

Chapter 3

# Hydrology, Water Supply, and Power

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### Affected Environment

California's flood control, water supply, and hydropower generation systems are intricately linked together through physical and institutional arrangements. Water supply diversions, as proposed for this project, have effects throughout the system of river, reservoir, groundwater, and water quality management operations. The State Water Project (SWP) and CVP provide a majority of the water storage and conveyance capacity of the system in combination with a numerous smaller systems that are operated by water supply and agricultural entities. Therefore, forecasting and planning for annual water supply, demand, and delivery functions are influenced with each additional project that serves to use water from the system. Consequently, the following section provides an overview of the major northern California water storage and conveyance facilities.

The "Affected Environment" section describes the hydrologic and water supply conditions in the Sacramento and Mokelumne River basins and Sacramento–San Joaquin Delta (Delta). Each of the project alternatives (i.e., Alternatives 2, 3, 4, 5, and 6) under consideration has the potential to change the timing, location, and volume of water diverted from the CVP system. To determine the probable magnitude and effect of these changes and to evaluate the ability of the alternatives to meet FRWA's project objectives, FRWA and Reclamation have used available technology to extensively model hydrologic conditions. This section also includes a description of the hydrologic modeling and related assumptions used for the analysis.

This chapter provides information on the evaluation of river and reservoir hydrology conducted for this EIR/EIS. It includes a summary of existing hydrologic conditions and changes in these conditions that are expected to occur under Alternative 1 (no-action conditions at the 2001 level of system development), project alternatives at the 2001 level of development with the FRWA agencies' demands set at the projected 2020 level of development, and project alternatives under cumulative conditions at the 2020 level of development and FRWA demands. This chapter also includes a discussion of the changes to water supply and power production that would occur under each of the conditions discussed above.

# Hydrology and Water Supply

## Sacramento River Basin

### Hydrologic Conditions and Water Supply

The Sacramento River drainage basin upstream of the American River confluence encompasses approximately 23,500 square miles and produces an average annual runoff of about 17,000,000 af at the Freeport gaging station (below the confluence with the American River). Principal reservoirs controlling flows in the lower Sacramento River include Lake Shasta (4,550,000 af) on the Sacramento River upstream of Redding and Trinity Lake (2,480,000 af), which regulates deliveries made to the Sacramento River from the Trinity River basin. Diversions from the Trinity River basin into the Sacramento River basin averaged 1,030,000 af annually from 1967 to 1991. The Feather River is a major tributary to the Sacramento River, and Lake Oroville is a component of the SWP system that provides 3,540,000 af of storage. Average runoff from the Feather River basin (including the Yuba River) is approximately 5,850,000 af at the Nicholas gaging station (downstream of the confluence with the Yuba River).

The proposed intake facility is located on the Sacramento River about 10 miles downstream of the confluence with the American River. The Sacramento River at the intake facility is confined within project levees that are maintained by the Corps. Based on the 30-year record of data for the period 1968 through 1998, which spans a variety of water year types, individual monthly average flows have ranged from a low of 4,500 cfs in October 1978 to a maximum of 87,000 cfs in January 1997. Overall, the average monthly flows of all 30 years range between 13,000 and 40,600 cfs, with the low occurring in October and peak flow in February. The 30-year average monthly flow during the wetter months of December through May is approximately 30,000 cfs; during the typically drier months of June through November, it is 16,500 cfs.

### Project Area Flood Conditions

The 100-year flood event flow in the Sacramento River at Freeport is about 130,000 cfs and is fully contained by the levees. The surrounding urban and rural areas of the pipeline alignments encompass the watersheds of a series of small streams collectively joining near I-5 to form Morrison Creek. The upper watershed streams from north to south include Morrison Creek, Florin Creek, Elder Creek, Union House Creek, Strawberry Creek, and the Laguna Creek system of tributaries. Morrison Creek flows through the Beach Lake and Stone Lake wildlife refuge area near I-5 and continues to a pump station that conveys the flow into the Sacramento River. The volume of water combined with the limited channel capacities of these small streams results in extensive flooding of low-lying areas during the 100-year flood.

## American River Basin

The American River drainage basin encompasses approximately 1,900 square miles. Folsom Reservoir is the principal reservoir in the basin with a capacity of 975,000 af; several smaller reservoirs upstream contribute another 820,000 af of storage capacity. Nimbus Dam impounds Lake Natoma downstream of Folsom Dam and regulates releases from Folsom Reservoir to the lower American River. The entrance facilities to the FSC are located along the south shore of Lake Natoma immediately upstream of Nimbus Dam. Annual average unimpaired runoff at the Fair Oaks gage is approximately 2,645,000 af but varies from less than 900,000 af (lowest 10% of years) to more than 5,000,000 af (wettest 10% of years). Mean annual flow in the lower American River is 3,300 cfs; the design capacity of the channel for floodflows is 115,000 cfs. Diversions to the FSC are about 20,000 af annually, with the large majority being conveyed for use by SMUD at their Rancho Seco nuclear power plant site. The power plant is in the process of being dismantled and the water is used for maintenance of the spent fuel rod bath facility and for dilution water.

## Mokelumne River Basin

The Mokelumne River basin has a watershed area of about 660 square miles (at the Woodbridge stream gage) on the western slope of the Sierra Nevada in Alpine, Amador, and Calaveras counties. The Cosumnes River basin lies between the American and Mokelumne River basins. The Mokelumne River basin upstream of Pardee Reservoir (watershed area of 570 square miles) is the principal water supply for EBMUD's service area. Rainfall averages 15 inches in the valley and 60 inches at the higher elevations. The average annual unimpaired flow at Pardee is about 700,000 af, with a range from less than 250,000 af (driest 10% of the years) to about 1,200,000 af (wettest 10% of the years).

The unimpaired flows indicate an average inflow to Pardee Reservoir of about 965 cfs. Snowmelt dominates the seasonal runoff pattern, with the highest flows in April–June of wet years. Unimpaired flows typically are very low (less than 100 cfs) in July through November.

PG&E operates seven reservoirs in the upper watershed upstream of Pardee Reservoir. Because these reservoirs store some of the winter snowmelt for hydropower production later in the year, they decrease springtime inflows to Pardee Reservoir while increasing inflows in the late summer in most years compared to what would normally occur without upstream storage capacity. Total PG&E reservoir storage upstream of Pardee Reservoir is about 220,000 af. Salt Springs Reservoir is the largest of the PG&E reservoirs with a capacity of 142,000 af.

## **Pardee Reservoir and Camanche Reservoir Operations and Flood Control**

Flood control operations for Pardee and Camanche Reservoirs are regulated by USACE. Flood control storage space can be coordinated between these reservoirs. A combined 200,000 af of flood storage space is required in Pardee Reservoir and Camanche Reservoir from November 15 until March 15. However, if PG&E's Salt Springs and Lower Bear Reservoirs are sufficiently drawn down, EBMUD can reduce the amount of space it must provide to a minimum of 130,000 af. For the period after March 15, flood storage space requirements are based on rainfall and snowpack estimates, and the reservoirs can be completely filled at the end of May in dry years and the end of July in wet years. No flood control storage is required from July 15 to November 15. When inflow is adequate, Camanche Reservoir is operated to reach full capacity by July 15. Camanche Reservoir is not allowed to store inflows after July 15; therefore, releases are made to meet instream flow requirements for the lower Mokelumne River and storage is gradually reduced to the flood control requirement by November 5.

The peak discharge into Pardee Reservoir from the upper watershed for the projected 1-in-100-year return frequency flood event is about 57,135 cfs; the 500-year event is about 95,250 cfs; and the probable maximum flood is estimated to produce a peak inflow to Pardee Reservoir of 203,000 cfs (HCG 1998).

## **Demands for Reservoir Water Supply and Lower Mokelumne River Flows**

Diversions of Mokelumne River basin water supplies upstream from Pardee Reservoir include about 25,000 af annually that is allocated to several purveyors, including Amador Water Agency, Calaveras Public Utility District, Calaveras County Water District, and JVID. The existing EBMUD demand from Pardee is about 250,000 af (220 MGD) under existing conditions (2001 demand) and is assumed to be about 260,000 af (228 MGD) under 2020 level of development. Downstream of Camanche Dam, the lower Mokelumne River flows west to the Delta. Existing water rights along the lower Mokelumne River include numerous riparian diversions and the North San Joaquin Water Conservation District (NSJWCD) and Woodbridge Irrigation District (WID). In 1997, EBMUD, DFG, and USFWS approved the Mokelumne Settlement Agreement (Partnership Agreement) for management of the lower Mokelumne River, which was later approved by FERC and the SWRCB. The agreement requires releases from Camanche Reservoir that depend on fish life-stage protection throughout the year and the water year type. The agreement also includes a provision called "gainsharing" requiring EBMUD to provide up to 20,000 af for use during a dry period should a new water supply be developed. Releases range from 100 to 325 cfs during normal and above-normal runoff water year types, 100 to 250 cfs in below-normal years, 100 to 220 cfs in dry years, and 100 to 130 cfs in critically dry years.

The lower Mokelumne River flows through Lodi Lake which is a seasonal impoundment created by the WID dam near Lodi. WID demands are between 39,000 af in dry years and 60,000 af in normal and wet years. The maximum summer deliveries are approximately 350 cfs. The NSJWCD has entitlements to about 20,000 AFA and historically has used about 8,000 to 10,000 AFA. Additional downstream deliveries are about 20,000 af for riparian and senior appropriate use. EBMUD must also release additional water termed “carriage” water from Camanche Reservoir to ensure that sufficient flow actually reaches downstream users. Flow can be lost from evaporation, evapotranspiration, and channel seepage into the groundwater basin. Loss rates have ranged from 57,000 to 130,000 af annually, with most of the loss occurring in the 21-mile reach between Camanche Dam and Lake Lodi near the town of Lodi (HCG 1998). Resulting minimum required releases from Camanche Reservoir range from 135,000 af in critical years to 315,000 af in wet years.

Downstream of the Lodi area and the City of Thornton, the lower Mokelumne River splits into the North and South Fork channels. The Delta Cross Channel (DCC) delivers water from the Sacramento River into the North Fork channel.

## Other Rivers and Reservoirs

The San Joaquin River basin encompasses approximately 13,500 square miles (at the Vernalis gage) and is controlled by several reservoirs on the Stanislaus, Tuolumne, Merced, and upper San Joaquin Rivers. The upper San Joaquin River is controlled by the Friant Dam (Millerton Reservoir) with most water diverted to the Kern and Madera Canals. The average annual unimpaired flow at Vernalis is about 6,200,000 af for 1972–1992. Average annual historical runoff for 1972–1992 at Vernalis is 3,200,000 af, but runoff varies from 700,000 af (lowest 10% of years) to more than 6,000,000 af (wettest 10% of years). Because San Joaquin River tributary reservoir projects and water deliveries are operated independently of the Sacramento River basin projects, there is no substantial connection between FRWA Sacramento River basin deliveries and San Joaquin River flows.

## Sacramento River–San Joaquin River Delta

All of the northern California drainage basins described above combine in the region that is officially designated as the Sacramento River–San Joaquin River Delta defined by the approximate extent of tidal action within the river channels. The Sacramento River at Freeport is within the Delta. CVP and SWP water deliveries are conveyed through Delta channels to the respective federal and state pumping plants that provide water for water exports to the San Joaquin Valley and southern California areas. The federal CVP pumping plant is located on Old River at Tracy and conveys water to the Delta Mendota Canal (DMC). The SWP Harvey O. Banks pumping plant lifts water into the California Aqueduct from Clifton Court Forebay. San Luis Reservoir is an important component for both canal systems and serves to provide storage for water that is pumped from the

Delta. The Contra Costa Water District (CCWD) diversion points at Old River and Rock Slough are also major diversions in the western Delta.

## Hydropower Resources and Energy Production

CVP's hydropower system in northern California consists of 11 facilities with a combined total power-generating capacity of 2,045 megawatts (MW). Most of this capacity is derived from the Trinity, Carr, Spring Creek, Shasta, Keswick, Folsom, and Nimbus powerplants, which are identified as the CVP North facilities. Two facilities, New Melones and San Luis, are located south of the Delta. CVP powerplants are located downstream from the storage reservoirs and operate in conjunction with releases of stored water that are made to meet demands. The major power supplier in the region is PG&E with a capacity of 20,000 MW.

CVP power-generation capacity is a function of reservoir elevation and the rate at which water is passed through the turbines. The pattern of generation is directly related to reservoir releases made for irrigation, municipal and industrial uses, instream flow requirements, and other CVP water demands. Maximum releases generally occur in the summer irrigation season, which often corresponds to the peak power load period within the CVP service area. Recent water quality requirements in the rivers and Delta have increased the need for water releases in spring and winter, reducing the amount of water available for release during peak power loads.

In northern California, the CVP generates power in coordination with PG&E operations. The Western Area Power Administration (Western), operates, maintains, and upgrades the transmission grid for the western United States. Power generated at CVP facilities is dedicated first to meeting CVP power requirements ("Project Use Load"), primarily for pumping facilities. CVP generating capacity is generally not sufficient to meet peak project-use demand; therefore, CVP coordinates power production with PG&E under a contract that expires in 2004 to ensure that peak power loads are satisfied. Western is responsible for ensuring that CVP Project Use Loads are met at all times. In addition, Western markets surplus power that is generated by CVP, with preference given to "Preference Power Customers," which include irrigation districts, cooperatives, public utility districts, municipalities, California educational and penal institutions, federal defense agencies, and other institutions.

Three generators at EBMUD's Pardee Dam powerhouse have a combined capacity of 29.2 MW and produce 83 GWh of electricity in average-to-above-normal years. Camanche Dam has a 10.6-MW-capacity powerhouse and generates about 40 GWh in average-to-above-normal years.

# Environmental Consequences

## Methods and Assumptions

### Use of Hydrologic Data for the Environmental Impact Assessment

Hydrologic data served as the primary assessment tool for the evaluation of effects on water supply, power production, water quality, fish, and recreation. A detailed discussion of how the hydrologic data were used to support the evaluations is included in the “Methods and Assumptions” section of Chapter 4, “Water Quality,” Chapter 5, “Fish,” and Chapter 6, “Recreation.” The evaluation of changes to water supply and power production is presented later in this chapter.

### Modeling Procedures and Assumptions

The potential effects of the alternatives on the hydrologic characteristics of upstream reservoir storage levels and river flows, Delta flows and export water operations, and other rivers and reservoirs in northern California were evaluated primarily with the DWR/Reclamation hydrologic simulation model CALSIM II. EBMUD’s comparable hydrologic simulation model EBMUDSIM also was used to simulate the Mokelumne River basin water supply operations at a monthly time step over the historical hydrologic record (1922–1993). Water demands for SCWA and EBMUD were modeled at full buildout. Although buildout demands for each agency will not occur for several years, it is appropriate to include the full demands in the simulations so that the complete effects of the alternatives can be adequately assessed.

The CALSIM and EBMUDSIM models each rely on a variety of user-defined inputs and modeling assumptions. The available planning models, although appropriate for comparative assessment of likely changes with these project alternatives, do not forecast actual operations of EBMUD, SCWA, CVP, or SWP facilities. The actual day-to-day operations of these water management facilities are more complex than can be simulated with available models. For purposes of this project evaluation, the water supply demands, instream flow requirements, and applicable Delta water quality objectives are assumed to remain unchanged. These models represent the state of the art in CVP, SWP, and EBMUD system hydrologic modeling, and the model results are appropriate for impact assessment purposes. The Modeling Technical Appendix (Volume 3) describes the criteria used for the CALSIM and EBMUDSIM modeling and a comprehensive set of tabular presentations of the modeling output for each alternative.

## **CALSIM Modeling**

CALSIM is a planning model designed to simulate the operations of the CVP and SWP reservoir and water delivery system for current and future facilities, flood control operating criteria, water delivery policies, instream flow and Delta outflow requirements, and hydroelectric power generation operations.

CALSIM is the best available tool for modeling the CVP and SWP and is the only systemwide hydrologic model being used by Reclamation and DWR to conduct planning and impact analyses of potential projects.

CALSIM simulations for this project were performed with model assumptions that incorporate CVPIA–prescribed (b)(2) actions and the Environmental Water Account (EWA) program. In December 2000, the ROD on the Trinity River Mainstem Fishery Restoration EIS/EIR was signed. The EIS/EIR was challenged in Federal District Court and litigation is ongoing. The District Court has limited the flows available to the Trinity River until preparation of a supplemental environmental document is completed. As a result of ongoing litigation, the flows described in the ROD may not be implemented at this time.

Therefore, the FRWP existing conditions run includes variable flows (between 369 TAF/year and 452 TAF/year depending on hydrologic conditions) up to the limit established by the court. This is consistent with the assumptions and modeling conducted for the CVP Operations Criteria and Plan (OCAP) biological assessment.

The future 2020 cumulative runs use the full Trinity ROD flows of 369,000 AFA to 815 TAF/year depending on hydrologic conditions, also consistent with the OCAP biological assessment modeling.

The modeling conducted for the FRWP is consistent with the modeling being conducted by Reclamation for its CVP OCAP. Specific and detailed information on the modeling conducted for the FRWP is included in the Modeling Technical Appendix (Volume 3).

In addition to the modeling described above, FRWA conducted a CALSIM analysis assuming that deliveries to EBMUD were treated as “Delta exports” for purposes of the Coordinated Operations Agreement. A summary of these modeling results can be found in Section 3.4.10 of the Modeling Technical Appendix (Volume 3).

## **EBMUDSIM Modeling**

Effects of the project alternatives on the Mokelumne River system were evaluated with results from EBMUD’s hydrologic simulation model EBMUDSIM, which simulates river hydrology, reservoir operations, demands on the Mokelumne River and within the EBMUD service area, Mokelumne River instream flow requirements, and the water delivery system constraints.

EBMUDSIM has been used by several other agencies including SWRCB and FERC to assess hydrologic conditions in the Mokelumne River and has been reviewed and accepted in numerous previous applications. Water supply forecasts are used in the preparation of operation projections. The operations projection is updated throughout February, March, and April as more reliable information becomes available. The main parameters considered in the operation projection are the water supply forecast of projected runoff, water demands of other users on the river, water demand of EBMUD customers, and flood control requirements. EBMUDSIM was used to determine when end-of-September total EBMUD storage is forecast to be less than 500,000 af, enabling EBMUD to take delivery of Sacramento River water under its CVP contract. Deliveries from the Sacramento River were then input to a second EBMUDSIM simulation to determine the effects on the Mokelumne River reservoirs, downstream Mokelumne River flows, and EBMUD deliveries.

## **CALSIM and EBMUDSIM Modeling Procedures**

Under the no-action condition (Alternative 1), CALSIM and EBMUDSIM data reflect current conditions at the 2001 level of system development and 2001 level of demands of the SWP and CVP contractors and the year 2000 demand schedule for EBMUD totaling 220 MGD annually. For Alternatives 2–5, the data reflect the same system level of development conditions as for the No-Action Alternative; however, SCWA annual surface water needs to serve buildout of development in its Zone 40 area and EBMUD's 2020 surface water needs to supplement its other water supplies to during droughts are imposed through the FRWP diversion facilities. This approach is appropriate because it provides for analysis of the full project against existing conditions, thereby fully analyzing the environmental effects of the entire project without including major (and likely speculative) assumptions about what other projects and water uses may be developed in the future. The FRWP alternatives are also analyzed against a future no project condition, which assumes that additional projects and water uses are implemented by others (see below). This analysis is part of the cumulative impact analysis considered in this EIR/EIS. For Alternatives 2–5, the 100-MGD EBMUD demand is allotted to the Freeport intake facility. Under Alternative 6, the additional EBMUD need is allotted to the enlarged Pardee Reservoir, while SCWA needs are modeled as described for Alternatives 2–5. Alternative 1 was used as the baseline for assessing effects of these project alternatives.

The cumulative scenarios of the alternative project facilities were modeled assuming the 2020 level of system development and 2020 demands. The cumulative scenarios reflect only changes to the systemwide level of development. The cumulative impacts are assessed as the difference between the cumulative project alternative scenarios and the 2001 no-action conditions (Alternative 1). However, a 2020 no-action scenario was used to determine the incremental effects of the project alternatives under cumulative conditions.

## **Simulated EBMUD and SCWA Deliveries for Alternatives 2–5**

Figure 3-1 shows simulated annual average water year deliveries by EBMUD and SCWA from the Freeport intake facility. Annual SCWA deliveries would be relatively uniform from year to year and range from 42,000 af to 90,000 af with an average of 71,000 af. This amount is slightly greater than the projected long-term SCWA demand of 68,500 AFA because of the specific hydrologic sequence portrayed in CALSIM II. EBMUD deliveries are simulated to occur in 32 of the 72 water years simulated, and about 20% of the total months. The annual average delivery to EBMUD would be 23,000 af; the maximum water delivery to EBMUD would be 99,000 af. The combined EBMUD and SCWA operations would result in a maximum annual delivery of 155,000 af. The maximum and average annual deliveries on a Reclamation contract year basis (March through February) would be similar at 196,000 af and 94,000 af, respectively.

### **Cumulative Conditions for Alternatives 2–5**

Figure 3-2 shows the deliveries to SCWA and EBMUD under future systemwide demands at a 2020 level of development. EBMUD or SCWA demands served from the Freeport intake facility are the same as those assumed for the 2001 model scenario. Therefore, there are only slight changes compared to the Alternatives 2–5 delivery patterns shown in Figure 3-1. The range of annual water year deliveries to SCWA (41,000 to 90,000 af) would be nearly identical to the 2001 scenario. Average and maximum annual EBMUD deliveries under 2020 conditions are the same as the 2001 scenario with only small differences in some months. Total combined average water year and Reclamation contract year deliveries to SCWA and EBMUD are nearly identical to the 2001 scenario.

## **Simulated EBMUD and SCWA Deliveries for Alternative 6**

EBMUDSIM was used to simulate delivery from an enlarged Pardee Reservoir under the projected 2001 level of development conditions with EBMUD demand elevated to 2020 levels. This is consistent with assumptions in Alternatives 2–5. Deliveries to SCWA from the Freeport intake facility are modeled in CALSIM. SCWA demands from the intake facility are assumed to be the same as for Alternatives 2–5. Figure 3-3 shows the annual EBMUD deliveries (i.e., that would be in addition to existing deliveries) to terminal reservoirs via the Mokelumne Aqueduct. Additional annual average EBMUD deliveries would range from –4,000 af to 71,000 af and average 14,000 af. The monthly delivery pattern in years that they occur would be fairly uniform. The project provides relatively uniform yield in most years of about 10,000 af, reflecting the additional 8 MGD of demand simulated at the 2020 level. SCWA deliveries from the Freeport intake facility location are nearly the same as described for Alternatives 2–5, with only negligible differences in a few months. The annual average, minimum, and maximum water year and Reclamation contract year delivery quantities are identical to Alternatives 2–5.

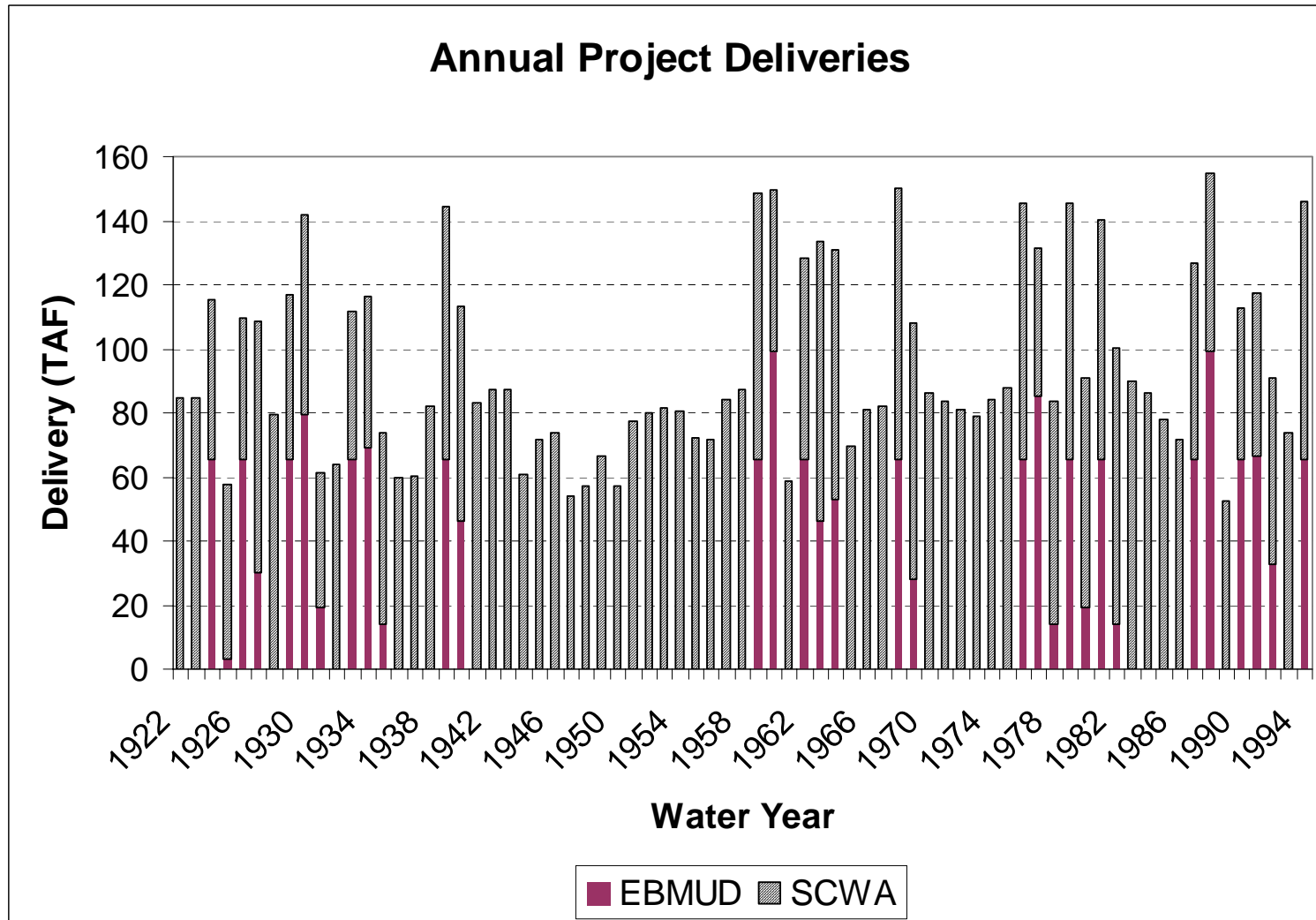


Figure 3-1.  
 Deliveries to EBMUD and SCWA for Alternatives 2-5 at the 2001 Level of Development

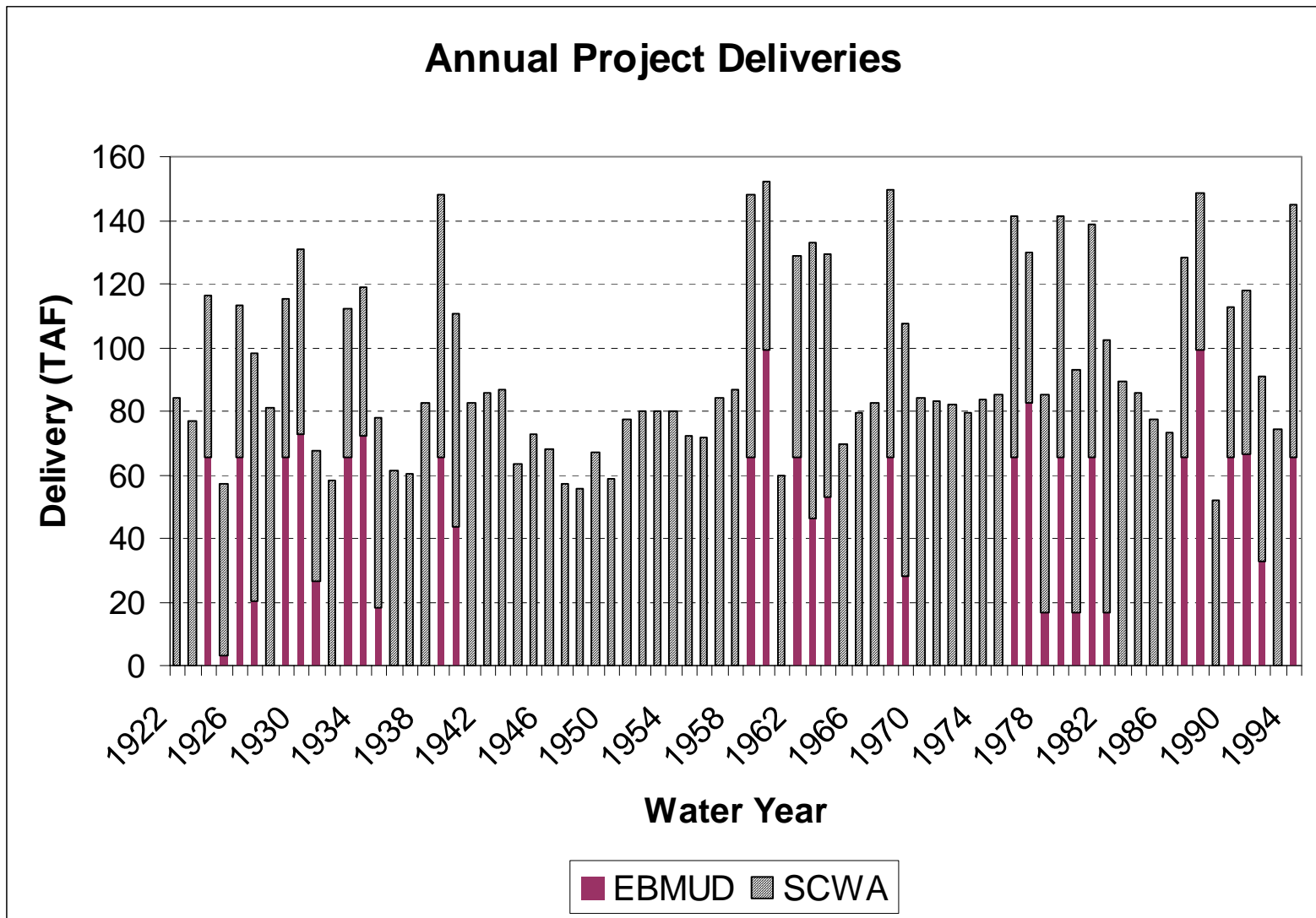


Figure 3-2.  
Deliveries to EBMUD and SCWA for Alternatives 2–5 at the 2020 Level of Development

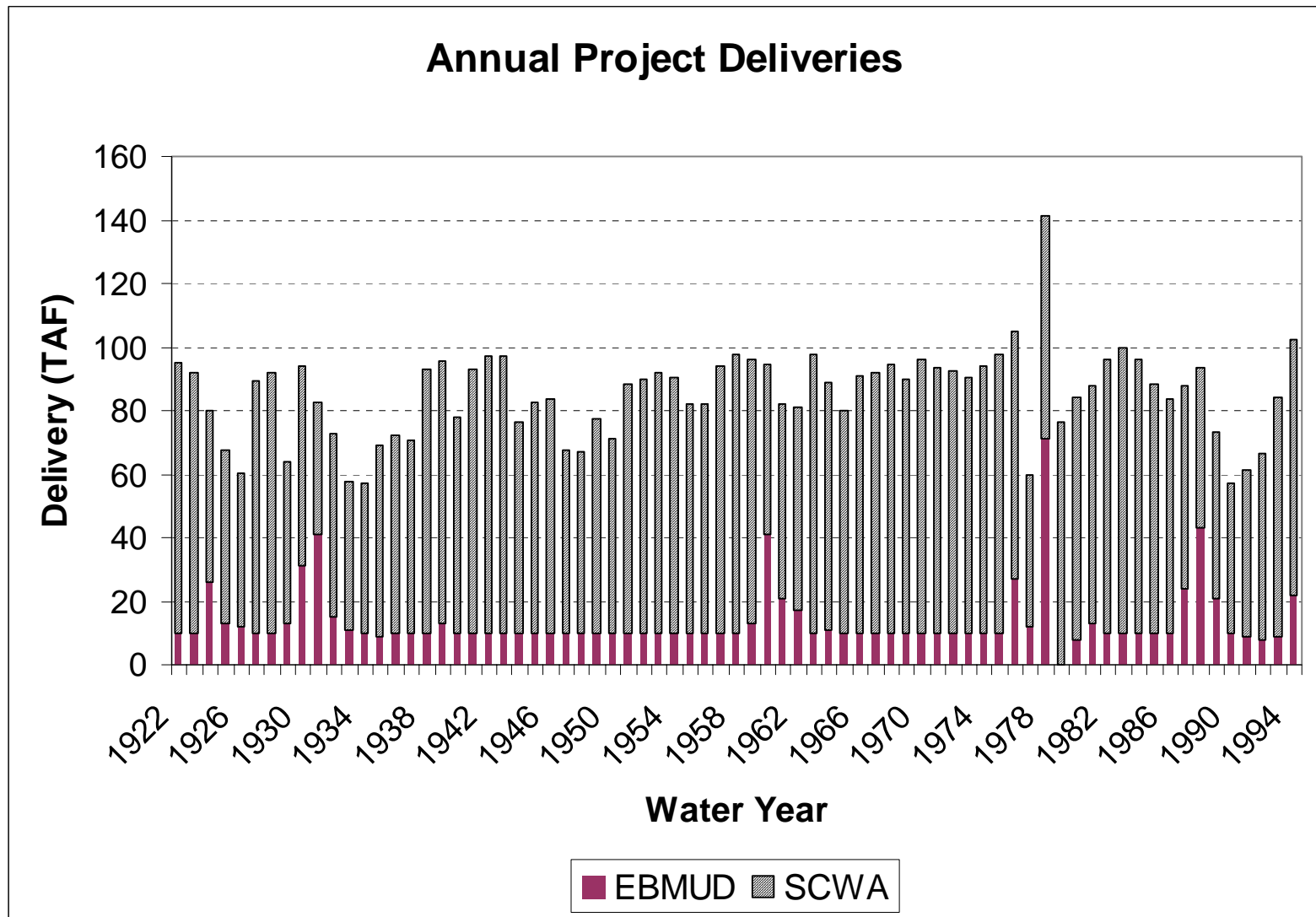


Figure 3-3.  
Deliveries to EBMUD and SCWA for Alternative 6 at the 2001 Level of Development

### **Cumulative Conditions for Alternative 6**

Cumulative water demand conditions for Alternative 6 included projections of systemwide demand at the 2020 level of development in the Mokelumne River basin and other CVP and SWP service areas. EBMUD or SCWA demands from the Freeport intake facility are the same as those assumed for the 2001 model scenario. Therefore, the deliveries shown in Figure 3-4 reflect only slight changes compared to the Alternative 6 delivery pattern shown in Figure 3-3. The incremental changes to EBMUD deliveries from Pardee Reservoir for individual months compared to the no-action condition would be very small. The annual average delivery quantity to EBMUD would increase by 6,000 af. Average annual water year and Reclamation contract year deliveries to SCWA would be similar to the 2001 scenario.

### **Interpretation of Graphs**

This chapter contains a series of graphs that are used to help explain the modeling results. While most of the graphs are self-explanatory, some graphs (frequency distributions) are not commonly used in other contexts and require an explanation. This section explains how to interpret these specific types of graphs. In these graphs (e.g., Figure 3-5), the vertical axis is the measure of a variable such as reservoir storage (expressed as thousand acre-feet [TAF]) or river flows (expressed as cubic feet per second [cfs]). The horizontal axis represents the percentage of time that a certain level of storage or flow is exceeded. Starting at the left end of the horizontal axis, the “0%” mark represents the level that is exceeded “0% of the time,” or in other words represents the highest level of storage or flow. At the right end of the horizontal axis, the “100%” mark represents the level that is exceeded “100% of the time,” or that which is always exceeded and therefore represents the lowest level of storage or flow.

In each graph, all alternatives are compared to one another in terms of a ranked distribution. To accomplish this, each data point (typically an end-of-month or monthly average) for each alternative is sorted and ranked from highest to lowest. Those data are then used to create a line between the 0% and 100% exceedance points on the graph. By overlaying each alternative’s frequency distribution, a comparison between alternatives can be made to the base condition. Generally, alternatives that substantially overlie each other can be interpreted as having a minimal effect on the feature of interest. Points that fall off of the base condition line identify where specific differences between the alternative and the base case exist.

## **Significance Criteria**

Numerous environmental documents have been published over the past 10 years that have addressed hydrologic, water supply, and hydropower production changes to the CVP and SWP potentially resulting from implementation of a

project or program. A review of significance criteria used in those documents was undertaken to determine appropriate significance thresholds for this EIR/EIS. Examples of the documents reviewed include, among others:

- Programmatic EIS for the Central Valley Project Improvement Act,
- Programmatic EIS for the CALFED Bay-Delta Program,
- Trinity River Mainstem Fishery Restoration Program EIS,
- Contra Costa Water District's Los Vaqueros Reservoir Project EIR/EIS,
- State Water Resources Control Board–U.S. Army Corps of Engineers Delta Wetlands Project EIR/EIS, and
- Central Valley Project Water Supply Contracts Under Public Law 101-514 (Section 206) EIS/EIR.

Many of the documents reviewed do not consider changes in hydrological conditions resulting from project operations, in and of themselves, to be environmental effects. Rather, such changes are often considered to be the causative agents that may result in impacts on water quality, fish, recreation, groundwater, and agricultural resources. However, in response to comments received during the scoping process, these hydrologic changes were evaluated as potential environmental effects for purposes of this analysis.

Based on a review of these documents as well as review of the potential impacts of the FRWP alternatives analyzed in this EIR/EIS, the significance criteria below were determined to be appropriate thresholds for this analysis. An alternative may result in a significant impact if it would result in the following:

- substantial changes in reservoir storage or river flows,
- substantial changes in amount of water available to other water users, or
- substantial changes in the production of hydroelectric power.

The information contained in this chapter is also used in the analysis of secondary environmental effects associated with changes in river flows, reservoir levels, and water supply conditions. Specifically, potential secondary environmental effects associated with river flows, reservoir levels, and water supply conditions are described in the following chapters of this EIR/EIS:

- Chapter 4, "Water Quality;"
- Chapter 5, "Fish;"
- Chapter 6, "Recreation;"
- Chapter 9, "Soils, Seismicity, and Groundwater;" and
- Chapter 11, "Agricultural Resources."

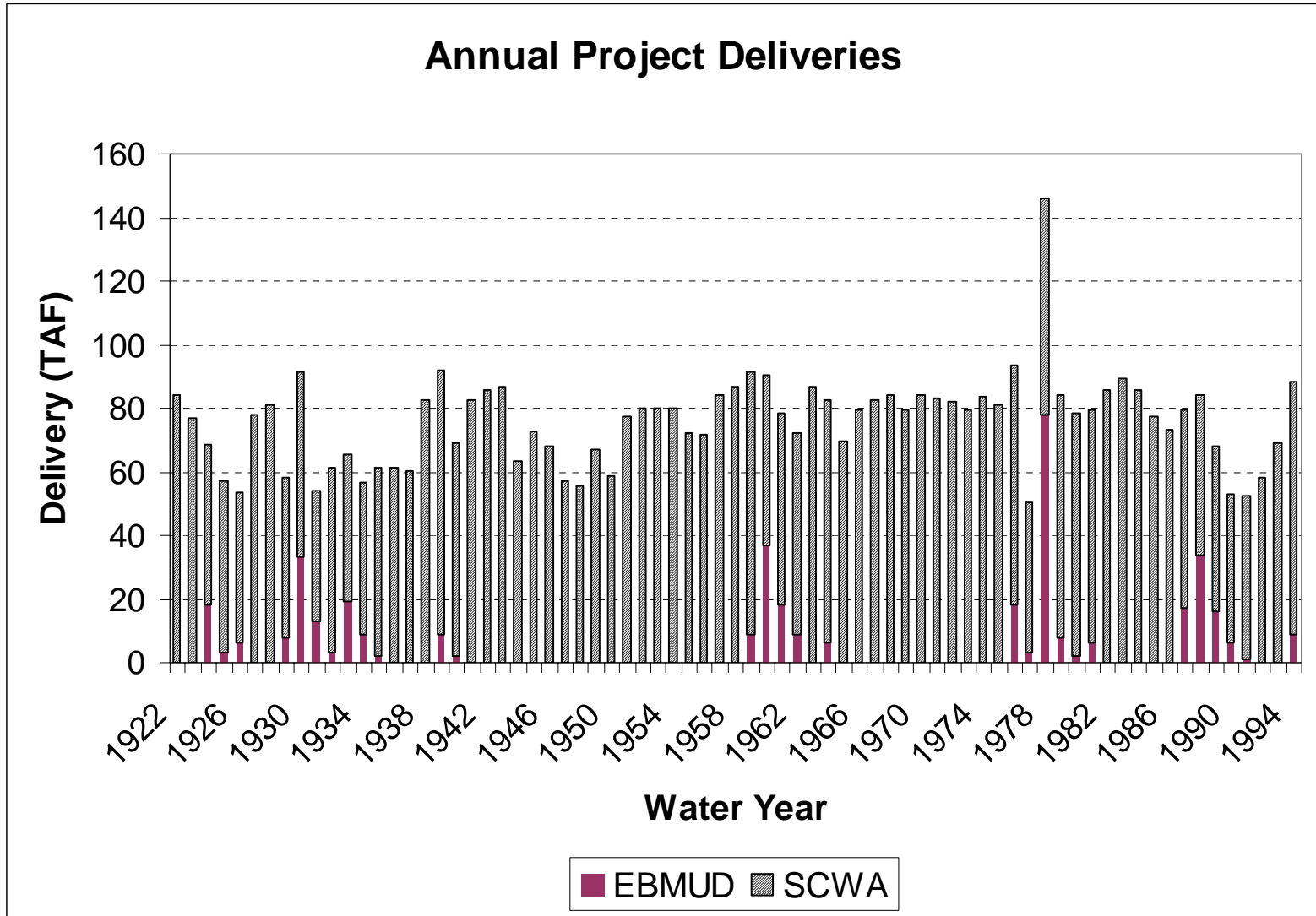


Figure 3-4.  
Deliveries to EBMUD and SCWA for Alternative 6 at the 2020 Level of Development

## Hydrologic Modeling Results

The modeling results from CALSIM and EBMUDSIM were evaluated to identify the magnitude and pattern of changes in water supply operational characteristics for some of the major river and reservoir variables that might be affected by project deliveries. Data that were evaluated include reservoir storage and elevation at the Shasta, Trinity, Oroville, Folsom, Pardee, and Camanche systems; flows in the Feather River, lower American River, Sacramento River, and lower Mokelumne River; total Delta inflow and outflow; and effects on Delta export operations reflected in Banks and Tracy pumping, CVP and SWP south-of-Delta deliveries, and San Luis Reservoir storage. Because CALSIM simulates monthly operations for the entire CVP and SWP water supply operations, CALSIM responds to project-related diversions by altering reservoir releases or river flows to meet system flow and water quality objectives. Conditions in a specific model year will not necessarily match those observed in the historical record. CALSIM uses unimpaired runoff as initial conditions and then applies existing or future land development and consumptive use conditions on the unimpaired runoff. Exports and reservoir operations are then calculated for a specific level of demand given the entire period of record. The model optimizes operations over the period to meet system operations and regulatory requirements. In addition, these responses in CALSIM can be numerically greater than the original project-related operation because operations may change at multiple locations, and/or the resolution of model parameters cannot accurately reflect the small changes caused by relatively small project-related diversions. Generally, agency personnel operating the water supply systems have flexibility in controlling these interactions between the criteria than the monthly model results would suggest.

### Alternatives 2–5

#### Impact 3-1: Changes in Upper Sacramento River Basin Hydrologic Conditions

Figures 3-5 and 3-6 show the frequency distribution of the ranked end-of-September storage (also known as carryover storage) in the major northern California SWP and CVP reservoirs (Shasta, Trinity, Oroville, and Folsom) for Alternative 1 (no-action scenario) and Alternatives 2–6. Carryover storage is important for protecting against unanticipated drought conditions that may occur during the following year. The frequency plots indicate the percentage of months with storage of a particular value. Table 3-1 shows summary statistics of carryover storage values for all water years, and for the historical dry water year period (1928–1934) (see section 3.4.1 of the Modeling Technical Appendix, Volume 3 of this EIR/EIS, for additional information on simulated project effects during other drought periods). The CALSIM simulation results indicate that reservoir storage responses to project deliveries are distributed throughout the SWP and CVP system. Average annual changes would be slightly greater during dry periods. Very infrequent, larger increases and reductions in storage are

observed in some individual months even though project diversions are small or not occurring. These changes in storage are typically associated with equivalent changes in storage or deliveries at other locations. Therefore, these changes are not substantial, are infrequent, and represent less-than-significant impacts. See Sections 3.4.3 and 3.4.9 of the Modeling Technical Appendix, Volume 3 of this EIR/EIS, for detailed information.

### **Impact 3-2: Changes in Lower Sacramento River, Delta Inflow, and Delta Outflow Hydrologic Conditions**

Changes to SWP and CVP operations simulated by CALSIM for upper basin reservoir storage and flows in response to project-related diversions at the Freeport Intake facility are ultimately reflected in Sacramento River flows and total Delta inflow. Figure 3-7 shows the frequency distribution plots for monthly average Sacramento River flow below the Freeport intake facility and monthly average total Delta inflow for all alternatives. The plots include data that are truncated to include only the relatively lower flow values where project-related differences would have the largest proportional effects to background flow conditions. As a result of the relatively small size of maximum project-related diversion rates compared to the background flows, there are no discernible differences in the overall distribution of flows with and without project operations.

Figure 3-8 shows time series of Sacramento River flows downstream of the project diversions at Freeport for the historical dry water year period (1928–1934) and historical wet water year period (1967–1971) for all alternatives. The project-related changes resulting from Freeport intake facility diversion rates of up to 286 cfs are negligible (less than 3%) relative to the background Sacramento River flows that are rarely less than 10,000 cfs. Consequently, the differences cannot be detected in the plots. Data for the San Joaquin River at Vernalis, which is a component of total Delta inflow, reflects similar negligible differences between conditions with and without the project diversions.

Figure 3-9 shows the frequency distributions of data for monthly Delta outflow volume (truncated to volumes less than 2,000 af per month) and the X2 position for all alternatives. Both variables have similar data distributions for with- and without-project conditions. Table 3-1 shows that average annual Delta outflow would be reduced by 33,000 af compared to the no-action conditions, equivalent to 0.2% of the total existing outflow volume. The pattern of incremental monthly outflow reductions indicates a similar average volume reduction through each month of the water year. The X2 position is directly related to Delta outflow, and both the frequency plot and tabulated results (Table 3-1) indicate that there would be no appreciable changes between with- and without-project conditions. These changes are not substantial and represent less-than-significant impacts. See Sections 3.4.4 and 3.4.5 of the Modeling Technical Appendix, Volume 3 of this EIR/EIS, for detailed information.

**Table 3-1. Summary Statistics of CALSIM and EBMUDSIM Hydrologic Modeling Parameters for 2001 Level of Development**

| Location/Resource                             | Year Type <sup>a</sup> | No Action <sup>b</sup> | Alternatives 2–5 |            | Alternative 6 |            |
|---|------------------------|------------------------|------------------|------------|---------------|------------|
|   |                        |                        | Change           | Change (%) | Change        | Change (%) |
| Trinity Reservoir Storage (TAF) <sup>c</sup>  | Dry                    | 584                    | 10               | 1.6        | -2            | -0.3       |
|   | Average                | 1318                   | -4               | -0.3       | -2            | -0.1       |
| Shasta Reservoir Storage (TAF) <sup>c</sup>   | Dry                    | 1512                   | -60              | -4.0       | -8            | -0.5       |
|   | Average                | 2672                   | -15              | -0.6       | -1            | -0.1       |
| Oroville Reservoir Storage (TAF) <sup>c</sup> | Dry                    | 1528                   | 14               | 0.9        | -8            | -0.6       |
|   | Average                | 2113                   | -8               | -0.4       | -13           | -0.6       |
| Folsom Reservoir Storage (TAF) <sup>c</sup>   | Dry                    | 400                    | -20              | -4.9       | -3            | -0.7       |
|   | Average                | 503                    | -4               | -0.9       | -2            | -0.4       |
| San Luis Reservoir Storage (TAF) <sup>c</sup> | Dry                    | 603                    | -25              | -4.2       | -1            | -0.2       |
|   | Average                | 573                    | -5               | -0.9       | -3            | -0.6       |
| Pardee Reservoir Storage (TAF) <sup>c</sup>   | Dry                    | 179                    | 3                | 1.7        | 90            | 50.3       |
|   | Average                | 176                    | 6                | 3.4        | 117           | 66.5       |
| Camanche Reservoir Storage (TAF) <sup>c</sup> | Dry                    | 174                    | 53               | 30.4       | -5            | -2.9       |
|   | Average                | 221                    | 17               | 7.7        | 25            | 11.3       |
| Mokelumne Inflow to Delta (TAF)               | Dry                    | 86                     | 4                | 4.7        | 0             | 0.0        |
|   | Average                | 284                    | 8                | 2.8        | -14           | -4.8       |
| Delta Outflow (TAF)                           | Dry                    | 6611                   | -19              | -0.3       | -15           | -0.2       |
|   | Average                | 14473                  | -33              | -0.2       | -35           | -0.2       |
| Exports, Banks Pumping Plant (TAF)            | Dry                    | 1947                   | 6                | 0.3        | -4            | -0.2       |
|   | Average                | 3170                   | -6               | -0.2       | -3            | -0.1       |
| Exports, Tracy Pumping Plant (TAF)            | Dry                    | 1636                   | -10              | -0.6       | -4            | -0.3       |
|   | Average                | 2300                   | -4               | -0.2       | 0             | 0.0        |

| Location/Resource                                | Year Type <sup>a</sup> | No Action <sup>b</sup> | Alternatives 2–5 |            | Alternative 6 |            |
|--|------------------------|------------------------|------------------|------------|---------------|------------|
|  |                        |                        | Change           | Change (%) | Change        | Change (%) |
| X2 Position (km)                                 | Dry                    | 81                     | 0.0              | 0.0        | 0.0           | 0.0        |
|  | Average                | 76                     | 0.0              | 0.0        | 0.0           | 0.0        |
| CVP Deliveries North of Delta (TAF) <sup>d</sup> | Dry                    | 1959                   | 0                | 0.0        | 1             | 0.0        |
|  | Average                | 2210                   | 0                | 0.0        | 1             | 0.1        |
| CVP Deliveries South of Delta (TAF)              | Dry                    | 1668                   | -6               | -0.3       | -2            | -0.1       |
|  | Average                | 2595                   | -4               | -0.2       | 1             | 0.0        |
| SWP Deliveries South of Delta (TAF)              | Dry                    | 2132                   | 6                | 0.3        | -8            | -0.4       |
|  | Average                | 3213                   | -6               | -0.2       | -7            | -0.2       |

<sup>a</sup> “Average” is the average value of 72-year simulation period (1922–1993). “Dry” is the average value of 1928–1934 dry period.

<sup>b</sup> Annual values are based on water years (October–September).

<sup>c</sup> End of September carry-over storage.

<sup>d</sup> Does not include American River Division and FRWP deliveries.

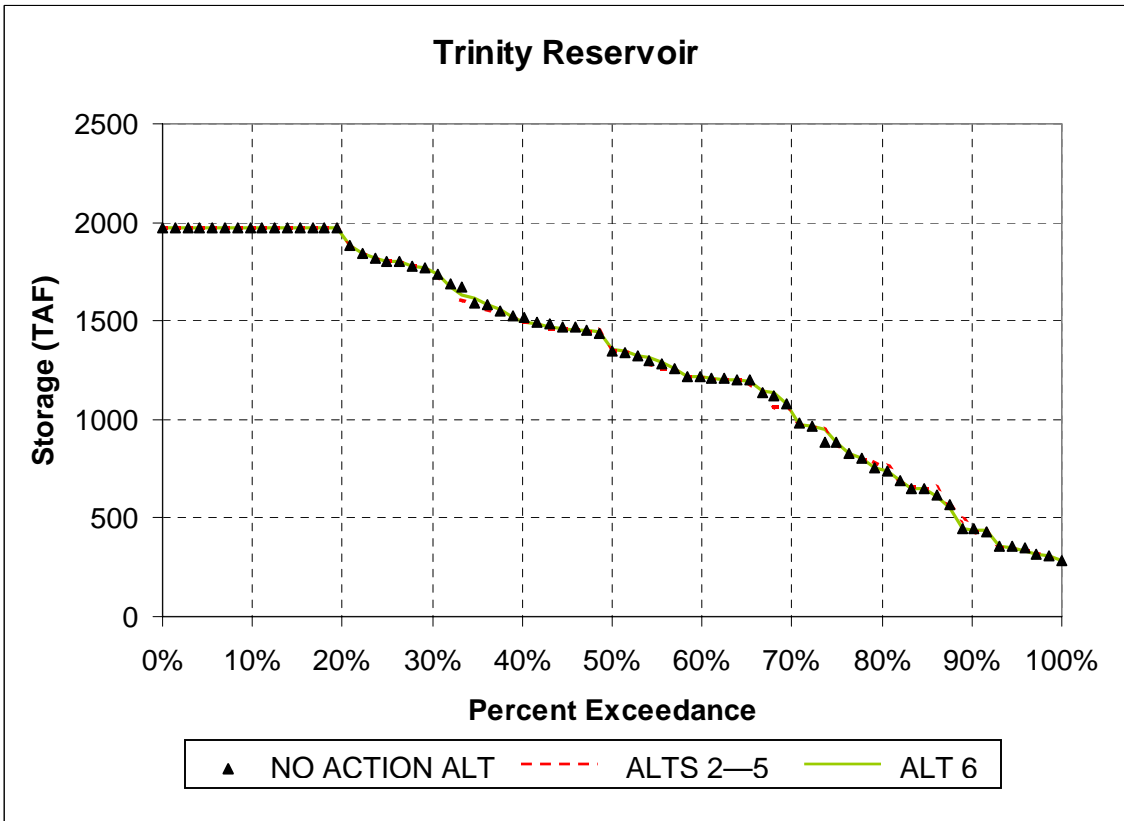
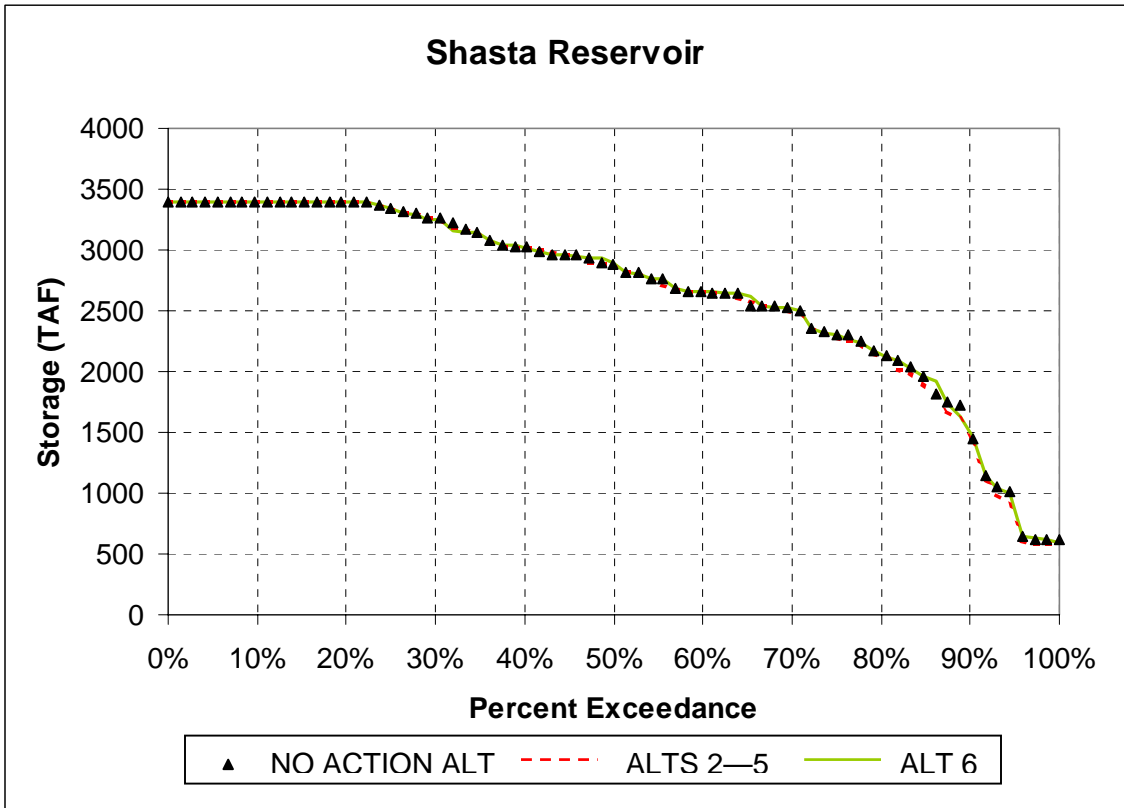


Figure 3-5.  
Frequency Distribution of End-of-September Storage in Shasta and Trinity Reservoirs

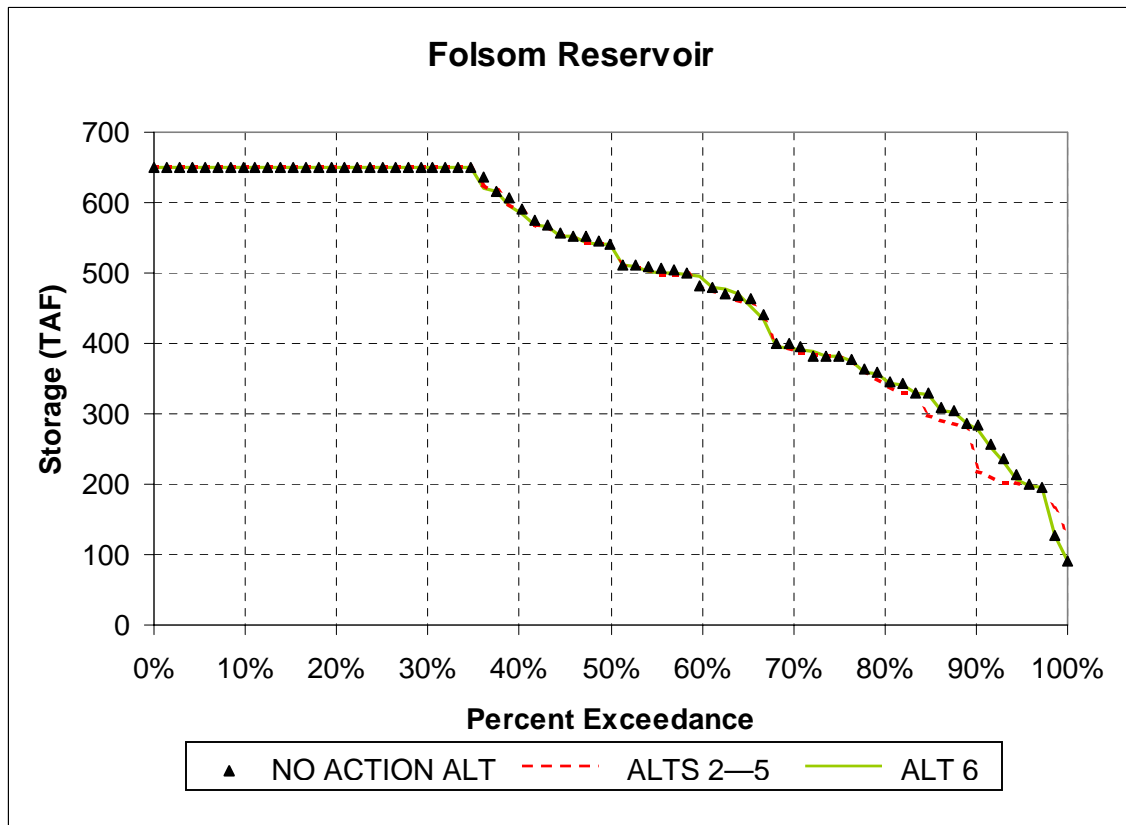
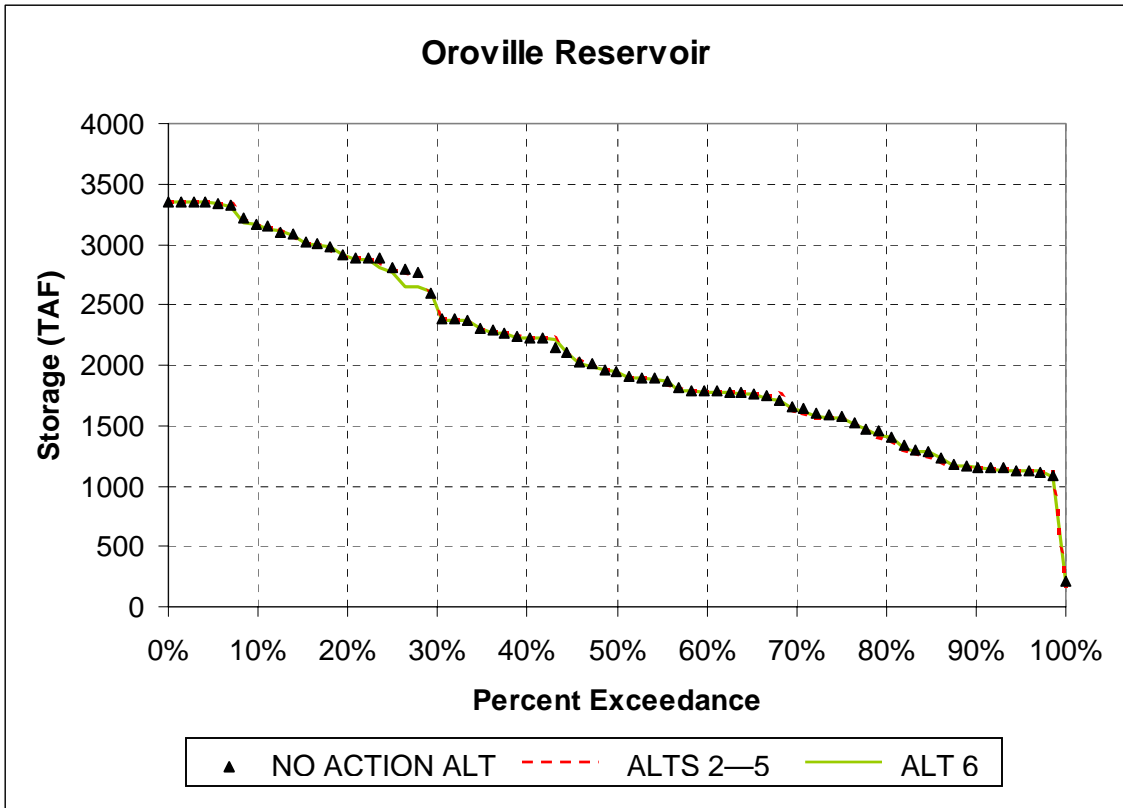


Figure 3-6.  
Frequency Distribution of End-of-September Storage in Oroville and Folsom Reservoirs

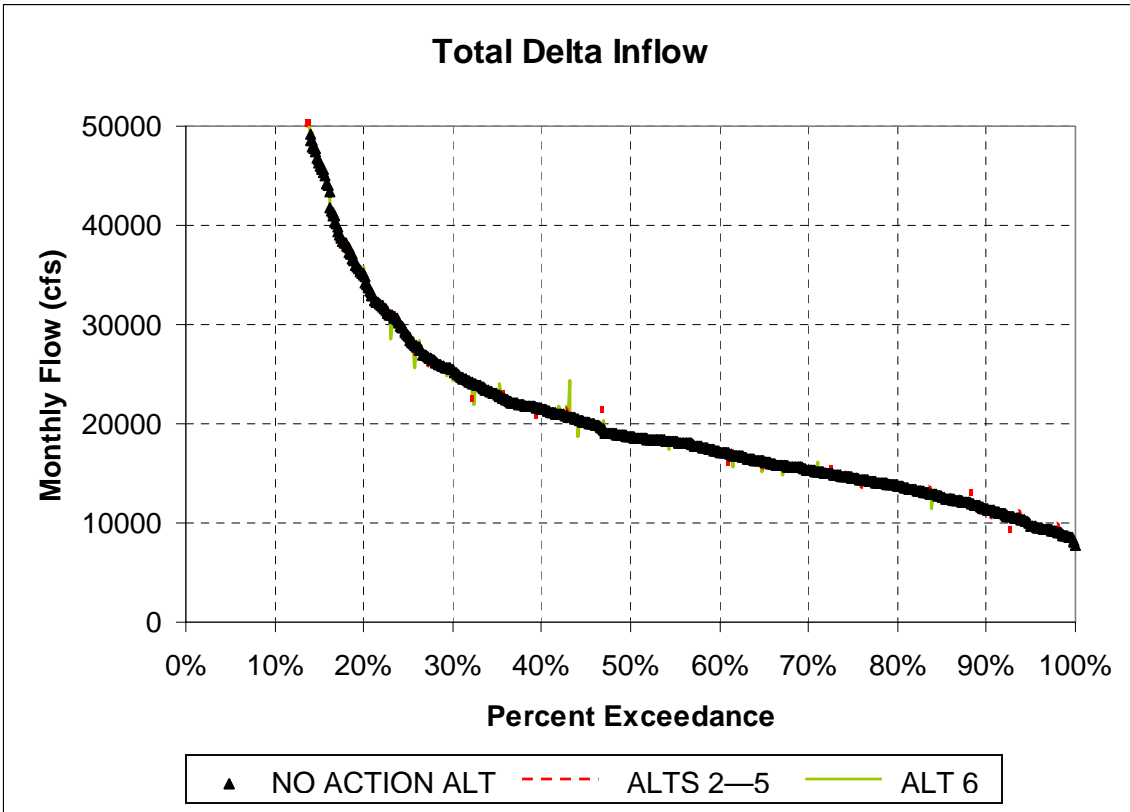
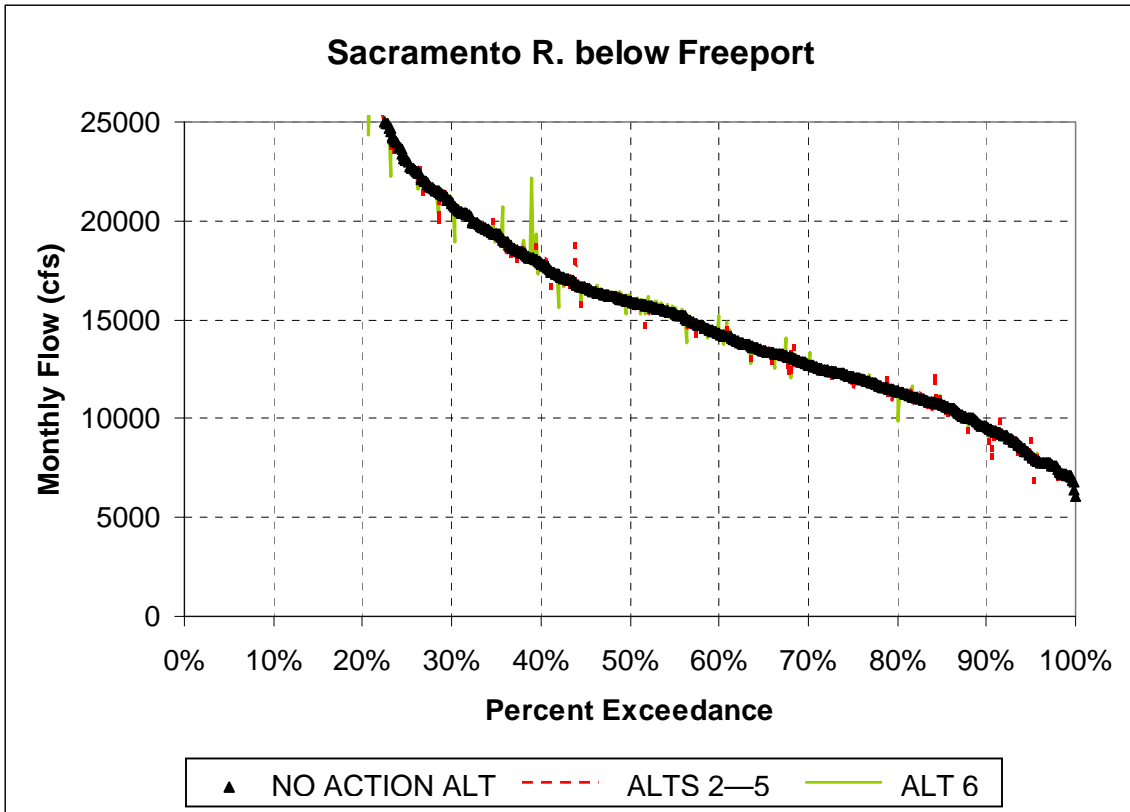


Figure 3-7.  
Frequency Distribution of Sacramento River Flow and Delta Inflow

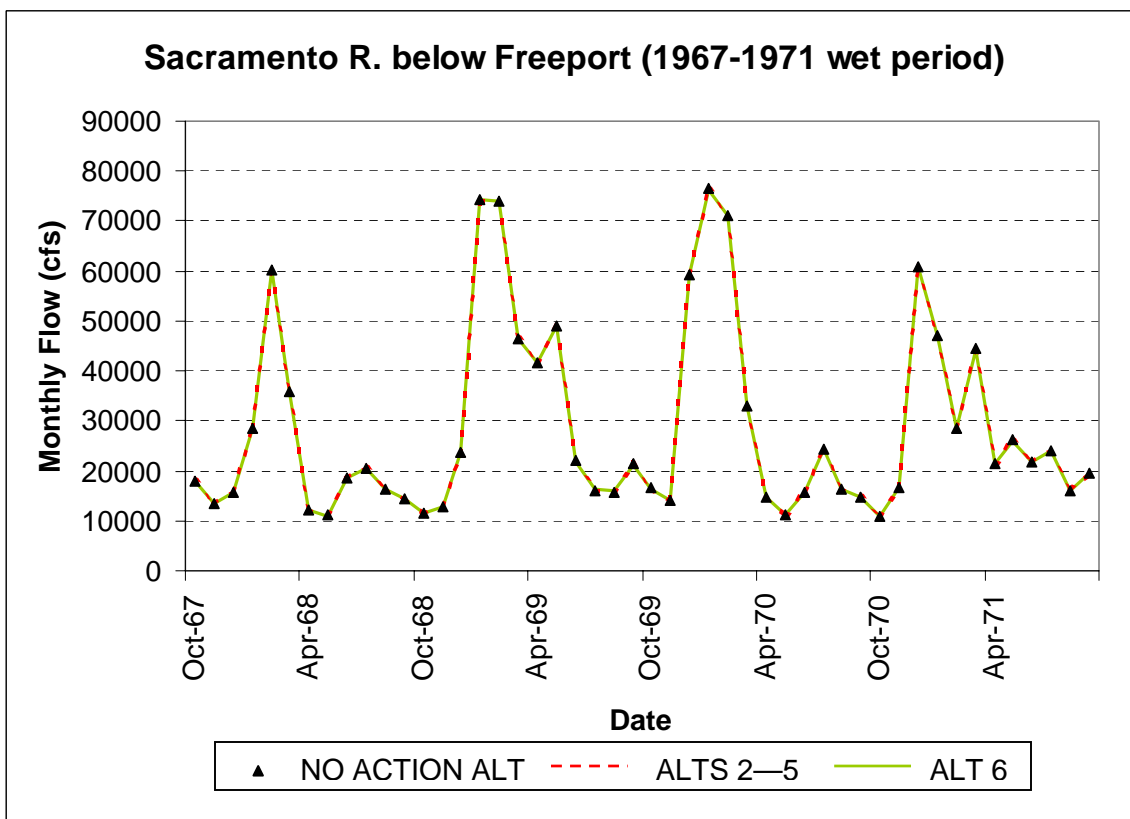
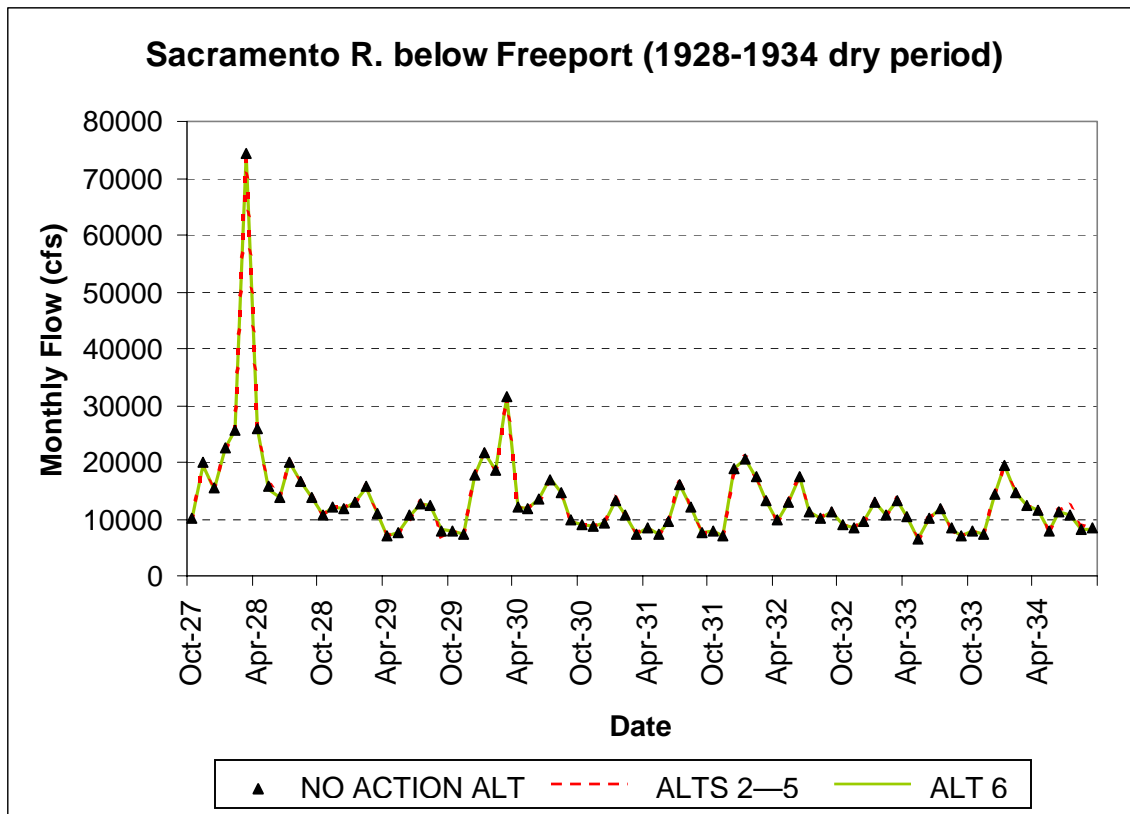


Figure 3-8.  
Time Series of Sacramento River Flow

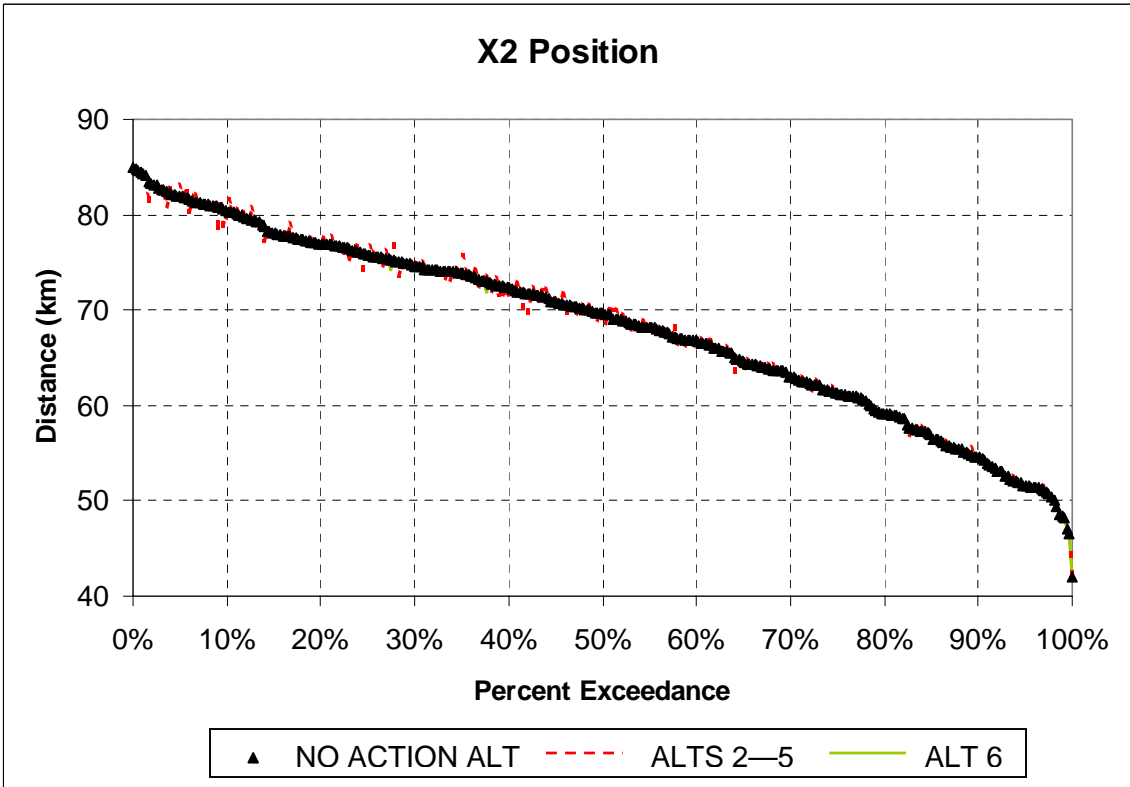
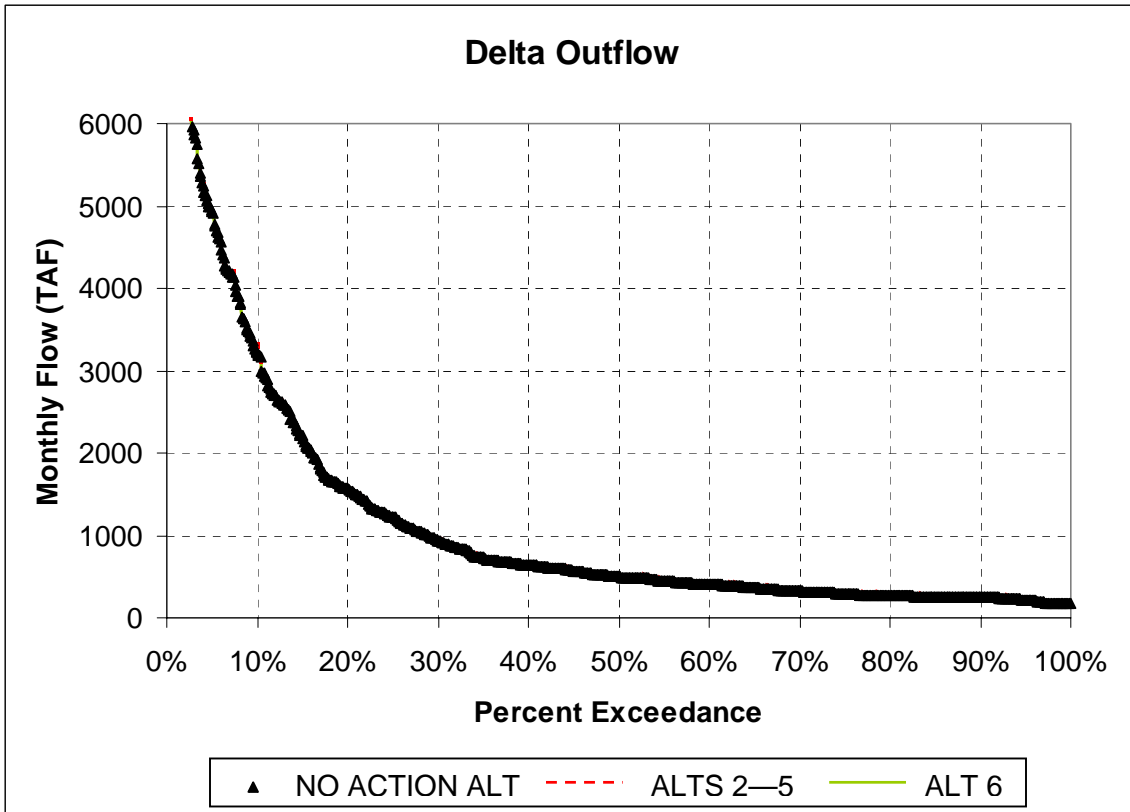


Figure 3-9.  
Frequency Distribution of Delta Outflow and X2 Position

## **Impact 3-3: Changes in Mokelumne River Basin Hydrologic Conditions**

### **Pardee and Camanche Reservoirs**

Figure 3-10 shows the frequency distributions of EBMUDSIM simulated Pardee Reservoir and Camanche Reservoir end-of-September carryover storage volume. For Alternatives 2–5, the magnitude of discernible differences in the overall distribution of storage levels with and without project operations are small. Summary data in Table 3-1 indicate that for Alternatives 2–5, the average carryover storage in Pardee Reservoir would be about 6,000 af greater than the no-action conditions; average carryover storage in Camanche Reservoir would increase by 17,000 af. Storage gains help to meet water supply demands and instream flow requirements. The reservoir storage savings are a direct result of project-related deliveries to the Mokelumne Aqueduct that serve to supplement EBMUD demands in their service area. During the 1928–1934 dry period, Pardee Reservoir carryover storage would be about 3,000 af higher than under no-action conditions, while Camanche reservoir storage would be approximately 53,000 af higher. These changes are not substantial and represent less-than-significant impacts. See Sections 3.4.4 and 3.4.5 of the Modeling Technical Appendix, Volume 3 of this EIR/EIS, for detailed information.

### **Lower Mokelumne River**

Figure 3-11 shows the frequency distribution of monthly flow volumes released from Camanche Reservoir and net inflow to the Delta from the lower Mokelumne River for all alternatives. For Alternatives 2–5, the observed changes are attributable to increased carryover storage levels in both Pardee Reservoir and Camanche Reservoir that result in an increased frequency of higher fishery releases under the 1998 Joint Settlement Agreement and a slightly greater probability of winter releases to maintain flood control storage requirements. The simulated annual average Mokelumne River inflow to the Delta under Alternatives 2–5 (Table 3-1) would be increased by 8,000 af; the value would be similar for the dry (increase of 4,000 af) and average annual conditions. These changes are not substantial and represent less-than-significant impacts. See Sections 3.4.4 and 3.4.5 of the Modeling Technical Appendix, Volume 3 of this EIR/EIS, for detailed information.

## **Impact 3-4: Changes in South-of-Delta Water Supply Delivery Operations**

Figure 3-12 shows the frequency distribution of CVP and SWP south-of-Delta deliveries for all alternatives. Table 3-1 shows summary statistics for changes in Banks and Tracy pumping plants and CVP and SWP deliveries. Similar to other variables, the relatively small project-related diversions under Alternatives 2–5 compared to Delta export operations would not be expected to cause substantial changes in deliveries and no discernible difference can be observed with the frequency distribution. Model simulations indicate that implementation of Alternatives 2–5 would result in reductions of annual average SWP and CVP

south-of-Delta deliveries by approximately 6,000 af and 4,000 af, respectively, compared to no project conditions. Relative to the total south-of-Delta deliveries, the changes are small and represent about a 0.2% reduction to each. The values for the total Delta exports from Banks and Tracy pumping plants are similar.

Figure 3-13 shows frequency distributions for the CVP and SWP portions of end-of-September storage volume in San Luis Reservoir for all alternatives. In response to the small changes in Delta export pumping, there are no discernible differences in the overall distribution of storage volumes between with- and without-project operations. The average annual total CVP and SWP end-of-September storage in San Luis Reservoir (Table 3-1) would decrease by approximately 5,000 af, representing approximately a 0.9% reduction. These changes are not substantial and represent less-than-significant impacts. See Sections 3.4.6, 3.4.7, and 3.4.8 of the Modeling Technical Appendix, Volume 3 of this EIR/EIS, for detailed information.

## Alternative 6

### **Impact3-5: Changes in Upper Sacramento River Basin Hydrologic Conditions**

Figures 3-5 and 3-6 also provide the frequency distributions end-of-September carryover storage for the four northern California reservoirs (Trinity, Shasta, Oroville, Folsom) for all alternatives. Table 3-1 provides summary statistics for average carryover storage for the full 72-year data set, and the historical dry period (1928–1934). The construction of a new Pardee Dam and enlarging the reservoir would result in the capture of additional spring and summer runoff from the upper Mokelumne River basin watershed and thereby increase EBMUD's water supply storage capacity. SCWA would divert water from a smaller Freeport intake facility at Freeport at a rate up to 85 MGD. Consequently, CALSIM-simulated responses would be controlled by additional SCWA demands for Sacramento River water and reduced overall Delta inflow. The resulting carryover storage in the Shasta, Oroville, and Folsom Reservoirs would be slightly less than under no-action conditions. Average storage in Trinity Reservoir would not change. However, these differences are not discernible in the frequency distributions. These changes are not substantial and represent less-than-significant impacts. See Section 3.4.3 of the Modeling Technical Appendix, Volume 3 of this EIR/EIS, for detailed information.

### **Impact 3-6: Changes in Lower Sacramento River, Delta Inflow, and Delta Outflow Hydrologic Conditions**

Figures 3-7 and 3-8 show that there is very little difference in Sacramento River flow below Freeport and Delta inflow between the alternatives and the no-action conditions. Figure 3-9 shows that there is a similar negligible difference in

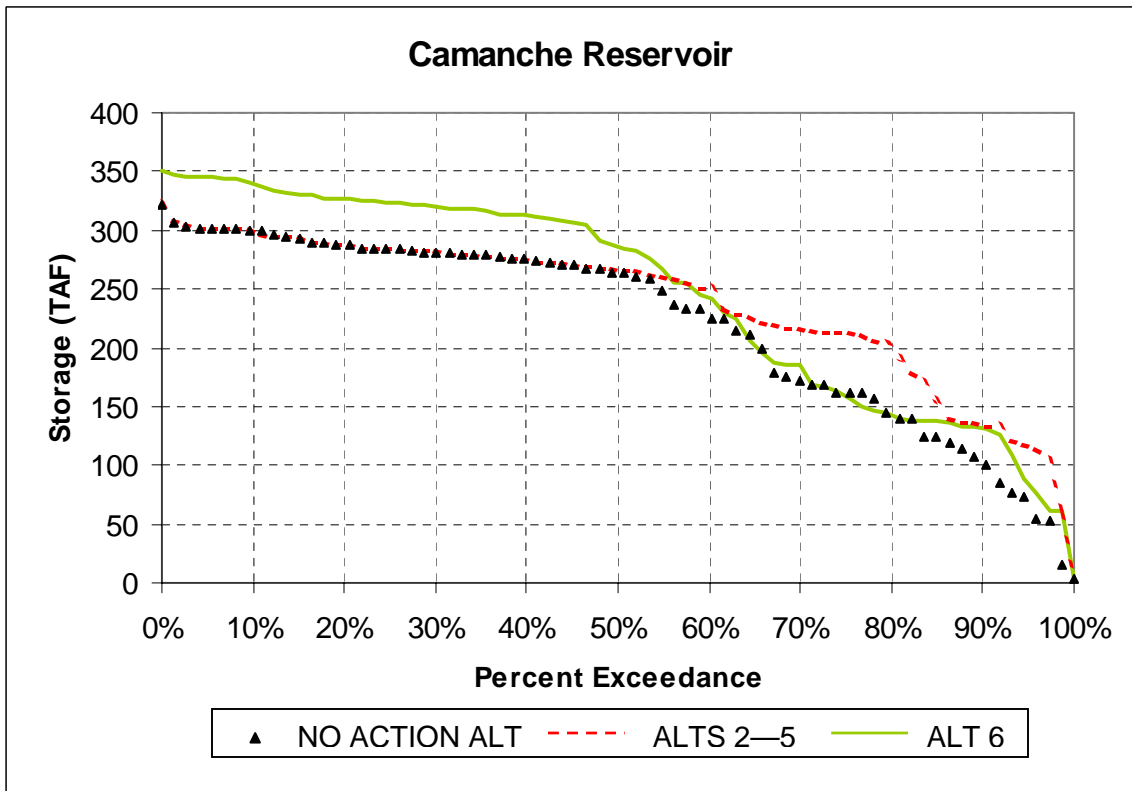
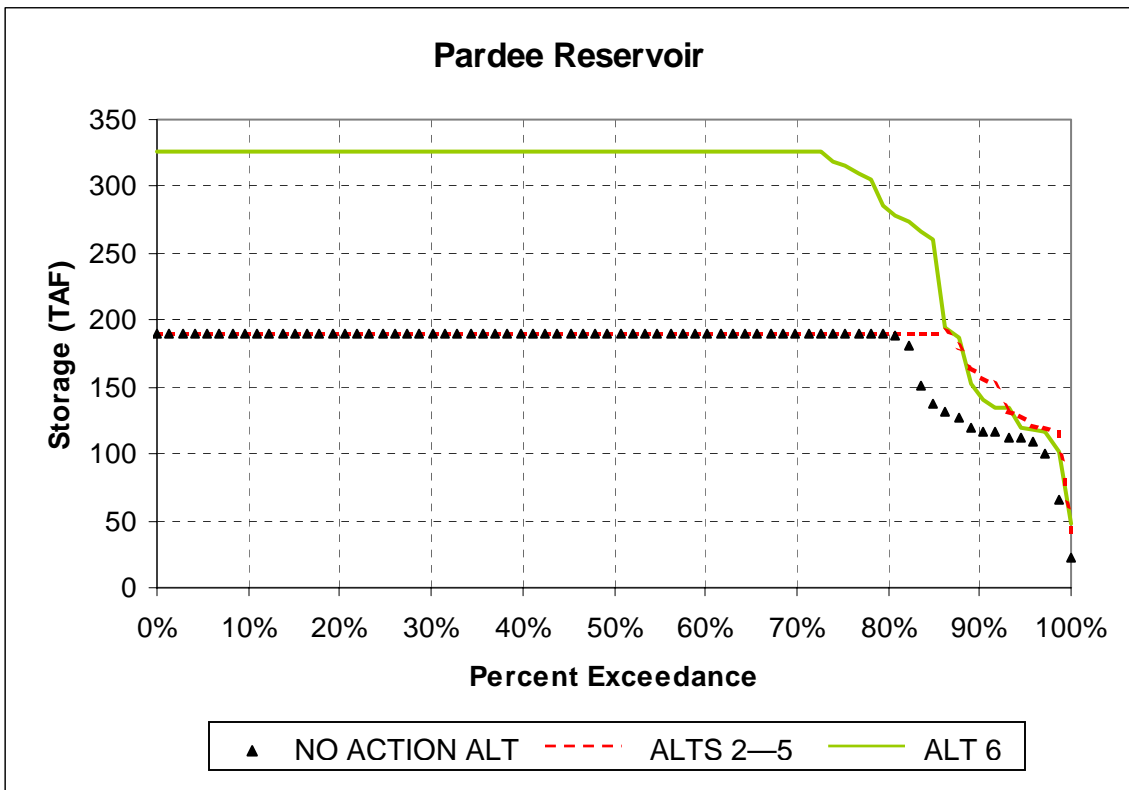


Figure 3-10.  
Frequency Distribution of End-of-September Storage in Pardee and Camanche Reservoirs

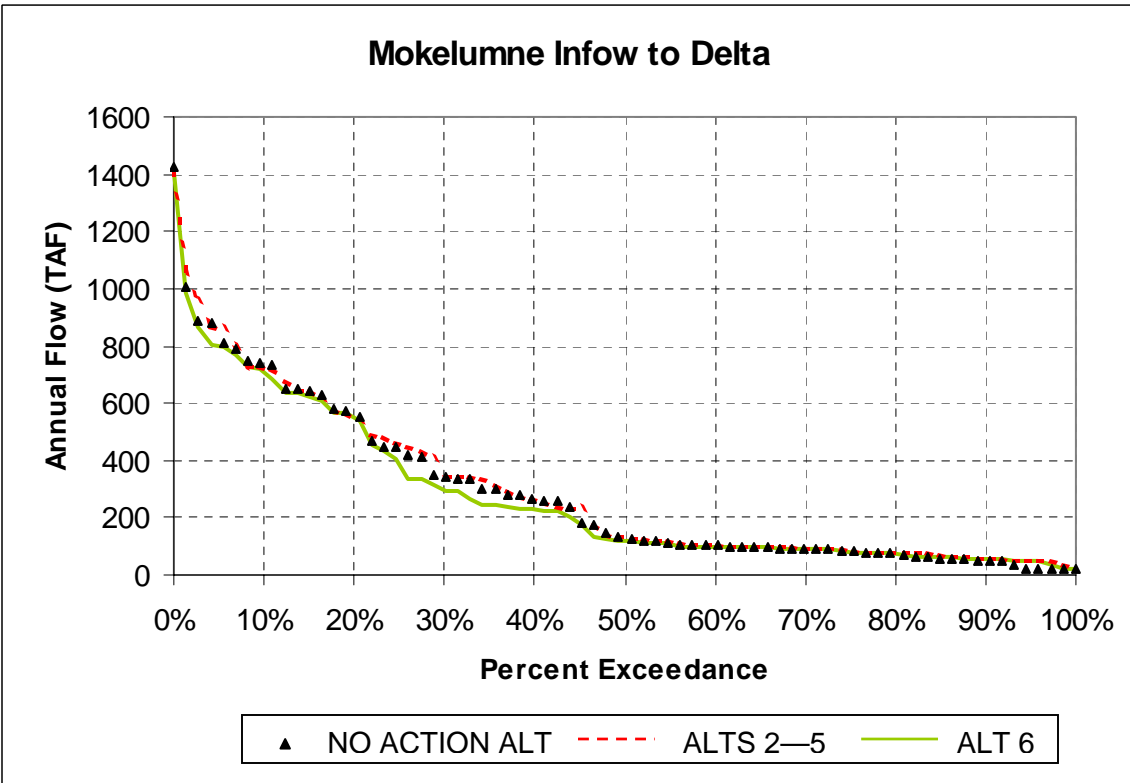
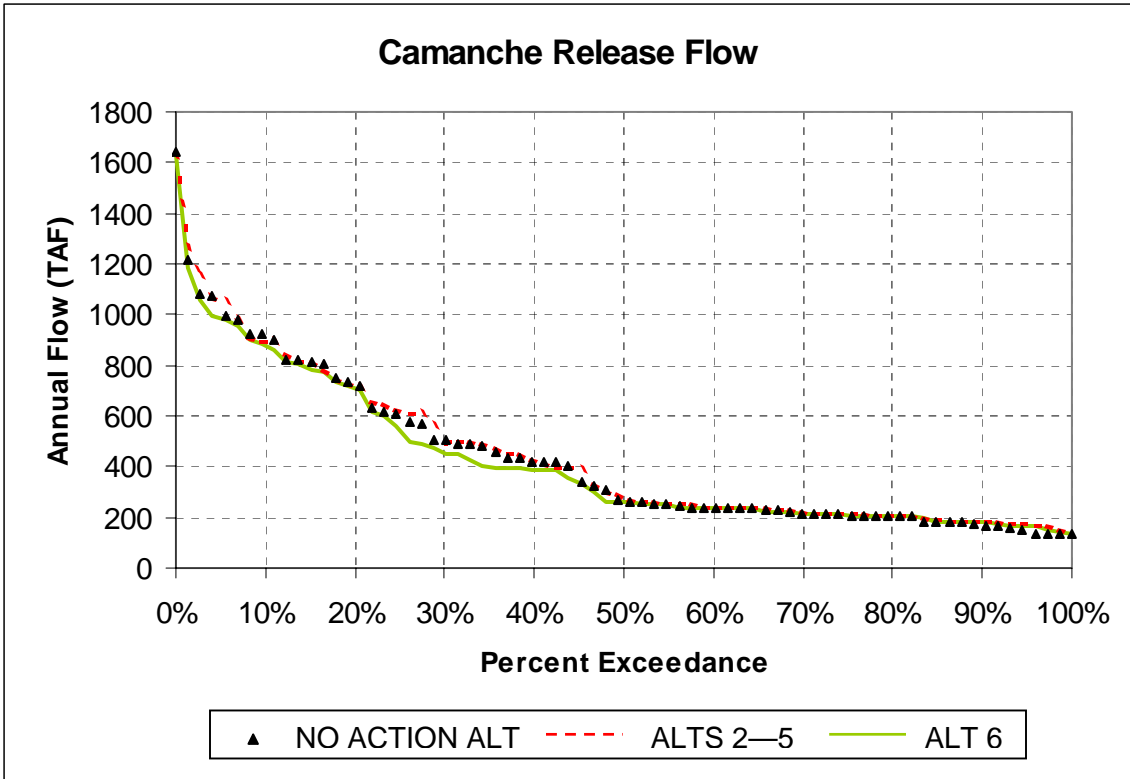


Figure 3-11.  
Frequency Distribution of Camanche Releases and Mokelumne Inflow to Delta

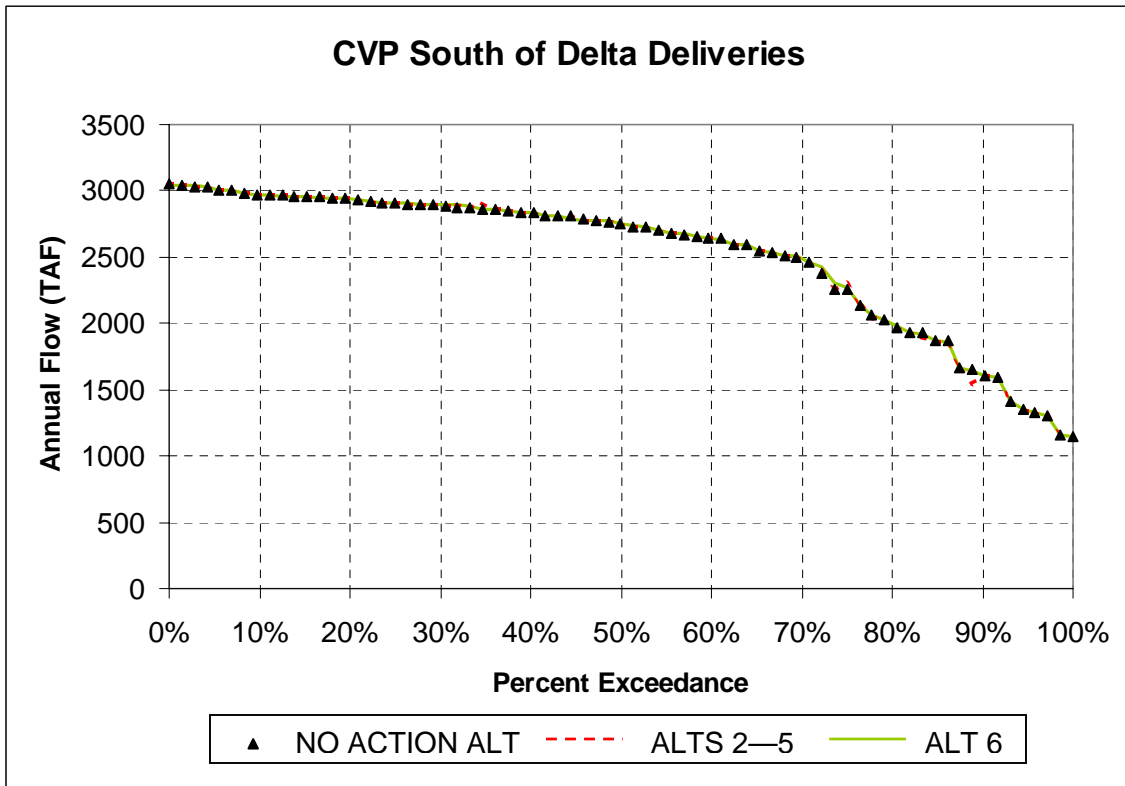
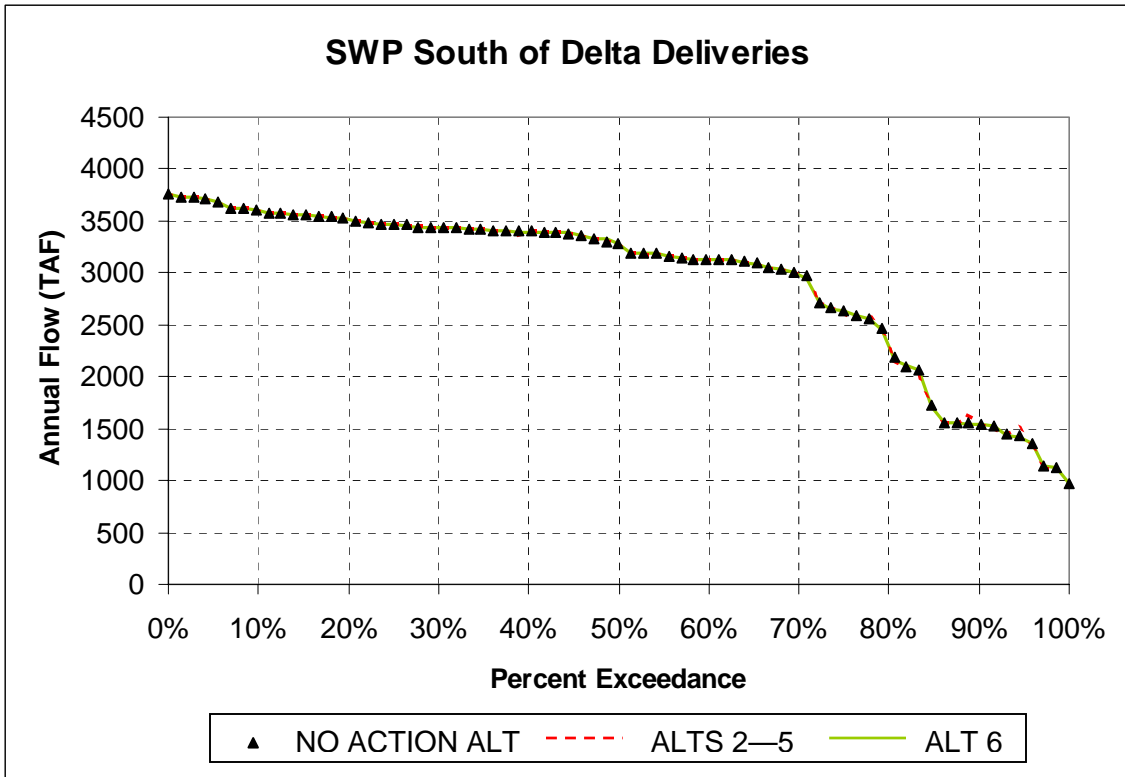


Figure 3-12.  
Frequency Distribution of SWP and CVP South of Delta Deliveries

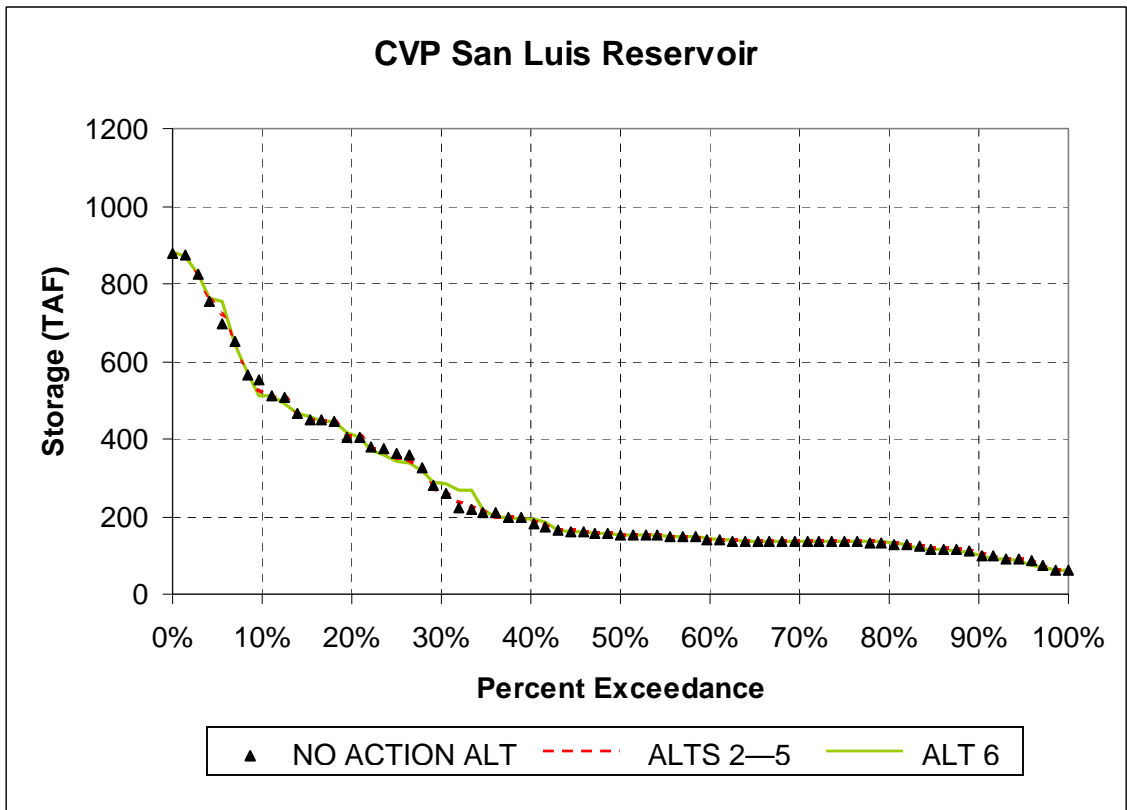
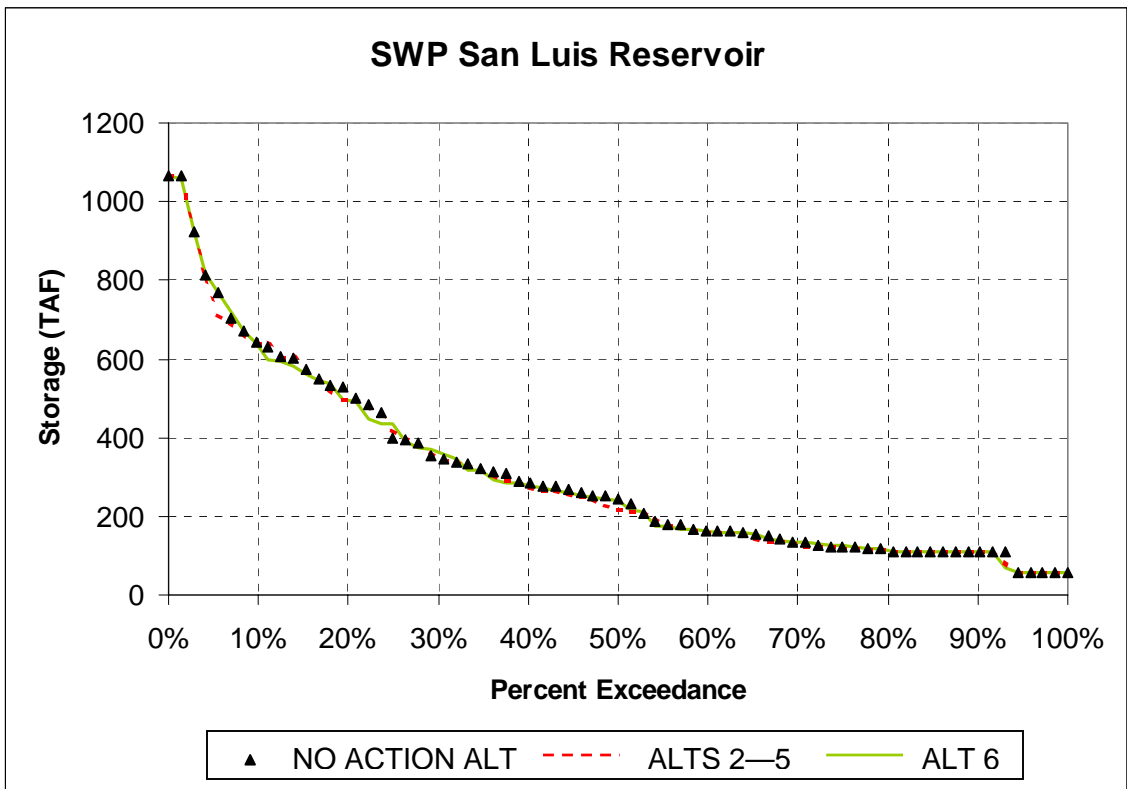


Figure 3-13.  
Frequency Distribution of CVP and SWP Storage in San Luis Reservoir

frequency distributions of Delta outflow and X2 position for all alternatives. Average annual Delta outflow would be reduced by 35,000 af compared to the no-action conditions (Table 3-1). The average monthly X2 position would not change appreciably. These changes are not substantial and represent less-than-significant impacts. See Section 3.4.4 of the Modeling Technical Appendix, Volume 3 of this EIR/EIS, for detailed information.

## **Impact 3-7: Changes in Mokelumne River Basin Hydrologic Conditions**

### **Pardee and Camanche Reservoirs**

Figure 3-10 shows Pardee and Camanche Reservoirs end-of-September storage data for all alternatives based on EBMUDSIM model results. Figure 3-10 shows that, under Alternative 6, Pardee and Camanche storage levels would be higher than the without-project case in most years, but would be drawn down in dry years. Table 3-1 shows that, under Alternative 6, average annual carryover storage would be 117,000 af greater in Pardee and 25,000 af greater in Camanche than under existing conditions. Camanche Reservoir levels are higher than no project because the enlarged Pardee Reservoir would provide more flood control space allowing less flood control space to be reserved in Camanche Reservoir. The combined average change in carryover storage in both reservoirs would be an additional 142,000 af. During the 1928–1934 dry period, Pardee storage would be increased by 90,000 af, while Camanche storage would decrease by 5,000 af compared to the No Action Alternative. Figure 3-10 shows that the additional storage in Pardee Reservoir provides the greatest monthly change in storage during the dry and critically dry water years.

Figure 3-14 shows the seasonal pattern of Pardee Reservoir storage that would result following construction of the new dam for the historical 1928–1934 dry water year period and 1967–1971 wet year period for all alternatives. Storage in Pardee Reservoir would be maintained at a higher level in most months, and inflows would be sufficient in the wet year period to maintain full storage conditions in the reservoir. However, inflows during critically dry periods would still be insufficient to maintain reservoir storage levels, and storage volumes would be reduced to identical levels as under base conditions. Figure 3-15 shows that seasonal patterns of Camanche Reservoir storage are very similar during both dry and wet periods for all alternatives. Camanche storage under the enlarged dam scenario shows a pattern similar to Pardee Reservoir. During wet periods, the reservoir tends to remain at maximum allowable levels, but during prolonged dry periods, the reservoir is drawn down as releases exceed inflows. These changes are not substantial and represent less-than-significant impacts. See Section 3.4.4 of the Modeling Technical Appendix, Volume 3 of this EIR/EIS, for detailed information.

### **Lower Mokelumne River**

Figure 3-11 shows the frequency distribution of Mokelumne River flows released from Camanche Reservoir and Mokelumne River inflow to the Delta for all alternatives. This figure shows that Mokelumne flows are generally less than

without project in the 20 to 50% exceedance range. Table 3-1 shows that, under this alternative, average annual inflow to the Delta would decrease by about 14,000 af compared to the no-action conditions, while during the 1928–1934 dry period, inflows would be unchanged. Individual monthly flows would increase in some months because of increased fishery flows. However, the changes would occur primarily during normal or wetter year types; average flows would not change appreciably during critically dry year types because fishery flow requirements control conditions in these years. However, the frequency of critically dry years would decrease per Joint Settlement Agreement provisions.

Figure 3-16 shows the seasonal pattern of Mokelumne River inflow at Woodbridge for the 1928–1934 dry period and 1967–1971 wet period for all alternatives. The plots indicate that there is no strong pattern in the monthly pattern of higher and lower flows relative to the base scenario for either dry or wet water year periods that would occur upon implementation of the project. These changes are not substantial and represent less-than-significant impacts. See Sections 3.4.4 and 3.4.5 of the Modeling Technical Appendix, Volume 3 of this EIR/EIS, for detailed information.

### **Impact 3-8: Changes in South-of-Delta Water Supply Delivery Operations**

Figures 3-12 and 3-13 show the frequency distribution of CVP and SWP south-of-Delta deliveries and the CVP and SWP portions of end-of-September storage volume in San Luis Reservoir, respectively, for all alternatives. Table 3-1 shows summary statistics for changes in Banks and Tracy pumping plants and CVP and SWP deliveries. Similar to other variables, the relatively small additional diversions of Mokelumne River basin water to the EBMUD service area cause negligible changes in the frequency distributions of these variables. Annual average CVP south-of-Delta deliveries would increase by 1,000 af, and SWP deliveries would decrease by approximately 7,000 af compared to no-project conditions. On a percentage basis of total CVP and SWP south-of-Delta deliveries, the changes reflect a 0.0% increase and a 0.2% reduction, respectively. The average annual total CVP and SWP end-of-September storage in San Luis Reservoir (Table 3-1) would decrease by 3,000 af, representing a reduction of approximately 0.6%. These changes are not substantial and represent less-than-significant impacts. See Sections 3.4.6, 3.4.7, and 3.4.8 of the Modeling Technical Appendix, Volume 3 of this EIR/EIS, for detailed information.



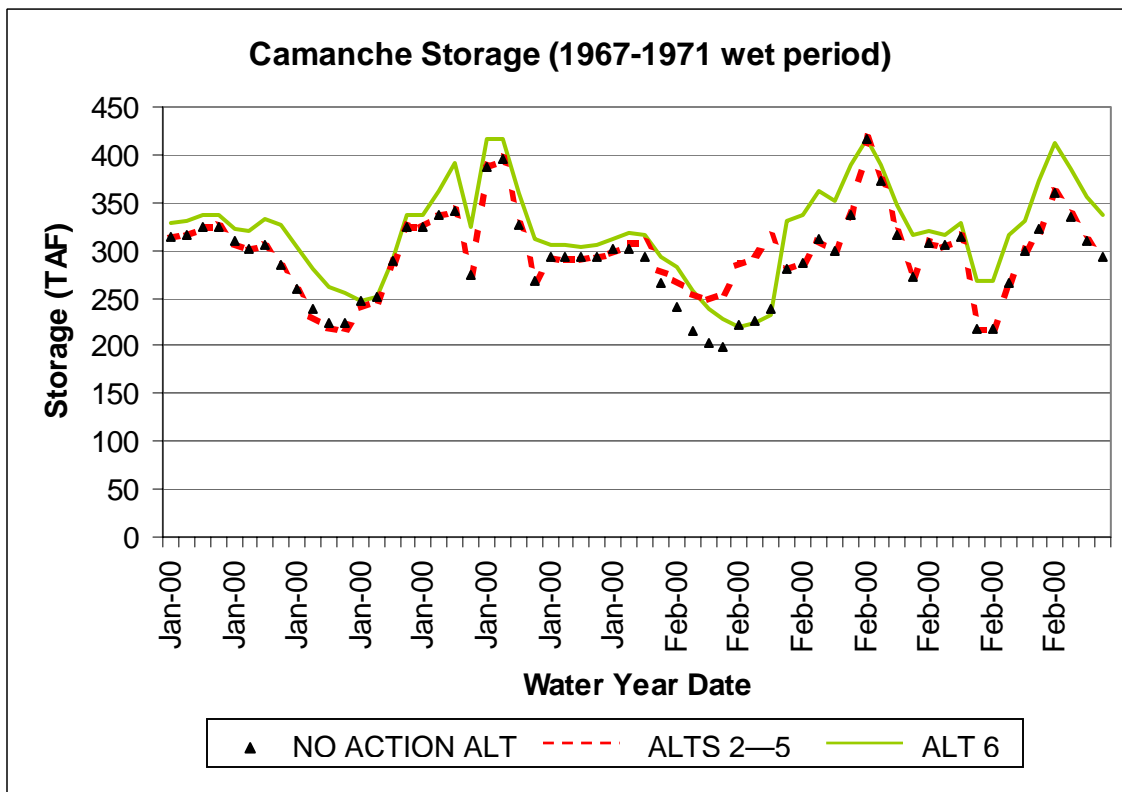
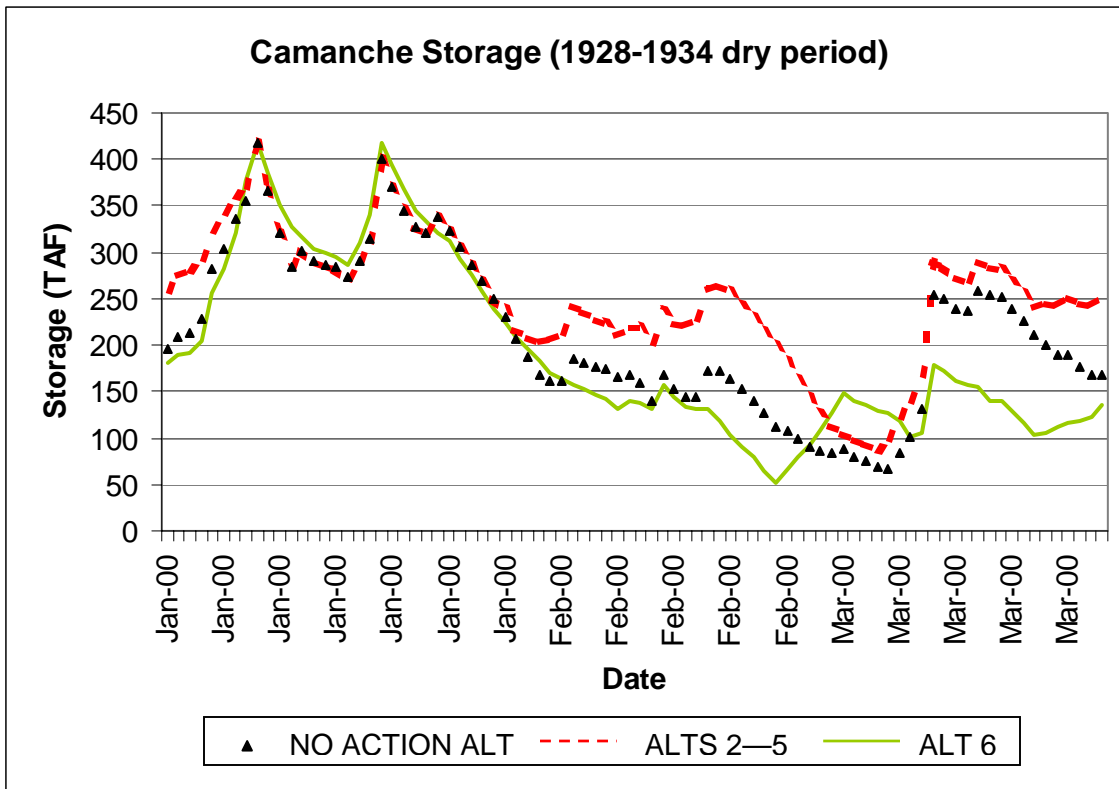


Figure 3-15.  
Time Series of Camanche Reservoir Storage

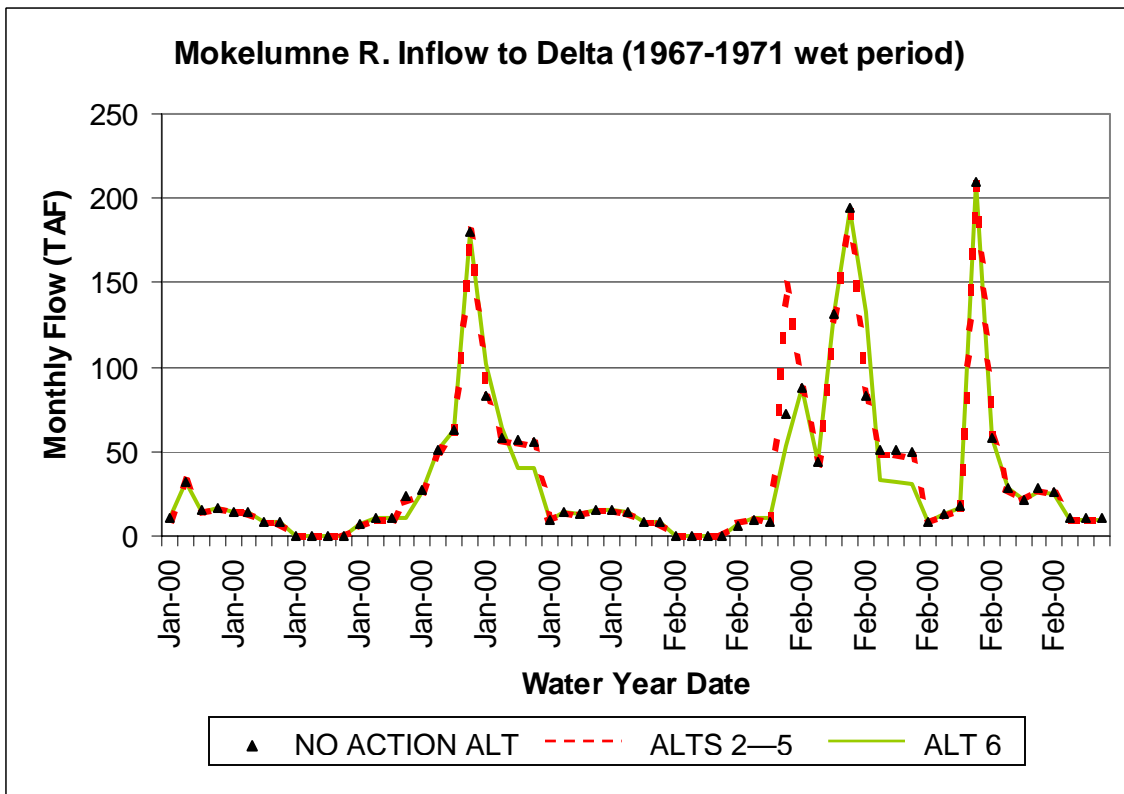
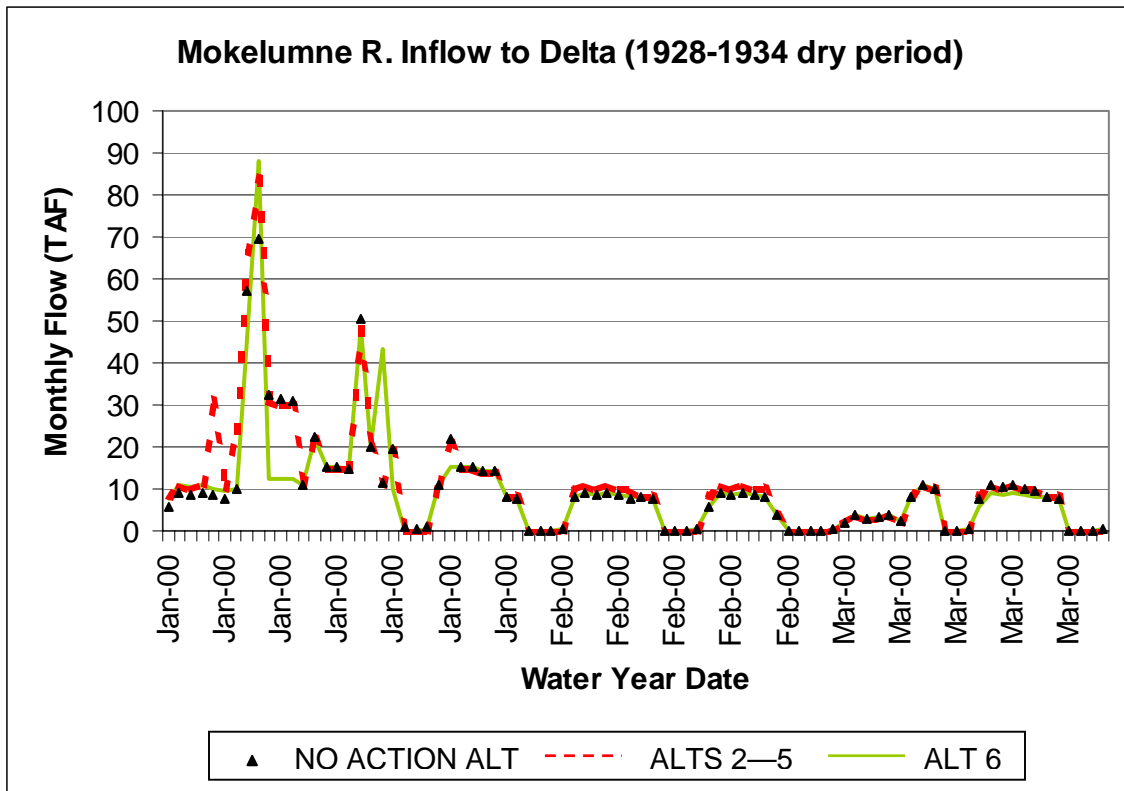


Figure 3-16.  
Time Series of Mokelumne River Inflow to the Delta

## Modeling Results for Hydropower Resources and Energy Production

### Impact 3-9: Hydropower and Energy Production

A summary of the annual energy generated at CVP facilities under Alternative 1 and changes induced under each alternative are shown in Table 3-2. Overall, energy production at CVP facilities would be reduced a very small amount under future the project alternatives as compared to the No Action Alternative (existing conditions). Power generation corresponds to revised release patterns that provide for operation of the FRWP alternatives. Compared to Alternative 1, energy production under Alternatives 2–5 and Alternative 6 would be reduced by 2 GWh (0.04%) and 0 GWh, respectively.

**Table 3-2.** Comparison of Annual Power Generation for Each Alternative

| Alternative  | Annual Power Generated<br>(GWh <sup>a</sup> )<br>CVP North Facilities |
|--|---|
| Alternative 1 (no action/existing conditions)      | 4,918   |
| Alternatives 2–5 minus Alternative 1               | -2  |
| Alternative 6 minus Alternative 1                  | -0  |
| Future no action                                   | 4,704   |
| Alternatives 2–5 cumulative minus future no action | -2  |
| Alternative 6 cumulative minus future no action    | -0  |

<sup>a</sup> 1 GWh is equivalent to 1,000 MW hours.

Under cumulative conditions, average annual power generation would be reduced by approximately 214 GWh without implementation of any of the FRWP alternatives. Similar to current conditions, implementation of the FRWP alternatives would reduce CVP power generation by 2 GWh (0.04%) and 0 GWh, respectively. These reductions are exceedingly small under both existing and cumulative conditions. These impacts are less than significant.

## Cumulative Impacts

### Methods and Assumptions

Methods and assumptions for the cumulative effects analysis are essentially identical to those described for the project alternatives analysis.

## Modeling Procedures and Assumptions

CALSIM II was also used to assess the potential cumulative effects of the project alternatives when reviewed together with past, present, and reasonably foreseeable future actions. For purposes of this analysis, cumulative future conditions are composed of projected hydrology, water supply, and power supply conditions as represented by the CALSIM II 2020 benchmark study (modified to remove the demands for SCWA that are assumed to be met in that benchmark study; This case also represents a likely “future no-action” condition), with the project alternatives then added to the modified CALSIM II 2020 benchmark study. This CALSIM II analysis is then compared to existing conditions, as represented by the CALSIM II 2001 benchmark study. To determine the potential incremental contribution of the project alternatives to any potential cumulative effects, the results are also compared to the modified 2020 CALSIM II benchmark study (future no action). Although the results of the modeling are complex, this comparison provides insight into the potential contribution of the alternative to any cumulative impacts.

## Hydrologic Modeling Results

### Cumulative Conditions

Table 3-3 shows summary statistics for CALSIM and EBMUDSIM results for cumulative conditions with Alternatives 2–5, including changes in reservoir storage, river flows, and deliveries for the dry (1928–1934) hydrologic period, and the average of all 74 water years. As described above, the cumulative effects are represented by the difference between 2020 conditions with the project alternatives and the 2001 no-action conditions. The incremental changes potentially attributable to the project alternatives are represented by the difference between the simulated 2020 conditions with the project alternatives and the 2020 no-action conditions. The data indicate that under 2020 no-action conditions, SWP and CVP systemwide north-of-Delta and south-of-Delta water demands and associated deliveries will increase substantially. Increased south-of-Delta deliveries would occur through additional Delta exports and additional reliance on storage reserves in San Luis Reservoir. Increased water demands and deliveries are reflected in reduced carryover storage in northern California reservoirs and reduced Delta outflow. Changes in Pardee Reservoir carryover storage are small under no-action conditions; however, increased demand in the lower basin results in substantial reduction in Mokelumne River inflow to the Delta.

The increments of change between 2001 and 2020 cumulative conditions that are attributable to Alternatives 2–5 relative to the total change varies from locations to location and are generally small (Table 3-3). The project-related contribution is uniformly small compared to the cumulative change at all locations. In some cases, such as Trinity Reservoir, the project-related contribution to the average change for the 1928–1934 period comprises all of the observed cumulative

**Table 3-3.** Summary Statistics of CALSIM and EBMUDSIM Hydrologic Modeling Parameters for Alternatives 2–5 at a 2020 Level of Development

| Location/Resource                             | Year Type <sup>a</sup> | No Action (2001) <sup>b</sup> | 2020 Alternatives 2–5 <sup>b</sup> | 2020 No Project <sup>b</sup> | 2020 Change | 2020 Change (%) |
|---|------------------------|-------------------------------|------------------------------------|------------------------------|-------------|-----------------|
| Trinity Reservoir Storage (TAF) <sup>c</sup>  | Dry                    | 584                           | 673                                | 696                          | -23         | -3.3            |
|   | Average                | 1318                          | 1314                               | 1318                         | -4          | -0.3            |
| Shasta Reservoir Storage (TAF) <sup>c</sup>   | Dry                    | 1512                          | 1400                               | 1438                         | -38         | -2.6            |
|   | Average                | 2672                          | 2568                               | 2582                         | -15         | -0.6            |
| Oroville Reservoir Storage (TAF) <sup>c</sup> | Dry                    | 1528                          | 1502                               | 1517                         | -15         | -1.0            |
|   | Average                | 2113                          | 2054                               | 2066                         | -11         | -0.5            |
| Folsom Reservoir Storage (TAF) <sup>c</sup>   | Dry                    | 400                           | 348                                | 355                          | -7          | -2.0            |
|   | Average                | 503                           | 476                                | 479                          | -3          | -0.6            |
| San Luis Reservoir Storage (TAF) <sup>c</sup> | Dry                    | 603                           | 606                                | 609                          | -3          | -0.5            |
|   | Average                | 573                           | 554                                | 558                          | -4          | -0.7            |
| Pardee Reservoir Storage (TAF) <sup>c</sup>   | Dry                    | 179                           | 181                                | 173                          | 8           | 4.4             |
|   | Average                | 176                           | 180                                | 173                          | 7           | 4.0             |
| Camanche Reservoir Storage (TAF) <sup>c</sup> | Dry                    | 174                           | 212                                | 157                          | 55          | 35.0            |
|   | Average                | 221                           | 232                                | 211                          | 21          | 10.0            |
| Mokelumne Inflow to Delta (TAF)               | Dry                    | 86                            | 86                                 | 83                           | 4           | 4.9             |
|   | Average                | 284                           | 284                                | 270                          | 15          | 5.5             |
| Delta Outflow (TAF)                           | Dry                    | 6611                          | 6562                               | 6563                         | -1          | 0.0             |
|   | Average                | 14473                         | 14265                              | 14291                        | -26         | -0.3            |
| Exports, Banks Pumping Plant (TAF)            | Dry                    | 1947                          | 1964                               | 1983                         | -16         | -0.8            |
|   | Average                | 3170                          | 3226                               | 3229                         | -2          | -0.1            |
| Exports, Tracy Pumping Plant (TAF)            | Dry                    | 1636                          | 1651                               | 1665                         | -14         | -0.8            |
|   | Average                | 2300                          | 2260                               | 2267                         | -7          | -0.3            |

| Location/Resource                                | Year Type <sup>a</sup> | No Action<br>(2001) <sup>b</sup> | 2020                             | 2020                    | 2020 Change | 2020       |
|--|------------------------|----------------------------------|----------------------------------|-------------------------|-------------|------------|
|  |                        |                                  | Alternatives<br>2-5 <sup>b</sup> | No Project <sup>b</sup> |             | Change (%) |
| X2 Position (km)                                 | Dry                    | 81                               | 81                               | 81                      | 0.0         | 0.0        |
|  | Average                | 76                               | 76                               | 76                      | 0.0         | 0.1        |
| CVP Deliveries North of Delta (TAF) <sup>d</sup> | Dry                    | 1959                             | 1984                             | 1986                    | -2          | -0.1       |
|  | Average                | 2210                             | 2274                             | 2274                    | 0           | 0.0        |
| CVP Deliveries South of Delta (TAF)              | Dry                    | 1668                             | 1655                             | 1672                    | -17         | -1.0       |
|  | Average                | 2595                             | 2520                             | 2526                    | -6          | -0.2       |
| SWP Deliveries South of Delta (TAF)              | Dry                    | 2132                             | 2120                             | 2137                    | -17         | -0.8       |
|  | Average                | 3213                             | 3313                             | 3319                    | -6          | -0.2       |

<sup>a</sup> “Average” is the average value of 72-year simulation period (1922–1993). “Dry” is the average value of 1928–1934 dry period.

<sup>b</sup> Annual values are based on water years (October–September).

<sup>c</sup> End of September carry-over storage.

<sup>d</sup> Does not include American River Division and FRWP deliveries.

**Table 3-4.** Summary Statistics of CALSIM and EBMUDSIM Hydrologic Modeling Parameters for Alternatives 6 at a 2020 Level of Development

| Location/Resource                               | Year Type <sup>a</sup> | No Action <sup>b</sup><br>(2001) | 2020<br>Alternative 6 <sup>b</sup> | 2020<br>No Project <sup>b</sup> | 2020 Change | 2020<br>Change (%) |
|---|------------------------|----------------------------------|------------------------------------|---------------------------------|-------------|--------------------|
| Trinity Reservoir Storage (TAF)                 | Dry                    | 584                              | 692                                | 696                             | -4          | -0.6               |
|   | Average                | 1318                             | 1316                               | 1318                            | -2          | -0.2               |
| Shasta Reservoir Storage (TAF)                  | Dry                    | 1512                             | 1430                               | 1438                            | -8          | -0.6               |
|   | Average                | 2672                             | 2578                               | 2582                            | -5          | -0.2               |
| Oroville Reservoir Storage (TAF)                | Dry                    | 1528                             | 1512                               | 1517                            | -5          | -0.3               |
|   | Average                | 2113                             | 2053                               | 2066                            | -13         | -0.6               |
| Folsom Reservoir Storage (TAF)                  | Dry                    | 400                              | 353                                | 355                             | -2          | -0.6               |
|   | Average                | 503                              | 477                                | 479                             | -2          | -0.4               |
| San Luis Reservoir Storage (TAF)                | Dry                    | 603                              | 607                                | 609                             | -2          | -0.3               |
|   | Average                | 573                              | 555                                | 558                             | -3          | -0.5               |
| Pardee Reservoir Storage (TAF)                  | Dry                    | 179                              | 260                                | 173                             | 87          | 50.3               |
|   | Average                | 176                              | 290                                | 173                             | 117         | 67.6               |
| Camanche Reservoir Storage (TAF)                | Dry                    | 174                              | 169                                | 157                             | 12          | 7.6                |
|   | Average                | 221                              | 242                                | 211                             | 30          | 14.2               |
| Mokelumne Inflow to Delta (TAF)                 | Dry                    | 86                               | 85                                 | 83                              | 3           | 3.7                |
|   | Average                | 284                              | 267                                | 270                             | -8          | -2.9               |
| Delta Outflow (TAF)                             | Dry                    | 6611                             | 6547                               | 6563                            | -16         | -0.2               |
|   | Average                | 14473                            | 14264                              | 14291                           | -28         | -0.2               |
| Exports, Banks Pumping Plant (TAF) <sup>c</sup> | Dry                    | 1947                             | 1979                               | 1983                            | -3          | -0.2               |
|   | Average                | 3170                             | 3230                               | 3299                            | 1           | 0.0                |
| Exports, Tracy Pumping Plant (TAF)              | Dry                    | 1636                             | 1659                               | 1665                            | -6          | -0.4               |
|   | Average                | 2300                             | 2263                               | 2267                            | -4          | -0.2               |

| Location/Resource                                | Year Type <sup>a</sup> | No Action <sup>b</sup><br>(2001) | 2020<br>Alternative 6 <sup>b</sup> | 2020<br>No Project <sup>b</sup> | 2020 Change | 2020<br>Change (%) |
|--|------------------------|----------------------------------|------------------------------------|---------------------------------|-------------|--------------------|
| X2 Position (km)                                 | Dry                    | 81                               | 81                                 | 81                              | 0.0         | 0.0                |
|  | Average                | 76                               | 76                                 | 76                              | 0.0         | 0.0                |
| CVP Deliveries North of Delta (TAF) <sup>d</sup> | Dry                    | 1959                             | 1986                               | 1986                            | 0           | 0.0                |
|  | Average                | 2210                             | 2275                               | 2274                            | 1           | 0.0                |
| CVP Deliveries South of Delta (TAF)              | Dry                    | 1668                             | 1665                               | 1672                            | -7          | -0.4               |
|  | Average                | 2595                             | 2523                               | 2526                            | -3          | -0.1               |
| SWP Deliveries South of Delta (TAF)              | Dry                    | 2132                             | 2132                               | 2137                            | -6          | -0.3               |
|  | Average                | 3213                             | 3214                               | 3319                            | -5          | -0.2               |

<sup>a</sup> “Average” is the average value of 72-year simulation period (1922–1993). “Dry” is the average value of 1928–1934 dry period.

<sup>b</sup> Annual values are based on water years (October–September).

<sup>c</sup> End of September carry-over storage.

<sup>d</sup> Does not include American River Division and FRWP deliveries.

change. The larger project-related incremental change occurs because there is no change between the 2001 no-action and 2020 no-action conditions under SWP and CVP operations. In other cases, such as Oroville Reservoir storage, the project-related increment during dry or wet hydrologic periods appears to be larger than the cumulative change simply because the conditions change between the 2001 no-action and 2020 no-action conditions. Project-related effects on Delta exports and CVP/SWP deliveries are relatively small. Project-related effects to cumulative changes in the Mokelumne River basin (i.e., Camanche Reservoir storage, lower Mokelumne River flow) are also negligible because EBMUD demands were simulated at 2020 conditions for both model scenarios. Consequently, cumulative changes observed are attributable solely to increase demands for other uses in the lower basin. These cumulative impacts are considered less than significant.

Table 3-4 shows similar summary statistics for cumulative conditions with Alternative 6 and the increment attributable to this alternative. With the enlarged Pardee Dam and reservoir, in combination with an intake facility at Freeport, similar cumulative changes are observed with reductions in northern California reservoir storage levels and Delta outflow, and increases in Delta exports and deliveries. The changes are slightly less than under cumulative conditions with Alternatives 2–5 because increased Pardee Reservoir water supply storage would be the primary source for EBMUD water supply needs. Camanche Reservoir carryover storage would be reduced considerably as a result of the combined effect of EBMUD deliveries from Pardee Reservoir and increased lower basin water supply demands. These cumulative impacts are considered less than significant.

The pattern of project-related contribution to cumulative changes is similar to that described for the cumulative conditions under the scenario for Alternatives 2–5. However, under this cumulative conditions scenario, there would be minor increased changes in the Mokelumne River system attributable to the project alternative. See Sections 3.5.3, 3.5.4, 3.5.5, 3.5.6, 3.5.7, and 3.5.8 of the Modeling Technical Appendix, Volume 3 of this EIR/EIS, for detailed information.