of the delivery ability of the SWP, these estimates are limited because of the uncertainty of future conditions. DWR will continue to use the CalSim II model and its updates as appropriate for analyses, but other information is being developed that will help us analyze, understand, and prepare for our uncertain future. Per the Governor's directive (Executive Order S-3-05), the potential impacts of climate change on the State's resources, including water supply, are being evaluated. Using CalSim II, preliminary estimates have been done of the potential impact upon the SWP 50 to 100 years in the future if no additional conveyance facilities or upstream reservoirs are built. As these estimates become more refined, they will be helpful in guiding strategies for the management and development of the State's water resources, including improvements to the SWP.

In addition, DWR is working on three projects that will improve our ability to make qualitative or quantitative statements about the reliability of conveyance across the Sacramento-San Joaquin Delta. These include: the Delta Risk Management Strategy, which will assess risks to the Delta from floods, seepage, subsidence, and earthquakes, evaluate the consequences of levee failure, and develop recommendations to manage the risk; implementation of AB 1200 (Laird, 2005) which calls for a similar evaluation of impacts on water supplies from catastrophic Delta failure; and a broader public process to develop a shared vision of a sustainable Delta that continues to support societal needs related to water supply, transportation, recreation, land use, energy, and environmental health. Although none of these efforts will be completed before release of the next Reliability Report, some preliminary results and conclusions may be completed. Subsequent Reliability Reports will fully incorporate this information.

The updated SWP delivery estimates are summarized in Chapter 5. Chapter 6 contains examples of how to incorporate this information into a local water supply assessment. These examples are based upon examples contained in the *Draft Guidelines for Documentation and Integration of SWP Supplies with UWMPs*, which will soon be released by DWR for public review. These draft guidelines are designed to assist SWP urban contractors in estimating the amount of SWP supplies available to them and in integrating the SWP supply information with information from other sources of supply to develop an overall assessment of each contractor's total water portfolio. For additional information on the *Draft Guidelines*, contact the Office of Water Use Efficiency and Transfers at (916) 651-7027. DWR's Bay-Delta Office may be contacted at (916) 653-1099 with questions about other aspects of *The SWP Delivery Reliability Report 2005*.

Lester A. Snow
Director
California Department of Water Resources

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DEPARTMENT OF WATER RESOURCES
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Nancy J. Saracino
Acting Chief Deputy Director

Gerald E. Johns
Deputy Director

David Sandino
Acting Chief Counsel

Ralph Torres
Acting Deputy Director

Viju Patel
Acting Deputy Director

Rick Soehren
Policy Advisor to the Director

Leslie Harder
Deputy Director

Brian E. White
Assistant Director Legislative Affairs

Susan Sims-Teixeira
Assistant Director Public Affairs

Bay-Delta Office
Katherine Kelly, Chief

Prepared under the supervision of
Francis Chung, Principal Engineer
Modeling Support Branch

Individuals contributing to the development of the report

Sushil Arora. . . . . Supervising Engineer, Bay-Delta Office

Nancy Quan . . . . .Supervising Engineer, State Water Project Analysis Office

Sina Darabzand. . . . . Senior Engineer, Bay-Delta Office

Alan Olson . . . . Engineer, Bay-Delta Office

Editorial review, graphics, and report production

Gretchen Goettl, Acting Supervisor of Technical Publications

Nikki Blomquist, Lead Editor
Research Writer

Marilee Talley
Research Writer

Chapter 1. Introduction

Will there be enough water? Public officials throughout California face this question with increasing frequency as growth and competing uses strain existing resources. Water supply, however, has always been an uncertain and contentious matter in our state. For many years, the Department of Water Resources (DWR) has investigated this question. At its simplest level, the question might be, "How many wells are needed for a rural town's water supply?" or "How many people can a 100,000 acre-foot reservoir serve?" But for most areas of the state, the evaluation of water supply adequacy is not simple. The answer requires a complex analysis, taking into account multiple sources of water, a range of water demands, the timing of water uses, hydrology, available facilities, regulatory restraints, levels of demand management (water conservation) strategies, and, of course, future weather patterns.

Most water users in California live in areas that rely on multiple sources of water supply, some local and some imported. Typically, local water providers "mix and match" their supply sources to maximize water supply and quality and to minimize cost. In addition to considering available sources of supply, local water providers are planning for ways to improve the efficiency of local water uses and the operation of their water management systems. To help with this effort, DWR presents 25 different resource management strategies available to local agencies and governments and private utilities in the *California Water Plan Update 2005* (see website at http://www.waterplan.water.ca.gov).

Purpose

The State Water Project Delivery Reliability Report 2005 presents DWR's current information regarding the annual water delivery reliability of the State Water Project (SWP) for existing and future levels of development in the water source areas, assuming historical patterns of precipitation. This report first looks at the general subject of water delivery reliability and then discusses how DWR determines delivery reliability for the SWP. A discussion of the analysis tool (the CalSim II computer simulation model), the analyses, and peer review regarding the accuracy of CalSim II and its suitability for use in this report is included. Finally, estimates of SWP delivery reliability today and in the future are provided along with examples of how to incorporate this information into local water management plans.

This report responds to a requirement in the settlement agreement[1] with the Planning and Conservation League to provide an assessment of the existing delivery capability of the SWP over a range of hydrologic conditions. The range of conditions is to include the historic extended dry cycle and the long-term average. In addition, the biennial report is to include the total amount of project water delivered and the amount of project water delivered to each contractor for each of the 10 years immediately preceding the report (see Appendix D, Recent SWP Deliveries).

The State Water Project Delivery Reliability Report 2005 does not include analyses of how specific water agencies should integrate SWP water supply into their water supply equation. That topic requires extensive information about local facilities, local water resources, and local water use, which is beyond the scope of this report. Moreover, such an analysis would require decisions about water supply and use that traditionally have been made at the local level. DWR believes that local officials should continue to fill this role. The examples provided in Chapter 6 are included to help local agencies incorporate the information presented in this report into local water management assessments.

[1] *Planning and Conservation League v. Department of Water Resources* (2000) 83 Cal. App. 4th 892

Background

The original *SWP Delivery Reliability Report* was issued as a draft in August 2002. In 2002, DWR held six public meetings throughout the state to discuss the report and receive comments upon the content. The final *SWP Delivery Reliability Report* was released in early 2003. *The State Water Project Delivery Reliability Report 2005* is an update to the report issued in 2003. DWR intends to publish biennial updates of the *SWP Delivery Reliability Report* in the future.

The SWP supplies two-thirds of the state's population with a portion of its water supply and provides water to irrigate, in part, 750,000 acres of agriculture. The SWP delivers water under long-term contracts to 29 public water agencies throughout the state. They, in turn, either deliver water to water wholesalers or retailers or deliver it directly to agricultural and urban water users.

The water delivery reliability of the SWP is of direct interest to those who use SWP supplies because it is an important element of the overall water supply in those areas. Local supply reliability is of key importance to local planners and local government officials who are responsible for planning for future growth while assuring that an adequate and affordable water supply is available for the existing population and businesses. This function is usually conducted in the course of preparing a water management plan such as the Urban Water Management Plans required by Water Code section 10610. The information in this report may be used by local agencies in preparing or amending their water management plans and identifying the new facilities or programs that may be necessary to meet future water demands.

Local agencies and governments and private utilities will also find in this report information that is useful in conducting analyses mandated by laws requiring water retailers to demonstrate whether their water supplies are sufficient for certain proposed subdivisions and development projects subject to the California Environmental Quality Act. DWR published the *Guidebook for Implementation of Senate Bill 610 and Senate Bill 221 of 2001*, which includes suggestions on how local water suppliers can integrate supplies from various sources, such as the SWP, into their analyses. DWR has also published the *Guidebook to Assist Water Suppliers in the Preparation of a 2005 Urban Water Management Plan*, which includes suggestions on how local water suppliers can integrate supplies from other sources such as the SWP in their analyses. Both documents can be found on the DWR's Office of Water Use Efficiency home page at http://www.owue.water.ca.gov.

The *Draft Guidelines for Documentation and Integration of SWP Supplies with UWMPs* will soon be released for public review. These guidelines are designed to assist SWP urban contractors in determining the amount of SWP supplies available to them. Using the information in this report (*SWP Delivery Reliability Report 2005)*, these guidelines explain how to integrate the SWP supply information with supply information from other sources to develop an overall reliability assessment of each contractor's total water portfolio.

Chapter 2. Water Delivery Reliability

What is Water Delivery Reliability?

"Water delivery reliability" means how much one can count on a certain amount of water being delivered to a specific place at a specific time.

Objectively, water delivery reliability indicates a particular amount of water that can be delivered with a certain numeric frequency. A delivery reliability analysis assesses such things as facilities, system operation, water demand, and weather projections.

Subjectively, water delivery reliability indicates an acceptable or desirable level of dependability of water deliveries to the people receiving the water. Usually, a local water agency in coordination with the public it serves determines the acceptable level of reliability and plans for new facilities, demand-management and conservation programs, or additional water supply sources to meet or maintain this level.

What Factors Determine Water Delivery Reliability?

In its simplest terms, water delivery reliability depends on three general factors:

1. Availability of water from the source (that is, the natural source or sources of the water from which the supplier draws, such as a particular watercourse or groundwater basin). Availability of water from the source depends on the amount and timing of precipitation and runoff, or "hydrology," which provides water to the stream or groundwater basin, and the anticipated patterns of use and consumption of this water within the source area, including water returned to the source after use.
2. Availability of means of conveyance (that is, the means for conveying the water from the source via pumps, diversion works, reservoirs, canals, etc. to its point of delivery). The ability to convey water from the source depends on the existence and physical capacity of the diversion, storage, and conveyance facilities and also on contractual, statutory, and regulatory limitations on the operation of the facilities.
3. The level and pattern of water demand in the delivery service area (destination). The level of water demand in the delivery service area is affected by the magnitude and types of water demands, level of water conservation strategies, local weather patterns, water costs, and other factors. Supply from a water system may be sufficiently reliable at a low level of demand but become less reliable as the demand increases. In other cases, the reliability of a water supply system to meet a higher demand may be maintained at its past level because new facilities have been added or the operation of the system has been changed.

How is Water Delivery Reliability Determined?

Water Delivery Reliability is Defined for a Specific Point in Time

For this report, water delivery reliability is analyzed for 2005 conditions and for conditions projected to exist 20 years in the future (2025). These analyses must describe current conditions adequately and make predictions about the three factors described earlier and discussed here.

The Availability of Water at the Source

This factor depends on how much rain and snow there will be in any given year and what the level of development (that is, the use of water) will be in the source areas. No model or analytical tool can predict the actual, natural water supplies for any year or years in the future. Until the impacts of climate change on precipitation and runoff patterns in California are better quantified, future weather patterns are usually assumed to be similar to those in the past, especially where there is a significant historical rainfall record.

The State Water Project analyses contained in this report are based upon 73 years of historical records (1922-1994) for rainfall and runoff that have been adjusted to reflect the current and future levels of development in the source areas by analyzing land use patterns and projecting future land and water use. These series of data are then used to forecast the amount of water available to the SWP under current and future conditions.

The assumption that past rainfall-runoff patterns will be repeated in the future has an inherent uncertainty, especially given the evolving information on the potential effects of global climate change. The *California Water Plan Update 2005* (December 2005) states:

> California's water systems have been designed and operated based on data from a relatively short hydrologic record. Mounting scientific evidence suggests that forecasted climate changes could significantly change California's precipitation pattern and amount from that shown by the record. Less snowpack would mean less natural water storage. More variability in rainfall, wetter at times and drier at times, would place more stress on the reliability of existing flood management and water systems. California's high dependence on reservoir storage and snowpack for water supply and flood management makes us particularly vulnerable to these types of projected hydrologic changes. (See Chapter 4 in this volume and articles in Volume 4 Reference Guide under Global Climate Change for further discussion.)
> (*California Water Plan Update*, December 2005, Vol. 1, page 3-15)

Potential changes in climate patterns are becoming better defined and attempts to quantify the resulting impacts to SWP water supply are underway. Broad brush estimates are being developed of the potential impact upon the SWP in 50 to 100 years if no additional conveyance facilities or upstream reservoirs are built. As this information becomes more refined, it will be helpful in guiding the development of statewide strategies for the future management and development of water resources facilities, including the SWP.

The Ability to Convey Water from the Source to the Desired Point of Delivery

This factor describes the facilities available to capture and convey surface water or groundwater and the institutional limitations placed upon the facilities. The facilities and institutional limitations may be assumed to be those that currently exist. Alternatively, predictions may be made regarding planned new facilities. Assumptions made about the institutional limitations to operation—such as legal, contractual, or regulatory restrictions—often are based upon existing conditions. Future changes in conditions that affect the ability to convey water usually cannot be predicted with certainty, particularly the regulatory and other institutional constraints on water conveyance.

The analyses in this report include the assumptions that current regulatory and institutional limitations regarding water quality, fish protection, and flows will exist 20 years in the future (2025); no facility improvements, expansions, or additions will be made to the SWP; and conveying water through the Sacramento-San Joaquin Delta will not be significantly interrupted.

Most of the Delta's levees do not meet modern engineering standards and are highly susceptible to failure. Levees are subject to failure at any time of the year due to seepage or the piping of water through the levee, slippage or sloughing of levee material, or sudden failure due to an earthquake. DWR is working on three projects that will improve the ability to make qualitative or quantitative statements about the reliability of conveyance across the Sacramento-San Joaquin Delta. These include: the Delta Risk Management Strategy, which will assess risks to the Delta from floods, seepage, subsidence, and earthquakes, evaluate the consequences of levee failure, and develop recommendations to manage the risk; implementation of AB 1200 (Laird, 2005) which calls for a similar evaluation of impacts on water supplies from catastrophic Delta failure; and a broader public process to develop a shared vision of a sustainable Delta that continues to support societal needs related to water supply, transportation, recreation, land use, energy, and environmental health. Information developed through these efforts will be incorporated into subsequent Reliability Reports.

The Level of Demand

This factor includes the amount and pattern of water demand on the water management system. Demand can have a significant effect upon the reliability of a water system. For example, if the demand occurs only three months in the summer, a water system with a sufficient annual supply but insufficient water storage may not be able to reliably meet the demand. If, however, the same total amount of demand is distributed over the year, the system could more easily meet the demand because the need for water storage is reduced.

Demand levels for the SWP are derived from historical data and information received from the SWP contractors. Demand on the SWP is nearing the maximum Table A amount. Each of the SWP contracts has a Table A, which lists the maximum annual delivery amount over the period of the contract. These annual amounts usually increase over time. Most contractors' Table A amounts reached a maximum in 1990. The total of all contractors' maximum Table A amounts is 4.173 million acre-feet (maf) per water year. Table A is used to define each contractor's portion of the available water supply that DWR will allocate and deliver to that contractor. The Table A amounts in any particular contract, accordingly, should not be read as a guarantee of that amount but rather as the tool in an allocation process that defines an individual contractor's "slice of the pie." The size of the "pie" itself is determined by the factors described in this report. (See Appendix C for additional explanation and listing of the maximum Table A amounts.)

There are 29 SWP contractors. Yuba City, Butte County, and the Plumas County Flood Control and Water Conservation District are north of the Delta. Their maximum Table A amounts total 0.040 maf. The maximum Table A amounts for the remaining 26 contractors, which receive their supply from the Delta, total 4.133 maf. This report focuses on SWP deliveries from the Delta because the amount of water pumped from the Delta by SWP facilities is the most significant component of the total amount of SWP deliveries. The results presented in this report regarding the percent of Table A deliveries applies to contractors north of the Delta in the same manner as those contractors receiving supply from the Delta.

Past Deliveries May Not Accurately Predict Future Deliveries

It is worthwhile to note that in some situations, actual, historical water deliveries cannot be used with a significant degree of certainty to predict future water deliveries. As discussed earlier, there are continual, significant changes over time in the determinants of water delivery for a specific water supply system: changes in water storage and delivery facilities, in water use in the source areas, in water demand in the receiving areas, and in the regulatory constraints on the operation of facilities for the delivery of water. Given the very significant changes that have occurred for the SWP over the past 40 years, past deliveries are not a good predictor of current deliveries, much less of future deliveries.

For example, the demand 30 years ago for water from the SWP was not as high as it is currently or expected to be in the future. Because the demand for SWP water then was low, less water was transported through the SWP during normal and wet times than could have been if the demand had been higher. Simply put, less water was delivered in those past years because less water was needed. Conversely, the projected deliveries of a water project would be less than the past if the water project had been operated at its maximum ability for many years, no new facilities were planned to be built, and the annual supply from one of its main sources of water was recently reduced and would remain at the reduced level.

Many Assumptions Must Be Made in the Determination and Analysis of Water Delivery Reliability

As discussed earlier, to plan for the future, many assumptions must be made about the future. One of the most significant assumptions for water planning in general is how wet, dry and variable the weather will be. For many planning purposes and until the potential effects of climate change are better defined, the assumption is that future patterns of weather will be like the past, and an effort is made to develop information on the longest historical period for which acceptable records exist.

Using the historical record, planners analyze the worst drought in the period of record to evaluate how the water management systems will respond. Precipitation information for the Central Valley used for this report begins in 1922 and records the area's worst multi-year drought (1928-1934), although the brief drought from 1976 through 1977 was more acutely dry. Whatever assumptions are made, every responsible water delivery reliability analysis should expressly state the assumptions, methods and data used to produce its results. It should be understood that those numbers depend on, and are no better than, the assumptions upon which they must necessarily rest.

Because assumptions are the foundation upon which the estimates are made, it is helpful to know how each assumption affects study results. For example, what impact would a significant increase in water use in the source areas have upon the projected SWP water delivery reliability? Would it significantly reduce the amount of SWP supply, and if so, by how much? These types of questions can be answered by varying specific factors to see the impact upon the results. These studies are referred to as sensitivity analyses and can be helpful in assessing the importance of certain assumptions to the study results. Per a commitment in the 2002 Reliability Report, DWR has conducted a sensitivity analysis for assumptions contained in the CalSim II model studies. The results of this study are discussed in Appendix E. In the future, the results of this study will be analyzed to develop more detailed findings regarding SWP Delta deliveries. Summaries of the findings of other studies of CalSim II, as well as a peer review of the model, are contained in this report and discussed in more detail in Appendix E.

Chapter 3. Study Approach and CalSim II Follow-up Studies

This report presents information from computer simulation studies of the operation of the SWP using the CalSim II model. CalSim II is a planning model developed by the Department of Water Resources (DWR) and the U.S. Bureau of Reclamation (USBR). It simulates the SWP and the Central Valley Project (CVP) and areas tributary to the Sacramento-San Joaquin Delta. Using historical rainfall and runoff data, which has been adjusted for changes in water and land use that have occurred or may occur in the future, the model simulates the operation of the water resources infrastructure in the Sacramento and San Joaquin river basins on a month-to-month basis. In the model, the reservoirs and pumping facilities of the SWP and CVP are operated to assure the flow and water quality requirements for these systems are met.

The month-to-month simulations are conducted over the 73-year period (1922-1994) of the adjusted historical rainfall/runoff data. This approach incorporates the over-arching assumption that the next 73 years will have the same rainfall/snowmelt amount and pattern, both within-year and from year to year, as the period 1922 through 1994. The studies do not incorporate any modifications to account for changes related to climate patterns or assess the risk of future seismic or flooding events significantly disrupting SWP deliveries. The results of the CalSim II studies conducted for this update to *The State Water Project Delivery Reliability Report 2002* (DWR 2003a) represent the best available assessment of the delivery capability of the SWP.

Since the release of the 2002 report, a peer-review and several studies have been conducted regarding CalSim II. These reports include:

- An external peer review commissioned by the California Bay-Delta Authority (CALFED);
- An analysis of an historical operations simulation;
- An analysis of the effect varying selected parameters has upon model results (sensitivity analysis study); and
- An analysis of the significance of the simulation time-step to the estimated SWP delivery amounts.

An overview of these efforts follows.

Science Program Peer Review of CalSim II

In 2003, the CALFED Science Program commissioned an external review panel to provide an independent analysis and evaluation of the strengths and weaknesses of CalSim II. The central question put to the review panel was whether the CALFED program had adopted an appropriate approach to modeling the Central Valley Project/State Water Project (CVP/SWP) system. The panel considered a variety of CalSim II issues and addressed how future model development activities could be managed to assure quality results for current and proposed applications. The panel published its results in *A Strategic Review of CALSIM II and its Uses for Water Planning, Management, and Operations in Central California* (Close and others 2003).

In general, the panel concluded that the current modeling approach was comparable to other state-of-the-art models and addressed many of the complexities of the CVP/SWP system. To balance the competing needs of those who require greater detail from the model and those who require less detail, the panel recommended steps to achieve a more comprehensive, modular, and flexible approach in modeling practices and tools. To increase user confidence in model results and to provide a basis for gauging the model's ability to produce absolute predictive results of system behavior, the panel suggested calibration and verification of the model, as well as analyses in sensitivity and uncertainty.

In what was most relevant to the subject of this report on the SWP delivery reliability, the panel summarized its observation on the accuracy of the model to estimate the delivery capability of both the CVP and SWP systems in the *Strategic Review's* Appendix F "Analysis of the November 2003 CalSim II Validation Report." Appendix F is discussed in the next section.

In August 2004, DWR and the USBR jointly responded to the questions, comments, and recommendations of the review panel in a report, *Peer Review Response: A Report by DWR/Reclamation in Reply to the Peer Review of the CalSim II Model Sponsored by the CALFED Science Program in December 2003.* (*Peer Review Response*). In their report, the agencies outline current and planned work on model development and the priorities for improving CalSim II. The *Peer Review Response* also highlights the ongoing and planned efforts to establish trust in and credibility for the model by improving documentation, conducting sensitivity and uncertainty analyses of the model parameters and results. Other efforts include enhancing the level of detail in the geographic representation of the system, and improving hydrologic input and software development.

Many of the elements of model development outlined in the *Peer Review Response* are in progress and will be implemented in the updated version of the model, CalSim III. Some of the *Strategic Review's* pressing issues regarding the reliability of CalSim II as a planning tool are addressed below.

The Ability of CalSim II to Estimate Water Deliveries

The accuracy of CalSim II in simulating "real-world" conditions was one of the major issues raised by the peer review panel. The review panel focused on the system's delivery capability as a major concern to water users as well as water managers who rely on CalSim II when making planning decisions. In Appendix F of the *Strategic Review,* the panel expresses concern that CalSim II overestimates deliveries to south-of-Delta water users. This observation is based on comparing the average deliveries for the last 10 years (1993-2002) with the average annual deliveries in a 73-year model simulation (1922-1994) conducted at the 2001 level of development.

In *Peer Review Response,* DWR and USBR (2004) conclude the concern about overestimations of south-of-Delta deliveries is unwarranted because the 73-year study referenced by the panel is not designed to mimic historical conditions; rather it is intended to determine the reliability of the SWP when the demand equals the maximum Delta Table A amount (4.133 maf) every year. The results of the referenced study are documented in *The SWP Delivery Reliability Report 2002* (DWR 2003a) as study 3 (2021B).

A more appropriate method for assessing the ability of CalSim II to accurately model SWP operations is to compare the historical SWP deliveries with the simulated deliveries of the Historical Operations Study. DWR committed to conducting this study in *The SWP Delivery Reliability Report 2002* (DWR 2003a). The study is documented in the November 2003 Technical Memorandum Report *CALSIM-II Simulation of Historical SWP/CVP Operations* (DWR 2003b). The Historical Operations Study is designed to assess the ability of CalSim II to mimic historical operations of the SWP. In this study, historical input is used where reliable data are available. In situations where reliable historical record is not readily available, reasonable assumptions and estimates are made.

Comparing the average annual historical deliveries with the simulated deliveries in the Historical Operations Study for the dry period shows reasonable results: The average annual SWP south-of-Delta Table A delivery for the 6-year drought of 1987-1992 is 1,930 taf per year, compared to 2,030 taf per year for actual historical deliveries (Figure 3-1). Figure 3-1 compares the simulated Table A deliveries with the actual Table A deliveries for calendar years 1987 through 1992. Although the averages are close, the annual differences between the simulated and actual values can be large. This illustrates that the results of CalSim II analyses are best used for estimating SWP performance over longer periods of time and that considerable judgment must be used when analyzing a specific year. Figure 3-1 replaces the figure contained in the draft of this report which showed the calculated annual delivery amounts would be very close to the

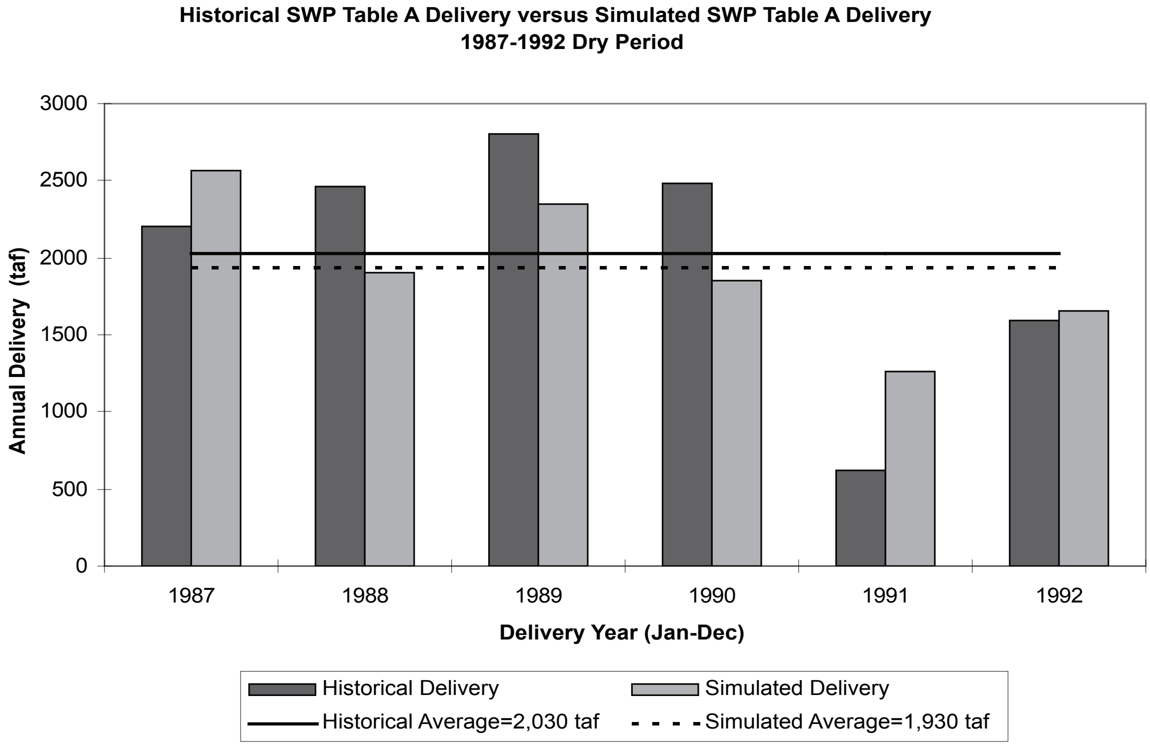

Figure 3-1 SWP south-of-Delta Table A deliveries (1987-1992 dry period)

actual annual delivery amounts, if SWP reservoir storages were adjusted to match the historical values. Additional discussion on this subject is contained in the response to the comment letter from the Planning and Conservation League (Appendix G, Comment Letters on the Draft Report and the Department's Responses).

The observed differences in the annual historical and simulated deliveries can be attributed to differences in the operational rules and parameters assumed in the simulation run. Some of the major operational parameters that could be different between the model run and the actual historical operations include the rule governing the amount of delivery versus the amount of storage to be carried-over into the following year (delivery-carryover storage rule), flood control rules, San Luis Reservoir operation rule, Delta outflow requirements, regulatory decisions, Delta export curtailments caused by pumping facilities outages or compliance with state and federal endangered species regulations, compliance with the provisions of the Coordinated Operations Agreement, implementation of a drought water bank, and water transfers.

In the wetter years (above-normal and wet year-types), when supply is plentiful and deliveries are mostly determined by demands, the simulated deliveries are very close to historical values. When long-term values are compared, the average annual delivery for the SWP during the 23-year period of 1975-1997 is 1,810 taf per year for the Historical Operations Study and 1,790 taf per year for the historical deliveries.

Additional details of this study are in Appendix E.

CalSim II Sensitivity Analysis Study

The sensitivity analysis is an important component of any water resources planning model evaluation. The sensitivity analysis procedures explore and quantify the impact of possible errors in input data on the model outputs and system performance measures. With a simple sensitivity analysis procedure, errors in model input parameters are generally investigated one at a time. With a more complex procedure, the investigation can be conducted by varying a set of parameters simultaneously. In the sensitivity analysis conducted in response to the recommendations in the *Strategic Review* (Close and others 2003), the simple procedure was adopted and errors in model input parameters were investigated one at a time. The objective of the analysis was twofold: (1) to examine the behavior of the model in response to variations in selected input parameters; (2) to provide a basis for CalSim II modelers for prioritizing future model development activities. The *CalSim-II Model Sensitivity Analysis* is available at website http://baydeltaoffice.water.ca.gov/index.cfm.

There are many input parameters used in the CalSim II model to define the physical characteristics of the system, as well as the regulatory environment and operational characteristics. Some input parameters are in the form of time series or monthly distribution curves, and others are simply single values. Some input parameters are estimated from the historical data, and others are values developed or calibrated by users. After consultation with model developers and project operators, 21 model input parameters in four major categories with reasonable ranges of variations were selected for this sensitivity analysis study. The results of the sensitivity analysis are given in more detail in Appendix E.

Examination of the results of the sensitivity analysis provides the following information on the behavior of the SWP system's delivery capability with respect to some of the key input parameters:

- The most significant input parameters affecting SWP Table A Delta deliveries are the assumed SWP Table A demands and the monthly Delta diversion limits applied to Banks Pumping Plant. The results show the long-term average annual SWP Table A Delta deliveries between 3.0 maf to 3.5 maf increase by 0.54 acre-foot for every acre-foot increase in Table A demands. The increase is 0.33 acre-foot for every acre-foot of increase in Table A demands for the range between 3.5 maf per year and 3.9 maf per year.
- Also, the long-term average annual SWP Table A Delta deliveries decrease by 0.48 acre-foot for every 1 acre-foot per month decrease in the monthly Delta diversion limits applied to Banks Pumping Plant during the March 16 to December 14 period. This sensitivity study evaluates a 5 percent reduction in the capacity during this period.
- Inflow to Lake Oroville displays a moderate impact on the SWP Table A Delta deliveries. The long-term average annual SWP Table A Delta deliveries increase by 0.20 acre-foot for every acre-foot increase in annual Oroville inflows.
- The effect of changing SWP contractors' demands for Article 21 water on Article 21 deliveries is high, as expected. The results show that for every acre-foot of change in the peak monthly demands for Article 21 water in the range between 134 taf per month and 400 taf per month, the long-term average annual Article 21 deliveries increase by 0.27 acre-foot.

Examples of parameters not significantly influencing the estimates for SWP Delta deliveries include the projected land use in the source areas and inflow into Lake Shasta and Folsom Reservoir.

Impact of Model Simulation Time-step in Estimating Projects Average Deliveries

In general, the delivery reliability of the SWP is assessed using monthly time-step CalSim II simulations. Monthly time-step simulations implicitly assume that daily hydrologic variability combined with daily physical and regulatory operating constraints are not significant to the forecast of expected average annual deliveries. In other words, it is assumed that a study with monthly inflows, reservoir releases, exports, and associated constraints would produce the same long-term average annual deliveries as a study where inflows, releases, exports, and associated constraints vary on a daily basis.

To confirm the above assumption, results were examined from a recently completed, simplified, daily time-step CalSim II simulation conducted for the California Bay-Delta Authority's Surface Storage Investigations. The assumptions for the baseline monthly and daily time-step simulations are documented in the draft report "Interim Common Model Package, Modeling Protocol and Assumptions" (CALFED 2005). The daily variability appears to have only minor impacts on SWP Table A deliveries. The results show the long-term average annual SWP Table A delivery is increased by 0.3 percent and the average annual deliveries during two 6-year droughts (1929-1934 and 1987-1992) is increased by 0.8 percent in the daily simulation.

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Chapter 4. Computer Simulation Assumptions

The selection of the assumptions and factors that go into the estimation of future water delivery reliability is very important and must be tailored to the particular water supplier. Assumptions and factors for the State Water Project focus on Sacramento and San Joaquin river basin precipitation; water rights and uses; SWP storage and conveyance facilities, including diversion facilities in the Delta; SWP service area demand; and the statutes, regulations, and contractual provisions that govern and regulate the SWP, including coordinating operations with the federal Central Valley Project (CVP). A detailed list of the study assumptions for this report is found in Appendix A.

The results of five computer simulations are included in this report. Studies 1, 2, and 3 are from the *The State Water Project Delivery Reliability Report 2002* (DWR 2003). The results of studies 1, 2 and 3 are included in this report for comparison purposes. Studies 4 and 5 are updated studies conducted specifically for this report. A significant difference between the updated studies and the earlier studies is the assumed demands for SWP Table A and Article 21. Article 21 refers to a section of the water supply contracts that allows additional water to be delivered under certain conditions (see Chapter 5 for further discussion).The assumed demands for studies 4 and 5 were developed in discussions with SWP water contractors and stakeholders involved in the development of the analyses associated with the environmental documentation for the Monterey Agreement. The demands developed for studies 4 and 5 are within the range covered under the current SWP biological opinions.

The assumptions for the studies differ in three main categories: the assumed level of water use in the source areas (the level of development), the assumed SWP Table A and Article 21 demands, and the base model assumptions. These categories are summarized in Table 4-1.

Table 4-1 Key study assumptions

Study	Study name	Level of development (year)	SWP Table A demand (maf/year)	SWP Article 21 demand (taf/month)	Model version
SWP Delivery Reliability Report (2003)					
1	2001 Study	2001	3.0–4.1	0–84, Apr–Nov 50–134, Dec–Mar	May 2002 benchmark
2	2021A Study	2021	3.3–4.1	0–84, Apr–Nov 50–134, Dec–Mar	May 2002 benchmark
3	2021B Study	2021	4.1	0–84, Apr–Nov 50–134, Dec–Mar	May 2002 benchmark
Updated Studies					
4	2005 Study	2005	2.3–3.9	0–84, Apr–Nov 100–184, Dec–Mar	2004 OCAP
5	2025 Study	2025	3.9–4.1	0–84, Apr–Nov 100–184, Dec–Mar	2004 OCAP

maf = million acre-feet

OCAP = 2004 Long-Term Central Valley Project Operations Criteria and Plan

taf = thousand acre-feet

The water use estimates for the source areas for 2001 are assumed to be representative of 2005. The water use estimates for the source areas for 2020 are assumed to be representative of 2021 and 2025 conditions.

The SWP contractors' Table A and Article 21 demands for deliveries from the Delta assumed for the five studies are shown in Table 4-1. In four of the studies, a range in Table A demands is shown because the demand is assumed to vary each year with the weather in the delivery areas. In study 3 (2021), the SWP Table A demand is maximized each year, regardless of weather. Article 21 deliveries are available on an unscheduled and interruptible basis and are not counted as part of the Table A amount. (See Chapter 5 for more discussion of Article 21.) The Article 21 demand in the updated studies (4 and 5) is higher than the earlier studies for the December through March period.

Two versions of the model are used for these studies as shown in Table 4-1. Studies 1, 2 and 3 are based on the May 2002 benchmark study version. The updated studies (4 and 5) use the most recent version, which was developed for the 2004 Long-Term Central Valley Project Operations Criteria and Plan (OCAP). The assumption differences between the May 2002 benchmark version and the 2004 OCAP version that affect the SWP simulation significantly are listed below. A complete list of the differences in key assumptions is included in Appendix A.

1. Addition of a minimum pumping level at Banks Pumping Plant of 300 cubic feet per second.
2. Addition of flow requirements for flow at the mouth of the Feather River for SWP Settlement Contractors.
3. Delivery-carryover relationship adjusted to reduce delivery targets and increase carryover in critically dry years.
4. Addition of Lake Oroville end-of-September carryover target storage rule.
5. Study 5 assumes the implementation of Freeport Regional Water Project, including modified East Bay Municipal Utility District operations on the Mokelumne River.

All studies assume current SWP Delta diversion limits (often referred to as "Banks Pumping Plant capacity"), existing conveyance capacity of the upper Delta-Mendota Canal/California Aqueduct system, and current SWP/CVP operations agreements.

Cited Reference

[DWR] California Department of Water Resources, Bay-Delta Office. 2003. The State Water Project Delivery Reliability Report 2002. Final.

Chapter 5. Study Results

The five CalSim II model studies in this report are described in Chapter 4. Studies 1, 2, and 3 are from the *The State Water Project Delivery Reliability Report 2002* (DWR 2003). Studies 4 and 5 are updated studies conducted specifically for this report. The results of studies 1, 2 and 3 are included in this report for comparison purposes. This chapter contains tables summarizing the estimated delivery amounts of the studies for the entire study period (1922-1994), dry years, and wet years and presents information on the estimated probability of SWP delivery amounts currently and twenty years in the future. The annual values for SWP deliveries estimated by CalSim II for the five studies are listed in tables B-3 through B-7 of Appendix B. These tables also show the annual Table A demands assumed for each study.

The results of the updated studies (4 and 5) are compared to the results of the earlier studies (1, 2 and 3) to identify and explain any significant differences in estimated delivery values. For most values, the differences are not large enough to be significant and are generally caused by differences in the assumed demands. There are, however, significant differences between the updated and earlier studies for the estimated deliveries during 1, 2 and 4-year droughts. These differences are discussed further in "Drought Years." Information from studies 4 and 5 was transmitted to SWP contractors (Notice Number 05-08) in May 2005. Studies 4 and 5 are referred to as studies 6 and 7 in the notice.

Article 21 Deliveries

The studies estimate delivery amounts for Table A and Article 21. As mentioned in Chapter 2, Table A is the contractual method for allocating available supply, and the total of all maximum Table A amounts for deliveries from the Delta is 4.133 million acre-feet (maf) per year. Article 21 refers to a provision in the contracts for delivering water that is available in addition to Table A amounts. (See Appendix C for more detail about Table A and Appendix D for historical delivery amounts.) Article 21 of SWP contracts allows contractors to receive additional water deliveries only under specific conditions. These conditions are:

1. It is available only when it does not interfere with Table A allocations and SWP operations;
2. It is available only when excess water is available in the Delta;
3. It is available only when conveyance capacity is not being used for SWP purposes or scheduled SWP deliveries; and
4. It cannot be stored within the SWP system. In other words, the contractors must be able to use the Article 21 water directly or store it in their own system.

Water supply under Article 21 becomes available only during wet months of the year, generally December through March. Because an SWP contractor must have an immediate use for Article 21 supply or a place to store it outside of the SWP, not all SWP contractors can take advantage of this additional supply.

The importance of Article 21 water to local water supply is tied to how each contractor uses its SWP supply. For those SWP contractors who are able to store their wet weather supplies, Article 21 supply can be stored by being put directly into a reservoir or by offsetting other water that would have been withdrawn from storage, such as local groundwater. In the absence of storage, Article 21 water is not likely to contribute significantly to local water supply reliability. Incorporating supplies received under Article 21 into the assessment of water supply reliability is a local decision based on specific local circumstances, facts, and level of water supply reliability required.

Table 5-1 SWP Table A demand from the Delta

Study	Average demand		Maximum demand		Minimum demand	
	(taf per year)	(percent of maximum Table A)	(taf per year)	(percent of maximum Table A)	(taf per year)	(percent of maximum Table A)
SWP Delivery Reliability Report (2003):						
1. 2001 Study	3,712	90%	4,114	100%	3,007	73%
2. 2021A Study	4,026	97%	4,133	100%	3,343	81%
3. 2021B Study	4,133	100%	4,133	100%	4,133	100%
Updated Studies:						
4. 2005 Study	3,290	80%	3,862	93%	2,321	56%
5. 2025 Study	4,110	99%	4,133	100%	3,898	94%

Maximum Delta Table A is 4.133 million acre-feet per year

This report presents information on Article 21 water separately, so local agencies can determine whether it is appropriate to incorporate this supply into their analyses.

SWP Water Deliveries under Different Hydrologic Scenarios

Tables 5-1 and 5-2 summarize the assumed Table A demands for the updated (4 and 5) and the earlier (1, 2, and 3) studies and the resulting estimates for SWP deliveries. Table 5-3 presents information on the assumed Article 21 demand and the estimated Article 21 deliveries. Tables 5-4 through 5-8 summarize values for dry and wet hydrologic periods. The estimated probabilities for a given amount of annual SWP delivery are presented in Figures 5-1 and 5-2.

Assumed Table A Demands

The average, maximum, and minimum Table A demands from the Delta for the five studies are shown in Table 5-1. Study 4 has lower assumed demands than study 1. The average demand for study 4 is 80 percent of maximum Table A compared to 90 percent of maximum Table A for study 1. The primary reason for the lower demand in study 4 is that it includes a new set of annual Table A demands for the Metropolitan Water District of Southern California (MWDSC) prepared specifically for 2003 conditions by MWDSC. The average demand for study 5 is 99.4 percent of maximum Table A and is very similar to study 3. The annual assumed demand for study 5 is less than maximum Table A in only seven wet years due to the assumption that some Table A deliveries would be replaced by supplies from the Kern River.

As explained in Chapter 2 and Appendix C, the maximum Table A amounts for the 26 contractors which receive their supply from the Delta total 4.133 maf. The demands for studies 1 and 4 assume slightly earlier conditions when the maximum Table A amounts totaled slightly less than 4.133 maf (4.114 maf and 4.112 maf, respectively). To simplify the use of this report, the calculation of demand or delivery in percent of maximum Table A is based on the maximum Delta Table A total of 4.133 maf for all five studies. This simplification has no significant effect on the annual delivery percentages for studies 1 and 4. Additional information can be found in Appendix B.

Table A and Article 21 Deliveries

Table 5-2 contains the average, maximum, and minimum estimates of Table A deliveries from the Delta for the five studies. Comparing the relevant updated and earlier studies shows the averages of the estimated delivery percentages and the maximum estimated deliveries do not vary significantly. Study 4 has an average delivery of 68 percent of maximum Table A compared to 72 percent for study 1. This lower delivery under current conditions is due to the lower demand level assumed for study 4. The slightly higher average delivery of 77 percent for study 5 compared to 75 percent for study 2 is attributed to the higher demand assumed for study 5 and to differences in modeling assumptions as summarized in Chapter 4 and listed in Appendix A. The average delivery for study 5 is one percentage

Table 5-2 SWP Table A delivery from the Delta

Study	Average delivery (taf per year)	Average delivery (percent of maximum Table A)	Maximum delivery (taf per year)	Maximum delivery (percent of maximum Table A)	Minimum delivery (taf per year)	Minimum delivery (percent of maximum Table A)
SWP Delivery Reliability Report (2003):						
1. 2001 Study	2,962	72%	3,845	93%	804	19%
2. 2021A Study	3,083	75%	4,128	100%	830	20%
3. 2021B Study	3,130	76%	4,133	100%	830	20%
Updated Studies:						
4. 2005 Study	2,818	68%	3,848	93%	159	4%
5. 2025 Study	3,178	77%	4,133	100%	187	5%

Maximum Delta Table A is 4.133 million acre-feet per year.

point higher than study 3 even though study 3 has a slightly higher demand. This slightly higher value for study 5 is due to differences in modeling assumptions.

Comparing the updated studies (2005 versus 2025 study levels) shows study 5 has an average delivery of 77 percent of maximum Table A compared to 68 percent for study 4, an increase of 9 percent. This average increase in delivery is due to the higher demand assumed for study 5. Although the average amount (quantity) of delivery is shown to increase over time, the ability of the SWP to meet the assumed demands decreases over time. The responses from the Department to the comments of the Coachella Valley Water District and the Planning and Conservation League in Appendix G discuss this subject in more detail.

The difference between the earlier studies and the updated studies for the estimated minimum Table A delivery is significant. The updated studies have a minimum delivery of 4 percent to 5 percent of maximum Table A compared to 19 to 20 percent for the studies in the *SWP Delivery Reliability Report 2002* (DWR 2003). The lower minimum delivery is primarily due to modification of the delivery-carryover storage rule. Compared to the rule used for the earlier studies, the modified rule reduces delivery by about 80 percent whenever carryover storage (sum of the end-of-September storages of Oroville Reservoir and the SWP share of San Luis Reservoir) is projected to be less than about 860 thousand acre-feet (taf). The modified rule was developed in coordination with the DWR's SWP Operations Control Office to meet the primary objective of reducing the number of years storage in Oroville Reservoir reaches a very low level. The minimum delivery occurs in 1977, the driest year in the 73-year simulation. A closer look at this estimation is done later in this chapter. It applies reasonable assumptions about the amount of Table A deliveries carried-over in San Luis Reservoir from the previous year by SWP contractors and the use of storage in San Luis Reservoir to illustrate how the estimate could be adjusted to 20 percent of maximum Table A while not reducing storage in Oroville Reservoir.

Average Article 21 demands and average, maximum, and minimum Article 21 deliveries for the five studies are shown in Table 5-3. All studies have the same Article 21 demand from April through November. The updated studies (4 and 5) assume a 200 taf increase in Article 21 demand for the period December through March compared to the earlier studies (50 taf per month).

The average Article 21 delivery for study 4 is 260 taf per year, an increase of 130 taf per year from the study 1 average delivery of 130 taf per year. This increase in delivery is a result of the increase in Article 21 demand of 200 taf per year in studies 4 and 5 and also due to the decrease in Table A demand in study 4 compared to study 1. Study 5 has an average Article 21 delivery of 120 taf per year, 40 taf per year more than study 2 and 50 taf per year more than study 3. These increases are the result of the higher assumed Article 21 demand.

Table 5-3 SWP Article 21 demand and delivery from the Delta (taf per year except as noted)

Study	Average Article 21 demand		Total	Annual delivery from the Delta		
	Dec-Mar	Apr-Nov		Average	Maximum	Minimum
SWP Delivery Reliability Report (2003):						
1. 2001 Study	504	607	1,111	130	510	0
2. 2021A Study	504	607	1,111	80	400	0
3. 2021B Study	504	607	1,111	70	400	0
Updated Studies:						
4. 2005 Study	704	607	1,311	260	1,110	0
5. 2025 Study	704	607	1,311	120	550	0

Delivery numbers rounded to the nearest 10,000 acre-feet.

Table 5-4 SWP average and dry year Table A delivery from the Delta

Study	SWP Table A delivery from the Delta (in percent of maximum Table A)					
	Average 1922-1994	Single dry year 1977	2-year drought 1976-1977	4-year drought 1931-1934	6-year drought 1987-1992	6-year drought 1929-1934
SWP Delivery Reliability Report (2003):						
1. 2001 Study	72%	19%	48%	37%	41%	40%
2. 2021A Study	75%	20%	44%	39%	40%	41%
3. 2021B Study	76%	20%	44%	39%	40%	41%
Updated Studies:						
4. 2005 Study	68%	4%	41%	32%	42%	37%
5. 2025 Study	77%	5%	40%	33%	42%	38%

Drought Years

Table 5-4 includes estimates of water deliveries under an assumed repetition of historical drought periods for the five studies. The years are identified as dry by the Eight River Index, a good indicator of the relative amount of water supply available to the SWP. The Eight River Index is the sum of the unimpaired runoff from the four rivers in the Sacramento Basin used to define water conditions in the basin plus the four rivers in the San Joaquin Basin, which correspondingly define water conditions in that basin. The eight rivers are the Sacramento, Feather, Yuba, American, Stanislaus, Tuolumne, Merced, and San Joaquin. Table 5-4 also includes the average deliveries for comparison purposes.

As discussed earlier in conjunction with the minimum deliveries shown in Table 5-2, the single-year drought deliveries for the updated studies are estimated at 4 percent to 5 percent of maximum Table A compared to 19 to 20 percent for the studies in the *SWP Delivery Reliability Report 2002* (DWR 2003). The 2-year drought average annual delivery decreases from 48 percent for study 1 to 41 percent for study 4. Similarly, study 5 delivery decreases to 40 percent as compared to 44 percent for studies 2 and 3. The results for a 4-year drought show a 5 percent decrease in delivery for study 4 compared to study 1 and a 6 percent decrease in delivery for study 5 compared to studies 2 and 3, for the same reason. The decreases in each of these cases are primarily due to modification of the delivery-carryover storage rule as discussed earlier.

For the updated studies, the annual delivery for the single dry year is estimated to be about the same amount whether the dry year happens now or in twenty years. This is also true for estimated annual deliveries during the multi-year drought periods. This is projected to occur even though the amount of reservoir carryover storage resulting from the increased demand is projected to be less. This result is attributable to the operation rules governing the amount of water that must be retained for carryover storage, the fact the SWP demand between 2005 and 2025

Table 5-5 Average and dry year delivery under Article 21 (taf per year)

Year	Study 1	Study 2	Study 3	Study 4	Study 5
	2001	2021A	2021B	2005	2025
1929	0	0	0	0	0
1930	90	30	30	120	140
1931	0	0	0	0	0
1932	200	40	40	240	110
1933	130	10	10	510	550
1934	0	0	0	210	240
1976	110	0	0	190	0
1977	0	0	0	0	0
1987	0	0	0	550	180
1988	0	0	0	0	0
1989	0	0	0	0	90
1990	0	0	0	0	0
1991	0	0	0	0	0
1992	0	0	0	0	100
1922-1994 average	130	80	70	260	120

Numbers rounded to the nearest 10,000 acre-feet.

increases only slightly, and because less water is made available under Article 21.

Table 5-5 summarizes the estimates of dry year deliveries under Article 21 for the five studies. The updated studies (4 and 5) have higher deliveries than the earlier studies (1, 2 and 3) because of assumed higher Article 21 demand. Also notice the reductions in delivery for studies 2 and 3 compared to study 1 in the years 1930, 1932, 1933, and 1976. These reductions are due to the increase in Table A deliveries. The average values for Article 21 deliveries for Study 5 is lower than study 4, primarily due to the assumed higher Table A demand in study 5.

Wet Years

Tables 5-6 and 5-7 summarize the model run results for historical wet years. As with drought years, the Eight River Index is used to identify the wet years. Because plenty of water is available for deliveries in wet years, variations in Table A delivery are due to variations in the demand assumed for each of the studies.

Table 5-7 contains information about Article 21 deliveries for the wet period 1978-1987. The information illustrates a significant decrease in the availability of Article 21 supply between study 5 and study 4. This is primarily due to the increase in Table A demand. Article 21 deliveries are generally higher in the updated studies (4 and 5) than the earlier studies (1, 2 and 3). This is attributed to the 200 taf per year increase in Article 21 demand assumed for studies 4 and 5. In addition, the increase in Article 21 deliveries for study 4 compared to the study 1 is partially due to the lower Table A demand assumed for study 4.

SWP Table A Delivery Probability

The probability that a given level of SWP Table A amount will be delivered from the Delta is shown for the two current condition studies (1 and 4) in Figure 5-1 and for the three future condition studies (2, 3, and 5) in Figure 5-2. The plot lines in the figures are derived from the study results listed in tables B-3 through B-7. Each line is constructed by ranking the 73 annual Table A delivery values of the relevant study from lowest to highest and calculating the percentage of values equal to or greater than the delivery value of interest. For example, for study 4 in Figure 5-1, the value of 3.3 maf is in the 30 percent position of the ranking; therefore,

Table 5-6 SWP average and wet year Table A delivery from Delta

Study	SWP Table A delivery from the Delta (in percent of maximum Table A)					
	Average 1922-1994	Single wet year 1983	2-year wet 1982-1983	4-year wet 1980-1983	6-year wet 1978-1983	10-year wet 1978-1987
SWP Delivery Reliability Report (2003):						
1. 2001 Study	72%	73%	79%	80%	80%	80%
2. 2021A Study	75%	82%	89%	86%	87%	84%
3. 2021B Study	76%	100%	100%	91%	91%	87%
Updated Studies:						
4. 2005 Study	68%	60%	65%	69%	75%	72%
5. 2025 Study	77%	95%	97%	93%	93%	89%

Table 5-7 Average and wet year delivery under Article 21 (taf per year)

Year	Study 1	Study 2	Study 3	Study 4	Study 5
	2001	2021A	2021B	2005	2025
1978	100	100	100	300	300
1979	140	90	100	160	140
1980	100	70	80	140	90
1981	120	0	0	550	70
1982	390	100	60	800	170
1983	200	200	160	400	360
1984	410	380	370	550	490
1985	0	0	0	0	0
1986	50	50	60	120	80
1987	0	0	0	550	180
1922-1994 average	130	80	70	260	120

Numbers rounded to the nearest 10,000 acre-feet.

it is equaled or exceeded by 30 percent (about 22) of the 73 delivery values. The delivery value of 0.16 maf, the minimum value for study 4, is equaled or exceeded by all of the delivery values.

The curve for study 4 is generally lower than study 1 due to assumed lower annual demands. Neither curve reaches 100 percent because the assumed annual demands are 100 percent (99.5 percent) of the maximum Delta Table A in only two years for study 1 and the assumed maximum demand for study 4 is 93 percent of the maximum Delta Table A. In study 1, the two years with demand at 100 percent are dry years so delivery of 100 percent is not possible. The divergence of the two curves for the minimum delivery amounts (100 percent probability of being equaled or exceeded) is due to modification of the delivery-carryover storage rule.

Study 5 shows higher deliveries than study 3 for delivery values exceeded by up to 70 percent of the values, and mostly lower deliveries for values exceeded by 80 to 100 percent of the values. Because the assumed demands are nearly the same for these two studies, the delivery differences between study 5 and study 3 are primarily due to modification of the delivery-carryover storage relationship. The delivery-carryover relationship assumed in study 5 allows less delivery than study 3 in dry years which results in higher carryover storage and higher deliveries in normal to above normal years. Study 5 deliveries reach 100 percent 26 percent of the time, the highest percentage for the five studies.

The amount of SWP Table A delivery per year, either in percent of maximum Delta Table A or in thousand acre-feet, associated with a

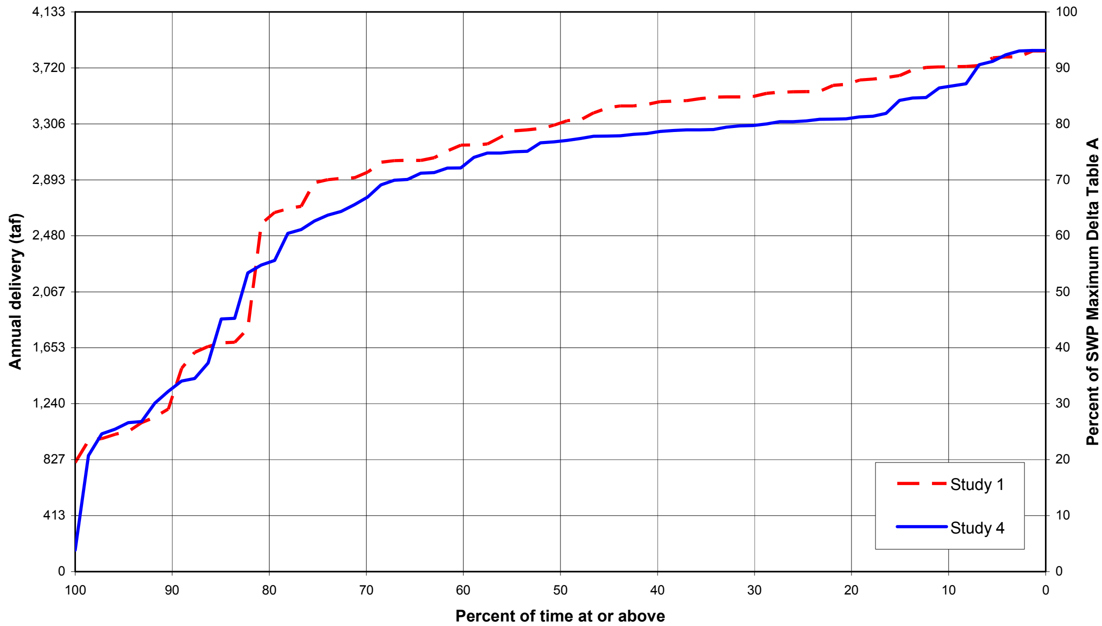

Figure 5-1 SWP Delta Table A delivery probability for year 2005

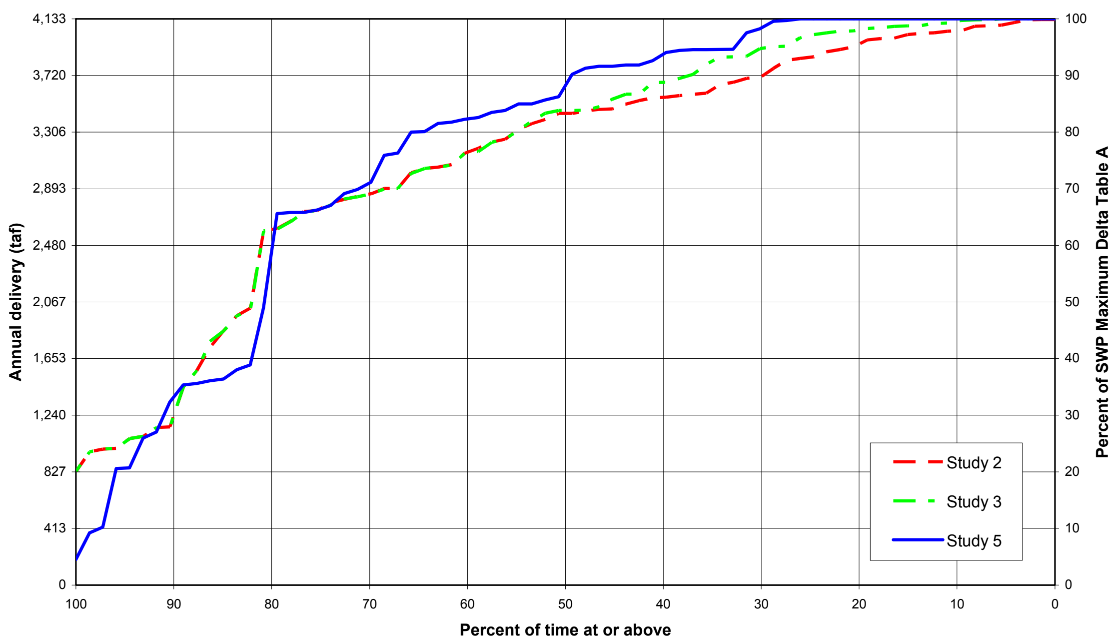

Figure 5-2 SWP Delta Table A delivery probability for year 2025

specific degree of reliability can be estimated from Figures 5-1 and 5-2 for 2005 and 2025 conditions, respectively. The study 4 curve in Figure 5-1 is recommended to be used to represent 2005 conditions, and the study 5 curve in Figure 5-2 is recommended to be used to represent 2025 conditions. By referencing the curve for study 5 in Figure 5-2, the following can be deduced:

- In 75 percent of the years, the annual water delivery of the SWP is estimated to be at or above 2.70 maf per year (65 percent of 4.13 maf).

- In 50 percent of the years, it is estimated to be at or above 3.50 maf per year (85 percent of 4.13 maf).
- In 25 percent of the years, it is at 4.13 maf per year.

Figures 5-1 and 5-2 depict the estimated reliability for the total of SWP deliveries. Under conditions when almost all contractors are requesting their maximum Table A, such as study 5, this information can be directly applied to individual long-term water supply contracts for the SWP. For example, if a water agency has a maximum SWP Table A amount of 400 taf, at least 260 taf per year (65 percent of 400 taf) is estimated to be delivered 75 percent of the time.

Potential Adjustments to 1977 CalSim II Table A Deliveries

The CalSim II model, a planning model, is best used for estimating SWP performance over long periods of time. Considerable judgment should be applied when evaluating CalSim II results for shorter periods of time. This is especially true for estimates for a single year. The updated studies (studies 4 and 5) show that the changes in the operations criteria assumed for the SWP produce a delivery estimate of about 5 percent of maximum Delta Table A for the driest year on record (1977). This estimate is lower than the amount actually delivered from the Delta in 1977 (733 taf, 18 percent of maximum Delta Table A), as well as lower than what was shown in *SWP Delivery Reliability Report 2002* (DWR 2003). The discussion below presents some adjustments contractors may consider in estimating Table A deliveries under weather conditions similar to 1977.

In order to understand what led to the lower delivery estimates for 1977, it is best to start with 1975. The year 1975 is a wet year and is immediately followed by two critically dry years (1977 being the driest year on record during the last 80 years of historical hydrology). SWP Table A deliveries estimated in study 4 for 1975, 1976, and 1977 are 3.23 maf, 3.27 maf, and 159 taf, respectively. For study 5 the respective deliveries are 4.13 maf, 3.14 maf, and 187 taf. As currently practiced and allowed under the SWP water supply contracts, many of the contractors would carry over a portion of their allocated Table A water during 1975 and 1976 to succeeding years. In the case of 1977, it is reasonable to assume that up to 500 taf of 1976 allocated Table A water could be carried over to 1977. In addition, due to the slightly conservative delivery-carryover rule curve used in these studies, the minimum SWP storage in San Luis Reservoir for 1977, which occurs during the June-August period, averages about 190 taf for both studies 4 and 5. The minimum pool for the SWP share of San Luis Reservoir is just over 40 taf. In a year as critically dry as 1977, it is also reasonable to assume an additional 150 taf would be made available for deliveries bringing the SWP storage in San Luis Reservoir to minimum pool. After August, the SWP storage in San Luis Reservoir begins to rise. It is reasonable to expect additional deliveries to be made in the September-December period.

In summary, under the hydrologic conditions similar to a critically dry year like 1977, project deliveries can be expected to range from 4 or 5 to 20 percent of Table A, depending upon such factors as the delivery-carryover risk curve applied by SWP operators and the amount of allocated Table A water carried over from the previous year by SWP contractors.

Additional Analysis of Tables B-3 through B-7 in Appendix B

The information presented earlier in this chapter is helpful in analyzing the delivery reliability of a specific water system receiving a portion of its water supply from the SWP. In addition, the series of data contained in tables B-3 through B-7 are very helpful in analyzing longer periods of time that contain not only dry periods but wetter periods, which can replenish local water supplies if there is a place to store the supply. Analysis of this information can help determine if a local agency has adequate storage for capturing these supplies or if more storage could be utilized in the local water system.

Cited Reference

[DWR] California Department of Water Resources, Bay-Delta Office. 2003. The State Water Project Delivery Reliability Report 2002. Final.

Chapter 6. Examples of How to Apply Information

The following two examples illustrate how to use the information presented in this report to develop water supply assessments for a hypothetical SWP contractor. Hypothetical examples illustrating applications of the delivery probability curves and adjustments to the data for a SWP contractor that cannot convey its maximum Table A amount are provided in *The State Water Project Delivery Reliability Report 2002*. Questions regarding the use of the information contained in these reports may be directed to the Department of Water Resources' Bay-Delta Office at (916) 653-1099.

Example 1

This example uses data directly from Table 5-4 for studies 4 and 5, and employs an allocation methodology that provides a simple means of estimating supplies to each contractor. The data in the table is interpolated for 5-year increments and contained in Table 6-1. In all but the average values in Table 6-1, the estimated percentages of Table A deliveries for the 2005 and the 2025 levels of development differ by one percentage point only. Interpolation between these values is shown in this example for illustration purposes. When values are this close, a valid alternative approach would be to use the same percentage value throughout the entire twenty-year period.

Although the percentage values are calculated using the maximum Delta Table A value, they may be directly applied to generate estimates for SWP deliveries for the entire 20-year period. This is because the Delta Table A value for 2005 is 4.114 maf/yr, 99.5 percent of the maximum Delta Table A value of 4.133 maf/yr. For comparison purposes, the percentage values for studies 1 and 4 based upon a full Table A value of 4.113 maf/yr and 4.133 maf/yr are listed in Tables B-3 and B-6. In addition, the percentages may also be used to estimate the Table A deliveries to SWP contractors in Butte and Plumas counties and Yuba City. The deliveries to these contractors would be calculated using the same method described below.

Table 6-1 shows the average percentage of maximum Delta Table A deliveries for average, single-dry year, and 2-, 4-, and 6-year multiple dry year scenarios from 2005 to 2025 in five-year increments. The maximum Table A amounts of each contractor are listed in Appendix C. Note that Table A amounts can be amended and a contractor's Table A amount over the next 20 years may be less than its maximum over some or all of this period. In this case, the contractor should use the amended Table A amounts for the corresponding years during this period. To use dry years other than those presented in Table 6-1, or to show year-to-year supplies instead of

Table 6-1 SWP average and dry year Table A delivery from the Delta in five-year intervals for studies 4 and 5

Year	SWP Table A delivery from the Delta (in percent of maximum Table A)					
	Average 1922-1994	Single dry year 1977	2-year drought 1976-1977	4-year drought 1931-1934	6-year drought 1987-1992	6-year drought 1929-1934
2005	68%	4%	41%	32%	42%	37%
2010	70%	4%	41%	32%	42%	37%
2015	73%	4%	41%	33%	42%	37%
2020	75%	4%	41%	33%	42%	37%
2025	77%	5%	40%	33%	42%	38%

Tables for Example 1

Average Annual Values (acre-feet)

Water Supply Source	2005	2010	2015	2020	2025
State Water Project (Table A)	68,000	70,000	73,000	75,000	77,000
State Water Project (Article 21)[1]					
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

[1] Annual Article 21 amounts vary significantly from year to year. Without the ability to store Article 21 supply, it is not likely to contribute to local supply. See discussion of Article 21 supply in Chapter 5.

Single Dry Year 1977 conditions (acre-feet)

Water Supply Source	2005	2010	2015	2020	2025
State Water Project (Table A)	4,000	4,000	4,000	4,000	5,000
State Water Project (Article 21)	0	0	0	0	0
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

Multiple Dry Year Period 1931-1934 conditions (acre-feet per year)

Water Supply Source	2005	2010	2015	2020	2025
State Water Project (Table A)	32,000	32,000	33,000	33,000	33,000
State Water Project (Article 21)[1]					
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

[1] Annual Article 21 amounts vary significantly from year to year. Without the ability to store Article 21 supply, it is not likely to contribute to local supply. See discussion of Article 21 supply in Chapter 5.

averages over a multiple-dry year period, see Example 2.

How to calculate supplies:

Multiply the contractor's Table A amount for a particular year by the corresponding delivery percentages for that year from Table 6-1 to get an estimated delivery amount, for the average and drought periods, for each 5 year increment from 2005 to 2025.

The example tables show the SWP Table A deliveries projected to be available to a hypothetical contractor with a maximum Table A amount of 100,000 af, on average and for the various drought periods. For this example, the supplies shown for the multiple-dry year period are average supplies over the four-year drought from 1931-1934. Data from other year types, although not required in an urban water management plan, could also be presented this way.

Example 2

This example is similar to Example 1 but allows a contractor to select alternative single year or multiple-dry year sequences other than those presented in Table 6-1. This option might be selected if analyzing different hydrologic year(s) makes more sense given a contractor's other supply sources, or given the locally acceptable risk level for water delivery shortages.

This example can also be used to identify supplies projected to be available in each year of a multiple-dry year period. While the Water Code does not specifically require this, the *Urban Water Management Plan Guidebook* suggests showing year-to-year supplies (see the *UWMP Guidebook*, Section 7, Step 3).

Where to find the data

Choose a single year or multiple-year sequence from Tables B-6 and B-7 to represent single-dry year and multiple-dry year scenarios. Table B-6 contains the percent of maximum Table A deliveries under all 73 hydrologic years in the updated model study for 2005. Table B-7 contains the percent of maximum Table A deliveries under all 73 hydrologic years in the updated model study for 2025.

How to calculate supplies

Multiply the contractor's Table A amount for a particular year by the percent of maximum Table A deliveries for the selected years, to get an estimated delivery amount for the years selected, for 2005 and 2025. Values for years between 2005 and 2025 can be linearly interpolated.

The following tables show the SWP Table A deliveries projected to be available to a hypothetical contractor with a maximum Table A amount of 100,000 af, in a single dry year and year-to-year over a multiple dry year period. For this example, the single dry year selected is for 1988 conditions, and the multiple dry year period selected is the three-year period from 1990-1992. In showing year-to-year supplies for the multiple dry year period, these year-to-year supplies should be shown for each five-year increment during the 20-year projection period.

Tables for Example 2

Single Dry Year
1988 conditions
(acre-feet)

Water Supply Source	2005	2010	2015	2020	2025
State Water Project (Table A)	21,000	18,000	15,000	13,000	10,000
State Water Project (Article 21)	0	0	0	0	0
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

Tables for Example 2 (cont.)

Multiple Dry Year Period 1990-1992
1990 conditions
(acre-feet per year)

Water Supply Source	2005	2010	2015	2020	2025
State Water Project (Table A)	27,000	25,000	24,000	22,000	21,000
State Water Project (Article 21)	0	0	0	0	0
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

Multiple Dry Year Period 1990-1992
1991 conditions
(acre-feet per year)

Water Supply Source	2005	2010	2015	2020	2025
State Water Project (Table A)	25,000	24,000	23,000	22,000	21,000
State Water Project (Article 21)	0	0	0	0	0
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

Multiple Dry Year Period 1990-1992
1992 conditions
(acre-feet per year)

Water Supply Source	2005	2010	2015	2020	2025
State Water Project (Table A)	34,000	34,000	35,000	35,000	35,000
State Water Project (Article 21)	0	0	0	0	0
Groundwater					
Local Surface Water					
Transfers					
Exchanges					
Reclaimed Water					
Other (identify)					
Total					

Appendix A. 2005 Delivery Reliability Report CalSim II Modeling Assumptions

Two versions of the model are used for this report. Studies 1, 2 and 3 are based on the May 2002 benchmark study version. The updated studies (4 and 5) use the most recent version, which was developed for the 2004 Long-Term Central Valley Project Operations Criteria and Plan (OCAP). The key assumption differences between the May 2002 benchmark version and the 2004 OCAP version are listed below.

1. Temperature flow below Keswick Dam was changed from a fixed time series flow to a dynamic storage dependent flow.

2. Relaxation of criteria for flow below Nimbus Dam when Folsom Lake storage drops below 300 thousand acre-feet.

3. Navigation control point flow criteria were modified from being dependent on water year type to being dependent on CVP agricultural allocation levels. Criteria were also relaxed for very low allocation years.

4. Clear Creek Tunnel target flows were modified to match the latest Trinity EIR analysis.

5. Addition of a minimum pumping level at Banks Pumping Plant of 300 cubic feet per second.

6. Addition of a minimum pumping level at Tracy Pumping Plant of 600 cubic feet per second.

7. Addition of flow requirements for flow at the mouth of the Feather River for Settlement Contractors.

8. Delivery-carryover relationship was adjusted to reduce delivery targets and increase carryover in critically dry years.

9. Addition of Lake Oroville end-of-September carryover target storage rule.

10. Five-step study setup modified to isolate (b)(2) accounting from “with Project” conditions.

11. Modification of American River demands as described in Tables A-2 and A-3.

12. Modification of Contra Costa Water District demands to include the effect of Los Vaqueros Reservoir operations.

13. The minimum flow of the Trinity River below Lewiston Dam in study 4 ranges from 369 to 453 thousand acre-feet per year depending on water year type. All other studies used in this report assume the Trinity River minimum flow has a greater range from 369 to 815 thousand acre-feet per year. This greater range of Trinity River minimum flows represents the Trinity Environmental Impact Statement Preferred Alternative.

14. Study 5 assumes the implementation of Freeport Regional Water Project, including modified East Bay Municipal Utility District operations on the Mokelumne River.

15. Implementation of May 2003 CVPIA 3406 (b)(2) decision and other changes:
    a. Streamlining actions to simplify analysis of the results.

b. Anadromous Fish Restoration Program table updates to better represent management of (b)(2) water under the May 2003 (b)(2) decision.
c. Action triggering modifications to attempt to meet 200 thousand-acre feet target during October through January period.

16. Environmental Water Account (EWA) changes include:
    a. Streamlining actions and coordination with (b)(2) actions.
    b. EWA purchase amount increase to a maximum of 250 thousand acre-feet per year.
    c. Addition of storage debt carryover accounting, including debt spill at San Luis Reservoir.
    d. Addition of EWA asset takeover by SWP and CVP at San Luis Reservoir when reservoir space utilized by EWA is needed for project operations.

All studies assume current Banks Pumping Plant capacity, existing conveyance capacity of the upper Delta-Mendota Canal/California Aqueduct system, and current SWP/CVP operations agreements.

The following table is a complete list of the study assumptions.

Table A-1 2005 Delivery Reliability Report CalSim II Modeling Assumptions

	Study 1 2001 Study, 2003 Report	Study 4 2005 Study, Updated Studies	Study 2 2021A Study, 2003 Report	Study 3 2021B Study, 2003 Report	Study 5 2025 Study, Updated Studies
Period of Simulation	73 years (1922-1994)	Same	Same	Same	Same
HYDROLOGY					
Level of Development (Land Use)	2001 Level, DWR Bulletin 160-98[1]	Same as Study 1	2020 Level, DWR Bulletin 160-98	Same as Study 2	Same as Study 2
Demands					
North of Delta (except American River)					
CVP	Land Use based, limited by Full Contract	Same	Same	Same	Same
SWP (FRSA)	Land Use based, limited by Full Contract	Same	Same	Same	Same
Non-Project	Land Use based	Same	Same	Same	Same
CVP Refuges	Firm Level 2	Same	Same	Same	Same
American River Basin					
Water rights	2001[2]	2001[3]	2020[4]	Same as Study 2	2020, as projected by Water Forum Analysis[5]
CVP	2001[2]	2001[3]	2020[6]	Same as Study 2	202 0, as projected by Water Forum Analysis[7]
San Joaquin River Basin					
Friant Unit	Regression of historical	Same	Same	Same	Same
Lower Basin	Fixed annual demands	Same	Same	Same	Same
Stanislaus River Basin	New Melones Interim Operations Plan	Same	Same	Same	Same
South of Delta					
CVP	Full Contract	Same	Same	Same	Same
CCWD	143 TAF/YR[8]	124 TAF/YR[8]	151 TAF/YR[8]	Same as Study 2	158 TAF/YR[8]

Table A-1 2005 Delivery Reliability Report CalSim II Modeling Assumptions (cont.)

	Study 1 2001 Study, 2003 Report	Study 4 2005 Study, Updated Studies	Study 2 2021A Study, 2003 Report	Study 3 2021B Study, 2003 Report	Study 5 2025 Study, Updated Studies
SWP (w/ North Bay Aqueduct)	3.0-4.1 MAF/YR	2.3-3.9 MAF/YR	3.3-4.1 MAF/YR	4.1 MAF/YR	3.9-4.1 MAF/YR
SWP Article 21 Demand	MWDSC up to 50 TAF/month, Dec-Mar, others up to 84 TAF/month	MWDSC up to 100 TAF/ month, Dec-Mar, others up to 84 TAF/month	Same as Study 1	Same as Study 1	Same as Study 4
FACILITIES					
Freeport Regional Water Project	None	Same as Study 1	Same as Study 1	Same as Study 1	Included[9]
Banks Pumping Capacity	6680 cfs	Same	Same	Same	Same
Tracy Pumping Capacity	4200 cfs + deliveries upstream of DMC constriction	Same	Same	Same	Same
REGULATORY STANDARDS					
Trinity River					
Minimum Flow below Lewiston Dam	Trinity EIS Preferred Alternative (369-815 TAF/YR)	369-453 TAF/YR	Same as Study 1	Same as Study 1	Same as Study 1
Trinity Reservoir End-of-September Minimum Storage	Trinity EIS Preferred Alternative (600 TAF as able)	Same	Same	Same	Same
Clear Creek					
Minimum Flow below Whiskeytown Dam	Downstream water rights, 1963 USBR Proposal to FWS and NPS, and FWS use of CVPIA 3406(b)(2) water	Same	Same	Same	Same
Upper Sacramento River					
Shasta Lake End-of-September Minimum Storage	SWRCB WR 1993 Winter-run Biological Opinion (1900 TAF)	Same	Same	Same	Same

Table A-1 2005 Delivery Reliability Report CalSim II Modeling Assumptions (cont.)

	Study 1 2001 Study, 2003 Report	Study 4 2005 Study, Updated Studies	Study 2 2021A Study, 2003 Report	Study 3 2021B Study, 2003 Report	Study 5 2025 Study, Updated Studies
Minimum Flow below Keswick Dam	Flows for SWRCB WR 90-5 and 1993 Winter-run Biological Opinion temperature control, and FWS use of CVPIA 3406(b)(2) water	Same	Same	Same	Same
Feather River					
Minimum Flow below Thermalito Diversion Dam	1983 DWR, DFG Agreement (600 CFS)	Same	Same	Same	Same
Minimum Flow below Thermalito Afterbay outlet	1983 DWR, DFG Agreement (750-1700 CFS)	Same	Same	Same	Same
American River					
Minimum Flow below Nimbus Dam	SWRCB D-893 (see accompanying Operations Criteria), and FWS use of CVPIA 3406(b)(2) water	Same	Same	Same	Same
Minimum Flow at H Street Bridge	SWRCB D-893	Same	Same	Same	Same
Lower Sacramento River					
Minimum Flow near Rio Vista	SWRCB D-1641	Same	Same	Same	Same
Mokelumne River					
Minimum Flow below Camanche Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (100-325 CFS)	Same	Same	Same	Same
Minimum Flow below Woodbridge Diversion Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (25-300 CFS)	Same	Same	Same	Same
Stanislaus River					
Minimum Flow below Goodwin Dam	1987 USBR, DFG agreement, and FWS use of CVPIA 3406(b)(2) water	Same	Same	Same	Same

Table A-1 2005 Delivery Reliability Report CalSim II Modeling Assumptions (cont.)

	Study 1 2001 Study, 2003 Report	Study 4 2005 Study, Updated Studies	Study 2 2021A Study, 2003 Report	Study 3 2021B Study, 2003 Report	Study 5 2025 Study, Updated Studies
Minimum Dissolved Oxygen	SWRCB D-1422	Same	Same	Same	Same
Merced River					
Minimum Flow below Crocker-Huffman Diversion Dam	Davis-Grunsky (180-220 CFS, Nov-Mar), and Cowell Agreement	Same	Same	Same	Same
Minimum Flow at Shaffer Bridge	FERC 2179 (25-100 CFS)	Same	Same	Same	Same
Tuolumne River					
Minimum Flow at Lagrange Bridge	FERC 2299-024, 1995 (Settlement Agreement) (94-301 TAF/YR)	Same	Same	Same	Same
San Joaquin River					
Maximum Salinity near Vernalis	SWRCB D-1641	Same	Same	Same	Same
Minimum Flow near Vernalis	SWRCB D-1641, and Vernalis Adaptive Management Program per San Joaquin River Agreement	Same	Same	Same	Same
Sacramento River-San Joaquin River Delta					
Delta Outflow Index (Flow and Salinity)	SWRCB D-1641	Same	Same	Same	Same
Delta Cross Channel Gate Operation	SWRCB D-1641	Same	Same	Same	Same
Delta Exports	SWRCB D-1641, FWS use of CVPIA 3406(b)(2) water and CALFED Fisheries Agencies use of EWA assets	Same	Same	Same	Same
OPERATIONS CRITERIA					
Subsystem					
Upper Sacramento River					
Flow Objective for Navigation (Wilkins Slough)	3,500-5,000 CFS based on Lake Shasta storage condition	3,250-5,000 CFS based on CVP Ag allocation levels	Same as Study 1	Same as Study 1	Same as Study 4

Table A-1 2005 Delivery Reliability Report CalSim II Modeling Assumptions (cont.)

	Study 1 2001 Study, 2003 Report	Study 4 2005 Study, Updated Studies	Study 2 2021A Study, 2003 Report	Study 3 2021B Study, 2003 Report	Study 5 2025 Study, Updated Studies
American River					
Folsom Dam Flood Control	SAFCA, Interim re-operation of Folsom Dam, Variable 400/670 (without outlet modifications)	Same	Same	Same	Same
Flow below Nimbus Dam	Operations criteria corresponding to SWRCB D-893 required minimum flow	Same	Same	Same	Same
Sacramento Water Forum Mitigation Water	None	Same as Study 1	Sacramento Water Forum (up to 47 TAF/YR in dry years)[10]	Same as Study 2	Same as Study 2
Feather River					
Flow at Mouth	No criteria	Maintain the DFG/DWR flow target above Verona or 2800 cfs for Apr-Sep dependent on Oroville inflow and FRSA allocation	Same as Study 1	Same as Study 1	Same as Study 4
Stanislaus River					
Flow below Goodwin Dam	1997 New Melones Interim Operations Plan	Same	Same	Same	Same
San Joaquin River					
Flow near Vernalis	San Joaquin River Agreement in support of the Vernalis Adaptive Management Program	Same	Same	Same	Same
System-wide					
CVP Water Allocation					
CVP Settlement and Exchange	100% (75% in Shasta Critical years)	Same	Same	Same	Same
CVP Refuges	100% (75% in Shasta Critical years)	Same	Same	Same	Same

Table A-1 2005 Delivery Reliability Report CalSim II Modeling Assumptions (cont.)

	Study 1 2001 Study, 2003 Report	Study 4 2005 Study, Updated Studies	Study 2 2021A Study, 2003 Report	Study 3 2021B Study, 2003 Report	Study 5 2025 Study, Updated Studies
CVP Agriculture	100% - 0% based on supply (reduced by 3406(b)(2) allocation)	Same	Same	Same	Same
CVP Municipal & Industrial	100% - 50% based on supply (reduced by 3406(b)(2) allocation)	Same	Same	Same	Same
SWP Water Allocation					
North of Delta (FRSA)	Contract specific	Same	Same	Same	Same
South of Delta	Based on supply; Monterey Agreement	Same	Same	Same	Same
CVP/SWP Coordinated Operations					
Sharing of Responsibility for In-Basin-Use	1986 Coordinated Operations Agreement	Same	Same	Same	Same
Sharing of Surplus Flows	1986 Coordinated Operations Agreement	Same	Same	Same	Same
Sharing of Restricted Export Capacity	Equal sharing of export capacity under SWRCB D-1641; use of CVPIA 3406(b)(2) only restricts CVP exports; EWA use restricts CVP and/or SWP exports as directed by CALFED Fisheries Agencies	Same	Same	Same	Same
Transfers					
Dry Year Program	None	Same	Same	Same	Same
Phase 8	None	Same	Same	Same	Same
MWDSC/CVP Settlement Contractors	None	Same	Same	Same	Same

Table A-1 2005 Delivery Reliability Report CalSim II Modeling Assumptions (cont.)

	Study 1 2001 Study, 2003 Report	Study 4 2005 Study, Updated Studies	Study 2 2021A Study, 2003 Report	Study 3 2021B Study, 2003 Report	Study 5 2025 Study, Updated Studies
CVP/SWP Integration					
Dedicated Conveyance at Banks	None	Same	Same	Same	Same
NOD Accounting Adjustments	None	Same	Same	Same	Same
CVPIA 3406(b)(2)	May 2002 benchmark study assumptions	Dept of Interior 2003 Decision	Same as Study 1	Same as Study 1	Same as Study 4
Allocation	800 TAF/YR (600 TAF/YR in Shasta Critical years)	800 TAF/YR, 700 TAF/YR in 40-30-30 Dry Years, and 600 TAF/YR in 40-30-30 Critical years	Same as Study 1	Same as Study 1	Same as Study 4
Actions	AFRP flow objectives (Oct-Jan), CVP export reduction (Dec-Jan), 1995 WQCP (up to 450 TAF/YR), VAMP (Apr 15- May 16) CVP export restriction, Post (May 16-31) VAMP CVP export restriction, Ramping of CVP export (Jun), Pre (Apr 1-15) VAMP CVP export restriction, CVP export reduction (Feb-Mar), Additional Upstream Releases (Feb-Sep)	1995 WQCP, Fish flow objectives (Oct-Jan), VAMP (Apr 15- May 16) CVP export restriction, 3000 CFS CVP export limit in May and June (D1485 Striped Bass continuation), Post (May 16-31) VAMP CVP export restriction, Ramping of CVP export (Jun), Upstream Releases (Feb-Sep)	Same as Study 1	Same as Study 1	Same as Study 4
Accounting adjustments per May 2003 Interior Decision	None	No limit on responsibility for non-discretionary D1641 requirements no Reset with the Storage metric and no Offset with the Release and Export metrics	Same as Study 1	Same as Study 1	Same as Study 4

Table A-1 2005 Delivery Reliability Report CalSim II Modeling Assumptions (cont.)

	Study 1 2001 Study, 2003 Report	Study 4 2005 Study, Updated Studies	Study 2 2021A Study, 2003 Report	Study 3 2021B Study, 2003 Report	Study 5 2025 Study, Updated Studies
CALFED Environmental Water Account					
Actions	Total exports restricted to 4,000 cfs, 1 wk/mon, Dec-Mar (wet year: 2 wk/mon), VAMP (Apr 15- May 16) export restriction, Pre (Apr 1-15) and Post (May 16-31) VAMP export restriction, Ramping of export (Jun)	Dec-Feb reduce total exports by 50 TAF/month relative to total exports without EWA; VAMP (Apr 15- May 16) export restriction on SWP; Post (May 16-31) VAMP export restriction on SWP and potentially on CVP if B2 Post-VAMP action is not taken; Ramping of exports (Jun)	Same as Study 1	Same as Study 1	Same as Study 4
Assets	50% of use of JPOD, 50% of any CVPIA 3406(b)(2) or ERP releases pumped by SWP, flexing of Delta Export/Inflow Ratio (not explicitly modeled), dedicated 500 CFS increase of Jul-Sep Banks PP capacity, north-of-Delta (35 TAF/Yr) and south-of-Delta purchases (50-200 TAF/Yr), 100 TAF/Yr from south-of-Delta source shifting agreements, and 200 TAF/YR south-of-Delta groundwater storage capacity	Fixed Water Purchases 250 TAF/yr, 230 TAF/yr in 40-30-30 dry years, 210 TAF/yr in 40-30-30 critical years. The purchases range from 0 TAF in Wet Years to approximately 153 TAF in Critical Years NOD, and 57 TAF in Critical Years to 250 TAF in Wet Years SOD. Variable assets include the following: used of 50% JPOD export capacity, acquisition of 50% of any CVPIA 3406(b)(2) releases pumped by SWP, flexing of Delta Export/Inflow Ratio (post-processed from CalSim II results), dedicated 500 CFS pumping capacity at Banks in Jul-Sep	Same as Study 1	Same as Study 1	Same as Study 4

Table A-1 2005 Delivery Reliability Report CalSim II Modeling Assumptions (cont.)

	Study 1 2001 Study, 2003 Report	Study 4 2005 Study, Updated Studies	Study 2 2021A Study, 2003 Report	Study 3 2021B Study, 2003 Report	Study 5 2025 Study, Updated Studies
Debt restrictions	No planned carryover of debt past Sep, no reset of unpaid debt, debt carried past Sep paid back by Feb	Delivery debt paid back in full upon assessment; Storage debt paid back over time based on asset/action priorities; SOD and NOD debt carryover is allowed; SOD debt carryover is explicitly managed or spilled; NOD debt carryover must be spilled; SOD and NOD asset carryover is allowed.	Same as Study 1	Same as Study 1	Same as Study 4

[1] 2000 Level of Development defined by linearly interpolated values from the 1995 Level of Development and 2020 Level of Development from DWR Bulletin 160-98

[2] 1998 level demands defined in Sacramento Water Forum's EIR with a few updated entries.

[3] Presented in attached Table 2001 American River Demand Assumptions

[4] Sacramento Water Forum 2025 level demands defined in Sacramento Water Forum's EIR.

[5] Presented in attached Table 2020 American River Demand Assumptions

[6] Sacramento Water Forum 2025 level demands defined in Sacramento Water Forum's EIR. Freeport Alternative defined in EBMUD Supplemental Water Supply Project REIR/SEIS.

[7] Same as footnote 5 but modified with PCWA 35 TAF CVP contract supply diverted at the new American River PCWA Pump Station

[8] Delta diversions include operations of Los Vaqueros Reservoir and represents average annual diversion

[9] Includes modified EBMUD operations of the Mokelumne River

[10] This is implemented only in the PCWA Middle Fork Project releases used in defining the CALSIM II inflows to Folsom Lake

Table A-2 2001 American River Demand Assumptions

Location / Purveyor	Allocation Type (maximum acre-feet)					
	CVP AG	CVP MI	CVP Set-tlement / Exchange	Water Rights / Non-CVP / No Cuts	CVP Refuge	Total
Auburn Dam Site (D300)						
Placer County Water Agency	0	0	0	8,500	0	8,500
Total	**0**	**0**	**0**	**8,500**	**0**	**8,500**
Folsom Reservoir (D8)						
Sacramento Suburban	0	0	0	0	0	0
City of Folsom (includes P.L. 101-514)	0	0	0	20,000	0	20,000
Folsom Prison	0	0	0	2,000	0	2,000
San Juan Water District (Placer County)	0	0	0	10,000	0	10,000
San Juan Water District (Sacramento County) (includes P.L. 101-514)	0	11,200	0	33,000	0	44,200
El Dorado Irrigation District	0	7,550	0	0	0	7,550
El Dorado Irrigation District (P.L. 101-514)	0	0	0	0	0	0
City of Roseville	0	32,000	0	0	0	32,000
Placer County Water Agency	0	0	0	0	0	0
Total	**0**	**50,750**	**0**	**65,000**	**0**	**115,750**
Folsom South Canal (D9)						
So. Cal WC/ Arden Cordova WC	0	0	0	3,500	0	3,500
California Parks and Recreation	0	100	0	0	0	100
SMUD (export)	0	0	0	15,000	0	15,000
South Sacramento County Agriculture (export, SMUD transfer)	0	0	0	0	0	0
Canal Losses	0	0	0	1,000	0	1,000
Total	**0**	**100**	**0**	**19,500**	**0**	**19,600**
Nimbus to Mouth (D302)						
City of Sacramento	0	0	0	63,335	0	63,335
Arcade Water District	0	0	0	2,000	0	2,000
Carmichael Water District	0	0	0	8,000	0	8,000
Total	**0**	**0**	**0**	**73,335**	**0**	**73,335**
Sacramento River (D162)						
Placer County Water Agency	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**
Sacramento River (D167/D168)						
City of Sacramento	0	0	0	38,665	0	38,665
Sacramento County Water Agency (SMUD transfer)	0	0	0	0	0	0
Sacramento County Water Agency (P.L. 101-514)	0	0	0	0	0	0
EBMUD (export)	0	0	0	0	0	0
Total	**0**	**0**	**0**	**38,665**	**0**	**38,665**
Total from the American River	**0**	**50,850**	**0**	**166,335**	**0**	**217,185**

Table A-3 2020 American River Demand Assumptions

Location / Purveyor	Allocation Type (maximum acre-feet)						Folsom Unimpaired Inflow (FUI)			Notes
	CVP AG	CVP MI	CVP Settlement / Exchange	Water Rights / Non-CVP / No Cuts	CVP Refuge	Total	FUI = Total TAF (Mar – Sep) + 60 TAF			
Auburn Dam Site (D300)										
Placer County Water Agency	0	35,000	0	35,500	0	70,500	70,500	70,500	70,500	1/2/3/12
Total	**0**	**35,000**	**0**	**35,500**	**0**	**70,500**	**70,500**	**70,500**	**70,500**	
Folsom Reservoir (D8)										
Sacramento Suburban	0	0	0	29,000	0	29,000	29,000	0	0	4/5/11
City of Folsom (includes P.L. 101-514)	0	7,000	0	27,000	0	34,000	34,000	34,000	20,000	1/2/3
Folsom Prison	0	0	0	5,000	0	5,000	5,000	5,000	5,000	
San Juan Water District (Placer County)	0	0	0	25,000	0	25,000	25,000	25,000	10,000	1/2/3/11
San Juan Water District (Sac County) (includes P.L. 101-514)	0	24,200	0	33,000	0	57,200	57,200	57,200	44,200	1/2/3
El Dorado Irrigation District	0	7,550	0	17,000	0	24,550	24,550	24,550	22,550	1/2/3
El Dorado Irrigation District (P.L. 101-514)	0	7,500	0	0	0	7,500	7,500	7,500	0	1/2/3
City of Roseville	0	32,000	0	30,000	0	62,000	54,900	54,900	39,800	1/2/3/11/12
Placer County Water Agency	0	0	0	0	0	0	0	0	0	11
Total	**0**	**78,250**	**0**	**166,000**	**0**	**244,250**	**237,150**	**208,150**	**141,550**	
Folsom South Canal (D9)										
So. Cal WC/ Arden Cordova WC	0	0	0	5,000	0	5,000	5,000	5,000	5,000	
California Parks and Recreation	0	5,000	0	0	0	5,000	5,000	5,000	5,000	
SMUD (export)	0	15,000	0	15,000	0	30,000	30,000	30,000	15,000	1/2/3
South Sacramento County Agriculture (export, SMUD transfer)	0	0	0	0	0	0	0	0	0	1/2/3
Canal Losses	0	0	0	1,000	0	1,000	1,000	1,000	1,000	
Total	**0**	**20,000**	**0**	**21,000**	**0**	**41,000**	**41,000**	**41,000**	**26,000**	
Nimbus to Mouth (D302)										
City of Sacramento	0	0	0	96,300	0	96,300	96,300	96,300	50,000	6/7/8

Table A-3 2020 American River Demand Assumptions (cont.)

Location / Purveyor	Allocation Type (maximum acre-feet)						Folsom Unimpaired Inflow (FUI)			Notes
	CVP AG	CVP MI	CVP Settlement / Exchange	Water Rights / Non-CVP / No Cuts	CVP Refuge	Total	FUI = Total TAF (Mar – Sep) + 60 TAF			
Arcade Water District	0	0	0	11,200	0	11,200	11,200	11,200	3,500	13
Carmichael Water District	0	0	0	12,000	0	12,000	12,000	12,000	12,000	
Total	**0**	**0**	**0**	**119,500**	**0**	**119,500**	**119,500**	**119,500**	**65,500**	
Sacramento River (D162)										
Placer County Water Agency	0	0	0	0	0	0	0	0	0	
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	
Sacramento River (D167/D168)										
City of Sacramento	0	0	0	34,300	0	34,300	34,300	34,300	80,600	8
Sacramento County Water Agency (SMUD transfer)	0	30,000	0	0	0	30,000				10
Sacramento County Water Agency (P.L. 101-514)	0	15,000	0	0	0	15,000				10
EBMUD (export)	0	133,000	0	0	0	133,000				
Total	**0**	**178,000**	**0**	**34,300**	**0**	**212,300**	**34,300**	**34,300**	**80,600**	
Total demands from the American River	**0**	**133,250**	**0**	**342,000**	**0**	**475,250**	**468,150**	**439,150**	**303,550**	

Notes

[1] Wet/average years for this diverter are defined as those years when the projected March through November unimpaired inflow to Folsom Reservoir is greater than 950,000 af.

[2] Drier years for this diverter are defined as those years when the projected March through November unimpaired inflow to Folsom Reservoir is less than 950,000 af but greater than 400,000 af.

[3] Driest years for this diverter are defined as those years when the projected March through November unimpaired inflow to Folsom Reservoir is less than 400,000 af.

[4] Wet/average years for this diverter are defined as those years when the projected March through November unimpaired inflow to Folsom Reservoir is greater than 1,600,000 af.

[5] Drier years for this diverter are defined as those years when the projected March through November unimpaired inflow to Folsom Reservoir is less than 1,600,000 af.

[6] Wet/average years as it applies to the City of Sacramento are time periods when the flows bypassing the E. A. Fairbairn Water Treatment Plant diversion exceed the "Hodge flows."

[7] Drier years are time periods when the flows bypassing the City's E.A. Fairbairn Water Treatment Plant diversion do not exceed the "Hodge flows."

[8] For modeling purposes, it is assumed that the City of Sacramento's total annual diversions from the American and Sacramento River in year 2030 would be 130,600 af.

[10] The total demand for Sacramento County Water Agency would be up to 78,000 af. The 45,000 af represents firm entitlements; the additional 33,000 af of demand is expected to be met by intermittent surplus supply. The intermittent supply is subject to Reclamation reduction (50%) in dry years.

[11] Water Rights Water provided by releases from PCWA's Middle Fork Project; inputs into upper American River model must be consistent with these assumptions.

[12] Demand requires "Replacement Water" as indicated below

[13] Arcade WD demand modeled as step function: one demand when FUI > 400, another demand when FUI < 400.

Appendix B. Results of Report Studies

A study to estimate the supply reliability of the State Water Project is done using a computer program that simulates the operation of the SWP on a monthly basis over a 73-year historical record of rainfall and runoff (1922–1994). The simulation model integrates all the relevant water resource components and calculates key water management parameters, such as:

- the amount of water released from reservoirs in the Sacramento-San Joaquin valleys,
- the amount of water required to maintain Delta water quality standards,
- the amount of water to be pumped from the Delta by the SWP and the Central Valley Project (CVP), and
- the amount of water that can be delivered by each of these projects.

The information required to run the simulation is referred to as the "model input." The most significant categories of input are:

- the physical description of the water system facilities (maximum pumping or release capacity, maximum reservoir storages, etc.);
- institutional requirements (delivery contract requirements, Delta water quality standards, the operations agreement between the SWP and CVP, endangered species requirements, and other requirements of federal and state laws, etc);
- hydrology (river and stream flows adjusted for water use in the source areas); and
- the level of SWP water demand.

CalSim II is the current version of the computer simulation model used to estimate SWP delivery reliability. All versions of CalSim employ commercially available linear programming software as a solution device. The application of the software, graphical user interface, and input/output devices are discussed in the documentation for CalSim.

The model studies selected for this report answer two questions.

1. "What is the estimated current delivery reliability of the SWP?" and
2. "What is the estimate for SWP deliveries in the year 2025, if there were no new facilities or improvements to existing facilities, SWP water demand increased, and the institutional requirements existing today were in place?"

The key study assumptions are shown in Table B-1 and listed in more detail in Chapter 4 and Appendix A. Additional discussions of these studies are on DWR's Modeling Branch's Website for the SWP Delivery Reliability Report 2002 (DWR 2003) studies and on the US Bureau of Reclamation's Website for Operations Criteria and Plan (OCAP) studies (http://modeling.water.ca.gov/hydro/studies/SWPReliability/index.html and http://www.usbr.gov/mp/cvo/ocap_page.html, respectively).

Study Results

The annual delivery amounts calculated by the supply reliability studies are contained in Tables B-3 through B-7 at the back of this appendix. The tables show the demand level in thousand acre-feet (taf), the amount of delivery from the Delta, and percent of full Delta Table A calculated for each year of simulation for the five studies. Delta Table A refers to the total of the Table A amounts for each of the SWP contractors receiving water from the Delta. Of the 29 SWP contractors, 26 receive their deliveries from the Delta. The total maximum Table A amount for all SWP contractors is 4.173 maf/year. Of this amount, 4.133 maf/yr is the maximum Delta Table A amount.

Table B-1 Key study assumptions

Study	Study name	Level of development (year)	SWP Table A demand (maf/year)	SWP Article 21 demand (taf/month)	Model version
SWP Delivery Reliability Report (2003)					
1	2001 Study	2001	3.0–4.1	0–84, Apr–Nov 50–134, Dec–Mar	May 2002 benchmark
2	2021A Study	2021	3.3–4.1	0–84, Apr–Nov 50–134, Dec–Mar	May 2002 benchmark
3	2021B Study	2021	4.1	0–84, Apr–Nov 50–134, Dec–Mar	May 2002 benchmark
Updated Studies					
4	2005 Study	2005	2.3–3.9	0–84, Apr–Nov 100–184, Dec–Mar	2004 OCAP
5	2025 Study	2025	3.9–4.1	0–84, Apr–Nov 100–184, Dec–Mar	2004 OCAP

maf = million acre-feet
OCAP = 2004 Long-Term Central Valley Project Operations Criteria and Plan
taf = thousand acre-feet

Table B-2 SWP average and dry year Table A delivery from the Delta for studies 4 and 5

Year	SWP Table A delivery from the Delta (in percent of maximum Table A)					
	Average 1922-1994	Single dry year 1977	2-year drought 1976-1977	4-year drought 1931-1934	6-year drought 1987-1992	6-year drought 1929-1934
2005	68%	4%	41%	32%	42%	37%
2025	77%	5%	40%	33%	42%	38%

To simplify the use of this report, the calculation of delivery in percent of full Delta Table A is based on the maximum Delta Table A total of 4.133 maf for all five studies. The demands for studies 1 and 4 were developed assuming slightly earlier conditions when the maximum Delta Table A amounts totaled slightly less than 4.133 maf (4.114 maf and 4.112 maf, respectively). To show the effect of these minor differences in Table A totals, the annual deliveries in percent of full Delta Table A for study 1 (Table B-3) are calculated with the earlier Delta Table A total of 4.114 maf and also with the maximum Delta Table A total of 4.133 maf. Similarly, study 4 results in Table B-6 are calculated with the earlier and maximum Delta Table A totals. The tables show that most years have the same delivery percentage for both Table A totals.

These values must be interpreted within the confines of the assumptions upon which they are calculated. For example, for the year 1958 in study 5, the annual delivery is calculated to be 4,133 taf or 100 percent of maximum Delta Table A (see Table B-7). This result should be stated as follows:

If the rainfall were the same as it was in 1958 but (1) the level of water use in the source area was increased to the level it would be in 2025; (2) SWP facilities and operation requirements were the same as they are today; and (3) SWP contractor demands were at their maximum Delta Table A level, the SWP would deliver approximately 4,133 taf or 100 percent of the maximum Delta Table A.

Actually, the conditional statement associated with the result for any particular year is even more complicated than this because the result is also dependent upon the rainfall that has occurred in previous years. For example, if the previous year (1957) were wet, runoff for 1958 for the same amount of rainfall would be greater than if 1957 were dry. In addition, reservoir storage for the beginning of 1958 would vary depending upon the weather conditions in

1957. This linkage makes each year's simulation dependent on the previous year's and, hence, links the entire historical series.

Table B-2 contains a summary of the delivery estimates for the SWP for important dry periods in history computed by the studies. Studies 4 and 5 were selected to represent the estimated 2005 and 2025 deliveries, respectively. This information can be helpful in analyzing the delivery reliability of a specific water system that receives a portion of its water supply from the SWP. The series of data contained in Tables B-3 through B-7 are also helpful in analyzing longer periods of time that contain not only dry periods but wetter periods, which can replenish water supplies.

Finally, to help analyze the chance of receiving a given level of delivery in any particular year, a probability distribution curve is useful. It simply shows the percent of the years the annual delivery estimate is at or above a given value. The probability distribution curves for the five studies are included as figures B-1 and B-2. For example, for study 5 (Figure B-2), the curve indicates that in 75 percent of the years, the annual delivery reliability is estimated to be at or above 65 percent of the maximum Delta Table A amount or 2.70 maf. Similarly, annual delivery reliability during 50 percent of the years is estimated to be at or above 85 percent of the maximum Delta Table A or 3.50 maf. The curve also shows that in 25 percent of the years, annual delivery reliability is estimated to be at 100 percent of the maximum Delta Table A.

Table B-3 SWP water delivery from the Delta for Study 1 (taf)

Year	Model variable Table A demand	Model Table A delivery	Percent of maximum Table A - 4.114 maf	Percent of future maximum Table A - 4.133 maf	Model Article 21 supply
1922	3,407	3,389	82%	82%	175
1923	3,717	3,727	91%	90%	143
1924	3,961	1,014	25%	25%	0
1925	3,940	1,502	36%	36%	0
1926	3,777	2,951	72%	71%	0
1927	3,543	3,504	85%	85%	220
1928	3,897	3,337	81%	81%	155
1929	3,952	1,037	25%	25%	0
1930	3,922	2,697	66%	65%	92
1931	3,971	1,141	28%	28%	0
1932	3,673	1,620	39%	39%	199
1933	3,939	1,663	40%	40%	134
1934	3,981	1,689	41%	41%	0
1935	3,697	3,439	84%	83%	81
1936	3,769	3,638	88%	88%	0
1937	3,451	3,297	80%	80%	87
1938	3,418	3,439	84%	83%	470
1939	3,673	3,475	84%	84%	227
1940	3,713	3,544	86%	86%	102
1941	3,013	3,036	74%	73%	100
1942	3,583	3,599	87%	87%	513
1943	3,632	3,545	86%	86%	447
1944	3,563	3,449	84%	83%	0
1945	3,613	3,479	85%	84%	136
1946	3,710	3,724	91%	90%	3
1947	3,954	2,653	64%	64%	0
1948	3,959	2,681	65%	65%	2
1949	3,864	2,568	62%	62%	2
1950	3,812	2,909	71%	70%	0
1951	3,779	3,794	92%	92%	311
1952	3,078	3,108	76%	75%	103
1953	3,790	3,801	92%	92%	272
1954	3,833	3,803	92%	92%	98
1955	3,761	1,694	41%	41%	0
1956	3,639	3,649	89%	88%	261
1957	3,759	3,331	81%	81%	96
1958	3,481	3,492	85%	84%	441
1959	4,055	3,506	85%	85%	265
1960	4,114	1,795	44%	43%	0
1961	4,114	2,873	70%	70%	0
1962	3,689	3,158	77%	76%	21
1963	3,634	3,630	88%	88%	223
1964	3,907	3,262	79%	79%	5
1965	3,586	3,256	79%	79%	98
1966	3,722	3,731	91%	90%	147
1967	3,439	3,424	83%	83%	497
1968	3,792	3,548	86%	86%	402
1969	3,157	3,151	77%	76%	100
1970	3,714	3,727	91%	90%	406
1971	3,837	3,845	93%	93%	0
1972	4,012	3,057	74%	74%	2
1973	3,611	3,592	87%	87%	261
1974	3,650	3,664	89%	89%	297
1975	3,720	3,737	91%	90%	415
1976	4,014	3,150	77%	76%	110
1977	3,948	804	20%	19%	0
1978	3,126	3,036	74%	73%	100
1979	3,527	3,509	85%	85%	140
1980	3,197	3,208	78%	78%	100
1981	3,834	3,532	86%	85%	124
1982	3,451	3,471	84%	84%	386
1983	3,007	3,036	74%	73%	200
1984	3,692	3,706	90%	90%	408
1985	3,753	3,540	86%	86%	0
1986	3,345	3,023	73%	73%	51
1987	3,905	2,894	70%	70%	0
1988	4,026	968	24%	23%	0
1989	4,097	2,903	71%	70%	0
1990	3,961	1,101	27%	27%	0
1991	3,957	983	24%	24%	0
1992	3,880	1,199	29%	29%	0
1993	3,559	3,505	85%	85%	133
1994	3,739	3,272	80%	79%	9
Average	3,712	2,962	72%	72%	134
Maximum	4,114	3,845	93%	93%	513
Minimum	3,007	804	20%	19%	0

Table B-4 SWP Water Delivery from the Delta for Study 2 (taf)

Year	Model variable Table A demand	Model Table A delivery	Percent of maximum Table A - 4.133 maf	Model Article 21 supply
1922	4,133	4,043	98%	0
1923	4,133	3,670	89%	0
1924	3,980	972	24%	0
1925	4,133	1,445	35%	0
1926	4,133	2,856	69%	113
1927	4,133	4,032	98%	124
1928	4,133	3,255	79%	3
1929	3,971	1,070	26%	0
1930	4,133	2,734	66%	27
1931	4,133	1,086	26%	0
1932	4,116	1,855	45%	39
1933	4,133	1,966	48%	6
1934	4,133	1,564	38%	0
1935	3,907	3,562	86%	59
1936	4,133	3,655	88%	5
1937	4,133	3,189	77%	65
1938	4,133	4,128	100%	192
1939	3,948	3,443	83%	1
1940	4,133	3,856	93%	22
1941	3,481	3,472	84%	0
1942	3,881	3,894	94%	378
1943	4,120	3,591	87%	375
1944	3,711	3,443	83%	2
1945	3,948	3,574	86%	123
1946	3,969	3,772	91%	0
1947	3,973	2,602	63%	0
1948	4,133	2,587	63%	2
1949	3,996	2,656	64%	0
1950	4,133	2,895	70%	0
1951	4,094	3,994	97%	230
1952	3,510	3,538	86%	100
1953	4,063	3,989	97%	236
1954	4,133	3,830	93%	6
1955	3,995	1,735	42%	0
1956	4,133	4,127	100%	129
1957	4,029	3,069	74%	3
1958	3,942	3,910	95%	335
1959	4,133	3,477	84%	167
1960	4,133	2,021	49%	0
1961	4,133	2,815	68%	0
1962	3,933	3,153	76%	2
1963	4,133	4,046	98%	134
1964	4,030	3,050	74%	0
1965	3,966	3,234	78%	3
1966	4,046	3,844	93%	61
1967	4,033	3,979	96%	167
1968	4,128	3,583	87%	398
1969	3,583	3,556	86%	93
1970	4,004	3,929	95%	398
1971	4,133	4,082	99%	0
1972	4,133	2,727	66%	0
1973	4,119	3,699	89%	211
1974	4,090	4,107	99%	147
1975	4,113	4,088	99%	209
1976	4,032	2,789	67%	0
1977	4,133	830	20%	0
1978	3,898	3,706	90%	100
1979	4,133	3,512	85%	89
1980	3,751	3,462	84%	74
1981	4,133	3,400	82%	0
1982	4,009	4,027	97%	101
1983	3,343	3,370	82%	200
1984	4,061	4,079	99%	379
1985	3,905	3,326	80%	0
1986	3,898	3,011	73%	52
1987	3,923	2,837	69%	0
1988	4,045	992	24%	0
1989	4,133	2,895	70%	0
1990	4,133	1,151	28%	0
1991	4,133	999	24%	0
1992	4,133	1,155	28%	0
1993	4,133	4,018	97%	156
1994	4,133	3,042	74%	0
Average	4,026	3,083	75%	78
Maximum	4,133	4,128	100%	398
Minimum	3,343	830	20%	0

Table B-5 SWP Water Delivery from the Delta for Study 3 (taf)

Year	Model fixed Table A demand	Model Table A delivery	Percent of maximum Table A - 4.133 maf	Model Article 21 supply
1922	4,133	4,043	98%	0
1923	4,133	3,670	89%	0
1924	4,133	972	24%	0
1925	4,133	1,446	35%	0
1926	4,133	2,856	69%	113
1927	4,133	4,031	98%	124
1928	4,133	3,255	79%	3
1929	4,133	1,070	26%	0
1930	4,133	2,734	66%	27
1931	4,133	1,086	26%	0
1932	4,133	1,855	45%	39
1933	4,133	1,967	48%	6
1934	4,133	1,564	38%	0
1935	4,133	3,729	90%	59
1936	4,133	3,669	89%	0
1937	4,133	3,165	77%	71
1938	4,133	4,129	100%	197
1939	4,133	3,444	83%	1
1940	4,133	3,856	93%	22
1941	4,133	4,084	99%	0
1942	4,133	4,122	100%	75
1943	4,133	3,584	87%	318
1944	4,133	3,465	84%	3
1945	4,133	3,547	86%	123
1946	4,133	3,801	92%	0
1947	4,133	2,597	63%	0
1948	4,133	2,586	63%	2
1949	4,133	2,654	64%	0
1950	4,133	2,893	70%	0
1951	4,133	3,996	97%	222
1952	4,133	4,133	100%	14
1953	4,133	3,931	95%	244
1954	4,133	3,860	93%	33
1955	4,133	1,779	43%	0
1956	4,133	4,126	100%	111
1957	4,133	3,067	74%	3
1958	4,133	4,063	98%	306
1959	4,133	3,467	84%	97
1960	4,133	2,007	49%	0
1961	4,133	2,818	68%	0
1962	4,133	3,153	76%	2
1963	4,133	4,046	98%	134
1964	4,133	3,050	74%	0
1965	4,133	3,233	78%	3
1966	4,133	3,853	93%	56
1967	4,133	4,069	98%	115
1968	4,133	3,584	87%	398
1969	4,133	4,078	99%	13
1970	4,133	3,933	95%	358
1971	4,133	4,082	99%	0
1972	4,133	2,725	66%	0
1973	4,133	3,699	89%	211
1974	4,133	4,133	100%	143
1975	4,133	4,102	99%	211
1976	4,133	2,775	67%	0
1977	4,133	830	20%	0
1978	4,133	3,915	95%	100
1979	4,133	3,493	85%	98
1980	4,133	3,465	84%	75
1981	4,133	3,387	82%	0
1982	4,133	4,133	100%	63
1983	4,133	4,133	100%	160
1984	4,133	4,101	99%	369
1985	4,133	3,322	80%	0
1986	4,133	3,006	73%	62
1987	4,133	2,835	69%	0
1988	4,133	993	24%	0
1989	4,133	2,895	70%	0
1990	4,133	1,151	28%	0
1991	4,133	999	24%	0
1992	4,133	1,155	28%	0
1993	4,133	4,018	97%	156
1994	4,133	3,042	74%	0
Average	4,133	3,130	76%	68
Maximum	4,133	4,133	100%	398
Minimum	4,133	830	20%	0

Table B-6 SWP water delivery from the Delta for Study 4 (taf)

Year	Model variable Table A demand	Model Table A delivery	Percent of maximum Table A - 4.112 maf	Percent of future maximum Table A - 4.133 maf	Model Article 21 supply
1922	3,750	3,743	91%	91%	104
1923	3,251	3,251	79%	79%	106
1924	3,489	1,244	30%	30%	0
1925	3,353	1,870	45%	45%	0
1926	3,393	2,981	72%	72%	54
1927	3,860	3,845	93%	93%	213
1928	3,458	3,384	82%	82%	134
1929	2,907	1,108	27%	27%	0
1930	3,326	2,855	69%	69%	117
1931	2,933	1,018	25%	25%	0
1932	3,139	1,406	34%	34%	242
1933	3,427	1,330	32%	32%	512
1934	3,470	1,541	37%	37%	206
1935	3,798	3,769	92%	91%	229
1936	3,596	3,573	87%	86%	0
1937	3,492	3,362	82%	81%	80
1938	3,344	3,344	81%	81%	714
1939	3,262	3,262	79%	79%	349
1940	3,239	3,219	78%	78%	154
1941	2,526	2,527	61%	61%	246
1942	3,167	3,167	77%	77%	918
1943	3,104	3,104	75%	75%	623
1944	3,090	3,091	75%	75%	0
1945	3,112	3,101	75%	75%	359
1946	3,215	3,215	78%	78%	249
1947	3,422	3,292	80%	80%	0
1948	3,395	2,942	72%	71%	0
1949	3,313	2,264	55%	55%	0
1950	3,465	3,199	78%	77%	0
1951	3,497	3,497	85%	85%	388
1952	2,585	2,588	63%	63%	275
1953	3,323	3,323	81%	80%	513
1954	3,294	3,294	80%	80%	523
1955	3,228	2,207	54%	53%	0
1956	3,581	3,586	87%	87%	324
1957	3,235	3,235	79%	78%	257
1958	2,980	2,980	72%	72%	1,106
1959	3,547	3,480	85%	84%	366
1960	3,555	1,865	45%	45%	0
1961	3,580	2,659	65%	64%	97
1962	3,690	3,262	79%	79%	0
1963	3,823	3,818	93%	92%	202
1964	3,492	3,323	81%	80%	0
1965	3,059	3,059	74%	74%	177
1966	3,282	3,282	80%	79%	518
1967	2,950	2,946	72%	71%	923
1968	3,324	3,329	81%	81%	552
1969	2,636	2,632	64%	64%	275
1970	3,257	3,257	79%	79%	552
1971	3,341	3,341	81%	81%	0
1972	3,457	3,342	81%	81%	414
1973	3,097	3,092	75%	75%	384
1974	3,184	3,184	77%	77%	854
1975	3,229	3,229	79%	78%	903
1976	3,471	3,265	79%	79%	189
1977	3,421	159	4%	4%	0
1978	3,623	3,603	88%	87%	300
1979	3,512	3,501	85%	85%	160
1980	2,715	2,709	66%	66%	138
1981	3,358	3,358	82%	81%	546
1982	2,890	2,890	70%	70%	801
1983	2,497	2,498	61%	60%	400
1984	3,227	2,766	67%	67%	552
1985	3,214	3,214	78%	78%	0
1986	2,321	2,297	56%	56%	120
1987	2,896	2,896	70%	70%	546
1988	2,967	856	21%	21%	0
1989	3,551	3,174	77%	77%	0
1990	3,628	1,099	27%	27%	0
1991	3,425	1,052	26%	25%	0
1992	3,366	1,426	35%	34%	0
1993	3,862	3,848	94%	93%	159
1994	3,689	3,306	80%	80%	0
Average	3,290	2,818	69%	68%	262
Maximum	3,862	3,848	94%	93%	1,106
Minimum	2,321	159	4%	4%	0

Table B-7 SWP water delivery from the Delta for Study 5 (taf)

Year	Model variable Table A demand	Model Table A delivery	Percent of maximum Table A -4.133 maf	Model Article 21 supply
1922	4,133	4,133	100%	21
1923	4,133	4,133	100%	0
1924	4,133	382	9%	0
1925	4,133	1,491	36%	190
1926	4,133	2,721	66%	279
1927	4,133	4,133	100%	301
1928	4,133	3,379	82%	0
1929	4,133	1,118	27%	0
1930	4,133	2,738	66%	141
1931	4,133	1,072	26%	0
1932	4,133	1,572	38%	112
1933	4,133	1,337	32%	547
1934	4,133	1,471	36%	242
1935	4,133	4,061	98%	218
1936	4,133	3,729	90%	0
1937	4,133	3,369	82%	70
1938	4,133	4,133	100%	200
1939	4,133	3,450	83%	0
1940	4,133	4,116	100%	114
1941	3,898	3,908	95%	0
1942	4,133	4,133	100%	123
1943	4,133	3,787	92%	487
1944	4,133	3,542	86%	0
1945	4,133	3,889	94%	118
1946	4,133	3,828	93%	0
1947	4,133	2,771	67%	0
1948	4,133	2,940	71%	0
1949	4,133	2,025	49%	0
1950	4,133	3,400	82%	0
1951	4,133	4,133	100%	252
1952	3,898	3,912	95%	0
1953	4,133	4,133	100%	296
1954	4,133	4,133	100%	0
1955	4,133	1,505	36%	0
1956	4,133	4,133	100%	352
1957	4,133	3,565	86%	0
1958	4,133	4,133	100%	229
1959	4,133	3,787	92%	107
1960	4,133	1,607	39%	0
1961	4,133	2,712	66%	299
1962	4,133	3,311	80%	1
1963	4,133	4,133	100%	161
1964	4,133	2,889	70%	0
1965	4,133	3,465	84%	47
1966	4,133	4,133	100%	178
1967	4,133	4,133	100%	157
1968	4,133	3,797	92%	465
1969	3,898	3,910	95%	63
1970	4,133	4,122	100%	493
1971	4,133	4,133	100%	0
1972	4,133	2,721	66%	0
1973	4,133	4,032	98%	259
1974	4,133	4,133	100%	69
1975	4,133	4,133	100%	134
1976	4,133	3,137	76%	0
1977	4,133	187	5%	0
1978	3,898	3,902	94%	300
1979	4,133	3,773	91%	144
1980	3,898	3,513	85%	86
1981	4,133	3,797	92%	71
1982	4,133	4,133	100%	171
1983	3,898	3,909	95%	357
1984	4,133	4,133	100%	490
1985	4,133	3,413	83%	0
1986	3,898	2,857	69%	83
1987	4,133	3,307	80%	183
1988	4,133	423	10%	0
1989	4,133	3,513	85%	91
1990	4,133	855	21%	0
1991	4,133	850	21%	0
1992	4,133	1,461	35%	102
1993	4,133	4,133	100%	255
1994	4,133	3,153	76%	0
Average	4,110	3,178	77%	124
Maximum	4,133	4,133	100%	547
Minimum	3,898	187	5%	0

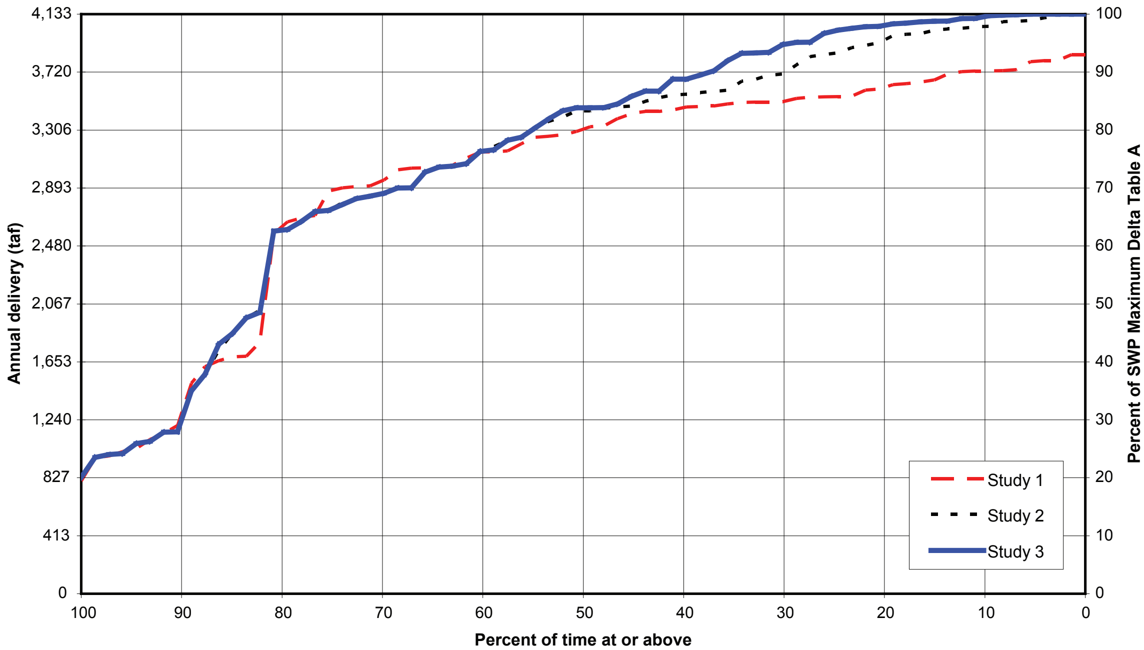

Figure B-1 SWP Delta Table A delivery probability for studies 1, 2 and 3

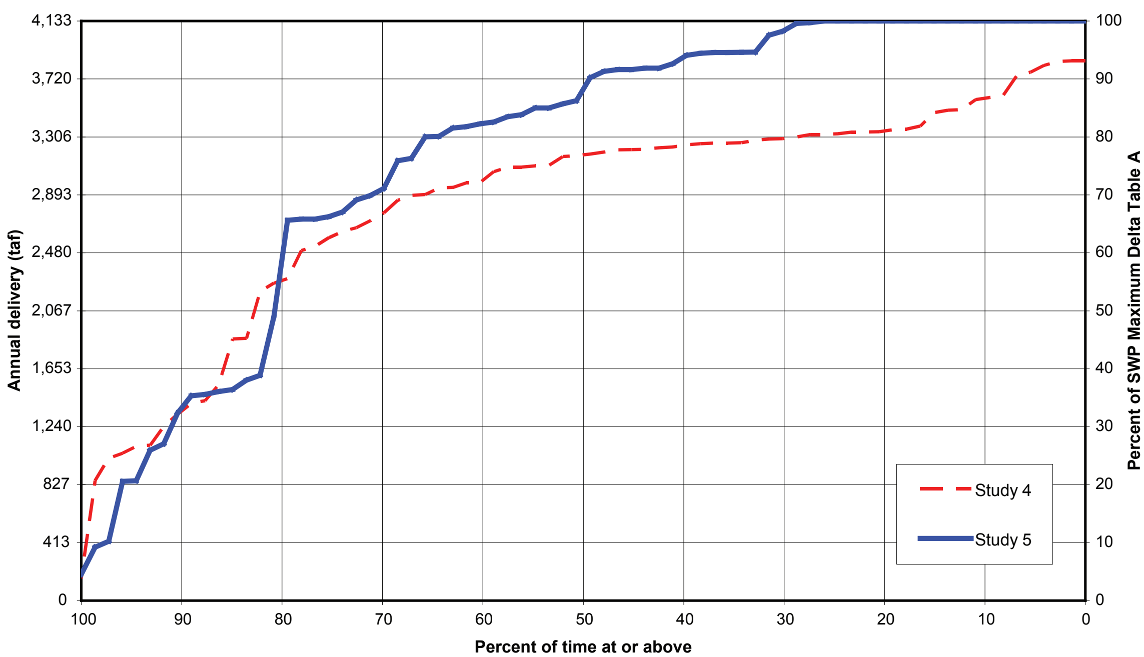

Figure B-2 SWP Delta Table A delivery probability for studies 4 and 5

Appendix C. State Water Project Table A Amounts

What is State Water Project Table A?

The contracts between the Department of Water Resources and the 29 State Water Project water contractors define the terms and conditions governing the water delivery and cost repayment for the SWP. Table A is an exhibit to these contracts. Comprehension of Table A is important in understanding the information in this report. To understand the table, it is necessary to understand how the contracts work.

All water-supply related costs of the SWP are paid by the contractors, and Table A serves as a basis for allocating some of the costs among the contractors. In addition, Table A plays a key role in the annual allocation of available supply among contractors. When the SWP was being planned, the amount of water projected to be available for delivery to the contractors was 4.2 million acre-feet (maf) per year. This was referred to as the minimum project yield, and it was recognized that in some years the project would be unable to deliver that amount and in other years project supply could exceed that amount. The 4.2 maf number was used as the basis for apportioning available supply to each contractor and as a factor in calculating each contractor's share of the project's costs. This apportionment is accomplished by Table A in each contract. Table A lists by year and acre-feet the portion of the 4.2 maf deliverable to each contractor. Other contract provisions permit changes to an individual contractor's Table A under special circumstances. The total of the maximums in all the contracts now equals 4.173 maf.

A copy of the consolidated Table A from all the contracts follows this explanation. The amounts listed in Table A cannot be viewed as an indication of the SWP water delivery reliability, nor should these amounts be used to support an expectation that a certain amount of water will be delivered to a contractor in any particular time span. Table A is simply a tool for apportioning available supply and cost obligations under the contract. In this report, reference to "Table A amounts" means the amounts listed in Table A. Contractors also receive other classifications of water from the project, as distinguished from Table A (for example, Article 21 water, and turnback pool water). These other contract provisions are discussed in Appendix D.

Table C-1 Maximum Annual SWP Table A Amounts

SWP Contractors	Maximum Table A
Delivered from the Delta	
North Bay	
Napa County FC&WCD	29,025
Solano County WA	47,756
Subtotal	**76,781**
South Bay	
Alameda County FC&WCD, Zone 7	80,619
Alameda County WD	42,000
Santa Clara Valley WD	100,000
Subtotal	**222,619**
San Joaquin Valley	
Oak Flat WD	5,700
County of Kings	9,305
Dudley Ridge WD	57,343
Empire West Side ID	3,000
Kern County WA	998,730
Tulare Lake Basin WSD	95,922
Subtotal	**1,170,000**
Central Coastal	
San Luis Obispo County FC&WCD	25,000
Santa Barbara County FC&WCD	45,486
Subtotal	**70,486**
Southern California	
Antelope Valley-East Kern WA	141,400
Castaic Lake WA	95,200
Coachella Valley WD	121,100
Crestline-Lake Arrowhead WA	5,800
Desert WA	50,000
Littlerock Creek ID	2,300
Mojave WA	75,800
Metropolitan WDSC	1,911,500
Palmdale WD	21,300
San Bernardino Valley MWD	102,600
San Gabriel Valley MWD	28,800
San Gorgonio Pass WA	17,300
Ventura County FCD	20,000
Subtotal	**2,593,100**
Delta Subtotal	**4,132,986**
Feather River	
County of Butte	27,500
Plumas County FC&WCD	2,700
City of Yuba City	9,600
Subtotal	**39,800**
Grand Total	**4,172,786**

Appendix D. Recent State Water Project Deliveries

SWP Contract Water Types

The State Water Project contracts define several classifications of water available for delivery to contractors under specific circumstances. All classifications are considered “project” water. Many contractors make frequent use of these additional water types to increase or decrease the amount available to them under Table A.

Table A Water

Each contract’s Table A is the amount in acre-feet that is used to determine the portion of available supply to be delivered to that contractor. Table A water is water delivered according to this apportionment methodology and is given first priority for delivery.

Article 21 Water

Article 21 of the contracts permits delivery of water excess to delivery of Table A and some other water types to those contractors requesting it. It is available under specific conditions discussed in Chapter 5. Article 21 water is apportioned to those contractors requesting it in the same proportion as their Table A.

Turnback Pool Water

Contractors may choose to offer their allocated Table A water excess to their needs to other contractors through two pools in February and March. Contributing contractors receive a reduction in charges, and taking contractors pay extra.

Carryover Water

Pursuant to the long-term water supply contracts, the Department of Water Resources (DWR) has offered contractors the opportunity to carry over a portion of their allocated water approved for delivery in the current year for delivery during the next year. The carryover program was designed to encourage the most effective and beneficial use of water and to avoid obligating the contractors to use or lose the water by December 31 of each year. The water supply contracts state the criteria of carrying over Table A water from one year to the next. Normally, carryover water is water that has been exported during the year, has not been delivered to the contractor during that year, and has remained stored in the SWP share of San Luis Reservoir to be delivered during the following year. Storage for carryover water no longer becomes available to the contractors if it interferes with storage of SWP water for project needs.

Updated Historical Deliveries

The tables in this appendix list annual historical deliveries by various water classifications for each contractor for 1995 through 2004. Similar delivery tables for years 1995 through 2002 are included in the *State Water Project Delivery Reliability Report 2002*. Amounts listed for these years are slightly different due to accounting adjustments made by DWR’s State Water Project Analysis Office.

Table D-1 Historical State Water Project Deliveries: 1995

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	203				203
Plumas County FC&WCD	308				308
City of Yuba City	910				910
Napa County FC&WCD	5,182				5,182
Solano County WA	21,345				21,345
Alameda County FC&WCD, Zone 7	30,091				30,091
Alameda County WD	17,793				17,793
Santa Clara Valley WD	28,756				28,756
Oak Flat WD	5,169				5,169
County of Kings	4,000				4,000
Dudley Ridge WD	57,700			2,986	60,686
Empire West Side ID	957	106		568	1,631
Kern County WA	1,089,063	59,671		2,795	1,151,529
Tulare Lake Basin WSD	71,679	4,553		25,637	101,869
Antelope Valley-East Kern WA	47,286				47,286
Castaic Lake WA (+Rch 31A, 5 & 7)	25,660			1,573	27,233
Coachella Valley WD	23,100				23,100
Crestline-Lake Arrowhead WA	409				409
Desert WA	38,100				38,100
Littlerock Creek ID	480				480
Mojave WA	3,722				3,722
Metropolitan WDSC	396,600			19,442	416,042
Palmdale WD	6,961				6,961
San Bernardino Valley MWD	696				696
San Gabriel Valley MWD	12,922				12,922
Totals	**1,889,092**	**64,330**	**0**	**53,001**	**2,006,423**
Total South of Delta	**1,887,671**	**64,330**	**0**	**53,001**	**2,005,002**

Table D-2 Historical State Water Project Deliveries: 1996

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	257				257
Plumas County FC&WCD	360				360
City of Yuba City	820				820
Napa County FC&WCD	4,893				4,893
Solano County WA	29,144			855	29,999
Alameda County FC&WCD, Zone 7	18,903				18,903
Alameda County WD	19,662				19,662
Santa Clara Valley WD	88,829			1,021	89,850
Oak Flat WD	4,904				4,904
County of Kings	4,000				4,000
Dudley Ridge WD	52,491	4,457			56,948
Empire West Side ID	1,371			497	1,868
Kern County WA	1,117,060	15,653		52,350	1,185,063
Tulare Lake Basin WSD	118,500	8,537	71,268	38,570	236,875
San Luis Obispo County FC&WCD	100				100
Antelope Valley-East Kern WA	56,356				56,356
Castaic Lake WA (+Rch 31A, 5 & 7)	32,500				32,500
Coachella Valley WD	23,100		39,119		62,219
Crestline-Lake Arrowhead WA	485				485
Desert WA	38,100		64,522		102,622
Littlerock Creek ID	494				494
Mojave WA	7,427				7,427
Metropolitan WDSC	553,259			40,121	593,380
Palmdale WD	11,434				11,434
San Bernardino Valley MWD	6,064				6,064
San Gabriel Valley MWD	15,989				15,989
Totals	**2,206,502**	**28,647**	**174,909**	**133,414**	**2,543,472**
Total South of Delta	**2,205,065**	**28,647**	**174,909**	**133,414**	**2,542,035**

Table D-3 Historical State Water Project Deliveries: 1997

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	185				185
Plumas County FC&WCD	231				231
City of Yuba City	1,005				1,005
Napa County FC&WCD	4,341				4,341
Solano County WA	35,530				35,530
Alameda County FC&WCD, Zone 7	27,522				27,522
Alameda County WD	24,063				24,063
Santa Clara Valley WD	95,601				95,601
Oak Flat WD	5,238				5,238
Dudley Ridge WD	51,623	7,141	12,544		71,308
Kern County WA	1,092,543	10,264			1,102,807
Tulare Lake Basin WSD	21,156	1,213			22,369
San Luis Obispo County FC&WCD	1,199				1,199
Santa Barbara County FC&WCD	7,439				7,439
Antelope Valley-East Kern WA	61,752	641			62,393
Castaic Lake WA (+Rch 31A, 5 & 7)	27,712				27,712
Coachella Valley WD	23,100		35,000		58,100
Crestline-Lake Arrowhead WA	651				651
Desert WA	38,100		15,000		53,100
Littlerock Creek ID	444				444
Mojave WA	10,374				10,374
Metropolitan WDSC	738,990				738,990
Palmdale WD	11,861				11,861
San Bernardino Valley MWD	9,654				9,654
San Gabriel Valley MWD	16,002	2,173			18,175
Ventura County FCD	1,850				1,850
Totals	**2,308,166**	**21,432**	**62,544**	**0**	**2,392,142**
Total South of Delta	**2,306,745**	**21,432**	**62,544**	**0**	**2,390,721**

Table D-4 Historical State Water Project Deliveries: 1998

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	527				527
City of Yuba City	1,054				1,054
Napa County FC&WCD	5,359				5,359
Solano County WA	21,377	9,982		407	31,766
Alameda County FC&WCD, Zone 7	17,941				17,941
Alameda County WD	19,075				19,075
Santa Clara Valley WD	62,526			884	63,410
Oak Flat WD	4,401				4,401
County of Kings	3	12			15
Dudley Ridge WD	52,919	984		1,747	55,650
Empire West Side ID				542	542
Kern County WA	856,906			1,684	858,590
Tulare Lake Basin WSD	11,367	9,310			20,677
San Luis Obispo County FC&WCD	3,592				3,592
Santa Barbara County FC&WCD	18,618				18,618
Antelope Valley-East Kern WA	52,926				52,926
Castaic Lake WA (+Rch 31A, 5 & 7)	20,093				20,093
Coachella Valley WD	23,100		55,000		78,100
Crestline-Lake Arrowhead WA	187				187
Desert WA	38,100		20,000		58,100
Littlerock Creek ID	404				404
Mojave WA	3,925				3,925
Metropolitan WDSC	359,213			33,672	392,885
Palmdale WD	8,752				8,752
San Bernardino Valley MWD	1,878				1,878
San Gabriel Valley MWD	9,310				9,310
Ventura County FCD	1,850				1,850
Totals	**1,595,403**	**20,288**	**75,000**	**38,936**	**1,729,627**
Total South of Delta	**1,593,822**	**20,288**	**75,000**	**38,936**	**1,728,046**

Table D-5 Historical State Water Project Deliveries: 1999

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	286				286
City of Yuba City	1,096				1,096
Napa County FC&WCD	4,550	754			5,304
Solano County WA	37,753				37,753
Alameda County FC&WCD, Zone 7	46,000	2,910			48,910
Alameda County WD	34,871	2,781			37,652
Santa Clara Valley WD	67,465	15,480			82,945
Oak Flat WD	4,871				4,871
County of Kings	4,000				4,000
Dudley Ridge WD	51,870	4,990	6,566		63,426
Empire West Side ID	3,000	176			3,176
Kern County WA	1,077,755	58,241	42,154		1,178,150
Tulare Lake Basin WSD	118,500	49,898	121,337		289,735
San Luis Obispo County FC&WCD	3,743				3,743
Santa Barbara County FC&WCD	20,137				20,137
Antelope Valley-East Kern WA	69,073				69,073
Castaic Lake WA (+Rch 31A, 5 & 7)	32,899				32,899
Coachella Valley WD	23,100		27,380		50,480
Crestline-Lake Arrowhead WA	1,132				1,132
Desert WA	38,100		20,000		58,100
Littlerock Creek ID	342				342
Mojave WA	5,144				5,144
Metropolitan WDSC	829,777	22,840			852,617
Palmdale WD	13,278				13,278
San Bernardino Valley MWD	12,874				12,874
San Gabriel Valley MWD	18,000				18,000
Ventura County FCD	1,850				1,850
Totals	**2,521,466**	**158,070**	**217,437**	**0**	**2,896,973**
Total South of Delta	**2,520,084**	**158,070**	**217,437**	**0**	**2,895,591**

Table D-6 Historical State Water Project Deliveries: 2000

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	586				586
City of Yuba City	901				901
Napa County FC&WCD	3,136	297		1,525	4,958
Solano County WA	32,882	1,040		1,417	35,339
Alameda County FC&WCD, Zone 7	53,877	3,740			57,617
Alameda County WD	33,598	2,380			35,978
Santa Clara Valley WD	70,433	18,381		13,174	101,988
Oak Flat WD	4,494			14	4,508
County of Kings	3,600				3,600
Dudley Ridge WD	38,673	7,454	12,193	2,884	61,204
Empire West Side ID	1,271	528			1,799
Kern County WA	825,856	78,908	233,202	13,193	1,151,159
Tulare Lake Basin WSD	98,595	56,818	27,073	15,827	198,313
San Luis Obispo County FC&WCD	3,962				3,962
Santa Barbara County FC&WCD	22,741				22,741
Antelope Valley-East Kern WA	83,577				83,577
Castaic Lake WA (+Rch 31A, 5 & 7)	40,680				40,680
Coachella Valley WD	20,790	17,820	3,713		42,323
Crestline-Lake Arrowhead WA	1,194				1,194
Desert WA	34,290	17,820	6,124		58,234
Mojave WA	9,135				9,135
Metropolitan WDSC	1,273,729	103,124		169,529	1,546,382
Palmdale WD	8,221			839	9,060
San Bernardino Valley MWD	18,399				18,399
San Gabriel Valley MWD	14,000	475			14,475
Ventura County FCD	4,050				4,050
Totals	**,702,670**	**308,785**	**282,305**	**218,402**	**3,512,162**
Total South of Delta	**2,701,183**	**308,785**	**282,305**	**218,402**	**3,510,675**

Table D-7 Historical State Water Project Deliveries: 2001

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	513				513
City of Yuba City	1,065				1,065
Napa County FC&WCD	4,293	996	82	1,723	7,094
Solano County WA	17,756	2,304		1,021	21,081
Alameda County FC&WCD, Zone 7	22,307		308	5,990	28,605
Alameda County WD	13,695	10	107	4,192	18,004
Santa Clara Valley WD	35,689			12,233	47,922
Oak Flat WD	2,089		22	101	2,212
County of Kings	1,560				1,560
Dudley Ridge WD	18,467	933	347	6,815	26,562
Empire West Side ID		253		1,107	1,360
Kern County WA	363,204	23,233	6,502	92,052	484,991
Tulare Lake Basin WSD	40,830	8,755	769	7,889	58,243
San Luis Obispo County FC&WCD	4,184		99		4,283
Santa Barbara County FC&WCD	14,285	396	296		14,977
Antelope Valley-East Kern WA	45,071		899		45,970
Castaic Lake WA (+Rch 31A, 5 & 7)	30,471	850	618		31,939
Coachella Valley WD	9,009		91		9,100
Crestline-Lake Arrowhead WA	1,057				1,057
Desert WA	14,859		151		15,010
Mojave WA	4,433				4,433
Metropolitan WDSC	686,545	10,415	7,949	200,000	904,909
Palmdale WD	8,170			2,257	10,427
San Bernardino Valley MWD	26,488				26,488
San Gabriel Valley MWD	6,534				6,534
Ventura County FCD	1,850				1,850
Totals	**1,374,424**	**48,145**	**18,240**	**335,380**	**1,776,189**
Total South of Delta	**1,372,846**	**48,145**	**18,240**	**335,380**	**1,774,611**

Table D-8 Historical State Water Project Deliveries: 2002

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	419				419
City of Yuba City	1,181				1,181
Napa County FC&WCD	2,022	827	283	3,743	6,875
Solano County WA	28,223	2,242			30,465
Alameda County FC&WCD, Zone 7	40,707	1,484	556	8,113	50,860
Alameda County WD	24,250	83	862	2,331	27,526
Santa Clara Valley WD	55,896	202	2,053	3,311	61,462
Oak Flat WD	3,841	50	76	134	4,101
County of Kings	2,800		54		2,854
Dudley Ridge WD	38,688	1,861	1,177	1,994	43,720
Empire West Side ID	1,278	26		101	1,405
Kern County WA	670,884	21,951	20,543	15,680	729,058
Tulare Lake Basin WSD	73,785	3,749	2,289	5,385	85,208
San Luis Obispo County FC&WCD	4,355				4,355
Santa Barbara County FC&WCD	24,166	436	324	3,455	28,381
Antelope Valley-East Kern WA	53,907		1,008	3,256	58,171
Castaic Lake WA (+Rch 31A, 5 & 7)	61,880	280		6,657	68,817
Coachella Valley WD	16,170	111	474		16,755
Crestline-Lake Arrowhead WA	2,189				2,189
Desert WA	26,670	189	781		27,640
Mojave WA	4,346				4,346
Metropolitan WDSC	1,273,205	9,624	14,335	97,940	1,395,104
Palmdale WD	8,359		437		8,796
San Bernardino Valley MWD	68,268			3,801	72,069
San Gabriel Valley MWD	18,353			4,698	23,051
Ventura County FCD	4,998				4,998
Totals	**2,510,840**	**43,115**	**45,252**	**160,599**	**2,759,806**
Total South of Delta	**2,509,240**	**43,115**	**45,252**	**160,599**	**2,758,206**

Table D-9 Historical State Water Project Deliveries: 2003

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	551				551
City of Yuba City	1,324				1,324
Napa County FC&WCD	6,026	376	180	1,055	7,637
Solano County WA	25,135	2,280		1,918	29,333
Alameda County FC&WCD, Zone 7	30,695		656	13,099	44,450
Alameda County WD	31,086		354	5,150	36,590
Santa Clara Valley WD	90,620	936	841	14,104	106,501
Oak Flat WD	4,059	19	48	140	4,266
County of Kings	3,600	58	34		3,692
Dudley Ridge WD	49,723	1,928	482	1,452	53,585
Empire West Side ID	1,074	175		187	1,436
Kern County WA	841,697	27,891	8,419	22,380	900,387
Tulare Lake Basin WSD	94,376	6,243	938	4,284	105,841
San Luis Obispo County FC&WCD	4,417	36			4,453
Santa Barbara County FC&WCD	24,312	339	43	2,274	26,968
Antelope Valley-East Kern WA	52,730		250	7,049	60,029
Castaic Lake WA (+Rch 31A, 5 & 7)	49,895	991	90	4,760	55,736
Coachella Valley WD	14,045	204	194		14,443
Crestline-Lake Arrowhead WA	1,563				1,563
Desert WA	23,168	330	321		23,819
Mojave WA	10,907			3,528	14,435
Metropolitan WDSC	1,550,356	17,622	16,920	134,845	1,719,743
Palmdale WD	9,701			1,846	11,547
San Bernardino Valley MWD	25,371	200		1,844	27,415
San Gabriel Valley MWD	13,034	200			13,234
San Gorgonio Pass WA	116				116
Ventura County FCD	5,000				5,000
Totals	**2,964,581**	**59,828**	**29,770**	**219,915**	**3,274,094**
Total South of Delta	**2,962,706**	**59,828**	**29,770**	**219,915**	**3,272,219**

Table D-10 Historical State Water Project Deliveries: 2004

	Table A	Art. 21	Turnback	Carryover	Total
County of Butte	1,440				1,440
City of Yuba City	1,434				1,434
Napa County FC&WCD	5,030	1,450	52	1,602	8,134
Solano County WA	15,991	7,787		47	23,825
Alameda County FC&WCD, Zone 7	38,895			11,466	50,361
Alameda County WD	20,959		214	6,714	27,887
Santa Clara Valley WD	52,867	2,983	508		56,358
Oak Flat WD	4,324		29	276	4,629
County of Kings	5,850	3,157	46		9,053
Dudley Ridge WD	36,676	7,393	291	1,886	46,246
Empire West Side ID	1,310	626		1,626	3,562
Kern County WA	641,368	86,513	5,075	38,729	771,685
Tulare Lake Basin WSD	58,125	15,299	489	5,638	79,551
San Luis Obispo County FC&WCD	4,096	69			4,165
Santa Barbara County FC&WCD	29,358		122		29,480
Antelope Valley-East Kern WA	50,532			9,199	59,731
Castaic Lake WA (+Rch 31A, 5 & 7)	46,358	1,618		35,785	83,761
Coachella Valley WD	8,631		89	6,745	15,465
Crestline-Lake Arrowhead WA	2,006				2,006
Desert WA	9,966		102	11,122	21,190
Mojave WA	13,176				13,176
Metropolitan WDSC	1,195,807	91,601	10,223	215,000	1,512,631
Palmdale WD	10,549			1,613	12,162
San Bernardino Valley MWD	35,523			20,631	56,154
San Gabriel Valley MWD	15,600				15,600
San Gorgonio Pass WA	837				837
Ventura County FCD	5,250				5,250
Totals	**2,311,958**	**218,496**	**17,240**	**368,079**	**2,915,773**
Total South of Delta	**2,309,084**	**218,496**	**17,240**	**368,079**	**2,912,899**

Appendix E. Technical Memorandum Report Summaries: Historical SWP/CVP Operations Simulation and CalSim II Model Sensitivity Analysis

Study

This appendix presents summaries of the findings of the CalSim II Simulation of Historical SWP/CVP Operations and a CalSim II Model Sensitivity Analysis Study. The entire reports are available at the websites listed at the end of this appendix.

1. CalSim II Simulation of Historical SWP/CVP Operations
Technical Memorandum Report

Objective of Study

The purpose of the Historical Operations Study is to evaluate the ability of CalSim II to represent CVP and SWP operations, in general, and the delivery capability of the projects, in particular, through the monthly simulation of recent historical conditions.

Study Description

The period of simulation for the Historical Operations Study is water years 1975 to 1998. This 24-year period includes the 1976-77 and 1987-92 droughts, as well as the driest (1977) and the wettest (1983) years on record. The version of CalSim II used for this study is the benchmark study dated 30 September 2002, but with some inputs changed to reflect the historically changing conditions rather than a fixed level of development. Model inflows correspond to the historical flow from gage records, or are estimated from a hydrologic mass balance, or stream-flow correlation. Land use-based demands are calculated for annual varying land use, as determined from DWR's land surveys and county commissioners' reports. The operational logic has been revised to reflect the changing regulatory environment. The historical regulations have been simplified into three periods:

- October 1974–September 1992: represented by State Water Resources Control Board (SWRCB) Water Right Decision 1485 (D-1485),
- October 1992–September 1994: represented by D-1485 and the 1993 National Marine Fisheries Service (NMFS) winter-run Chinook salmon biological opinion (minimum carryover storage in Lake Shasta, and temperature related minimum instream flows downstream of Keswick Reservoir),
- October 1994–September 1998: represented by SWRCB Water Right Decision 1641 (D-1641) and the 1993 winter-run biological opinion.

The Historical Operations Study is limited in geographical scope to a dynamic operation of the Sacramento Valley, the Delta, and the CVP-SWP facilities south of the Delta. Delta inflows from the San Joaquin Valley and East Side streams are constrained to their historical values. Imports from the Trinity River system are similarly constrained.

Results and Discussion

The key performance measures in evaluating CalSim II are considered to be SWP and CVP deliveries, project storage operations, and stream flows. During the study period of water years 1975-1998, SWP demands were historically much lower than the current or projected level of demands. Simulation of historically wet years, when the system was not supply constrained, may therefore be a poor indicator of the model's ability to accurately simulate future levels of development. Particular attention is therefore placed on model results during the six-year drought of 1987-1992. Results for four key performance parameters are summarized in the table below.

The table below shows that simulated SWP Table A and CVP south-of-Delta deliveries during the drought are less than historical values. Differences are, however, within 5 percent. Comparison of Sacramento Valley inflow to the Delta (flow at Freeport) is a good measure of how well the Sacramento Valley hydrology is simulated by CalSim II. Simulated Delta inflows are 0.3 percent greater than historical. Comparison of the Net Delta Outflow Index, a measure of how well the Sacramento-San Joaquin Delta is represented by CalSim II, appears favorable. Simulated values are 3.5 percent greater than historical during the 1987-1992 period. The table also shows that simulated long-term (1975-1998) average deliveries compare quite well and are within 7 percent of historical values.

The total volume of surface water to be held in storage or routed through the model network is the same as historical. Model inflows to the Delta can deviate from historical due to three reasons: storage regulation, groundwater pumping to supplement surface water diversions, and stream-aquifer interaction.

Differences in Delta inflows are primarily caused by differences in project storage regulation (i.e. Lake Shasta, Lake Oroville and Folsom Lake). Storage operations in CalSim II are driven by two sets of rule curves. The first set of rule curves determines how much of the available project water will be held as carryover storage and how much will be delivered to meet contractors' current-year demands. The second set of rule curves determines when and how-much water will be transferred from north of Delta storage to San Luis Reservoir. These two sets of rule curves are fixed throughout the period of simulation. The rule curves have been determined in prior simulations of CalSim II. They are subjective in nature, but balance the conflicting objectives to maximize long-term average annual deliveries, to maintain water deliveries during the critically dry period 1928-34, and to keep water levels in project reservoirs above minimum levels while meeting minimum flow requirements. Secondly, differences in Delta inflows are due to differences in upstream surface water diversions and return flows. The historical consumptive water demand must be met by the model. Differences in Delta inflow, after accounting for differences in upstream storage regulation, therefore reveal how well CalSim II matches the historical mix of surface water and groundwater to meet demands. Lastly inflows to the Delta are influenced by the stream-aquifer interaction.

For a given south-of-Delta demand and a given Delta inflow, differences in model and historical project exports are indicative of how well the model represents the regulatory operating constraints to which the projects must comply, and how the model simulates storage operations in the San Luis Reservoir.

Conclusions from the study can be framed in the form of answers to some frequently asked questions about CalSim II.

Does CalSim II overestimate the projects' ability to export water from the Delta?

For the supply constrained years 1987-1992, model exports from the Delta average 4,450 taf/yr compared to a historical six-year average of 4,460 taf/yr. This suggests that CalSim II's

	Dry-period average 1987-1992				Long-term average			
	Simulated	Historical	Difference		Simulated	Historical	Difference	
Performance parameter		taf/yr		%		taf/yr		%
SWP south-of-Delta Table A deliveries	1,930	2,030	-100	-4.9	1,810	1,790	20	1.1
CVP south-of-Delta deliveries	2,230	2,320	-90	-3.9	2,650	2,490	160	6.4
Sacramento Valley inflow to the Delta	9,700	9,670	30	0.3	19,830	19,920	-90	-0.5
Net Delta Outflow Index	5,270	5,090	180	3.5	19,070	19,690	-620	-3.1

simulation of the Delta operations is representative of actual historical conditions.

Does CalSim II overestimate the availability of surface water in the Delta by meeting Sacramento Valley in-basin use through excessive groundwater pumping?

The mix of surface water and groundwater used by the model to meet Sacramento Valley consumptive demands depends primarily on project water allocation decisions and levels of minimum groundwater pumping that are specified in the model. Over the 24-year period average annual net groundwater extraction in CalSim II as compared to estimates based on the Central Valley Groundwater Surface water Model (CVGSM) is lower by 378 taf. The average annual net stream inflow from groundwater in CalSim II is 190 taf greater than estimated by the CVGSM for the same period. The combined effect of dynamically modeling groundwater operations in CalSim II (pumping, recharge and stream-aquifer interaction) leads to 188 taf/yr less water being available to the Delta. For the 1987-1992 period the combined effect results in 46 taf/yr additional water being available to the Delta.

How well does CalSim II represent stream flows?

Differences in long-term average annual flows at key stream locations are typically 1.2 percent or less. It is noted that differences are larger for the Sacramento River at the Ord Ferry gage. At this location a proportion of the water diverted upstream returns downstream so that simulated river flows are sensitive to assumed model water use efficiencies.

How well does CalSim II simulate the Sacramento Valley system?

The net Sacramento Valley accretion is calculated as the Sacramento Valley Delta inflow less releases from Whiskeytown Reservoir, Keswick Reservoir, Lake Oroville and Folsom Lake. The historical 24-year average annual net accretion is 5,950 taf/yr compared with a model value of 5,920 taf/yr.

Do different reservoir operating rules in CalSim II translate into differences in project deliveries?

Simulated month-to-month and year-to-year model results can vary significantly from historical operations. This is primarily due to differences in storage operations. However when averaged over a longer period, model operations (stream flows and deliveries) are very close to historical.

2. CalSim II Model Sensitivity Analysis Study Technical Memorandum Report

Background

The sensitivity analysis is an important component of any water resources planning model evaluation. It enhances understanding of the model, builds greater public confidence, and expands public acceptance of the model. The sensitivity analysis explores and quantifies the effects of various inputs on the model outputs. With a simple sensitivity analysis procedure, variations of model input parameters are generally investigated one at a time. With a more complex procedure, the investigation is conducted by changing a set of input parameters simultaneously. For this study, the simple sensitivity study procedure is used.

The Sensitivity Analysis Study responds to the commitment in *The State Water Project Delivery Reliability Report 2002* to conduct such a study and to issues raised during the public review of that report. The sensitivity analysis study is also one of the recommendations by the CalSim II peer review sponsored by the CALFED Science Program in December 2003. The review panel recommended such a study would help identify key input parameters that have significant effects on the model output, and to provide a systematic way to measure the sensitivity of the model output to variations of key input parameters.

Study Objectives

There are three objectives of the CalSim II Sensitivity Analysis Study:

- to examine the behavior of the SWP-CVP system performance in response to variations in selected input parameters within CalSim-II

- to help SWP contractors and others understand the impact of key assumptions within CalSim II on the SWP delivery capability
- to aid CalSim II modelers for prioritizing future model development activities on the basis of sensitivities of input parameters

Study Description

The development of the CalSim II model is an ongoing effort. DWR and Reclamation periodically release updated versions of the model. This study uses the modified benchmark study of September 30, 2002, under the D-1641 regulatory environment as the base study.

The CalSim II model uses many input parameters to define the physical characteristics of the system, as well as the regulatory environment and operational parameters. Input parameters include time series, single dimensionless coefficients, or monthly distribution curves. Some input parameters are estimated from the historical data and others are user-input or calibrated values. After discussions with model developers and project operators, 21 model input parameters in four major categories and their reasonable ranges of variations were selected for this study. Similarly, there are many output variables in different categories, including reservoir storage, flows at key locations, Delta outflows, project exports and deliveries that characterize the overall outcome of any particular simulation run. After discussions with model users, project operators, and model developers, 22 key output variables that cover various aspects of the SWP-CVP system performance were selected.

In this study, two performance measures – Sensitivity Index (SI) and Elasticity Index (EI) – are used to quantify the model output sensitivity with respect to a certain model input parameter. The SI is a first-order derivative of a model output variable with respect to an input parameter. It can be used to measure the magnitude of change in an output variable per unit change in the magnitude of an input parameter from its base value. The EI is a dimensionless expression of sensitivity that measures the relative change in an output variable to a relative change in an input parameter. As an example, assuming SI = 0.5 and EI = 0.25 for the output variable of total Delta outflow with respect to the input parameter of Oroville inflow, means that for one thousand acre-feet (taf) increase in Oroville inflow, total Delta outflow increases by 0.5 taf; and for 1 percent increase in Oroville inflow, total Delta outflow increases by 0.25 percent, respectively.

Study Results and Discussions

The complete results of the study showing sensitivity and elasticity indices for each one of the selected output variables are listed in terms of their long-term (1922–1994) averages with respect to variations of input parameters. Table E-1 highlights the behavior of some of the key output variables that define the important aspects of SWP–CVP system performance. In Table E-1, the top row is the list of model input parameters and the left-most column is the list of model output variables. In general, each cell in the table contains two numbers except cells in Columns 8 and 9. The number inside parentheses is the SI value and the number outside parentheses is the EI value. Signs in front of SI and EI values can be either positive or negative. In general, the positive sign indicates that the output variable changes in the same direction as the input parameter. For example, as shown in the Row 1 of Column 1 in the table, when SWP Table A demand increases, SWP total delivery, which is the sum of SWP Delta delivery and FRSA delivery, increases as well (SI = +0.39). SWP Delta Delivery is defined as SWP Table A deliveries to South-of-Delta plus deliveries to North Bay (Solano and Napa Counties) contractors. FRSA delivery is defined as the sum of deliveries to the Settlement Contractors in Feather River Service Area (FRSA) and Table A deliveries to Butte and Yuba Counties. The negative sign indicates that the output variable changes in the opposite direction as the input parameter. For example, as shown in the Row 5 of Column 1 in the table, when SWP Table A demand increases, Article 21 delivery decreases (SI = -0.13). In order to highlight relative sensitivity of the various input parameters, a color coded cell background has been used. A red color cell background represents a relatively higher sensitivity or (SI >= 0.2); yellow background represents a moderate sensitivity or (0.1 <= SI <= 0.2); and white background shows a lower sensitivity or (SI <= 0.1).

Table E-1 Summary excerpt of Elasticity Index (EI) and Sensitivity Index (SI) for selected variables from Table 2

	Model Output Response	Model Input Parameters											
		SWP Table A Demand	Article 21 Demand	Banks Pumping Limit	Historical Land Use	Projected Land Use	Crop ET	Basin Efficiency	SWP Delivery-Carryover Curve	SWP San Luis Rule Curve	Shasta Inflow	Oroville Inflow	Folsom Inflow
		1	2	3	4	5	6	7	8	9	10	11	12
1	**SWP Total Delivery**	0.31 (0.39)	0.01 (0.16)	0.15 (1.45)	0.09 (-0.13)	-0.05 (-0.03)	0.00 (0.00)*	-0.15 (0.10)	-0.01	0.02	0.07 (0.05)	0.18 (0.19)	0.05 (0.14)
2	**CVP total Delivery**	-0.01 (-0.01)	0.00 (0.00)*	-0.01 (-0.12)	0.10 (-0.18)	0.14 (0.11)	0.16 (0.09)	-0.32 (0.26)	0.00*	0.00*	0.25 (0.22)	0.05 (0.07)	0.03 (0.09)
3	**SWP SOD Delivery**	0.55 (0.52)	0.00 (-0.01)	0.07 (0.48)	0.12 (-0.13)	-0.09 (-0.04)	-0.21 (-0.08)	-0.17 (0.08)	-0.02	0.00*	0.08 (0.04)	0.26 (0.20)	0.05 (0.12)
4	**SWP NOD Delivery**	-0.01 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.17 (0.02)	0.78 (0.08)	-0.17 (0.02)	0.00	0.00*	0.00 (0.00)	0.01 (0.00)	0.00 (0.00)
5	**Article 21 Delivery**	-2.62 (-0.13)	0.15 (0.17)	2.63 (0.96)	-0.05 (0.00)*	-0.45 (-0.01)	-0.03 (0.00)*	0.30 (-0.01)	0.08	0.46	0.34 (0.01)	-0.51 (-0.02)	0.16 (0.02)
6	**CVP SOD Delivery**	-0.01 (-0.01)	0.00 (0.00)*	-0.02 (-0.10)	0.15 (-0.15)	-0.25 (-0.11)	-0.27 (-0.09)	-0.10 (0.04)	0.00*	0.00*	0.38 (0.18)	0.08 (0.06)	0.04 (0.08)
7	**CVP NOD Delivery**	0.00 (0.00)	0.00 (0.00)*	0.00 (-0.02)	0.03 (-0.03)	0.59 (0.21)	0.66 (0.18)	-0.59 (0.22)	0.00*	0.00*	0.10 (0.04)	0.02 (0.01)	0.01 (0.01)
8	**Total Delta Outflow**	-0.08 (-0.35)	0.00 (-0.16)	-0.04 (-1.48)	0.07 (-0.36)	-0.09 (-0.22)	-0.18 (-0.30)	-0.07 (0.15)	0.00	0.00	0.27 (0.69)	0.20 (0.74)	0.07 (0.75)
9	**Banks Export**	0.35 (0.37)	0.01 (0.16)	0.20 (1.63)	0.11 (-0.14)	-0.11 (-0.06)	-0.20 (-0.08)	-0.14 (0.08)	-0.01	0.02	0.10 (0.06)	0.21 (0.18)	0.05 (0.14)
10	**Tracy Export**	-0.01 (-0.01)	0.00 (0.00)*	-0.02 (-0.10)	0.16 (-0.15)	-0.25 (-0.10)	-0.28 (-0.09)	-0.10 (0.04)	0.00*	0.00*	0.39 (0.18)	0.09 (0.06)	0.04 (0.08)
11	**Banks SWP Export**	0.37 (0.38)	0.01 (0.16)	0.18 (1.46)	0.11 (-0.13)	-0.10 (-0.05)	-0.20 (-0.08)	-0.14 (0.07)	-0.01	0.02	0.08 (0.05)	0.22 (0.18)	0.06 (0.14)
12	**Banks CVP Export**	-0.53 (-0.02)	0.00 (0.00)	0.79 (0.17)	0.42 (-0.01)	-0.37 (-0.01)	-0.43 (0.00)	-0.31 (0.00)	0.00	0.02	0.86 (0.01)	0.04 (0.00)	0.02 (0.00)*

Note: (1) Values inside parentheses are SI and outside are EI. Values with asterisks indicate that EI and SI are not monotonic functions.
(2) Cell with an asterisk (*) indicates that the SI and EI of that output variable are non-monotonic functions of the corresponding input parameter. Please refer to the main report for details.

High Sensitivity	0.2 < |SI|
Moderate Sensitivity	0.1 <= |SI| <= 0.2
Low Sensitivity	|SI| < 0.1

An examination of Row 3 of Table E-1 highlights the behavior of SWP Delta delivery with respect to changes in some of the key input parameters. It shows that the SWP Table A demand, the Banks pumping limit, and the Oroville inflow affect SWP Delta delivery the most. Folsom inflow and historical land use display moderate effects on the SWP Delta delivery. A positive SI of 0.52 for the SWP Table A demand indicates that the SWP Delta delivery will increase by an average of 0.52 taf if the SWP Table A demand increases by 1 taf; and a positive EI of 0.55 for the SWP Table A demand indicates that the SWP Delta delivery will increase by an average of 0.55 percent if the SWP Table A demand increases by one percent. Similarly, a positive SI of 0.20 for the Oroville inflow indicates that the SWP Delta delivery will increase by an average of 0.20 taf if the Oroville inflow increases by 1 taf; and a positive EI of 0.26 for the Oroville inflow indicates that the SWP Delta delivery will increase by an average of 0.26 percent if the Oroville inflow increases by one percent.

No SI values are computed for input parameters of the SWP Delivery-Carryover Curve and the SWP San Luis Rule-curve (see Columns 8 and 9) because the equivalent changes in the commensurate units of taf are difficult to define for these two parameters. A more detailed discussion of their impact on the SWP Delta delivery is presented in the Memorandum Report.

Future Work

Further analysis of this sensitivity study will be done to develop more detailed findings regarding the impact of various parameters on SWP Delta deliveries.

This sensitivity study is mainly focused on Sacramento Valley hydrology, Sacramento-San Joaquin Delta water quality, and SWP operations. Additional sensitivity studies focused on San Joaquin Valley hydrology and CVP operations are planned for the near future by Reclamation.

Linear programming solution methodology used in the CalSim II model has the potential to produce an array of sensitivity analyses as a by-product of the linear programming analysis automatically. Discussion of these results will provide a degree of transparency to model users and an internal diagnostic tool that the current CalSim II does not provide. Studying these by-products of the linear programming solution procedure will be considered during the development of the next generation of the CalSim II model.

The CALFED report, A Strategic Review of CalSim-II and its Use for Water Planning, Management, and Operations in Central California (December 2003), recommends a model uncertainty analysis be conducted. An uncertainty analysis is not the same as a sensitivity analysis. It takes a set of randomly chosen input values (that can include parameter values), passes them through a model to obtain the probability distributions (or statistical measures of the probability distributions) of the resulting outputs, while a sensitivity analysis attempts to determine the relative change in model output values given modest changes in model input values. The uncertainty analysis would help users of the model understand better the risks of various decisions and the confidence they can have in various model predictions. DWR is currently working on a contract with University of California, Davis to develop a strategy for the evaluation of the major sources of uncertainty in CalSim II modeling studies, and to implement a recommended procedure for the quantification of uncertainties in a CalSim II study.

Websites for the Memorandum Reports:

1. [DWR] California Department of Water Resources, Bay-Delta Office. 2003. CalSim II Simulation of Historical SWP/CVP Operations. Technical Memorandum Report. Availability: http://science.calwater.ca.gov/pdf/CalSimII_Simulation.pdf

2. [DWR] California Department of Resources, Bay-Delta Office. 2005. CalSim II Model Sensitivity Analysis Study. Technical Memorandum Report. Availability: http://baydeltaoffice.water.ca.gov/

Appendix F. Guidelines for Review of Proposed Permanent Transfers of SWP Annual Table A Amounts

This appendix contains a copy of the Notice to State Water Project Contractors Number 03-09 entitled "Guidelines for Review of Proposed Permanent Transfers of State Water Project Annual Table A Amounts". These guidelines are being included per the Settlement Agreement, dated May 5, 2003, reached in the Planning and Conservation League et al. v. Department of Water Resources, 83 Cal. App. 4th 892 (2000).

STATE OF CALIFORNIA • RESOURCES AGENCY • DEPARTMENT OF WATER RESOURCES

NOTICE TO STATE WATER PROJECT CONTRACTORS

NUMBER: 03-09

DATE: 7/3/03

SUBJECT: Guidelines for Review of Proposed Permanent Transfers of State Water Project Annual Table A Amounts

FROM: INTERIM DIRECTOR, DEPARTMENT OF WATER RESOURCES

The Department of Water Resources is issuing the following guidelines prepared in connection with the Settlement Agreement, dated May 5, 2003, reached in *Planning and Conservation League et al. v. Department of Water Resources, 83 Cal. App. 4th 892 (2000)*. These guidelines are effective upon the superior court's approval of the Settlement Agreement on May 20, 2003.

1. Purpose: The purpose of these guidelines is to describe the process for DWR's review of proposed permanent transfers of State Water Project Annual Table A Amounts and, by so doing, provide disclosure to SWP contractors and to the public of DWR's process and policy for approving permanent transfer of SWP Annual Table A Amounts. Such disclosure should assist contractors in developing their transfer proposals and obtaining DWR review expeditiously, and assist the public in participating in that review.

2. Coverage: These guidelines will apply to DWR's approval of proposed permanent transfers of water among existing SWP contractors and, if and when appropriate, to proposed permanent transfers of water from an existing SWP contractor to a new SWP contractor.

3. Interpretation: These guidelines are in furtherance of the State policy in favor of voluntary water transfers and shall be interpreted consistent with the law, including but not limited to Water Code Section 109, the Burns-Porter Act, the Central Valley Project Act, the California Environmental Quality Act, area of origin laws, the public trust doctrine, and with existing contracts and bond covenants. These guidelines are not intended to change or augment existing law.

4. Revisions: Revisions may be made to these guidelines as necessary to meet changed circumstances, changes in the law or long-term water supply contracts, or to address conditions unanticipated when the guidelines are adopted. Revisions shall be in accordance with the Settlement Agreement.

Notice to State Water Project Contractors
JUL 3 2003
Page 2

5. Distribution: The transfer guidelines shall be published by DWR in the next available edition of Bulletin 132, and also as part of the biennial disclosure of SWP reliability as described in the Settlement Agreement.

6. Contract Amendment: Permanent transfers of SWP water are accomplished by amendment of each participating contractor's long-term water supply contract. The amendment consists of amending the Table A upwards for a buying contractor and downwards for a selling contractor. The amendment shall be in conformity with all provisions of the long-term water supply contracts, applicable laws, and bond covenants. Other issues to be addressed in the contract amendment will be subject to negotiation among DWR and the two participating contractors. The negotiations will be conducted in public, pursuant to the Settlement Agreement and Notice to State Water Project Contractors Number 03-10.

7. Financial Issues: The purchasing contractor must demonstrate to DWR's satisfaction that it has the financial ability to assume payments associated with the transferred water. If the purchasing entity was not a SWP contractor as of 2001, special financial requirements pertain as described below, as well as additional qualifications.

8. Compliance with CEQA: Consistent with CEQA, the State's policy to preserve and enhance environmental quality will guide DWR's consideration of transfer proposals (Public Resources Code Section 21000). Identification of the appropriate lead agency will be based on CEQA, the CEQA Guidelines, and applicable case law, including *PCL v. DWR.* CEQA requires the lead agency at a minimum to address the feasible alternatives to the proposed transfer and its potentially significant environmental impacts (1) in the selling contractor's service area; (2) in the buying contractor's service area; (3) on SWP facilities and operations; and (4) on the Delta and areas of origin and other regions as appropriate. Impacts that may occur outside of the transferring SWP contractors' service areas and on fish and wildlife shall be included in the environmental analysis. DWR will not approve a transfer proposal until CEQA compliance is completed. The lead agency shall consult with responsible and trustee agencies and affected cities and counties and, when DWR is not the lead agency, shall provide an administrative draft of the draft EIR or Initial Study/Negative Declaration to DWR prior to the public review period. A descriptive narrative must accompany a checklist, if a checklist is used. The lead agency shall conduct a public hearing on the EIR during the public comment period and notify DWR's State Water Project Analysis Office of the time and place of such hearing in addition to other notice required by law.

9. Place of Use: The purchasing contractor must identify the place and purpose of use of the purchased water, including the reasonable and beneficial use of the water.

Notice to State Water Project Contractors
JUL 3 2003
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Typically, this information would be included in the environmental documentation. If a specific transfer proposal does not fit precisely into any of the alternatives listed below, DWR will use the principles described in these Guidelines to define the process to be followed. The information to be provided under this paragraph is in addition to the CEQA information described in Paragraph 8 of these guidelines.

a. If the place of use is within the contractor's service area, the contractor should disclose the purpose of the transferred water, such as whether the water is being acquired for a specific development project, to enhance overall water supply reliability in the contractor's service area, or some other purpose. If the transferred water is for a municipal purpose, the contractor should state whether the transfer is consistent with its own Urban Water Management Plan or that of its member unit(s) receiving the water.

b. If the place of use is outside the contractor's service area, but within the SWP authorized place of use, and service is to be provided by an existing SWP contractor, then, in addition to Paragraph 9(a) above, the contractor should provide DWR with copies of LAFCO approval and consent of the water agency with authority to serve that area, if any. In some instances, DWR's separate consent is required for annexations in addition to the approval for the transfer.

c. If the place of use is outside the SWP authorized place of use and service is to be provided by an existing SWP contractor, the contractor should provide information in Paragraph 9(a) and 9(b). Prior to approving the transfer, DWR will consider project delivery capability, demands for water supply from the SWP, and the impact, if any, of the proposed transfer on such demand. If DWR approves the transfer, DWR will petition State Water Resources Control Board for approval of expansion of authorized place of use. Water will not be delivered until the place of use has been approved by the SWRCB and will be delivered in compliance with any terms imposed by the SWRCB.

d. If the place of use is outside the SWP authorized place of use and service is not to be provided by an existing SWP contractor, DWR will consider the transfer proposal as a proposal to become a new SWP contractor. Prior to adding a new SWP contractor, DWR will consider project delivery capability, demands for water supply from the SWP, and the impact, if any, of the proposed transfer on such demand. DWR will consult with existing SWP contractors regarding their water supply needs and the proposed transfer. In addition to the information in Paragraph 9(a), 9(b), and 9(c), the new contractor should provide information similar to that provided by the original SWP contractors in the 1960's Bulletin 119 feasibility report addressing hydrology, demand for water supply, population growth, financial feasibility, etc.

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DWR will evaluate these issues independently and ordinarily will act as lead agency for CEQA purposes. In addition, issues such as area of origin claims, priorities, environmental impacts and use of water will be addressed. The selling contractor may not be released from financial obligations. The contract will be subject to a CCP 860 validation action initiated by the new contractor. If DWR approves the transfer, DWR will petition the SWRCB for approval of expansion of authorized place of use. Water will not be delivered until the place of use has been approved by the SWRCB and will be delivered in compliance with any terms imposed by the SWRCB.

10. DWR Discretion: Consistent with the long-term water supply contract provisions, CEQA, and other provisions of law, DWR has discretion to approve or deny transfers. DWR's exercise of discretion will incorporate the following principles:

    a. As required by CEQA, DWR as an agency with statewide authority will implement feasible mitigation measures for any significant environmental impacts resulting from a transfer if such impacts and their mitigation are not addressed by other public agencies and are within DWR's jurisdiction.

    b. DWR will invoke "overriding considerations" in approving a transfer only as authorized by law, including but not limited to CEQA, and, to the extent applicable, the public trust doctrine and area of origin laws.

If you have any questions or need further information, please contact Dan Flory, Chief of DWR's State Water Project Analysis Office, at (916) 653-4313 or Nancy Quan of his staff at (916) 653-0190.

Appendix G. Comment Letters on the Draft Report and the Department's Responses

Written comments from the public on the *Draft State Water Project Delivery Reliability Report* (November 2005) were accepted through December 2005. DWR reviewed the letters and made appropriate modifications to the report. These letters and the responses to them are contained in this appendix.

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COACHELLA VALLEY WATER DISTRICT

POST OFFICE BOX 1058 • COACHELLA, CALIFORNIA 92236 • TELEPHONE (760) 398-2651 • FAX (760) 398-3711

December 29, 2005

File: 022.57
0644.103

Katherine Kelly, Chief
Bay-Delta Office
California Department of Water Resources
1416 9th Street, Room 215-37
Sacramento, CA 95814

Dear Ms. Kelly:

Subject: Draft 2005 State Water Project Delivery Reliability Report

On December 23, the Coachella Valley Water District (CVWD) e-mailed comments on the draft report, to Johnnie Young-Craig. This is a follow-up to that e-mail submittal. In response to the Department of Water Resources (DWR) Draft 2005 State Water Project Delivery Reliability Report, CVWD submits the following comments:

1. On page 18, the report states, "To simplify the use of this report, the calculation of demand or delivery in percent of maximum Table A is based on the maximum Delta Table A total of 4.133 maf for all five studies." CVWD believes that this approach may result in misleading conclusions if State Water Project (SWP) contractors simply rely on the percentages to estimate their supply reliability.

   Most SWP contractors (with the probable exception of Metropolitan) would be expected to request their full Table A amounts, regardless of the water year type. However, when some contractors request less than their full Table A amount, more water should be available for allocation to other contractors. The use of the maximum Table A amounts to compute the delivery percentages indicates a lower reliability for current (2005) demands than for future (2025) demands. This is demonstrated in Table 5-2, where Study 4 shows an average delivery of 68 percent of the maximum Table A, while Study 5 shows an average delivery of 77 percent. If the delivery percentages were expressed as a percent of the corresponding Table A demand, the results for the current demands would be higher. Study 4 would have an average delivery of 85.7 percent of Table A demand (281/3290 = 0.857) while Study 5 would have an average delivery of 77.3 percent of Table A demand (3178/4110 = 0.773). Similar calculations for maximum and minimum deliveries would also indicate the lower reliability of future SWP deliveries. For dry and wet years, it is recommended that percentages be based on the ratio of deliveries to demands for the corresponding years.

TRUE CONSERVATION
USE WATER WISELY

Katherine Kelly
California Department of Water Resources 2 December 29, 2005

CVWD believes this computation would more accurately indicate the lower reliability of SWP deliveries in the future as demands increase. SWP contractors could then more directly apply the percentages to estimate their current and future Table A deliveries.

2. It is recommended that the probability charts shown on Figures 5-1 and 5-2 be revised such that the percentages are based either on the maximum demand requests, or the percentages be eliminated. While these figures correctly depict the deliveries in acre-feet, they seem to imply that the project is better able to meet demands in the future simply because demands are closer to the maximum Table A amounts.

3. In Chapter 6, examples are presented on the application of the reliability data. Information from Table 6-1 is used to estimate the potential supplies under average, single dry and multiple dry years. Due to the method whereby the percentages are computed, the average supply is shown to increase over the next twenty years. In reality, the average supply would be spread over a greater demand. Using the average values computed under Comment 1 above, the average annual values in the example would be 85,700 acre-feet in 2005, decreasing to 77,300 acre-feet in 2025. If a contractor were to request less than its full Table A amount in 2005, then the requested amount would be used instead of the Table A value.

4. It is recommended that DWR include, in an appendix, a table showing the annual demands used for each contractor under 2005 and 2025 conditions. This information could then be used to interpret the results of the studies for a particular contractor.

CVWD wishes to thank DWR for the opportunity to comment on this report and looks forward to receiving the final version.

If you have any questions, please call Zachary Ahinga, Resource Engineer, at (760) 398-2661, extension 2510.

Yours very truly,

Steve Robbins
General Manager – Chief Engineer

ZA:sa\engr\resource\05\dec\kelly-draft 2005 State Wtr Project

COACHELLA VALLEY WATER DISTRICT

STATE OF CALIFORNIA -- THE RESOURCES AGENCY **ARNOLD SCHWARZENEGGER,** *Governor*

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

January 30, 2006

Mr. Steven B. Robbins
Coachella Valley Water District
Post Office Box 1058
Coachella, California 92236

Dear Mr. Robbins:

Thank you for your comments on the Draft State Water Project Delivery Reliability Report 2005 (Report 2005). Your comments have been thoroughly reviewed and the recommended changes considered for inclusion into the final report.

I appreciate your concern that, by simplifying the presentation of the information, the report may cause the State Water Project (SWP) contractors to come to an incorrect conclusion about the ability of SWP to meet their needs. You make the point that the ability of the SWP to meet demands will decrease as these demands increase. This is certainly correct. A plot of studies 4 and 5 (from the draft report) showing how well the SWP is estimated to meet demand is attached. It shows that the amount of years under which at least 90 percent of the assumed SWP demand can be met drops from 70 percent for 2005 demands to 50 percent for 2025 demands. The final Report 2005 has been modified to assure that readers will not come to an incorrect conclusion regarding the estimated ability of SWP to meet future demands.

The final report has not been modified, per your request, to present the results as a percentage of assumed demand. The results contained in Report 2005 are shown as percentages of the maximum Table A amount so the information can be easily interpreted by SWP contractors and incorporated into their analyses. Presenting the information as a percentage of the assumed demand would require additional calculations and, we believe, would increase the potential for calculation errors. For example, with the data presented as a percentage of the maximum Table A amount, a contractor may apply a percentage value to the specific maximum Table A amount for his or her district to determine how much water would be available to the district. Once this is done, the capability of the district to convey that amount could be analyzed and the amount of supply reduced accordingly. If the information were presented as a percent of the demand, the amount of water that it equates to must be determined by referencing the assumed demand for a specific year and then calculating the amount of water associated with it. This is particularly cumbersome when calculating average values for any given period.

Mr. Steven B. Robbins
January 30, 2006
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Finally, you recommend an appendix be included showing the annual demands assumed for each SWP contractor for the 2005 and the 2025 studies. The values for the total annual assumed Table A demand for studies 4 and 5 are listed in Tables B-6 and B-7. Tables containing a breakdown of these values for each contractor would be very long and provide a relatively small increase in the usefulness of the report. Individual contractors are encouraged to contact DWR staff at (916) 653-1099 to discuss the specific applicability to their district of the information in the report.

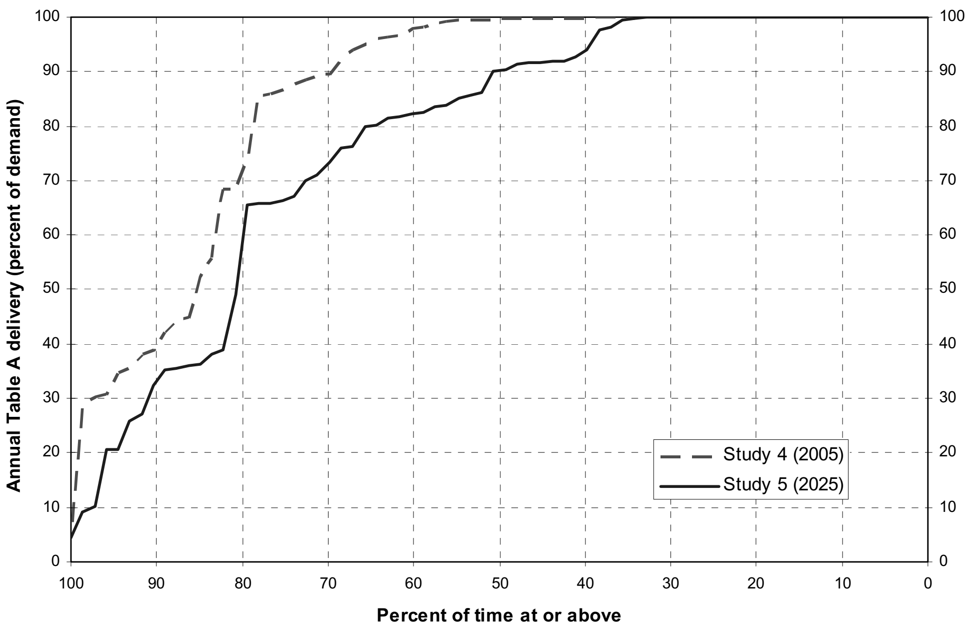
I appreciate your review of this document. The final report will be available soon and will include your letter and this response in an appendix. If you wish to discuss this report further, please contact me at (916) 653-1099 or kkelly@water.ca.gov. Francis Chung, Chief of the Modeling Support Branch of the Bay-Delta Office, should be contacted for technical questions on the CalSim II modeling studies. He can be reached at (916) 653-5924 or chung@water.ca.gov.

Sincerely,

Katherine F. Kelly, Chief
Bay-Delta Office

Attachment

SWP Delta Table A delivery probability for studies 4 and 5



CUDDY VALLEY
statistical
CONSULTING

JAN DE LEEUW
11667 STEINHOFF ROAD
FRAZIER PARK CA 93225
661.245.1725
DELEEUW@FRAZMTN.COM
WWW.CUDDYVALLEY.ORG

California Department of Water Resources
SWP Delivery Reliability Report -- Attn: Johnnie Young-Craig
P.O. Box 942836
Sacramento, CA 94236-0001
Date 12/20/05

Dear Sir or Madam,

These are my comments on the 2005 Delivery Reliability Report. I have been studying the WRIMS/CALSIM methodology for some time, although this is made difficult by lack of documentation, non-availability of the WRIMS source code, use of proprietary libraries, and so on. Also, the CALSIM model is inherently very complicated, so it takes a long time to find out what the actual constraints and variables are. So my comments will necessary be of a general methodological character, without using any of the specifics of CALSIM. I think these general considerations are sufficient to argue that the delivery predictions made by CALSIM for the next 20 years cannot possibly be taken seriously. There may be a paucity of data, even in the past, but it simply will not do to compensate for this by making a multitude of seemingly unreasonable assumptions. It is obvious that modeling SWP/CVS is a gargantuan task, but the importance of Table A predictions for development in Southern and Central California is now so important that we really have to do better.

Let me explain what I understand WRIMS/CALSIM modeling to do. I may be wrong, because as I said good documentation is difficult to come by. The SWP/CVS system, or a subset of it, is modeled as the CALSIM network with hundreds of nodes and (valued) arcs. Flows through the system are modeled as arcs, and there are inflow, outflow, and through-flow nodes. There are many

SPECIALIZING IN MULTIVARIATE ANALYSIS & ENVIRONMENTAL STATISTICS constraints on the flows, depending on capacity, environmental regulations, demands, and balance of inflows and outflows at through-flow nodes. Some outflows are deliveries, some inflows are runoff and rainfall. The objective function is a combination of delivery outflows. We choose flows in such a way that (a) they satisfy the constraints, and (b) over all possible flows satisfying the constraints they maximize the objective function. In actual WRESL modeling the objective function and the constraints are linear, which means that the optimization is actually a linear programming network optimization method. I don't discuss complications, such as using mixed integer programming and soft constraints, which generally make matters worse anyway.

To discuss the results of this process, and the way they are presented, define a function F_N which gives as its value y the total delivery to the 29 SWP contractors and takes as input runoff and rainfall x. The structure of the CALSIM network, including all the constraints, is considered to be fixed. Thus F_N transforms runoff and rainfall x uniquely to delivery y, for a given structure of CALSIM (and for a given objective function). In the delivery reliability studies DWR calculates F_N (ca) for t=1,...,73 and for N a limited number of variations of the basic network. Here 73 is the number of years for which we have data, i.e. 1922 to 1994. One N is the network in 2005, another N the network in 2025. Those two networks are supposed to differ only in demand, not in the constraints defined by the infrastructure or regulations. Thus $F_N(x_t)$ is a time series of 73 different values, and as a next step DWR calculates for each number z the percentage of the 73 numbers F_N (x_t) larger than or equal to z. Let's write this as $p_N(z)$. DWR calls $p_N(z)$ the probability that the delivery of network N will be at least z aft/year.

Now let us look at the assumptions inherent in this process. In the first place it assumes that F_N represents the SWP/CVS system adequately. This means that if we assume that if N is the actually network at time t and x_t is the actual rainfall at time t, then $y_t=F_N(x_t)$ should be at least close to the observed deliveries at time t. This is basically all we want, but clearly a sufficient condition for this to be the case are that N represents the infrastructure and the constraints adequately and that the many people operating SWP/CVS act as if they are optimizing a particular linear function under the particular constraints used. Both these sufficient conditions are obviously false. It is known that the model does not adequately represent the environmental regulations, it is also know that the mix-and-match strategies used by suppliers to add ground water or banked water to the system are not adequately represented either. It is unknown how serious these violations are. From the system theoretic point of view it is not necessary to assume that the network is true and the operators are optimizers, the only thing we are interested in is if y_t is sufficiently close to $F_N(x_t)$ (ands, eventually, if the predicted future observed y_t will be close to the predicted $F_N(x_t)$.

Another assumption that seems inherent in the calculations is that x_t is, in some sense, a random sample of size 73 of the possible values of rainfall/runoff in California, not just for now but also for the future. Now certainly there are large autocorrelations in the hydrologic time series x_t, so we certainly do not have independent observations. In fact, it is highly debatable if the notion of randomness applies here at all, and if we do not have a unique series of 73 observations for which there is no suitable framework of replication. Of course if randomness does not apply, then the notion of probability does not apply. But if randomness applies, then it should also be possible, and in fact highly desirable, to construct confidence regions for the $p_N(z)$ curves. Recently published time series also suggest that rainfall/runoff exhibit systematic trends, possibly related to climate change. So in particular extrapolating into the future may be risky.

For now, we will just insert some additional words of caution. A system that maximizes deliveries will obviously tend to overestimate deliveries. A system with hundreds and hundreds of variables can easily be manipulated to reproduce historic results, so future predictions are much more important than close fit. Sensitivity analysis, i.e. changing the network from N to N', is definitely important but is a huge undertaking with a network as large as CALSIM. The assumption that the constraints (except for demand) and the structure of the network will remain basically the same until 2025 seem very arbitrary. The sensitivity study looks at some variation in the pumping done at Banks, but what we want to know, of course, is the actual level of pumping in future years. There is no way to tell what the environmental regulations in 2025 will be, because those depend on politics, climate change, and possible catastrophes.

DWR argues that the CALSIM projections are the best we have. This may be true, but it may be just a reflection of historical circumstances during development of the model. It certainly does not mean that it is the best we can do. DWR also argues, in many places, that past deliveries cannot be used to reliably predict future deliveries. This is dangerous nonsense. Of course they can. Even CALSIM uses them. It is true that the structure of the network and the constraints also play an important role, but ultimately all we have is a complicated way to relate the time series of runoff/rainfall to the time series of deliveries to the SWP contractors. With the many threats to the Delta, which the possible impact of climate change, with the rapid population growth in Southern California, with the increasing demand of Northern California, with much less water from the Colorado River going to Southern California, we may have to face the fact that "best we have" is simply not good enough any more.

In summary, I do not think the DWR Delivery Reliability estimates are, themselves, very reliable. They are build on a host of unrealistic assumptions, that are "saved" by a model with the property that it always outputs a single number. And that single number is what the clients downstream are interested in. As far as I can see, a large fraction of that number is "model" or "virtual" water. It looks good on paper, but only water agency boards and modeling divisions can live on it.

Sincerely yours,

Jan de Leeuw

Director CVSC

Distinguished Professor and Chair, UCLA Department of Statistics

STATE OF CALIFORNIA -- THE RESOURCES AGENCY **ARNOLD SCHWARZENEGGER,** *Governor*

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

January 30, 2006

Dr. Jan de Leeuw
Cuddy Valley Statistical Consulting
11667 Steinhoff Road
Frazier Park, California 93225

Dear Dr. de Leeuw:

This letter responds to your letter dated December 20, 2005 commenting on the Draft State Water Project Delivery Reliability Report (Report 2005). Most of your comments are regarding the suitability of the CalSim II computer simulation model for estimating the delivery reliability of the State Water Project (SWP).

You state that due to the lack of documentation for the CalSim model and its tremendous complexity, you may have a limited understanding of the model. Your general understanding of the model is correct with respect to its basic structure. It should be noted that CalSim II is not an optimization model but, rather, a system simulation model. The simulation is done on a monthly time step. It is not designed to maximize deliveries but to meet the assumed annual requested contractors' demands to the extent possible while meeting all physical, operational, and institutional constraints. The CalSim II modeled operation has been critically reviewed by both the SWP and the Central Valley Project operators and they are satisfied with the degree the model results mimic the actual real-world operations. The CalSim II model has been used extensively by State Water Contractors and SWP operation staff to help them develop annual water supply guidelines.

Over the past few years, there has been significant outreach to the interested public regarding CalSim II. Explaining what the model is and how it works is a big challenge given its complexity and the varying levels of understanding desired by interested parties. As you are aware, the CalSim II model has undergone a peer review (November 2003) which was open to the public and identified the strengths and weaknesses of the model. The peer reviewers produced a report of their findings (December 2003) to which the Department of Water Resources (DWR) responded (August 2004). This response includes a description of the goals for improving different aspects of CalSim and the plan for meeting them. Improving the credibility of the model with the interested public is a top priority in the plan. We will continue to strive to increase public understanding of the model.

Dr. Jan De Leeuw
January 30, 2006
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With respect to technical understanding of the model, documentation of the CalSim II Benchmark Studies (September 2002) and the associated assumptions is available on the Bay-Delta Office web site. This site also includes drafts of a CalSim Manual, Users Guide and WRSL Reference. In addition, an intense training session on CalSim was conducted in October 2003 for the interested public and was attended by 45 individuals. This training was designed to increase the technical understanding of the model, encourage informed discussion of the technical strengths and weaknesses of the model, and decrease the demand on DWR staff to conduct or assist with modeling studies by increasing the ability of other agencies and private consultants. This effort was very successful and DWR will conduct training sessions in the future as appropriate.

The CalSim II results in the Report 2005 are the best quantifications available of the delivery ability of the SWP but, as you point out, these estimates are limited because of the uncertainty of future conditions. DWR will continue to use the CalSim model as appropriate for analyses but other information is being developed that will help us analyze, understand, and prepare for our uncertain future. The potential impacts of climate change on the State's resources, including water supply, are being evaluated per the Governor's directive (Executive Order S-3-05). This effort includes broad brush estimates, using CalSim II, of the potential impact upon the SWP in 50 to 100 years if no additional conveyance facilities or upstream reservoirs are built. In addition, DWR is working on three projects that will improve our ability to make qualitative or quantitative statements about the reliability of conveyance across the Sacramento-San Joaquin Delta. These are: the Delta Risk Management Strategy, which will assess risks to the Delta from floods, seepage, subsidence, and earthquakes, evaluate the consequences of levee failure, and develop recommendations to manage the risk; implementation of AB 1200 (Laird, 2005) which calls for a similar evaluation of impacts on water supplies from catastrophic Delta failure; and a broader public process to develop a shared vision of a sustainable Delta that continues to support societal needs related to water supply, transportation, recreation, land use, energy, and environmental health. Although none of these efforts will be completed before release of the next Reliability Report, some preliminary results and conclusions may be done in time for inclusion. Subsequent Reliability Reports will fully incorporate this information.

In closing, the discussion of using past deliveries to predict future deliveries has been clarified in response to your comment. You comment that it is incorrect to state that past deliveries cannot be used reliably to predict future deliveries. We certainly believe, for the SWP, past deliveries cannot be reliably used to predict future deliveries because of the significant increase over time in the demand for SWP supplies.

Dr. Jan De Leeuw
January 30, 2006
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Thank you for your comments on the draft Report 2005. The final report will be available soon and will include your letter and this response in an appendix. If you wish to discuss the report further, please contact me at (916) 653-1099 or kkelly@water.ca.gov. Francis Chung, Chief of the Modeling Support Branch of the Bay-Delta Office, should be contacted for technical questions on the CalSim II modeling studies. He may be reached at (916) 653-5924 or chung@water.ca.gov.

Sincerely,

Katherine F. Kelly, Chief
Bay-Delta Office

December 22, 2005

Kathy Kelly
California Department of Water Resources
Bay Delta Office Chief
1416, 9th Street, Room 215-37
Sacramento, CA 95814

California Department of Water Resources
SWP Delivery Reliability Report – Attn: Johnnie Young-Craig
P.O. Box 942836
Sacramento, CA 94236-0001

via facsimile to: (916) 653-6077
via email to: Comments-on-2005DRR@water.ca.gov

Re: Comments on Public Review Draft of the State Water Project Delivery Reliability Report 2005

Ms. Kelly:

The Planning and Conservation League (PCL), a strong advocate for accurate and realistic water supply planning, submits the following comments on DWR's Public Review Draft of the State Water Project Delivery Reliability Report (Draft Reliability Report). As one of the signatories to the court-approved settlement agreement requiring DWR to prepare these biennial reliability reports, PCL seeks to ensure that the final report lives up to the rigorous reporting requirements specified in that agreement. Serious deficiencies are present in the Draft Report that, if left uncorrected, would dangerously overestimate DWR's future ability to deliver water and compound the risk that local planning decisions will be predicated on "paper" rather than deliverable water.

The Reliability Report Should Accurately Disclose its Foundation in the Settlement Agreement and the State Water Project Contracts

The present Draft fails to inform local decision-makers and the public of the context and history behind DWR's reporting requirement. DWR's legal duty to prepare biennial reliability reports arises from the court-approved settlement agreement executed by PCL, DWR, state water contractors and other entities in the wake of the Third District Court of Appeal's ruling in the "Monterey Amendments" case, *Planning & Conservation League v. Department of Water Resources* (2000) 83 Cal. App. 4th 892.

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In *Planning & Conservation League*, the decision invalidating the Monterey Amendments EIR, the court bluntly addressed the "huge gap" between the 4.23 million acre-feet of SWP entitlements referenced in Table A of the SWP contracts and the half or less of that amount the state can reliably deliver. Recognizing the practical consequences of paper water for local development decisions, that court vindicated "the commonsense notion that land use decisions are predicated at some level on assumptions about available water supply. The Court also recognized that reliance on "paper water in local development decisions can produce excessive groundwater pumping and a host of other detrimental environmental consequences. " (83 Cal. App. 4th at p. 915.)

In the settlement decision following that ruling, DWR expressly agreed to add a rigorous new set of reporting requirements. In a new provision (Article 58) of the SWP contract, DWR committed to the following:

> 1.Commencing in 2003, and every two years thereafter, the Department Water of Resources (DWR) shall prepare and deliver to all State Water Project (SWP) contractors, all city and county planning departments, and all regional and metropolitan planning departments within the project service area a report which accurately sets forth, under a range of hydrologic conditions, the then existing overall delivery capability of the project facilities and the allocation of that capacity to each contractor. The range of hydrologic conditions shall include the historic extended dry cycle and long-term average. The biennial report shall also disclose, for each of the ten years immediately preceding the report, the total amount of project water delivered and the amount of project water delivered to each contractor. The information presented in each report shall be presented in a manner readily understandable by the public. (Settlement Agreement Attachment B)

The Settlement Agreement further states:

> 3. DWR shall provide assistance to enable all Municipal and Industrial Contractors to provide complete and accurate information to relevant land-use planning agencies to assure that local land-use decisions reflect accurate information on the availability of water from state, local, and other sources. (Settlement Agreement Attachment B)

The Draft Reliability Report does not fulfill these requirements. As detailed in the remaining sections of these comments, the Draft omits important information and misinterprets data, which would mislead both the public and local water agencies. Accordingly, it lacks the accuracy that the settlement agreement requires. In order to help DWR meet the commitments made under the settlement agreement, we submit the following comments for inclusion in the final 2005 Reliability Report.

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Excerpts of the Reliability Report should not have been privately shared with the State Water Contractors, but denied to PCL and the public

We are aware that DWR provided an earlier draft chapter of the Draft Reliability Report to State Water Project contractors in May 2005 ("Excerpts from Working Draft 2005 SWP Delivery Reliability Report") and further recommended that local agencies incorporate information provided in that draft chapter in their Urban Water Management Plans (UWMPs). Castaic Lake Water Agency has acknowledged relying on that document in reviewing other projects, and other contractors may have done so as well. However, DWR did not provide that draft chapter to PCL or the public, even though PCL staff requested the opportunity to review the draft. After followup requests, we were informed that the draft chapter would be posted to a web page for contractor announcements. There was no public announcement informing interested parties of the availability of the draft chapter.

DWR's decision to circulate part of the report to the contractors, while denying that same document to PCL and members of the public, represents an unfortunate throwback to the defective process singled out for criticism in *Planning and Conservation League*, where the court took notice of the interested parties and members of the public who were "not invited to the table." (83 Cal. App. 4th at 905.)

The draft and final Reliability Reports should be available to the public prior to deadlines for local agency Urban Water Management Plans

The most important purpose of the Reliability Report is to provide local water agencies and the public with accurate and realistic information on the reliability of SWP deliveries. Those local agencies should be able to use that information in planning documents and to inform land use decisions. Unfortunately, the timing of this report significantly compromises its utility. DWR did not release its draft to the public until just weeks prior to the state mandated deadline for local water agencies to complete and submit their 2005 Urban Water Management Plans.

DWR's decision to provide a single draft chapter prior to release of the full draft significantly compromises the information now included in many UWMPs. Without the complete report and the benefit of public review, decision-makers, planners and the public were denied the opportunity to evaluate and confirm the credibility of the information included in the draft chapter and now included in the UWMPs. Releasing the draft chapter and significantly delaying the release of this report is functionally equivalent to eliminating public oversight and transparency.

Water supply information from one chapter of a draft report also does not provide an adequate level of certainty or rigorous review required to determine the reliability of future water supplies for millions of Californians. To avoid damaging that review, water agencies and the public were supposed to have the complete final report, not just a preliminary part of it.

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DWR must ensure that in the future, the public will have ample opportunity to review and comment on Draft Reliability Reports, and that those public comments will be appropriately responded to and incorporated into vetted and substantiated final future reports well before Urban Water Management Plans are due to the State.

The Reliability Report should include DWR's analysis of SWP reliability under anticipated effects of climate change.

The 2005 Draft Reliability Report recognizes that a primary factor in determining reliability of SWP supplies is the availability of water in source areas. Yet the Draft Report fails to discuss and incorporate known and recognized information regarding the substantial adverse impacts climate change will have upon California's water supply. This omission is particularly troubling because DWR previously committed to including such information.

In 2002 DWR's first Reliability Report recognized that climate change could significantly alter availability of water in source areas. The 2002 report stated that information on climate change impacts to California was being developed in the California Water Plan Update process, and that such information would be incorporated into the 2005 reliability report. The California Water Plan Update 2005 is now nearly complete, and it contains information on climate change. The April 7, 2005 draft of the Water Plan Update states:

> California's relies on snowpack as its largest means of annual water storage. Runoff from the Sierra Nevada mountains during April through July of each year averages 14 million acre-feet and comes primarily from snowmelt. Computer modeling of global climate change scenarios predict significant future reductions in the Sierra snowpack. A reduced snowpack will reduce the total water storage for the state. Figure 4-7 (Model simulation of potential changes in snowpack during the 21st Century) shows a 52 percent reduction in the annual April through July runoff for a 2.1 degree C (3.8 F) of warming, well within the 1.4 to 5.8 degree C (2.5–10.4 F) range predicted by global climate models for this century.
>
> Changes in the timing of snowfall and snowmelt, as a result of climate change, may make it more difficult to refill reservoir flood control space during late spring and early summer, potentially reducing the amount of surface water available during the dry season. Changes in reservoir levels also affect lake recreation, hydroelectric power production, and fish habitat by altering water temperatures and quality. Reductions in snowpack may require changes in the operation of California's water systems and infrastructure, and increase the value of additional flood control space in reservoirs.
> (Public Review Draft California Water Plan Update, April 7, 2005, Vol. 4, page 4-27)

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Despite the commitments made in the 2002 Reliability Report, this information is not included in the recent draft of the 2005 Delivery Reliability Report.

In addition, the Draft Reliability Report misleads readers by suggesting that information on climate change impacts in California is not available. Since the release of the Draft Reliability Report 2002, a large amount of analysis on potential climate change impacts on water management in California has been published. Yet, the Draft Report 2005 states:

> The studies do not incorporate any modifications to account for changes related to climate change or assess the risk of future seismic or flooding events significantly disrupting SWP deliveries. As tools are developed to address these risks and the resulting studies become available, the information will be incorporated into the assessment of SWP delivery reliability. The results of the CalSim-II studies conducted for this update to *The State Water Project Delivery Reliability Report 2002* (DWR 2003b) represent the best available assessment of the delivery capability of the SWP. (Draft Reliability Report page 17)

However, estimates of the deliveries from the SWP under climate change conditions have been modeled and analyzed. The California Energy Commission recently completed such an analysis in their report, "Predictions of Climate Change Impacts on California Water Resources Using CalSim-II: A Technical Note" (CEC report).

In contrast to the statement included in the Draft Reliability Report, the CEC report provides assessments of SWP delivery capability under several probable climate change scenarios. This work was prepared in response to Executive Order S-3-05 issued by Governor Schwarzenegger, which called for a report on the impacts to California of global warming, including impacts to water supply, public health, agriculture, the coastline, and forestry.

It includes analysis carried out using CalSim-II, some of it performed by DWR staff.
It is disappointing that it took the initiative of the Energy Commission to generate climate change scenarios that PCL has been requesting of DWR for over two years. Moreover, DWR cannot credibly represent that such studies are impossible even after they become publicly available. To claim otherwise would fatally compromise the commitment to accuracy that is the hallmark of DWR's reporting requirement.

The figures below from the CEC Report show that under climate change hydrologies, SWP deliveries at 75% reliability could be as much as 1.9 million acre feet less than the base condition.

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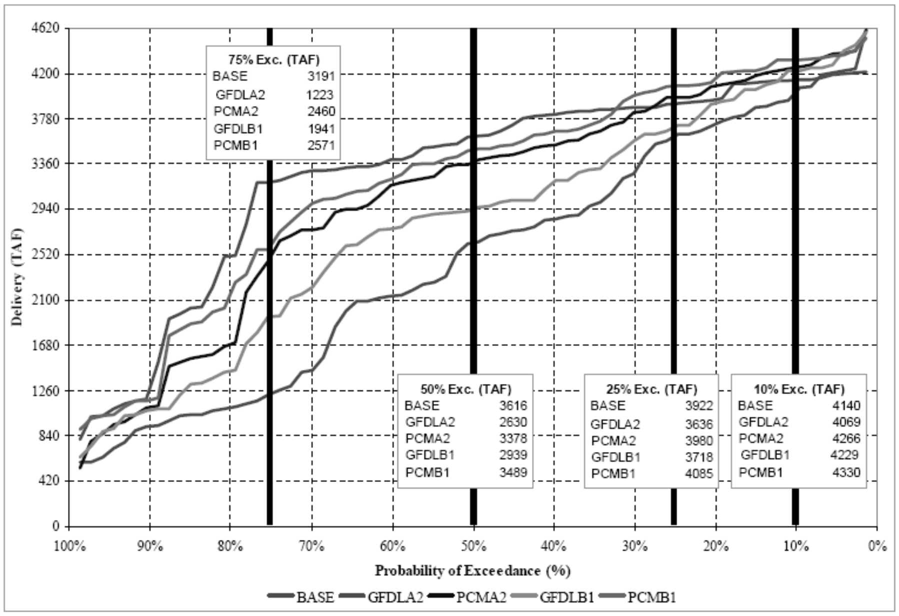

Figure 7. Exceedance probability plot of SWP Annual Deliveries under climate change scenarios PCM B1-A2 and GFDL B1-A2 for 2070-2099

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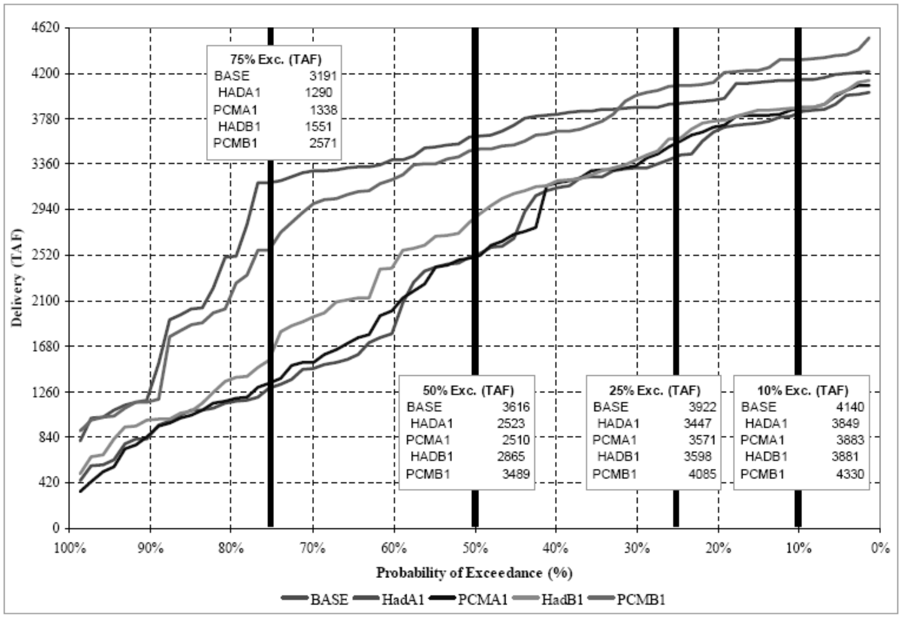

Figure 8. Exceedance probability plot of SWP Annual Deliveries under climate change scenarios PCM B1-A1 and HadCM3 B1-A1 for 2070-2099

(California Energy Commission, draft Predictions of Climate Change Impacts on California Water Resources Using CalSim-II: A Technical Note, December 2005 page 14 & 15
http://www.energy.ca.gov/2005publications/CEC-500-2005-200/CEC-500-2005-200-SD.PDF)

The CEC report concluded that modeling, "results show great negative impacts on California hydrology and water resources associated with most of climate change scenarios analyzed (only one scenario PCM run under B1 emission scenarios show just mild negative impacts)." (page 4)

This information demonstrates the range of outcomes that water managers must be prepared to address. This important assessment of the delivery capability of the SWP should be included in the Draft Reliability Report.

We also understand that DWR may have done its own analysis of the impacts of climate change on SWP deliveries. On the official State of California Climate Change Portal (http://www.climatechange.ca.gov/climate_action_team/reports/index.html) there is a reference to a study done by DWR. However unlike all of the other references, no results are included. The Reliability Report should include the results of DWR's own analysis.

Omission of this information prevents planners and decision makers from preparing for the inevitable implications for their water supplies. If the CEC already is predicting that water

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availability, and thus SWP deliveries, will be substantially reduced in the near future, water planners must adjust to that reality. DWR must address this problem, and will do California an enormous disservice if it continues to pretend that this problem does not exist.

Information in the Reliability Report will be used by local planners to make infrastructure investments and development decisions. The decisions made today about where to place infrastructure and where to approve development are long term commitments that will have impacts for hundreds of years into the future.

For instance, local decision-makers may chose not to place purple pipe in new development on the basis of assumed high level of delivery reliability from the SWP. Instead, decision-makers could choose to invest in new infrastructure to provide traditional supplies, including SWP supplies to new development. Once development is approved, the local area has foregone the opportunity to increase water supply reliability through use of recycled water. Should SWP supplies become significantly lower than predicted in the Reliability Report due to foreseeable impacts of climate change, significant local and statewide investments in infrastructure and housing would be stranded.

If local decisions are predicated on information from DWR that does not fully acknowledge potential constraints on DWR deliveries, they run the risk of producing excessive groundwater pumping and a host of other detrimental environmental consequences " (See *Planning and Conservation League*, 83 Cal. App. 4th at p. 915.)]

The long term nature and the resulting implications for the future of local areas as well as California as a whole, demand that the Reliability Report provide accurate, realistic information that fully discloses foreseeable uncertainty and risks.

The Report's unreliability also creates financial risks for the state. In many cases bonds will be committed to infrastructure built on expectations generated or encouraged by the Reliability Report. As with any financial investment, the risks associated with these investments must be fully disclosed to those who buy the bonds, those who approved the bonds, and those who invest in that infrastructure or in the developments supported by that infrastructure. As the state has learned in the past with levee liability, there is a potential risk that the State may be held accountable for decisions and investments made by others on the basis of false interpretation of the State's ability to protect and guarantee those investments.

The Reliability Report should include risk analysis and impacts from catastrophic failure in the Bay Delta Estuary from earthquake or flood

The Draft Reliability Report correctly identifies the availability and means of conveyance as a primary factor in determining reliability of SWP supplies. However, like climate change impacts, the Draft Report fails to include analysis or discussion of serious and eminent risks to the Bay Delta

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Estuary, an essential component of the SWP conveyance system. Significant risks to the ability of the SWP to export water from the Bay Delta Estuary are posed by the vulnerability of levees to flood, sea level rise and earthquake, as well as environmental degradation and continued declines of important fish species.

Dr. Jeffery Mount from the University of California, Davis, recently completed a risk analysis estimating that there is a 64 percent probability that the Bay Delta Estuary will experience abrupt changes resulting from flooding or seismic activity within the next fifty years. These changes would permanently alter the hydrology, water quality and ecosystem of the Estuary. Furthermore, Dr. Mount found that there is no institutional capacity to address these permanent changes. (Subsidence, Seismicity and Sea Level Rise: Hell AND High Water in the Delta; presented by Dr. Jeffery Mount to the California Bay-Delta Authority October 14, 2004. http://calwater.ca.gov/CBDA/AgendaItems_10-13-14-04/Presentation/Item_13_6_Subsidence_Seismicity_Sea_Level_Rise.pdf)

In recent testimony to a joint committee of the California Legislature, Lester Snow, Director of DWR, outlined the serious risks to SWP water supply availability associated with Bay Delta levee failure. In his presentation, "How a Delta Earthquake Could Devastate California's Economy," Director Snow stated that extended impacts to water availability would include:

• Using most optimistic projection, levee repairs will require at least 15 months. More realistically, the repairs will take much longer.
• Southern California water agencies are drawing from reserves. Some will last up to 36 months; others will go dry sooner.
• Extreme water conservation measures enacted
• Ground water basins drawn dangerously down – may lead to contamination
• Water conservation and transfer programs enacted
(Slide 16 of Lester Snow's presentation to the joint legislative committee, November 1, 2005 http://www.publicaffairs.water.ca.gov/newsreleases/2005/11-01-05DeltaEarthquake.pdf)

Director Snow further indicated that recovery of the conveyance through the Delta could be abandoned. (Slide 19 of Lester Snow's presentation). Director Snow told the Legislature that "… we also need to recognize the Statewide impacts …if Delta water supplies are reduced or eliminated as a result of a catastrophic failure of our levee system." (Quote taken from DWR Press Release, November 1, 2005, http://www.publicaffairs.water.ca.gov/newsreleases/2005/11-01-05flood.cfm)

Accordingly, the Reliability Report should incorporate Director Snow's recommendation to recognize the risk to SWP reliability from flood, sea level rise and earthquake.

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In addition to vulnerable levees, ecosystem degradation poses a significant risk to the ability to convey SWP water reliably through the Bay Delta Estuary. Recently, data from the Department of Fish & Game's Fall Mid Water Trawl signaled that there is a serious ecosystem collapse in the Estuary, with four important pelagic fish populations at historic lows, including the California and Federally Endangered Species Act listed Delta Smelt.

In response, many agencies, including DWR are participating in an emergency science review called the 'Pelagic Organism Decline' (POD) investigation. The most recent report from the POD investigations indicates that increased exports, which increase fish entrainment and decrease available habitat, may be a primary contributor to the fisheries declines ("Interagency Ecological Program Synthesis of 2005 Work to Evaluate the Pelagic Organism Decline (POD) in the Upper San Francisco Estuary," November 2005 http://science.calwater.ca.gov/pdf/workshops/IEP_POD_2005WorkSynthesis-draft_111405.pdf).

The final Reliability Report should acknowledge the current pelagic organism decline and disclose the possibility that decreases in exports may be necessary in order to reverse those declines. Lastly, while the pelagic species decline currently is the most salient of the Bay-Delta Estuary's environmental problems, it is not the only problem that might compel delivery reductions. Bay-Delta water currently does not meet federal or state water quality standards, and many other species are listed as threatened or endangered. The final Reliability Report should acknowledge that fixing these other environmental problems also may require export reductions.

The Reliability Report should evaluate variable levels of demand, utilizing demand modeled in the Draft California Water Plan Update 2005

The Draft Reliability Report identifies the level and pattern of water demand in the delivery service area as the third primary component in determining SWP reliability. However, the Draft Reliability Report does not examine a significantly varied range of possible demand scenarios for the future. That omission is important, for such analysis would likely show that reliability is inversely proportional to California's overall level of demand.

Recent work completed by DWR for the California Water Plan provides a range of demand scenarios that should be included in the Reliability Report. The California Water Plan Update 2005 identifies three plausible demand scenarios: current trends continued; less resource intensive; and more resource intensive. Two of these three scenarios demonstrate that it is plausible that in 2030 California water demands will *decrease*, even with an expected 12 million more residents. The greatest decreases in water demands in every scenario occur in the SWP service area of Tulare Lake.

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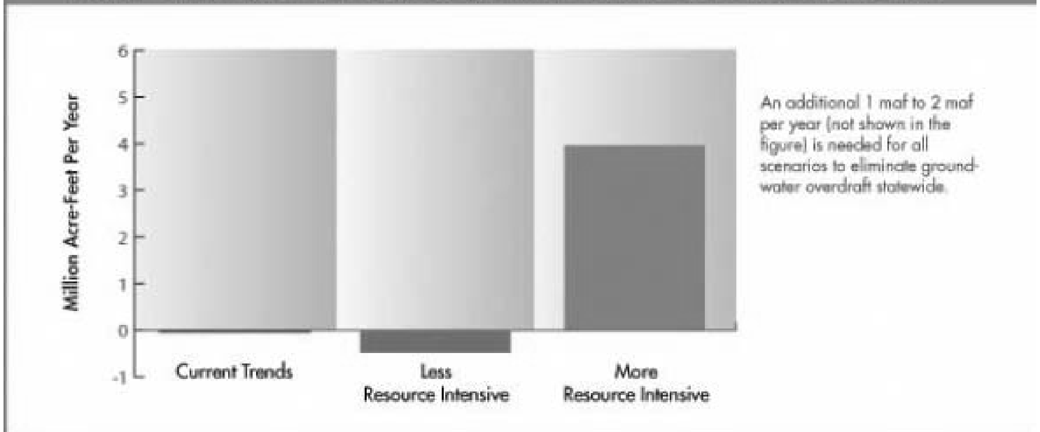
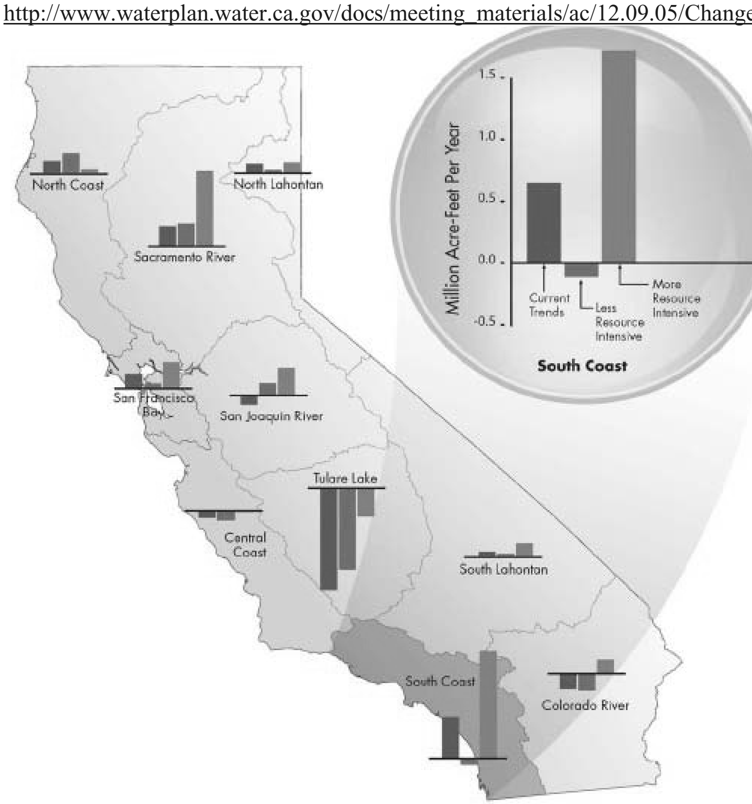
Figure 4-2 Net changes statewide in average-year water demand for baseline scenarios, 2000–2030



Water demands may change between 2000 and 2030 for average water conditions. Statewide water demand changes are shown for three baseline scenarios.

http://www.waterplan.water.ca.gov/docs/meeting_materials/ac/12.09.05/Changes_to_PRD_Slides_(12-08-2005).pdf



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Recently, the California Court of Appeals determined that state and Federal water agencies erred when they failed to adequately assess a range of reasonable scenarios in the CALFED ROD EIR in part because the environmental document did not include an analysis of reduced pumping from the Bay Delta Estuary (*In Re Bay Delta Programmatic Environmental Impact Report Coordinated Cases* (2005) 133 Cal.App.4th 154). Consistent with this finding, and DWR's recent good work on the State Water Plan Update, the Reliability Report should evaluate reliability under the three demand scenarios presented in the California Water Plan Update.

The Reliability Report should be consistent with operations described in environmental reviews

The Draft Reliability Report assumes that SWP deliveries into the future will be much higher than historic averages. In the past, SWP deliveries have averaged about 2 maf per year, while the Draft Reliability Report proposes that future deliveries will average from 2.8 to 3.1 maf annually. The Draft Reliability Report also assumes that an additional maximum of 1.11 maf of water could be delivered under Article 21.

Because CalSim-II is an optimization model that does not necessarily reflect options available to water operators, it may predict these levels of exports. However, federal and state water quality and endangered species laws and regulations probably would prohibit such high export levels for water quality problems and if species impacts were chronic even at historic levels. In light of the recent pelagic organism declines in the Bay Delta Estuary, it is prudent to ensure the Draft Reliability delivery predictions would not violate conditions of the Federal Clean Water Act, the Federal or California Endangered Species Acts, or any other environmental permit condition, regulation, standard, or law.

In order to ensure that stated water deliveries would be legally feasible, the Reliability Report must explicitly state whether listed export levels are consistent with those modeled in environmental reviews, including the recently issued biological opinions. For instance, the Reliability Report should state whether the Biological Opinions for OCAP in 2004 accounted for impacts to listed species under a modeling scenario that contemplated deliveries of 1.11 million acre feet of Article 21 water.

The Reliability Report should not recommend that water agencies integrate Article 21 as firm annual supplies in planning documents

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Article 21 water is by definition interruptible water; indeed, the word "interruptible" replaces the formerly used "surplus" in the Monterey Amendments. It should not be used as the basis for uninterruptible demands. Yet in chapter 6 of the Draft Reliability Report, local agencies are encouraged to include Article 21 water in a table of average annual values.

As DWR is aware, water supplies accounted for in the Urban Water Management Plans become the basis for approval of water supply assessments for new development in California. It is not only imprudent, but would provide institutional cover for unreliable planning, to recommend that local decision-makers approve housing that will be dependent on water that is 'interruptible.'

Article 21 water should be removed from the recommended table of average annual deliveries.

Use of CalSim-II as the sole tool to determine reliability is inappropriate given the following significant and yet to be resolved deficiencies

The lack of calibration and other deficiencies of CalSim-II have been made known the DWR in formal comments on the 2002 Draft by several parties, specifically Arve Sjovold and Dennis O'Conner. In addition, a 2003 expert peer review report documented numerous problems in CalSim II, and concluded that its predictions should be treated as "hypotheses." A. Close et al., A Strategic Review of CalSim II and its User for Water Planning, Management and Operations in California 13 (2003). This Draft has not adequately addressed those deficiencies. Some of these previously-highlighted deficiencies are listed below.

- CalSim-II has not been calibrated or validated
- It is unclear whether CalSim-II incorporates limitations to groundwater use in the Sacramento Valley
- The CalSim-II model should not be used to make absolute predictions, such as those incorporated into the Reliability Report
- CalSim-II does not recognize or report uncertainty

Additionally, CalSim-II may produce results not consistent with reality, replacing the problem of paper water with an even greater problem of 'cyber water.' For example, in 2001, California experienced water supply associated with approximately the 75% exceedence level, and the State Water Project was able to deliver 1,607,570 ac-ft. However, the CalSim-II simulations predicted a 75% exceedence level of supply of roughly 2,500,000 ac-ft (as read from Figure 5.1). In other words, CalSim-II overpredicted deliveries by more than 50%. These discrepancies demonstrate the need to use multiple tools to determine reliability, as well as the need to articulate limitations of this particular model. Similarly, they demonstrate that local agencies will take enormous risks if they approve projects in reliance on CalSim II's predictions that future deliveries will be substantially higher than historic deliveries.

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The Draft Reliability Report attempts to respond to the recent to the recommendations and conclusions from the recent CBDA Peer Review, *A Strategic Review of CalSim II and its Uses for Water Planning, Management, and Operations in Central California* (Close and others 2003).

The Draft Reliability Report states:

> In *Peer Review Response,* DWR and USBR (2004) conclude the concern about overestimations of south-of-Delta deliveries is unwarranted because the 73-year study referenced by the panel is not designed to mimic historical conditions; rather it is intended to determine the reliability of the SWP when the demand equals the maximum Delta Table A amount (4.133 MAF) every year. The results of the referenced study are documented in *The SWP Delivery Reliability Report 2002*
> (DWR 2003b) as study 3 (2021B).
>
> A more appropriate method for assessing the ability of CalSim II to accurately model SWP operations is to compare the historical SWP deliveries with the simulated deliveries of the Historical Operations Study. DWR committed to conducting this study in *The SWP Delivery Reliability Report 2002* (DWR 2003b). The study is documented in the November 2003 Technical Memorandum Report *CalSim-II Simulation of Historical SWP/CVP Operations* (DWR 2003a). The Historical Operations Study is designed to assess CalSim II's ability to mimic historical operations of the SWP. In this study, historical input is used where reliable data are available. In situations where reliable historical record is not readily available, reasonable assumptions and estimates are made. (pages 10 & 11)

Before stating that this approach is the most appropriate response to the Peer Review concerns, DWR should reconvene the panel in order to review whether DWR's response satisfies the concerns raised in the original peer review. To verify that this response appropriately satisfies the concerns raised by that panel.

Additional specific comments on uses of CalSim-II in the Draft Reliability Report 2005 are attached in Appendix A.

Conclusion

PCL hopes that these comments assist DWR in arriving at a final version of the Reliability Report that corrects the serious deficiencies identified in the draft, and provides the

additional analysis recommended here. Without these additional efforts, the report would not fulfill DWR's responsibilities under the settlement agreement and the Article 58 of the SWP contracts, and would fail to provide local decision-makers with a credible basis to ensure that development decisions are grounded in an accurate assessment of deliverable SWP supply.

Sincerely,

Mindy McIntyre
Water Program Manager
Planning and Conservation League

Cc:
Lester Snow, Director , Department of Water Resources
Antonio Rossmann, Rossmann & Moore, LLP
Roger Moore, Rossmann & Moore, LLP
Dave Owen, Rossmann & Moore, LLP
Senator Kuehl,
Senator Machado
Senator Kehoe
Senator Ducheny
Senator Perata
Assemblywoman Wolk
Kip Lipper, Senator Perata's office
Carol Baker, Speaker, Assemblyman Nunez's office
Susan Kennedy, Chief of Staff
South Delta Water Agency-John Herrick, Michael Jackson
Dante Nomellini, Tom Zuckerman
David Nesmith, EWC
Alisha Dean, EJCW
Steve Macaulay, California Urban Water Agencies
Terry Erlewine, State Water Contractors terryerlewine@swc.org
Wes Banister, Metropolitan Water District
Debra Man, Metropolitan Water District
Individual SWP contractors

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APPENDIX A: **Specific comments on uses of CalSim-II in this Draft Reliability Report are highlighted below.**

Page 7: "Whatever assumptions are made, every responsible water delivery reliability analysis should expressly state the assumptions, methods and data used to produce its results. It should also be understood that those numbers depend on, and are no better then, the assumptions upon which they must necessarily rest."

This statement is entirely true. Yet this particular "water delivery reliability analysis" does not measure up to its own standard, because it does not adequately disclose the weaknesses of the key assumptions it makes and the key model upon which it relies. The reliability report should acknowledge that the simulated levels of SWP deliveries reported on the Draft Reliability Report are defined entirely by the explicit and implicit assumptions used in CalSim-II—they are CalSim-II's reliability results and not the results for the physical system itself—and should address the potential weaknesses in the "assumptions, methods and data" used to make those predictions.

Additionally, a statement such as this is so important that it should be made prominently, perhaps in a highlighted text box, rather than at the end of a paragraph in the body of the report.

Page 7: "For example, the demand 30 years ago for the SWP was not as high as it is currently or expected to be in the future. Because the need for SWP water then was relatively low, less water was exported through the SWP during normal and wet times then could have been if the demand had been higher. Simply put, less water was delivered because less water was needed."

The implicit assumption in this statement that there was no logic for contractors to take the water they were entitled to under Table A because 1) they had no need for it at that time, and 2) they had no place to store it for later use. If the assumption is that now and into the future the contractors will want to take delivery of their full Table A amounts—in other words, that circumstances have changed—then one or both of two conditions must be true 1) they need it and/or 2) they can store it. The reliability report should substantiate its reasons for assuming such a change in conditions.

On page 15, the Draft Reliability Report states that studies 4 and 5 were developed in discussions with SWP contractors and stakeholders involved with the development of the analysis associated with the environmental documentation for the Monterey Agreement. What analysis of current or future demand patterns and our available storage capacities is used to justify the assumption of a demand for the full Table A allotments? What are the assumptions about population growth, water use rates, availability of non-SWP supplies and available local storage capacity that lead to the conclusion that contractors will consistently ask for full Table A allotments?

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Page 7: "Conversely, the current or projected delivery capability of the a water project would be less if (1) demand for water from a water project was at its maximum level for many years, (2) no new facilities were built, and (3) the supply of the main sources of water was recently reduced because another entity with a prior water right increased its use of that source."

This statement is unclear and counterintuitive. The Draft Reliability Report often argues that higher levels of demand will increase the delivery capability not decrease it. DWR should clarify the point it is trying to make here or eliminate this statement altogether.

Page 8: "In the 2002 Reliability Report, the Department committed to conducting a comprehensive sensitivity analysis for assumptions contained in the CalSim-II model studies. This analysis is complete."

While this analysis is reported on in the Draft Reliability Report, DWR has made no attempt to use the results of that analysis to comment on the results of the CalSim-II modeling conducted for the reliability investigation. This seems to defeat the purpose of conducting and reporting on the sensitivity analysis. An attempt to consider the implications of the sensitivity analysis is included later in these comments.

Page 11: "The simulated deliveries in Figure 3-1 were adjusted for any differences between the historical and simulated carry-over storage in the SWP system reservoirs, Lake Oroville and SWP's portion of San Luis Reservoir."
Page 74 "(in Appendix E dealing with the Historical SWP/CVP Operations Simulation Technical Memorandum: Simulations of historically wet years, when the system was not supply constrained, may therefore be a poor indicator of the model's ability to accurately simulate future levels of development. Particular interest is therefore place on model results during the six-year drought of 1987-1992."

The Draft Reliability Report appears to offers up the Technical Memorandum Report entitled *CalSim-II Simulation of Historical SWP/CVP Operations* in order to support the legitimacy of the using CalSim-II to conduct the reliability analysis. If this is the goal then these two statements are problematic.

While the Draft Reliability Report gives no clear indication about what the adjustments referred to on page 11 entail, the fact that adjustments had to be made to generate the claimed correspondence shown in Figure 3-1 cannot stand without further explanation. The goal of the *CalSim-II Simulation of Historical SWP/CVP Operations* Technical Memorandum should have been to see if CalSim-II could be used to faithfully reproduce all aspects of system operations, not simply the SWP exports during the 1987-1992 drought. If the storage levels in SWP reservoirs were not faithfully reproduced and had to be adjusted in some unexplained way to generate the results in Figure 3-1, then the Technical Memorandum should not be used to build the creditability of the CalSim-II.

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In the same way, the comment in Appendix E that only the results for drought periods are critical for reliability analysis is not valid. The Technical Memorandum is being offered as support for the use of CalSim-II, not as a part of the reliability analysis itself. The claim that is being made is that the model faithfully replicated history and therefore has creditability in terms of simulating future conditions. The apparent recognition that the model did not do particularly well in normal and wet periods calls into question the validity of this claim.

In addition, even if CalSim II did accurately simulate deliveries in one past drought, that does not mean it can accurately simulate deliveries in a future drought, for constraints on the system are likely to be different. Water quality standards and endangered species protections have changed substantially since the 1987-02 drought, largely because the standards in place during that drought proved insufficiently protective. If the same drought conditions were to recur in the future, those heightened protections would likely prevent the SWP from exercising the same delivery capacity. CalSim II's predictions that those past diversions would be repeated therefore may prove the model's inadequacy rather than its credibility.

In keeping with the first comment, the inconclusive and somewhat opaque presentation of the *CalSim-II Simulation of Historical SWP/CVP Operations* Technical Memorandum results suggest that this report is about the reliability of SWP deliveries in the CalSim-II model and that the CalSim-II model is not a fully faithful representation of the how the system has been or presumably will be operated. Once again, it is fair to point out that if one wants to imagine future conditions then one must use some sort of model but the reader should not be left with the assumption that CalSim-II is a fully faithful representation of the system.

As an aside, Table 4 of the *CalSim-II Simulation of Historical SWP/CVP Operations* Technical Memorandum offers the most real, albeit limited, assessment of the reliability of the actual system if one is to assume that at some point in the future SWP contractors will consistently request their full Table A allotments. In 2001, contractors requested 4,124,126 ac-ft of SWP water and were allotted 1,607,570 ac-ft of supply. In 2003, contractors requested 4,126,929 ac-ft of SWP water and were allotted 3,714,233 ac-ft supply. These are two points on the exceedence curve of the real system reliability, certainly not enough to develop a robust reliability assessment. It is interesting to point out, however, that these delivery levels fall at roughly the 85% and 8% exceedence levels on the results for Study 4 that are meant to approximate current levels of development and demand (Figure 5.1). In terms of the hydrologic conditions 2001 and 2003 fall at approximately the 77% and 42% exceedence levels in terms of the Sacramento Valley water year index values for the period from 1922 to 1994 period simulated in CalSim-II. While far from a perfect metric for evaluating the performance of CalSim-II, this points out how the operations of the real system under roughly current conditions when nearly the full Table A amount was requested by the contractors compare with the simulated results.

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In terms of system reliability during dry periods, the most interesting conclusion to draw from this comparison is that actual operations in 2001, which benefited from a water supply associated with approximately the 75% exceedence level, provided a level of service of only 1,607,570 ac-ft while the CalSim-II simulations yielded a 75% exceedence level of supply of roughly 2,500,000 ac-ft (as read from Figure 5.1).

Page 16: "The Article 21 demand in the updated studies (4 and 5) is higher than the earlier studies for the December through March period."

It does not appear that DWR makes any attempt to explain why these higher levels were assumed. They are used in CalSim-II to prompt an export of water to SWP contractors when conditions warrant. While the Draft Reliability Report fairly comments on page 17 that "Incorporating supplies received under Article 21 into the assessment of water supply reliability is a local decision based on specific local circumstances, facts and level of water supply reliability required", including these numbers that are driven by a somewhat unjustified level of assumed Article 21 demand is not the clearest manner in which to present reliability analysis.

Page 25: "By referencing the curve for Study 5 in Figure 5-2, the following can be deduced":

- *In 75 percent of the years, the annuall delivery of the SWP is estimated to be at of above 2.7 maf per year (65 % of 4.13 maf).*

There is nothing special about the 75, 50 and 25% thresholds used in providing a narrative description of Figure 5.2 In fact it is equally valid to open and close the list of bullets with statements like:

- The maximum amount of water that can be delivered in response to full Table A demands with 100 percent reliability, in the CalSim-II model, is 187,000 ac-ft.
- Under the least supply constricted conditions the SWP will be able to deliver, in the CalSim-II model, the full Table A allotments.

Without even worrying about whether or not the assumptions used in the CalSim-II model are valid or not, these two statements are as valid as the three offered by DWR and they create a much different impression of SWP reliability.

Even if 100% reliability is not a valid standard, water utility plans for a system that will fail 25% of the time, as is the corollary of the 75% exceedence, are no more valid. Municipal utilities are often looking for, 90-95% reliability. According to these standards, Figure 5-2 suggests that the reliability of the system is between 1.4 maf and 0.8 maf. These numbers, which are no more or less valid than those reported by DWR, are perhaps more useful for water managers in assessing the reliability of a water supply.

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Page 26: "In the case of 1977, it is reasonable to assume that up to 500 taf of 1976 allocated Table A water could be carried over to 1977."
This sort of conditional post-processing of model output, which could have ripple effect across the rest of the simulation with potential changes in model results, is not valid and this whole section should be removed. To its credit DWR does not try and use any of this after the fact hand waving in the Table and Figures published in the Draft Reliability Report. Nonetheless, by including this narrative DWR is attempting to argue both that the model can be trusted and that the model cannot be trusted. This is not legitimate model interpretation.

Page 49: "The estimate could be viewed as too low because the Department of Water Resources (DWR) is planning to have facilities in place by 2025 that will increase the reliability of the SWP. The estimate could be viewed as too high because there is the potential for exports to be required to be reduced to protect endangered fish species."

It is inappropriate to speculate on what deliveries could be with new facilities when the information is to be used under the provisions of Senate Bill 221 to verify that water supplies are available for new developments.

Page 78: "Table E-1 Summary of the Expected Elasticity Index (EI) and Sensitivity Index (SI) for Selected Variables."

These very interesting results are included in the Draft Reliability Report and are then ignored completely interpreting the results of the reliability analysis. Let us for example attempt to recast the statement offered above:

- The maximum amount of water that can be delivered in response to full Table A demands with 100 percent reliability, according to the CalSim-II model, is 187,000 ac-ft.

If the sensitivity analysis is valid, it is legitimate to make the following statements.

- If the assumed levels of Banks Pumping vary by ±10% relative to the base level assumed in the CalSim-II simulation, then the maximum amount of water that be delivered in response to full Table A demands with 100 percent reliability, in the CalSim-II model, will very between 184,195 and 189,805 ac-ft.
- If the assumed levels of Oroville inflows vary by ±10% relative to the base level assumed in the CalSim-II simulation, then the maximum amount of water that can be delivered in response to full Table A demands with 100 percent reliability, according to the CalSim-II model, will very between 182,138 and 191,862 ac-ft.

DWR should either make these sorts of statements or they should not attempt to use the results of the sensitivity analysis to assert the legitimacy of the use of CalSim-II for SWP reliability analysis.

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STATE OF CALIFORNIA -- THE RESOURCES AGENCY

ARNOLD SCHWARZENEGGER, *Governor*

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

April 20, 2006

Ms. Mindy McIntyre
Water Program Manager
Planning and Conservation League
921 11th Street, Suite 300
Sacramento, California 95814

Dear Ms. McIntyre:

This letter responds to your letter dated December 22, 2005 providing comments of the Planning and Conservation League on the draft of the State Water Project Delivery Reliability Report–2005 (DRR (2005)). Your letter expresses concern regarding the adequacy of the analysis, criticizes the timing of the release of the report, makes several recommendations for improvement, and includes an attachment with comments regarding specific statements in the draft report. The following addresses the body of your letter. Responses to the detailed comments in the attachment of your letter are included as an attachment to this letter.

Your letter states that the draft DRR (2005) should mention that it is required per the settlement agreement to the case *Planning and Conservation League v. Department of Water Resources* (2000) 83 Cal. App. 4th 892. The final report includes such a statement. Your comment also says the draft DRR (2005) does not satisfy the requirements of the settlement agreement. This report is the first one issued since the settlement agreement became effective in May, 2003 and updates an earlier report (The State Water Project Delivery Reliability Report–2002). The 2002 report was designed to meet the requirements of the attachment to the settlement agreement, which was very near final at that time. Both reports include useful information for State Water Project (SWP) contractors, planners and interested parties on the delivery capability of the SWP. The Department of Water Resources (Department) believes these reports fulfill the requirements of Principle 1 in Attachment B of the settlement agreement. It should be noted that, although not a requirement of the settlement agreement, drafts of each report underwent public review. We believe this process improves the final report. The final of the first report was revised in response to public comments and the comment letters and their responses were included as an appendix. The final DRR (2005) has been modified in a similar way.

Ms. Mindy McIntyre
April 20, 2006
Page 2

You comment that the use of CalSim-II as the sole tool for determining reliability is inappropriate due to the lack of calibration and other deficiencies as identified in comments on the draft 2002 report and due to inadequacies mentioned in the peer-review report, *A Strategic Review of CalSim-II and its Use for Water Planning, Management, and Operations in Central California* (Close and others 2003). The final 2002 report includes thorough responses to the comments received on the draft 2002 report. Updated responses to the issues regarding CalSim-II mentioned in your letter are included in Attachment 2 to this letter. As mentioned in the draft DRR (2005), several studies have been conducted analyzing the ability of CalSim-II to simulate water project operations. The results support the conclusion that CalSim-II is a useful and appropriate tool for assessing the delivery capability of the SWP. You also comment that the peer reviewers should be reconvened to review the Department's written response to their review. The peer review of CalSim-II was an intensive and expensive effort involving many staff hours to develop the background information for the reviewers and handle the administrative details for the participation of the panel members and the two-day public meeting of the review itself. Some of the panel members, as well as other experts who were not on the panel, are and will continue to be a great resource to both the Department and Bureau of Reclamation modeling staff. We do not, however, believe conducting a peer review of the response is an effective use of the Department's staff resources.

Several of the concerns within your letter relate to the uncertainty in future conditions that may affect water supplies, such as levee failures in the Delta, climate change, or declines in the population of Delta fishes. Information relevant to these factors is evolving rapidly but has not reached a level at which it can be quantitatively incorporated into delivery projections of the SWP. The Department is working on two projects that will improve our ability to make qualitative or quantitative statements about the reliability of conveyance across the Sacramento-San Joaquin Delta. The first is the Delta Risk Management Strategy, which will assess risks to the Delta from floods, seepage, subsidence, and earthquakes; evaluate the consequences of levee failure; and develop recommendations to manage the risk. The second is a broader public process to develop a shared vision of a sustainable Delta that continues to support societal needs related to recreation, land use, water supply, transportation, energy, and environmental health. This Delta Vision process incorporates the requirements of AB 1200, passed by the legislature and signed by the Governor in 2005. None of these efforts will be completed before release of the next Reliability Report, but they may yield some preliminary results and conclusions in time for the next report, and will be fully incorporated into subsequent Reliability Reports.

Ms. Mindy McIntyre
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Page 3

As directed in the Governor's Executive Order S-3-05, the potential impacts of climate change are being analyzed. This effort and the results referenced in your letter are broad brush estimates of the potential impact upon the SWP 50 to 100 years into the future if no additional conveyance facilities or upstream reservoirs are built. This information is helpful in developing strategies for the future management and development of the State's water resources, including improvements to the SWP. The Department does not want to leave any reader of DRR (2005) with the impression that this developing information is being ignored. Therefore, the final report has been modified accordingly.

You comment that information planned to be used in the draft DRR (2005) should not have been given to the State Water Contractors in the spring of 2005 for incorporation into their Urban Water Management Plans. The Department provided the contractors results of the analyses planned to be used in the draft report because they were the best information available at that time. The information was conveyed in the Notice to State Water Project Contractors No. 05-08 as an excerpt from the draft technical chapter of an incomplete draft report. There was no intent of the Department to exclude this information from the public. This notice was not announced on the Department's Home page but all State Water Project Contractors' Notices are available at http://www.swpao.water.ca.gov/deliveries/. As soon as the Department learned that you wanted a copy of this information, it was provided to you. It is the Department's responsibility to provide the best available information to water supply contractors of the SWP.

You make the point that the report should be available to the public as a draft and finalized prior to deadlines for local agency Urban Water Management Plans. The Department agrees with this comment. It is unfortunate that the review of the draft report and completion of the final report could not be done in late 2004 or early 2005 for full incorporation into Urban Water Management Plans. The objectives of the Department for the Reliability Report are to encourage public discussion and understanding of the estimation of the SWP delivery capability, meet the conditions of the settlement agreement, and provide the best available quantification of SWP deliveries. Given the situation, the Department chose to provide the information to the contractors, as described above, and to delay the completion of the report to allow public review of a draft. The next time the Reliability Report is due in the same year as the Urban Water Management Plans, the Department will strive to complete it as early in the year as possible.

Ms. Mindy McIntyre
April 20, 2006
Page 4

Your letter also makes the observation that the percentage of time the assumed demand is met decreases as the level of demand increases. This is correct. The results contained in the draft DRR (2005) are shown as percentages of the maximum Table A amount so the information can be easily interpreted by SWP contractors and incorporated into their analyses. Presenting the information as a percentage of the assumed demand would require additional calculations and would increase the potential for misinterpretation. For example, with the data presented as a percentage of the maximum Table A amount, a contractor can take this percentage and apply it to the specific maximum Table A amount for his or her district to determine how much water would be available to the district. If the information were presented as a percent of the demand, the amount of water that it equates to must be determined by referencing the assumed demand for a specific year and then calculating the amount of water associated with it. Attachment 1 is a plot of the results of the draft DRR (2005) as percentages of the assumed demand. It confirms your observation that the percentage of time the assumed demand is met decreases as the level of demand increases.

Your letter recommends the report include scenarios for future SWP demands that reflect the approach taken in the current California Water Plan. The Water Plan includes estimates for California's water demands which assume a continuation of current trends, a less intensive use of water, and a more intensive use of water. As noted in the Water Plan, the scenarios presented there are for demonstration of the kind of scenarios that should be looked at in more detail once the analytic tools are developed. The Department will undertake an effort to define a range of future demand scenarios for the SWP. This effort will not only provide information for future delivery reliability reports but also for the next Water Plan. As a point of clarification, your letter refers to the Tulare Lake hydrologic region analyzed in the Water Plan as an SWP service area. A few of the SWP agricultural contractors are in the Tulare Lake hydrologic region. Their service areas occupy a portion of the hydrologic region. The region is much larger than these service areas and includes the cities of Fresno, Visalia, and Bakersfield.

You express a concern about the consistency of the studies in the draft DRR (2005) with the description of the operation of the SWP in the Operations Criteria and Plan (OCAP), upon which the current biological opinions for the SWP and Central Valley Project are based. Studies 4 and 5 of the draft DRR (2005) use the same version of CalSim-II as the OCAP analyses and are, therefore, consistent with the OCAP project description. The Table A and Article 21 demands of the studies are within the range of the OCAP project description. If regulatory standards are modified in the future, the model will be updated to include any modified standards.

Ms. Mindy McIntyre
April 20, 2006
Page 5

Your letter states that Article 21 should not be recommended as a supply to be integrated as a firm annual supply in planning documents. This comment is regarding the examples shown in Chapter 6 which illustrate how to calculate water supplies from the information presented in the report. In response to your concern, a footnote alerting the reader to the variability of Article 21 deliveries and referring back to the discussion in Chapter 5 has been added to the tables addressing average values. Chapter 5 thoroughly discusses the limitations of Article 21 supply.

The final report will be issued soon and will include an appendix containing the comment letters on the draft report and the Department's responses. Thank you for your comments and recommendations. If you wish to discuss this report further, please contact me at (916) 653-1099 or kkelly@water.ca.gov. Francis Chung, Chief of the Modeling Support Branch of the Bay-Delta Office, should be contacted for technical questions on the CalSim-II modeling studies. He may be reached at (916) 653-5924 or chung@water.ca.gov.

Sincerely,

Original signed by

Katherine F. Kelly, Chief
Bay-Delta Office

Attachments

cc: (See attached list.)

Mr. Lester Snow, Director
Department of Water Resources
1416 Ninth Street, Room 1115-1
Sacramento, California 95814

Mr. Antonio Rossmann, Rossmann & Moore, LLP
380 Hayes Street, Suite One
San Francisco, California 94102

Mr. Roger Moore, Rossmann & Moore, LLP
380 Hayes Street, Suite One
San Francisco, California 94102

Mr. Dave Owen, Rossmann & Moore, LLP
380 Hayes Street, Suite One
San Francisco, California 94102

Honorable Sheila Kuehl
Member of the Senate
State Capitol, Room 5108
Sacramento, California 95814

Honorable Michael Machado
Member of the Senate
State Capitol, Room 5066
Sacramento, California 95814

Honorable Christine Kehoe
Member of the Senate
State Capitol, Room 3086
Sacramento, California 95814

Honorable Denise Ducheny
Member of the Senate
State Capitol, Room 4081
Sacramento, California 95814

Honorable Don Perata
Member of the Senate
State Capitol, Room 205
Sacramento, California 95814

Honorable Lois Wolk
Member of the Assembly
State Capitol, Room 6012
Sacramento, California 95814

Honorable Don Perata
Member of the Senate
Attn: Kip Lipper
State Capitol, Room 205
Sacramento, California 95814

Honorable Fabian Nunez
Speaker of the Assembly
Attn: Carol Baker
State Capitol, Room 219
Sacramento, California 95814

Ms. Susan Kennedy, Chief of Staff
Governors Office
State Capitol
Sacramento, California 95814

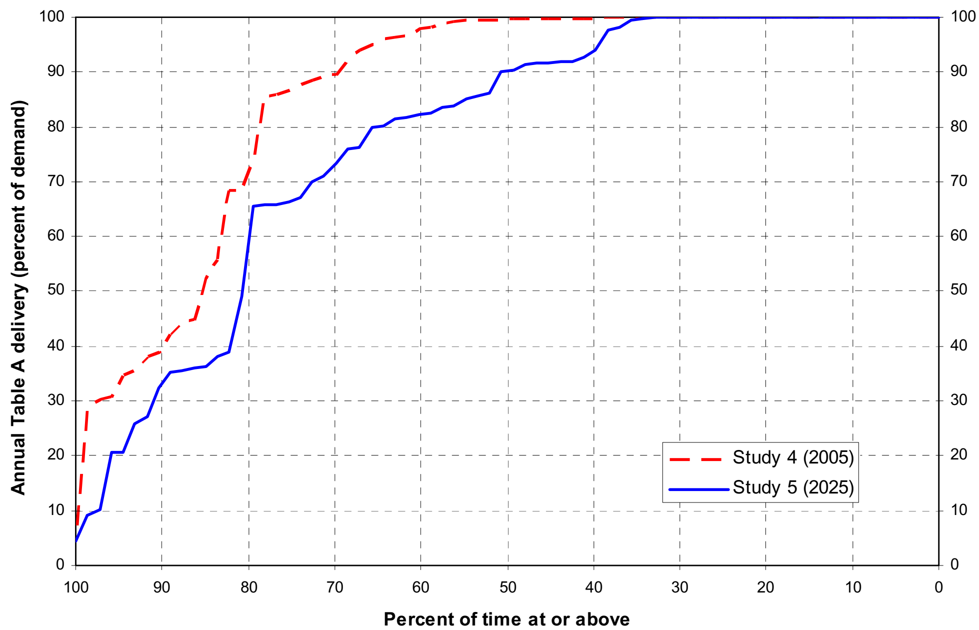
Mr. David Nesmith
Environmental Water Caucus
Post Office Box 471958
San Francisco, California 94147-1958

Executive Director
California Urban Water Agencies
455 Capitol Mall, Suite 705
Sacramento, California 95814

Mr. Terry Erlewine, General Manager
State Water Contractors
455 Capitol Mall, Suite 220
Sacramento, California 95814
terryerlewine@swc.org
Will distribute to SWCs

Attachment 1
Planning and Conservation League

SWP Delta Table A delivery probability
for studies 4 and 5
as percent of Table A demand



Study 4 simulates a variable Table A demand of 2.3 – 3.9 million acre-feet (MAF) per year, dependent upon water-year type.

Study 5 simulates a variable Table A demand of 3.9 – 4.1 MAF/year, dependent upon water-year type.

Attachment 2
Response to PCL

Responses to comments from Planning and Conservation League (December 22, 2005) on Draft State Water Project Delivery Reliability Report – 2005

Responses to comments on the adequacy of CalSim-II

Comment: **CalSim-II has not been calibrated or validated.**

Response: CalSim-II is essentially a continuous accounting model, supplemented by a linear programming module to optimize the monthly operation of the system without foresight about the conditions in the next period. The primary physical law governing the simulation procedure is conservation of mass, maintaining a mass balance from one period to the next, while optimizing allocations of the available water in that period without foresight about the future periods of simulation. Models such as CalSim-II are inherently different from models that simulate hydrologic processes based on the physical laws governing the precipitation-runoff and the physical routing of water through a system of channels with defined geometry, roughness, streambed slope, etc. The classical model calibration process is difficult to apply to planning models, such as CalSim-II, that are primarily used to predict operations and water availability for a fixed level of development in the future. Continuing development of new supplies, along with changes in demands and the regulatory environment have all resulted in considerable changes to the management of the Central Valley Project (CVP)/State Water Project (SWP) system in the past 35 years. Project operations to meet future demands are often predicated on operation rules, storage and conveyance facilities, and demand levels which are necessarily different from historical conditions.

Although classical approach to model calibration can not be applied to models like CalSim-II, calibration of some of the important components of the model is possible, and has been done. For instance, one of the most important components of the model, its hydrologic component, has been calibrated by including closure terms in the form of local surface water accretions from every depletion study area (DSA) of the model network to match the historically available stream gage records. The routine used to determine the Sacramento River flows and the corresponding Delta exports that meet Delta water quality standards, is an Artificial Neural Network (ANN) model that is trained using the calibrated Delta Simulation Model (DSM2) prior to being used in CalSim-II simulation runs. Also, a revised groundwater-surface water interaction module is currently being developed that uses groundwater-surface water response functions produced by the simulation of the historical groundwater pumping

1

Attachment 2
Response to PCL

amounts that match the available historical data on groundwater levels and stream gage data. The above components of CalSim-II, that are either directly or indirectly calibrated, are three of the most important components of the model that have the most significant impacts on the simulation results, and as such, it would be inaccurate to claim that CalSim-II has not been calibrated. In the absence of a classical approach to calibration applicable to complex models like CalSim-II, the next best approach is generally to set model parameters for a simulation run relying on experience and then verifying the results of the simulation run by comparing to historical operations. To verify model results, the Department of Water Resources (DWR) conducted a 24-year simulation using historical input from 1975 to 1998. The results of this study showed remarkable matching of the simulated values of the major components of system operation to historical values. Components such as stream flows at key locations and the net Delta outflow index showed little difference between simulated and historical values. Therefore, it would be inaccurate to claim that CalSim-II has not been validated. For detailed examination of the validation study the reader is referred to *CalSim-II Simulation of Historical SWP/CVP Operations, Technical Memorandum Report*, November 2003.

Comment: **It is unclear whether CalSim-II incorporates limitations to groundwater use in the Sacramento Valley.**

Response: The issue of over-estimation of the water available in the Delta as a result of excessive pumping of groundwater in the Sacramento Valley was examined in the *CalSim-II Simulation of Historical SWP/CVP Operations, Technical Memorandum Report*, November 2003, and addressed in the *Peer Review Response* report of August 2004. The results of the simulation indicated that CalSim-II, in fact, under-estimates the long-term contribution of the groundwater when compared to the historical groundwater pumping in the Valley, and only slightly over-estimates this contribution in extended drought periods. The *Peer Review Response* report states:

> "The mix of surface water and groundwater used by the model to meet Sacramento Valley consumptive demands depends primarily on project water allocation decisions and levels of minimum groundwater pumping that are specified in the model. Over the 24-year period average annual net groundwater extraction in CalSim-II as compared to estimates based on the Central Valley Groundwater Surface Water Model (CVGSM) is lower by 378 thousand acre-feet (taf). The average annual net stream inflow from groundwater in CalSim-II is 190 taf greater than estimated by the CVGSM for the same period. The combined effect of dynamically modeling groundwater operations in CalSim-II (pumping, recharge and stream-aquifer interaction) leads to 188 taf per year <u>less water being available to the Delta</u>. For the 1987-92 period the combined effect results

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> in 46 taf per year additional water being available to the Delta. Thus the Historical Operations Study concludes that the current representation of groundwater in CalSim-II results, on average, in an under-estimation of water available at the Delta."

For more details on how groundwater-surface water interaction is modeled in CalSim-II, the reader is referred to pages A-2 and A-3 of the *Peer Review Response* report. As mentioned above, a revised groundwater-surface water interaction module is currently being developed and will be implemented in CalSim-III to use groundwater-surface water response functions produced by the simulation of the historical groundwater pumping amounts that match the available historical data on groundwater levels and stream gage data.

Comment: **The CalSim-II model should not be used to make absolute predictions, such as those incorporated into the Reliability Report.**

Response: It is true that a planning model like CalSim-II is best used in the comparative mode, when a "without project" scenario is compared with a "with project" scenario. However, this does not preclude the use of this model in studies like the ones used in the Delivery Reliability Report, provided that the users are sufficiently aware of the model assumptions and how to use the output data that CalSim-II simulations provide. The conversion of raw output data to usable information in planning studies requires judgment by the user. As discussed earlier, in the response to comments on the validation efforts by the Historical Operation Study, CalSim-II does very well in mimicking historical operations as evident by the comparisons made on the key system operation components. Furthermore, the reader is referred to the general comments made by the CALFED peer review panel in the executive summary of their December 2003 report. The panel proposes the following question: "Is the general CalSim modeling approach appropriate for predicting the performance of the general facilities and for use in allocation planning, assessing water supply reliabilities and for carrying out operational studies?" The panel's answer to this question is: "We believe the use of an optimization engine for simulating the hydrology and for making allocation decisions is an appropriate approach and is in fact the approach many serious efforts of this kind are using. It is a substantial improvement of the previous modeling approaches and provides a basis for consensus among federal and state interests. The modeling approach addresses many of the complexities of the CVP/SWP system and its water management decisions."

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Comment: CalSim-II does not recognize or report uncertainty.

Response: Recognizing and addressing uncertainties in the CalSim-II simulations is an important issue that has been under consideration by the DWR and Bureau of Reclamation model development teams. After several discussions with the experts in the area, a research project is planned as a joint effort of DWR and the University of California at Davis to further investigate ways to identify and address uncertainties.

In addition to the planned joint effort with the UCD, DWR has recently completed the CalSim-II sensitivity analysis study focusing mainly on the Sacramento Valley hydrology, Sacramento-San Joaquin Delta water quality, and SWP operations. As a supplement to the sensitivity study, DWR will conduct a more focused statistical analysis of the impact of model input parameters on the modeled SWP.

Comment: CalSim-II may produce "cyber water."

Response: This comment does not indicate how the 75 percent exceedance level was estimated for the 2001 water supply. From the comments made later in Appendix A, it appears to refer to the Sacramento Valley water year index values for the period 1922 to 1994. The Sacramento Valley water year index data alone would not provide an accurate estimate of the capability of the SWP to deliver water since it does not consider project storage. Deliveries to the SWP south-of-Delta contractors in CalSim-II are not based on the Sacramento River Index, but on the storage in the SWP conservation facilities, Lake Oroville and SWP portion of San Luis Reservoir, the forecasted inflow to Lake Oroville, and other unregulated flows and accretions. Based on Figure 5-1 of the report, an annual delivery of 1.6 million acre-feet (maf) or more would occur in 85 percent of the years.

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Response to PCL

Responses to Comments in Appendix A

First comment regarding page 7 of the draft report

The report should highlight the weaknesses in the analysis and put the referenced statement in a text box.

The final Report (2005) has been modified to expound upon uncertainties associated with the analyses. Many of these modifications have been done in response to the comments of the PCL. We believe the final report sufficiently addresses the uncertainties associated with the projections.

Second comment regarding page 7 of the draft report

What analysis of current or future demand patterns is used to justify the assumption of a demand for full Table A allotments?

As stated on page 15 of the draft report, "The assumed demands for studies 4 and 5 were developed in discussions with SWP water contractors and stakeholders involved in the development of the analyses associated with the environmental documentation for the Monterey Agreement." SWP contractor's Table A requests for the real-time operations are developed and submitted to DWR by contracting agencies and their consultants. Examination of the historical requests show an increasing trend and they reach the full Table A request of 4.1 maf in 2001. As the following table indicates, contractors' requests were at full Table A amounts in 5 out of the 6 recent years.

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Response to PCL

Year	SWP Contractor's Table A Request (maf)
1986	2.4
1987	2.7
1988	2.6
1989	3.0
1990	3.1
1991	3.5
1992	3.6
1993	2.7
1994	2.7
1995	3.1
1996	2.7
1997	3.0
1998	3.2
1999	3.2
2000	3.6
2001	4.1
2002	3.9
2003	4.1
2004	4.1
2005	4.1
2006	4.1

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Third comment regarding page 7 of the draft report

Statement: The following statement should be clarified or removed.

"Conversely, the current or projected delivery capability of the a water project would be less if (1) demand for water from a water project was at its maximum level for many years, (2) no new facilities were built, and (3) the supply of the main sources of water was recently reduced because another entity with a prior water right increased its use of that source."

The statement is revised as follows:
"Conversely, the projected deliveries of a water project would be less than the past if the water project had been operated at its maximum ability for many years, no new facilities were planned to be built, and the annual supply from one of its main sources of water was recently reduced and would remain at the reduced level."

Comment regarding page 8 of the draft report

The results of sensitivity analysis are not included in the report.
(See response to the last comment in this appendix.)

Response to comments regarding page 11 and page 74 of the draft report

Historical Operation Study as a means to validate CalSim-II

An objection is raised in Appendix A of the letter to the Department's claim that the results of the Historical Operation Study validate the CalSim-II model as an appropriate tool for planning studies. The specific objection seems to be to the statement in the Delivery Reliability Report, page 11 that states "The simulated deliveries in Figure 3-1 were adjusted for any differences between the historical and simulated carryover storage in the SWP system reservoirs, Lake Oroville and SWP's portion of San Luis Reservoir." The letter from the Planning and Conservation League raises the objection that "If the storage levels in SWP reservoirs were not faithfully reproduced and had to be adjusted in some unexplained way to generate the results in Figure 3-1, then the Technical Memorandum should not be used to build the credibility of the CalSim-II."

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The detailed explanation of how and for what purpose the deliveries were adjusted to produce Figure 3-1 was deemed to be out of the scope of the 2005 update of the Delivery Reliability Report and the reader is referred to the Technical Memorandum Report, pages 18 and 19, for further detail. In summary, the resulting simulated annual deliveries during the 6-year drought of 1987-92 were adjusted by post-processing to account for the differences between the historical and simulated initial and end-of-year storages in the SWP system reservoirs. The adjustments were made to show the resulting year-to-year deliveries had the model's delivery for that particular year reflected identical use of stored water from the SWP reservoirs. In both the adjusted and the unadjusted case, however, the average annual delivery during the 6-year drought was 1,930 taf per year. The following table and the attached charts (Figure 1 for the unadjusted simulated deliveries, and Figure 2 for the resulting deliveries after adjustments) should clarify the post-processing procedure.

Calendar Year	Simulated SWP SOD Deliv (TAF)	Simulated January 1 Storage (TAF)	Simulated December 31 Storage (TAF)	Simulated Storage Withdrawal (TAF)	Historical Storage Withdrawal (TAF)	Storage Withdrawal Adjustment (Historical-Simulated) (TAF)	Adjusted Delivery (TAF)
1987	2567	4120*	2634	1486*	1182*	-304	2263
1988	1903	2634	2026	608	1050	442	2345
1989	2350	2026	2635	-609	-597	12	2362
1990	1851	2635	1738	897	1512	615	2466
1991	1266	1738	1730	8	-682	-690	576
1992	1652	1730	1748	-18	-110	-92	1560
Average**	**1930**						**1930**

* This storage and the corresponding withdrawals are from April 1, 1987 to December 1987, because the 6-year drought is assumed to have started from April 1, 1987, the last month before the onset of the drought in which the system's reservoirs were full.

** Rounded off to the nearest 10 taf.

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Figure 1
Historical versus Simulated SWP Table A Delivery (Unadjusted)
1987-1992 Dry Period

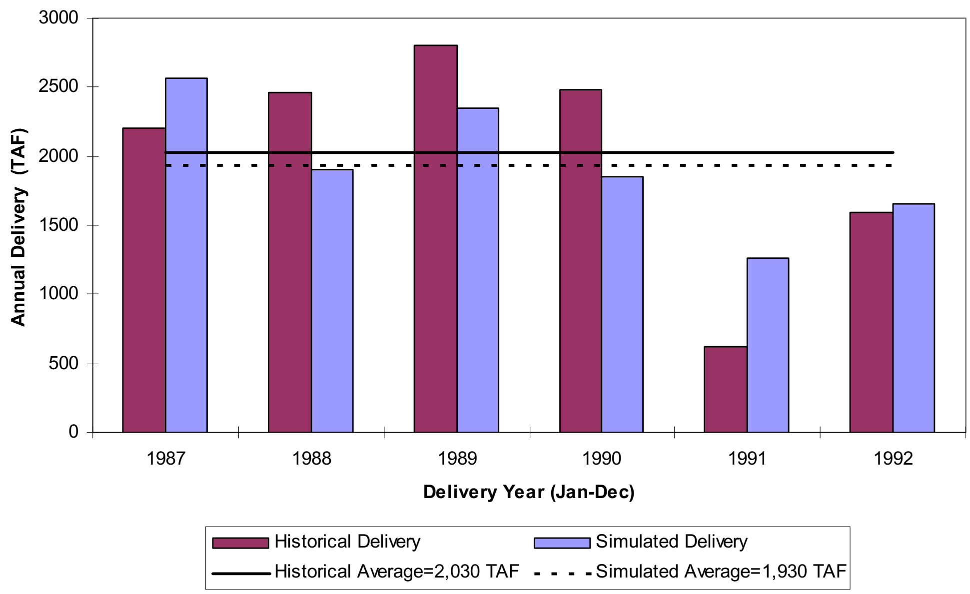

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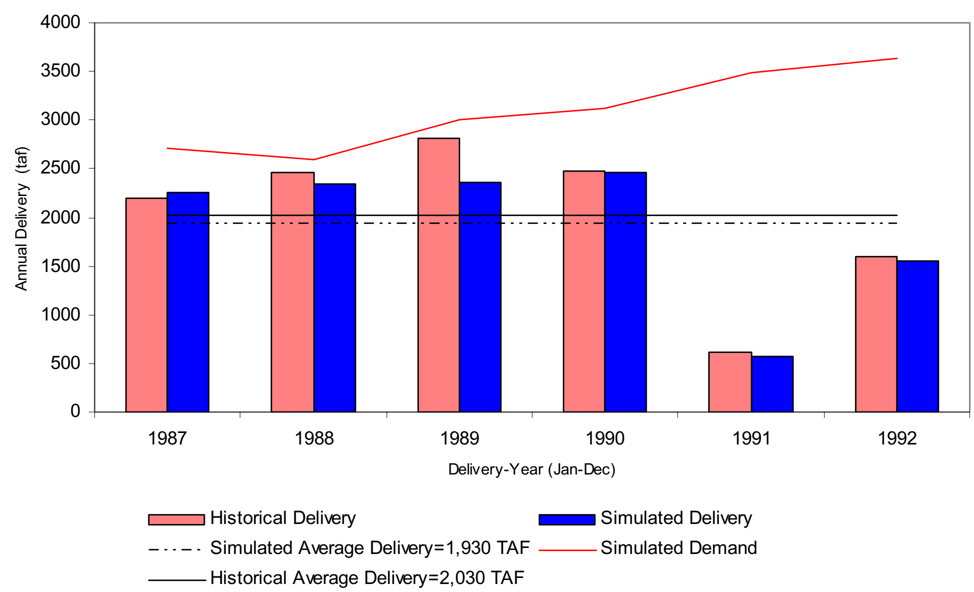
Figure 2
Historical versus Simulated SWP Table A Delivery (Adjusted)
1987-1992 Dry Period



The simulated month-to-month operation of the system may vary substantially from the actual historical operation, although the long-term average flows and deliveries are typically close. Therefore, post-processing of some of the raw data resulting from the simulation run is sometimes necessary to account for some of the unavoidable differences between the historical and simulated results. Some of the factors that could contribute to these differences in the month-to-month operation are:

- Delivery versus carryover storage rules
- Delta outflow requirements to comply with SWRCB standards
- South-of-Delta demand assumptions
- Level of north-of-Delta groundwater pumping
- Rule curves to transfer water from north-of-Delta reservoirs to San Luis Reservoir
- Crop consumptive use of applied water and agricultural water use efficiency
- Assumptions on historical land use, and project versus non-project demands
- Stream-aquifer interactions

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- Historical operation based on decisions that are made in shorter time resolutions that the monthly simulation model captures, such as flood control operations, hydropower operations, export curtailments due to fish take limits, system scheduled and unscheduled outages, etc.
- CVP reservoirs balancing north of Delta
- Compliance with the provisions of the Coordinated Operations Agreement
- Drought water bank and water transfers

The following summary should be helpful in determining how well the Historical Operation Study was able to reproduce the actual historical records on the key components of the system operation. Figure 10 on page 46 of the Technical Memorandum Report shows that the simulated long-term average SWP delivery to the south-of-Delta contractors exceeded the historical average delivery by only 1.1 percent. Figure 12 on page 48 (same as Figure 2 in this response) shows that the simulated average annual delivery in the 1987-92 drought was less than the historical average delivery by 4.9 percent. Figure 26 on page 62 shows that the total project exports from the Delta during the 6-year drought was less than the historical average by only 0.2 percent. Figures 31 through 35 on pages 67 through 71 show that the simulated average annual flows in various key locations along the Sacramento River vary from the historical values by 0.5 percent to 4.5 percent. Figure 37 on page 73 shows that the simulated long-term average annual net Delta outflow index is less than the historical value by 3.1 percent. There were many other simulated variables that were compared to their historical values in the Technical Memorandum Report that reflect a more complete picture of how well CalSim-II was able to mimic historical operations. These results, of course, should be examined carefully with an eye on what caused the variation, and how significant the variations were. In other words, how close is close enough to validate CalSim-II as an appropriate model in long-term planning applications, and whether the model reflects the historical record on important system performance measures with sufficient accuracy.

Response to comment regarding page 16 of the draft report

Updated Article 21 demand should be explained.

The demand for Article 21 water is submitted to DWR by the contracting agencies and the increase of 50 taf in December through March is due to the increased requests submitted to DWR by the Metropolitan Water District of Southern California.

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Responding to comment regarding page 25 of the draft report

There is nothing special about the thresholds used to reference the curve in Figure 5-2. They should be changed as recommended.

The percentages of 75, 50, and 25 are chosen as simple examples to illustrate how to read the curve. These percentages are at or near the mid-range of the curve and the results are surrounded by several data points. Using the end points of the curve for an illustration is not as effective and, in the case of the lowest delivery value, focuses on the result for a single year.

Response to comment regarding page 26 of the draft report

DWR's attempt at post-processing 1976-77 deliveries is not valid

As stated on page 25 of the draft report, CalSim-II is a planning model and is best used for estimating SWP performance over long periods of time. Considerable judgment should be applied when evaluating CalSim-II results for shorter periods of time. This is especially true for estimates for the single driest year on record in a 73-year sequence.

Response to comment regarding page 49 of draft report

It is inappropriate to speculate on what deliveries will be with new facilities.

The paragraph is deleted.

Response to comment regarding page 78 of the draft report

Results of the sensitivity analysis should be applied to interpreting the results of the reliability analysis.

The Sensitivity Analysis Study is discussed in the draft report to inform the reader of the status of DWR's commitment to conducting such a study. The sensitivity study will be further analyzed in view of the SWP Delta deliveries and the results of that analysis will be incorporated as appropriate in the next Reliability Report.

It should be noted that the summary results on SI and EI shown in the Table E-1 are strictly applicable to the long-term (1922-1994) performance of the project. It is not appropriate to apply these results to a single year. In addition, these results should be applied with caution since they are applicable only within the investigated range of variation of the input parameters. The sensitivity study analyzed the response of the SWP total and Delta delivery for a 5 percent reduction in the Banks pumping capacity and ±5 percent variation in Oroville inflow.

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California Department of Water Resources December 19, 2005
SWP Reliability Report-Attn: Johnnie Young-Craig
P.O. box 042836
Sacramento, CA 94236-0001

Subject: The State Water Project Reliability Report 20005—Draft

Dear Sirs:

The report informs us that it is an update to the 2002 edition of the report of the same name. The foreword states that DWR will update this information every 2 years. However, the Department of Water Resources is derelict in not acknowledging that this report is a requirement of the amendments to the SWP contracts that was agreed to in the settlement negotiations pursuant to the Monterey litigation.

Purpose

The report is not simply information to help the contractors understand to what degree they can rely on SWP deliveries, but in fact is an essential requirement stemming from the need to eliminate "paper water" from the contracts. The Appellate Court was clear on the problems in planning that proceeded from the previous interpretations allowed by DWR that in effect created the notion of "paper water." In the settlement negotiations it was made clear that a well documented and unambiguous report of delivery reliability was essential to the elimination of "paper water." Accordingly, this report must be reviewed with that primary objective in mind.

Does the report fulfill that purpose? Its self-defined scope certainly allows for that possibility, but without serious calibrations of the main analytic tool, CALSIM II, used to perform the analysis, it is doubtful that it can. This deficiency has been pointed out many times over the past several years and DWR has still failed to come to grips with it. Their limited study, whose results are summarized in the draft, do little to meet the requirements of a legitimate calibration. Calibration, properly done, allows the program developers to assure that all elements of the computer program work properly. In the case of CALSIM II the calibration will show from where in the operational regimen of the SWP the increased amounts of water it predicts will materialize. Even the Scientific Peer Review Committee stated as much; they noted without a proper calibration there is no assurance that the results that are calculated from an optimization routine are a real solution. They must be shown to conform to realistic operations that are known to be feasible. No where in the report is this demonstrated or even hinted at.

Previously Noted Deficiencies

The lack of calibration and other deficiencies have been made known the DWR in formal comments on the 2002 draft. On reading this draft there seems to be no acknowledgement that any of these deficiencies have been addressed. The list of these previous deficiencies is highlighted below.

1.) The frequency diagrams are without statistical merit and therefore cannot be used to provide estimates of "reliability."

2.) The draft continually refers to CALSIM II as a "simulation." Until CALSIM II has been calibrated to show that it conforms to a real and feasible operational regimen, its results cannot be interpreted as though it is a simulation. Even then, its computerized configuration is not even close to what is ordinarily referred to as "simulation." CALSIM II is an optimization model in which the objective function is to maximize exports of water from the Delta given certain constraints. In typical optimization models not all solutions are feasible. Only calibration can establish that possibility. This model does not meet that criterion.

3.) The model makes certain assumptions about the individual contractors' demand for SWP deliveries. Those demand functions have not been vetted against the realistic capabilities of each contractor to take SWP water. In one case the assumption is factually wrong- San Luis Obispo County physically cannot take its full Table A amount of 25,000 acre feet because it is limited by physical capacity of the SWP pipeline to only 4800 acre-feet. Nonetheless, the model assumes that SLO County will take 25,000 acre-feet when it is available at the Delta. Also there are some contractors that are unable to take their full Table A amount simply because they don't have the proper amount of equalizing storage to take the water when the SWP says it is available. The demand functions have not taken these and many other considerations into account. Because the model is an optimization against these demand functions the results cannot be taken at face value until the demand functions have been made realistic in terms of the requirements of the individual contractors.

4.) The report uses a definition of reliability that follows from their construct -ion of the frequency charts they use to summarize the results. When they state for example that the project can deliver 73% reliability, that is an incorrect interpretation of the data in the chart. In fact, the point at which 73% of the Table A water is delivered is actually the 50% point in the frequency chart. The correct statement would be: The project can deliver 73% of the water 50% of the time. However, this is not quite true either because the frequency charts are not statistically valid and insufficient to support an estimate of delivery reliability.

Additional Deficiencies

There are also some additional deficiencies that have since been revealed through careful studies of the CALSIM II model. These have to do with the assumptions on constraints and some fundamental errors in the statistical basis of the model's inputs.

The model exercises for this report assume that SWRCB rules that operate to constrain export pumping will continue unchanged into the future. If the model results showed that future export pumping would continue at about the same level, that may perhaps be a defensible assumption. However, we have the case where the model results show that on average future export pumping will be 50% greater than the recent historical average under most all anticipated hydrologic conditions. Given that result it would seem prudent to examine to what degree SWRCB rules might be modified in anticipation of the environmental damage to be expected with such an increase in export pumping. The model does not do that. In fact, before these results can be used by anyone, the model's calculations should be explored to discover where and to what degree existing historic pumping regimens are expected to change. After all, the existing rules were developed in response to concerns with the operational problems that were demonstrated along the way during historic pumping. The rules certainly cannot be interpreted as definitive statements on what is acceptable for the Delta environment irrespective of the levels of export in the future.

The model also uses a sub-model to calculate the movement of the X 2 salinity threshold in the Delta as a function of hydrologic conditions. Unbelievably the sub-model calculational routine does not include the level of pumping. It is difficult to believe that the movement of the salinity threshold is independent of export pumping. Furthermore, given that CALSIM II predicts a 50% increase in exports over historic levels it would seem prudent to examine whether this simple routine is really applicable at that higher level. The research that went into the development of this calculational routine should be peer reviewed. The same may be said with the entire modeling of cross Delta transport calculations.

Perhaps the greatest problem with CALSIM II is its total disregard for proper statistical analysis in the development of the model. It is easy to verify that the input hydrology to the model represents a complex statistical distribution. In fact, it is what is referred to by statisticians as "bi-modal" meaning there are two main modes. One significant consequence of this feature is that the grand average of the total 73 year record is a very unlikely occurrence. All references in the report to average deliveries over 73 years are totally misleading.

The two modes clearly depict a collection of dry years and another of wet years. There are slightly more cases of dry years than wet ones although for practical purposes they are roughly equal. It is also the case that except for droughts there is virtually no serial correlation year-to-year. This means that a wet year may be followed with equal likelihood by either a dry or wet year. The fundamental problem that SWP operators must continually face is under what conditions is it prudent to pump given uncertainty in what kind of year the project will face. It is a classic operations research problem and involves tradeoffs between the objective of pumping water and the risk that too much will be taken. This operational problem is faced at the beginning of every water year beginning in the fall. A careful study of historic input flows from the Sacramento River in the fall and winter shows that it may be difficult to establish until late in January if the water year will likely be wet so as to allow higher levels of pumping. But a careful examination of SWP pumping capacity shows that the pumps must run at nearly maximum capacity for most of the year if export flows near 4 MAF are to be realized. Clearly, if the 73 average predicted by this model is near 4 MAF then we must assume that heavy pumping is allowed during the fall and winter months before it is known that the year will indeed be wet. How is this reconciled with prudence and so call risk avoidance?

Because the model incorrectly deals with the statistical nature of the input hydrology it also includes some totally improper inputs. The model relies on a "water year index" which is a convolution of the spring and fall/winter runoffs across years. The affect is to produce an index which is uni-modal in contrast to the bi-modal hydrologic input. Because there is no significant year-to-year correlation in runoff, this convolution is without scientific merit and totally distorts the basic operational decision problem so that it no longer represents any reality. Furthermore, this water year index is further convoluted to a "water year type" designator that is used to establish Delta export/inflow ratios that ostensibly are used to protect the Delta environment.

The "water year type" is the index that is used in the CALSIM II model to establish what the required outflow in the Delta must be to satisfy the SWRCB rules. It is used in the model by a "lookup table" that predetermines the water year before it is fully developed. It does this by combining the previous spring's runoff with the current fall and/or winter runoff to decide whether the coming water year is going to be wet or dry. Needless to say, the statistical nature of the runoff record defies predicting what the upcoming water year will be. But by this simple mechanism the model is given fore knowledge of conditions before they are experienced. This departs radically from any notion of simulation. The convolution giving rise to this "water year type" has no demonstrable logical analysis for its existence. Clearly, the CALSIM II model cannot be taken as a valid model until some of these logical flaws are explained or corrected. By extension, the Reliability Report is without any scientific merit and is virtually useless for the purposes stated.

Additional Inconsistencies

There are additional problems that deserve explanation beyond what is stated in the Reliability Report. When one compares the set of tables documenting the past 10 years of deliveries to the various contractors and compares them to the same years reported in the 2002/2003 version there are some significant changes. Out of the ten years only one of the years appears to be the same in the two volumes. Most of the changes in deliveries seem to occur in the values reported for Kern Co. and Castaic Lake Water Agency. The latest report should explain these differences.

Sincerely,
Arve R. Sjovold
Arve R. Sjovold

Plaintiff CPA Representative
In the Monterey Settlement
Negotiations

Plaintiff CPA Representative
To Monterey ++ EIR Comm.

RETURN ADD:

186 SIERRA VISTA
SANTA BARBARA, CA
93108

STATE OF CALIFORNIA -- THE RESOURCES AGENCY **ARNOLD SCHWARZENEGGER,** *Governor*

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

January 30, 2006

Mr. Arve Sjovold
186 Sierra Vista
Santa Barbara, California 93108

Dear Mr. Sjovold:

This letter responds to your letter dated December 19, 2005 commenting on the Draft State Water Project Delivery Reliability Report (Report 2005). Your comments have been thoroughly reviewed and the recommended changes considered and incorporated as appropriate.

Most of your comments are regarding the suitability of the CalSim-II computer simulation model for estimating the delivery reliability of the State Water Project (SWP). You state that the use of CalSim-II is inappropriate due to the lack of calibration and other deficiencies as identified in comments on the *State Water Project Delivery Reliability Report 2002 (2003)* and mentioned in the peer-review report, *A Strategic Review of CalSim-II and its Uses for Water Planning, Management, and Operations in Central California* (Close and others 2003). Many studies conducted by the Department of Water Resources (DWR), self-initiated or in response to public questions or criticisms, support the conclusion that CalSim-II provides a reasonable simulation of SWP operation and is a useful tool for assessing the delivery capability of the SWP.

The CalSim-II studies provide quantitative estimates of reliability based on historical rainfall and runoff data under the assumption that reliable conveyance capability will continue into the future. As we know, the Delta is a very dynamic environment. DWR is working on three projects that will improve the ability to make qualitative or quantitative statements about the reliability of conveyance across the Sacramento-San Joaquin Delta. These include: the Delta Risk Management Strategy, which will assess risks to the Delta from floods, seepage, subsidence, and earthquakes, evaluate the consequences of levee failure, and develop recommendations to manage the risk; implementation of AB 1200 (Laird, 2005) which calls for a similar evaluation of impacts on water supplies from catastrophic Delta failure; and a broader public process to develop a shared vision of a sustainable Delta that continues to support societal needs related to water supply, transportation, recreation, land use, energy, and environmental health. These efforts will not be completed before release of the next Reliability Report, but may yield some preliminary results and conclusions by then. Our intent is to fully incorporate this information into subsequent Reliability Reports.

Mr. Arve Sjovold
January 30, 2006
Page 2

The final Report 2005 includes a discussion of these uncertainties and a commitment to incorporate the above-mentioned information as it evolves. The final report also includes a statement regarding the report being required per the settlement agreement to the case *Planning and Conservation League v. Department of Water Resources* (2000) 83 Cal. App. 4^{th} 892.

Responses to the specific technical comments you make regarding CalSim-II are attached.

The final report will be available soon and will include an appendix containing copies of all commenting letters accompanied with the Department's responses. If you wish to discuss this report further, please contact me at (916) 653-1099 or kkelly@water.ca.gov. Francis Chung, Chief of the Modeling Support Branch of the Bay-Delta Office, should be contacted for technical questions on the CalSim-II modeling studies. He may be reached at (916) 653-5924 or chung@water.ca.gov.

Sincerely,

Katherine F. Kelly, Chief
Bay-Delta Office

Attachment

cc: Francis Chung, Chief
Modeling Support Branch
Bay-Delta Office
1416 Ninth Street, Room 252-6
Sacramento California 95814

1. **CalSim-II has not been calibrated or validated.**

Models such as CalSim-II are inherently different from models that simulate hydrologic processes based on the physical laws governing the process that is being modeled. Although a classical approach to model calibration can not be applied to models like CalSim-II, calibration of some of the important components of the model is possible, and has been done. For instance, one of the most important components of the model, its hydrologic component, has been calibrated by including closure terms in the form of local surface water accretions from every depletion study area of the model network to match the historically available stream gage records. The routine used to determine the Sacramento River flows and the corresponding Delta exports that meet Delta electrical conductivity standards is an Artificial Neural Network (ANN) model that is trained using the calibrated Delta Simulation Model (DSM2) prior to being used in CalSim-II simulation runs. Also, a revised groundwater-surface water interaction module is being developed that uses groundwater-surface water response functions produced by the simulation of the historical groundwater pumping amounts. The above components of CalSim-II, which are either directly or indirectly calibrated, are three of the most important components of the model that have the most significant impacts on the simulation results. It is, therefore, inaccurate to assert that CalSim-II has not been calibrated.

In the absence of a classical approach to calibration, the next best approach is to set model parameters for a simulation run relying on experience and then verify the results of the simulation run by comparing them to historical operations. To verify model results, DWR conducted a 24-year simulation using historical input from 1975 to 1998. The results of this study showed the simulated values of the major components of system operation matched the historical values very well. Components such as stream flows at key locations and the net Delta outflow index showed little difference between simulated and historical values. For detailed examination of the validation study the reader is referred to *CalSim-II Simulation of Historical SWP/CVP Operations, Technical Memorandum Report*, November 2003.

2. **CalSim-II is an optimization model that has not been calibrated.**

CalSim-II is a simulation model of the Central Valley Project (CVP)/State Water Project (SWP) system. It is a continuous accounting model, supplemented by a linear programming module to optimize the operation of the system for the current period of simulation (a month) subject to physical, operational, and institutional constraints of the system without foresight about the conditions in the next period. It should be noted that although a linear programming module is used as a tool to allocate water subject to all the constraints of the system in that particular month, CalSim-II does not attempt to optimize the overall operation of the system over the 73-year study period, and therefore it is not an optimization model. The issue of calibration of the model has been addressed in item 1, above. The model is not designed to maximize deliveries but to meet the assumed annual requested contractors' demands to the extent possible while meeting all physical and operational constraints. CalSim-II modeled operation has been critically reviewed by both SWP and CVP operators, and they are satisfied with the degree of mimicking actual real world operations done by the model. The CalSim-II model has been used extensively by State Water Contractors and the SWP operation staff to help them develop annual water supply guidelines.

3. **Demand functions have not been vetted against the realistic capabilities of each contractor to take SWP water; case in point San Luis Obispo County.**

It is true that San Luis Obispo County cannot currently take its maximum Table A amount of 25,000 acre-feet. Because of this limitation, their demand in the 2005 level study (study 4) was assumed to be 4,400 acre-feet/year. In the future level study (study 5), however, it was assumed that facilities will have been constructed by the year 2025 to allow delivery of their maximum Table A amount.

4. **The report uses an incorrect interpretation of the data in the chart.**

The proper interpretation of Figures 5-1 and 5-2 is outlined on page 25 of the draft report and the example given for interpreting Figure 5-2 is as follows:

By referencing the curve for study 5 in Figure 5-2, the following can be deduced:

- In 75 percent of the years, the annual water delivery of the SWP is estimated to be at or above 2.70 million acre-feet (maf) per year (65 percent of 4.13 maf).
- In 50 percent of the years, it is estimated to be at or above 3.50 maf per year (85 percent of 4.13 maf).
- In 25 percent of the years, it is at 4.13 maf per year.

5. **The model exercises assume that State Water Resources Control Board (SWRCB) rules will continue unchanged into the future.**

This is correct. The model is based on current SWRCB rules that govern project operations. The Delivery Reliability Report does not speculate on any future modification of the SWRCB rules.

6. **The sub-model does not include the level of pumping as a variable in the relationship that calculates the movement of the X2 salinity threshold.**

First, it is important to note that the level of project pumping in CalSim-II is determined after all Delta requirements, including the outflow to meet the required position of the 2 parts per thousand salinity line (X2), are met. Secondly, the computation of the X2 salinity threshold position in CalSim-II is based on the empirical relationship, developed in a collaborative effort by

Wim Kimmerer of BioSystems and Steve Monismith of Stanford University, which is based on observed data. The development process of this relationship and the back-up data were presented and thoroughly examined in the SWRCB hearing process that lead to the Board adopting 1995 Water Quality Control Plan (SWRCB Water Rights Decision 1641). The position of the X2 line in any given month in this empirical model is presented as a function of its location in the previous month and the current month's net Delta outflow. Net Delta Outflow, by definition, includes the total CVP and SWP diversions from the Delta. This relationship has been confirmed to be a good predictor of the movement and position of the X2 line. For more information on this subject, you may refer to the May 18, 1992 memorandum report to the San Francisco Estuary Project by Kimmerer and Monismith, titled *"Revised Estimates of Position of 2 PPT Salinity,"* and Chapter 10 of the June 1994 *Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh, 15th Annual Progress Report to the State Water Resources Control Board,* titled "Two Part per Thousand Isohaline Equation Analysis."

7. **The pumps must run at nearly maximum capacity for most of the year if export flows near 4 MAF are to be realized.**

Model results for study 5 show that annual SWP pumping at Banks Pumping Plant would exceed 4 maf in 15 percent of the years. These higher pumping amounts generally only occur in wet years and the average annual SWP pumping at Banks for study 5 is 3.17 maf. The permitted pumping capacity of Banks Pumping Plant is normally 6,680 cfs, although additional pumping above this limit is allowed from December 15 to March 15 whenever the San Joaquin River flow at the Vernalis gage exceeds 1,000 cubic feet per second (cfs). The maximum pumping rate during this 3-month period is 8,500 cfs. Year-round pumping at the lower rate of 6,680 cfs would result in total annual pumping of approximately 4.8 maf. It should also be noted that export pumping is limited to actual demand for water and/or the amount needed to refill storage reservoirs.

8. **Use of the water-year type look-up table predetermines the water year before it is fully developed and this departs radically from any notion of simulation.**

Water Year Type Indices for the Sacramento River basin and San Joaquin River basin are defined in the SWRCB Water Rights Decision 1641. The definition of the Sacramento Valley Water Year Hydrologic Classification is the computation of the following equation:

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*INDEX (in MAF) = 0.4 * X + 0.3 * Y + 0.3 * Z*

Where: *X* = Current Year's April – July Sacramento Valley Unimpaired Runoff

Y = Current October – March Sacramento Valley Unimpaired Runoff

Z = Previous year's index (With a cap of 10 MAF)

The Sacramento Valley unimpaired runoff for the current water year (October 1 of the preceding calendar year through September 30 of the current calendar year), as published in California Department of Water Resources Bulletin 120, is a forecast of the sum of the following locations: Sacramento River above Bend Bridge, near Red Bluff; Feather River, total inflow to Oroville Reservoir; Yuba River at Smartville; American River, total inflow to Folsom Reservoir. Preliminary determinations of the year classification are made in February, March, and April, with the final determination in May. These preliminary determinations are based on hydrologic conditions to date plus forecasts of future runoff assuming normal precipitation for the remainder of the water year.

D-1641 mandates water quality objectives in and around the Sacramento/San Joaquin Delta Estuary to be met by the SWP and the CVP. Some of these water quality objectives vary according to the water year type of the given year. Real-Time project operators must therefore use the forecast of the water year type from Bulletin 120 in order to determine what level of water quality objectives need to be met. As the water year type forecast is updated, each passing month gives more data of the actual runoff for the current water year and thus firms up the forecast. Also, because the majority of annual runoff occurs in the winter and early spring months, the May forecast is generally very accurate.

CalSim-II uses the historic Water Year Hydrologic Classification Indices for the study period of 1922–1994, rather than the forecasted water year types, in a manner that parallels how the project is operated in real-time. In CalSim-II, the water year type indices do not change for the current water year until February, the same month that real-time operators receive their first forecast of year type. Standards set by in the SWRCB D-1641 for the Delta water quality objectives that vary according to the water year type are mostly specified for months after May. Therefore, the use of the historical water year type index for the Delta water quality objectives in CalSim-II would not be significantly different than how real-time operators arrive at operational decisions about water quality objectives, i.e., using the May forecast of year type. It is important to note that Water Year Type indices are not used in CalSim-II to determine SWP South-of-Delta contractor allocations.

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9. **There are significant unexplained differences in the historical SWP delivery data between the last report and the current report.**

There are some minor differences in the historical SWP deliveries between the two reports, ranging from 528 acre-feet to 25,000 acre-feet. These differences come from two sources. The first is the periodic corrections that are made by the DWR State Water Project Analysis Office (SWPAO) in the historical deliveries. The second is the revised procedure by SWPAO to include articles 12d and 14b water types as a part of the Table A delivery in the year that it is requested, rather than the following year when the water is actually delivered to the contractor. In the previous report, amounts associated with these water delivery categories were separately listed and accounted for in the year that they were actually delivered.

ROBERT C. WILKINSON, Ph.D.
1428 West Valerio
Santa Barbara, California 93101 USA

Phone/fax: 1-805-569-2590
E-mail: wilkinson@es.ucsb.edu

12/23/05

Lester Snow, Director
Department of Water Resources
c/o ddeanda@water.ca.gov

cc: Joe Grindstaff, Chief Deputy Director
Department of Water Resources
c/o lcooper@water.ca.gov

Katherine Kelly, Chief, Office of SWP Planning
Department of Water Resources
kkelly@water.ca.gov

RE: Comments on DWR's Draft Report "The State Water Project Delivery Reliability Report 2005"

Dear Lester,

I appreciate the opportunity to comment on the department's Draft Report: "The State Water Project Delivery Reliability Report 2005" dated November 16, 2005. I am commenting as an interested citizen, and not on behalf of any institution or organization.

Overview

An accurate assessment of the actual amounts of water the SWP can reliably deliver to users under various future conditions is important to the state. This draft report is DWR's second effort to characterize the reliability of the SWP. One might have expected that in light of current discussions (including your own statements) regarding levee failures (by whatever cause), impacts of climate change, vulnerability to "perturbations" ranging from earthquakes to terrorism, and budget and financing challenges, DWR staff would have made further efforts to characterize the range of risks and vulnerabilities affecting the reliability of the SWP. Unfortunately, the reliability report once again places inappropriate confidence in a single computer model as the sole basis for its findings, and it summarily dismisses analysis of these other factors. As such, it does not provide a reasonable representation of the reliability of the SWP for decision-making purposes.

Importance of the Issue

Why is an accurate and comprehensive assessment of SWP reliability important? Significant public and private investments are being made in water system infrastructure. More will be needed, as you have argued. Billions of dollars devoted to water systems have recently been approved by voters in bond funding, and more is anticipated in the future. Thoughtful proposals for revenue streams to service this investment have been advanced, including your own ideas. All of these water system investments are linked to substantial private and public investments requiring reliable water supplies.

As voters weigh the options before them, it is critical that they have an accurate and reasonably complete understanding of the risks as well as the benefits of different options. The report fails to provide the information and analysis needed to properly assess the reliability of the SWP system.

Risk and Reliability

The reliability of SWP system deliveries in the future is of course impossible to predict perfectly. It is possible, however, to identify important factors that may impact system performance. The reliability of SWP deliveries will clearly be impacted by issues such as the following:

- Amounts and patterns (time, place, and form – rain/snow) of precipitation and runoff
- Climate change (e.g. impacting flows, timing, temperature, and dam operations for flood control)
- SWP operations impacts on ecosystems and listed species such as the delta smelt
- Reduction of flows into the basin, such as the Trinity River, and changes of flows within the basin
- FERC re-licensing (of Oroville and other facilities)
- Levee failures (due to floods, earthquakes, or other causes)
- Earthquakes impacting key pumping, storage, and conveyance facilities
- Operations of federal and other facilities to meet legal requirements for environmental factors

Issues have also been raised regarding factors that will influence SWP system reliability such as:

- "Take" permits for impacted species
- SWP water rights (vs. extraction and export of "surplus" flows)
- Delta ecosystem impacts

It is not clear that Calsim II is capable of providing a robust and reasonably complete assessment of system reliability, notwithstanding the numerous assertions on the model's behalf provided in the draft report. (I will refrain from reiterating key questions raised in the peer review and elsewhere with regard to Calsim II. Notwithstanding a steadfast assertion by DWR staff that the model is OK, serious problems remain with its use for this type of application.) Some of the issues listed above are factored into the Calsim II analysis at certain levels, others are not. Where they are included, the implications for system reliability are in many cases difficult to determine. It *is clear* that a robust reliability analysis should use more than one method and tool, and that the tools should be properly applied. Additional tools are in fact available to develop a more complete understanding of system reliability.

To suggest that these factors be taken into consideration does not imply that anyone expects DWR to have a crystal ball. Understanding a range of potential reliability factors is useful, and doable. It does not imply a perfect prediction. For example, climate scenarios can provide important information regarding a range of reliability levels under possible future conditions. (Indeed, researchers have undertaken just such studies, including recent ones with Calsim II as the key model for supply reliability analysis. These should be included in the report.)

Disturbingly, in addition to ignoring climate change, the report fails to discuss a number of current issues including: levee integrity and risks related to failure; environmental impacts and issues relating to delta water extractions impacting listed species; and vulnerability of key SWP system components. Nor does it comment on recent decisions in various courts invalidating EIR/Ss dealing with SWP contracts and delta operations. The

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implications of these decisions, and the eventual environmental analyses, may include important constraints on system operations which would in turn impact system reliability.

A Comment on Timing

The 2002 reliability report was "finalized" in 2003. The 2005 report will presumably be finalized in 2006 (comments are due on December 23, 2005). There are two problems with this timing.

The first problem is that the Urban Water Management Plans (UWMPs), required every five years by law, are due in December 2005. Thus, the final SWP reliability report is not available to water managers as input into this important process to evaluate imported water reliability to the retail agencies served by the state contractors. (Though a draft document was reportedly provided to contractors in May 2005, the public and other interested parties – including land-use decision-makers concerned with water supply reliability – were not provided with a draft until mid-November 2005.) Clearly, the information from this report has not been readily available for use in the preparation of the 2005 UWMPs. To the extent that assertions of the SWP reliability may be in question, all of the UWMPs relying on SWP supplies for any portion of their water will be flawed. It is most unfortunate that DWR did not release the draft report much earlier (e.g. at least in May when it was provided to contractors) in order for the accuracy and validity of the report to be discussed.

This relates to the second problem, which is that the report is supposed to be provided every two years. The two-year cycle is not being met.

Conclusion

The 2002 reliability report acknowledged for the first time that the SWP cannot deliver full "Table A" volumes. This was an important step towards a more honest and accurate assessment of system reliability. It too, however, was strongly criticized for its over-reliance on the Calsim II model. The current draft report begins its defense of Calsim II in the *Forword* and continues it at tedious length throughout the document. Rather than mounting a protracted defense of an imperfect model, the SWP should be subjected to a credible reliability analysis with outside peer review. DWR staff should be directed to develop an open process that begins to account for the range of factors that will likely impact system reliability.

Sincerely,

Robert C. Wilkinson

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STATE OF CALIFORNIA -- THE RESOURCES AGENCY
ARNOLD SCHWARZENEGGER, *Governor*

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

March 24, 2006

Robert C. Wilkinson, Ph.D.
1428 West Valerio
Santa Barbara, California 93101

Dear Dr. Wilkinson:

This is in response to your letter of December 23, 2005 commenting on the draft State Water Project Delivery Reliability Report–2005 (Report 2005).

In your letter, you state that the Report 2005 does not provide an accurate assessment of the delivery ability of the State Water Project (SWP) because it does not incorporate future uncertainties associated with such things as climate change, earthquakes, terrorism, etc. You also point out that the timing of Report 2005 is problematic because it was not released early enough to be publicly reviewed prior to being incorporated into Urban Water Management Plans and does not meet the two-year interval required for updating this information.

The estimates contained in the Report 2005 are the best quantifications available of the delivery ability of the SWP. These estimates are limited, however, because of the uncertainty of future conditions. The Department of Water Resources (DWR) will continue to use the CalSim model as appropriate for analyses but other information is being developed that will help us analyze, understand, and prepare for our uncertain future. Per the Governor's directive (Executive Order S-3-05), the potential impacts of climate change on the State's resources, including water supply, are being evaluated. Preliminary estimates have been done, using CalSim-II, of the potential impact upon the SWP in 50 to 100 years if no additional conveyance facilities or upstream reservoirs are built. As these estimates become more refined, they will be helpful in guiding strategies for the management and development of the State's water resources, including improvements to the SWP.

In addition, DWR is working on two projects that will improve our ability to make qualitative or quantitative statements about the reliability of conveyance across the Sacramento-San Joaquin Delta. They are: the Delta Risk Management Strategy, which will assess risks to the Delta from floods, seepage, subsidence, and earthquakes, evaluate the consequences of levee failure, and develop recommendations to manage the risk; and a broader public process to develop a shared vision of a sustainable Delta that continues to support societal needs related to land use, recreation, water supply, transportation, energy, and environmental health. The Delta Vision process incorporates the requirements of AB 1200 passed by the legislature and signed by the Governor in 2005. Although none of these efforts will be completed before release of the next Reliability Report, some preliminary results and conclusions may be completed in time for inclusion. Subsequent Reliability Reports will fully incorporate this information.

Robert C. Wilkinson, Ph.D.
March 24, 2006
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DWR does not want to leave any reader of the Report 2005 with the impression that this developing information is being ignored. Therefore, the final report includes a discussion of these uncertainties, the efforts to quantify them, and a commitment to incorporate the above-mentioned information as it is developed and refined.

You make the point that the report is supposed to be updated every two years and this condition has not been met. In addition, you state that the report should be available to the public as a draft and finalized prior to deadlines for local agency Urban Water Management Plans. I agree that the report should be available to the public as a draft and finalized prior to deadlines for local agency UWMPs. It is unfortunate that the review and completion of the Report 2005 could not be done in early 2005 for incorporation into UWMPs and well within the two-year interval specified in the settlement agreement (*Planning and Conservation League v. Department of Water Resources* (2000) 83 Cal. App. 4^{th} 892). The objectives of DWR for the Reliability Report are to encourage public discussion and understanding of the estimation of the SWP delivery capability, meet the conditions of the settlement agreement, and provide the best available quantification of SWP deliveries. Given the situation this year, DWR chose to provide the information to the SWP water contractors as a memorandum in May, 2005 and to delay the completion of the final Report 2005 to allow public review of a draft. Public review of the draft is not a requirement of the settlement agreement but the review encourages public discussion of the issue and improves the final report.

The final Report 2005 will be issued soon and will include an appendix containing the comment letters on the draft report and DWR's responses. Thank you for your comments and recommendations. If you wish to discuss this further, please contact Gerald Johns, DWR's Deputy Director at (916) 653-8045 or jjohns@water.ca.gov.

Sincerely,

Original signed by

Lester A. Snow
Director

cc: P. Joseph Grindstaff, Acting Director
California Bay-Delta Authority
650 Capitol Mall, Fifth Floor
Sacramento, California 95814