Chapter 5
Surface Water

This chapter describes potential changes to surface water resources that could result from implementation of the Delta Conveyance Project (project) alternatives. Changes to surface water resources, by themselves, are not considered an impact of the project alternatives under the California Environmental Quality Act (CEQA), and thus, are not evaluated as impacts in this chapter. A description of potential changes to surface water resources is presented in this introductory chapter to provide a basis for understanding the potential impacts on other surface water–related resources in this Draft Environmental Impact Report (Draft EIR).

Many of the impacts evaluated in this Draft EIR are related to the potential changes to surface water resources presented in this chapter. Chapter 6, *Water Supply*, is an introductory chapter that describes State Water Project (SWP) and Central Valley Project (CVP) facilities and operations, and the corresponding changes in water supply resulting from implementation of the project alternatives. Chapter 7, *Flood Protection*, describes flood risks and impacts in the Sacramento River Basin and the Sacramento–San Joaquin Delta (Delta). Chapter 9, *Water Quality*, describes surface water quality impacts in the Sacramento River and San Joaquin River Basins. Chapter 8, *Groundwater*, describes groundwater impacts in the Sacramento River and San Joaquin River Basins that are directly or indirectly affected by changes in surface water characteristics. Chapter 12, *Fish and Aquatic Resources*, and Chapter 13, *Terrestrial Biological Resources*, discuss riparian corridor biological resources in the study area that are dependent on surface water flows.

The surface water study area comprises the Sacramento River Basin and the Delta—located at the confluence of the Sacramento and San Joaquin Rivers. Specifically, this chapter examines the Trinity, Sacramento, Feather, and American Rivers (and relevant associated reservoirs) in the Sacramento River Basin. These surface waters represent the geographic areas where potential changes could occur to surface waters as a result of the operation of new diversion and conveyance facilities for the SWP and, potentially, the CVP identified in the project alternatives. Surface water resources associated with the San Joaquin River are not expected to be affected and therefore are discussed only briefly.

5.0 Summary Comparison of Changes by Project Alternatives

Table 5-0 highlights simulated river and storage conditions at select locations. This table provides information on the magnitude of the most pertinent changes to Sacramento River Basin flows and SWP/CVP reservoir storages that are expected to result from implementation of the project alternatives. Existing regulations, operational rules, and water supply allocation procedures governing SWP and CVP system operations would not change because of operation of the project alternatives. However, because of the effect that integration of the proposed north Delta intakes has on the overall system, their operation could lead to changes in river flows and upstream storages.

Generally, long-term average monthly flows for the project alternatives are similar to existing conditions for all locations examined. However, there are consistent decreases among project alternatives in long-term average flows for all months on the Sacramento River north of Courtland (i.e., downstream of the proposed north Delta intakes) due to the diversions of available excess water at the proposed north Delta intakes beyond the needs to satisfy downstream regulatory requirements in the Delta, including Delta outflows and south-of-Delta exports. Long-term average monthly flows under the No Project Alternative generally (1) increase between December and April and (2) decrease between May and October when compared to existing conditions for all locations examined. These changes are due to changes in inflow patterns to major reservoirs as a result of climate change—with a shift of precipitation distribution to be earlier, more precipitation falling as rain (rather than snow), high intensity of winter precipitation events when they occur, and an earlier snowpack melt.

Storages at SWP and CVP north-of-Delta reservoirs averaged for all years and for dry/critical years under the project alternatives are similar to existing conditions for all time periods examined (i.e., end-of-May, end-of-June, end-of-August, and end-of-September periods). For Trinity Lake, Shasta Lake, Lake Oroville, and Folsom Lake, storage changes are extremely minimal. There are more substantial changes in storage in San Luis Reservoir as long-term averages show increases for all of the project alternatives when compared to existing conditions for all time periods examined (i.e., end-of-May, end-of-June, end-of-August, and end-of-September periods). Increases in San Luis Reservoir storage during the winter and spring are due to diversions at the proposed north Delta intakes. Some of this increased storage is used to support deliveries during the summer, although some carries over into September and is used for Article 56 carryover (i.e., SWP contractor deliveries that were allocated in the previous year, but were stored in SWP storage before being delivered in the current year). A similar pattern is present for most of the dry/critical year averages, although there are decreases in the end-of-September storages. This decrease in end-of-September storage is due to increased SWP allocations in the prior spring. SWP and CVP reservoir storage averages for all years simulated under the No Project Alternative generally decrease when compared to existing conditions for all time periods examined. These decreases are most pronounced for the end-of-August and end-of-September periods and are due to altered inflow patterns as a result of climate change.

Changes to surface water resources, by themselves, are not considered an impact of the project under CEQA and thus are not evaluated as impacts in this chapter. Instead, a description of potential changes to surface water resources is presented in this introductory chapter to provide a basis for understanding the potential effects on other surface water–related resources in this Draft EIR.

Table ES-2 in the Executive Summary highlights simulated river and storage conditions disclosed in this chapter. A more detailed comparison of the river and storage conditions under the No Project Alternative and the project alternatives is included in Section 5.3.2, *Comparison of Project Alternatives with Existing Conditions*; Appendix 5A, *Modeling Technical Appendix*; and Appendix 5C, *Simulated Monthly Flows*.

Table 5-0. Comparison of Surface Water Resources by Project Alternative

		Project Alternative								
Chapter 5, Surface Water	Existing Conditions	1	2a	2b	2c	3	4a	4b	4c	5
Sacramento River Basin Flows, Sacramento River at Freeport (Long-Term Annual Average [a] [cfs])	21,160	21,150	21,149	21,150	21,153	21,150	21,149	21,150	21,153	21,149
Sacramento River Basin Flows, Sacramento River at Freeport (Dry/Critical Years [b] [cfs])	12,213	12,295	12,279	12,272	12,294	12,295	12,279	12,272	12,294	12,291
Sacramento River Basin Flows, Sacramento River North of Courtland (Long-Term Annual Average [a] [cfs])	21,464	20,429	20,382	20,681	20,522	20,429	20,382	20,681	20,522	20,419
Sacramento River Basin Flows, Sacramento River North of Courtland (Dry/Critical Years [b] [cfs])	12,484	12,116	12,065	12,197	12,163	12,116	12,065	12,197	12,163	12,111
SWP and CVP Reservoir Storage, San Luis Reservoir (End-of-September Storage; Long-Term Average [a] [TAF])	619	699	699	695	696	699	699	695	696	700
SWP and CVP Reservoir Storage, San Luis Reservoir (End-of-September Storage; Dry/Critical Years [b] [TAF])	379	358	362	366	362	358	362	366	362	358

cfs = cubic feet per second; CVP = Central Valley Project; SWP = State Water Project; TAF = thousand acre-feet.

[a] Long-term average is the average annual flow or storage for the period October 1921–September 2015 simulated in CalSim 3.

[b] Water year types are State Water Resources Control Board Water Right Decision 1641 40-30-30 water year types as computed in CalSim 3 for the period October 1921–September 2015. Dry/critical year averages are for those two water year types combined.

5.1 Overview of California Water Resources

5.1.1 Historical Precipitation Patterns

Precipitation in California varies greatly from year to year, by season, and geographically throughout the state. Statewide annual precipitation ranges from 100 million acre-feet (MAF) in a dry year to more than 250 MAF during a wet year (California Department of Water Resources 2020:8).

The diverse topography of the state is one of the factors that influences the varying amounts of precipitation that different regions receive. Annual precipitation of 50 inches per year is generally characteristic of the west slope of the Sierra Nevada, parts of the Cascades, and the Coast Ranges (Western Regional Climate Center 2021). Conversely, parts of the Sacramento Valley receive less than 15 inches of precipitation per year and the San Joaquin Valley receives less than 8 inches of precipitation per year (Western Regional Climate Center 2021). Of all the precipitation that California receives, over half evaporates or is used by vegetation and deep groundwater percolation, leaving about 40% to 50% of the water available in the form of runoff for urban and agricultural consumptive uses and for environmental purposes, collectively (Bureau of Reclamation 2019:H-3).

The geographic variation and the variability in precipitation that California receives make it challenging to manage the available runoff that can be diverted or captured in storage to meet urban and agricultural water needs. The majority of California's precipitation occurs between November and April, yet most of the state's demand for water is in the hot, dry summer months. In addition, most of the precipitation falls in the mountains in the northern half of the state, far from major population and agricultural centers. In some years, the far north of the state can receive 100 inches or more of precipitation, while the southernmost regions receive only a few inches (Western Regional Climate Center 2021).

The historical record also shows that California has frequently experienced multiyear droughts, as well as extremely wet years that coincide with substantial flooding. Between 1906 and 1960, one-third of the water years in California were considered by the California Department of Water Resources (DWR) to have been "dry or critical"; that percentage increased to 46% from 1961 to 2017 (Bureau of Reclamation 2019:H-2). From 1906 to 1960, DWR classified 45% of water years in California as "above normal" or "wet" and that percentage increased to 48% from 1961 to 2017. Additionally, the 1906 to 1960 period had 42% of water years classified as extreme (i.e., "critical" or "wet") and that percentage increased to 59% after 1960. Recently, California experienced a multiyear drought, receiving between 56% and 77% of the average precipitation from 2012 to 2015 (California Department of Water Resources 2019:1-4).

Historically, precipitation in most of California has been dominated by extreme variability over seasonal, annual, and decadal timescales. In the context of climate change, projections of future precipitation are even more uncertain than projections for temperature. Uncertainty regarding precipitation projections is greatest in the northern part of the state, and a stronger tendency toward drying is indicated in the southern part of the state. The projected reduction in snowpack under climate change can significantly change the availability and pattern of surface water resources because Sierra Nevada snowpack is the primary source of water supply and natural groundwater recharge in California (California Department of Water Resources 2019:1-14). Climate models project more extreme winter precipitation events that would be more in the form of rain but not snow; therefore, they would generate higher runoffs, creating additional flooding concerns; and a more rapid spring snow melt, leading to shorter, more intense spring periods of river flow and freshwater discharge.

5.1.2 Surface Water Management

To cope with the state's hydrologic variability and to provide more stable flood management and water supply for consumptive use and environmental purposes, state, federal, and local agencies have constructed vast interconnected systems (i.e., the SWP and CVP) of surface reservoirs, aqueducts, and water diversion facilities. California depends on these statewide water management systems to provide clean and reliable water supplies, protect lives and property from floods, endure drought, and sustain environmental values. These systems help California store and convey water supplies from areas that are water sufficient to areas that are water deficient. These exported water supplies supplement local and regional water sources in the San Joaquin Valley, San Francisco Bay Area, Central Coast, and Southern California.

5.2 Central Valley Hydrology

5.2.1 Sacramento River Basin

Sacramento River Basin topography ranges in elevation from approximately 14,000 feet above sea level on Mount Shasta to approximately 1,070 feet at Shasta Dam, to sea level in the Delta (Bureau of Reclamation 2013:1-12). Generally, precipitation occurs in the form of snow at elevations above 5,000 feet during winter and early spring months; snowmelt generally occurs in spring months.

The Sacramento River flows generally north to south from its source near Mount Shasta to the Delta near Freeport. The Sacramento River receives contributing flows from numerous major and minor streams and rivers that drain the east and west sides of the basin, including creeks upstream of the confluence with the Feather River (Cow, Battle, Cottonwood, Mill, Thomes, Deer, Stony, Big Chico, and Butte Creeks); Feather River (including flows from Yuba and Bear Rivers); American River; and Putah and Cache Creeks, which flow into the Yolo Bypass and Cache Slough complex prior to entering the Sacramento River upstream of Rio Vista, as shown in Figure 5-1.

Flows in the Sacramento River are regulated by operation of Shasta and Keswick Dams. Water in Shasta Lake is released through or around the Shasta Powerplant to the Sacramento River, where it is further regulated downstream by Keswick Dam. Similarly, water diverted from the Trinity River enters the Sacramento River through Keswick Reservoir. Chapter 6, *Water Supply*, provides additional detail on the facilities and operations of CVP's Trinity River and Shasta Divisions.

The Feather River flows into the Sacramento River immediately upstream of Verona. The Feather River watershed is approximately 3,607 square miles and located on the east side of the Sacramento Valley (Bureau of Reclamation et al. 1999:III-5). The Feather River is the largest tributary to the Sacramento River below Shasta Dam. The Yuba River is a major tributary to the Feather River and flows into the Feather River near the town of Marysville (Bureau of Reclamation et al. 1999:III-5). The Yuba River watershed is approximately 1,339 square miles. Yuba River flows are partially regulated by New Bullards Bar Dam, which is owned and operated by Yuba Water Agency; South Yuba River is mostly unregulated. Flows in the lower Feather River are regulated by operations of the Oroville and Thermalito Dams and diversions by the Western Canal, Richvale Canal, the Pacific Gas and Electric Company Lateral, and Sutter-Butte Canal. Chapter 6 provides additional detail on the SWP facilities and operations.

During flood season, the diversion of water to the Yolo Bypass relieves the pressure of high flows along the Sacramento River. At the Fremont Weir, downstream of Knights Landing, a portion of the Sacramento River water flows into the Yolo Bypass during high water. The Sacramento Weir and Bypass, downstream of the Fremont Weir, serve an identical function during high flows. Yolo Bypass conveys flood flows from the Sacramento River and Sutter Bypass to Cache Slough for continued conveyance into the Sacramento River upstream of Rio Vista.

The American River watershed is approximately 1,895 square miles. The American River joins the Sacramento River near the city of Sacramento. As described in Chapter 6, flows in the lower American River are regulated by the operation of Folsom and Nimbus Dams of the CVP. American River flows are regulated upstream of Folsom Lake by operations of several reservoirs owned and operated by Placer County Water Agency, El Dorado Irrigation District, Georgetown Divide Public Utility District, Pacific Gas and Electric Company, and Sacramento Municipal Utility District.

The Sacramento River enters the Delta near Freeport, downstream of the American River confluence.

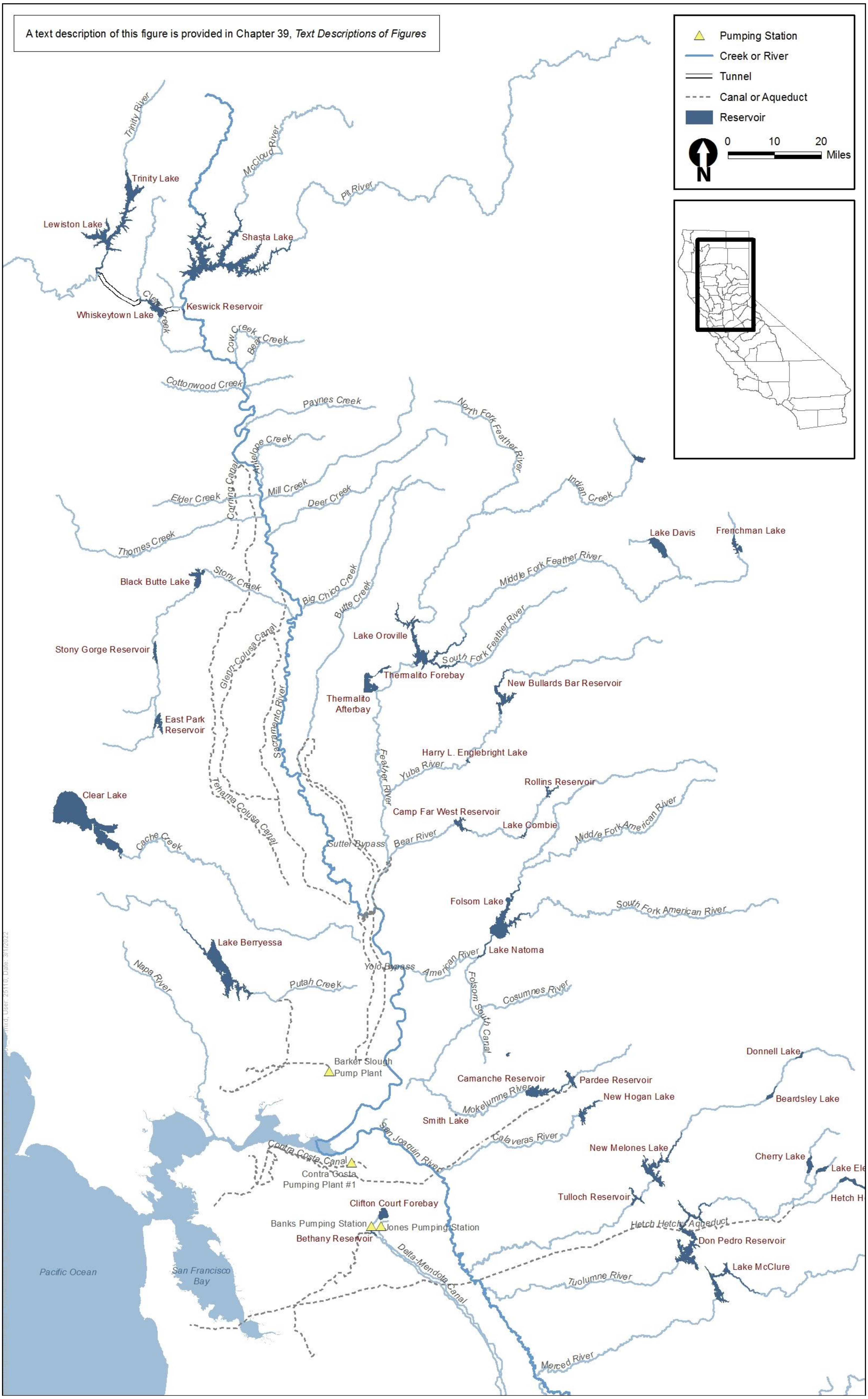
5.2.2 San Joaquin River Basin

The San Joaquin River Basin topography ranges in elevation from over 10,000 feet above sea level in the Sierra Nevada to sea level in the Delta. Generally, precipitation occurs in the form of snow during winter and early spring at the upper elevations and snowmelt occurs in the late spring and early summer months.

The San Joaquin River originates in the Sierra Nevada and then flows west into the San Joaquin Valley through Millerton Lake at Friant in Fresno County, as shown in Figure 5-2. The San Joaquin River turns north near Mendota and flows through the San Joaquin Valley and into the Delta near Vernalis. The San Joaquin River receives contributing flows from the Fresno, Chowchilla, Merced, Tuolumne, Stanislaus, Calaveras, Mokelumne, and Cosumnes Rivers. The Calaveras, Mokelumne, and Cosumnes Rivers flow into the San Joaquin River within the boundaries of the Delta.

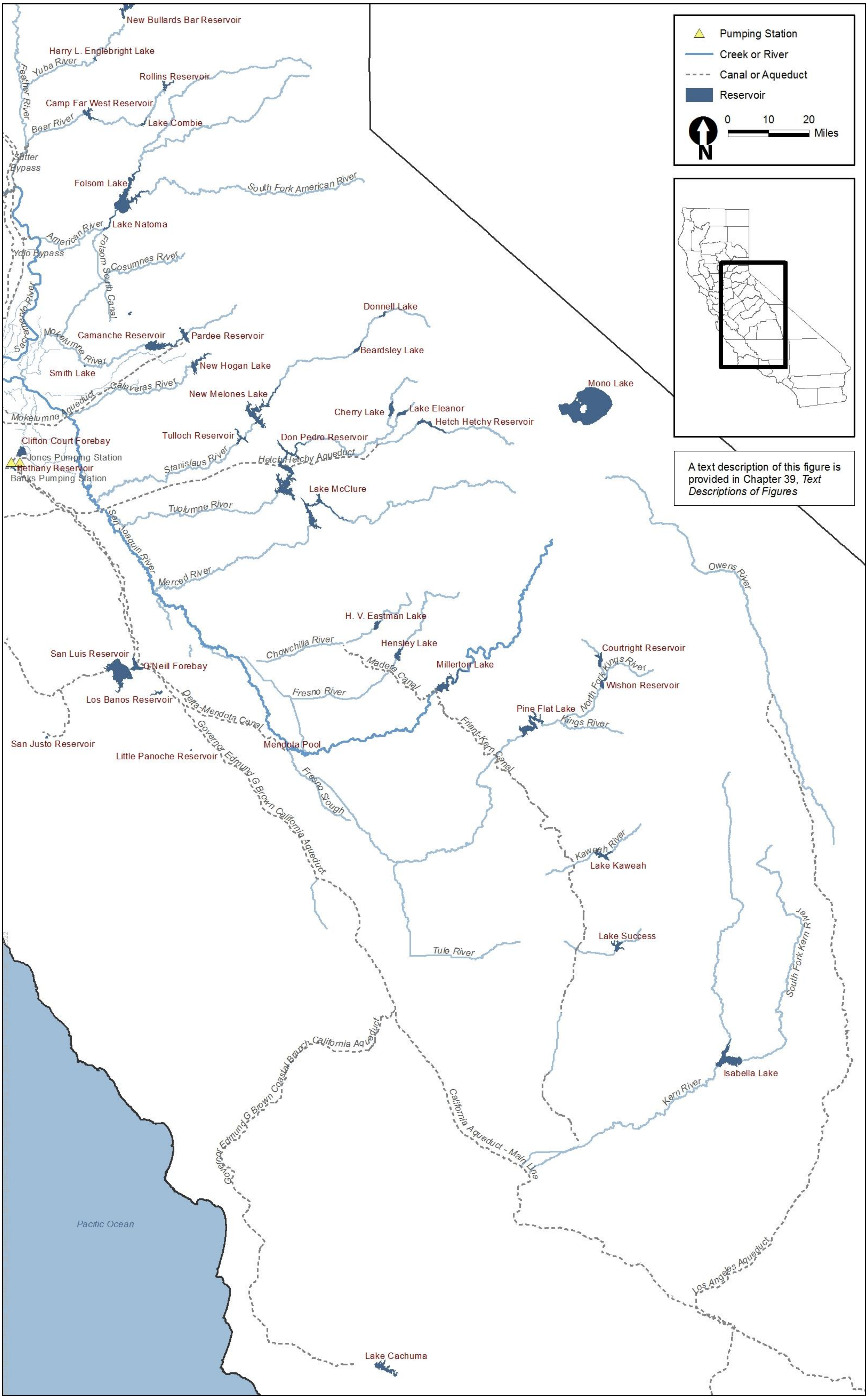
The San Joaquin River enters the Delta near Vernalis. Downstream of Vernalis, the San Joaquin River splits into several channels including the main river channel that flows through Lathrop and Stockton, Middle River, and Old River. The Middle and Old River channels are used by the SWP/CVP system to convey water from the Sacramento River to the SWP/CVP south Delta intakes. Middle River and Old River reconnect with the San Joaquin River downstream of the South Fork Mokelumne River and upstream of North Fork Mokelumne River.

Flows in the upper San Joaquin River are regulated by operation of the Bureau of Reclamation's (Reclamation) Friant Dam, which diverts water into the CVP Friant Division (described in additional detail in Chapter 6). The Friant Division conveys water in the Madera Canal to the north and the Friant-Kern Canal to the south for irrigation and municipal and industrial water supplies in the eastern portion of the San Joaquin Valley, and releases water in the San Joaquin River to meet downstream water rights and instream flow requirements.



A text description of this figure is provided in Chapter 39, *Text Descriptions of Figures*

Figure 5-1. Sacramento River Basin in the Study Area and Major Surface Water Facilities



A text description of this figure is provided in Chapter 39, *Text Descriptions of Figures*

Figure 5-2. San Joaquin and Tulare River Basins and Major Surface Water Facilities

San Joaquin River flow is diverted into several bypasses during high water stages. Upstream of Mendota Pool and Mendota Dam, a major portion of the flow is diverted into the Chowchilla Bypass, which conveys water into the Eastside Bypass for further conveyance through Mariposa and Deep Sloughs prior to discharge into the San Joaquin River near the confluence with the Merced River.

5.2.3 Delta Hydraulics

The Delta is a complex network of over 700 miles of tidally influenced channels and sloughs (U.S. Geological Survey 2012:1). Four strong forcing mechanisms drive circulation, transport, and mixing of water in the Delta: (1) freshwater river flow from drainages to the Delta; (2) tides from the west propagating from the Pacific Ocean through the San Francisco Bay; (3) SWP/CVP water supply facilities operating in the Delta; and (4) collective effects of in-Delta agricultural diversions. The Delta is shown in Figure 1-1 in Chapter 1, *Introduction*.

5.2.3.1 Influence of Delta Inflows

The Sacramento River is the primary contributor to Delta inflows. Typically, it contributes over 73% of the total inflow into the Delta, averaging about 16.1 MAF per year (Delta Stewardship Council 2018:84). Yolo Bypass typically contributes 8% of the total inflow into the Delta, averaging about 1.8 MAF per year (Delta Stewardship Council 2018:84). Once the Sacramento River reaches the Delta, north Delta channels convey Sacramento River and Yolo Bypass flows to the west toward the San Francisco Bay and to the south toward the central and south Delta for local consumptive demands and exports. Flows that travel south are diverted by the Delta Cross Channel gates or enter Georgiana Slough toward the SWP/CVP south Delta intakes.

The San Joaquin River enters the Delta from the south and is the second biggest contributor to Delta inflows, contributing approximately 14% of the total Delta inflow, averaging about 3.1 MAF per year (Delta Stewardship Council 2018:84). Temporary barriers and tidal flows throughout the Delta add further complexity to the circulation and mixing of waters (U.S. Geological Survey 2012:1). Tributaries to the east (i.e., Mokelumne, Cosumnes, and Calaveras Rivers) also provide Delta inflows—contributing approximately 4% of Delta inflows at an average of 0.8 MAF per year—that generally flow to the west (Delta Stewardship Council 2018:84).

5.2.3.2 Influence of Tides on Delta Flows

The Delta connects to the Pacific Ocean through the San Francisco Bay. Tides are the rise and fall of sea levels caused by the combined gravitational pull of the moon and the sun; the moon's gravitational pull is approximately twice as strong than that of the sun. The Earth's rotation results in a diurnal tide, and the range of a tidal event is also influenced by the relative positions of the moon and the sun to the Earth. The spring tide occurs when the moon is new or full and closest to the Earth, producing the maximum tidal range by aligning their gravitational pulls. The neap tide occurs during the quarter phases of the moon when the moon's gravitational pull is perpendicular to that of the sun, producing the minimum tidal range. At Martinez, the tidal range can vary by about 30% between the spring and neap conditions. The resulting tidal flows in and out of the Delta have a major influence on Delta hydraulics. Tidal flows at Martinez can be as high as 600,000 cubic feet per second (cfs). However, on average, tidal inflows to the Delta are approximately equal to tidal outflows.

All tidal flows enter and leave the Delta along the combined Sacramento and San Joaquin Rivers at Chipps Island. Further into the Delta interior, for example in Old River near Bacon Island, tidal flows can be as high as 16,000 cfs. In relatively upstream locations such as Freeport and Vernalis, riverine conditions dominate the tidal effects. In the Sacramento River, at a daily average flow of 15,000 cfs, instantaneous flows at Freeport may vary plus or minus 4,000 cfs to 10,000 cfs from the daily average value. Similarly, for low San Joaquin River flows (< 5,000 cfs), the flows at Mossdale under tidal influence can vary by a few hundred cfs to 2,000 cfs within a day.

Water levels vary greatly during each tidal cycle, from less than 1 foot on the San Joaquin River near Interstate 5 to more than 5 feet near Pittsburg. The water levels at Freeport, at a daily average river flow of 15,000 cfs, can vary by 1 to 3.5 feet.

5.2.3.3 Influence of SWP/CVP Delta Operations

Export operations and withdrawal rates at the south Delta intakes (i.e., C. W. “Bill” Jones Pumping Plant and Harvey O. Banks Pumping Plant) influence Delta hydraulics locally and can slow or reverse the direction of flow in the south Delta. Flows moving downstream toward the western Delta are *positive flows* while flows moving upstream toward the San Joaquin River at Vernalis are *reverse* or *negative flows*. The waterways most affected by reverse flows are Old and Middle Rivers; although, reverse flows also occur in False River in the western Delta and in Turner Cut in the San Joaquin River. Chapter 9, *Water Quality*, and Chapter 12, *Fish and Aquatic Resources*, provide additional detail on the implications that reverse flow conditions have for water quality and biological resources.

5.3 Surface Water Changes

This section describes the environmental changes associated with surface water that would result from construction, operation, and maintenance of the project alternatives. Such changes could result in impacts on resources dependent upon existing hydrologic conditions. While no changes are being proposed in operational rules and water supply allocation procedures for the existing SWP/CVP system, operation of the proposed north Delta intakes (as part of a dynamic system) could result in changes in simulated river flows and reservoir storage levels. Descriptions of estimated potential changes to surface water resources are presented in this section to provide a basis for understanding potential impacts on other resources.

Potential impacts of changes in reservoir storage and river and stream flows in the study area are discussed in other chapters of this Draft EIR. As an introductory chapter, Chapter 6, *Water Supply*, provides the changes associated with imported water supply of public water agencies resulting from implementation of the project alternatives. Impacts associated with flood protection and changes to water surface elevations at the construction sites are addressed in Chapter 7, *Flood Protection*. Impacts associated with water quality are addressed in Chapter 9, *Water Quality*. Impacts associated with wind and water erosion, accretion, sedimentation, and seismic risks are addressed in Chapter 10, *Geology and Seismicity*. Impacts associated with changes in velocities and water surface elevations related to riparian corridors and biological resources are addressed in Chapter 12, *Fish and Aquatic Resources*, and Chapter 13, *Terrestrial Biological Resources*. Impacts associated with changes in water surface hydrodynamics related to availability of water for agricultural and community uses are addressed in Chapter 15, *Agricultural Resources*, and Chapter 21, *Public Services* *and Utilities*, respectively. Impacts associated with navigability issues are addressed in Chapter 20, *Transportation*, and Chapter 16, *Recreation*.

5.3.1 Methods for Analysis

This section describes the qualitative and quantitative methods used to evaluate surface water–related changes associated with project alternatives in the study area. These changes would be associated with construction, operation, and maintenance of the project alternatives, and implementation of the Compensatory Mitigation Plan (Appendix 3F, *Compensatory Mitigation Plan for Special-Status Species and Aquatic Resources*).

The qualitative and quantitative analyses discussed in this section assess the magnitude of project-related changes in relation to the existing conditions. While existing conditions includes existing facilities and ongoing programs that existed as of January 15, 2020 (i.e., the publication date of the Notice of Preparation), the No Project Alternative includes reasonably foreseeable changes in existing conditions (e.g., sea level rise, climate change) and changes that would be expected to occur in the foreseeable future (i.e., 2040) without the Delta Conveyance Project.

SWP/CVP operations for the existing conditions and No Project Alternative were determined in accordance with applicable federal and state regulations—including the 2019 Biological Opinions (BiOps) from the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) on the long-term operations of the CVP and SWP (U.S. Fish and Wildlife Service 2019; National Marine Fisheries Service 2019), and the 2020 Incidental Take Permit (ITP) from the California Department of Fish and Wildlife (CDFW) for long-term operations of the SWP (California Department of Fish and Wildlife 2020).

A more detailed description of the existing conditions, No Project Alternative, and the assumptions associated with each are included in Appendix 3C, *Defining Existing Conditions, No Project Alternative, and Cumulative Impact Conditions*.

5.3.1.1 Methods to Identify Potential Changes to Surface Water

This section describes the changes to surface water resources within the study area associated with construction and operation of the project alternatives. Specifically, the section evaluates the project alternatives' potential to:

- Result in changes to Trinity, Sacramento, Feather, and American River flows.
- Result in changes to SWP or CVP reservoir storage levels.

Modeling tools were used to identify these potential changes to use as the basis for impact assessment in subsequent resource chapters. While no changes are being proposed in operational rules and water supply allocation procedures for the existing SWP/CVP system, operation of the proposed north Delta intakes (as part of a dynamic system) could result in changes in simulated river flows and reservoir storage levels.

CalSim 3 is a reservoir-river basin planning model developed by DWR and Reclamation to simulate the operation of the SWP and CVP over a range of different hydrologic conditions. CalSim 3 allows for specification and achievement of a series of user-specified priorities and goals. CalSim 3 is the best available planning model for the SWP and CVP system operations. Earlier versions of CalSim, in particular CalSim II, have been used in previous system-wide evaluations of SWP and CVP operations. Inputs to CalSim 3 include water diversion requirements (demands), stream accretions and depletions, reservoir inflows, irrigation efficiencies, and parameters to calculate return flows, non-recoverable losses and groundwater hydrology. Sacramento and San Joaquin Valley and tributary rim basin hydrologic inputs are based on an adjusted historical sequence of monthly stream flows over a 94-year period (1922–2015), in order to represent a sequence of flows at a given level of development. Adjustments to historic hydrologic sequences are imposed based on current land use and meteorological and hydrologic conditions to develop an existing (2020) level of hydrology. Projected future land use, meteorological, and hydrologic conditions expected in 2040 are used to develop a future (2040) level of development. The resulting hydrology represent the simulated water supply available from Central Valley streams to the SWP and CVP at the given level of development for use in CalSim 3 simulations. For this document, the 2020 level hydrology was used for the existing conditions simulation and all project alternatives. The No Project Alternative uses the 2040 level hydrology in the CalSim 3 simulations.

CalSim 3 was used to simulate SWP/CVP operations—providing information about the surface water flows and reservoir storage associated with each project alternative. As previously mentioned, CalSim 3 (and its predecessor, CalSim II) have been adopted by DWR and Reclamation for the purpose of SWP/CVP system operations analysis in the context of long-term planning. Despite being recognized as the best available tool for this purpose and as the standard tool for project evaluation to support the environmental review process, CalSim 3 is subject to certain limitations. Limitations include the use of assumptions for approximating the operations of various facilities and regulatory requirements, approximations of real-time daily or even hourly operational considerations in order to incorporate them into a monthly model, and additional uncertainty inherited from input data and the model development process (see Appendix 5A, *Modeling Technical Appendix*, Section B, *Hydrology and Systems Operations Modeling*, for more detail). Therefore, inferences using CalSim 3 results from any single scenario may be appropriate for general, long-term trend assessment, but may not be adequate to support detailed reviews on an individual time-step basis or for selected periods. The following provides some examples for illustrative purposes.

Under extreme hydrologic and operational conditions where there is not enough water supply to meet all requirements, the SWP and CVP operators use a complicated decision process to decide on how to operate the projects to best meet the overall balance of requirements. This process is unique depending on the specific circumstances and operational requirements in place at the time. During these periods in a simulation, CalSim 3 utilizes a series of operating rules to reach a solution to allow the continuation of the simulation. These operating rules are a simplified version of the very complex decision processes that SWP and CVP operators would use in actual extreme conditions. Therefore, model results and potential changes under these extreme conditions should be recognized as an approximation of the actual operations that would occur under those conditions.

As an example, CalSim 3 results show very infrequent simulated occurrences of extremely low storage conditions at SWP and CVP reservoirs during critical drought periods, when reservoir storage is at "dead pool" levels (below the elevation of the lowest river outlet). Simulated occurrences of reservoir storage conditions at dead pool levels may occur coincidentally with simulated potential impacts. These conditions can occur both with and without the project alternatives, though not necessarily in the same timestep. Dead pool conditions are never more frequent under the project alternatives and are often less frequent when compared to simulation results without the project alternatives. When reservoir storage is at dead pool levels, there may be instances in the simulation results in which flow conditions fall short of minimum flow criteria, salinity conditions may exceed salinity standards, diversion conditions fall short of allocated diversion amounts, or operating agreements are not met. During real-life operations, operators would use allowable real-time adjustments in operation to satisfy regulatory, legal, and contractual requirements given the current conditions and hydrologic constraints to the maximum extent possible. In some cases, certain voluntary extraordinary water conservation and changes in regulatory requirements for water rights or for flow and water quality requirements may be imposed to accommodate extreme conditions, such as during the drought emergency of 2012–2016. These potential, specific real-time actions are not simulated in CalSim 3 during these periods because these actions were implemented under an emergency declaration and associated emergency regulations. These specific actions or level of implementation cannot be predicted *a priori*, nor could they be reasonably incorporated as regular operations or model rules. Therefore, the results of CalSim 3 reflect the assumption that these interventions are not imposed.

Recognizing the model limitations discussed here and in Appendix 5A, the applications of CalSim 3 (and its predecessors) are considered appropriate only when modeling results are used in a statistical comparative analysis, that is, with two scenarios that differ only in terms of operational and other assumptions that are needed to understand the effects of the project being analyzed. Under a comparative analysis, the potential influences of model limitations can be reduced. This application mode is compatible with the needs of the environmental review process, and thus is used in the analysis presented in this chapter as described below.

Even with comparative analysis, model uncertainty and its influence on the model results that are presented cannot be completely avoided. Therefore, in addition to showing the effects of the project being analyzed, observed differences between two scenarios can sometimes include the effects of model uncertainty. While no exact quantification of model uncertainty is available, DWR believes that CalSim 3 results are subject to uncertainty that is within 5% and likely much lower. Therefore, the appropriate inference from an observed difference in modeling results that is less than 5% is likely null, unless there is additional evidence from detailed examination to suggest otherwise. Throughout the use of CalSim 3 and its predecessors, other rule-of-thumb criteria have generally been used for considering the potential significance of an observed difference in modeling results from a comparative analysis. For example, observed changes in monthly flow or storage of less than 10 thousand acre-feet (TAF) are generally considered null. It should be understood that 5% and 10 TAF are given here as examples, and that the appropriate criteria to be used vary depending on the exact impact being analyzed. These considerations and appropriate use of CalSim 3 and its modeling results are discussed in more detail in Appendix 5A, Section B.

5.3.1.2 Evaluation of Operations

The project alternatives would provide an additional conveyance facility for transporting water from the north Delta for SWP/CVP export without changing the operational rules of other SWP/CVP facilities or the procedures for specifying the overall water supply allocations for their corresponding contractors. However, as part of a dynamic system, the opportunities for using the north Delta intakes for diversion of additional water supplies could result in changes in corresponding simulated river flows and reservoir storage levels even without any change in operational rules and procedures. Unless stated otherwise, changes associated with operation of the project alternatives are relative to 2020 (i.e., existing conditions). See Appendix 5B, *Surface Water 2040 Analysis*, for the results of the modeled hydrologic conditions for the project alternatives under 2040 conditions.

Changes to Sacramento River Basin flows at several key locations that can depict the SWP/CVP system operation were examined, including the Trinity River downstream of Lewiston Dam, Sacramento River downstream of Keswick Reservoir, Sacramento River at Bend Bridge, Yolo Bypass at Fremont Weir, Sacramento River at Freeport (i.e., upstream of the proposed north Delta intakes), Sacramento River north of Courtland (i.e., downstream of the proposed north Delta intakes), Feather River downstream of Thermalito Afterbay, and American River at Watt Avenue Bridge. For comparative analyses, the simulated monthly flows from CalSim 3 are summarized on a long-term average basis and are also averaged by water year type (i.e., wet, above normal, below normal, dry, critical, and dry/critical years) for existing conditions and all project alternatives. The project is not expected to affect San Joaquin River flows; therefore, locations on the San Joaquin River were not evaluated further. Appendix 5A includes surface flows for additional locations in the project area (that are not relevant to the discussion in this chapter).

To evaluate changes to reservoir storage, end-of-month storages from CalSim 3 were analyzed for Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and San Luis Reservoir, for all years and for dry/critical years only. Storage in major SWP/CVP reservoirs usually increases in early spring because of snowmelt and often peaks in May. End-of-month storages were analyzed for May, June, and August since these periods correspond with operational rules that support recreational uses (for Memorial Day, Independence Day, and Labor Day, respectively). End-of-month storages were also analyzed for September, which is the water supply reserve for the coming water year. These storages were calculated for existing conditions and all project alternatives, and then compared.

The project is not expected to affect the operations of reservoirs south of the Delta on the tributaries of the San Joaquin River (e.g., Millerton Lake on the San Joaquin River and the New Melones Lake on the Stanislaus River); therefore, these reservoirs were not evaluated further. Appendix 5A includes storage for additional reservoirs within the project area (that are not relevant to the discussion in this chapter).

Modeling results are presented with project alternatives paired based on their corresponding facility capacity and operation for better contrasting the differences. For example, CalSim 3 results for Alternative 1 (6,000 cfs) and Alternative 3 (6,000 cfs) are paired together, Alternative 2a (7,500 cfs) and Alternative 4a (7,500 cfs) are paired together, etc. CalSim 3 is a mass balance model, and thus, its results are not influenced by alternative alignment. However, despite having the same north Delta intake capacity and operation as Alternatives 1 and 3, Alternative 5 (i.e., Bethany Reservoir Alternative) is presented separately from the other alternatives because export capacity assumptions are slightly different than under Alternatives 1 and 3. All alternatives include assumptions about Harvey O. Banks Pumping Plant (Banks Pumping Plant) outages, which can reduce exports below physical or permit capacity. For alternatives other than Alternative 5, this outage-based limit on exports is applied to the total pumping at Banks Pumping Plant; for Alternative 5, this outage-based limit is only applied to the south Delta exports at Banks Pumping Plant. This difference is due to diversions under Alternative 5 going directly to Bethany Reservoir through facilities that are different than those associated with the other project alternatives (i.e., Southern Complex). This distinction allows for slightly higher exports under Alternative 5 when compared to Alternatives 1 and 3, which can cause small differences in the results of the surface water analyses between the two alignments.

Water year types (i.e., State Water Resources Control Board Water Right Decision 1641 Sacramento Valley 40-30-30 Index) are calculated based on snowmelt and rainfall hydrology as well as the previous year's index. Because of this, water year types using the 2040 level hydrology (such as the No Project Alternative and the project alternatives presented in Appendix 5B) differ from those using the 2020 level hydrology due to the changing climate conditions discussed below in Section 5.3.2.1, *No Project Alternative*. Generally, the Sacramento Valley 40-30-30 Index under 2040 conditions reflects a decrease in the number of wet, above normal, dry, and critical years and an increase in the number of below normal years when compared to 2020 conditions. See Appendix 5A, Section B, Attachment 4, *Climate Change Development for Delta Conveyance Project*, for more information related to these water year type changes.

5.3.2 Comparison of Project Alternatives with Existing Conditions

This section provides the simulated river and storage conditions for the No Project Alternative and project alternatives, when compared to existing conditions (i.e., 2020). The No Project Alternative is evaluated under 2040 conditions when compared to existing conditions. All project alternatives are evaluated under 2020 conditions when compared to existing conditions.

As described in Chapter 3, *Description of the Proposed Project and Alternatives*, the project alternatives represent three conveyance alignments combined with the proposed construction of new north Delta conveyance facilities capable of conveying a range of up to 3,000 cfs to 7,500 cfs in total. The north Delta conveyance could provide additional opportunities for transporting water across the Delta for south-of-Delta export; however, there are no additional changes in other SWP/CVP facilities or operation rules for the SWP/CVP system. As a dynamic system, the additional opportunities for water conveyance could result in changes to the simulated SWP/CVP operation including river flows and storage conditions.

A detailed description of the modeling assumptions associated with these project alternatives is included in Appendix 5A*.* A detailed analysis of the project alternatives under 2040 conditions can be found in Appendix 5B.

5.3.2.1 No Project Alternative

As described in Chapter 3, CEQA Guidelines Section 15126.6 directs that an EIR evaluate a specific alternative of "no project" along with its impact. The No Project Alternative in this Draft EIR represents the circumstances under which the project (or project alternative) does not proceed and considers predictable actions, such as projects, plans, and programs, that would be predicted to occur in the foreseeable future if the Delta Conveyance Project is not constructed and operated. This description of the environmental conditions under the No Project Alternative first considers how surface water resources could change over time and then discusses how other predictable actions could affect surface water resources.

Future Surface Water Conditions

Future surface water conditions are expected to change considerably when compared to existing conditions as a result of climate change and sea level rise. A warmer atmosphere will modify precipitation and runoff patterns, which will alter both the timing and volume of flow and affect extreme hydrologic events like floods and droughts. An increase in temperatures is expected to diminish snow accumulation during the cool season (i.e., late autumn through early spring) and snowmelt availability to sustain runoff during the warm season (i.e., late spring through early autumn). Warming may lead to more rainfall runoff during the cool season rather than snowpack accumulation. Within the Delta, this would likely lead to increases in December to March runoff and decreases in April to July runoff. It is also anticipated that droughts will increase in severity and duration, resulting in periods of critical dryness—further reducing Delta inflows between April and October.

The tide range in the Delta may also increase because of sea level rise. This effect is most pronounced in the south Delta, where the tide range is projected to increase by more than 20% (Delta Stewardship Council 2021:5-4). The tide range amplification is progressively less in the north Delta (approximately 10% to 15%) and central Delta (approximately 5%) and negligible in strongly tidally influenced areas such as Suisun Bay, Rio Vista, and lower Yolo Bypass.

Warming air and water temperatures, sea level rise, and changes in hydrologic patterns that could be expected to occur due to climate change will affect water quality in the Delta in the future and may require changes in in-Delta water use patterns and upstream reservoir management. Increasing runoff magnitude—from more precipitation as rain and earlier snowmelt—may stress reservoirs more frequently during wet years, requiring more frequent and larger reservoir releases. The potential for increased flooding means that reservoirs may need to release more water to maintain flood storage capacity, but this depleted storage may not be replenished by rainfall and snowmelt, exacerbating the potential for lower water availability in future years.

Under the No Project Alternative, the SWP/CVP operations are assumed to continue in a manner similar to their operations under existing conditions. DWR and Reclamation would continue to operate the SWP and CVP to divert, store, and convey water consistent with applicable laws and contractual obligations.

The No Project Alternative encompasses programs adopted during the early stages of development of the Draft EIR, facilities that are permitted or under construction during the early stages of development of the Draft EIR, projects that are permitted or are assumed to be constructed by 2040, and changes due to climate change and sea level rise. A detailed description of the effects of climate change and sea level rise on system operations is discussed in Chapter 4, *Framework for the Environmental Analysis,* and Appendix 5A. Similarly, a detailed description of the modeling assumptions associated with the No Project Alternative is included in Appendix 5A.

The existing regulatory environment is assumed unchanged, and actions required by the 2019 USFWS and NMFS BiOps and the 2020 CDFW ITP are also included in the No Project Alternative. A detailed description of the No Project Alternative assumptions for implementing the BiOps can be found in Appendix 3C. Detailed assumptions for the SWP and CVP operations are represented in hydrological analytical models, as described in Appendix 5A.

Changes to Sacramento River Basin Flows

Long-term average monthly flows under the No Project Alternative generally increase between December and April when compared to existing conditions for all locations examined. These increases are due to altered inflow patterns as a result of climate change, with more precipitation falling as rain, rather than snow, and more extreme winter precipitation events. In addition, a snowpack melt that occurs earlier in the year will lead to shorter, more intense spring periods of river flow and freshwater discharge (Table 5-1). The higher inflows during this period cannot usually be captured in upstream reservoirs because of the need to maintain flood control space, so they translate directly into increases in downstream river flows.

Long-term average monthly flows under the No Project Alternative generally decrease between May and October when compared to existing conditions for all locations examined. These decreases are also due to altered inflow patterns as a result of climate change with diminished snow accumulation and an earlier snowpack melt (Table 5-1). Water that would normally be held as snow and ice until spring or early summer—that would sustain runoff during the warm seasons (i.e., late spring through early autumn)—would not be available because it falls as rain, becomes runoff, and is released for flood management purposes as previously described.

Most average monthly flows by water year type mirror the pattern exhibited by long-term average monthly flows when compared to existing conditions for all locations examined, as shown in Appendix 5C, *Simulated Monthly Flows*. Average monthly flows generally increase during the cool season (i.e., December through April) and decrease during the warm season (i.e., May through October). Similarly, these changes are due to altered inflow patterns as a result of the climate change effects discussed above (Table 5-1).

There are, however, some exceptions to the general pattern by month and water year type. On the Trinity River in dry and critical water years, flows do not change in the winter since Trinity Lake can capture any increased inflow during those periods. The Sacramento River downstream of Keswick Reservoir and at Bend Bridge, and the Feather River downstream of Thermalito Afterbay all show some deviations from the general pattern in drier years, specifically decreases in flows in some winter months and some increases in flows in the summer. In drier years reservoir releases are dominated less by inflow patterns and more by export operations and outflow requirements in the Delta. Reservoir releases are often lower in the winter because of lower exports which are, in turn, due to lower project allocations under conditions with climate change. Releases can also be lower if reservoir releases needed to meet salinity standards are lower in the winter. Despite sea level rise, the latter condition can happen because of lower exports in the fall, combined with higher Delta inflow in the winter. During the summer, reservoir releases can increase because of the increased outflow needed to meet salinity standards in the Delta. These increases are due to sea level rise and less natural inflow to the Delta during the summer.

The percent change in the long-term average monthly flows between the No Project Alternative and existing conditions in the Sacramento River Basin is shown in Figure 5-3. Tables in Appendix 5C provide additional detail by project alternative and water year type.

SWP and CVP reservoir storage averages for all years simulated under the No Project Alternative generally decrease when compared to existing conditions for all time periods examined (i.e., end-of-May, end-of-June, end-of-August, and end-of-September periods). These decreases are most pronounced for end-of-August and end-of-September periods. These changes are due to altered inflow patterns as a result of climate change, with greater inflows in the winter and early spring—

resulting from the shift from snow to rain previously discussed—and lower inflows in the late spring and summer—resulting from lower snow accumulation and early snowmelt. Generally, the increased winter and early spring inflows cannot be captured in reservoirs (because of flood management operations) while the decreased late spring and summer inflows reduce the supplies available for capture. The net effect of changes in hydrology and seasonal inflow patterns under climate change is reduced reservoir storages in the SWP/CVP system in general, including carryover storages in the end of September that contribute to water supply in the subsequent year, especially in dry conditions. To a lesser extent, sea level rise causes increased Delta outflow requirements to meet salinity standards in the summer and fall when reservoir inflows are often limited—which also contributes to the decrease in SWP or CVP storage for some reservoirs in those months and resulting carryover storage in the end of September.

Over the dry and critical water years, the average SWP and CVP reservoir storage simulated under the No Project Alternative generally decreases when compared to existing conditions for all time periods examined (i.e., end-of-May, end-of-June, end-of-August, and end-of-September periods). These changes are also due to altered inflow patterns as a result of the climate change effects discussed above. Even in drier years, when there is reservoir space available to store any increased winter inflows, storage conditions will still be reduced because of reduced carryover from previous wetter years.

The only exception to these trends is San Luis Reservoir storage, which increases during the end-of-May, end-of-June, and end-of-August periods for the average of all years; and the end-of-June period for dry and critical water year averages. Because it is an off-stream reservoir supplied mostly by water diverted from the Delta, changes to San Luis Reservoir storage are primarily driven by export operations and project allocations (rather than natural local inflows). Higher storage levels in San Luis Reservoir in the early to mid-summer are facilitated by lower water supply allocations for the public water agencies; these allocations compensate for the expected lack of releases for exports from upstream reservoirs during the summer and early fall.

Changes to SWP and CVP reservoir storage for the No Project Alternative are shown in Tables 5-2 through 5-6.

Table 5-1. Monthly Reservoir Inflows Under Existing Conditions and the No Project Alternative

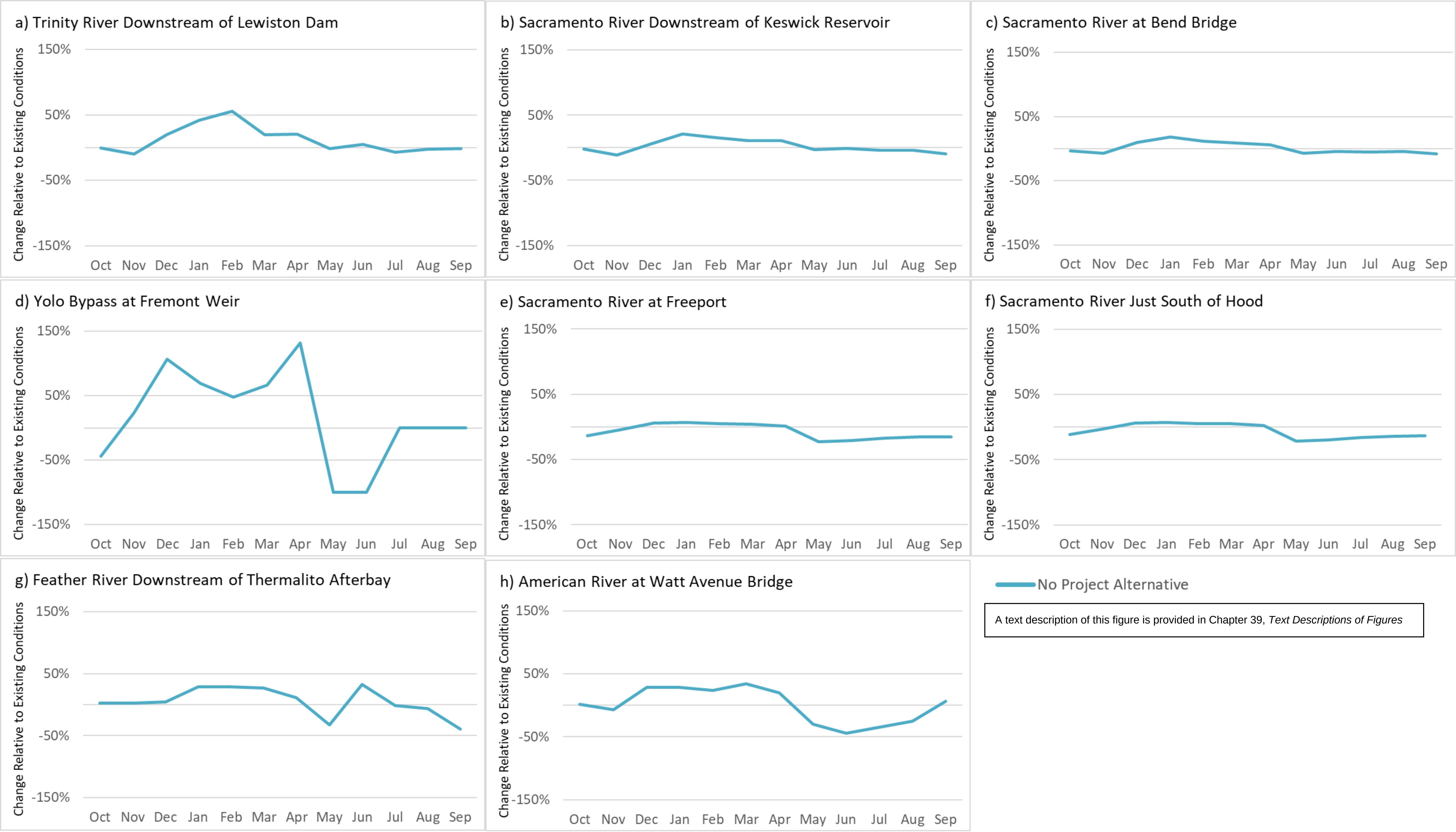
	October	November	December	January	February	March	April	May	June	July	August	September
	Reservoir Inflows (cfs)	Reservoir Inflows (cfs)	Reservoir Inflows (cfs)	Reservoir Inflows (cfs)	Reservoir Inflows (cfs)	Reservoir Inflows (cfs)	Reservoir Inflows (cfs)	Reservoir Inflows (cfs)	Reservoir Inflows (cfs)	Reservoir Inflows (cfs)	Reservoir Inflows (cfs)	Reservoir Inflows (cfs)
Trinity Lake												
Long-Term Average [a]												
Existing Conditions (2020)	276	840	1,642	1,980	2,604	2,845	3,404	3,882	2,126	627	187	121
No Project Alternative (2040)	260	1,023	2,459	3,067	3,607	3,306	3,198	2,348	953	386	187	141
Dry/Critical Years [b]												
Existing Conditions (2020)	211	448	798	679	1,613	2,059	2,367	2,323	1,090	271	115	87
No Project Alternative (2040)	183	367	1,128	1,065	2,149	2,498	2,049	1,344	606	231	108	97
Shasta Lake												
Long-Term Average [a]												
Existing Conditions (2020)	3,925	5,503	8,918	11,323	13,936	13,480	11,429	8,295	5,410	3,842	3,434	3,467
No Project Alternative (2040)	3,726	5,741	10,418	13,238	15,460	14,456	11,272	6,945	4,470	3,552	3,345	3,473
Dry/Critical Years [b]												
Existing Conditions (2020)	3,601	4,043	5,443	5,340	8,704	9,144	6,726	5,569	4,044	3,157	2,956	2,996
No Project Alternative (2040)	3,413	3,831	6,206	5,981	9,187	9,936	6,237	4,858	3,591	3,040	2,921	3,011

	October	November	December	January	February	March	April	May	June	July	August	September
	Reservoir Inflows (cfs)	Reservoir Inflows (cfs)	Reservoir Inflows (cfs)	Reservoir Inflows (cfs)	Reservoir Inflows (cfs)	Reservoir Inflows (cfs)	Reservoir Inflows (cfs)	Reservoir Inflows (cfs)	Reservoir Inflows (cfs)	Reservoir Inflows (cfs)	Reservoir Inflows (cfs)	Reservoir Inflows (cfs)
Lake Oroville												
***Long-Term Average* [a]**												
Existing Conditions (2020)	2,347	3,278	5,772	7,230	8,596	9,272	9,357	8,419	4,501	2,516	2,222	2,119
No Project Alternative (2040)	2,253	3,724	7,683	9,941	11,318	11,170	8,736	5,370	2,683	1,770	1,899	2,072
***Dry/Critical Years* [b]**												
Existing Conditions (2020)	2,019	1,973	2,642	2,325	4,189	5,423	4,824	3,933	1,979	1,531	1,637	1,779
No Project Alternative (2040)	1,927	1,941	3,367	3,133	5,012	6,362	4,124	2,827	1,316	1,156	1,491	1,692
Folsom Lake												
***Long-Term Average* [a]**												
Existing Conditions (2020)	1,291	2,433	5,591	6,635	7,593	7,924	7,394	5,909	3,106	1,394	1,065	2,023
No Project Alternative (2040)	1,353	1,904	4,703	6,042	6,599	6,995	6,058	4,711	2,396	1,048	1,145	1,818
***Dry/Critical Years* [b]**												
Existing Conditions (2020)	964	1,532	2,627	2,076	4,003	4,317	3,937	3,021	1,519	881	783	1,571
No Project Alternative (2040)	1,046	936	1,725	1,639	2,965	3,450	2,732	2,147	1,419	875	863	1,474

cfs = cubic feet per second.

[a] Long-term average is the average annual inflows for the period October 1921–September 2015 simulated in CalSim 3.

[b] Water year types are State Water Resources Control Board Water Right Decision 1641 Sacramento Valley 40-30-30 water year types as computed in CalSim 3 for the period October 1921–September 2015. Dry/critical year averages are for those two water year types combined.



A text description of this figure is provided in Chapter 39, *Text Descriptions of Figures*

Figure 5-3. Percent Change in the Long-Term Average of Monthly Flows Under the No Project Alternative Relative to Existing Conditions at Select Locations

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Table 5-2. Changes to Trinity Lake Storage under the No Project Alternative

	Existing Conditions	No Project Alternative	
	Reservoir Storage (TAF)	Reservoir Storage (TAF)	Percent Change from EC
End of May			
Long-Term Average [a]	1,867	1,809	-3.1%
Dry/Critical Years [b]	1,396	1,390	-0.4%
End of June			
Long-Term Average [a]	1,838	1,707	-7.1%
Dry/Critical Years [b]	1,338	1,291	-3.5%
End of August			
Long-Term Average [a]	1,566	1,436	-8.3%
Dry/Critical Years [b]	1,043	1,004	-3.8%
End of September			
Long-Term Average [a]	1,438	1,321	-8.1%
Dry/Critical Years [b]	946	908	-4.1%

CalSim 3 output variable: S_TRNTY.

EC = existing conditions; TAF = thousand acre-feet.

[a] Long-term average is the average annual storage for the period October 1921–September 2015 simulated in CalSim 3.

[b] Water year types are State Water Resources Control Board Water Right Decision 1641 Sacramento Valley 40-30-30 water year types as computed in CalSim 3 for the period October 1921–September 2015. Dry/critical year averages are for those two water year types combined.

Table 5-3. Changes to Shasta Lake Storage under the No Project Alternative

	Existing Conditions	No Project Alternative	
	Reservoir Storage (TAF)	Reservoir Storage (TAF)	Percent Change from EC
End of May			
Long-Term Average [a]	4,051	3,939	-2.8%
Dry/Critical Years [b]	3,299	3,257	-1.3%
End of June			
Long-Term Average [a]	3,789	3,627	-4.3%
Dry/Critical Years [b]	2,931	2,876	-1.9%
End of August			
Long-Term Average [a]	2,979	2,838	-4.7%
Dry/Critical Years [b]	2,237	2,178	-2.6%
End of September			
Long-Term Average [a]	2,827	2,715	-4.0%
Dry/Critical Years [b]	2,162	2,115	-2.2%

CalSim 3 output variable: S_SHSTA.

EC = existing conditions; TAF = thousand acre-feet.

[a] Long-term average is the average annual storage for the period October 1921–September 2015 simulated in CalSim 3.

[b] Water year types are State Water Resources Control Board Water Right Decision 1641 Sacramento Valley 40-30-30 water year types as computed in CalSim 3 for the period October 1921–September 2015. Dry/critical year averages are for those two water year types combined.

Table 5-4. Changes to Lake Oroville Storage under the No Project Alternative

	Existing Conditions	No Project Alternative	
	Reservoir Storage (TAF)	Reservoir Storage (TAF)	Percent Change from EC
End of May			
Long-Term Average [a]	3,007	2,870	-4.6%
Dry/Critical Years [b]	2,231	2,067	-7.4%
End of June			
Long-Term Average [a]	2,869	2,546	-11.3%
Dry/Critical Years [b]	1,967	1,698	-13.7%
End of August			
Long-Term Average [a]	2,073	1,717	-17.2%
Dry/Critical Years [b]	1,305	1,109	-15.0%
End of September			
Long-Term Average [a]	1,964	1,673	-14.8%
Dry/Critical Years [b]	1,301	1,100	-15.5%

CalSim 3 output variable: S_OROVL.

EC = existing conditions; TAF = thousand acre-feet.

[a] Long-term average is the average annual storage for the period October 1921–September 2015 simulated in CalSim 3.

[b] Water year types are State Water Resources Control Board Water Right Decision 1641 Sacramento Valley 40-30-30 water year types as computed in CalSim 3 for the period October 1921–September 2015. Dry/critical year averages are for those two water year types combined.

Table 5-5. Changes to Folsom Lake Storage under the No Project Alternative

	Existing Conditions	No Project Alternative	
	Reservoir Storage (TAF)	Reservoir Storage (TAF)	Percent Change from EC
End of May			
Long-Term Average [a]	839	808	-3.7%
Dry/Critical Years [b]	622	581	-6.6%
End of June			
Long-Term Average [a]	806	746	-7.5%
Dry/Critical Years [b]	588	516	-12.2%
End of August			
Long-Term Average [a]	587	526	-10.4%
Dry/Critical Years [b]	425	352	-17.0%
End of September			
Long-Term Average [a]	546	484	-11.4%
Dry/Critical Years [b]	395	332	-16.0%

CalSim 3 output variable: S_FOLSM.

EC = existing conditions; TAF = thousand acre-feet.

[a] Long-term average is the average annual storage for the CalSim 3 period October 1921 through September 2015.

[b] Water year types are State Water Resources Control Board Water Right Decision 1641 Sacramento Valley 40-30-30 water year types as computed in CalSim 3 for the period October 1921–September 2015. Dry/critical year averages are for those two water year types combined.

Table 5-6. Changes to San Luis Reservoir Total Storage under the No Project Alternative

	Existing Conditions	No Project Alternative	
	Reservoir Storage (TAF)	Reservoir Storage (TAF)	Percent Change from EC
End of May			
Long-Term Average [a]	1,225	1,286	5.0%
Dry/Critical Years [b]	1,024	998	-2.5%
End of June			
Long-Term Average [a]	927	1,048	13.1%
Dry/Critical Years [b]	785	811	3.3%
End of August			
Long-Term Average [a]	613	647	5.4%
Dry/Critical Years [b]	381	352	-7.7%
End of September			
Long-Term Average [a]	619	558	-9.8%
Dry/Critical Years [b]	379	373	-1.6%

CalSim 3 output variable: S_SLUIS.

EC = existing conditions; TAF = thousand acre-feet.

[a] Long-term average is the average annual storage for the period October 1921–September 2015 simulated in CalSim 3.

[b] Water year types are State Water Resources Control Board Water Right Decision 1641 Sacramento Valley 40-30-30 water year types as computed in CalSim 3 for the period October 1921–September 2015. Dry/critical year averages are for those two water year types combined.

Reverse flows in the Sacramento River upstream of the DCP intake occur naturally, especially during low flows in Sacramento River. Operation of the DCP has the potential to increase the frequency of these reverse flows in the Sacramento River upstream of the intake locations. These changes were evaluated by DWR through the application of DSM2 based on the 92-year CalSim 3 simulation of with and without project conditions. The result of the assessment determined the frequency of reverse flows in the Sacramento River upstream of the proposed intakes, near the Sacramento Regional Wastewater Treatment Plant, would increase slightly when the intakes were operating. The reverse flows attributable to these operations are very small in both duration and reverse flow distance. According to DSM2 results, there is no increase in frequency of stronger reverse flow events (Reverse flow distance greater than 0.8 mile).

Predictable Actions by Others

A list and description of actions included as part of the No Project Alternative are provided in Appendix 3C. As described in Chapter 4, *Framework for the Environmental Analysis,* the No Project Alternative analyses focus on identifying the additional water-supply related actions public water agencies may opt to follow if the Delta Conveyance Project does not occur. However, none of these projects are expected to draw upon existing surface water resources and as such would not change surface water resources within the areas in which these projects would be located. Conversely, the greatest changes to surface water resources are expected to occur as a result of climate change and sea level rise, which would modify hydrologic patterns and upstream reservoir management.

Public water agencies participating in the project have been grouped into four geographic regions. The water agencies within each geographic region would likely pursue a similar suite of water supply projects under the No Project Alternative (see Appendix 3C).

5.3.2.2 Project Alternatives

The proposed north Delta intakes would operate in conjunction with the existing SWP/CVP intakes in the south Delta for all alternatives. Operation of the proposed north Delta intakes would remain consistent with existing regulatory requirements and any additional requirements that result from project permitting. The project would not change operational criteria associated with upstream reservoirs. In addition, diversions at the proposed north Delta intakes would be governed by new operational criteria specific to these intakes, such as the fish screen approach velocity requirements, bypass flow requirements, and pulse protection. The proposed north Delta intakes would augment the ability to capture excess flows and improve the flexibility of the SWP operations for meeting the State Water Resources Control Board D-1641 Delta salinity requirements.

During the winter and spring, when there are excess flows in the system, the proposed north Delta intakes would be used to capture additional excess flows when south Delta exports are limited and unable to capture those flows. During the late spring, summer, and fall—when the SWP and CVP are typically operating to meet the D-1641 salinity requirements in the Delta—both the existing south Delta intakes and the proposed north Delta intakes would be operated together to meet the D-1641 salinity requirements. Use of the proposed north Delta intakes, particularly in July through December, can be used to reduce carriage water requirements—which are necessary to move exports through the south Delta when D-1641 salinity requirements are controlling. The resulting carriage water savings can then be exported or retained in upstream reservoirs, since the water no longer needs to be released. In the CalSim 3 model, increasing exports is always prioritized; however, these savings would remain in storage when sufficient export capacity does not exist. Carriage water savings from operation of the proposed north Delta intakes benefits both the SWP and CVP under all alternatives in accordance with the provisions of the Coordinated Operations Agreement,

Existing regulations, operational rules, and water supply allocation procedures governing SWP and CVP system operations would not change because of operation of the project alternatives. However, because of the effect that integration of the proposed north Delta intakes has on the overall system, their operation could lead to changes in river flows and upstream storages. For example, when carriage water savings cannot be exported, there could be reduced reservoir releases, reduced river flows, and greater upstream reservoir storages in certain months (when compared to existing conditions). These increased reservoir storages could lead to greater spills in the following winter and shift reservoir balancing for the SWP and CVP; consequently, increased carryover storage could lead to differing export operations in the following year. Increased storage in San Luis Reservoir—because of exports at the proposed north Delta intakes—could lower releases for exports in the following summer to conserve upstream storage. Higher Table A allocations (i.e., the portion of the annual Table A amount that is approved for delivery to each SWP water contractor) from additional exports could also lead to changes in Article 56 carryover, which cause operations to adjust in the following year. More details of water supply conditions under the project alternatives are described in Chapter 6, *Water Supply*.

All nine project alternatives (i.e., Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5) described in Chapter 3, *Description of the Proposed Project and Alternatives*, are discussed together since they produce similar changes to Sacramento River Basin flows and reservoir storage.

Changes to Sacramento River Basin Flows

Generally, long-term average monthly flows for the project alternatives are similar to existing conditions, with some minor differences described below. Differences vary by water year type, and are sometimes more extreme and/or more concentrated in certain month and water year type combinations, as shown in Appendix 5C.

There are consistent decreases in long-term average flows for all months on the Sacramento River north of Courtland (i.e., downstream of the proposed north Delta intakes). These decreases occur in most water year type and month combinations, although the decreases are smaller or nonexistent in the summer of drier years. During the winter and spring in most years, and in wetter years when the Delta is in excess, these decreases are due to diversions of excess flows at the proposed north Delta intakes.

In the summer and early fall, the decreases on the Sacramento River north of Courtland (i.e., downstream of the proposed north Delta intakes) are due to three reasons. First, releases for exports from upstream reservoirs can be lower in these months because San Luis Reservoir is fuller entering the summer; this is due to the diversions of excess water at the proposed north Delta intakes previously discussed. Second, in months when there is shifting of exports from the south Delta to the north Delta to reduce carriage water requirements, flow at Hood is reduced because water that was previously exported in the south Delta is now exported at the north Delta intakes. Third, while in many cases all carriage water savings are exported, in cases where that is not possible due to regulatory or physical capacity limits and there is an ability to store that water by reducing upstream reservoir releases, backing up of carriage water savings also decreases flows north of Courtland.

This third reason also applies to conditions of tributaries in the Sacramento River basin. While the flow decreases on the upstream tributaries are minor when measured on an annual average basis, they can be larger for certain water year types. Because carriage water savings are split between the SWP and CVP according to the Coordinated Operations Agreement, flows downstream of both SWP and CVP reservoirs exhibit these decreases. These conditions result in reduced flows in the Sacramento River downstream of Keswick Reservoir, the Sacramento River at Bend Bridge, the Feather River downstream of Thermalito Afterbay, and the American River at Watt Avenue.

In addition to the direct effects of the proposed north Delta intakes on flows previously discussed, there are additional flow changes that occur for certain month and water year type combinations. While these changes make sense in terms of the simplified operational rules that are used in CalSim 3, in many cases, they may be exaggerations of the differences that would occur in an actual operation because CalSim 3 tends to occasionally adjust operations drastically in a single month, while in actual seasonal operations this change would occur more gradually over a period of multiple months.

There are changes in flows during the winter and spring in certain month and water year type combinations on the tributaries mentioned above, as well as on the Trinity River downstream of Lewiston Dam. These changes are typically increases in flows, although decreases in flows occur as well. Such changes are commonly due to operational shifts in a small number of years that are large enough to affect the water year type averages. These operational shifts happen because of a variety of factors, which include: (1) changes in reservoir spills when entering the month with storage that is a different distance from the flood curve, (2) shifts in reservoir balancing for the CVP (i.e., similar overall releases would be split differently between Trinity Lake, Shasta Lake, and Folsom Lake depending on the scenario), (3) changes in releases for exports due to different conditions in San Luis Reservoir when entering the month, (4) differences in reservoir releases for meeting salinity standards in the Delta, and (5) differences in releases for wheeling. All of these differences can occur when operations for the previous month were different and can generally be traced back to a prior month(s) when diversions at the proposed north Delta intakes caused changes in other components of the operation.

Flows in the Feather River downstream of Thermalito Afterbay show a consistent, minor increase in flows in October because of increased releases for exports to increase storage in the SWP share of San Luis Reservoir, allowing for additional Article 56 deliveries in the following year. Article 56 carryover demands are higher due to higher Table A allocations in the project alternatives, as a result of additional exports at the proposed north Delta intakes. Flows on the American River at Watt Avenue show a minor increase in October and November, mostly due to flow changes in a few years in the model simulations from reservoir rebalancing or changes in Delta salinity requirements.

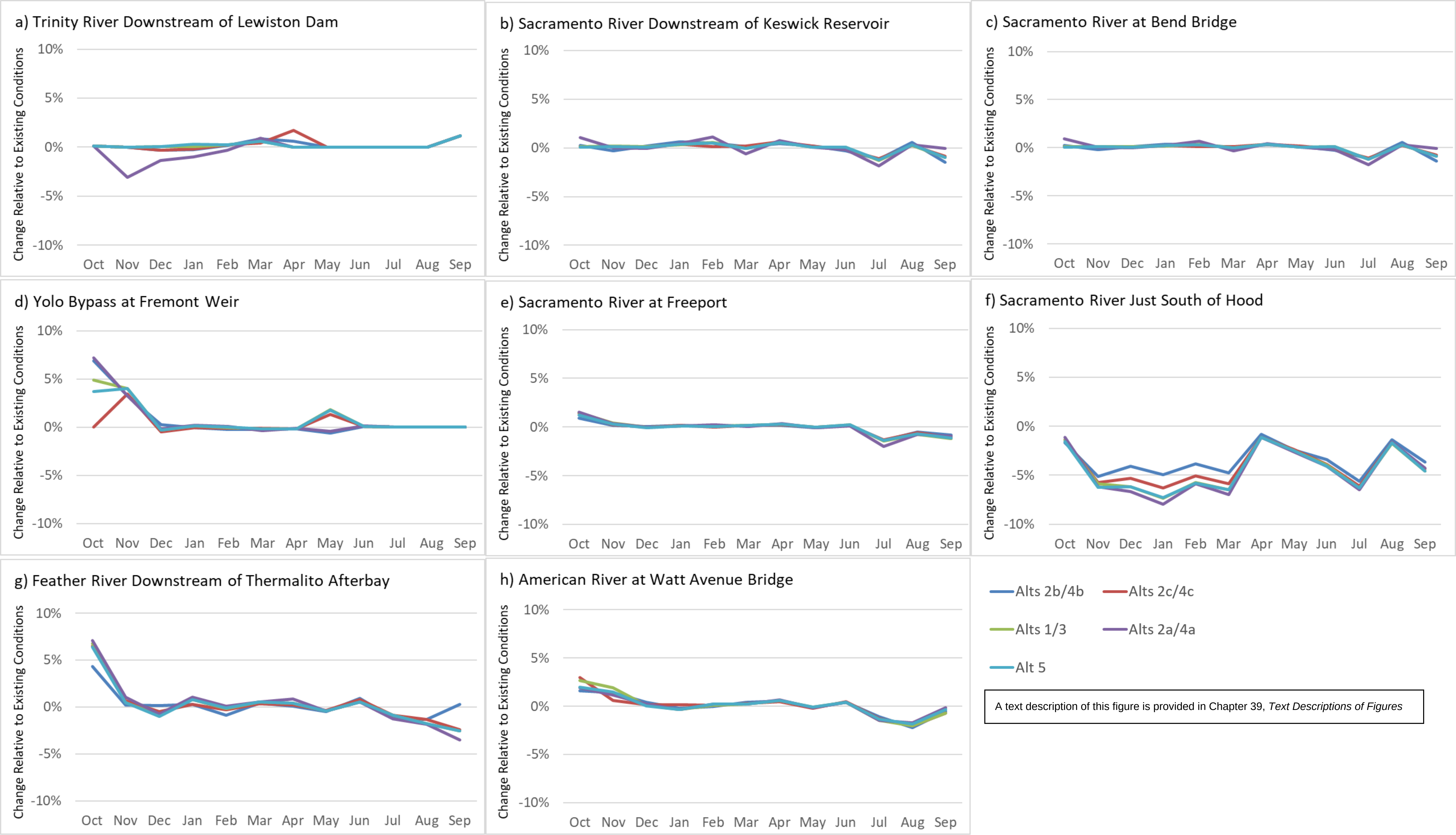
The percent changes in the long-term average monthly flows between the project alternatives and existing conditions in the Sacramento River Basin are shown in Figure 5-4. Tables in Appendix 5C provide additional detail by alternative and water year type.

Changes to SWP and CVP Reservoir Storage

Storages at SWP and CVP north-of-Delta reservoirs averaged for all years and for dry/critical years under the project alternatives are similar to existing conditions for all time periods examined (i.e., end-of-May, end-of-June, end-of-August, and end-of-September periods). For Trinity Lake, Shasta Lake, Lake Oroville, and Folsom Lake, storage changes are extremely minimal, and the changes that do occur are generally minor increases. The minor increases occur because of lower releases for exports (because of diversions at the proposed north Delta intakes) and carriage water savings.

There are more substantial changes in storage in San Luis Reservoir as long-term averages show increases for all of the project alternatives when compared to existing conditions for all time periods examined (i.e., end-of-May, end-of-June, end-of-August, and end-of-September periods). These increases are due to diversions at the proposed north Delta intakes, which augment storage in San Luis Reservoir during the winter and spring. Some of this increased storage is used to support deliveries during the summer, although some carries over into September and is used for Article 56 carryover. A similar pattern is present for most of the dry/critical year averages, although there are decreases in the end-of-September storages, mainly because of decreases in the SWP share of San Luis Reservoir. This decrease in end-of-September storage is due to increased SWP allocations in the prior spring—which is caused by increased exports and higher storages in SWP San Luis Reservoir at that time. These lead to greater deliveries in the summer, which can decrease San Luis Reservoir storage in September.

Changes to SWP and CVP reservoir storage for all project alternatives are shown in Tables 5-7 through 5-11.



A text description of this figure is provided in Chapter 39, *Text Descriptions of Figures*

Figure 5-4. Percent Change in the Long-Term Average of Monthly Flows Under the Project Alternatives Relative to Existing Conditions at Select Locations

Table 5-7. Changes to Trinity Lake Storage under the Project Alternatives

	Existing Conditions	Alternatives 2b, 4b		Alternatives 2c, 4c		Alternatives 1, 3		Alternatives 2a, 4a		Alternative 5	
	Reservoir Storage (TAF)	Reservoir Storage (TAF)	Percent Change from EC	Reservoir Storage (TAF)	Percent Change from EC	Reservoir Storage (TAF)	Percent Change from EC	Reservoir Storage (TAF)	Percent Change from EC	Reservoir Storage (TAF)	Percent Change from EC
End of May											
Long-Term Average [a]	1,867	1,871	0.2%	1,873	0.3%	1,870	0.2%	1,870	0.2%	1,871	0.2%
Dry/Critical Years [b]	1,396	1,405	0.7%	1,408	0.9%	1,403	0.5%	1,403	0.5%	1,402	0.5%
End of June											
Long-Term Average [a]	1,838	1,842	0.2%	1,844	0.3%	1,841	0.2%	1,841	0.2%	1,842	0.2%
Dry/Critical Years [b]	1,338	1,348	0.8%	1,350	0.9%	1,344	0.4%	1,345	0.5%	1,344	0.4%
End of August											
Long-Term Average [a]	1,566	1,570	0.2%	1,573	0.4%	1,570	0.2%	1,569	0.2%	1,570	0.3%
Dry/Critical Years [b]	1,043	1,050	0.6%	1,050	0.6%	1,047	0.3%	1,046	0.3%	1,047	0.3%
End of September											
Long-Term Average [a]	1,438	1,443	0.3%	1,445	0.5%	1,443	0.3%	1,441	0.2%	1,443	0.3%
Dry/Critical Years [b]	946	951	0.5%	951	0.5%	948	0.2%	948	0.1%	947	0.1%

CalSim 3 output variable: S_TRNTY.

EC = existing conditions; TAF = thousand acre-feet.

[a] Long-term average is the average annual storage for the period October 1921–September 2015 simulated in CalSim 3.

[b] Water year types are State Water Resources Control Board Water Right Decision 1641 Sacramento Valley 40-30-30 water year types as computed in CalSim 3 for the period October 1921–September 2015. Dry/critical year averages are for those two water year types combined.

Table 5-8. Changes to Shasta Lake Storage under the Project Alternatives

	Existing Conditions	Alternatives 2b, 4b		Alternatives 2c, 4c		Alternatives 1, 3		Alternatives 2a, 4a		Alternative 5	
	Reservoir Storage (TAF)	Reservoir Storage (TAF)	Percent Change from EC	Reservoir Storage (TAF)	Percent Change from EC	Reservoir Storage (TAF)	Percent Change from EC	Reservoir Storage (TAF)	Percent Change from EC	Reservoir Storage (TAF)	Percent Change from EC
End of May											
Long-Term Average [a]	4,051	4,059	0.2%	4,060	0.2%	4,053	0.1%	4,053	0.1%	4,053	0.1%
Dry/Critical Years [b]	3,299	3,321	0.7%	3,318	0.6%	3,304	0.1%	3,308	0.3%	3,303	0.1%
End of June											
Long-Term Average [a]	3,789	3,799	0.3%	3,798	0.2%	3,790	0.0%	3,792	0.1%	3,790	0.0%
Dry/Critical Years [b]	2,931	2,954	0.8%	2,950	0.6%	2,936	0.2%	2,945	0.5%	2,936	0.2%
End of August											
Long-Term Average [a]	2,979	2,994	0.5%	2,994	0.5%	2,988	0.3%	2,995	0.5%	2,987	0.3%
Dry/Critical Years [b]	2,237	2,256	0.9%	2,252	0.7%	2,239	0.1%	2,255	0.8%	2,239	0.1%
End of September											
Long-Term Average [a]	2,827	2,846	0.7%	2,844	0.6%	2,838	0.4%	2,841	0.5%	2,837	0.4%
Dry/Critical Years [b]	2,162	2,178	0.7%	2,172	0.5%	2,161	0.0%	2,172	0.5%	2,161	0.0%

CalSim 3 output variable: S_SHSTA.

EC = existing conditions; TAF = thousand acre-feet.

[a] Long-term average is the average annual storage for the period October 1921–September 2015 simulated in CalSim 3.

[b] Water year types are State Water Resources Control Board Water Right Decision 1641 Sacramento Valley 40-30-30 water year types as computed in CalSim 3 for the period October 1921–September 2015. Dry/critical year averages are for those two water year types combined.

Table 5-9. Changes to Lake Oroville Storage under the Project Alternatives

	Existing Conditions	Alternatives 2b, 4b		Alternatives 2c, 4c		Alternatives 1, 3		Alternatives 2a, 4a		Alternative 5	
	Reservoir Storage (TAF)	Reservoir Storage (TAF)	Percent Change from EC	Reservoir Storage (TAF)	Percent Change from EC	Reservoir Storage (TAF)	Percent Change from EC	Reservoir Storage (TAF)	Percent Change from EC	Reservoir Storage (TAF)	Percent Change from EC
End of May											
Long-Term Average [a]	3,007	3,017	0.3%	3,014	0.2%	3,013	0.2%	3,010	0.1%	3,015	0.3%
Dry/Critical Years [b]	2,231	2,252	0.9%	2,249	0.8%	2,243	0.5%	2,236	0.2%	2,247	0.7%
End of June											
Long-Term Average [a]	2,869	2,876	0.3%	2,874	0.2%	2,873	0.1%	2,870	0.1%	2,875	0.2%
Dry/Critical Years [b]	1,967	1,985	0.9%	1,982	0.8%	1,978	0.5%	1,971	0.2%	1,983	0.8%
End of August											
Long-Term Average [a]	2,073	2,089	0.8%	2,085	0.6%	2,086	0.6%	2,085	0.6%	2,088	0.7%
Dry/Critical Years [b]	1,305	1,314	0.6%	1,306	0.1%	1,304	-0.1%	1,302	-0.2%	1,307	0.2%
End of September											
Long-Term Average [a]	1,964	1,979	0.7%	1,980	0.8%	1,981	0.8%	1,982	0.9%	1,983	0.9%
Dry/Critical Years [b]	1,301	1,312	0.8%	1,305	0.3%	1,302	0.1%	1,301	0.0%	1,306	0.3%

CalSim 3 output variable: S_OROVL.

EC = existing conditions; TAF = thousand acre-feet.

[a] Long-term average is the average annual storage for the period October 1921–September 2015 simulated in CalSim 3.

[b] Water year types are State Water Resources Control Board Water Right Decision 1641 Sacramento Valley 40-30-30 water year types as computed in CalSim 3 for the period October 1921–September 2015. Dry/critical year averages are for those two water year types combined.

Table 5-10. Changes to Folsom Lake Storage under the Project Alternatives

	Existing Conditions	Alternatives 2b, 4b		Alternatives 2c, 4c		Alternatives 1, 3		Alternatives 2a, 4a		Alternative 5	
	Reservoir Storage (TAF)	Reservoir Storage (TAF)	Percent Change from EC	Reservoir Storage (TAF)	Percent Change from EC	Reservoir Storage (TAF)	Percent Change from EC	Reservoir Storage (TAF)	Percent Change from EC	Reservoir Storage (TAF)	Percent Change from EC
End of May											
Long-Term Average [a]	839	839	0.1%	839	0.0%	838	-0.1%	838	0.0%	838	0.0%
Dry/Critical Years [b]	622	623	0.2%	622	0.1%	619	-0.4%	621	-0.2%	621	-0.2%
End of June											
Long-Term Average [a]	806	805	-0.1%	805	-0.1%	804	-0.2%	804	-0.2%	804	-0.2%
Dry/Critical Years [b]	588	586	-0.4%	586	-0.4%	583	-0.8%	584	-0.7%	585	-0.6%
End of August											
Long-Term Average [a]	587	593	0.9%	593	0.9%	592	0.8%	592	0.8%	592	0.8%
Dry/Critical Years [b]	425	425	0.0%	425	0.0%	422	-0.6%	426	0.3%	423	-0.4%
End of September											
Long-Term Average [a]	546	552	1.0%	552	1.1%	552	1.0%	551	0.8%	551	0.9%
Dry/Critical Years [b]	395	396	0.1%	395	0.0%	393	-0.6%	397	0.4%	394	-0.4%

CalSim 3 output variable: S_FOLSM.

EC = existing conditions; TAF = thousand acre-feet.

[a] Long-term average is the average annual storage for the CalSim 3 period October 1921 through September 2015.

[b] Water year types are State Water Resources Control Board Water Right Decision 1641 Sacramento Valley 40-30-30 water year types as computed in CalSim 3 for the period October 1921–September 2015. Dry/critical year averages are for those two water year types combined.

Table 5-11. Changes to San Luis Reservoir Total Storage under the Project Alternatives

	Existing Conditions	Alternatives 2b, 4b		Alternatives 2c, 4c		Alternatives 1, 3		Alternatives 2a, 4a		Alternative 5	
	Reservoir Storage (TAF)	Reservoir Storage (TAF)	Percent Change from EC	Reservoir Storage (TAF)	Percent Change from EC	Reservoir Storage (TAF)	Percent Change from EC	Reservoir Storage (TAF)	Percent Change from EC	Reservoir Storage (TAF)	Percent Change from EC
End of May											
Long-Term Average [a]	1,225	1,401	14.4%	1,422	10.5%	1,438	17.4%	1,463	19.4%	1,437	17.3%
Dry/Critical Years [b]	1,024	1,097	7.2%	1,117	11.9%	1,137	11.1%	1,163	13.6%	1,135	10.9%
End of June											
Long-Term Average [a]	927	1,097	18.3%	1,116	6.4%	1,129	21.8%	1,148	23.8%	1,129	21.8%
Dry/Critical Years [b]	785	831	5.9%	846	4.3%	860	9.5%	880	12.1%	858	9.3%
End of August											
Long-Term Average [a]	613	713	16.3%	723	11.8%	727	18.5%	727	18.5%	727	18.6%
Dry/Critical Years [b]	381	383	0.5%	390	10.9%	391	2.6%	391	2.6%	391	2.6%
End of September											
Long-Term Average [a]	619	695	12.2%	696	24.6%	699	12.9%	699	12.9%	700	13.0%
Dry/Critical Years [b]	379	366	-3.5%	362	-2.8%	358	-5.5%	362	-4.3%	358	-5.5%

CalSim 3 output variable: S_SLUIS.

EC = existing conditions; TAF = thousand acre-feet.

[a] Long-term average is the average annual storage for the period October 1921–September 2015 simulated in CalSim 3.

[b] Water year types are State Water Resources Control Board Water Right Decision 1641 Sacramento Valley 40-30-30 water year types as computed in CalSim 3 for the period October 1921–September 2015. Dry/critical year averages are for those two water year types combined.