6. Surface Water Resources

6.1 Introduction

This chapter describes Existing Conditions (the environmental setting) and Sites Reservoir Project (Project)-related changes to surface water resources in the Extended, Secondary, and Primary study areas. Detailed descriptions and maps of these three study areas are provided in Chapter 1 Introduction, and summarized descriptions are included in this chapter. Surface water resources generally include reservoirs, rivers, and diversions. Permits and authorizations for surface water resources are presented in Chapter 4 Environmental Compliance and Permit Summary. The regulatory setting for surface water resources is presented in Appendix 4A Environmental Compliance.

This chapter also includes a description of the surface water supply facilities operations and resulting surface water resources characteristics of California's major water systems that are relevant to the Project: the Central Valley Project (CVP), a federal project that is operated and maintained by the Bureau of Reclamation (Reclamation), the State Water Project (SWP), operated and maintained by the California Department of Water Resources (DWR), and associated tributary rivers and streams. A schematic showing the layout of these two water systems, with the relative location of the Project, is shown in Figures 6-1A, 6-1B, and 6-1C. A comparison of these characteristics has been made between the Existing Conditions/No Project/No Action Condition, and the four action alternatives (Alternatives A, B, C, and D). Unless noted, all numbers shown related to storages, flows, exports, and deliveries in this chapter are generated from the CALSIM II computer simulation model.

Appendix 6A Modeling of Alternatives, Appendix 6B Water Resources System Modeling, and Appendix 6C Upper Sacramento River Daily River Flow and Operations Modeling describe the assumptions and the analytical framework used in the surface water modeling analyses. Appendix 6B Water Resources System Modeling also includes figures that present geographical locations used for surface water and surface water quality analyses. Appendix 6D Comparison of Impact Assessment Results Using CALSIM II 2010 and 2015 Versions presents sensitivity analyses related to model results for Alternatives A, B, C, and D conducted with different versions of the CALSIM II model. Changes in surface water flows also affects groundwater elevations in some parts of the Central Valley, as described in Chapter 10 Groundwater Resources.

6.2 Environmental Setting/Affected Environment

6.2.1 Overview of Hydrologic Variability in the Extended, Secondary, and Primary Study Areas

Variability and uncertainty are the dominant characteristics of California's water resources. Precipitation is the source of 97 percent of California's water supply (DWR, 2009); however, it varies greatly on an annual and seasonal basis, as well as by location within the state. The unpredictability and geographic variation in precipitation that California receives make it challenging to manage the available runoff to meet urban, agricultural, and environmental water needs. In an average water year, precipitation provides California with approximately 200 million acre-feet (MAF) of water falling as either rain or snow. The total volume of water the state receives can vary dramatically between dry and wet years; for example, California may receive less than 100 MAF of water during a dry year and more than 300 MAF in a

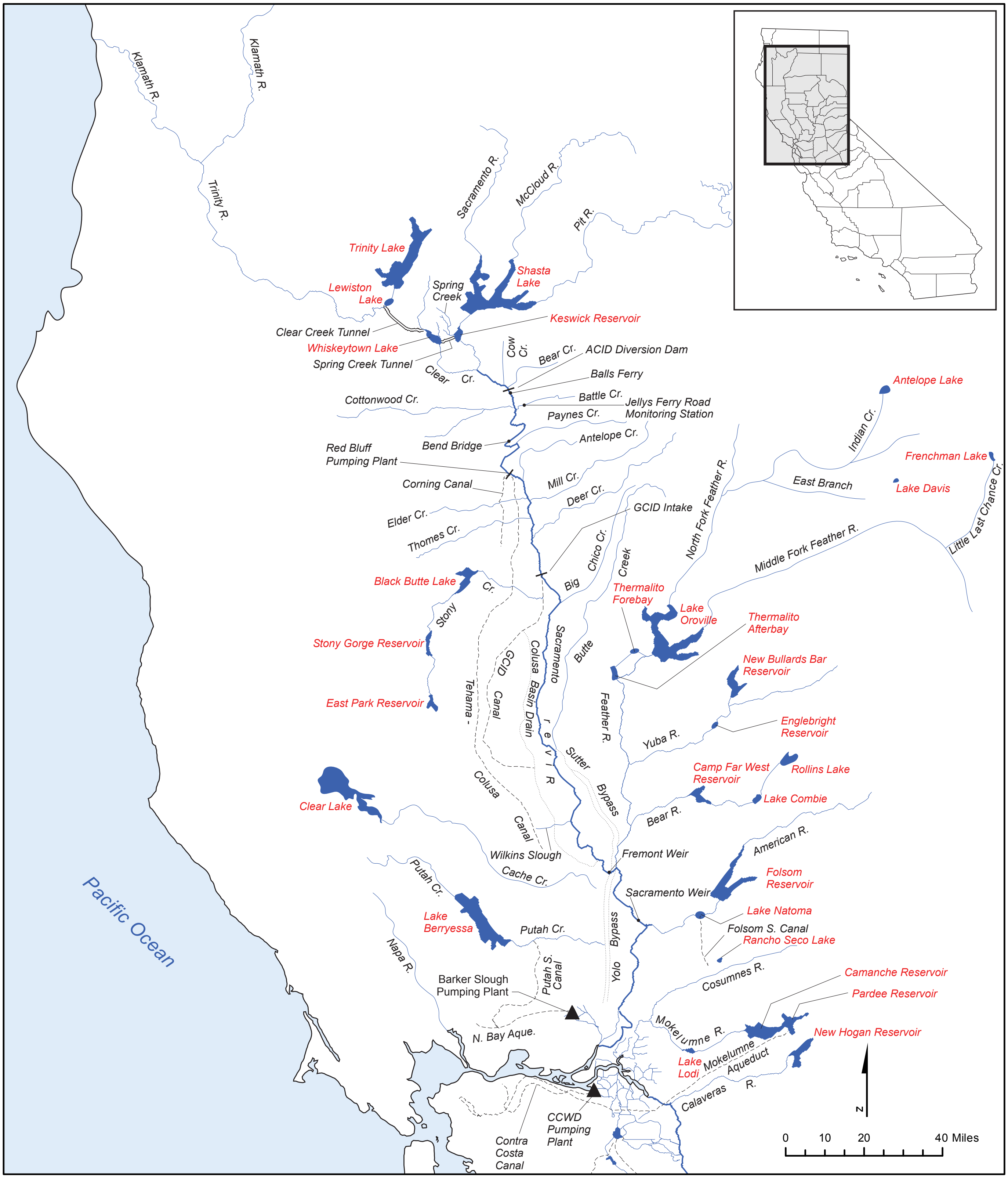

FIGURE 6-1A
Northern California Major Water Supply Facilities

Sites Reservoir Project EIR/EIS

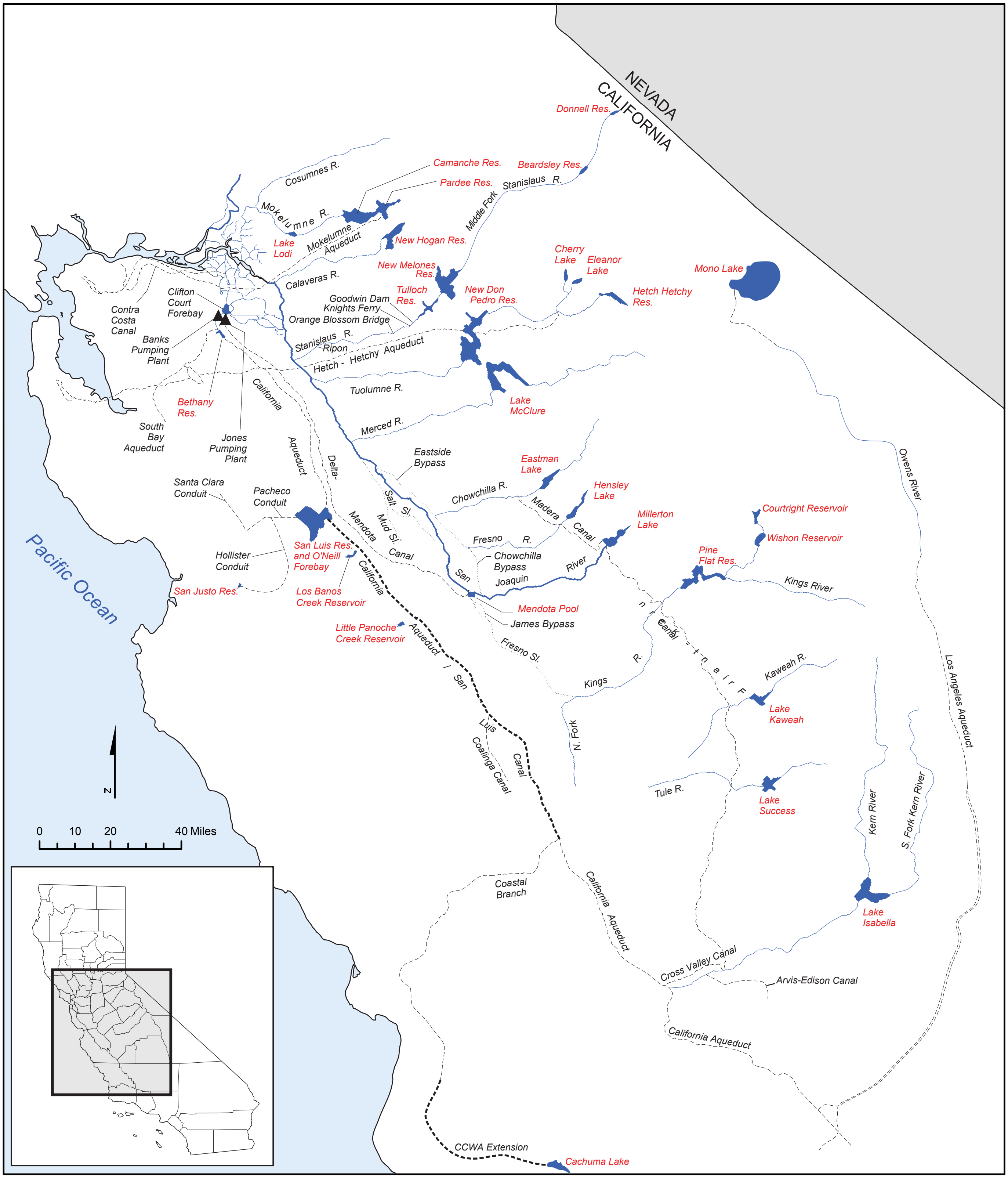

FIGURE 6-1B
San Francisco Bay Area,
San Joaquin Valley, and Tulare Lake
Major Water Supply Facilities
Sites Reservoir Project EIR/EIS

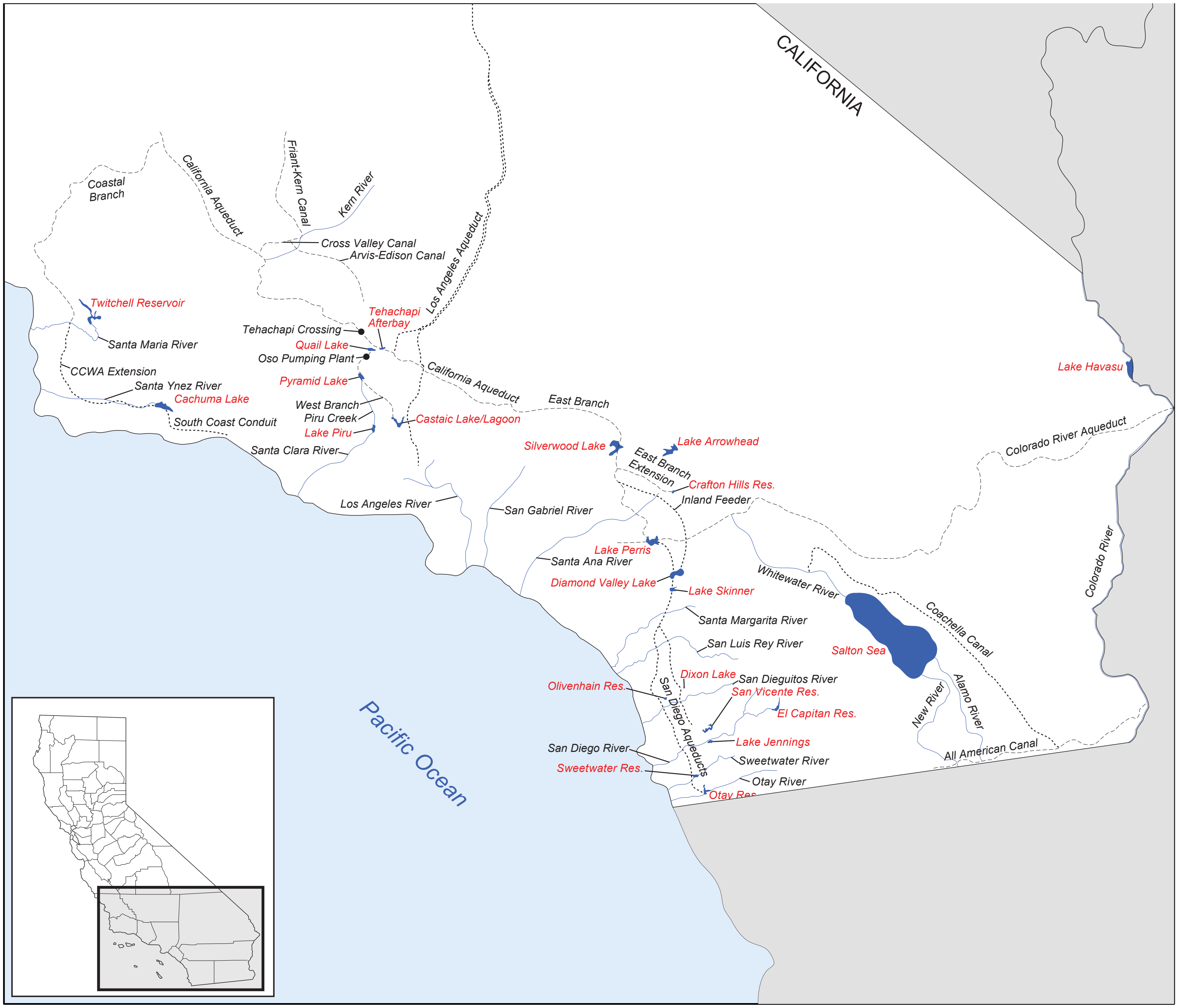

FIGURE 6-1C
Central Coast and Southern California
Major Water Supply Facilities
Sites Reservoir Project EIR/EIS

wet year (Western Regional Climate Center, 2011). The majority of California's precipitation occurs between November and April, while most of the state's demand for water is in the summer months. In addition, most of the precipitation falls in the northern portion of the state. In some years, the northern regions of the state can receive 100 inches or more of precipitation, while the southern regions receive only a few inches.

Over time, annual precipitation trends in the Sacramento Valley have been changing and continue to change with more extreme water years. For example, the percentage of total water years defined as Dry or Critical increased from 33 percent between 1906 and 1960 to 38 percent between 1961 and 2015. Additionally, the percentage of total water years defined as Above Normal or Wet decreased from 45 percent between 1906 and 1960, to 47 percent between 1961 and 2015. However, the overall annual average precipitation levels in pre-1960 years and post-1960 years are similar, although extreme condition occurrences were larger and more frequent between 1961 and 2015 as compared to the 1906 to 1960 period.

Because of the hydrologic variability that ranges from dry summer and fall months to floods in winter and spring months, water from precipitation in the winter and spring must be stored for use in the summer and fall. Therefore, federal, State, and local agencies and private entities have constructed reservoirs, aqueducts, pipelines, and water diversion facilities to capture and use the rainfall and the subsequent snowmelt.

6.2.2 Overview of Surface Water Resources in the Extended, Secondary, and Primary Study Areas

Surface water resources in the Extended, Secondary, and Primary study areas are defined as the natural surface water bodies as well as the reservoir and conveyance facilities that have been constructed to provide water supplies and floodwater management.

6.2.2.1 Overview of Major Surface Water Bodies in the Extended, Secondary, and Primary Study Areas

As described in Chapter 1 Introduction, the Extended, Secondary, and Primary study areas include the service area of the CVP and SWP through the Central Valley, San Francisco Bay Area, Central Coast, and Southern California; areas with CVP and SWP facilities; and the areas with the Project. Figures 6-1A, 6-1B, and 6-1C show major rivers and water supply facilities in the Extended, Secondary, and Primary study areas, respectively.

Surface water bodies in the Central Valley are defined by the geologic and geographic characteristics of this area. The Central Valley of California is a vast, oblong valley that lies within the interior of the state, 400 miles north to south and about 50 miles east to west. The Central Valley is bounded on the north by the Cascade Range, on the east by the Sierra Nevada mountain ranges, by the Tehachapi Mountains on the south, and by the Coastal Ranges on the west. Three major drainage areas are present in the Central Valley: the Sacramento River watershed, the San Joaquin River watershed, and the Tulare Lake watershed. The Sacramento River watershed consists of the northern third of the Central Valley and is drained by the Sacramento River, yielding approximately 35 percent of the total outflow of all rivers in the state. Most of the southern two-thirds of the Central Valley, a much drier region, is drained by the San Joaquin River, which flows west, then north, and meets the Sacramento River at the Sacramento-San Joaquin Delta (Delta). The Sacramento and San Joaquin rivers join in the Delta where their combined flows continue west through Suisun, San Pablo, and San Francisco bays to the Pacific Ocean.

The southernmost portion of the Central Valley, the Tulare Lake watershed, is an inland drainage area that receives flows from the Kings, Kaweah, Kern, and Tule rivers and several smaller streams that drain the western slope of the Sierra Nevada Range, and from several ephemeral streams that drain the eastern slope of the Coast Range.

The San Francisco Bay Area covers more than 4,600 acres of the coastal plain bounded on the east by the crest of the Coast Ranges mountains. Major rivers and streams in the portion of the San Francisco Bay Area served by the CVP and SWP water supplies include the Guadalupe River, Alameda Creek, and Coyote Creek, which drain the southern Coast Ranges, Walnut Creek draining the Mt. Diablo foothills, Napa River and Sonoma River draining the northern Coast Ranges, and numerous creeks draining the coastal foothills around San Francisco Bay (DWR, 2009).

The Central Coast region served by SWP water supplies spans portions of San Luis Obispo and Santa Barbara counties. The region consists of coastal plains, inland valleys, and portions of the Coast Ranges. Surface water sources in the Central Coast region consist of waters from the Santa Ynez and Santa Maria rivers that drain the coastal mountains. Water along these rivers is stored in Reclamation’s Twitchell Reservoir (part of the Cuyama Project) and Cachuma Lake (part of the Santa Maria Project), respectively.

The portion of Southern California served by SWP water supplies includes numerous rivers, streams, and creeks. The majority of these water bodies have headwaters in the mountains that flow down to the valley floor and out to the Pacific Ocean over the coastal plains. In general, the headwaters of the watercourses are in undeveloped areas, and the downstream reaches are in highly urbanized areas. These rivers and streams either have little to no flows during most of the year, except during storm events, when flows peak and flooding can occur. Major rivers in Southern California include the Calleguas Creek and Ventura and Santa Clara rivers in Ventura County, the Los Angeles and San Gabriel rivers in Los Angeles County, the Santa Ana River in Orange County, the San Diego River in San Diego County, and the Mojave River in San Bernardino County.

Implementation of the action alternatives would result in changes in operations of the CVP and SWP reservoirs and surface water flows in downstream of those reservoirs, and flows in the Sacramento River and the Delta downstream of the Tehama-Colusa Canal Authority and Glenn-Colusa Irrigation District (GCID) Main Canal intakes and at the Delevan Pipeline Intake/Discharge Facilities as compared to the Existing Conditions/No Project/No Action Condition. It is anticipated that reservoir operations and related flow conditions in the San Joaquin River watershed upstream of the Delta (as defined at Vernalis) would not be affected by implementation of the action alternatives as compared to the Existing Conditions/No Project/No Action Condition. Surface water conditions in the San Francisco Bay Area, Central Coast, and Southern California regions, also would not be affected by implementation of the action alternatives as compared to the Existing Conditions/No Project/No Action Condition because the surface water streams generally are not affected by availability of CVP and SWP water supplies. Therefore, surface water conditions are not further discussed in this chapter for the San Joaquin River upstream of Vernalis or streams in the San Francisco Bay Area, Central Coast, and Southern California regions.

6.2.2.2 Overview of Major Surface Water Facilities in the Extended, Secondary, and Primary Study Areas

During the past 100 years, numerous water supply, flood management, and hydroelectric generation reservoirs were constructed throughout California. Many of these projects were constructed on tributaries to the Sacramento and San Joaquin rivers and tributaries to the Tulare Lake watershed. In the early 1900s, several reservoirs were constructed to improve flood management and water supplies, including East Park Reservoir on Little Stony Creek and Stony Gorge Reservoir on Stony Creek by Reclamation under the Orland Project, Pardee Lake on the Mokelumne River by East Bay Municipal Utility District, and Hetch Hetchy Reservoir on the Tuolumne River by San Francisco Public Utilities Commission. In 1930, the State of California published a statewide water plan (California Department of Public Works, 1930) that included 37 water supply and flood management reservoirs on the Trinity River, Sacramento River, Sacramento River tributaries, San Joaquin River, and San Joaquin River tributaries.

In 1933, the State authorized the California CVP Act. However, during the Great Depression of the 1930s, the State could not raise the funds and appealed to the federal government for assistance for construction of a portion of the facilities by the U.S. Army Corps of Engineers (USACE) and Reclamation. Reservoirs constructed by USACE included Black Butte Reservoir on Stony Creek. Reclamation initiated construction of the CVP facilities after the completion of World War II. The State initiated construction of the SWP facilities in the 1960s. Local and regional water suppliers and hydropower electric entities also constructed reservoirs on tributaries in the Sacramento Valley and San Joaquin Valley watersheds with associated conveyance facilities.

CVP Water Facilities

Under the Rivers and Harbors Act of 1935, as reauthorized in 1937, Congress appropriated funds and authorized Reclamation to construct the CVP. The CVP then became subject to Reclamation Law (as defined in the Reclamation Act of 1902 and subsequent legislation) (Reclamation 1997, 2011a).

Reclamation constructed the following CVP facilities, listed from north to south, as shown on Figures 6-1A, 6-1B, and 6-1C (DWR, 2014; Reclamation 1994, 2014):

- Trinity Lake and Lewiston Reservoir on the Trinity River, which conveys portion of the Trinity River flows to the Sacramento River watershed through Whiskeytown Lake on Clear Creek.
- Shasta Lake and Keswick Reservoir on the Sacramento River.
- Red Bluff Pumping Plant on the Sacramento River, which conveys water into the Tehama-Colusa and Corning canals. A portion of the flows from the Tehama-Colusa Canal are conveyed to Funks Reservoir.
- Folsom Lake and Lake Natoma (formed by Nimbus Dam) on the American River.
- Folsom-South Canal, which conveys a portion of the American River flows to southeastern Sacramento County.
- Delta Cross Gate and Channel in the Delta, which conveys a portion of the Sacramento River flows into the Mokelumne and San Joaquin rivers.
- Rock Slough Intake and Contra Costa Pumping Plant in the central Delta, which convey water through the Delta into the Contra Costa Canal. A portion of the flows from the Contra Costa Canal flow into Contra Loma Reservoir and Martinez Reservoir.
- Millerton Lake (formed by Friant Dam) on the San Joaquin River, which conveys water into the Friant-Kern and Madera canals.

- C.W. Jones Pumping Plant (Jones Pumping Plant) (previously known as the Tracy Pumping Plant) in the south Delta, which conveys water into the Delta-Mendota Canal, which extends to the CVP Mendota Pool.
- Delta-Mendota Canal/California Aqueduct Intertie allows for conveyance of CVP and SWP water supplies from the Delta through either the CVP Jones Pumping Plant or the Harvey O. Banks Pumping Plant (Banks Pumping Plant).
- San Luis Reservoir-related facilities, including the CVP facilities consisting of the O'Neill Forebay, Pumping Plant, and Canal; Coalinga Canal, Pleasant Valley Pumping Plant, and San Luis Drain. The O'Neill Forebay is operated in coordination with the SWP. The SWP facilities operated in coordination with the CVP include the B.F. Sisk San Luis Dam (the major dam that forms San Luis Reservoir), San Luis Canal, Los Banos and Little Panoche dams, and associated pumping plants.
- Pacheco Tunnel and Conduit which deliver water from the San Luis Reservoir into the San Justo Dam and Reservoir, Hollister Conduit, and Santa Clara Tunnel and Conduit.
- New Melones Reservoir along the Stanislaus River.
- Hensley Lake on the Fresno River.
- H.V. Eastman Lake on the Chowchilla River.

Reclamation also owns and operates facilities under the Orland Project (which are not part of CVP), including East Park Reservoir on Little Stony Creek and Stony Gorge Reservoir on Stony Creek.

SWP Water Facilities

As the CVP facilities were being constructed after World War II, the State began investigations to meet additional water needs through development of the California Water Plan. In 1957, DWR identified new facilities to provide flood control in Northern California and water supplies to the San Francisco Bay Area, San Joaquin Valley, San Luis Obispo and Santa Barbara counties in the Central Coast Region, and Southern California (DWR 1957, 2012; Reclamation, 2011a). In 1960, California voters authorized the Burns-Porter Act to construct the initial SWP facilities. DWR constructed the following SWP facilities, listed from north to south, as shown on Figures 6-1A, 6-1B, and 6-1C:

- Antelope Lake, Lake Davis, and Frenchman Lake on the upper Feather River, upstream of Lake Oroville.
- Lake Oroville and Thermalito Forebay and Complex on the Feather River.
- Barker Slough Pumping Plant in the north Delta, which diverts water into the North Bay Aqueduct.
- Clifton Court Forebay and Banks Pumping Plant in the south Delta, which convey water into the Bethany Forebay and California Aqueduct.
- South Bay Pumping Plant, which conveys water from Bethany Forebay to the South Bay Aqueduct and Lake Del Valle.
- San Luis Reservoir-related facilities, including the SWP facilities B.F. Sisk San Luis Dam (the major dam that forms San Luis Reservoir), San Luis Canal, Los Banos and Little Panoche dams and associated pumping plants. These facilities are operated in coordination between the SWP and CVP.

- California Aqueduct, which conveys water from the Banks Pumping Plant to San Luis Reservoir and continues to Lake Perris in Riverside County. The California Aqueduct facilities in Southern California also include Quail Lake, Pyramid Lake, Castaic Lake, Silverwood Lake, Crafton Hills Reservoir, and Lake Perris.
- The Coastal Branch of the California Aqueduct, which conveys water from the California Aqueduct to San Luis Obispo and Santa Barbara counties.

6.2.2.3 Surface Water Bodies and Major Surface Water Facilities in the Extended, Secondary, and Primary Study Areas Not Affected by Implementation of Action Alternatives

Implementation of the action alternatives would change operations of several of the CVP and SWP reservoirs and operations of CVP and SWP Delta conveyance facilities. However, reservoir operations of all non-CVP and non-SWP reservoir as well as operations of the CVP New Melones Reservoir and Millerton Lake would be the same under the Existing Conditions/No Project/No Action Condition as under the action alternatives. Therefore, surface water conditions along rivers without CVP and SWP reservoirs, along rivers upstream of the CVP and SWP reservoirs, along the Stanislaus River, and along the San Joaquin River upstream of Vernalis would be the same under the action alternatives as under the Existing Conditions/No Project/No Action Condition; and will not be analyzed further in this chapter.

6.2.3 Overview of CVP and SWP Water Users in the Extended, Secondary, and Primary Study Areas

The CVP and SWP water systems provide water in the Extended, Secondary, and Primary study areas, as summarized in this section. Many of the CVP and SWP water users also rely upon local surface water and groundwater supplies. Several water users also rely upon non-local surface water supplies, including the Reclamation Solano Project (Solano County Water Agency), San Francisco Public Utilities Commission Hetch Hetchy Project (portions of the Alameda County Water District, Santa Clara Valley Water District, and Zone 7 Water Agency), Mokelumne River Project (East Bay Municipal Utility District), and Colorado River (portions of the service area of the Metropolitan Water District of Southern California and Coachella Valley Water District). However, the CVP water supplies are the sole source of supplies for several water users, including communities near Redding (Centerville, Clear Creek, Shasta Community services district, Bella Vista Water District, Mountain Gate Community Services District, City of Shasta Lake, and Shasta County Water Agency), and communities in the San Joaquin Valley (cities of Avenal, Coalinga, and Huron). The SWP water supplies are the sole source of supplies for several communities served by the Antelope Valley-East Kern Water Agency.

6.2.3.1 CVP Water Users

Reclamation provides CVP water to several types of water users in accordance with water rights issued by the State, including the following:

- Water users that had water rights prior to construction of the CVP facilities, as follows:
  - Water rights met by minimum instream flow criteria in the water rights issued by the State Water Resources Control Board (SWRCB) to the federal government. Water rights met through instream flow criteria or for water rights holders located upstream of the reservoir are provided by Reclamation as the highest priority in every water year type up to the full agreed-upon amount.

  - Sacramento River Settlement Contractors (Sacramento River Settlement Contractors).
  - San Joaquin River Exchange Contractors.
- CVP Water Service Contractors that have agreed-upon contracts with Reclamation for delivery of CVP water.
- Refuge water supplies for federal and State wildlife refuges that were defined under the Central Valley Project Improvement Act (CVPIA) under Public Law 102-575, Title 34.

The SWRCB issues water rights that authorize the diversion of water from a particular source for beneficial use. All water rights are limited to amounts reasonably necessary for the intended use. Many of the CVP water rights originated from applications filed by DWR in 1927 and 1938 as part of the California Water Plan. Those water rights were transferred to the federal government, and Reclamation made applications for additional water rights needed for the CVP. In granting water rights, the SWRCB sets certain conditions to protect prior water rights located upstream and downstream of CVP facilities. These conditions include fish and wildlife needs in the water bodies affected by operations of CVP facilities and other prerequisites that the SWRCB deems in the public interest through minimum instream flows, periods of the year when water may be directly diverted, and periods when water may be stored at CVP facilities.

Sacramento River Settlement Contractors held water rights prior to construction of Shasta Lake. The agreements established a quantity of water the contractor is allowed to divert from April through October without charge. Some agreements include a supplemental CVP supply allocated by Reclamation through storage in Shasta Lake. San Joaquin River Exchange Contractors were senior water rights holders on the San Joaquin River prior to construction of Millerton Lake and Friant Dam. Under the Exchange Contracts, the parties agreed to not exercise their San Joaquin River water rights in exchange for a substitute CVP water supply from the Delta at Mendota Pool. Full agreed-upon contract amounts are provided in all water year types to all water users upstream and downstream of the CVP reservoirs, except in extremely dry years for the Sacramento River Settlement Contractors and the San Joaquin River Exchange Contractors. In extremely dry years, as defined by the “Shasta Criteria” based upon inflow to Shasta Lake in critical water years, water deliveries to the Sacramento River Settlement Contractors and the San Joaquin River Exchange Contractors may be reduced to 75 percent of total contract amount. However, in extreme droughts such as during Water Year 2014, water supplies provided to San Joaquin River Exchange Contractors by Reclamation were 65 percent of total exchange contract amounts.

Reclamation also entered into water service contracts throughout the CVP for a specified amount of CVP water to be applied for beneficial use. The purposes of a water service contract are to stipulate provisions under which a water supply is provided, to produce revenues sufficient to recover an appropriate share of capital investment, and to pay the annual operations and maintenance costs of the project. Availability of water under the CVP water service contracts is dependent on hydrologic, regulatory, and operational conditions. The water service contractors have lower priority and receive available water supplies following compliance with water rights and water quality requirements established by the SWRCB, and environmental requirements established by the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and California Department of Fish and Wildlife (CDFW). CVP water service contracts indicate the maximum volumes available for agricultural and municipal and industrial (M&I) water users. During wetter years, both agricultural and M&I water users receive full contract amounts. However, during drier years, water made available to agricultural water uses are reduced up to 25 percent of the contract amount before water made available to M&I water uses are reduced. Then, both types of water contractors experience shortages, with agricultural users experiencing greater shortages than M&I users. Reclamation also operates the system to provide water to support public and health and safety uses within the availability of the water supplies.

The CVP Cross Valley Contractors include eight agencies on the eastern side in Fresno, Kern, Tulare and Kings counties that use the Cross Valley Canal (CVC) for conveying their water supply (Reclamation, 2014b). The CVC was constructed in the mid-1970s through a collaborative effort of several agencies that use CVP or SWP water supplies. The CVC conveys CVP water to the Cross Valley Contractors between the SWP California Aqueduct and the CVP Friant-Kern Canal. The CVP water is released from CVP storage and conveyed in the SWP Banks Pumping Plant and California Aqueduct if adequate capacity is available. The water can be delivered directly to the Cross Valley Contractors or through an exchange with other water contractors, generally Arvin Edison Water Storage District (AEWSD). Under the exchange agreement, AEWSD diverts water from the CVC instead of the Friant Kern Canal; and the Cross Valley Contractors divert water from the Friant Kern Canal.

The CVPIA established firm water supplies for specific National Wildlife Refuges and State Wildlife Areas as Level 2 water supplies. Level 2 water supplies were defined under CVPIA as the average amount of water obtained from non-firm water supplies in the late 1980s. Level 4 water supplies were defined as the amount of water needed for each refuge to support its habitat throughout the refuge. CVPIA required that Level 2 water supplies are provided by CVP with a higher priority than CVP water service contracts. Level 2 water supplies are provided at 100 percent of contract amounts except in drier years, subject to the Shasta Criteria (in the same manner as shortages for Sacramento River Settlement Contractors and San Joaquin River Exchange Contractors). The incremental difference between Level 2 and Level 4 water supplies were to be provided under CVPIA through water transfers or purchases. Reclamation has been working with the CDFW, Grasslands Water District (representing the Grasslands Resources Conservation District), and USFWS to develop long-term Level 4 water supply memoranda of understanding.

6.2.3.2 SWP Water Users

DWR provides SWP water to several types of water users in accordance with water rights issued by the State, including the following:

- Seven Water Rights Settlement Agreement Users in the Feather River Service Area (FRSA) that had senior water rights prior to construction of the SWP facilities on the Feather River. SWP also conveys non-SWP water through SWP facilities to two other agencies in the Feather River area.
- SWP Water Contractors that have agreed-upon contracts with DWR for delivery of CVP water in the North Bay Area, San Francisco Bay Area, San Joaquin Valley, Central Coast, and Southern California regions. The Southern California region is further divided into the Lahontan and South Coast regions.

During drier periods, water is delivered to the FRSA as the highest priority to fulfill total contract amounts. However, in extreme droughts such as that in 2015, water supplies were less than total contract amounts. The water contractors have lower priority and receive available water supplies following compliance with water rights and water quality requirements established by the SWRCB, and environmental requirements established by the USFWS, NMFS, and CDFW.

DWR also has formal agreements with six Delta water agencies related to maintaining flow and salinity conditions in the Delta during operations of the SWP.

The SWP water contracts include a total water contract amount in “Table A,” and these demands are referred to as “Table A Demands.” Article 21 of the water contracts describes the conditions under which water can be delivered in addition to the amounts specified in Table A of the contracts.

Article 21 water is offered to SWP contractors for short periods of time when SWP reservoirs south of the Delta are full or the SWP conveyance capacity to fill the reservoirs are maximized; the San Luis Reservoir is full or projected to be full in the near future; the maximum allocation for SWP contracting agencies, as identified in Table A developed by the SWP Analysis Office is met; the Delta is in excess conditions, as defined by the Coordinated Operations Agreement[1]; and Banks Pumping Plant would be able to convey additional flows in accordance with physical capacity and regulatory requirements. Article 21 is only offered periodically when all of these conditions exist, which occurs typically for periods of a few days to a few weeks. Availability of SWP water supplies is also related to Article 56 of the SWP water contracts. Article 56 provides for storage by SWP water contractors of SWP and non-SWP water in SWP and non-SWP reservoirs and groundwater banks outside of their service areas, and programs to allow sale of Table A water contract water between SWP water contractors or to DWR.

6.2.3.3 CVP and SWP Water Demands

The CVP and SWP demand assumptions included in the surface water modeling analyses for the Existing Conditions/No Project/No Action Condition are presented in Table 6-1 for the north of the Delta and south of the Delta regions, as described in Appendix 6A Modeling of Alternatives.

Table 6-1
Summary of CVP and SWP Existing Conditions/No Project/No Action Condition Demands (TAF/Year)

CVP and SWP Water Users	North of the Delta	South of the Delta
CVP Water Users		
Sacramento River Settlement Contractors	2,194	
San Joaquin River Exchange Contractors		840
Water Service Contracts		
Agriculture (Ag)	378	1,937
M&I	557	164
Level 2 Refuge Supplies	189	281
SWP Water Users		
FRSA	983	
Water Contractors (per Table A schedules)*	114	4,056
Agriculture (Ag)	0	1,032
M&I	114	3,024

*Table A refers to the basic contract amount included in SWP contracts and does not include water delivered in accordance with other provisions of the contracts (e.g., Article 21).

Note:

TAF = thousand acre-feet

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[1] The agreement defines how DWR and Reclamation share their joint responsibility to meet Delta water quality standards and meet the water demands of senior water rights holders in the Delta watershed, including the Delta.

6.2.4 Surface Water Resources in the Extended Study Area

The Extended Study Area includes the service areas of the CVP and the SWP that are not included in the Secondary and Primary study areas.

6.2.4.1 San Luis Reservoir

The San Luis Unit, which is part of the SWP and the CVP, was authorized in 1960. Some features of the San Luis Unit are "joint-use facilities" of the State and federal governments. The joint-use facilities, as identified above, are O'Neill Dam and Forebay, B.F. Sisk San Luis Dam, San Luis Reservoir, William R. Gianelli Pumping/Generating Plant, Dos Amigos Pumping Plant, Los Banos and Little Panoche reservoirs, San Luis Canal from O'Neill Forebay to Kettleman City, and the associated switchyard facilities. The CVP facilities also include the O'Neill Forebay, Pleasant Valley Pumping Plant, and Coalinga Canal.

Completed in 1967 and dedicated on April 20 of that year, B. F. Sisk Dam (which created San Luis Reservoir) is a zoned earthfill structure 382 feet high with a crest length of 18,600 feet; it contains 77,656,000 cubic yards of material. The dam's crest is 30 feet thick; the maximum base width is 2,420 feet. The reservoir filled for the first time on May 31, 1969. The reservoir has a capacity of slightly more than 2.027 MAF, with approximately 1.062 MAF used by the SWP and 0.965 MAF used by the CVP.

Water generally is diverted into San Luis Reservoir during late fall through early spring when irrigation water demands of CVP and SWP water users are low and are being met by Delta exports. By April or May, demands from CVP and SWP water users located south of the Delta usually exceed the pumping rate at the CVP Jones Pumping Plant and the SWP Banks Pumping Plant in the southern Delta.

CVP water is conveyed from the southern Delta at the Jones Pumping Plant through the Delta-Mendota Canal to the O'Neill Pumping Plant, which lifts the CVP water into the O'Neill Forebay. SWP water is conveyed from the southern Delta at the Banks Pumping Plant through the SWP California Aqueduct and into O'Neill Forebay. The William R. Gianelli Pumping/Generating Plant lifts water from O`Neill Forebay and discharges it into San Luis Reservoir. CVP or SWP water is released from San Luis Reservoir by gravity into the San Luis Canal for continued conveyance to the Dos Amigos Pumping Plant, where it is lifted more than 100 feet to permit gravity flow to the end of the San Luis Canal at Kettleman City. The SWP California Aqueduct continues downstream of Kettleman City to convey SWP water to the southern San Joaquin Valley, Central Coast, and Southern California. SWP water from the California Aqueduct can also flow through O`Neill Forebay directly into the San Luis Canal instead of being pumped into San Luis Reservoir, especially during irrigation season when water demands are high. Two detention reservoirs, Los Banos and Little Panoche, control cross drainage along the San Luis Canal. The reservoirs also provide recreation and flood control benefits (Reclamation, 2011b, 2016).

CVP water from San Luis Reservoir also is diverted at the Pacheco Pumping Plant to convey CVP water through the Pacheco Conduit into Santa Clara and San Benito counties, and through the Pleasant Valley Pumping Plant and Coalinga Canal to convey water into Fresno County. CVP water also can flow through the William R. Gianelli Pumping/Generating Plant from the San Luis Reservoir into O'Neill Forebay in a manner that will generate electricity. The water can be conveyed from the O'Neill Forebay through the Delta-Mendota Canal, which ends at the Mendota Pool.

6.2.5 Secondary Study Area

The Secondary Study Area is defined as the CVP and SWP reservoirs, rivers, creeks, and associated floodplains that could be affected by Project operations, located in 18 counties. The Project operations under the action alternatives would not affect all of the reservoirs and streams in the Secondary Study Area. The following CVP and SWP facilities and associated water bodies could be affected (listed from north to south): Trinity Lake, Lewiston Reservoir, Trinity River, Klamath River downstream of the Trinity River confluence, Whiskeytown Lake, Spring Creek, Clear Creek, Shasta Lake, Keswick Reservoir, Sacramento River (also included below in Shasta Division and Sacramento River Division, GCID Main Canal, and Tehama-Colusa Canal), Lake Oroville, Thermalito Complex (Thermalito Diversion Pool, Thermalito Forebay, and Thermalito Afterbay), Feather River, Sutter Bypass, Yolo Bypass, Folsom Lake, Lake Natoma, American River, Sacramento-San Joaquin Delta (“Delta”), Suisun Bay (also called Suisun Marsh), San Pablo Bay, and San Francisco Bay.

6.2.5.1 Trinity River Division Operations

The CVP Trinity River Division, completed in 1964, includes facilities to store and regulate water in the Trinity River, as well as facilities to divert water to the Sacramento River watershed. The Trinity River Division consists of Trinity Dam, which forms Trinity Lake; Trinity Power Plant; Lewiston Dam, which forms Lewiston Reservoir; Lewiston Power Plant; Clear Creek Tunnel; Judge Francis Carr Powerhouse; Whiskeytown Dam, which forms Whiskeytown Lake; Spring Creek Tunnel and Power Plant; and Spring Creek Debris Dam, which forms Spring Creek Reservoir, as well as related pumping and distribution facilities.

Trinity Lake

Trinity Dam regulates flows on the Trinity River and stores water for various uses. Completed in 1962, Trinity Dam is an earthfill structure 538 feet high with a crest length of 2,450 feet. Trinity Lake, located approximately 50 miles west of the City of Redding, has a capacity of approximately 2.4 MAF and is operated for a variety of purposes: irrigation water supply, flood control, improved Sacramento River navigation, domestic and industrial water supply, electric power generation, fish and wildlife conservation, creation of recreation opportunities, and water quality enhancement. Releases from Trinity Dam through the downstream Trinity Power Plant are regulated downstream at Lewiston Reservoir. Water is diverted from the Trinity River at Lewiston Dam via the Clear Creek Tunnel and passes through the Judge Francis Carr Powerhouse as it is discharged into Whiskeytown Lake on Clear Creek. From Whiskeytown Lake, water is released either through the Spring Creek Power Conduit to the Spring Creek Power Plant and into Keswick Reservoir, or into Clear Creek, which flows into the Sacramento River downstream of Keswick Reservoir. Water from Trinity Lake provides water to meet instream temperature objectives for the Trinity and upper Sacramento rivers, and minimum instream flow requirements downstream of Lewiston Dam on the Trinity River, as stipulated in the 2000 Trinity River Record of Decision (ROD) (U.S. Department of the Interior [DOI], 2000), as discussed in Chapter 7 Surface Water Quality.

Lewiston Reservoir

Lewiston Dam was constructed by Reclamation from 1960 to 1963 and has a capacity of approximately 14,600 acre-feet (AF). CVP water is diverted through the Lewiston Power Plant at the base of Lewiston Dam and the Clear Creek Tunnel for conveyance to Whiskeytown Lake. The power plant began operating in 1964.

Lewiston Reservoir maintains and regulates releases to the Trinity and Sacramento rivers. Lewiston Power Plant provides power to the adjacent Trinity River Fish Hatchery. Energy in excess of hatchery loads is sold to Pacific Gas and Electric Company (Reclamation, 2011b).

Trinity River

The Trinity River, located in northwest California, is the largest tributary to the Klamath River.

The 2000 Trinity River ROD stipulated specific releases to the Trinity River downstream of Lewiston Dam to meet instream flow requirements. The total volume of water released to the Trinity River ranges from approximately 368,600 AF in critically dry years to 815,000 AF in extremely wet years, depending on the annual water-year type (hydrology) determined as of April 1st (DOI, 2000). Table 6-2 shows the annual flow volumes, peak flows, and peak flow durations by water type.[2]

Table 6-2
Trinity River Record of Decision
Annual Flow Volumes and Peak Flows

Water Year Type	Volume (AF)	Peak Flow (cfs)	Peak Flow Duration (days)
Extremely Wet	815,000	11,000	5
Wet	701,000	8,500	5
Normal	647,000	6,000	5
Dry	453,000	4,500	5
Critically Dry	369,000	1,500	36

Notes:
cfs = cubic feet per second
Source: DOI, 2000.

The release schedules based on water year type have a minimum release of 450 cfs between October 1st through October 15th, and 300 cfs from October 16th through April 21st. Release schedules are variable, based upon water year type between April 22nd and July 21st. Releases across all water year types are then fixed at a minimum of 450 cfs from July 22nd through September 30th (DOI, 2000).

Water is also released to the Trinity River to meet the temperature objectives set forth in the SWRCB Water Rights Order 90-05. These objectives vary by reach and by season, as discussed in Chapter 7 Surface Water Quality.

Additional water releases into the Trinity River occur periodically as part of flood control operations and to provide flows for other purposes (North Coast Regional Water Quality Control Board et al., 2009; Reclamation, 2011a). Although flood control is not an authorized purpose of the Trinity River Division, flood control benefits are provided through normal operations. The Reclamation Safety of Dams Act release criteria generally provide for maximum storage in Trinity Lake of 2.1 MAF between November and March. Initial flood releases are discharged from Trinity Lake into Lewiston Reservoir, and then, through the power plant and into Whiskeytown Lake in the Clear Creek watershed. To reduce the potential for flooding on the Trinity River, releases from Lewiston Dam into Trinity River are generally

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[2] The water year types included in the Trinity ROD are probability-based and classified by ranges of annual Trinity River Basin water year runoff. This classification is different from the water year types presented in all other tables of this chapter, which are based on the historical record of WY1922 through WY2003 and defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 2000).

less than 11,000 cfs (under Reclamation Safety of Dams Act release criteria) due to local high water concerns in the floodplain and local bridge flow capacities.

Reclamation has historically released water from Lewiston Dam into the Trinity River to improve late summer flow conditions, to avoid fish die-offs in the lower Klamath River (DOI, 2014; Trinity River Restoration Program, 2014).

Lower Klamath River Downstream of the Trinity River

The Klamath River watershed extends over 15,600 square miles from southern Oregon to Northern California, and ranges in elevation from more than 9,500 feet above sea level near the headwaters to sea level at the Pacific Ocean (DOI, 2000). The Klamath River watershed is generally divided into two or three subbasins. For the purpose of this study, the upper Klamath River basin extends over 60 miles from the headwaters to Iron Gate Dam (DOI and CDFG, 2012). The lower Klamath River basin extends 190 miles from Iron Gate Dam to the Pacific Ocean. Four major tributaries flow into the lower Klamath River, including Shasta, Scott, Salmon, and Trinity rivers. The lower Klamath River flows 43.5 miles from the confluence with the Trinity River to the Pacific Ocean (DOI, 2000). Downstream of the Trinity River confluence, the Klamath River flows through Humboldt and Del Norte counties and through the Hoopa Indian Reservation, Yurok Indian Reservation, and Resighini Indian Reservation (DOI and CDFG, 2012).

The Trinity River is the largest tributary to the Klamath River (DOI and CDFG, 2012). There are no dams located in the Klamath River watershed downstream of the confluence with the Trinity River. The western portion of the Klamath River watershed receives substantial rainfall during the winter months.

Clear Creek

Since 1964, a portion of the flow from the Trinity River watershed has been exported to the Sacramento River watershed. The water is diverted through Clear Creek Tunnel from Lewiston Reservoir into the CVP Whiskeytown Lake. Water flows from Whiskeytown Lake into the CVP Spring Creek facilities or is released into Clear Creek.

Construction of Whiskeytown Dam on Clear Creek modified the hydraulics, gravel loading, and sediment transport in lower Clear Creek. The overall average annual flow in the lower Clear Creek was reduced by 87 percent following construction of the dam (DWR, 1984, 1986). The dam also reduced gravel loading into the lower Clear Creek and the frequency of high-flow events that move the gravel and remove fine sediments from riffles. This change in hydrology and loss of gravel loading adversely affected the salmonid habitat downstream of Whiskeytown Dam, including compaction of riffles with sand. Minimum flow releases from Whiskeytown Lake into Clear Creek occurred in accordance with federal and State requirements (DWR, 1984). Starting in the early 1980s, numerous studies were conducted to evaluate methods to rehabilitate or restore habitat along lower Clear Creek. The Lower Clear Creek Floodway Rehabilitation Project was implemented under CVPIA to implement gravel augmentation, increase Whiskeytown Dam releases, remove the McCormick-Saeltzer Dam, reconstruct and revegetate the Lower Clear Creek floodway, and reduce erosion (CALFED, 2004; Western Shasta Resource Conservation District, 2003). The 2009 NMFS biological opinion requires Reclamation to release spring attraction flows for adult spring-run Chinook salmon and channel maintenance flows in Clear Creek, and to continue gravel augmentation programs initiated under CVPIA.

Whiskeytown Lake

Whiskeytown Dam was constructed on Clear Creek in 1963 by Reclamation. Located approximately 8 miles west of Redding, it was one of the first units of the Trinity River Diversion of the CVP to be constructed. The earthfill dam is 282 feet high and 4,000 feet long. Crest elevation is 1,228 feet. Whiskeytown Dam regulates Trinity River flows discharged from the Judge Francis Carr Powerhouse and regulates the runoff from the Clear Creek drainage area. Whiskeytown Lake has a capacity of approximately 241,000 AF.

Whiskeytown Lake is normally operated to regulate inflows from Trinity River for power generation in the Spring Creek Powerplant, provide recreation opportunities, support upper Sacramento River temperature objectives, and provide releases to Clear Creek, in accordance with CVPIA objectives and the 2009 NMFS biological opinion.

The following agreements govern releases from Whiskeytown Lake:

- A 1960 Memorandum of Agreement with the California Department of Fish and Game (CDFG), now known as the California Department of Fish and Wildlife (CDFW), established minimum flows to be released to Clear Creek at Whiskeytown Dam.
- A 1963 release schedule for Whiskeytown Dam was developed with USFWS and implemented but never finalized. Although this release schedule was never formalized, Reclamation has used this flow schedule for minimum flows since May 1963.
- A water rights permit modification in 2002 allowed release of water from Whiskeytown Lake into Clear Creek for the purposes of maintenance of fish and wildlife resources as provided for in Provision 2.1 of the Instream Flow Preservation Agreement by and among Reclamation, USFWS, and CDFG, dated August 11, 2000.
- Dedication of water in accordance with CVPIA Section 3406(b)(2) water on Clear Creek provides instream flows downstream of Whiskeytown Dam greater than the minimum flows (that would have occurred under pre-CVPIA conditions). Augmentation in the summer months is usually in consideration of water temperature objectives for steelhead and in late summer for flows to support spring-run Chinook salmon, as discussed in Chapter 7 Surface Water Quality.
- The 2009 NMFS biological opinion requires Reclamation to release spring attraction flows for adult spring-run Chinook salmon and channel maintenance flows in Clear Creek, and to continue gravel augmentation programs initiated under CVPIA.

Whiskeytown Lake storage is relatively constant as a result of agreements between Reclamation and the National Park Service to maintain certain winter and summer lake elevations for recreation. Whiskeytown Lake outflow variations were greater prior to 2006 when Trinity River restoration flows were implemented, which reduced the amount of water available for conveyance to CVP water users. In addition, hydrologic conditions in the years following 2006 were drier than the water years between 2001 and 2006.

Spring Creek Facilities

The Spring Creek Tunnel diverts water from Whiskeytown Lake on Clear Creek to the Spring Creek Power Plant. The tunnel is 18.5 feet in diameter and approximately 2.4 miles long, including the 0.6-mile-long, 17-foot-diameter Rock Creek Siphon. The Spring Creek Power Plant (a peaking plant that has been operating since 1964) is located at the foot of the Spring Creek Debris Dam. Water from the plant is discharged to Spring Creek, which flows into Keswick Reservoir. Flows on Spring Creek are partially regulated by the Spring Creek Debris Dam.

The Spring Creek Debris Dam, located on Spring Creek upstream of the Spring Creek Power Plant tailrace, is an earthfill structure that is 196 feet high with a crest length of 1,110 feet. Spring Creek Reservoir has a capacity of approximately 5,800 AF. It controls debris that would otherwise enter the power plant tailrace, including contaminated drainage from old mine tailings on Spring Creek (Reclamation, 2011b).

6.2.5.2 Shasta Division and Sacramento River Division

The Shasta Division includes Shasta Dam, Lake, and Power Plant; Keswick Dam, Reservoir, and Power Plant; and the Shasta Temperature Control Device (TCD). The Sacramento River Division was authorized after completion of the Shasta Division. The Sacramento River Division includes facilities for the diversion and conveyance of water to CVP contractors on the western side of the Sacramento River, including the Sacramento Canals Unit, which was authorized in 1950 and consists of the Red Bluff Pumping Plant, the Corning Pumping Plant, and the Corning and Tehama-Colusa canals. Sacramento River Settlement Contractors divert Base Supply (quantity of surface water established in the Settlement Contract for which no payment is due) and Project Water pursuant to the Settlement Contract with Reclamation, and divert both volumes of water through their own facilities, such as the GCID Main Canal. The Sacramento Canals Unit was authorized to supply irrigation water to more than 200,000 acres of land in the Sacramento Valley, principally in Tehama, Glenn, Colusa, and Yolo counties. Black Butte Dam, which is operated by USACE, also provides supplemental water to the Tehama-Colusa Canal as it crosses Stony Creek. The Shasta and Sacramento River divisions are operated in an integrated manner.

Shasta Lake

Shasta Dam was constructed in 1945 by Reclamation as an integral element of the CVP for six purposes: irrigation water supply, M&I water supply, flood control, hydropower generation, fish and wildlife conservation, and navigation. Shasta Dam is located on the upper Sacramento River approximately 9 miles northwest of Redding. Shasta Lake has a storage capacity of approximately 4.5 MAF. Shasta Lake captures runoff from the Sacramento, McCloud, and Pit rivers. Water in Shasta Lake is released through or around the Shasta Power Plant, a peaking power plant located downstream of Shasta Dam, to the Sacramento River which flows into Keswick Reservoir. A small amount of CVP water is diverted directly from Shasta Lake for M&I uses by local communities. Releases from Shasta Reservoir are managed to meet minimum fish flows and temperature requirements, flood control requirements, salinity control, and water supply demands of CVP contractors (Reclamation, 2011b).

The TCD was installed at Shasta Dam between 1996 and 1998 to both minimize power losses and control the water temperature downstream of Shasta Lake to protect salmon. The TCD has allowed for warmer water withdrawals in the spring/early summer, resulting in conservation of the deep cold water pool for colder withdrawals in the late summer/early fall to meet downstream temperature requirements, as discussed in Chapter 7 Surface Water Quality.

Keswick Reservoir

Keswick Reservoir was formed by the completion of Keswick Dam in 1950. It has a capacity of approximately 23.8 TAF and serves as an afterbay for releases from Shasta Dam and for discharges from the Spring Creek Power Plant. Releases from Keswick Reservoir are made to the Sacramento River from Keswick Dam. The dam has a fish trapping facility that operates in conjunction with the Coleman National Fish Hatchery on Battle Creek. Keswick Dam and Reservoir are located approximately 9 miles downstream of Shasta Dam and 5 miles west of the City of Redding. Keswick Power Plant is located at Keswick Dam. Keswick Reservoir has a storage capacity of approximately 24,000 AF.

Nearly all releases from Keswick Dam are made through its generating facilities. On occasion, however, outflows during flood operations are made through the flood control outlets and over the spillway. During these instances, the existing power plant is bypassed for much of the flood release.

Releases from Keswick Reservoir are managed to meet minimum fish flow and temperature requirements, flood control requirements, salinity control requirements, and water supply demands of CVP contractors (Reclamation, 2011b).

Sacramento River

The Sacramento River is the largest river in California. Runoff from the upper Sacramento River and its tributaries are regulated by Shasta Lake, and then by Keswick Reservoir.

Downstream of Keswick Reservoir, the Sacramento River is also influenced by tributary stream runoff from precipitation and snowmelt; diversions for agricultural, municipal, and industrial purposes; agricultural and municipal discharges; and a flood damage reduction system that includes levees, floodplains (including the Yolo, Sutter, and Colusa bypasses), and weirs.

An April 5, 1960 Memorandum of Agreement between Reclamation and CDFG originally established flow objectives in the Sacramento River for the protection and preservation of fish and wildlife resources. The agreement provided for minimum releases into the natural channel of the Sacramento River at Keswick Dam for normal years. Since October 1981, Keswick Dam has operated based on a minimum release of 3,250 cfs from September 1 through the end of February during normal years, in accordance with an agreement between Reclamation and CDFG, and during all water year types except critically dry years in accordance with SWRCB Order 90-05. Generally, releases from Keswick Reservoir are implemented to comply with the minimum fishery requirement by October 15 each year, and to minimize changes in Keswick releases between October 15 and December 31. Releases may be increased during this period to meet downstream needs such as higher outflows in the Delta to meet water quality requirements, or to meet flood control requirements. Releases from Keswick Dam may be reduced when downstream tributary inflows increase to a level that will meet flow needs. Reclamation attempts to establish a base flow that minimizes release fluctuations to reduce impacts to fisheries and bank erosion from October through December.

The Sacramento River between Keswick Dam and Red Bluff flows through the northern foothills of the Sacramento Valley. Flows are influenced by outflows from Keswick Reservoir and inflows from Clear Creek (described above), and from Cow Creek, Bear Creek, Cottonwood Creek, Battle Creek, and Paynes Creek, which provide 15 to 20 percent of the flows in this reach as measured at Bend Bridge. There are several major diversions along the Sacramento River upstream of Red Bluff, including the CVP Wintu Pumping Plant to provide water for the Bella Vista Water District, and the Anderson-Cottonwood Irrigation District Diversion. Both of these diversions near Redding provide water to agricultural and M&I water users (Reclamation, 1997). No major storage or diversion structures have been constructed in the tributary watersheds in this reach of the Sacramento River, although several small diversions for irrigation, domestic use, and hydroelectric power generation are present.

Between Red Bluff and Colusa, the Sacramento River is a meandering stream, migrating through alluvial deposits between widely spaced levees. Major streams entering the Sacramento River between Red Bluff and the Feather River include Antelope, Elder, Mill, Thomes, Deer, Stony, Big Chico, and Butte creeks. No major storage or diversion structures have been constructed on Antelope, Elder, Mill, and Thomes creeks, although several small seasonal diversions for irrigation, domestic use, and hydroelectric power generation are present (Reclamation, 1997), as well as Maxwell Irrigation District's diversion. Moderate non-CVP and non-SWP diversion dams are located on Deer, Big Chico, and Butte creeks. Right-bank levees from Ord Ferry through Colusa prevent Sacramento River floodwater from entering the Colusa Basin, except when flows exceed 300,000 cfs near Ord Ferry (DWR, 2013a). Three flood relief weirs along the right bank, downstream of Chico Landing, allow flood flows to spill into the Butte Basin Overflow Area. The left bank levee begins midway between Ord Ferry and Butte City and extends south through Verona, and includes the Moulton and Colusa weirs that allow flood flows to spill into the Butte Basin Overflow Area.

Stony Creek flows are controlled by East Park Dam, Stony Gorge Dam, and Black Butte Dam (Reclamation, 1997). East Park and Stony Gorge reservoirs store surplus water for irrigation deliveries and are operated by Reclamation as part of the Orland Project, which is independent of the CVP. Black Butte Dam is operated by the USACE for flood control and irrigation supply. Black Butte Dam operations are coordinated with the CVP.

The Sacramento River flood channel capacity between Red Bluff and Chico Landing near the mouth of Stony Creek is approximately 260,000 cfs. The Sacramento River Flood Control Project levees begin near Ord Bend. From Ord Bend to downstream of Butte City, the Sacramento River flood channel capacity is approximately 160,000 cfs. Floodwaters exceeding the channel capacity between Chico Landing and Colusa Weir overflow into the Butte Sink area and then to the Sutter Bypass. The capacity of the Sacramento River decreases to approximately 110,000 cfs downstream of Moulton Weir, and to approximately 48,000 cfs downstream of Colusa Weir (USACE, 1960).

Historically, Reclamation has maintained a minimum flow of 5,000 cfs at Chico Landing to support navigation in accordance with references to Sacramento River Division operations in the River and Harbors Act of 1935, as reauthorized in 1937. There is no commercial traffic between Sacramento and Chico Landing, and USACE has not dredged this reach to preserve channel depths since 1972. However, long-time water users diverting from the river have set their pump intakes just below this level. Therefore, the CVP is operated to meet the navigation flow requirement of 5,000 cfs at the Wilkins Slough gauging station when diversions are occurring downstream under all but the most critical water supply conditions.

Major diversions occur near Red Bluff into the Tehama-Colusa Canal and Corning Canal, and near Hamilton City into the GCID Main Canal. Surface water demands along the Sacramento River between Red Bluff and Colusa are more than 2.3 MAF annually, including water supplies for Sacramento Valley refuges and agricultural activities.

The Sacramento River channel downstream of Colusa is quite different than upstream of Colusa. Downstream of Colusa, the gradient of the river decreases, the channel becomes deeper and narrower, the capacity decreases, and the bed material is finer (Sacramento River Advisory Council, 1998). The Colusa Basin Drain provides irrigation water and collection of irrigation return flows from lands on the western side of the Sacramento Valley in Glenn, Colusa and Yolo counties. Water from the drain is discharged to the Sacramento River through the Knights Landing Outfall, a gravity flow structure, and prevents the Sacramento River from flowing into the Colusa Basin.

The river is also contained by levees with excess flow bypassed through spills at Tisdale, Fremont, and Sacramento weirs. The bypassed flows enter the Sutter Bypass and the Yolo Bypass. The Feather River joins the Sacramento River at the community of Verona, and the American River joins at the City of Sacramento. The Sacramento River then flows south, joining with the San Joaquin River in the Delta, and out to the Pacific Ocean.

Glenn-Colusa Irrigation District Canal

The GCID Main Canal Intake, located approximately 5 miles northwest of Hamilton City, diverts water into the existing GCID Main Canal for distribution to over 130,000 acres of irrigated lands within the GCID service area. The approximately 65-mile-long Canal terminates at the Colusa Basin Drain near the town of Williams, California.

GCID's system has undergone significant infrastructure and operational changes. Infrastructure changes have included a major expansion of the GCID Fish Screen (completed in 2001) and several improvements along the GCID Main Canal to allow year-round water delivery operations. Two major operational changes included a shift to year-round water delivery to convey water in the fall and winter to the federal Sacramento, Colusa, and Delevan National Wildlife Refuges, as well as to meet increased fall and winter season water demands by growers within GCID for rice straw decomposition purposes.

The existing GCID Main Canal is an unlined earthen channel with capacity varying from 3,000 cfs at the upstream end to 300 cfs at its terminus. Approximately 40 miles of the Canal, from the Main Pump Station south to the Terminal Regulating Reservoir, would be used for conveying water to the Sites Reservoir. The 40-mile section of the Canal has six main reaches. There are 40 major structures within this area, including bridges, siphons, and check structures. The GCID Main Canal crosses Stony Creek downstream of Black Butte Dam.

Tehama-Colusa Canal

Constructed in 1980 by Reclamation, the Tehama-Colusa Canal is a concrete-lined canal that is approximately 111 miles long. It extends from Red Bluff in Tehama County to south of the community of Dunnigan in Yolo County. It is operated by the Tehama-Colusa Canal Authority through a Joint Powers Authority composed of 17 water districts. Tehama-Colusa Canal Authority delivers water to the 17 water districts' irrigation service areas in Tehama, Glenn, Colusa, and northern Yolo counties. Since the canal operation began, fall and winter diversions have increased due to increased water demands for rice straw decomposition purposes.

When constructed in 1980, the intake facilities included gates that were placed in the Sacramento River to allow water to flow by gravity into the Tehama-Colusa and Corning canals (known as the Red Bluff Diversion Dam [RBDD]). Closure of the RBDD gates adversely affected passage of green sturgeon, steelhead, and winter, spring-, and fall-run Chinook salmon. Therefore, the gates were replaced in August 2012 with the Red Bluff Pumping Plant and intake with a fish screen.

Water from the Sacramento River enters the Tehama-Colusa Canal Intake at Red Bluff. Canal capacity is 2,530 cfs at the start and 1,700 cfs at the terminus. Water in the Tehama-Colusa Canal flows enter Funks Reservoir approximately 66 canal miles downstream of the Tehama-Colusa Canal Intake. The canal capacity at Funks Reservoir is 2,100 cfs.

6.2.5.3 Feather River and Feather River State Water Project Facilities

The Feather River, with a drainage area of 3,607 square miles on the east side of the Sacramento Valley, is the largest tributary to the Sacramento River downstream of Shasta Dam (Reclamation, 1997; DWR, 2007a). The Feather River enters the Sacramento River from the east at Verona. The total flow is provided by the Feather River and tributaries, which include the Yuba and Bear rivers.

The Upper Feather River, extending to Lake Oroville, includes numerous reservoirs and power plant diversions, including the 1,308-TAF Lake Almanor, owned by Pacific Gas & Electric Company, and the SWP Upper Feather River Lakes, including Antelope Lake, Lake Davis, and Frenchman Lake.

Lake Oroville and the Thermalito Complex (Thermalito Diversion Pool, Thermalito Forebay, and Thermalito Afterbay)

The Lake Oroville and Thermalito Complex facilities include Oroville Dam and Lake Oroville, three power plants (Edward Hyatt Pumping-Generating Plant, Thermalito Diversion Dam Power Plant, and Thermalito Pumping-Generating Plant), Thermalito Diversion Dam, the Feather River Fish Hatchery and Fish Barrier Dam, Thermalito Power Canal, Oroville Wildlife Area, Thermalito Forebay and Forebay Dam, Thermalito Afterbay and Afterbay Dam, and overhead power lines, as well as several recreational facilities. The Oroville Facilities were developed as part of the SWP and are operated by DWR.

The mainstem of the Feather River is regulated by Oroville Dam. The dam and its two saddle dams were completed in 1968 and formed Lake Oroville, a 3.5-MAF capacity storage reservoir with a surface area of approximately 16,000 acres at its normal maximum operating level.

The Oroville hydroelectric facilities have a combined licensed generating capacity of approximately 762 megawatts. A maximum of 17,400 cfs can be released from Lake Oroville through the Edward Hyatt Pumping-Generating Plant and the Thermalito Power Canal into the Thermalito Diversion Pool. Water continues through the Thermalito Diversion Pool into the Feather River Fish Hatchery and the 11,768-acre-foot Thermalito Forebay formed by the Thermalito Diversion Dam. Water is released from the Thermalito Forebay through the Thermalito Power Plant into the Thermalito Afterbay and the low-flow channel of the Feather River.

The Thermalito Afterbay is used to release water into the Feather River downstream of the hydroelectric facilities. It helps regulate the power system, provides storage for pump-back power operations, and provides recreational opportunities. Several local irrigation districts receive water from the Afterbay during the May through August season. Major diversions on the Feather River downstream of the Thermalito complex include diversions into the Western Canal, Richvale Canal, the Pacific Gas and Electric Company Lateral, and the Sutter-Butte Canal. Some of the water diverted into these canals is exported to the Butte Creek watershed. Riparian water users along the Feather River also divert water for agricultural and municipal uses within the Feather River and Butte Creek watersheds (Reclamation, 1997; DWR, 2007b).

Operation of the Lake Oroville and Thermalito Complex facilities varies depending upon hydrology and the objectives DWR is trying to meet. Lake Oroville stores winter and spring runoff for release to the Feather River, as necessary, for project purposes. Typically, releases to the Feather River are managed to conserve water while meeting a variety of water delivery requirements, including flow, temperature, fisheries, recreation, diversions, and water quality. Power production is scheduled within the boundaries specified by the water operations criteria.

During the wintertime, the facilities are operated pursuant to flood control requirements specified by USACE. Pursuant to these requirements, Lake Oroville is operated to maintain up to 750,000 AF of storage space to allow for the capture of significant inflows.

Annual operations are conducted for multi-year carryover. The current methodology is to retain half of the Lake Oroville storage above a specific level for subsequent years. That level has been established at 1 MAF; however, this does not limit drawdown of the reservoir below that level. If hydrology is drier than expected, or requirements greater than expected, additional water would be released from Lake Oroville. The operations plan is updated regularly to reflect changes in hydrology and downstream operations. Project operations are directly constrained by downstream operational constraints and flood management criteria.

An August 1983 agreement between DWR and CDFG titled, "*Agreement Concerning the Operation of the Oroville Division of the State Water Project for Management of Fish & Wildlife*," sets criteria and objectives for flow and temperatures in the low-flow channel and the reach of the Feather River between Thermalito Afterbay and Verona where the Feather River joins the Sacramento River. This agreement: (1) establishes minimum flows between Thermalito Afterbay Outlet and Verona, which vary by water year type; (2) requires flow changes under 2,500 cfs to be reduced by no more than 200 cfs during any 24-hour period, except for situations such as flood management or failures; (3) requires flow stability during the peak of the fall-run Chinook spawning season; and (4) sets an objective of suitable temperature conditions during the fall months for salmon and during the later spring/summer for shad and striped bass. In addition, the 2006 Feather River Settlement Agreement established minimum flows of 800 cfs during October through March and 700 cfs during April through August across all water year types in the low-flow channel.

Lake Oroville and the Thermalito Complex operations also are regulated by the Federal Energy Regulatory Commission (FERC). The FERC licenses for these facilities expired in January 2007. Since then, annual licenses have been issued, with DWR operating to the existing FERC license. FERC continues to issue an annual license until it is prepared to issue the new 50-year license. To prepare for the expiration of the FERC license, DWR began working on the relicensing process in 2001. As part of the process, DWR entered into the 2006 Feather River Settlement Agreement with State, federal, and local agencies, SWP water contractors, non-governmental organizations, Tribal governments, and others to implement improvements. FERC finalized the EIS in 2007, and DWR finalized the EIR in 2008 for the Oroville FERC re-licensing. A final biological opinion was issued by NMFS in 2009 on December 5, 2016. The new FERC license has not been adopted but is anticipated to include the FERC license terms and conditions, the 401 Certification, and the terms and conditions therein.

Lower Feather River

Lower Feather River flows vary from Lake Oroville to its terminus with the Sacramento River at Verona due to varying releases from the Thermolito Complex facilities; however, flows remain constant during certain times of the year due to the 2006 Feather River Settlement Agreement. At the upper extent, the approximate 8-mile low flow section contains mainly riffles and runs. The low-flow section also has a series of remnant gravel pit pools/ponds that connect to the main channel. This stretch is fairly confined by levees as it flows through the City of Oroville. The 2006 Feather River Settlement Agreement established minimum flows of 800 cfs during October through March and 700 cfs during April through August across all water year types in the low-flow channel. From the downstream end of the low-flow section, the Feather River is bordered by active farmland, which confines the river into an incised channel in certain stretches.

6.2.5.4 Sutter Bypass

The natural Sutter Basin overflow (Sutter Bypass) to the east of the Sacramento River and downstream of the Sutter Buttes was included in the Sacramento River Flood Control Project. The 18,000-acre Sutter Bypass is an expansive land area for agriculture in Sutter County during non-flood times, and conveys floodwaters from the Butte Basin overflow area (including flows from Sacramento River near Ord Ferry), Butte Creek, Wadsworth Canal, and Reclamation Districts 1660 and 1500 drainage plants, state drainage plants, and Tisdale Weir to the confluence of the Sacramento and Feather rivers. Floodwater from the Sacramento River upstream of Verona flows into the Sutter Bypass through the Moulton and Colusa weirs. In times of high water, Sacramento River water also enters the Sutter Bypass through the Butte Slough outfall and the Tisdale Weir. The Sutter Bypass also receives water from natural runoff areas south of Chico, overflow and weir flow from the Sacramento River, and drainage from the east side of the bypass through Wadsworth Canal and pumping plants. The bypass meets the Feather River upstream of the confluence with the Sacramento River near the Fremont Weir where floodwaters flow into the Yolo Bypass, as described in the next subsection. The Feather River flows in a joint channel in the Sutter Bypass to the Sacramento River.

6.2.5.5 Yolo Bypass

The Yolo Bypass is an approximately 59,000-acre land area that conveys Sacramento River floodwaters around Sacramento during times of high runoff. Diversion of the majority of the Sacramento River, Sutter Bypass, and Feather River floodwaters to the Yolo Bypass controls Sacramento River flood stages at Verona. The Yolo Basin was a natural overflow area located to the west of the Sacramento River. The Sacramento River Flood Control Project modified the basin by confining the extent of overflow through a leveed bypass and allowing flood flows to enter the Yolo Bypass from the Sacramento River over the Fremont and Sacramento weirs. The Yolo Bypass conveys floodwaters around the Sacramento metropolitan area and reconnects them to the Sacramento River at Rio Vista (Frantzich, 2014). Tributaries within the Yolo Bypass include the Cache Creek Detention Basin, Willow Slough, and Putah Creek. Flows also enter the Yolo Bypass from the Colusa Basin, including from the Colusa Basin Drain through the Knights Landing Ridge Cut. In 2011 and 2012, construction at the outfall gates required water from the Colusa Basin Drain to be diverted into the Yolo Bypass. These events temporarily resulted in a fall pulse flow in the Yolo Bypass that increased the volume of flow by more than 300 to 900 percent (Frantzich, 2014).

The 2009 NMFS biological opinion requires Reclamation to evaluate approaches to increase acreage of seasonal floodplain rearing habitat with biologically appropriate durations and magnitudes, from December through April, in the lower Sacramento River basin, on a return rate of approximately 1 to 3 years. The initial performance measure was defined as 17,000 to 20,000 acres of floodplain rearing habitat, such as in the Yolo Bypass, excluding tidally influenced areas. Reclamation also is required to develop enhancement plans for lower Putah Creek, Liberty Island/lower Cache Slough, and lower Yolo Bypass. The plans also are required to develop improvements to Fremont Weir and Lisbon Weir to eliminate migration barriers and stranding potential.

6.2.5.6 American River and CVP American River Facilities

The CVP Folsom Lake, located downstream of numerous smaller reservoirs in the upper American River watershed, provides hydroelectric generation and water supply, and is owned and operated by Reclamation.

Folsom Lake and Lake Natoma

The Folsom Facilities, owned and operated by Reclamation, were developed as an integral part of the CVP. The facilities consist of Folsom Lake, which is formed by Folsom Dam, and Lake Natoma, which is formed by Nimbus Dam. Construction of Folsom Dam was completed in 1956 and impounds Folsom Lake. Total Folsom Lake storage capacity is approximately 967,000 AF.

Folsom Lake is a multiple-purpose facility. It is managed to provide flood control, recreation, hydroelectric power generation, M&I water supply, Delta water quality protection, and minimum fish protection flows in the American River and the Delta. It is located on the American River approximately 15 miles northeast of the City of Sacramento, near the City of Folsom, and approximately 30 miles upstream of the confluence of the Sacramento and American rivers. Water is diverted to M&I water users, including water rights holders, upstream of Folsom Dam, from the Folsom South Canal and from the American River downstream of Folsom Dam.

Nimbus Dam is located 7 miles downstream of Folsom Dam and impounds Lake Natoma. Lake Natoma reregulates the releases made through the Folsom Power Plant. Lake Natoma has a storage capacity of approximately 8,760 AF (Reclamation, 2011b). Releases from Nimbus Dam to the American River pass through the Nimbus Power Plant when releases are less than 5,000 cfs or they pass through the spillway gates for higher flows. The American River flows 23 miles between Nimbus Dam and the confluence with the Sacramento River.

Flood control requirements and regulating criteria are specified by USACE and described in the *Folsom Dam and Lake, American River, California Water Control Manual* (USACE, 1987).

Since 1996, Reclamation has operated the facilities according to modified flood control criteria, which reserve 400,000 to 670,000 AF of flood control space in Folsom Lake and in a combination of three upstream reservoirs. This flood control plan, which provides additional protection for the lower American River, is implemented through an agreement between Reclamation and Sacramento Area Flood Control Agency. The terms of the agreement allow some of the empty reservoir space in the upstream reservoirs (Hell Hole, Union Valley, and French Meadows reservoirs) to be treated as if it were available in Folsom Lake. Reclamation and USACE constructed an auxiliary spillway under the Joint Federal Project at Folsom Dam in accordance with the recommendations of the Water Control Manual Update (Reoperation Study). USACE is also implementing increased system capabilities provided by the authorized features of the Common Features Project to strengthen the American River levees to convey up to 160,000 cfs, and completion of the authorized Folsom Dam Mini-raise Project.

Reclamation uses Folsom Lake releases to help meet Delta Salinity objectives to improve fisheries and downstream water quality. Weather conditions combined with tidal action and local accretions from runoff and return flows can quickly affect Delta salinity conditions and require increases in spring Delta inflow to maintain salinity standards. In accordance with federal and State regulatory requirements, the CVP and SWP are frequently required to release water from upstream reservoirs to maintain Delta water quality. Folsom Lake is located closer to the Delta than Lake Oroville and Shasta Lake; therefore, the water generally is first released from Folsom Lake. Water released from Lake Oroville and Shasta Lake generally reaches the Delta in approximately 3 and 4 days, respectively. As water from the other reservoirs arrives in the Delta, Folsom Lake releases can be reduced.

The 2009 NMFS biological opinion requires Reclamation to implement the Flow Management Standard; minimize flow fluctuation effects in the lower American River between January and May; and meet specific temperature requirements in the lower American River. These requirements have been met through operational modifications of temperature control shutters on Folsom Dam, and installation of structural improvements (TCDs or the functional equivalent) on several intakes in Folsom Lake and Lake Natoma.

Lower American River

Downstream of Folsom Lake, the river passes through an urbanized area that is buffered by a riparian park, known as the American River Parkway. The river flows approximately 30 miles from Folsom Lake through Lake Natoma and onto the river’s confluence with the Sacramento River.

The minimum allowable flows in the lower American River are defined by SWRCB Water Right Decision 893 (D-893), which states that in the interest of fish conservation, releases should not ordinarily fall below 250 cfs between January 1 and September 15, or below 500 cfs at other times. D-893 minimum flows are rarely the controlling objective of CVP operations at Nimbus Dam. Nimbus Dam releases are nearly always controlled during significant portions of a water year by flood control requirements or are coordinated with other CVP and SWP releases to meet CVP water supply and Delta operations objectives. Power regulation and management needs occasionally control Nimbus Dam releases. Nimbus Dam releases generally exceed the D-893 minimum flows in all but the driest of conditions.

In accordance with Section 3406(b)(2) of CVPIA, dedication of water on the American River provides instream flows downstream of Nimbus Dam greater than those that would have occurred under pre-CVPIA conditions. Instream flow objectives from October through May generally aim to provide suitable habitat for salmon and steelhead spawning, incubation, and rearing, while considering impacts to other CVP and SWP uses. Instream flow objectives for June to September endeavor to provide suitable flows and water temperatures for juvenile steelhead rearing, while balancing the effects on temperature operations into October and November to help support fall-run Chinook salmon spawning, as described in Chapter 7 Surface Water Quality.

In July 2006, Reclamation, the Sacramento Area Water Forum, and other stakeholders agreed to a flow and temperature regime (known as the Lower American River Flow Management Standard) to improve conditions for fish in the lower American River. Minimum flow requirements during October, November, and December are primarily intended to address fall-run Chinook salmon spawning, and flow requirements during January and February address fall-run Chinook salmon egg incubation and steelhead spawning. From March through May, minimum flow requirements are primarily intended to facilitate steelhead spawning and egg incubation, as well as juvenile rearing and downstream movement of fall-run Chinook salmon and steelhead. The June through September flows are designed to address over-summer rearing by juvenile steelhead, although this period partially overlaps with adult fall-run Chinook salmon immigration.

Water temperature control operations in the lower American River are affected by many factors and operational tradeoffs. These include available coldwater resources, Nimbus Dam release schedules, annual hydrology, Folsom power penstock shutter management flexibility, Folsom Dam Urban Water Supply TCD management, and Nimbus Hatchery considerations. Meeting both the summer steelhead and fall salmon temperature objectives without negatively affecting other CVP project purposes requires reserving water in Folsom Lake for use in the fall to provide suitable fall-run Chinook salmon spawning temperatures. In most years, the volume of cold water is not sufficient to support strict compliance with the summer water temperature target of 65 degrees Fahrenheit at the downstream end of the compliance reach at the Watt Avenue Bridge, while at the same time reserving adequate water for fall releases to protect fall-run Chinook salmon, or in some cases, continuing to meet steelhead over-summer rearing objectives later in the summer. The Folsom Water Supply Intake TCD has provided additional flexibility to conserve cold water for later use and providing for CVP and senior water rights water diversions.

6.2.5.7 Sacramento-San Joaquin Delta and Suisun Marsh

The Delta, located to the east of San Francisco Bay, includes integrated channels and islands at the confluence of the Sacramento and San Joaquin rivers. The Delta and adjacent Suisun Marsh area constitute a natural floodplain that covers 1,315 square miles and drains approximately 40 percent of the state (DWR, 2013a).

In the late 1800s, local land reclamation efforts in the Delta resulted in the construction of channels and levees that began altering the Delta's surface water flows. Over time, the natural pattern of water flows continued to change as the result of upper watershed diversions and the construction of facilities to divert and export water through the Delta to areas where supplemental water supplies were needed, including densely populated areas such as San Francisco and Southern California, and agricultural regions such as the San Joaquin Valley and Tulare Lake. The SWP and CVP use the Delta as the hub of their conveyance systems to deliver water to large pumps located in the southern Delta.

Inflows to the Delta occur primarily from the Sacramento River system and Yolo Bypass, the San Joaquin River, and other eastside tributaries such as the Mokelumne, Calaveras, and Cosumnes rivers. In general, in any given year, approximately 77 percent of water enters the Delta from the Sacramento River, approximately 15 percent enters from the San Joaquin River, and approximately 8 percent enters from the eastside tributaries (DWR, 1994). The Delta is tidally influenced; rise and fall varies from less than 1 foot in the eastern Delta to more than 5 feet in the western Delta (DWR, 2013a).

Water quality in the Delta is highly variable and strongly influenced by inflows from the rivers and by seawater intrusion into the western and central portions of the Delta during periods of low outflow that may be affected by high volumes of export pumping. The concentrations of salts and other materials in the Delta are affected by river inflows, tidal flows, agricultural diversions, drainage flows, wastewater discharges, water exports, cooling water intakes and discharges, and groundwater accretions. Seawater intrusion into the Delta is dependent on tidal conditions, inflows to the Delta, and Delta channel geometry. Delta channels are typically less than 30 feet deep, unless dredged, and vary in width from less than 100 feet to more than 1 mile. Although some channels are edged with riparian and aquatic vegetation, steep mud or rip-rap covered levees border most channels. To enhance flow and aid in levee maintenance, vegetation is often removed from the channel margins. The tidal currents carry large volumes of seawater back and forth through the San Francisco Bay-Delta Estuary with the tidal cycle. The mixing zone of salt and fresh water can shift 2 to 6 miles daily depending on the tides, and may reach far into the Delta during periods of low inflow.

Salinity objectives adopted by the SWRCB were established to protect beneficial uses, including agricultural and municipal water supplies, and fisheries. The SWP and CVP facilities are operated to comply with the requirements that would protect the Delta water quality. These operational requirements affect the hydrology in the Delta.

Hydrological conditions in the Delta and Suisun Marsh are substantially affected by structures that route water through the Delta toward the major Delta water diversions in the south Delta, including the CVP Jones Pumping Plant, the SWP Banks Pumping Plant, the Delta-Mendota/California Aqueduct Intertie, the CVP Contra Costa Canal Pumping Plant at Rock Slough, and the Contra Costa Water District (CCWD) intakes on Old and Middle rivers; while protecting Delta water quality for these intakes, the SWP Barker Slough Pumping Plant in the north Delta and over 1,800 municipal and agricultural in-Delta diversions (DWR, 2010). These structures include the Delta Cross Channel and temporary barriers in the south Delta.

Diversion patterns for the major facilities also are regulated to maintain Delta water quality and to protect fish that are listed as threatened or endangered species under ESA in accordance with the SWRCB D-1641, 2008 USFWS biological opinion, and the 2009 NMFS biological opinion. The diversion patterns are implemented to maintain ratios of exports of the SWP and CVP facilities to the Delta inflow, and ratios of San Joaquin River inflow to Delta exports, and to reverse flow conditions in Old and Middle rivers (known as the OMR criteria). Operations of the Jones and Banks pumping plants are affected by downstream SWP and CVP water demands, and reservoir operations in San Luis Reservoir, which is jointly used by the SWP and CVP. Facilities implemented in Suisun Marsh also affect hydrologic and water quality conditions throughout the Delta. To meet the Delta water quality requirements and water rights requirements of users located upstream of the Delta, the CVP and SWP are operated in a coordinated manner in accordance with the Coordinated Operation Agreement.

The CVP Delta Cross Channel is a gated diversion channel in the Sacramento River near Walnut Grove and Snodgrass Slough. When the gates are open, water flows from the Sacramento River through the cross channel to channels of the lower Mokelumne and San Joaquin rivers toward the interior Delta. The Delta Cross Channel operation improves water quality in the interior Delta by improving circulation patterns of good quality water from the Sacramento River toward Delta diversion facilities. Reclamation operates the Delta Cross Channel in the open position to (1) improve the movement of water from the Sacramento River to the export facilities at the Banks and Jones Pumping Plants, (2) improve water quality in the southern Delta, and (3) reduce salt water intrusion rates in the western and southern Delta. During the late fall, winter, and spring, the gates are often periodically closed to protect outmigrating salmonids from entering the interior Delta. In addition, whenever flows in the Sacramento River at Sacramento reach 20,000 to 25,000 cfs (on a sustained basis), the gates are closed to reduce potential scouring and flooding that might occur in the channels on the downstream side of the gates. Flow rates through the gates are determined by Sacramento River stage and are not affected by export rates in the south Delta. The Delta Cross Channel also serves as a link between the Mokelumne River and the Sacramento River for small craft and is used extensively by recreational boaters and fishermen whenever it is open. The SWRCB D-1641 requires closure of the Delta Cross Channel gates for fisheries protection.

The DWR South Delta Temporary Barrier Project was initiated in 1991 to seasonally construct and demolish four rock barriers across south Delta channels on Middle River, Old River, and Grant Line Canal. In various combinations, these barriers improve water levels and San Joaquin River salmon migration in the south Delta.

Major water diversions in the Delta include the CVP Jones Pumping Plant, the SWP Banks Pumping Plant, CVP Contra Costa Canal Pumping Plant at Rock Slough, SWP Barker Slough Pumping Plant for the North Bay Aqueduct, CCWD intakes on Old and Middle rivers, and more than 1,800 municipal and agricultural diversions for in-Delta use (DWR, 2010). Delta channels have been modified to allow transport of Delta inflow to the diversions throughout the Delta, including the CVP and SWP south Delta intakes, and to reduce the effects of pumping on the direction of flows and salinity intrusion within the Delta. The conveyance of water from the Sacramento River southward through the Delta to the CVP and SWP south Delta intakes is aided by the Delta Cross Channel, a constructed gated channel that conveys water from the Sacramento River to the Mokelumne River.

Operation of the CVP and SWP facilities is coordinated according to their respective water right permits, and a series of other governing laws, regulations, and agreements that have been developed to ensure compliance with specific hydrology, water quality, and ecosystem requirements while meeting the water supply contract obligations. CVP and SWP operations are adjusted to meet Delta flow and water quality standards by increasing releases of stored water in project reservoirs, or altering export pumping, gate positions, and other Delta facility operations. DWR and Reclamation must operate the SWP and CVP, respectively, in accordance with the SWRCB requirements to implement the Bay-Delta Water Quality Control Plan flow and water quality objectives, including SWRCB Decision (D)1641 (adopted on December 29, 1999, and revised on March 15, 2000) (SWRCB, 1999).

The SWRCB D-1641 amended certain terms and conditions of the CVP and SWP water rights to include flow and water quality objectives to ensure protection of beneficial uses in the Delta and Suisun Marsh. SWRCB also grants conditional changes to points of diversion for the CVP and SWP under SWRCB D-1641. The requirements in SWRCB D-1641 address the standards for fish and wildlife protection, water supply water quality, and Suisun Marsh salinity. These objectives include specific Delta outflow requirements throughout the year, specific export limits in the spring, and export limits based on a percentage of estuary inflow throughout the year. The water quality objectives are designed to protect agricultural, municipal, industrial, and fishery uses, and vary throughout the year and by water year type. One of the requirements is to provide a minimum flow on the Sacramento River at Rio Vista from September through December of 3,000 to 4,500 cfs, depending on the month and water year type, to protect water quality for Delta water users.

The SWRCB D-1641 also includes two Delta outflow criteria. A Net Delta Outflow Index is specified for all months in all water year types. A “spring X2” Delta outflow is specified from February through June to maintain freshwater and estuarine conditions in the western Delta to protect aquatic life. The criteria require operations of the CVP and SWP upstream reservoir releases and Delta exports in a manner that maintains a salinity objective at an X2 location. X2 refers to the horizontal distance from the Golden Gate Bridge up the axis of the Delta estuary to where tidally averaged near-bottom salinity concentration of 2 parts of salt in 1,000 parts of water occurs. The X2 standard was established to improve shallow water estuarine habitat in the months of February through June and relates to the extent of salinity movement into the Delta (DWR et al., 2013). The location of X2 is important to both aquatic life and water supply beneficial uses.

From February through June, SWRCB D-1641 also limits CVP and SWP exports as compared to Delta inflows (also known as the “E/I Ratio”) to reduce potential impacts on migrating salmon and spawning delta smelt, Sacramento splittail, and striped bass.

The 2008 USFWS and 2009 NMFS biological opinions restrict CVP and SWP diversions to reduce reverse flows in the Old and Middle rivers. The 2009 NMFS biological opinion requires south Delta exports to be reduced during April and May as related to Delta inflows from the San Joaquin River to protect emigrating steelhead from the lower San Joaquin River into the south Delta channels and intakes. The 2008 USFWS biological opinion also includes an additional Delta salinity requirement in September and October in wet and above normal water years. This new requirement is frequently referred to as Fall X2.

The Coordinated Operations Agreement defines how DWR and Reclamation share their joint responsibility to meet Delta water quality standards and meet the water demands of senior water right holders in the Delta watershed, including the Delta.

Operations of SWP facilities in Suisun Marsh also affect hydrologic and water quality conditions throughout the Delta. The Suisun Marsh Preservation Agreement requires DWR and Reclamation to meet salinity standards, sets a timeline for implementing the Plan of Protection, and delineates monitoring and mitigation requirements in accordance with SWRCB D-1641 to implement and operate physical facilities in the Marsh and for management of Delta outflow. The Suisun Marsh facilities include the Suisun Marsh Salinity Control Gates (SMSCGs), Roaring River Distribution System (RRDS), and Morrow Island Distribution System (MIDS). The SMSCGs are located on Montezuma Slough about 2 miles downstream of the confluence of the Sacramento and San Joaquin rivers, near Collinsville.

The objective of SMSCG operation is to decrease the salinity of the water in Montezuma Slough by restricting the flow of higher salinity water from Grizzly Bay into Montezuma Slough during incoming tides, and retaining lower salinity Sacramento River water from the previous ebb tide. Operation of the gates in this fashion lowers salinity in Suisun Marsh channels and results in a net movement of water from east to west. The SMSCGs are operated during the salinity control season, which spans from October to May. The RRDS 40-acre pond was constructed during 1979 and 1980 to provide lower salinity water to 5,000 acres of private and 3,000 acres of CDFG-managed wetlands on Simmons, Hammond, Van Sickle, Wheeler, and Grizzly islands. The MIDS was constructed in 1979 and 1980 in the southwestern Suisun Marsh to channel drainage water from the adjacent managed wetlands for discharge into Suisun Slough and Grizzly Bay. This approach increases circulation and reduces salinity in Goodyear Slough.

6.2.5.8 San Pablo Bay and San Francisco Bay

San Francisco Bay is a shallow productive estuary through which water from the Sacramento and San Joaquin rivers enters the Pacific Ocean. Specifically, both rivers flow into Suisun Bay, which flows through the Carquinez Strait to meet with the Napa River at the entrance to San Pablo Bay. San Pablo Bay connects at its south end to San Francisco Bay. However, the entire group of interconnected bays is often referred to as the “San Francisco Bay.”

The outlet of San Francisco Bay at Golden Gate Bridge is located 74 km from Chipps Island, the interface between the Delta and Suisun Bay. The Suisun Marsh is located north of Suisun Bay and east of Carquinez Strait; it is an extensive mosaic of variably controlled tidal marshlands. Tributaries to San Pablo Bay include the Napa, Sonoma, and Petaluma rivers. Numerous lesser streams collectively drain the Bay Region.

San Francisco Bay has a surface area of approximately 400 square miles at mean tide level. Most of the Bay’s shoreline has a mild slope, which creates a relatively large intertidal zone. The volume of water in the Bay changes by approximately 21 percent from mean higher-high tide to mean lower-low tide. The overall average depth of the Bay is approximately 20 feet, with the Central Bay averaging 43 feet and the South Bay averaging 15 feet. San Francisco Bay is surrounded by approximately 130 square miles of tidal flats and marshes.

Average net Delta outflow into the Bay Region, as measured at Chipps Island, is approximately 20,400 cfs, or 15 MAF per year. Average natural freshwater inflow to the Delta varies by a factor of more than 10 between the highest month in winter or spring and the lowest month in fall. During summer months of Critically Dry water years, net Delta outflow can decrease to 3,000 cfs.

In addition to Delta outflow, San Francisco Bay receives freshwater inflow from the Napa, Petaluma, and Guadalupe rivers, and from Alameda, Coyote, Walnut, and Sonoma creeks, as well as several smaller streams. The total average annual inflow volume of these tributaries (excluding the Delta) is approximately 350,000 AF. Stream flow is highly seasonal, with more than 90 percent of the annual runoff occurring during November through April.

Downstream of Carquinez Strait are the San Pablo and central San Francisco bays. Carquinez Strait separates these bays from Suisun Bay and the Delta, and allows tides to play a leading role in their salinity and circulation. These embayments can become fresh, especially at the surface, during extremely high freshwater flows. During these high flows, the entrapment zone can be temporarily relocated downstream to San Pablo Bay. During periods of low freshwater flows and high tides, these embayments are saline.

The South Bay is different from the other parts of the system. This area is not in the main path of Delta outflows. Thus, except during sustained high-outflow periods, water quality is not significantly affected by Delta outflow. During low Delta outflow periods, evaporation, combined with limited tidal flushing, can cause salinity levels to be higher in the South Bay than in the ocean outside of the Golden Gate.

6.2.6 Primary Study Area

The Primary Study Area is considered to be the footprint of the Project facilities, the land immediately surrounding them that could be affected by construction and/or maintenance activities (construction disturbance area), and the land parcels surrounding those areas that would be purchased as buffer lands around the Project facilities.

The Primary Study Area is located entirely within Glenn and Colusa counties, and includes Funks Creek, Stone Corral Creek, Funks Reservoir, Colusa Basin Drain, and other small tributaries. A saline seep is located within the inundation area of the proposed Sites Reservoir. These surface water bodies are discussed in Sections 6.2.4.1 through 6.2.4.5.

6.2.6.1 Funks Creek

Funks Creek headwaters begin in the foothills west of the town of Maxwell. Funks Creek flows into Funks Reservoir at the Tehama-Colusa Canal, both of which are operated by Tehama-Colusa Canal Authority. The drainage area of Funks Creek at Funks Dam is 43 square miles. The last stream gage that was operated on Funks Creek washed out in 1985 and was not replaced due to the constantly degrading channel. Peak winter flows of approximately 2,000 cfs are common (Weathers, 2005). Because the topography and soil composition of the watershed are similar to those of Stone Corral Creek, where stream flow records are available, and given the comparable drainage areas of the two watersheds, it is reasonable to assume that the 100-year discharge on Funks Creek would be similar to that of Stone Corral Creek.

6.2.6.2 Stone Corral Creek

The drainage area of the Stone Corral Creek watershed is 38.2 square miles. The USGS collected 25 years of discharge measurements near the town of Sites from 1958 through 1985 with periodic interruptions.

During that time, there were 3 years of zero flow: 1972, 1976, and 1977. The maximum mean daily flow of 2,230 cfs occurred on December 24, 1983. The instantaneous peak flow was 5,700 cfs on January 26, 1983. The 100-year discharge upstream of Sutton Road (aka Cemetery Road) is 3,560 cfs. A summary of the flow statistics is shown in Table 6-3 (Federal Emergency Management Agency, 2003).

Table 6-3
Stone Corral Creek Daily and Monthly Flows Near Sites, USGS 11390672
Period of Record 4/1/1958 – 9/30/1964 and 10/1/1965 – 9/30/1985
Drainage Area = 38.2 Square Miles

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Daily Flows for Period of Record (cfs)												
Min	0	0	0	0	0	0	0	0	0	0	0	0
Max	0	74	2,230	1,910	2,150	1,980	619	45	9	1	0	0
Avg	0	1	11	32	39	21	8	1	0	0	0	0
Monthly Flows (AF) for Period of Record												
Min	0	0	0	0	0	0	0	0	0	0	0	0
Max	0	427	11,432	8,825	11,137	15,227	4,451	740	146	19	0	0
Avg	0	37	660	1,946	2,190	1,300	484	83	13	1	0	0

Source: Federal Emergency Management Agency, 2003.

6.2.6.3 Funks Reservoir

Funks Reservoir is located on Funks Creek approximately 7 miles northwest of the town of Maxwell, in Colusa County. Constructed in 1975 by Reclamation, Funks Reservoir has a designed storage capacity of approximately 2,200 AF with a surface area of 232 acres. Water from the Tehama-Colusa Canal enters Funks Reservoir in an inlet at the northeast end adjacent to the dam spillway and leaves the reservoir in an outlet at the southeast end. Both the inlet and outlet have gates. The Funks Reservoir spillway is designed to pass 25,000 cfs. Both Funks Reservoir and the Tehama-Colusa Canal are operated and maintained by Tehama-Colusa Canal Authority (Reclamation, 2012).

The typical summer releases from Funks Reservoir to the lower portions of Tehama-Colusa Canal range from 500 cfs to 1,000 cfs. Total flows of 50 cfs to 200 cfs for off-peak limited agricultural releases are needed between November and February, and possibly into March, depending on the weather (DWR, 2003).

6.2.6.4 Colusa Basin Drain

Runoff from 11 stream systems draining the foothill and valley floor watersheds contribute flow to the Colusa Basin Drain. The Colusa Basin Drain flows southward through Glenn, Colusa, and Yolo counties and enters the Sacramento River at the town of Knights Landing. This natural historic drainage system for the Colusa Basin has been almost entirely cut off from receiving floodwaters from the Sacramento River by an extensive levee system (except when flood flows on the Sacramento River exceed 300,000 cfs near Ord Ferry). In general, the Colusa Basin Drain conveys flood flows from November through March, and agricultural irrigation and drainage flows from April through October. The northern half of the Colusa Basin Drain is unleveed. Beginning south of Colusa, left bank (looking downstream) levees extend southward to the Colusa Basin Drain’s confluence with the Sacramento River. A DWR gaging station located at State Route (SR) 20 near the City of Colusa has been operating since 1924. The drainage area at SR 20 is 973 square miles, and the average annual runoff is 497,000 AF. A summary of the flow statistics is shown in Table 6-4.

Table 6-4
Colusa Basin Drain Daily and Monthly Flows at Highway 20
Period of Record 11/1/1944 - 9/30/1994
Drainage Area = 973 square miles

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Mean Daily Flows for Period of Record (cfs)												
Min	0	62	22	64	22	44	0	0	0	0	0	0
Max	2,352	2,680	11,300	10,800	23,900	15,300	3,260	2,390	2,620	1,560	2,230	7,287
Avg	289	434	554	894	1,016	606	425	820	578	624	896	942
Monthly Flows (TAF) for Period of Record												
Min	0	7	4	6	3	6	5	10	7	4	11	5
Max	37	77	223	192	387	326	96	81	65	81	97	88
Avg	18	26	34	55	57	37	25	50	34	38	55	56

Source: DWR, 2013b.

6.2.6.5 Other Local Creeks

Numerous small tributaries exist within the Primary Study Area. Grapevine Creek starts on the west side of the Sites Reservoir inundation area and flows north and into the reservoir area near Sites Lodoga Road. It also flows into Funks Creek approximately 7 miles upstream of Funks Reservoir. Antelope Creek starts on the west side of the reservoir inundation area, south of the headwaters of Grapevine Creek. Antelope Creek flows south, then east, and then north through the southern portion of the reservoir inundation area, and joins with Stone Corral Creek near the town of Sites. North of the Sites Reservoir inundation area, Hunters Creek flows to the east. Southeast of Sites Reservoir, Lurline Creek flows to the east. Both Hunters and Lurline creeks flow into the Colusa Basin Drain.

6.2.6.6 Salt Lake

Saline water has been observed to seep from underground salt springs in the vicinity of the Salt Lake fault along the slopes above the valley and along the valley floor within the proposed inundation area of Sites Reservoir. These areas are generally located in the Funks Creek watershed. The water from the underground springs accumulates along the trough of the valley in several locations, including Salt Lake (USGS, 1915; DWR, 2000). The size of Salt Lake and adjacent seasonal brackish wetlands varies with time and was observed in the late 1990s to extend over approximately 28 acres.

6.3 Environmental Impacts/Environmental Consequences

6.3.1 Evaluation Criteria and Significance Thresholds

Descriptions in changes in reservoir storage, stream flow downstream of the reservoirs, diversions, in-Delta flows, and Delta outflow are presented to provide a basis for understanding changes in CVP and SWP exports and deliveries. However, the specific changes to environmental resources are addressed in specific chapters associated with each resource. For example, changes in surface water storage in the CVP and SWP reservoirs could affect recreational opportunities under the action alternatives as compared to the Existing Conditions/No Project/No Action Condition. Therefore, the changes in surface water storage are presented in this chapter as part of the description of Surface Water Resources; and the changes in Recreation Resources are presented in Chapter 21. Because the values under the action alternatives and the Existing Conditions/No Project/No Action Condition are only being reported in this chapter, no specific environmental impacts/environmental consequences are presented in this chapter. The environmental effects of these physical changes under the California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) are presented for the following resources: surface water quality (see Chapter 7 Surface Water Quality), geomorphology (Chapter 8 Fluvial Geomorphology and Riparian Habitat), flood control (Chapter 9 Flood Control and Management), groundwater (Chapter 10 Groundwater Resources and Chapter 11 Groundwater Quality), biological resources (Chapter 12 Aquatic Biological Resources, Chapter 13 Botanical Resources, Chapter 14 Terrestrial Biological Resources, and Chapter 15 Wetlands and Other Waters), recreation (Chapter 21 Recreation Resources), socioeconomics (Chapter 22 Socioeconomics), environmental justice (Chapter 23 Environmental Justice), climate change (Chapter 25 Climate Change and Greenhouse Gas Emissions), and hydroelectric generation potential (Chapter 31 Power Production and Energy). Specific impact analyses and mitigation measures related to physical changes in these resources that are a result of changes in surface water and water supply conditions are provided in those chapters as appropriate.

6.3.2 Impact Assessment Assumptions and Methodology

6.3.2.1 Assumptions

Combinations of Project facilities were used to create Alternatives A, B, C, C_1, and D. In all resource chapters, the Sites Project Authority (Authority) and Reclamation described the potential impacts associated with the construction, operation, and maintenance of each of the Project facilities for each of the five action alternatives. Some Project features/facilities and operations (e.g., reservoir size, overhead power line alignments, provision of water for local uses) differ by alternative, and are evaluated in detail within each of the resource areas chapters. As such, the Authority has evaluated all potential impacts with each feature individually and collectively, and may choose to select or combine individual features as determined necessary.

Impacts associated with the construction, operation, and maintenance for Alternative C_1 would be the same as Alternative C and are therefore not discussed separately below.

Pulse Flow Protection Diversion Assumptions

In anticipation of the use of the analyses in this EIR/EIS by cooperating and trustee agencies to support their decision making and the future permit acquisition process with NMFS, CDFW, and other resource agencies, the hydrology and operations modeling of the Project included restrictions on diversions to limit impacts on outmigrating juvenile fish as a “surrogate” for likely permit conditions. Based on recent literature and the proposed permit conditions for other diversion projects, operations modeling for the Project diversions were assumed to be restricted to promote fish passage associated with pulse flow events that stimulate the observed spike in juvenile salmon outmigration. Actual operations are anticipated to be informed by real-time monitoring of fish movement.

An assumed pulse protection period was developed that would extend from October through May to address outmigration of juvenile winter-, spring-, fall-, and late-fall-run Chinook salmon, as well as steelhead. Pulse flows during this period would provide flow continuity between the upper and lower Sacramento River to support fish migration. It is recognized that research regarding the benefits of pulse flows is ongoing, and further research and adaptive management would be required to develop and refine a pulse flow protection strategy for fish migration and, as such, this assumption was used for modeling/informational purposes only. Further detail on the diversion limitation assumptions is included in Chapter 5 Guide to the Resource Analyses. The diversion limitation is included as a proposed mitigation measure in Chapter 12 Aquatic Biological Resources to address potential diversion-related impacts. It is anticipated that discussions with federal and state resource agencies would likely result in refinements to the proposed operational approach to best minimize potential impacts to aquatic resources.

6.3.2.2 Methodology

Changes in CVP and SWP operations under the action alternatives as compared to the Existing Conditions, No Project Alternative, No Action Alternative Condition result in changes to reservoir storage volumes (and elevations) and flow patterns in the downstream rivers. Numerical models are available to quantitatively analyze the changes in CVP and SWP reservoirs and pumping plants in the Central Valley, affected surface water bodies, and deliveries of CVP and SWP water.

As described in Section 2.3, the CEQA Baseline is developed to assess the significance of Project impacts in relation to the actual environment upon which the Project will operate; and the No Project Alternative includes reasonably foreseeable changes in Existing Conditions and changes that would be reasonably expected to occur in the foreseeable future if the project were not approved, based on current plans and consistent with available infrastructure and community services. For this EIR/EIS, the No Project Alternative assumes the same regulatory criteria as Existing Conditions, including implementation of biological opinions and SWRCB water rights and water quality criteria related to the CVP and SWP operations. Under NEPA, the No Action Alternative generally focuses on programs, projects, or policies that are assumed to be in place in the future that would affect or be affected by the action alternatives, including Existing Conditions and future actions that are authorized and approved through completion of NEPA, CEQA, Endangered Species Act, and other applicable regulatory compliance processes.

Existing conditions and the future No Project/No Action alternatives were assumed to be similar in the Primary Study Area given the generally rural nature of the area and limited potential for growth and development in Glenn and Colusa counties within the 2030 study period used for this EIR/EIS as further described in Chapter 2 Alternatives Analysis. As a result, within the Primary Study Area, it is anticipated that the No Project/No Action Alternative would not entail material changes in conditions as compared to the existing conditions baseline. Therefore, assumptions for Existing Conditions are the same as for the No Project/No Action Alternative.

With respect to the Extended and Secondary study areas, the effects of the action alternatives would be primarily related to changes to available water supplies in the Extended and Secondary study areas and the Project’s cooperative operations with other existing large reservoirs in the Sacramento watershed, and the resultant potential impacts and benefits to biological resources, land use, recreation, socioeconomic conditions, and other resource areas. DWR has projected future water demands through 2030 conditions that assume the vast majority of CVP and SWP water contractors would use their total contract amounts, and that most senior water rights users also would fully use most of their water rights. This increased demand in addition to the projects currently under construction and those that have received approvals and permits at the time of preparation of the EIR/EIS would constitute the No Project/No Action Condition. As described in Section 2.3 of Chapter 2 Alternative Analysis, the primary difference in these projected water demands would be in the Sacramento Valley; and as of the time of preparation of this EIR/EIS, the water demands have expanded to the levels previously projected to be achieved on or before 2030, and have become part of the Existing Conditions assumptions.

Accordingly, Existing Conditions and the No Project/No Action alternatives are assumed to be the same for this EIR/EIS and as such are referred to as the Existing Conditions/No Project/No Action Condition, which is further discussed in Section 2.3 of Chapter 2 Alternatives Analysis. With respect to applicable reasonably foreseeable plans, projects, programs and policies that may be implemented in the future but that have not yet been approved, these are included as part of the analysis of cumulative impacts in Chapter 35 Cumulative Impacts.

The surface water supply analysis discussed in this chapter was conducted using the CALSIM II and DSM2 models to simulate the operational assumptions of the Existing Conditions/No Project/No Action Condition and Alternatives A, B, C, and D, as described in Appendix 6A Modeling of Alternatives and Appendix 6B Water Resources System Modeling.

CALSIM II Model

CALSIM II is a reservoir-river basin planning model developed by DWR and Reclamation to simulate the operation of the CVP and SWP over a range of different hydrologic conditions. Inputs to CALSIM II include water demands (including water rights), stream accretions and depletions, reservoir inflows, irrigation efficiencies, and parameters to calculate return flows, non-recoverable losses, and groundwater operations. The CALSIM II model simulates river flows, reservoir storage, Delta outflow, and diversions including Delta exports. The use of CALSIM II allows for comparative changes or effects to the CVP and SWP water resources system associated with adding a new surface storage reservoir located north of the Delta.

As described in Appendix 6A Modeling of Alternatives and Appendix 6B Water Resources System Modeling, CALSIM II uses the Sacramento Valley and tributary rim basin hydrology with an adjusted historical sequence of monthly stream flows over an 82-year period (1922 to 2003) to represent a sequence of flows at a specific level of land use development and associated water demands. The CALSIM II model includes water demands and associated water deliveries to water rights holders in the same patterns under the Existing Conditions/No Project/No Action Condition and action alternatives. The CALSIM II model also includes discharges and releases from non-CVP and non-SWP water users and wastewater dischargers in the same patterns under the Existing Conditions/No Project/No Action Condition and action alternatives.

The CALSIM II model monthly simulation of real-time daily (or even hourly) operation of the CVP and SWP results in several limitations in use of the CALSIM II model results. The model results must be used in a comparative manner to reduce the effects of use of monthly assumptions and other assumptions that are indicative of real-time operations, but do not specifically match real-time observations. Given the CALSIM II model uses a monthly time step, incremental flow and storage changes of 5 percent or less are generally considered within the standard range of uncertainty associated with model processing, and as such flow changes of 5 percent or less were considered to be similar to Existing Conditions/No Project/No Action flow levels in the comparative analyses using CALSIM II conducted in this EIR/EIS.

Analysis of Changes in Surface Water Conditions

The analyses of changes in surface water conditions under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition are based upon CALSIM II outputs for Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and San Luis Reservoir; flows downstream of CVP and SWP reservoirs in Trinity, Sacramento, Feather and American rivers, and Clear Creek; flows between Lewiston Reservoir and Whiskeytown Lake in the Clear Creek Tunnel; flows from the Sacramento River into the Sutter Bypass through Tisdale, Colusa, Moulton, and Ord Ferry weirs; flows from the Sacramento River into the Yolo Bypass through the Fremont Weir; diversions from the Sacramento River into the Tehama-Colusa and GCID Main canals; flows from Sacramento River through the Delta Cross Channel; Delta outflow; reverse flows in Old and Middle rivers (OMR criteria); exports through the Jones and Banks pumping plants; and deliveries to CVP and SWP water users.

Reservoir operations of the New Melones Reservoir on the Stanislaus River and Millerton Lake on the San Joaquin River, and all existing non-CVP and non-SWP reservoirs would be similar between the Existing Conditions/No Project/No Action Condition and all of the action alternatives. Therefore, surface water conditions on the Feather River upstream of Oroville Reservoir, American River upstream of Folsom Lake, all other tributaries to the Sacramento River and Delta that are influenced by operations of existing non-CVP and non-SWP reservoirs, and San Joaquin River upstream of Vernalis are not analyzed further in this chapter.

Under extreme hydrologic and operational conditions where there is not enough water supply to meet all requirements, CALSIM II uses a series of operating rules to reach a solution to allow for the continuation of the simulation. It is recognized that these operating rules are a simplified version of the very complex decision processes that CVP and SWP operators would use in actual extreme conditions. Therefore, model results and potential changes under these extreme conditions should be evaluated on a comparative basis between alternatives and are an approximation of extreme operational conditions. As an example, CALSIM II model results show simulated occurrences of extremely low storage conditions at CVP and SWP reservoirs during critical drought periods when storage is at dead pool levels at or below the elevation of the lowest level outlet. Simulated occurrences of reservoir storage conditions at dead pool levels may occur coincidentally with simulated impacts that are determined to be potentially significant. When reservoir storage is at dead pool levels, there may be instances in which flow conditions fall short of minimum flow criteria, salinity conditions may exceed salinity standards, contract allocations cannot be provided due to limited storage volumes in CVP reservoirs, and operating agreements are not met.

Changes in CVP and SWP operations under the action alternatives as compared to the Existing Conditions/No Project/No Action Condition would change CVP and SWP exports and deliveries, as analyzed using the CALSIM II model. Assumptions used in the CALSIM II model are described in Appendix 6A Modeling of Alternatives and Appendix 6B Water Resources System Modeling. It should be noted that volumes of water delivered to CVP and SWP water users south of the Delta are not necessarily the same as volumes of Delta exports because a portion of the exported water is stored in San Luis Reservoir and released in different patterns than Delta exports.

It also should be noted that the monthly CALSIM II model results do not represent daily water operations decisions, especially for extreme conditions. For example, in very dry years, the model simulates minimum reservoir volumes (dead pool conditions) that appear to prevent Reclamation and DWR from meeting their contractual obligations. Such model results are anomalies that reflect the inability of the monthly model to make real-time policy decisions under extreme circumstances. Projected reservoir storage conditions near dead pool conditions should only be considered as an indicator of stressed water supply conditions, and not necessarily reflective of actual CVP and SWP operations in the future.

The metrics from the CALSIM II model output files presented in this document were chosen to evaluate differences between the Existing Conditions/No Project/No Action Condition and Alternatives A, B, C, and D. The metrics were chosen for those locations at which a relative change could occur due to implementation of the action alternatives as compared to the Existing Conditions/No Project/No Action

Condition. In many cases, the CALSIM II model output provides several similar metrics that can be used to describe the changes between the different scenarios. For example, the CALSIM II model output provides values for reservoir storage, reservoir surface water elevation, and reservoir surface area at specific points in time. Modeling output values for multiple metrics are included in Appendix 6B Water Resources System Modeling. However, to facilitate review of this chapter, only values for reservoir storage were included to describe potential changes in reservoir conditions. The additional metrics are used in other chapters, as appropriate; for example, changes in surface water elevation are considered under Chapter 21 Recreation Resources. Maps showing the specific locations used for surface water and surface water quality modeling are included in Appendix 6B Water Resources System Modeling.

6.3.3 Comparison of Alternatives A, B, C, and D with the Existing Conditions/ No Project/No Action Condition

This section describes the changes to surface water resources associated with implementation of Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition. Detailed modeling results for all water year types and long-time average are presented in Appendix 6B Water Resources System Modeling.

The action alternatives would be fully integrated with the CVP and SWP systems. Consequently, the action alternatives would affect operations and resultant storage, flows, and diversions associated with the CVP and SWP systems and respective streams and waterways.

Major differences in operational effects between Alternatives A, B, C, and D would result primarily from differences in the storage capacity of Sites Reservoir (1.3 MAF for Alternative A and 1.8 MAF for Alternatives B, C, and D) and differences in diversion capabilities (Alternatives A, C, and D include a 2,000 cfs Delevan Pipeline Intake/Discharge Facility, and Alternative B includes a 1,500 cfs Delevan Pipeline release-only facility).

6.3.3.1 Extended Study Area – Alternatives A, B, C, and D Compared to the Existing Conditions/No Project/No Action Condition

Changes in San Luis Reservoir storage and CVP and SWP deliveries between Alternatives A, B, C, and D, when compared to the Existing Conditions/No Project/No Action Condition are discussed below.

San Luis Reservoir

Over the long term, average San Luis Reservoir storage would be similar under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition except in in November when storage would increase because water would be specifically released from Sites Reservoir, as shown in Appendix 6B Water Resources System Modeling. Slight storage reductions would occur Alternative C in October and Alternative D in July-August as compared to the Existing Conditions/No Project/No Action Condition due to slight variations in the CALSIM II operations of San Luis Reservoir and Delta export operations.

In Dry and Critical water years, average San Luis Reservoir storage would be similar under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition would be similar from January through May and reduced from June through December, as shown in Appendix 6B Water Resources System Modeling. The reductions in San Luis Reservoir storage would occur because water from Sites Reservoir would be delivered to water users located south of the Delta in these months under A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition.

CVP Contract Deliveries

Table 6-5 shows total annual average CVP deliveries under A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition for averages over the long-term and for Dry and Critical water years.

Table 6-5
Annual CVP Deliveries (TAF)[a]
Alternatives A, B, C, and D Compared to the Existing Conditions/No Project/No Action Condition

Region and Delivery Type		Average (Annual)	EC/NP/ NAC (TAF)	Change from the Existing Conditions/No Project/ No Action Condition			
				Alt. A (TAF/%)	Alt. B (TAF/%)	Alt. C (TAF/%)	Alt. D (TAF/%)
Sacramento Valley							
CVP Sacramento River Settlement Contractors	Contract Delivery	Long-Term[b]	1,934	9 (0%)	6 (0%)	9 (0%)	7 (0%)
		Dry and Critical[c]	1,918	14 (1%)	6 (0%)	15 (1%)	8 (0%)
CVP Refuge Level 2	Contract Delivery	Long-Term	155	4 (3%)	3 (2%)	6 (4%)	4 (3%)
		Dry and Critical	137	4 (3%)	2 (2%)	5 (4%)	5 (3%)
Refuge Incremental Level 4	Supply from acquisitions	Long-Term	27	-1 (-3%)	-1 (-5%)	-2 (-6%)	-1 (-3%)
		Dry and Critical	25	0 (0%)	-1 (-3%)	-1 (-3%)	0 (0%)
	Supply from Sites Reservoir	Long-Term	0	1 (N/A)	1 (N/A)	2 (N/A)	1 (N/A)
		Dry and Critical	0	0 (N/A)	1 (N/A)	1 (N/A)	0 (N/A)
CVP M&I	Contract Delivery	Long-Term	211	2 (1%)	0 (0%)	2 (1%)	1 (0%)
		Dry and Critical	174	1 (0%)	0 (0%)	1 (1%)	0 (0%)
CVP Ag	Contract Delivery (does not include Sacramento River Settlement Contractors)	Long-Term	213	10 (5%)	3 (1%)	10 (5%)	6 (3%)
		Dry and Critical	93	10 (11%)	5 (5%)	9 (10%)	6 (7%)
San Joaquin Valley (not including Friant-Kern and Madera Canal water users)							
CVP San Joaquin River Exchange Contractors	Contract Delivery	Long-Term	852	0 (0%)	0 (0%)	0 (0%)	0 (0%)
		Dry and Critical	814	0 (0%)	0 (0%)	0 (0%)	0 (0%)
CVP Refuge Level 2	Contract Delivery	Long-Term	261	0 (0%)	0 (0%)	0 (0%)	0 (0%)
		Dry and Critical	249	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Refuge Incremental Level 4	Supply from acquisitions	Long-Term	86	-35 (-40%)	-56 (-65%)	-58 (-68%)	-38 (-44%)
		Dry and Critical	82	-17 (-21%)	-29 (-36%)	-29 (-35%)	-19 (-23%)
	Supply from Sites Reservoir	Long-Term	0	35 (N/A)	56 (N/A)	58 (N/A)	38 (N/A)
		Dry and Critical	0	17 (N/A)	30 (N/A)	29 (N/A)	19 (N/A)
CVP M&I	Contract Delivery	Long-Term	16	0 (0%)	0 (0%)	0 (0%)	0 (0%)
		Dry and Critical	13	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Region and Delivery Type		Average (Annual)	EC/NP/NAC (TAF)	Change from the Existing Conditions/No Project/ No Action Condition			
				Alt. A (TAF/%)	Alt. B (TAF/%)	Alt. C (TAF/%)	Alt. D (TAF/%)
CVP Ag	Contract Delivery (does not include San Joaquin River Exchange Contractors)	Long-Term	290	6 (2%)	-2 (-1%)	2 (1%)	2 (1%)
		Dry and Critical	137	10 (7%)	2 (1%)	6 (4%)	5 (4%)
San Francisco Bay Area							
CVP M&I	Contract Delivery	Long-Term	290	1 (0%)	0 (0%)	1 (0%)	0 (0%)
		Dry and Critical	318	1 (0%)	0 (0%)	1 (0%)	0 (0%)
CVP Ag	Contract Delivery	Long-Term	36	1 (2%)	0 (0%)	0 (1%)	0 (0%)
		Dry and Critical	17	1 (10%)	0 (0%)	1 (7%)	1 (6%)
Tulare Lake Region (not including Friant-Kern Canal water users)							
CVP Refuge Level 2	Contract Delivery	Long-Term	12	0 (0%)	0 (0%)	0 (0%)	0 (0%)
		Dry and Critical	11	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Refuge Incremental Level 4	Supply from acquisitions	Long-Term	20	-8 (-41%)	-13 (-65%)	-14 (-69%)	-9 (-45%)
		Dry and Critical	20	-4 (-21%)	-7 (-37%)	-7 (-35%)	-4 (-23%)
	Supply from Sites Reservoir	Long-Term	0	8 (N/A)	14 (N/A)	14 (N/A)	9 (N/A)
		Dry and Critical	0	4 (N/A)	7 (N/A)	7 (N/A)	4 (N/A)
CVP Ag	Contract Delivery (includes CVC)	Long-Term	599	13 (2%)	-3 (-1%)	6 (1%)	6 (1%)
		Dry and Critical	283	25 (9%)	7 (3%)	16 (6%)	15 (5%)
Total For All Regions							
Total CVP Supplies	Contract Delivery (Includes Sacramento River Settlement Contractors, San Joaquin River Exchange Contractors, Water Service Ag M&I Contractors, and Level 2 Refuge water supply – does not include Refuge Level 4 water supply from acquisitions)	Long-Term	4,868	45 (1%)	7 (0%)	36 (1%)	28 (1%)
		Dry and Critical	4,164	67 (2%)	22 (1%)	55 (1%)	40 (1%)

[a]Based on CALSIM-II modeling over an 82-year simulation period.

[b]Long-Term is the average quantity for the period of October 1921 through September 2003.

[c]Dry and Critical Years Average is the average quantity for the combination of the SWRCB D-1641 40-30-30 Dry and Critical years for the period of October 1921 through September 2003.

Notes:

Ag = Agricultural
EC/NP/NAC = Existing Conditions/No Project/No Action Condition
M&I = Municipal and Industrial

Over the long term and Dry and Critical water years, average deliveries under Alternatives A, B, C, and D would be similar to the Existing Conditions/No Project/No Action Condition for all CVP water users.

As shown in Table 6-5, Incremental Level 4 refuge water supplies would be provided by Sites Reservoir under Alternatives A, B, C, and D as compared to the CVP under the Existing Conditions/No Project/No Action Condition.

Overall, implementation of Alternatives A, B, C, and D would result in no change to average annual CVP water deliveries as compared to the Existing Conditions/No Project/No Action Condition. Over the Dry and Critical water years, average annual CVP deliveries to CVP Agricultural Contractors would increase under Alternative D which would be an improvement compared to the Existing Conditions/No Project/No Action Condition.

SWP Contract Deliveries

Table 6-6 shows the total annual SWP deliveries for Alternatives A, B, C, and D and the Existing Conditions/No Project/No Action Condition for averages over the long term and for Dry and Critical water years.

Table 6-6
Annual SWP Regional Deliveries (TAF)[a]
Alternatives A, B, C, and D Compared to the Existing Conditions/No Project/No Action Condition

Region and Delivery Type		Average (Annual)	EC/NPA/NAC (TAF)	Change from the Existing Conditions/ No Project/No Action Condition			
				Alt. A (TAF/%)	Alt. B (TAF/%)	Alt. C (TAF/%)	Alt. D (TAF/%)
Sacramento Valley							
SWP FRSA	Contract Delivery	Long-Term[b]	950	0 (0%)	0 (0%)	-2 (0%)	1 (0%)
		Dry and Critical[c]	901	0 (0%)	0 (0%)	-5 (-1%)	4 (0%)
SWP M&I	Contract Delivery	Long-Term	23	1 (6%)	1 (6%)	2 (7%)	1 (5%)
		Dry and Critical	16	2 (16%)	2 (15%)	3 (19%)	2 (14%)
San Joaquin Valley (not including Friant-Kern and Madera Canal water users)							
SWP Ag	Contract Delivery (including Article 21)	Long-Term	4	0 (5%)	0 (5%)	0 (5%)	0 (4%)
		Dry and Critical	3	0 (14%)	0 (14%)	0 (17%)	0 (12%)
San Francisco Bay Area							
SWP M&I	Contract Delivery (including Article 21, includes transfers to SWP contractors)	Long-Term	199	9 (5%)	10 (5%)	10 (5%)	9 (4%)
		Dry and Critical	142	18 (13%)	18 (12%)	21 (15%)	16 (11%)
Central Coast Region							
SWP M&I	Contract Delivery	Long-Term	44	2 (5%)	2 (5%)	2 (5%)	2 (4%)
		Dry and Critical	31	5 (14%)	4 (14%)	5 (17%)	4 (12%)
Tulare Lake Region (not including Friant-Kern Canal water users)							
SWP M&I	Contract Delivery	Long-Term	84	4 (5%)	4 (5%)	5 (5%)	4 (4%)
		Dry and Critical	60	9 (14%)	8 (14%)	10 (17%)	7 (12%)
SWP Ag	Contract Delivery) (including Article 21	Long-Term	658	31 (5%)	33 (5%)	35 (5%)	27 (4%)
		Dry and Critical	460	58 (13%)	55 (12%)	66 (14%)	50 (11%)
South Lahontan Region							
SWP M&I	Contract Delivery (including Article 21)	Long-Term	267	13 (5%)	14 (5%)	14 (5%)	12 (5%)
		Dry and Critical	197	30 (15%)	28 (14%)	33 (17%)	26 (13%)

Region and Delivery Type		Average (Annual)	EC/NPA/NAC (TAF)	Change from the Existing Conditions/ No Project/No Action Condition			
				Alt. A (TAF/%)	**Alt. B (TAF/%)**	**Alt. C (TAF/%)**	**Alt. D (TAF/%)**
South Coast Region							
SWP M&I	Contract Delivery (including Article 21, includes transfers to SWP contractors)	Long-Term	1,353	62 (5%)	65 (5%)	68 (5%)	59 (4%)
		Dry and Critical	990	141 (14%)	131 (13%)	155 (16%)	119 (12%)
SWP Ag	Contract Delivery (including Article 21)	Long-Term	8	0 (5%)	0 (5%)	0 (5%)	0 (4%)
		Dry and Critical	6	1 (13%)	1 (12%)	1 (14%)	1 (11%)
Total For All Regions							
Total SWP Supplies	Contract Delivery (FRSA, Ag, and M&I from SWP and Sites Reservoir)	Long-Term	3,589	123 (3%)	131 (4%)	135 (4%)	115 (3%)
		Dry and Critical	2,804	265 (9%)	247 (9%)	289 (10%)	229 (8%)

[a] Based on CALSIM-II modeling over an 82-year simulation period.

[b] Long-Term is the average quantity for the period of October 1921 through September 2003.

[c] Dry and Critical Years Average is the average quantity for the combination of the SWRCB D-1641 40-30-30 Dry and Critical years for the period of October 1921 through September 2003.

Notes:

Ag = Agricultural
M&I = Municipal and Industrial
EC/NP/NAC = Existing Conditions/No Project/No Action Condition

Over the long term, average annual SWP deliveries would be similar under Alternatives A, B, C, and D and the Existing Conditions/No Project/No Action Condition.

Over the Dry and Critical water years, average annual SWP deliveries would increase under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition because water is released from Sites Reservoir specifically to increase water deliveries to water users located south of the Delta. The Sites Reservoir releases would increase Delta exports in the late summer and fall months, and many SWP water users have water demands during those months (e.g., M&I water users) and have storage capacity in surface water reservoirs and groundwater banks. This increase in water supply reliability in dry and critically dry years would be an improvement compared to the Existing Conditions/No Project/No Action Condition.

6.3.3.2 Secondary Study Area – Alternatives A, B, C, and D Compared to the Existing Conditions/No Project/No Action Condition

Operations for the regulating reservoirs that are located within the Secondary Study Area (i.e., Lewiston Reservoir, Whiskeytown Lake, Spring Creek Debris Dam, Keswick Reservoir, the Thermalito Complex, and Lake Natoma) are assumed to continue to operate as they have historically and, therefore, would not experience changes in operations or surface water conditions. Changes in flows into Suisun, San Pablo, and San Francisco bays were not analyzed. Rather, changes in flows into these water bodies are considered through comparison of Delta outflow and DSM2 model output, which is presented in Chapter 7 Surface Water Quality as part of the water quality analyses.

Trinity Lake

Over the long term, average Trinity Lake end-of-month storage volumes would be similar under Alternatives A, B, C, and D and the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling.

Over the Dry and Critical water years, average annual Trinity Lake end-of-month storage volumes would be similar from January through July under Alternatives A, B, and C, and in all months under Alternative D, as compared to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. Under Alternatives A, B, and C, Trinity Lake storage would be slightly higher in August through December as compared to the Existing Conditions/No Project/No Action Condition. From August through December, average monthly storage in Trinity Lake would increase under Alternatives A, B, and C as compared to the Existing Conditions/No Project/No Action Condition because more water would be released from Sites Reservoir to meet water quality objectives in the Sacramento River and the Delta which would allow more water to be stored in Trinity Lake.

Trinity River

Over the long term and Dry and Critical water years, average Trinity River flows downstream of Lewiston Reservoir would be similar under Alternatives A, B, C, and D and the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling.

Klamath River Downstream of the Trinity River

Changes to Klamath River flows downstream of the confluence with the Trinity River were analyzed qualitatively. Over the long term and Dry and Critical water years, Trinity River flows would be similar under Alternatives A, B, C, and D to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. Therefore, changes in the lower Klamath River due to implementation of Alternatives A, B, C, and D also would be similar to the Existing Conditions/No Project/No Action Condition.

Clear Creek Tunnel

Over the long term under Alternatives A, B, C, and D, flows in the Clear Creek Tunnel between Lewiston Reservoir and Whiskeytown Lake would be similar in June, July, and September; would decrease in August, October through November, and May; and increase from January through April as compared to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. Under Alternative D, flows would be similar in December and from April through September, would decrease in October and November, and increase from January through March as compared to the Existing Conditions/No Project/No Action Condition.

Over the Dry and Critical water years under Alternatives A, B, C, and D, flows would be similar in June, would increase from December through April, and decrease from July through November and May as compared to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. Under Alternative D, flows would be similar in December, April, and July; would decrease in October, November, and May; and increase from January through March, June, August, and September as compared to the Existing Conditions/No Project/No Action Condition. The increased flows in the Clear Creek Tunnel from December through April would occur because there was additional water stored in Trinity Lake from August through December under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition; and the additional water would be diverted to the Sacramento River through Whiskeytown Lake and the Clear Creek Tunnel during the winter months. As described above, Trinity Lake storage would increase from August through December under Alternatives A, B, and C; therefore, flows into Clear Creek Tunnel decreases as the CALSIM II model balances storage between Shasta Lake and Trinity Lake.

Clear Creek Downstream of Whiskeytown Lake

Over the long term, average Clear Creek flows downstream of Whiskeytown Lake under Alternatives A, B, C, and D would be similar as compared to the Existing Conditions/No Project/No Action Condition, except for increased flows in July, as shown in Appendix 6B Water Resources System Modeling.

Over the long-term in Dry and Critical water years types, average Clear Creek flows downstream of Whiskeytown Lake under Alternatives B and D would be similar to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. Under Alternatives A and C, flows would be similar to the Existing Conditions/No Project/No Action Condition, except for increased flows in July.

Shasta Lake

Over the long term, average monthly storage in Shasta Lake under Alternatives A, B, C, and D would be similar to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling.

Over the Dry and Critical water years, average monthly storage in Shasta Lake under Alternatives A, B, C, and D from January through May would be similar to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. From June through December, average monthly storage in Shasta Lake would increase under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition because water would be released from Sites Reservoir to meet Delta water quality and other downstream flow criteria which would allow cold water storage in Shasta Lake to increase.

Sacramento River

Changes in flows in the Sacramento River are described in this subsection at several locations, including the following:

- Downstream of Keswick Reservoir
- Downstream of the Tehama-Colusa Canal Intake near Red Bluff
- Downstream of the GCID Main Canal Intake near Hamilton City
- Downstream of Delevan Pipeline Intake/Discharge Facilities

Sacramento River Flows Downstream of Keswick Reservoir

Over the long term, average monthly flows in the Sacramento River downstream of Keswick Reservoir would be similar in all months under Alternatives A, B, C, and D to the Existing Conditions/No Project/No Action Condition, except in December when flows would increase due to the need to release water from Shasta Lake to meet flood management criteria, as shown in Appendix 6B Water Resources System Modeling.

Over the Dry and Critical water years, flows in the Sacramento River downstream of Keswick Reservoir would be similar from July through September under Alternatives A, B, C, and D to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. From March through June and in October, flows would decrease under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition because cold water storage in Shasta Lake would be increased by releasing water from Sites Reservoir for downstream uses.

Sacramento River Flows Downstream of the Tehama-Colusa Canal Intake near Red Bluff

Over the long term, average monthly flows in the Sacramento River downstream of the Tehama-Colusa Canal Intake near Red Bluff would be similar from April through February under Alternatives A, B, C, and D to the Existing Conditions/No Project/No Action Condition, except in March when flows would decrease due to additional diversions from the Sacramento River, as shown in Appendix 6B Water Resources System Modeling.

Over the Dry and Critical water years, flows in the Sacramento River downstream of the Tehama-Colusa Canal Intake near Red Bluff would be similar from November through January and from June through September under Alternatives A, B, C, and D to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. From February through June and in October, flows would decrease under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition because water would be diverted from the Sacramento River into Sites Reservoir and cold water storage in Shasta Lake would be increased by releasing water from Sites Reservoir for downstream uses.

Sacramento River Flows Downstream of GCID Main Canal Intake near Hamilton City

Over the long term, average monthly flows in the Sacramento River downstream of the GCID Main Canal Intake near Hamilton City would be similar from August through February under Alternatives A, B, C, and D to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. In January and from March through May flows would decrease because water would be diverted from the Sacramento River into Sites Reservoir under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition. In July under Alternatives A, B, C, and D flows would increase as compared to the Existing Conditions/No Project/No Action Condition due to increased Shasta Lake releases to stabilize flows.

Over the Dry and Critical water years, average monthly flows in the Sacramento River downstream of the GCID Main Canal Intake near Hamilton City would be similar from November through January and in May, June, August, and September under Alternatives A, B, C, and D to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. From February through April and in October, flows would decrease under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition because water would be diverted from the Sacramento River into Sites Reservoir and cold water storage in Shasta Lake would be increased by releasing water from Sites Reservoir for downstream uses. In June and July under Alternatives A, B, C, and D flows would increase as compared to the Existing Conditions/No Project/No Action Condition due to increased Shasta Lake releases to stabilize flows.

Sacramento River Flows Downstream of Delevan Pipeline Intake/Discharge Facilities

Over the long term, average monthly flows in the Sacramento River downstream of the Delevan Pipeline Intake/Discharge Facilities would be similar in December and from April through June under Alternatives A, B, C, and D to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. From January through March flows would decrease because water would be diverted from the Sacramento River into Sites Reservoir under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition, including diversions at the Tehama-Colusa Canal and GCID Main Canal intakes. From July through November under

Alternatives A, B, C, and D flows would increase as compared to the Existing Conditions/No Project/No Action Condition due to increased Shasta Lake releases to stabilize flows.

Over the Dry and Critical water years, average monthly flows in the Sacramento River downstream of the Delevan Pipeline Intake/Discharge Facilities would be similar in December and from April through June under Alternatives A, B, C, and D to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. From January through March, flows would decrease because water would be diverted from the Sacramento River into Sites Reservoir under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition, including diversions at the Tehama-Colusa Canal and GCID Main Canal intakes. In July through November under Alternatives A, B, C, and D flows would increase as compared to the Existing Conditions/No Project/No Action Condition due to increased Shasta Lake releases to stabilize flows.

Tehama-Colusa Canal Intake

Over the long term, the average monthly Tehama-Colusa Canal Intake flows under Alternatives A, B, C, and D would increase from November through May as compared to the Existing Conditions/No Project/No Action Condition due to diversions from the Sacramento River into Sites Reservoir, as shown in Appendix 6B Water Resources System Modeling. In June, July, and September, flows would decrease under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition because the diversions are increased in other months.

Over the long term, the average monthly Tehama-Colusa Canal Intake flows under Alternatives A, B, C, and D would increase from November through April as compared to the Existing Conditions/No Project/No Action Condition due to diversions from the Sacramento River into Sites Reservoir, as shown in Appendix 6B Water Resources System Modeling. In June, July, and September, flows would decrease under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition because the diversions are increased in other months.

GCID Main Canal Intake near Hamilton City

Over the long term, the average monthly GCID Main Canal Intake flows under Alternatives A, B, C, and D would increase from December through March as compared to the Existing Conditions/No Project/No Action Condition due to diversions from the Sacramento River into Sites Reservoir, as shown in Appendix 6B Water Resources System Modeling. From June through October, flows would decrease under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition because the diversions are increased in other months.

Over the long term, the average monthly GCID Main Canal Intake flows under Alternatives A, B, C, and D would increase from December through March as compared to the Existing Conditions/No Project/No Action Condition due to diversions from the Sacramento River into Sites Reservoir, as shown in Appendix 6B Water Resources System Modeling. From April through September, flows would decrease under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition because the diversions are increased in other months.

Lake Oroville

Over the long term, average monthly Lake Oroville storage under Alternatives A, B, C, and D would be similar to conditions under the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling.

Over the Dry and Critical water years, average monthly Lake Oroville storage under Alternatives A, B, and C would be similar to conditions under the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. Under Alternative D from January through May, average monthly storage would be similar to the Existing Conditions/No Project/No Action Condition. From June through December, storage in Lake Oroville would increase under Alternative D as compared to the Existing Conditions/No Project/No Action Condition because flows would be released from Sites Reservoir to meet Delta water quality and other downstream water quality criteria which would allow increased cold water storage in Lake Oroville.

Feather River

Over the long term, average monthly Feather River flows under Alternatives A, B, C, and D would be similar to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling, except in October and December when the flows would decrease because water would be released from Sites Reservoir to meet Delta water quality criteria.

Over the Dry and Critical water years, average monthly Feather River flows in November and July and from January through March, Alternatives A, B, C, and D would be similar to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. In October and December and from April through June, flows under Alternatives A, B, C, and D would decrease as compared to the Existing Conditions/No Project/No Action Condition because water would be released from Sites Reservoir to meet Delta water quality criteria. In August and September, flows under Alternatives A, B, C, and D would increase as compared to the Existing Conditions/No Project/No Action Condition due to flows released from Lake Oroville to stabilize flows in the Feather River.

Sutter Bypass

Flows enter the Sutter Bypass at Tisdale Weir, Colusa Weir, Moulton Weir, and the weir at Ord Ferry. Overall, flows into Sutter Bypass are generally reduced in the wetter months (between November and April) as flows are diverted from the Sacramento River into the Sites Reservoir.

Tisdale Weir

Over the long-term, average monthly flows over the Tisdale Weir into the Sutter Bypass under Alternatives A, B, C, and D would be similar in December and January and from June through September to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. In October, flows would increase under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition when flows are released from upstream reservoirs for flood management purposes. In November and from February through May, flows would decrease as compared to the Existing Conditions/No Project/No Action Condition because water from the Sacramento River would be diverted to Sites Reservoir.

Over the Dry and Critical water years, average monthly flows over the Tisdale Weir into the Sutter Bypass under Alternatives A, B, C, and D would be similar from April through October to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System

Modeling. From November through March, flows would decrease as compared to the Existing Conditions/No Project/No Action Condition because water from the Sacramento River would be diverted to Sites Reservoir.

Colusa Weir

Over the long-term, average monthly flows over the Colusa Weir into the Sutter Bypass under Alternatives A, B, C, and D would be similar in November, January, and February and from July through September to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. In October and December, flows would increase under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition when flows are released from upstream reservoirs for flood management purposes. From March through May and in June, flows would decrease as compared to the Existing Conditions/No Project/No Action Condition because water from the Sacramento River would be diverted to Sites Reservoir.

Over the Dry and Critical water years, average monthly flows over the Colusa Weir into the Sutter Bypass under Alternatives A, B, C, and D would be similar from April through October to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. In December, flows would increase under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition when flows are released from upstream reservoirs for flood management purposes. In November and from January through March, flows would decrease as compared to the Existing Conditions/No Project/No Action Condition because water from the Sacramento River would be diverted to Sites Reservoir.

Moulton Weir and Weir at Ord Ferry

Over the long-term, average monthly flows over the Moulton Weir and weir at Ord Ferry into the Sutter Bypass under Alternatives A, B, C, and D would be similar from May through November to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. In December, flows would increase under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition when flows are released from upstream reservoirs for flood management purposes. From January through April, flows would decrease as compared to the Existing Conditions/No Project/No Action Condition because water from the Sacramento River would be diverted to Sites Reservoir.

Over the Dry and Critical water years, average monthly flows over the Moulton Weir and weir at Ord Ferry into the Sutter Bypass under Alternatives A, B, C, and D would be similar from January through November to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. In December, flows would increase under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition when flows are released from upstream reservoirs for flood management purposes.

Yolo Bypass

Over the long term, average flows in the Yolo Bypass in February through August under Alternatives A, C, and D would be similar to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. Average flows in the Yolo Bypass from December through February and from May through September under Alternative B would be similar to the Existing Conditions/No Project/No Action Condition.

Over the long term, average flows in the Yolo Bypass in September and October under Alternatives A, B, C, and D would increase as compared to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling, due to increased flows released into the Sacramento River from upstream reservoirs, including Sites Reservoir, to stabilize fall flows. From November through January under Alternatives A, C, and D, flows in the Yolo Bypass would decrease as compared to the Existing Conditions/No Project/No Action Condition due to diversions from the Sacramento River into Sites Reservoir. In March and April under Alternative B, flows in the Yolo Bypass would decrease as compared to the Existing Conditions/No Project/No Action Condition due to diversions from the Sacramento River into Sites Reservoir.

Over the Dry and Critical water years, average flows in the Yolo Bypass from December and April through September under Alternatives A, B, and D would be similar to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. Average flows in the Yolo Bypass in December and February and from April through September under Alternative C would be would be similar to the Existing Conditions/No Project/No Action Condition. In November under Alternatives A, B, C, and D, flows in the Yolo Bypass would increase as compared to the Existing Conditions/No Project/No Action Condition due to increased flows released into the Sacramento River from upstream reservoirs, including Sites Reservoir, to stabilize fall flows. From November through March under Alternatives A, B, and D and in December through March under Alternative C, flows in the Yolo Bypass would decrease as compared to the Existing Conditions/No Project/No Action Condition due to diversions from the Sacramento River into Sites Reservoir.

Folsom Lake

Over the long-term, average monthly storage in Folsom Lake under Alternatives A, B, C, and D would be similar to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling.

Over the Dry and Critical water years, average monthly storage in Folsom Lake from February through June under Alternatives A, B, C, and D would be similar to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. From July through November under Alternatives A, B, C, and D, the average monthly storage in Folsom Lake would increase as compared to the Existing Conditions/No Project/No Action Condition because water would be released from Sites Reservoir to meet Delta water quality objectives which would allow more water to be stored in Folsom Lake.

American River

Over the long-term, average monthly flows in the American River downstream of Lake Natoma from November through June and from August through September under Alternatives A, B, C, and D would be similar to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. In October, average monthly flows in the American River would increase under Alternatives B and C as compared to the Existing Conditions/No Project/No Action Condition because flows would be released from Folsom Lake to stabilize American River flows. In July, flows would decrease under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition because flows would be released from Sites Reservoir to meet Delta water quality objectives which would allow more water to be stored in Folsom Lake.

Over the Dry and Critical water years, the average monthly flows in the American River downstream of Lake Natoma under Alternative A would generally be similar to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. From February through May and from August through September, the average monthly flows in the American River downstream of Lake Natoma under Alternatives B, C, and D would generally be similar to the Existing Conditions/No Project/No Action Condition. In June and July under Alternatives B, C, and D, the average monthly flows in the American River would decrease as compared to the Existing Conditions/No Project/No Action Condition because water would be released from Sites Reservoir to meet Delta water quality objectives which would allow more water to be stored in Folsom Lake and less water to be released into the American River.

Sacramento-San Joaquin Delta

To analyze conditions in the Delta, the following factors were considered:

- Delta Outflow
- Old and Middle Rivers Flow
- Total Exports from CVP Jones Pumping Plant and SWP Banks Pumping Plant

Delta Outflow

Over the long term, Delta outflow from September through June under Alternatives A, B, C, and D would be similar to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. In July and August, Delta outflow under Alternatives A, B, C, and D would increase as compared to the Existing Conditions/No Project/No Action Condition.

Over Dry and Critical Dry water years, Delta outflow in November, December, April, and May under Alternatives A, B, C, and D would be similar to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. From June through October, Delta outflow under Alternatives A, B, C, and D would increase as compared to the Existing Conditions/No Project/No Action Condition. From January through March, Delta outflow under Alternatives A, B, C, and D would decrease as compared to the Existing Conditions/No Project/No Action Condition.

Old and Middle Rivers Flows

Flows in the southern Delta are tidal in nature, and flow towards the western Delta are considered to be “positive flows” and flows towards the San Joaquin River at Vernalis are considered to be “reverse flows” or “negative flows.” Operations of the Jones Pumping Plant and Banks Pumping Plant increase the extent of the reverse flows. The combined flows in Old and Middle Rivers (known as OMR flows) is a measure of positive and reverse flows in the southern Delta. As described in Section 6.2, regulatory criteria have been implemented to reduce the extent of reverse flows under specific flow conditions from December through June, as described in Appendix 6A Modeling of Alternatives.

Over the long term, average monthly OMR flows from December through August under Alternatives A, B, C, and D would be similar to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. From September through November, OMR flows indicate that the reverse flows would become larger under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition because Delta exports would increase in these months. However, the increased reverse flows would be compliant with the regulatory criteria.

Over the Dry and Critical water years, average monthly OMR flows from February through October and in December would be similar under Alternatives A, B, C, and D to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. In November, January, August and September OMR flows indicate that the reverse flows would become larger under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition because Delta exports would increase in these months. However, the increased reverse flows would be compliant with the regulatory criteria.

Total Exports from CVP Jones Pumping Plant and SWP Banks Pumping Plant

Over the long-term, total exports through Jones Pumping Plant and Banks Pumping Plant from December through August would be similar under Alternatives A, B, C, and D to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. From September through November, total exports through Jones Pumping Plant and Banks Pumping Plant under Alternatives A, B, C, and D would increase as compared to the Existing Conditions/No Project/No Action Condition. Improved Delta outflow and water quality conditions would allow for increased exports under the federal and State water rights and water quality criteria (see Appendix 6A Modeling of Alternatives).

Over the Dry and Critical water years, total exports through Jones Pumping Plant and Banks Pumping Plant from February through July and in October and December would be similar under Alternatives A, B, C, and D to the Existing Conditions/No Project/No Action Condition, as shown in Appendix 6B Water Resources System Modeling. In November, January, August, and September, total exports through Jones Pumping Plant and Banks Pumping Plant under Alternatives A, B, C, and D would increase as compared to the Existing Conditions/No Project/No Action Condition.

6.3.3.3 Primary Study Area – Alternatives A, B, C, and D Compared to the Existing Conditions/No Project/No Action Condition

Funks Creek and Stone Corral Creek

With implementation of Alternative A, B, C, and D, Sites and Golden Gate dams would impound Funks and Stone Corral creeks. After Project construction is complete, minimum instream flows up to a maximum of 10 cfs would be maintained in both Funks and Stone Corral creeks downstream of Sites Reservoir (refer to Chapter 9 Flood Control and Management and Chapter 3 Description of the Sites Reservoir Project Alternatives for additional details).

Funks Reservoir

The existing Funks Reservoir is a reregulating reservoir that balances water level operations of the Tehama-Colusa Canal upstream and downstream of Funks Creek. With implementation of the Project, Funks Reservoir would be expanded to form Holthouse Reservoir by constructing a new dam (Holthouse Dam) and reservoir to the east of Funks Reservoir, and breaching the existing Funks Dam so that the new and existing reservoirs would act as one unit with an enlarged active storage capacity of approximately 6,500 AF and a surface area of approximately 450 acres. Holthouse Reservoir would facilitate balancing and regulating Sites Reservoir inflows and outflows through the Sites Pumping/Generating Plant, and to provide sufficient supplemental storage to allow simultaneous pump back power generation.

Colusa Basin Drain

The Colusa Basin Drain conveys runoff and agricultural return flows from approximately 1 million acres of watershed in the Colusa Basin and discharges the flows to the Sacramento River at Knights Landing. The Colusa Basin Drain also collects flood flows from the local creeks within the Primary Study Area. During high flows, flows in the Colusa Basin Drain are diverted to Yolo Bypass through the Knights Landing Ridge Cut.

The operation of Sites Reservoir would reduce potential flood flow impacts primarily from Funks and Stone Corral creeks, as well as from Grapevine and Antelope creeks, which are located within the Sites Reservoir Inundation Area. Flows from these creeks would be regulated by Sites and Golden Gate dams through releases of minimum instream flows. Hunters and Lurline creeks, which flow into the Colusa Basin Drain, would not be affected by Sites Reservoir's operation.

The Colusa Basin Drain would, therefore, change from an unregulated sporadic flow that is responsive to local storms to a regulated low maintenance flow resulting from the reduced drainage from Funks, Stone Corral, Grapevine, and Antelope creeks once Sites Reservoir becomes operational.

Other Local Creeks

Many small tributaries exist within the Primary Study Area, including Grapevine Creek, Antelope Creek, Hunters Creek, and Lurline Creek.

Grapevine and Antelope creeks are located within the Sites Reservoir Inundation Area; flows from both of these creeks would be reduced with operation of Sites Reservoir.

Hunters Creek (located north of Sites Reservoir) flows to the east. Lurline Creek (located southeast of Sites Reservoir) flows to the east. Hunters and Lurline creeks flow into the Colusa Basin Drain. The operation of Sites Reservoir would not affect Hunters and Lurline creeks.

Sites Reservoir

Table 6-7 shows the average monthly storage at the Sites Reservoir over the long-term and over the Dry and Critical water years under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition.

Table 6-7
Sites Reservoir End of Month Storage (TAF)
Alternatives A, B, C, and D Compared to the Existing Conditions/No Project/No Action Condition

Long-term Average[a,b]						Dry and Critical Water Years Average[a,c]					
		Change from the Existing Conditions/ No Project/No Action Condition						Change from the Existing Conditions/ No Project/No Action Condition			
Month	EC/NP/NAC	Alt. A	Alt. B	Alt. C	Alt. D	Month	EC/NP/NAC	Alt. A	Alt. B	Alt. C	Alt. D
Oct	0	633	902	1049	1031	Oct	0	365	452	623	568
Nov	0	596	862	1004	998	Nov	0	348	433	591	553
Dec	0	679	924	1084	1090	Dec	0	394	469	628	604
Jan	0	812	1013	1220	1225	Jan	0	595	770	938	937
Feb	0	926	1106	1349	1349	Feb	0	703	837	1041	1044
Mar	0	1017	1237	1463	1460	Mar	0	803	921	1154	1148

Long-term Average[a,b]						Dry and Critical Water Years Average[a,c]					
		Change from the Existing Conditions/ No Project/No Action Condition						Change from the Existing Conditions/ No Project/No Action Condition			
Month	EC/NP/NAC	Alt. A	Alt. B	Alt. C	Alt. D	Month	EC/NP/NAC	Alt. A	Alt. B	Alt. C	Alt. D
Apr	0	1012	1253	1465	1469	Apr	0	750	876	1103	1115
May	0	985	1235	1441	1447	May	0	682	805	1034	1054
Jun	0	934	1171	1386	1357	Jun	0	620	710	949	913
Jul	0	826	1068	1276	1230	Jul	0	552	613	862	775
Aug	0	759	1014	1192	1154	Aug	0	471	540	758	674
Sep	0	687	947	1114	1083	Sep	0	412	491	688	614

[a] Based on CALSIM II modeling over an 82-year simulation period.

[b] Long-Term is the average quantity for the period of October 1921 through September 2003.

[c] Dry and Critical Years Average is the average quantity for the combination of the SWRCB D-1641 40-30-30 Dry and Critical years for the period of October 1921 through September 2003.

Note:

EC/NP/NAC = Existing Conditions/No Project/No Action Condition

Over the long-term and over Dry and Critical water years, the average monthly storage in Sites Reservoir would be the highest in March and April and lowest in November under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition, which does not include Sites Reservoir.

Delevan Pipeline Intake/Discharge Facilities

Table 6-8 shows the average monthly inflows in the Delevan Pipeline, which conveys water from the Sacramento River to Sites Reservoir under Alternatives A, C, and D. Under Alternative B, the Delevan Pipeline is not used to convey water from the Sacramento River to Sites Reservoir. These values do not include discharge flows from Sites Reservoir to the Sacramento River.

Table 6-8
Delevan Pipeline Intake/Discharge Facilities Monthly Flow (cfs)
Alternatives A, B, C, and D Compared to the Existing Conditions/No Project/No Action Condition

Long-term Average[a,b]						Dry and Critical Water Years Average[a,c]					
		Change from the Existing Conditions/No Project/No Action Condition						Change from the Existing Conditions/No Project/No Action Condition			
Month	EC/NP/NAC	Alt. A	Alt. B	Alt. C	Alt. D	Month	EC/NP/NAC	Alt. A	Alt. B	Alt. C	Alt. D
Oct	0	7	0	16	16	Oct	0	0	0	6	0
Nov	0	55	0	55	57	Nov	0	26	0	27	26
Dec	0	343	0	335	369	Dec	0	180	0	180	192
Jan	0	761	0	806	793	Jan	0	391	0	391	392
Feb	0	655	0	776	735	Feb	0	610	0	610	615
Mar	0	308	0	406	384	Mar	0	348	0	460	399
Apr	0	68	0	71	0	Apr	0	186	0	193	0
May	0	66	0	78	0	May	0	180	0	213	0
Jun	0	694	0	690	36	Jun	0	778	0	622	0

Long-term Average[a,b]						Dry and Critical Water Years Average[a,c]					
		Change from the Existing Conditions/No Project/No Action Condition						Change from the Existing Conditions/No Project/No Action Condition			
Month	EC/NP/NAC	Alt. A	Alt. B	Alt. C	Alt. D	Month	EC/NP/NAC	Alt. A	Alt. B	Alt. C	Alt. D
Jul	0	468	0	485	15	Jul	0	704	0	560	21
Aug	0	19	0	16	23	Aug	0	13	0	13	14
Sep	0	7	0	2	9	Sep	0	20	0	7	24

[a] Based on CALSIM II modeling over an 82-year simulation period.

[b] Long-Term is the average quantity for the period of October 1921 through September 2003.

[c] Dry and Critical Years Average is the average quantity for the combination of the SWRCB D-1641 40-30-30 Dry and Critical years for the period of October 1921 through September 2003.

EC/NP/NAC = Existing Conditions/No Project/No Action Condition

Over the long-term, the average flows diverted from the Sacramento River to Sites Reservoir would be the highest in January and the lowest in September under Alternatives A, C, and D as compared to the Existing Conditions/No Project/No Action Condition, which does not include Sites Reservoir and the Delevan Pipeline. Under Alternative B, the Delevan Pipeline is not used to convey water from the Sacramento River to Sites Reservoir.

Over the Dry and Critical water years, the average flows would be the highest in March and the lowest in October under Alternatives A, C, and D as compared to the Existing Conditions/No Project/No Action Condition, which does not include Sites Reservoir and the Delevan Pipeline. Under Alternative B, the Delevan Pipeline is not used to convey water from the Sacramento River to Sites Reservoir.

6.4 Evaluation of Changes to CVP/SWP Operational Flexibility

The existing State and federal water systems, SWP and CVP, respectively, have become relatively rigid in terms of timing, location, and quantity of stored and released water. This lack of flexibility creates difficulty in addressing many of the challenges facing California’s water managers, including drought impacts, flood risk, declining ecosystems, impaired water quality, and climate change. As described in Chapter 1 Introduction, having more water in storage would improve the operational flexibility of California’s major water systems and would give water managers the ability to develop more solutions to respond to California’s water resources challenges.

Changes in SWP and CVP storage associated with implementation of Alternatives A, B, C, and D, when compared to the Existing Conditions/No Project/No Action Condition, are discussed in Section 6.4.1.

6.4.1 Total North-of-the-Delta SWP and CVP Reservoir Storage

Table 6-9 presents total average annual north of the Delta storage in Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and the Sites Reservoir under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition.

Table 6-9
Total Annual North-of-the-Delta Storage (TAF)

Long-term Average[a,b]						Dry and Critical Water Years Average[a,c]					
	Existing Conditions/No Project/ No Action Condition	**Change from the Existing Conditions/No Project/No Action Condition**					**Existing Conditions/ No Project/ No Action Condition**	**Change from the Existing Conditions/No Project/No Action Condition**			
		Alt. A	**Alt. B**	**Alt. C**	**Alt. D**			**Alt. A**	**Alt. B**	**Alt. C**	**Alt. D**
Annual	7,591	964 (13%)	1,205 (16%)	1,410 (19%)	1,385 (18%)	Annual	6,040	821 (14%)	983 (16%)	1,203 (20%)	820 (14%)

[a] Based on CALSIM II modeling over an 82-year simulation period.

[b] Long-Term is the average quantity for the period of October 1921 through September 2003.

[c] Dry and Critical Years Average is the average quantity for the combination of the SWRCB D-1641 40-30-30 Dry and Critical years for the period of October 1921 through September 2003.

Over the long-term and over Dry and Critical water years, the Sites Reservoir would provide additional operational flexibility and substantial increases in total storage under Alternatives A, B, C, and D as compared to the Existing Conditions/No Project/No Action Condition.

Alternative A would provide the lowest increase in total storage because this alternative has the smallest Sites Reservoir (1.3 MAF). Alternative B would provide the second lowest increase in total storage because the ability to convey water from the Sacramento River to the Sites Reservoir does not include the use of the Delevan Pipeline. Alternative C and D would provide similar increases in total storage because these alternatives have identical facilities.

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