Chapter 6
Hydrology, Hydraulics, and Water Management

6.1 Affected Environment

This affected environment section first presents background information and then describes storage and diversion facilities, and hydrology, hydraulics, and water management (H&H), including flood management, south Delta water levels, and groundwater resources. For a more in-depth description of the affected environment, see the *Hydrology, Hydraulics, and Water Management Technical Report*.

6.1.1 Storage Facilities

Facilities described below include Shasta Dam and Powerplant, Keswick Dam and Powerplant, and Anderson-Cottonwood Irrigation District Diversion Dam.

Shasta Lake and Vicinity

This section describes storage facilities in the Shasta Lake area.

Shasta Dam and Powerplant Shasta Dam is a curved, gravity-type, concrete structure that rises 533 feet above the streambed with a total height above the foundation of 602 feet. The dam has a crest width of about 41 feet and a length of 3,460 feet. Shasta Reservoir has a storage capacity of 4,550,000 acre-feet, and water surface area at full pool of 29,600 acres. Maximum seasonal flood management storage space in Shasta Reservoir is 1.3 million acre-feet (MAF). Releases from Shasta Dam can be made through the powerplant, over the spillway, or through the river outlets. The powerplant has a maximum release capacity of nearly 20,000 cubic feet per second (cfs), the river outlets can release a maximum of 81,800 cfs at full pool, and the maximum release over the drum-gated spillway is 186,000 cfs.

Upper Sacramento River (Shasta Dam to Red Bluff)

This section describes storage facilities along the Upper Sacramento River.

Keswick Dam and Powerplant Keswick Dam is about 9 miles downstream from Shasta Dam. In addition to regulating outflow from the dam, Keswick Dam controls runoff from 45 square miles of drainage area. Keswick Dam is a concrete, gravity-type structure with a spillway over the center of the dam. The spillway has four 50- by 50-foot fixed wheel gates with a combined discharge capacity of 248,000 cfs at full or full pool elevation (587 feet). Storage capacity below the top of the spillway gates at full pool is 23,800 acre-feet. The powerplant has a nameplate generating capacity of 105,000 kilowatts and can pass about 15,000 cfs at full pool.

6.1.2 Diversion Facilities

In the Klamath Basin, the Clear Creek Tunnel diverts water from Lewiston Reservoir (below Trinity Reservoir) to Whiskeytown Reservoir. The Spring Creek Tunnel then diverts water from Whiskeytown Reservoir to Keswick Reservoir on the Sacramento River. These two diversions bring water from the Klamath Basin into the Sacramento Basin; the water is used for power generation, water temperature regulation and local water supplies.

Below Keswick Dam, two facilities divert flows from the Sacramento River, the Anderson-Cottonwood Irrigation District Diversion Dam and Red Bluff Pumping Plant (RBPP). The primary purpose of these two facilities is to divert water into canals for local agricultural use.

In the Delta, the CVP and SWP primarily make diversions through two pumping plants, the CVP C.W. “Bill” Jones Pumping Plant (Jones) and the SWP Harvey O. Banks Pumping Plant (Banks). These two pumping plants supply water to the CVP/SWP service areas south of the Delta. Although other diversion facilities are located between RBPP and the Delta, they would have less of an effect on project operations than those discussed above.

6.1.3 Hydrology and Hydraulics

The Sacramento Valley contains the Sacramento, Feather, and American river basins, covering an area of more than 24,000 square miles in the northern portion of the Central Valley. The Sacramento Valley comprises four distinct areas; the Sacramento River headwater that includes the McCloud River, Pit River, and Sacramento River in the north; the Delta in the south; the Sierra Nevada Mountains and Cascade Ranges in the east; and the Coast Range and Klamath Mountains in the west.

Shasta Lake and Vicinity

The most northern portion of the Sacramento River basin, upstream from Shasta Dam, is drained by four major tributaries (the Sacramento River, McCloud River, Pit River, and Squaw Creek) in addition to numerous minor tributary creeks and streams.

Upper Sacramento River (Shasta Dam to Red Bluff)

Flows in the Sacramento River in the 65-mile reach between Shasta Dam and Red Bluff (River Mile (RM) 244) are regulated by Shasta Dam and are reregulated downstream at Keswick Dam (RM 302). In this reach, flows are influenced by tributary inflow. Major west side tributaries to the Sacramento River in this reach of the river include Clear and Cottonwood creeks. Major east side tributaries to the Sacramento River in this reach of the river include Battle, Bear, Churn, Cow, and Paynes creeks. This section of the Sacramento River also receives water from Klamath Basin (see Section 6.1.2, "Diversion Facilities).

Lower Sacramento River and Delta

The Sacramento River enters the Sacramento Valley about 5 miles north of Red Bluff. From Red Bluff to Chico Landing (52 miles), the river receives flows from Antelope, Mill, Deer, Big Chico, Rock, and Pine creeks on the east side and Thomes, Elder, Reeds, and Red Bank creeks on the west side. From Chico Landing to Colusa (50 miles), the Sacramento River meanders through alluvial deposits between widely spaced levees. Stony Creek is the only major tributary in this segment of the river. No tributaries enter the Sacramento River between Stony Creek and its confluence with the Feather River.

Floodwaters in the Sacramento River overflow the east bank at three sites in a reach referred to by the State of California (State) as the Butte Basin Overflow Area. In this river reach, several Federal projects begin, including the Sacramento River Flood Control Project, Sacramento River Major and Minor Tributaries Project, and Sacramento River Bank Protection Project. Levees of the Sacramento River Flood Control Project begin in this reach, downstream from Ord Ferry on the west (RM 184), and downstream from RM 176 above Butte City on the east side of the river.

Shasta Reservoir also is operated to meet a flow requirement in the Sacramento River, at Wilkins Slough near Grimes (RM 125), also known as the Navigation Control Point. Downstream from Wilkins Slough, the Feather River, the largest east side tributary to the Sacramento River, enters the river just above Verona. Between Wilkins Slough and Verona, floodwater is diverted at two places in this segment of the river—Tisdale Weir into the Tisdale Bypass and Fremont Weir into the Yolo Bypass. The bypass system routes floodwater away from the mainstem Sacramento River to discharge into the Delta.

Below Verona, the Sacramento River flows 79 miles to the Delta, passing the City of Sacramento. The Yolo Bypass parallels this river reach to the west. Flows enter this river reach at various points. First, flows from the Natomas Cross Canal enter the Sacramento River approximately 1 mile downstream from the Feather River mouth. The American River flows into the Sacramento River in the City of Sacramento. When Sacramento River system flood flows are the highest, a portion of the flow is diverted into the Yolo Bypass at the Sacramento Weir, about 3 miles upstream from the American River confluence in downtown Sacramento. At the downstream end, Yolo Bypass flows reenter the Sacramento River near Rio Vista. As the river enters the Delta, Georgiana Slough branches off from the mainstem of the Sacramento River, routing a portion of the flow into the central Delta.

The hydraulics of the Delta are complicated by tidal influences, a multitude of agricultural and municipal and industrial (M&I) diversions for use within the Delta itself, and by CVP and SWP exports. The principal factors affecting Delta hydrodynamics are (1) river inflow and outflow from the Sacramento River and San Joaquin River systems, (2) daily tidal inflow and outflow through San Francisco Bay, and (3) export pumping from the south Delta, primarily through the Jones and Banks pumping plants.

The Jones Pumping Plant consists of six pumps, with a maximum export capacity of 4,600 cfs. The Jones Pumping Plant is at the end of an earth-lined intake channel about 2.5 miles long.

The Banks Pumping Plant supplies water for the South Bay Aqueduct and the California Aqueduct, with an installed capacity of 10,300 cfs. Under current operational constraints, exports from Banks Pumping Plant generally are limited to a daily average of 6,680 cfs, except between December 15 and March 15, when exports can be increased by 33 percent of San Joaquin River flow. The Banks Pumping Plant exports water from the Clifton Court Forebay, a 31,000-acre-foot reservoir that provides storage for off-peak pumping, and moderates the effect of the pumps on the fluctuation of flow and stage in adjacent Delta channels.

The Contra Costa Water District (CCWD) supplies CVP water to its users via a pumping plant at the end of Rock Slough. The Rock Slough diversion capacity of 350 cfs gradually decreases to 22 cfs at the terminus. CCWD also constructed and operates the 160,000-acre-foot Los Vaqueros Reservoir, which has intakes and pumping plants on the Old River and Victoria Canal for diverting surplus Delta flows to reservoir storage or contract water to CCWD users. Because tidal inflows are approximately equivalent to tidal outflows during each daily tidal cycle, tributary inflows and export pumping are the principal variables that define the range of hydrodynamic conditions in the Delta. Excess outflow occurs almost entirely during the winter and spring months. Average winter outflow is about 32,000 cfs, while the average summer outflow is 6,000 cfs.

CVP/SWP Service Areas

This section describes the hydrology and hydraulics of the CVP/SWP service areas, located south of the primary study area.

Downstream from the Jones Pumping Plant, CVP water flows in the Delta-Mendota Canal and can be either diverted by the O’Neill Pumping-Generating Plant into the O’Neill Forebay or can continue down the Delta-Mendota Canal for delivery to CVP contractors. The O’Neill Pumping-Generating Plant consists of six pump-generating units, with a capacity of 700 cfs each.

The O’Neill Forebay is a joint CVP/SWP facility, with a storage capacity of about 56,000 acre-feet. In addition to its interactions with the Delta-Mendota Canal via the O’Neill Pumping-Generating Plant, it is a part of the SWP California Aqueduct. The O’Neill Forebay serves as a regulatory body for San Luis Reservoir; the William R. Gianelli Pumping-Generating Plant, also a joint CVP/SWP facility, can pump flows from the O’Neill Forebay into San Luis

Reservoir and also make releases from San Luis Reservoir to the O'Neill Forebay for diversion to either the Delta-Mendota Canal or the California Aqueduct. Also, several water districts receive diversions directly from the O'Neill Forebay. The William R. Gianelli Pumping-Generating Plant consists of eight units, with 1,375 cfs of capacity each.

San Luis Reservoir provides offstream storage for excess winter and spring flows diverted from the Delta. It is sized to provide seasonal carryover storage, with a total capacity of 2,027,840 acre-feet. The CVP share of the storage is 965,660 acre-feet; the remaining 1,062,180 acre-feet are the SWP share. During spring and summer, water demands and schedules are greater than the capability of Reclamation and DWR to pump water from the Jones and Banks pumping plants; water stored in San Luis Reservoir is used to make up the difference. The CVP share of San Luis Reservoir typically is at its lowest in August and September, and at its maximum in April. The San Felipe Division of the CVP supplies water to customers in Santa Clara and San Benito counties from San Luis Reservoir. The operation of San Luis Reservoir has the potential to affect the water quality and reliability of these supplies if reservoir storage drops below 300,000 acre-feet.

South of the O'Neill Forebay, the Delta-Mendota Canal terminates in the Mendota Pool, about 30 miles west of Fresno. From the Delta-Mendota Canal, the CVP makes diversions to multiple water users and refuges. Delta-Mendota Canal capacity at the terminus is 3,211 cfs. Parallel to the Delta-Mendota Canal, the San Luis Canal-California Aqueduct is a joint-use facility for the CVP and SWP. It begins on the southeast edge of the O'Neill Forebay and extends about 101.5 miles southeasterly to a point near Kettleman City. Water from the canal serves the San Luis Federal service area, mostly for agricultural purposes and for some M&I uses. The canal has a capacity ranging from 8,350 cfs to 13,100 cfs.

South of Banks Pumping Plant, the California Aqueduct flows into Bethany Reservoir, a 5,000-acre-foot forebay for the South Bay Pumping Plant. Exiting the Bethany Forebay, the California Aqueduct flows through a series of checks to the aforementioned O'Neill Forebay, and is either pumped into San Luis Reservoir or released to the San Luis Canal, the CVP/SWP joint-use portion of the California Aqueduct. Deliveries are made from the California Aqueduct to agricultural and M&I contractors.

Downstream from the pumping plants is the Delta-Mendota Canal/California Aqueduct Intertie, a shared federal-state water system improvement project which connects the Delta-Mendota Canal (federal facility) and the California Aqueduct (state facility) and pumping station and two 108-inch-diameter pipes. The pumping station has a capacity of 467 cfs up hill and 900 cfs gravity flow from the California Aqueduct to the Delta-Mendota Canal. The Intertie is located at the closest point between the Delta-Mendota Canal and California Aqueduct which is 500 feet horizontal and 50 feet vertical. The Intertie provides redundancy in the water distribution system, allows for maintenance and repair activities that are less disruptive to water deliveries, and provides the flexibility to respond to CVP and SWP emergencies.

6.1.4 Surface Water Supply

Although water supply reliability is one of the two primary planning objectives of the SLWRI, operations for Shasta Reservoir primarily are focused on delivering water supply to CVP contractors. However, because of the interconnectivity of the CVP and SWP, water supply operations of the SWP could be affected by changes in operations of the CVP associated with the SLWRI.

CVP/SWP Service Areas

This section describes surface water supply to CVP and SWP contractors.

CVP Contractors At certain times of the year, operations of Shasta Reservoir are driven by water supply needs of the CVP contractors. The CVP provides water to settlement contractors in the Sacramento Valley, exchange contractors in the San Joaquin Valley, agricultural and M&I water service contractors in both the Sacramento and San Joaquin valleys, and wildlife refuges both north and south of the Delta. At the beginning of each year, Reclamation evaluates hydrologic conditions throughout California and uses this information to forecast CVP operations, and to estimate the amount of water to be made available to the Federal water service contractors for the year.

The majority of the Federal water service contractors have service areas located south of the Delta. In general, allocations to CVP water service contractors south of the Delta are lower than allocations to service contractors in the Sacramento Valley. Because of water rights secured before construction of the CVP, Sacramento Valley settlement contractors and San Joaquin Valley exchange contractors have a higher level of reliability for their supplies; except in extremely dry years, when the water year type, as defined by the Shasta Hydrologic Index, is classified as critical, settlement and exchange contractors receive 100 percent of their contract amounts. In Shasta critical years, settlement and exchange contractors receive 75 percent of their contract amounts. A Shasta critical year is defined as a year when the total inflow to Shasta Reservoir is below 3.2 MAF, or the average inflow for a 2-year period is below 4.0 MAF and the total 2-year deficiency for deliveries is higher than 0.8.

SWP Contractors The CVP and SWP are intrinsically linked through the Delta; shared responsibilities under their respective water rights and coordinated operations agreements mean that a change in flow from one project could result in a flow change from the other. Accordingly, SWP water supply operations are discussed below.

The SWP operates under long-term contracts with public water agencies throughout California. These agencies, in turn, deliver water to wholesalers or retailers, or deliver it directly to agricultural and M&I water users (DWR 1999). The SWP contracts between DWR and individual State water contractors define several classifications of water available for delivery under specific circumstances.

6.1.5 Flood Management

This section describes major features of the flood management system in the primary and extended study areas, including reservoirs, levees, weirs, and bypasses. Historical operation of these facilities also is described.

Shasta Lake and Vicinity

Releases from Shasta Dam often are made for flood management. Releases for flood management occur either in the fall, beginning in early October, to reach the prescribed vacant flood space, or to evacuate space during or after a storm event to maintain the prescribed vacant flood space in the reservoir. During a storm event, releases for flood management occur either over the spillway during large events or through river outlets for smaller events. Between 1950 and 2006, flows over the spillway occurred in 12 years, or in 21 percent of years. During the same time interval, releases for flood management (either for seasonal space evacuation or during a flood event, and including spills over the spillway) occurred in about 37 years, or nearly 70 percent of the years.

Upper Sacramento River (Shasta Dam to Red Bluff)

Historically, the largest flood events along the upper Sacramento River have been from heavy rainfall, with a relatively smaller component of the flows coming from snowmelt in the upper basin. Flood management operations at Shasta Dam include forecasting runoff into Shasta Lake as well as runoff of unregulated creek systems downstream from Keswick Dam. A critical component of upper Sacramento River flood operations is the forecast of local runoff entering the Sacramento River between Keswick Dam and Bend Bridge near Red Bluff.

The unregulated creeks (major tributaries include Cottonwood, Cow, and Battle creeks) discharging into the Sacramento River between Keswick Dam and Bend Bridge can produce high runoff rates into the Sacramento River in short periods of time. During large flood events, the local runoff between Keswick Dam and Bend Bridge can exceed 100,000 cfs.

Lower Sacramento River and Delta

Flood management facilities along the lower Sacramento River and in the Delta include the levees, weirs, and bypasses of upper and lower Butte basin, the Sacramento River between Colusa and Verona, and the Sacramento River between Verona and Collinsville. The levees, weirs, and bypasses are features of the Sacramento River Flood Control Project, which began operation in the 1930s and was significantly expanded in the 1950s.

When Sacramento River flows exceed between 90,000 and 100,000 cfs at Ord Ferry, water flows naturally over the banks of the river into Butte basin. In addition to the Sacramento River overbank flows at Ord Ferry, the basin receives inflow over the Colusa and Moulton weirs and from tributary streams draining from the northeast, principally Cherokee Canal and Butte Creek. Before construction of the Feather River levees, Butte basin also received overflows from the Feather River north of the Sutter Buttes. Outflows from Butte basin move through the Sutter Bypass when the Sacramento River is high or through the Butte Slough outfall gates (RM 139) into the Sacramento River when the river is low.

The Sacramento River meanders through the 64 miles between Colusa (RM 143) and Verona (RM 79). The levee system continues along both sides of this river reach. The levee spacing (or channel width), east to west, is wider between the upstream sections, from RM 176 to RM 143 at Colusa, than the levee spacing downstream from Colusa. The Feather River, the largest east side tributary to the Sacramento River, enters the river just above Verona. Flood management diversions occur at two places in this segment of the river, at the Tisdale Weir and Fremont Weir.

Below Verona, the Sacramento River flows 79 miles to Collinsville, at the mouth of the Delta, passing the City of Sacramento along the way. The Yolo Bypass parallels this river reach to the west. Flows enter this river reach at various points. First, flows from the Natomas Cross Canal enter the Sacramento River approximately 1 mile downstream from the Feather River mouth (RM 80). The American River (RM 60), the southernmost major Sacramento River tributary, enters the river at the City of Sacramento. Flows in the Yolo Bypass reenter the river near Rio Vista (RM 12). As the river enters the Delta, Georgiana Slough branches off from the mainstream Sacramento River, routing flows into the central Delta. The one diversion point for flood management is at Sacramento Weir, where floodwaters are diverted from the Sacramento River through the Sacramento Bypass to the Yolo Bypass under the highest flow conditions.

CVP/SWP Service Areas

This section describes flood management facilities in the CVP/SWP service areas by river basin, including the Feather River, American River, San Joaquin River, and east side tributaries to the Delta (i.e., Littlejohns Creek, Calaveras River, and Mokelumne River).

The primary flood management feature of the Feather River basin is Oroville Reservoir, with a flood management reservation volume of 750,000 acre-feet. Oroville Reservoir releases are used to help meet the objective flow on the Feather River of 150,000 cfs, and in conjunction with New Bullards Bar Reservoir on the Yuba River, to meet an objective flow below the Yuba River confluence of 300,000 cfs. Levees line the Feather River from its confluence with the Sacramento River to the City of Oroville (RM 63).

The lower American River is primarily protected from flooding by Folsom Dam. The Folsom Reservoir flood management reservation volume is variable, ranging from 400,000 acre-feet to 670,000 acre-feet. The objective release on the American River is 115,000 cfs; however, some damage to infrastructure along the American River occurs at flows above 20,000 cfs. The American River is leveed from its confluence with the Sacramento River to near the Carmichael Bluffs on the north bank, and to near the Sunrise Boulevard Bridge on the south bank (RM 19).

The San Joaquin River basin is protected by an extensive reservoir system, including the following:

- Friant Dam and Millerton Lake (RM 270), with a flood management reservation volume of 170,000 acre-feet
- Big Creek Dam, on Big Creek, with a flood management reservation of 30,200 acre-feet
- Hidden Dam and Hensley Lake on the Fresno River, with a flood management reservation of 65,000 acre-feet
- Buchanan Dam and H.V. Eastman Lake on the Chowchilla River, with a flood management reservation of 45,000 acre-feet
- Los Banos Detention Dam on Los Banos Creek, with a flood management reservation of 14,000 acre-feet
- Merced County Stream Group Project, consisting of five dry dams (i.e., Bear, Burns, Owens, Mariposa, and Castle) and two diversion structures, with a total flood storage capacity of 30,500 acre-feet
- New Exchequer Dam and Lake McClure on the Merced River, with a flood management reservation of 350,000 acre-feet
- Don Pedro Dam and Lake on the Tuolumne River, with a flood management reservation of 340,000 acre-feet
- New Melones Dam and Lake on the Stanislaus River, with a flood management reservation of 450,000 acre-feet

The streams in the northern portion of the San Joaquin River basin, between the American and Stanislaus rivers, commonly are referred to as the eastside tributaries to the Delta. These rivers flow into the San Joaquin River within the boundaries of the Delta. Flood management features on the eastside tributaries to the Delta include the following:

- Farmington Dam and Reservoir on Littlejohns Creek, with a flood management reservation of 52,000 acre-feet
- New Hogan Dam and Lake on the Calaveras River, with a flood management reservation of 165,000 acre-feet
- Camanche Dam and Reservoir on the Mokelumne River, with a flood management reservation of 200,000 acre-feet

6.1.6 South Delta Water Levels

This section discusses the variability of water levels in the south Delta, as part of CVP/SWP operations in the extended study area.

In the south Delta, decreases in water levels resulting from CVP and SWP export pumping are a concern for local agricultural diverters because, during periods of low water levels, sufficient pump draft cannot be maintained and irrigation can be interrupted. Historically, the highest minimum stage in the Middle River typically occurs in February and is about 0.1 foot below mean sea level (msl). The lowest minimum stage typically occurs in August and is about 0.8 foot below msl. During dry and critical years,[1] under existing conditions, the highest minimum stage in the Middle River typically occurs in April and is about 0.6 foot below msl. The lowest minimum stage typically occurs in September and is about 0.7 foot below msl (CALFED 2000a).

6.1.7 Groundwater Resources

The use and sustainable management of groundwater resources is an important component in meeting water demands in California. More than 70 percent of California’s groundwater extraction occurs in the Central Valley from Tulare Lake, San Joaquin River, and Sacramento River Hydrologic Regions (HR) combined (DWR 2003b). The South Coast, North Coast, North Lahontan, San Joaquin River, and Sacramento River HRs take between 20 and 40 percent of their supply from groundwater. Information specific to groundwater resources includes groundwater levels and budget and groundwater quality.

Shasta Lake and Vicinity

Shasta Lake and vicinity are located in the foothill area northwest of the Redding groundwater basin. Small groundwater basins underlying Shasta Lake and vicinity do not have significant groundwater availability for use as a source of supply (Shasta County Water Agency 1998). Groundwater basins underlying Shasta County include the Fall River Valley groundwater basin, Lake Britton groundwater basin, and North Fork Battle Creek. Of these three groundwater basins, the Fall River Valley groundwater basin covers the largest area (54,800 acres) and groundwater extraction for agricultural use in this basin is the highest (approximately 19,000 acre-feet). Estimated groundwater extraction for M&I

[1] Throughout this document, water year types are defined according to the Sacramento Valley Index Water Year Hydrologic Classification unless specified otherwise.

use in these subbasins ranges from 5 acre-feet to 240 acre-feet. Deep percolation from applied water is minor, ranging from 10 acre-feet to 4,800 acre-feet. Groundwater quality in Shasta Lake and vicinity typically is good. Total dissolved solids (TDS) concentrations in the Fall River Valley groundwater basin are low, ranging from 115 to 232 milligrams per liter (mg/L) and some wells in the area have high iron concentrations (DWR 2003b).

Upper Sacramento River (Shasta Dam to Red Bluff)

The upper Sacramento River portion of the study area extends from Redding to Red Bluff and includes the Redding groundwater basin and the northern portion of the Sacramento groundwater basin.

The Redding groundwater basin underlies most of the upper Sacramento River area between Shasta Dam and Red Bluff. The basin is bordered on the north, east, and west by foothills, and on the south by the Sacramento Valley groundwater basin (Tehama 1996). The foothill areas that constitute the eastern and western portions of Shasta and Tehama counties, adjacent to the Redding groundwater basin, are designated as “highland” areas, noted for their relative scarcity of groundwater resources. DWR Bulletin 118 (2003b) subdivides the Redding groundwater basin into six subbasins: Anderson, Enterprise, Millville, Rosewood, Bowman, and South Battle Creek.

The Sacramento groundwater basin extends from the Redding groundwater basin to the San Joaquin Valley, and includes Tehama, Glenn, Butte, Yuba, Colusa, Placer, and Yolo counties.

In general, groundwater flows southeasterly on the west side of the Redding groundwater basin and southwesterly on the east side, toward the Sacramento River (Reclamation and DWR 2003). DWR conducted a review of groundwater level hydrographs in the Anderson, Enterprise, Millville, Rosewood, and Bowman subbasins where groundwater level data was available. This review illustrated the following trends associated with the 1976-1977 and 1987-1994 droughts in each subbasin, followed by a gradual recovery in levels to pre-drought conditions of the early 1970’s and 1980’s (DWR 2003b).

- Slight decline (Anderson Subbasin),
- Gradual decline of approximately 5- to 10-feet (Enterprise Subbasin),
- Slight decline of approximately 5-feet (Millville Subbasin),
- Slight decline (Rosewood Subbasin),
- Slight decline (Bowman Subbasin)

This review also illustrated generally seasonal fluctuations in groundwater levels in the Anderson, Enterprise, Millville, Rosewood, and Bowman subbasins where groundwater level data was available, within the following ranges:

- Ranges from 1- to 10-feet for normal and dry years (Anderson Subbasin),
- Ranges from 5- to 10-feet and for the semi-confined wells, between 10- to 15-feet for normal and dry years (Enterprise Subbasin),
- Range from 2- to 8-feet for normal and dry years (Millville Subbasin),
- Range from 5- to 10-feet for normal and dry years (Rosewood Subbasin),
- Approximately 5-feet for normal and dry years (Bowman Subbasin).

Historically, groundwater levels in the Redding groundwater basin have remained relatively stable, with no apparent long-term trend of declining or increasing levels. DWR has estimated the total quantity of groundwater storage in the Redding groundwater basin at approximately 6.9 MAF (Reclamation and DWR 2003).

In the northern portion of the Sacramento groundwater basin, the following three subbasins are included in upper Sacramento River portion of the primary study area: Red Bluff, Antelope, and Bend subbasins. Groundwater extraction in the Red Bluff subbasin is nearly 90,000 acre-feet. DWR reported that Red Bluff, Corning, Woodland, Davis, and Dixon are completely dependent on groundwater. Domestic use of groundwater varies, but in general, rural unincorporated areas rely completely on groundwater (DWR 2003b).

Groundwater in the Redding area is of good quality, as shown by low TDS concentrations, ranging from 70 to 360 mg/L within the six Redding Groundwater Basin subbasins (DWR 2003b). This range is below the U.S. Environmental Protection Agency and California Environmental Protection Agency secondary drinking water standard of 500 mg/L, and also below the agricultural water quality goal of 450 mg/L. Areas of high salinity and poor quality are generally found on the basin margins where groundwater is derived from marine sedimentary rock containing brackish to saline water (Reclamation and DWR 2003). The groundwater is degraded by underlying marine sediments mixing with fresh water from the younger alluvial aquifer (DWR 2003b).

Groundwater quality in the Sacramento groundwater basin is generally good and sufficient for agricultural and M&I uses, with TDS levels ranging from 200 to 500 mg/L (Reclamation and DWR 2003). Localized groundwater quality issues occur as a result of natural water quality impairments at the north end of the Sacramento Valley, where marine sedimentary rocks containing brackish to saline water are near the surface (Reclamation and DWR 2003).

Lower Sacramento River and Delta

The groundwater basins underlying the lower Sacramento River and Delta areas include the Sacramento Valley groundwater basin, and North and South San Joaquin Valley groundwater basins.

In the Sacramento groundwater basin, groundwater flows inward from the edges of the basin and south parallel to the Sacramento River. Groundwater extraction in some local areas resulted in groundwater depressions and local groundwater gradients (Reclamation and DWR 2003). Before completion of CVP facilities (1964 through 1971), pumping along the west side of the basin caused groundwater levels to decline. In the Sacramento groundwater basin, a slight decline of 2 to 12 feet was experienced in groundwater levels as a result of the 1976 through 1977 and 1987 through 1994 droughts. This was followed by a recovery to predrought conditions of the early 1970s and 1980s. Generally, groundwater level data show an average seasonal fluctuation ranging from 2 to 15 feet. Groundwater production in the basin increased from 500,000 acre-feet in the 1940s to 2 MAF annually in the mid-1990s.

As mentioned, groundwater quality in the Sacramento groundwater basin is generally good and is sufficient for agricultural and M&I uses, with TDS levels ranging from 200 to 500 mg/L (Reclamation and DWR 2003).

CVP/SWP Service Areas

The groundwater basins underlying the CVP/SWP service areas include the San Joaquin Valley, Santa Clara Valley, Antelope Valley, Fremont Valley, Coastal Plain of Los Angeles, and Coastal Plain of Orange County groundwater basins, and multiple other smaller groundwater basins underlying areas that receive water from the CVP/SWP system.

The San Joaquin Valley groundwater basin is a regional basin and is the largest in California, extending approximately from the Delta to Bakersfield. Areas within the San Joaquin Valley groundwater basin are heavily groundwater-reliant. Groundwater accounts for about 30 percent of the annual supply used for agricultural and urban purposes (Reclamation and DWR 2003). Groundwater production in the north San Joaquin Valley groundwater basin alone increased from 1.5 MAF annually in the 1920s to more than 3.5 MAF annually in 1990 (Reclamation and DWR 2003). In the south San Joaquin Valley groundwater basin, groundwater production for agriculture rose from approximately 3.0 MAF per year in the 1920s to more than 5.0 MAF per year in the 1980s (Reclamation and DWR 2003). Much of the San Joaquin groundwater basin is in overdraft conditions because of extensive groundwater pumping and irrigation, although the extent of overdraft varies widely from region to region.

Groundwater quality throughout the San Joaquin Valley is in general suitable for most urban and agricultural uses. Average TDS concentrations range from 218 to 1,190 mg/L. Areas of high TDS concentration, primarily along the west side of the San Joaquin Valley, are the result of streamflow recharge that originates from marine sediments. High TDS concentrations are also seen in the trough of the San Joaquin Valley because of concentration of salts resulting from evaporation and poor drainage (Reclamation and DWR 2003). Agricultural pesticides and herbicides have been detected in groundwater throughout the region, but primarily along the east side of the San Joaquin Valley, where soil permeability is higher and depth to groundwater is shallower. From 1994 to 2000, 523 public wells out of 689 wells sampled met the State primary maximum contamination levels for drinking water. The remaining wells have constituents that exceed one or more maximum contamination levels (Reclamation and DWR 2003).

6.2 Regulatory Framework

6.2.1 Federal

The following Federal laws, regulations, standards, and plans are discussed as part of the regulatory setting:

- The U.S. Department of the Interior, Fish and Wildlife Service (USFWS) 2008 *Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the CVP and SWP* (2008 USFWS Biological Opinion (BO)) (USFWS 2008)
- The National Marine Fisheries Service (NMFS) 2009 *BO and Conference Opinion on the Long-Term Operations of the CVP and SWP* (2009 NMFS BO) (NMFS 2009b)
- Central Valley Project Improvement Act (CVPIA) (Reclamation 1999)
- San Joaquin River Restoration Program (SJRRP) Programmatic Environmental Impact Statement/Environmental Impact Report (PEIS/R) (Reclamation and DWR 2012)
- CVP long-term water service contracts
- Trinity River Record of Decision (ROD) (Reclamation 2000)
- Flow objective for navigation (Wilkins Slough)
- Flood management requirements

Regulatory requirements include the 2008 USFWS BO, the 2009 NMFS BO and associated Reasonable and Prudent Alternatives (RPA), and the agreement between the United States and the State for the coordinated operation of the CVP and SWP, otherwise commonly known as the “Coordinated Operations Agreement” (COA).

Ongoing consultation for the 2008 USFWS and 2009 NMFS BOs have resulted in some uncertainty in future CVP and SWP operational constraints. In response to lawsuits challenging the 2008 and 2009 BOs, the District Court for the Eastern District of California (District Court) remanded the BOs to USFWS and NMFS in 2010 and 2011, respectively, and subsequently ordered reconsultation and preparation of new BOs. These legal challenges may result in changes to CVP and SWP operational constraints if the revised USFWS and NMFS BOs contain new or amended RPAs.

Despite this uncertainty, the 2008 and 2009 BOs issued by the fishery agencies contain the most recent estimate of potential changes in water operations that could occur in the near future. Because the RPAs contained in the 2008 and 2009 BOs have the potential to significantly impact SWP/CVP operations and potential benefits of the SLWRI, they have been implemented in this analysis.

National Marine Fisheries Service 2009 Biological Opinion

The 2009 NMFS BO addresses the effects of the continued long-term operation of the CVP and SWP on Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead and their critical habitat, as well as the green sturgeon and its proposed critical habitat and the killer whale (NMFS 2009). The BO includes an RPA that specifies a number of actions, including formation of operation groups, habitat improvements, monitoring requirements and fish passage as well as flow and temperature objectives. Key operational actions in the NMFS RPA that would directly affect project water operations, mainly flow and temperature objectives are listed below. Operations in the RPA that were directly modeled in CalSim II are described in Table 2-2 of the Modeling Appendix.

Shasta-Trinity Division

- Clear Creek flow and temperature objectives
- Reclamation deliverable water forecast procedures
- End-of-year (September 30) Shasta target storages
- Sacramento River temperature objectives between Keswick Dam and Bend Bridge

American River Division

- Lower American River flow objectives
- Lower American River temperature objectives

East Side Division

- Stanislaus River flow objectives
- Stanislaus River temperature objectives

Delta Division

- Delta Cross Channel gate operation
- San Joaquin River Inflow to Export Ratio objectives
- Old and Middle River (OMR) negative or reverse flow objectives

U.S. Fish and Wildlife Service 2008 Biological Opinion

The 2008 USFWS BO addresses the effects of the continued operation of the CVP and SWP on delta smelt and its critical habitat (USFWS 2008). The BO included habitat restoration, formation of the smelt working group, and monitoring requirements as well as RPA actions that would impact project operations. This section discusses the actions in the RPA that would directly affect project water operations, mainly flow and delta salinity conditions. The details on how these were implemented in the modeling and subsequent analysis are included in the Table 2-2 of the Modeling Appendix.

- OMR flow limits of no more than -1500 to -5000 cfs during periods when delta smelt could be subject to entrainment at the pumps.
- X2 location limits during the fall following above normal and wet years.

Central Valley Project Improvement Act

Reclamation's evolving mission was written into law on October 30, 1992, with the passage by Congress, and signing by President George H. W. Bush, of Public Law 102-575, the Reclamation Projects Authorization and Adjustment Act of 1992. Included in the law was Title 34, the CVPIA (Reclamation 1999). The CVPIA amended previous authorizations of the CVP to include fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation and domestic water supply uses, and fish and wildlife enhancement having equal priority with power generation. Among the changes mandated by the CVPIA are the following:

- Dedicating 800,000 acre-feet annually to fish, wildlife, and habitat restoration
- Authorizing water transfers outside the CVP service area
- Implementing the Anadromous Fish Restoration Program
- Creating a restoration fund financed by water and power users
- Providing for the Shasta Dam temperature control device (TCD)
- Implementing fish passage measures at RBPP

- Planning to increase water supplies for CVP deliveries
- Mandating firm water supplies for Central Valley wildlife refuges
- Meeting Federal trust responsibility to protect fishery resources on the Trinity River

The CVPIA is being implemented on a broad front. The Final Programmatic Environmental Impact Statement (Reclamation 1999) for the CVPIA analyzes projected conditions in 2022, 30 years from the CVPIA's adoption in 1992. The Final Programmatic Environmental Impact Statement was released in October 1999, and the CVPIA ROD was signed on January 9, 2001.

Operations of the CVP reflect provisions of the CVPIA, particularly Sections 3406 (b)(1), (b)(2), and (b)(3). The U.S. Department of the Interior Final Decision on Implementation of Section 3406 (b)(2) of the CVPIA, May 9, 2003 provides the basis for implementing upstream and Delta actions with CVP delivery capability. The Vernalis Adaptive Management Program assumes that San Joaquin River water will be acquired under Section 3406 (b)(3) to support increased Vernalis flows during certain times of the year. Similarly, the Anadromous Fish Restoration Program assumes Sacramento River water will be acquired under Section 3406 (b)(3).

San Joaquin River Restoration Program

The SJRRP was established in 2006 to implement the Stipulation of Settlement in *NRDC, et al., v. Kirk Rodgers, et al.* (Settlement). Federal authorization for implementing the Settlement is provided in the San Joaquin River Restoration Settlement Act, included in Public Law 111-11. Alternatives for implementation of the Settlement and related legislation were evaluated in the SJRRP PEIS/R (Reclamation and DWR 2012).

The Settlement calls for releases of water from Friant Dam to the confluence of the Merced River, referred to as Interim and Restoration flows; a combination of channel-related and structural modifications along the San Joaquin River below Friant Dam; and reintroduction of Chinook salmon. Restoration Flows are specific volumes of water to be released from Friant Dam during different year types, according to Exhibit B of the Settlement. Interim Flows were experimental flows that were implemented from 2009 until Restoration Flows were implemented in 2014. Interim Flows allowed the SJRRP to collect relevant data about flows, temperatures, fish needs, seepage losses, recirculation, recapture, and reuse.

The release of Interim Flows began in October 2009; however, the release of Interim Flows was limited by channel capacity constraints between Friant Dam and the Merced River confluence. The release of Restoration Flows began on January 1, 2014, but is currently restricted due to capacity constraints. Full Restoration Flows are intended to include annual releases from Friant Dam of up to 840,000 acre-feet, depending on year type. In some years, peak releases from Friant Dam could reach as much as 8,000 cfs for several hours, within the constraints of channel capacity. For the SLWRI, existing conditions include Interim Flows and future conditions include full Restoration Flows.

Central Valley Project Long-Term Water Service Contracts

In accordance with CVPIA Section 3404c, Reclamation is renegotiating long-term water service contracts. As many as 113 CVP water service contracts in the Central Valley may be renewed during this process. Reclamation issued a Notice of Intent for long-term contract renewal in October 1998. Environmental documentation was prepared on a regional basis. In February 2005, Reclamation issued decisions (a ROD or Finding of No Significant Impact) for renewing contracts of the Sacramento River, San Luis, and Delta-Mendota Canal divisions, the Sacramento River settlement contracts, and several individual contracts. Preparation of environmental documents for other divisions and contracts is ongoing.

Trinity River Record of Decision

Export of Trinity River water to the Sacramento basin provides increased water supply for the CVP and is a major source of CVP power generation. The amounts and timing of the Trinity exports are determined after consideration is given to forecasted Trinity water supply available and Trinity in-basin needs, including carryover storage. Trinity exports also are a key component of water temperature control operations on the upper Sacramento River.

Based on the December 19, 2000, Trinity River Mainstem ROD (Reclamation 2000), 368,600 to 815,000 acre-feet are allocated annually for Trinity River flows. After several challenges and injunctions, on July 13, 2004, the Ninth Circuit Court upheld the ROD flows for the Trinity River.

Flow Objective for Navigation (Wilkins Slough)

Historical commerce on the Sacramento River resulted in the requirement to maintain minimum flows of 5,000 cfs at Chico Landing to support navigation. Currently, no commercial traffic exists 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 to Wilkins Slough under all but the most critical water supply conditions to facilitate pumping.

At flows below 5,000 cfs at Wilkins Slough, diverters have reported increased pump cavitation as well as greater pumping head requirements. Diverters operate for extended periods at flows of 4,000 cfs at Wilkins Slough, but pumping operations are severely affected and some pumps become inoperable at flows lower than 4,000 cfs. Flows may drop as low as 3,500 cfs for short periods while changes are made in Keswick releases to reach target levels at Wilkins Slough.

No criteria have been established that specify when the navigation minimum flow should be relaxed. However, the basis for Reclamation's decision to operate at less than 5,000 cfs is the increased importance of conserving water when water supplies are not sufficient to meet full contractual deliveries and other operational requirements.

Flood Management Requirements

Shasta Dam provides flood protection to the nearby communities of Redding, Anderson, Red Bluff, and Tehama, as well as to agricultural lands, industrial developments, and communities downstream along the Sacramento River. Shasta Dam is operated for an objective release of 100,000 cfs at Bend Bridge in Red Bluff, subject to consideration of the following:

- Releases are not to be increased more than 15,000 cfs or decreased more than 4,000 cfs in any 2-hour period.
- The 2,500-square-mile uncontrolled drainage area between Keswick Dam and Bend Bridge can produce flows well in excess of the design channel capacity of 100,000 cfs. These high-magnitude flows can occur very rapidly, requiring release changes based on official flow forecasts, and are complicated by the 8- to 12-hour travel time between Keswick Dam and Bend Bridge.
- Flow gages on major east side tributaries (Cow, Battle, and Paynes creeks) between Keswick Dam and Red Bluff are helpful in coordinating operations of Shasta Dam and Reservoir with flows from uncontrolled downstream areas. Whiskeytown Dam, located on Clear Creek, provides regulation of Trinity River flows and regulates runoff to the Sacramento River from the Clear Creek drainage area. The most critical flood forecast for the Sacramento River is that of local runoff entering the Sacramento River between Keswick Dam and Bend Bridge. As the Bend Bridge flow is projected to recede, Keswick Dam releases are increased to evacuate water stored in the flood management space in Shasta Reservoir.

The following constraints are considered when making release changes at Keswick Dam:

- The maximum capacity of Shasta Powerplant is about 18,000 cfs, but this varies considerably with head. Maximum powerplant release is required when Shasta Reservoir storage encroaches on the flood management space by 25 percent or less, with actual or forecasted inflows of 40,000 cfs or less.
- The capacity of Keswick Powerplant is about 16,000 cfs, which represents a maximum release rate when no flood management space is being used. The Keswick Dam release must include discharge from

Spring Creek Powerplant, releases from Spring Creek Debris Dam, and local flows into Keswick Reservoir.

- Flows greater than 36,000 cfs begin to cause flood coordination efforts in the local Redding area to close riverfront roads and parks. These coordination efforts require some advance notice to increase Keswick releases above this rate.

All outflows from Shasta Dam flow into and through Keswick Reservoir, located about 5 miles west of Redding. Keswick Reservoir also receives inflow from the drainage area of Whiskeytown Reservoir on Clear Creek. Clear Creek flows are augmented by the interbasin transfer coming from Trinity Reservoir (see Section 6.1.2, “Diversion Facilities”).

Flood Management Space Requirements Shasta Reservoir capacity is 4.552 MAF, with a maximum objective release capacity of 79,000 cfs. The end-of-September storage target for Shasta Reservoir is 1.9 MAF, except in the driest 10 percent of water years, to conserve sufficient cold water for meeting temperature criteria for the winter-run Chinook incubation period (summer to early fall). Storage levels are lowest by October to provide sufficient flood protection and capture capacity during the following wet months. The storage target gradually increases from October to full pool in May. Storage is then withdrawn for high water demand (i.e., municipal, agricultural, fishery, and water quality uses) during summer.

A storage space of up to 1.3 MAF below a full pool elevation of 1,067 feet is also kept available for flood management purposes in the reservoir in accordance with the Shasta Dam and Lake Flood Control Diagram (USACE 1977) , as prescribed by USACE (USACE 1977) (see Exhibit B in the *Hydrology, Hydraulics, and Water Management Technical Report*). Under the diagram, flood management storage space increases from zero on October 1 to 1.3 MAF (elevation 1,018.55) on December 1, and is maintained until December 23. From December 23 to June 15, the required flood management space varies according to parameters based on the accumulation of seasonal inflow. This variable space allows for the storage of water for conservation purposes, unless it is required for flood management based on basin wetness parameters and the level of seasonal inflow. Daily flood management operation consists of determining the required flood storage space reservation, and scheduling releases in accordance with flood operations criteria.

Objective Flow The current regulation of Shasta Dam for flood management requires that releases be restricted to quantities that will not cause downstream flows or stages to exceed, insofar as possible, (1) a flow of 79,000 cfs at the tailwater of Keswick Dam and (2) a stage of 39.2 feet for the Sacramento River at the Bend Bridge gaging station near Red Bluff (corresponding roughly to a flow of 100,000 cfs).

Tributary Inflows Shasta Lake collects flow in the upper Sacramento River watershed, but many uncontrolled tributaries enter the Sacramento River downstream from the dam. Stream gages have been added to major uncontrolled tributaries entering downstream from Shasta Lake (Cow, Battle, Cottonwood, and Thomes creeks). To a limited extent, operators of Shasta Dam can adjust releases containing these uncontrolled flows to try to reduce downstream peak flows. Trinity Lake, Lewiston and Whiskeytown reservoirs can also adjust releases to some extent. Accordingly, the influence of Shasta Dam and Reservoir operation on reducing peak flood flows diminishes downstream on the Sacramento River.

6.2.2 State

The following State laws, regulations, standards, and plans are discussed as part of the regulatory setting:

- State Water Resources Control Board (State Water Board) Orders 90-05 and 91-01
- 1960 CDFW-Reclamation Memorandum of Agreement (CDFG and Reclamation 1960)
- Water Quality Control Plan (WQCP) for the San Francisco Bay/San Joaquin Delta Estuary (State Water Board 1995)
- State Water Board Revised Water Right Decision 1641 (RD-1641) (State Water Board 2000)
- COA (Reclamation and DWR 1986)
- Groundwater regulations

State Water Resources Control Board Orders 90-05 and 91-1

In 1990 and 1991, the State Water Board issued Water Right Orders 90-05 and 91-01 modifying Reclamation’s water rights for the Sacramento River. The orders included a narrative water temperature objective for the Sacramento River, and stated that Reclamation shall operate Keswick and Shasta dams and Spring Creek Powerplant to meet a daily average water temperature of 56°F at RBPP in the Sacramento River during periods when higher temperatures would be harmful to fisheries.

Under the orders, the water temperature compliance point may be modified when the objective cannot be met at RBPP. The Sacramento River Temperature Task Group (SRTTG), a multiagency group, develops temperature operational plans for the Shasta and Trinity divisions of the CVP pursuant to State Water Board Water Rights Orders 90-5 and 91-1. These temperature plans consider the impacts to winter-run Chinook salmon and other races of Chinook salmon from project operations. Previous plans have included releases of water from the low-level outlets at Shasta Dam and Trinity Dam, operation of the TCD, warm-water releases, and manipulating the timing of Trinity River diversions through Spring Creek Powerplant. Warm-water releases from the upper level outlets have been made to conserve cold water in Shasta Lake for temperature control in the late summer and to induce winter-run Chinook salmon to spawn as far upstream as possible. The SRTTG typically first meets in the spring once the cold-water availability in Shasta Lake is known. In almost all years since installation of the TCD on Shasta Dam in 1997, those plans have included modifying the compliance point near the RBPP to make the best use of the cold-water resources based on the location of spawning Chinook salmon (NMFS 2009).

The water right orders also recommended construction of a TCD to improve management of the limited cold-water resources. Two temperature control curtains were installed at both the Lewiston Reservoir and the Whiskeytown Reservoir to reduce temperature of water released from the Trinity Dam (Vermeyen 1995). Reclamation constructed the TCD on Shasta Dam in 1997. This device releases cool water from Shasta Lake through low-level river outlets that bypass the powerplant. These devices provide flexibility to Shasta Dam operations and allows downstream temperature goals to be consistently achieved (Reclamation 2004).

Reclamation operates the Shasta, Sacramento River, and Trinity River divisions of the CVP to meet, to the extent possible, the provisions of State Water Board Order 90-05 and 91-01 and the 2009 NMFS BO.

1960 California Department of Fish and Wildlife-Reclamation Memorandum of Agreement

An April 5, 1960, Memorandum of Agreement between CDFW and Reclamation (CDFW and Reclamation 1960) 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 and critical years. Since October 1981, Keswick Dam has been operated based on a minimum release of 3,250 cfs for normal years from September 1 through the end of February, in accordance with an agreement between CDFW and Reclamation. This release schedule was included in Order 90-05, which maintains a minimum release of 3,250 cfs at Keswick Dam and RBPP from September through the end of February in all water years, except critical years.

Water Quality Control Plan for the San Francisco Bay/San Joaquin Delta Estuary

The 1995 San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta) WQCP (State Water Board 1995) established water quality control objectives for the protection of beneficial uses in the Delta. The 1995 WQCP identified (1) beneficial uses of the Delta to be protected, (2) water quality objectives for the reasonable protection of beneficial uses, and (3) a program of implementation for achieving the water quality objectives. Because these new beneficial objectives and water quality standards were more protective than those of the previous State Water Board Water Right Decision 1485, the new objectives were adopted in 1995 through a water right order for operation of the CVP and SWP. Key features of the 1995 WQCP include estuarine habitat objectives for Suisun Bay and the western Delta (consisting of salinity measurements at several locations), export/inflow (E/I) ratios intended to reduce entrainment of fish at the export pumps, Delta Cross Channel gate closures, and San Joaquin River electrical conductivity (EC) and flow standards. The State Water Board adopted a new Bay-Delta WQCP on December 13, 2006. However, this new WQCP made only minor changes to the 1995 WQCP.

State Water Resources Control Board Revised Water Right Decision 1641

The 1995 Bay-Delta WQCP contains current water quality objectives. State Water Board RD-1641 (State Water Board 2000) and Water Right Order 2001-05 contain the current water right requirements to implement the 1995 WQCP. RD-1641 incorporates water right settlement agreements between Reclamation and DWR and certain water users in the Delta and upstream watersheds regarding contributions of flows to meet water quality objectives. However, the State Water Board imposed terms and conditions on water rights held by Reclamation and DWR that require these two agencies, in some circumstances, to meet many of the water quality objectives established in the 1995 WQCP. RD-1641 also authorizes the CVP and SWP to use joint points of diversion (JPOD) in the south Delta, and recognizes the CALFED Bay-Delta Program (CALFED) Operations Coordination Group process for operational flexibility in applying or relaxing certain protective standards.

Delta Outflow Requirement Delta outflow, inflow that is not exported or diverted, is the primary factor controlling water quality in the Delta. When Delta outflow is low, seawater is able to intrude further into the Delta, impacting water quality at drinking water intakes. RD-1641 specifies minimum monthly Delta outflow objectives to maintain a reasonable range of salinity in the estuarine aquatic habitat based on the Net Delta Outflow Index (NDOI). The NDOI is a measure of the freshwater outflow and is determined from a water balance that considers river inflows, precipitation, agricultural consumptive demand, and project exports. The NDOI does not take into account the semidiurnal and spring-neap tidal cycles.

The monthly minimum values of the NDOI specified in RD-1641 depend on the water year type. Minimum flows are specified for the months of January and July to December. The outflow objectives from February to June are determined based on the X2[2] objective.

Delta Salinity Objectives Salinity standards for the Delta are stated in terms of EC (for protection of agricultural and fish and wildlife beneficial uses), and

[2] X2 is the most downstream location of either the maximum daily average or the 14-day running average of 2.64 millimhos per centimeter (mmhos/cm) isohaline, as measured in river kilometers from the Golden Gate Bridge.

chloride (for protection of M&I uses). Compliance values vary with water year and month. The salinity objectives at Emmaton on the Sacramento River and at Jersey Point on the San Joaquin River often control Delta outflow requirements during the irrigation season from April through August, requiring additional releases from upstream CVP and SWP reservoirs.

X2 Objective The location of X2, the 2 parts per thousand salinity unit isohaline at 1 meter above the bottom of the Sacramento River channel, is used as a surrogate measure of ecosystem health in the Delta. The X2 objective requires specific daily surface EC criteria to be met for a certain numbers of days each month, from February through June. Compliance can also be achieved by meeting a 14-day running average salinity or 3-day average outflow equivalent. These requirements were designed to provide improved shallow water habitat for fish species in the spring. Because of the relationship between seawater intrusion and interior Delta water quality, the X2 objective also improves water quality at Delta drinking water intakes.

Maximum Export/Inflow Ratio RD-1641 includes a maximum E/I standard to limit the fraction of Delta inflows that are exported. This requirement was developed to protect fish species and to reduce entrainment losses. Delta exports are defined as the combined pumping of water at Banks and Jones pumping plants. Delta inflows are the gaged or estimated river inflows. The maximum E/I ratio is 0.35 for February through June and 0.65 for the remainder of the year. If the January eight-river runoff index is less than 1.0 MAF, the February E/I ratio is increased to 0.45. The CVP and SWP have agreed to share the allowable exports equally if the E/I ratio is limiting exports.

Joint Point of Diversion The JPOD refers to the CVP and SWP use of each other's pumping facilities in the south Delta to export water from the Delta. The CVP and SWP have historically coordinated use of Delta export pumping facilities to assist with deliveries and to aid each other during times of facility failures. In 1978, by agreement with DWR, and with authorization from the State Water Board, the CVP began using the SWP Banks Pumping Plant for replacement pumping (195,000 acre-feet per year) for pumping capacity lost at Jones Pumping Plant because of striped bass pumping restrictions in State Water Board Water Right Decision 1485. In 1986, Reclamation and DWR formally agreed that "either party may make use of its facilities available to the other party for pumping and conveyance of water by written agreement" and that the SWP would pump CVP water to make up for striped bass protection measures (Reclamation and DWR 1986).

Reclamation filed a number of temporary petitions with the State Water Board to use Banks Pumping Plant for purposes other than replacement pumping and CVP deliveries that contractually relied on SWP conveyance. Such uses included deliveries to Cross Valley Contractors, the Musco Olive Company, and the San Joaquin National Cemetery. In RD-1641, the State Water Board conditionally approved the use of the JPOD in three separate stages:

- Stage 1 is the use of the JPOD to serve Cross Valley Canal contractors, the Musco Olive Company and the San Joaquin National Cemetery; to support a recirculation study; and to recover export reductions made to benefit fish. Authorization for Stage 1 JPOD pumping to recover export reductions prohibits the CVP and SWP from annually exporting more water than each would have exported without the use of each other's pumping facilities. Stage 1 pumping is subject to State Water Board approval of a water level response plan, and a water quality response plan.

- Stage 2 is the use of the JPOD for any purpose authorized in the water rights permits up to the limitations contained in the USACE permit. In addition to the Stage 1 requirements, Stage 2 pumping is subject to State Water Board approval of an operations plan to protect aquatic resources and other legal users of water.

- Stage 3 is the use of the JPOD for any purpose authorized under the water right permits up to the physical capacity of the export pumps. Stage 3 is subject to the operation of barriers or other means to protect water levels in the south Delta, a State Water Board-approved operations plan that adequately protects aquatic resources and other legal users of water, and certification of a project-level EIR by DWR for the South Delta Improvements Program.

The State Water Board has had a policy that all water transfers must meet similar criteria and conditions, as set forth for the JPOD, and the State Water Board has mandated a "response plan" evaluation process for real-time incremental export operations to determine the effects of water transfers and JPOD operations. The State Water Board approval of the 2006 and 2007 Accord Pilot Programs included the provision that rediversion of transfer water at Banks and Jones pumping plants must be in compliance with the various plans under RD-1641 that are prerequisites for the use of the JPOD by Reclamation and DWR.

Reclamation and DWR have produced the following response plans:

- Water Level Response Plan, to address incremental effects of additional export, at the time of the export, to water levels in the south Delta environment (Reclamation and DWR 2004a)

- Water Quality Response Plan, to address incremental effects of additional export, at the time of the export, to water quality in the Delta, and south Delta specifically (Reclamation and DWR 2004b)

- Operations Plan, to protect fish and wildlife, and other legal uses of water

Vernalis Adaptive Management Plan The Vernalis Adaptive Management Plan (VAMP) was a 12-year experimental management program proposed under the 1998 San Joaquin River Agreement (SJRA), which was adopted by the State Water Resources Control Board (State Water Board) in Water Right Decision 1641 (December 1999). Although VAMP expired in 2011, VAMP requirements are included in SLWRI modeling to represent interim actions and future State Water Board objectives for San Joaquin River flows at Vernalis.

VAMP was initiated to protect juvenile Chinook salmon emigrating through the San Joaquin River and Delta, and to evaluate how Chinook salmon survival rates change in response to alterations in San Joaquin River flows and exports at CVP and SWP facilities in the south Delta when the Head of Old River Barrier is installed. A water acquisition program for in-stream flows and a monitoring program for VAMP were implemented through the SJRA, which was adopted in 2000 and twice extended, finally expiring in December 2011. Signatories to the SJRA included Reclamation, DWR, CDFW, USFWS, San Joaquin River Group Authority and member agencies, Exchange Contractors, and select CVP and SWP Contractors, San Francisco Public Utilities Commission, and several environmental interest groups.

VAMP provided guidance for flows in the lower San Joaquin River during a 31-day pulse-flow period during April and May. The predicted April 15 San Joaquin River flows at Vernalis were increased by 1 to 2 predefined “steps,” ranging from 1,200 cfs to 1,300 cfs between each step. If the average of water-year conditions for the current year and the previous year was a below-normal, dry, or critical condition, then the flows would only be increased to the next step. However, if the average of water-year conditions for the current year and the previous year was a wet, above-normal, or average (i.e., between above normal and below normal) condition, then the flows would be increased by two steps. During a multiple year drought, when the current and previous two water years were comprised of either (1) three critical years or (2) two critical years and one dry year, there would be no required flow increases under VAMP. VAMP flow requirements typically were met either through additional releases or through reductions in demands from the Merced Irrigation District, Oakdale Irrigation District, Mendota Pool Exchange Contractors, Modesto Irrigation District, and Turlock Irrigation District.

The expiration of VAMP in 2011 introduced uncertainty regarding responsibility for meeting San Joaquin River flow standards set forth in the 1995 Bay Delta Plan until new San Joaquin River flow standards are identified. In 2012 and 2013, Reclamation implemented a “single-step” VAMP, in which flows were increased by only one step in all water year types. It is anticipated that future State Water Board objectives will be as protective as the original VAMP requirements and will remain in place through 2030.

Coordinated Operations Agreement

The COA defines how Reclamation and DWR share their joint responsibility to meet Delta water quality standards and the water demands of senior water right holders, and how the two agencies share surplus flows (Reclamation and DWR 1986). The COA defines the Delta as being in either "balanced water conditions" or "excess water conditions." Balanced water conditions are periods when Delta inflows are just sufficient to meet water user demands within the Delta, outflow requirements for water quality and flow standards, and export demands. Under excess water conditions, Delta outflow exceeds the flow required to meet the water quality and flow standards. Typically, the Delta is in balanced water conditions from June to November, and in excess water conditions from December through May. However, depending on the volume and timing of winter runoff, excess or balanced water conditions may extend throughout the year.

With the goal of using coordinated management of surplus flows in the Delta to improve Delta export and conveyance capability, the COA received Congressional approval in 1986, and became Public Law 99-546. The COA, as modified by interim agreements, coordinates operations between the CVP and SWP, and provides for the equitable sharing of surplus water supply. The COA requires that the CVP and SWP operate in conjunction to meet State water quality objectives in the Bay-Delta estuary, except as specified. Under this agreement, the CVP and SWP can each contract from the other for the purchase of surplus water supplies, potentially increasing the efficiency of water operations.

Since 1986, the COA principles have been modified to reflect changes in regulatory standards, facilities, and operating conditions. At its inception, the COA water quality standards were those of the 1978 WQCP; these were subsequently modified in the 1991 WQCP. The adoption of the 1995 WQCP by the State Water Board superseded those requirements. The Environmental Water Account was established by CALFED in 2000 to protect the fish of the Bay-Delta estuary via changes in the operations of the CVP and SWP, without incurring uncompensated cost to the projects' water users. Evolution of the Clean Water Act over time has also impacted implementation of the COA.

Groundwater Regulations

Groundwater use is subject to limited statewide regulation; however, all water use in California is subject to constitutional provisions that prohibit waste and unreasonable use of water (State Water Board 1999). In general, groundwater is subject to a number of provisions in the Water Code. Assembly Bill 3030, Water Code Section 10750, commonly referred to as the Groundwater Management Act, permits local agencies to develop groundwater management plans (Reclamation and DWR 2003).

Other groundwater regulation is related primarily to water quality issues, which are addressed by several different State agencies, including the State Water

Board and nine Regional Water Quality Control Boards, the California Department of Toxic Substances Control, Department of Pesticide Regulation, and Department of Health Services.

The Supplemental Report of the 1999 Budget Act required the State Water Board to develop a comprehensive ambient groundwater monitoring plan. To meet this mandate, the State Water Board created the Groundwater Ambient Monitoring and Assessment (GAMA) Program. The primary objective of the GAMA Program is to assess water quality and relative susceptibility of groundwater resources. The GAMA Program has two sampling components: the California Aquifer Susceptibility Assessment for addressing public drinking water wells, and the Voluntary Domestic Well Assessment Project for addressing private drinking water wells.

The GAMA Program is being directed by the State Water Board Division of Water Quality, Land Disposal Section, Groundwater Special Studies Unit. The Voluntary Domestic Well Assessment Project samples domestic wells for various constituents commonly found in domestic well water, and provides that information to domestic well owners. In addition, the Voluntary Domestic Well Assessment Project includes a public education component to aid the public in understanding water quality data and water quality issues affecting domestic water wells. The Voluntary Domestic Well Assessment Project focuses on specific areas, as resources permit. The focus areas are chosen based on existing knowledge of water quality and land use, in coordination with local environmental agencies. The State Water Board incurs the costs of sampling and analysis, and results are provided to domestic well owners as quickly as possible.

6.2.3 Regional and Local

The following local laws, regulations, standards, and plans are discussed as part of the regulatory setting:

- Local surface water regulations (i.e., water supply master plans, general plans, habitat and conservation plans, land use ordinances)
- Local groundwater regulations (i.e., management plans, county ordinances)

Local Surface Water Regulations

Local surface water regulations include goals, objectives, and policies pertaining to the primary and extended study areas, including the following:

- Local water supply master plans
- County general plans
- City general plans

- Local habitat and conservation plans (e.g., Natomas Basin Habitat Conservation Plan)

- Local land-use ordinances

Local Groundwater Regulations

Local regulatory setting documents on groundwater resources in the study areas include local groundwater management plans and county ordinances. Table 6-1 lists current groundwater management plans and county ordinances that apply to agencies in the Redding Area and Sacramento Valley groundwater basins. Groundwater management plans and county ordinances in the San Joaquin Valley groundwater basins are presented in Table 6-2. These documents typically involve provisions to limit or prevent groundwater overdraft, protect groundwater quality, and regulate transfers.

Table 6-1. Groundwater Management Plans and County Ordinances for Redding Area and Sacramento Valley Groundwater Basins

Groundwater Basin	Agency	Plan Name	Year
Redding Area: Subbasins include--Bowman, Rosewood, Anderson, Enterprise, Millville, and South Battle Creek	Shasta County Water Agency for Redding Area Water Council	Coordinated GWMP for the Redding Groundwater Basin	2007
	Anderson-Cottonwood ID	ACID GWMP	2006
	Shasta County	Shasta County Ordinance No. SCC-98-1	1998
	Tehama County	Tehama County Urgency Ordinance No. 1617	1997
Sacramento Valley: Subbasins include--Red Bluff, Corning, Colusa, Bend, Antelope, Dye Creek, Los Molinos, Vina, West Butte, East Butte, North Yuba, South Yuba, Sutter, North American, South American, Solano, Yolo, Capay Valley	Tehama County Flood Control and Water Conservation District	Coordinated AB 3030 GWMP-Draft	2012
	Sutter County	Sutter County Groundwater Management Plan	2012
	City of Woodland	Groundwater Management Plan	2011
	City of Vacaville	AB 3030 GWMP	2011
	Sacramento Groundwater Authority	Groundwater Management Plan	2008
	Reclamation District 2035	GWMP	2008
	Dunnigan WD	Dunnigan WD GWMP	2007
	Diablo Water District	GWMP for AB 3030	2007
	Yolo County Flood Control and Water Conservation District	GWMP	2006
	Sacramento County Water Agency	Central Sacramento County GWMP	2006
	City of Davis/University of California, Davis	GWMP	2006
	Reclamation District No. 787	GWMP	2005
	Yuba County Water Agency	Yuba County Water Agency GWMP	2010
	Reclamation District 2068	GWMP	2005

Table 6-1. Groundwater Management Plans and County Ordinances for Redding Area and Sacramento Valley Groundwater Basins (contd.)

Groundwater Basin	Agency	Plan Name	Year
Sacramento Valley: Subbasins include--Red Bluff, Corning, Colusa, Bend, Antelope, Dye Creek, Los Molinos, Vina, West Butte, East Butte, North Yuba, South Yuba, Sutter, North American, South American, Solano, Yolo, Capay Valley (contd.)	Feather Water District	GWMP	2005
	Butte County	Butte County Groundwater Management Plan	2004
	Sacramento County Water Agency	GWMP	2004
	City of Lincoln	City of Lincoln GWMP	2003
	Placer County Water Agency	West Placer GWMP	2003
	Natomas Central Mutual Water Company	GWMP	2002
	Maine Prairie WD	Maine Prairie Water District GWMP	1997
	Reclamation District 1500	GWMP	1997
	Butte WD	Butte WD GWMP	1996
	El Camino ID	El Camino ID GWMP	1995
	Glenn-Colusa ID	Glenn-Colusa ID GWMP AB 3030	1995
	Western Canal WD	GWMP	1995
	Biggs-West Gridley WD	Biggs-West Gridley WD GWMP	1995
	Richvale ID	Richvale ID GWMP	1995
	Thermalito ID	Thermalito ID GWMP	1995
	Sutter Extension Water District	Sutter Extension GWMP	1995
	Sacramento Metropolitan Water Authority	GWMP Initial Phase	1994
	Glenn County	Glenn County Ordinance No. 1115	2000
	Colusa County	Colusa County Ordinance No. 615	2009
	Yolo County	Yolo County Export Ordinance No. 615	1970
	Butte County	Chapter 33 of the Butte County Code	2000
	Butte County	Well Spacing Ordinance	1999/2014
	Glenn County	Ordinance No. 1115 and BMOs	2000
	The Water Forum	Water Forum Agreement	2000

Key:
AB = Assembly Bill
ACID = Anderson-Cottonwood Irrigation District
BMO = Basin Management Objective
GWMP = Groundwater Management Plan
ID = Irrigation District
No. = Number
SCC = Shasta County Code
WD = Water District

Table 6-2. Groundwater Management Plans and County Ordinances for San Joaquin Valley Groundwater Basins

Groundwater Basin	Agency	Plan Name	Year
San Joaquin Valley: Subbasins include-- Eastern San Joaquin, Modesto, Turlock, Merced, Chowchilla, Madera, Delta-Mendota, Tracy, Cosumnes	Turlock GW Basin Association	Turlock GW basin GWMP	2008
	San Joaquin River Exchange Contractors Water Authority	AB 3030-GWMP	2008
	Merced Area Groundwater Pool Interests and Stevinson WD	Merced GW basin GWMP	2008
	San Luis and Delta Mendota Water Authority-North	GWMP for the Northern Agencies in the Delta-Mendota Canal Service Area and a Portion of San Joaquin County	2007
	City of Tracy	Tracy Sub-basin Regional Groundwater Management Plan	2007
	City of Tracy	Tracy Regional GWMP	2007
	Modesto Subbasin	Modesto Subbasin Integrated Regional GWMP	2005
	Eastern San Joaquin Groundwater Banking Authority	Eastern San Joaquin groundwater basin GWMP	2004
	Root Creek WD	GWMP for Root Creek Water District	2003
	Madera County	AB 3030 GWMP	2002
	Southeast Sacramento County Agricultural Water Authority GWMP	Southeast Sacramento County Agricultural Water Authority GWMP	2002
	Calaveras County WD	Camanche Valley Springs AB 3030 GWMP	2001
	Madera ID	AB 3030 GWMP	1999
	Gravelly Ford WD	GWMP for Gravelly Ford ID	1998
	Turlock ID	GWMP	1997
	Chowchilla WD-Red Top Resource Conservation District Joint Powers Authority	GWMP	1997
	Madera WD	GWMP for Madera WD	1997
	Merced ID	Merced ID GWMP	1996
	San Luis and Delta Mendota Water Authority-Southern	GWMP for the Southern Agencies in the Delta-Mendota Canal Service Area	1996
	North San Joaquin WCD	GWMP	1996
	Modesto ID	GWMP for the Modesto ID	1996
	Aliso Water District	GWMP	1996
	Oakdale ID	Oakdale Irrigation District GWMP	1995
	South San Joaquin ID	South San Joaquin Irrigation District GWMP	1995
	Stockton East Water District	Stockton East Water District GWMP	1995
	El Nido ID	El Nido ID GWMP	1995
	Eastside WD	Eastside Water District GWMP	1994
	Merced County	Wellhead Protection Program	1997
	Delano-Earlimart ID	GWMP	2007

Table 6-2. Groundwater Management Plans and County Ordinances for San Joaquin Valley Groundwater Basins (contd.)

Groundwater Basin	Agency	Plan Name	Year
San Joaquin Valley: Subbasins include-- Kings, Westside, Pleasant Valley, Kaweah, Tulare Lake, Tule, Kern County	Kaweah Delta Water Conservation District	Kaweah Delta Water Conservation District GWMP	2006
	Deer Creek and Tule River Authority	Deer Creek and Tule River Authority GWMP	2006
	10 agencies in the Fresno Area	Fresno Area Regional GWMP	2006
	Riverdale ID	GWMP for Riverdale Irrigation District	2005
	Kings River Conservation District	Lower Kings Basin GWMP	2005
	Alta ID	GWMP	2004
	Kings County WD	Kings County Water District GWMP	2004
	Pleasant Valley WD	GWMP	2004
	Semitropic Water Storage District	GWMP	2004
	Arvin-Edison Water Storage District	Arvin-Edison Water Storage District GWMP	2003
	James ID	GWMP for James Irrigation District	2001
	County of Fresno	County of Fresno GWMP	1997
	Orange Cove ID	GWMP	1997
	West Kern WD	West Kern WD GWMP	1997
	Fresno ID	GWMP	1996
	Tulare Lake Reclamation District No. 761	GWMP within the Westside Groundwater Basin	1996
	Westlands WD	GWMP	1996
	Kern Delta WD	Kern Delta Water District GWMP	1996
	Consolidated ID	GWMP	1995
	Kings River Conservation District Area "A"	GWMP for the Kings River Conservation District Area "A"	1995
	Kings River Conservation District Area "B"	GWMP for the Kings River Conservation District Area "B"	1995
	Kings River Conservation District Area "C"	GWMP for the Kings River Conservation District Area "C"	1995
	Lower Tule River ID	Deer Creek and Tule River Authority GWMP	1995
	Rosamond Community Services District	GWMP	1995
	Tulare Lake Bed	Tulare Lake Bed Coordinated GWMP	1994
	North Kern Water Storage District	North Kern Water Storage District GWM Program	1993
	Shafter-Wasco ID	GWM Program	1993
	Fox Canyon Groundwater Management Authority	Groundwater Management Plan for the Fox Canyon Groundwater Management Agency	1985

Key:
AB =Assembly Bill
GW = Groundwater
GWM = Groundwater Management
GWMP = Groundwater Management Plan
ID = Irrigation District
WCD = Water Conservation District
WD = Water District

6.3 Environmental Consequences and Mitigation Measures

The purpose of this section is to provide information about the environmental consequences of the SLWRI study alternatives on hydraulics and hydrology, including water management, and potential impacts on existing facilities. This section describes the methods and assumptions, criteria for determining significant impacts, and impacts and mitigation measures associated with the H&H effects of each of the SWLRI alternatives. Implementation of the action alternatives considered in the study would affect the H&H of the Sacramento River, Feather River, American River, and the CVP/SWP systems. Impacts on the H&H of the CVP/SWP systems would translate to potential impacts on related surface and groundwater supplies available for CVP/SWP water users.

6.3.1 Methods and Assumptions

A suite of modeling tools was used to evaluate the potential impacts of the No-Action Alternative and various SLWRI action alternatives on the H&H of the project, and to quantify potential benefits. The SLWRI 2012 Version CalSim-II model, developed for the SLWRI, was used to simulate CVP and SWP operations, determining the surface water flows, storages, and deliveries associated with each alternative. CalSim-II is a specific application of the Water Resources Integrated Modeling System (WRIMS) to simulate CVP and SWP water operations. A detailed description of the SLWRI 2012Version CalSim-II model, including modeling assumptions, is included in Chapter 2 of the Modeling Appendix. Delta Simulation Model 2 (DSM2), Version 8.0.6, was used to simulate Delta hydrodynamics and Delta water quality, providing the data used to discuss the water-level-related impacts of each alternative. A detailed description of DSM2 and the assumptions used in the SLWRI analysis are included in Chapter 7 of the Modeling Appendix. Analysis and modeling results are summarized below; more detailed results of the CalSim-II output can be found in Attachment 1 of the Modeling Appendix. Attachment 16 of the Modeling Appendix contains detailed results of the DSM2 modeling.

CalSim-II

CalSim-II is the application of the WRIMS software to the CVP/SWP. This application was jointly developed by Reclamation and DWR for comparative planning studies relating to CVP/SWP operations. The primary purpose of CalSim-II is to evaluate the water supply reliability of the CVP and SWP at current and/or future levels of development (e.g., 2005, 2030), with and without various assumed future facilities, and with different modes of facility operations. Geographically, the model covers the drainage basin of the Delta, and CVP/SWP exports to the San Francisco Bay Area, San Joaquin Valley, Central Coast, and Southern California.

CalSim-II simulates system operations for an 82-year period using a monthly time step. The model assumes that facilities, land use, water supply contracts, and regulatory requirements are constant over this period, representing a fixed level of development (e.g., 2005, 2030). The historical flow record of October

1921 to September 2003, adjusted for the influences of land use changes and upstream flow regulation, is used to represent the possible range of water supply conditions. Major Central Valley rivers, reservoirs, and CVP/SWP facilities are represented by a network of arcs and nodes. CalSim-II uses a mass balance approach to route water through this network. Simulated flows are mean flows for the month; reservoir storage volumes correspond to end-of-month storage.

CalSim-II models a complex and extensive set of regulatory standards and operations criteria. Descriptions of both are contained in Chapter 2 of the Modeling Appendix. The hydrologic analysis conducted for this EIS used SLWRI 2012 Version CalSim-II models, which are the best available hydrological modeling tools, to approximate system-wide changes in storage, flow, salinity, and reservoir system reoperation associated with the SLWRI alternatives. Although CalSim-II is the best available tool for simulating system-wide operations, the model also contains simplifying assumptions in its representation of the real system. CalSim-II's planning capability is limited and cannot be readily applied to analyzing flood flows and hourly, daily, or weekly time steps for hydrologic conditions. The model, however, is useful for comparing the relative effects of alternative facilities and operations within the CVP/SWP system.

A general external review of the methodology, software, and applications of CalSim-II was conducted in 2003 (Close et al. 2003). An external review of the San Joaquin River Valley CalSim-II model also was conducted (Ford et al. 2006). Several limitations of the CalSim-II models were identified in these external reviews. The main limitations of the CalSim-II models are as follows:

- Model uses a monthly time step
- Accuracy of the inflow hydrology is uncertain
- Model lacks a fully explicit groundwater representation

In addition, Reclamation, DWR, and external reviewers have identified the need for a comprehensive error and uncertainty analysis for various aspects of the CalSim-II model. DWR has issued the CalSim-II Model Sensitivity Analysis Study (DWR 2005) and Reclamation has completed a similar sensitivity and uncertainty analysis for the San Joaquin River basin (Reclamation and DWR 2006a). This information will improve understanding of model results.

Despite these limitations, monthly CalSim-II model results remain useful for comparative purposes. It is important to differentiate between "absolute" or "predictive" modeling applications and "comparative" applications. In "absolute" applications, the model is run once to predict a future outcome; errors or assumptions in formulation, system representation, data, operational criteria, etc., all contribute to total error or uncertainty in model results. In "comparative" applications, the model is run twice, once to represent a base condition (no-action) and a second time with a specific change (action) to assess the change in the outcome because of the input change. In the comparative mode (the mode used for this EIS), the difference between the two simulations is of principal importance. Most potential errors or uncertainties affecting the "no-action" simulation also affect the "action" simulation in a similar manner; as a result, the effect of errors and uncertainties on the difference between the simulations is reduced. However, not all limitations are fully eliminated by the comparative analysis approach; small differences between the alternatives and the bases of comparison are not considered to be indicative of an effect of the alternative.

DSM2

DSM2 is a branched 1-dimensional model used to simulate hydrodynamics, water quality, and particle tracking in a network of riverine or estuarine channels. The hydrodynamic module can simulate channel stage, flow, and water velocity. The water quality module can simulate the movement of both conservative and nonconservative constituents. DWR uses the model to perform operational and planning studies of the Delta.

DSM2 analysis is typically performed for the period 1922 to 2003. In model simulations, EC is typically used as a surrogate for salinity. Results from CalSim-II are used to define Delta boundary inflows. CalSim-II-derived boundary inflows include the Sacramento River flow at Hood, the San Joaquin River flow at Vernalis, inflow from the Yolo Bypass, and inflow from the eastside streams. In addition, Net Delta Outflow from CalSim-II is used to calculate the salinity boundary at Martinez.

Details of the model, including source codes and model performance, are available online at the DWR Bay-Delta Office's Modeling Support Branch Web site. Documentation on model development is discussed in annual reports to the State Water Board, such as Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh, prepared by the Delta Modeling Section of DWR (DWR 2009).

6.3.2 Criteria for Determining Significance of Effects

An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental effects that would be caused by, or result from, the proposed action. Under NEPA, the significance of an effect is used solely to determine whether an EIS must be prepared. An environmental document prepared to comply with CEQA must identify the potentially significant environmental effects of a proposed project. A significant effect on the environment means a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project (State CEQA Guidelines, Section 15382). CEQA also requires that the environmental document propose feasible measures to avoid or substantially reduce significant environmental effects (State CEQA Guidelines, Section 15126.4(a)).

The significance criteria were developed based on the guidance provided by the State CEQA Guidelines, and consider the context and intensity of the environmental effects as required under NEPA. Impacts of an alternative on H&H would be significant if project implementation would cause the results in the second column of Table 6-3 to occur. Simulated stream flow and reservoir storage data, generated as part of the H&H impact assessment, were used in the impact assessments for groundwater, hydropower, flood control, water quality, fisheries, terrestrial biology, recreation, and cultural resources. Accordingly, a detailed description of changes in flow and storage expected to result from each of the SLWRI alternatives is included, in addition to the impact analysis.

Significance statements are relative to both existing conditions (2005) and future conditions (2030) unless stated otherwise.

Table 6-3. Impact Indicators and Significance Criteria for Water Management

Impact Indicator	Significance Criterion
Flood Management	Increase frequency or severity of damaging flood flows, as indicated by the following: • Increase frequency of daily flows above 100,000 cfs on the Sacramento River below Bend Bridge • Place housing or other structures within a 100-year flood hazard area as mapped on a Federal flood hazard boundary or Flood Insurance Rate Map or other flood hazard delineation map • Place within a 100-year flood hazard area structures that would impede or redirect flood flows
Water Supply Reliability	Reduce water supply reliability to the following CVP/SWP contractors: • North-of-Delta CVP Water Service Contractors or Refuges • South-of-Delta CVP Water Service Contractors or Refuges • SWP Table A Contractors
Water Levels in the South Delta[1]	Reduce water surface elevation, relative to the basis of comparison, with sufficient frequency and magnitude to adversely affect south Delta water users' abilities to divert water during the irrigation season.
X2 Location	Increase in X2 that adversely affects CCWD's ability to fill Los Vaqueros Reservoir: • Movement of X2 location to west of Chipps Island from February through May • Movement of X2 location to west of Collinsville during December, January, and June
Delta Excess Water Conditions	Reduction in the duration of Delta excess conditions during the November-to-June period that adversely affects CCWD's ability to fill Los Vaqueros Reservoir.
Groundwater Resources	A change in groundwater level or quality that would adversely affect users, as indicated by the following: • A change in groundwater level resulting in long-term overdraft conditions for the groundwater basins • A change groundwater quality resulting in substantially adverse effects to designated beneficial uses of groundwater.

Note:
[1] Changes in south Delta water levels are estimated using the DSM2 Model.

Key
CCWD = Contra Costa Water District
cfs = cubic feet per second
CVP = Central Valley Project
Delta = Sacramento-San Joaquín Delta
SWP = State Water Project

Flood Management

To prevent an increase in flood damages in the study area, the SLWRI must not cause a significant increase in the frequency or magnitude of flood flows on the Sacramento River. The current regulation of Shasta Dam for flood control requires that releases be restricted to quantities that will not cause downstream flows or stages to exceed, insofar as possible, (1) a flow of 79,000 cfs at the tailwater of Keswick Dam, and (2) a stage of 39.2 feet at the Sacramento River Bend Bridge gaging station near Red Bluff (corresponding roughly to a flow of 100,000 cfs). Because of the uncontrolled nature of the inflows between Keswick Dam and Bend Bridge, the 100,000 cfs flow objective at Bend Bridge is the critical objective for minimizing flood damage. It is also important to ensure that the project does not increase potential flood damages by locating any new facilities within the 100-year floodplain or in a location that could impede or redirect flood flows, thereby potentially increasing damage to other property.

Water Supply Reliability

The CVP provides water to a range of contract types; Settlement and Exchange contractors have the highest degree of reliability because of water rights senior to the CVP. Because of their high priority, these contractors are not strongly affected by any of the SLWRI alternatives. Water service contractors and refuges are subject to shortages according to water availability and their geographic location; because of conveyance constraints, south-of-Delta water service contractors and refuges have a lower degree of reliability than North-of-Delta water service contractors and refuges. Although the SWP has several contractors north of the Delta, the vast majority of recipients of SWP water supplies are south of the Delta. SWP contractors have several types of water in their contract; the Table A contracts (DWR 2003a) are most susceptible to variability of supply.

To prevent a decrease in water supply, the SLWRI must not cause a significant reduction in long term water supply reliability to CVP and SWP contractors. For this analysis a significant reduction in long term reliability is defined as a 5 percent or greater reduction in average annual or average dry and critical year reliability. This is assumed to represent a reduction that could not reliably be replaced from other sources, such as groundwater pumping or water transfers.

Some flexibility would exist to adjust for changes in surface water supply from month to month (e.g., temporarily increased ground water pumping), but long term changes in monthly supply could have a significant impact. For this analysis a significant reduction in monthly reliability is defined as a greater than 10 percent reduction in average monthly water supply. This is assumed to represent a reduction that could not reliably be replaced from other sources, such as groundwater pumping or water transfers.

South Delta Water Levels

Water levels in the south Delta are influenced to varying degrees by natural tidal fluctuations, San Joaquin River flows, barrier operations, CVP and SWP export pumping, local agricultural diversions and drainage return flows, channel capacities, siltation, and dredging. When the CVP and SWP are exporting water, water levels in local channels can be drawn down, particularly during low water years. The South Delta Water Agency and local farmers in the south and central Delta have interests in maintaining the water levels so that their siphons and pumps, which are installed at fixed locations in the Delta, can continue to be used for irrigation diversions. The SLWRI alternatives could affect the ability of the South Delta Water Agency to divert water if changes in Delta operations reduce Delta channel water levels during the irrigation season, from April to October.

The South Delta Temporary Barriers Program was initiated by DWR in 1991 to improve water conditions in the south Delta and to provide design data for permanent gates. Since 1991, DWR has seasonally installed four barriers. Three barriers, located on the Middle River, Grant Line Canal, and Old River, ensure adequate water levels and water quality for agricultural diversions. The barriers are constructed from rock fill and incorporate overflow weirs and gated culverts. These barriers are installed in spring and removed in fall. A fourth barrier is seasonally installed at the Head of the Old River for fish control. The existing seasonal barriers significantly affect water levels in the south Delta.

To determine the potential for changes in Delta CVP/SWP operations to occur as an indirect effect of Restoration flows from the San Joaquin River reaching the Delta, analyses in the EIS compared water surface elevations simulated using DSM2 to the criteria identified in the Water Level Response Plan. The criteria identified in the plan also are applied in the EIS, such that a change in water level is considered potentially significant if the following conditions are both true:

1. The simulated water level is below 0.0 feet at msl at the Old River near Tracy Boulevard Bridge and at locations above the Grant Line Canal Barrier, or 0.3 foot above msl at the Middle River near the Howard Road Bridge. A simulated water level below these thresholds would indicate a time period when Reclamation and DWR would adjust real-time operations at Jones and Banks pumping plants to maintain consistency with the provisions of the Water Level Response Plan. Typically this would include reducing diversions at Jones and Banks pumping plants.

2. The simulated water level change between the alternative and baseline is greater than a 0.1-foot decrease during the irrigation season of April through October when the simulated water levels under the baseline conditions are below the threshold values for the three locations described above. A threshold of change of 0.1-foot was selected

because it is consistent with the level of precision provided in the water level response plan standards, and it provides a conservative threshold to identify the likelihood that real-time adjustments to CVP/SWP operations would result in water recapture from the Delta that would differ from simulated operations.

X2 Location

CCWD depends almost entirely on the Delta for water supply. CCWD's raw water system consists of four Delta pumping plants (i.e., Mallard Slough, Rock Slough, Old River, and Victoria Canal), and a 160,000-acre-feet reservoir (Los Vaqueros). The intakes on Rock Slough, Old River, and Victoria Canal are the primary source for CCWD. The fourth intake at Mallard Slough is used only when water quality conditions in the western Delta permit, usually following a prolonged period of surplus Delta outflow. Water diverted at the Old River and Victoria Canal intakes is either used directly or stored in Los Vaqueros Reservoir for later use. CCWD's current operational priority is to fill Los Vaqueros Reservoir with high quality water whenever possible.

CCWD diversions to fill Los Vaqueros Reservoir are constrained by the USFWS delta smelt BOs on operations of Los Vaqueros Reservoir (USFWS 1993 and 2011), as modified by agreements among CCWD, USFWS, CDFW, and the State Water Board. From February through May, the BO precondition for filling the reservoir is that the X2 location is west of Chipps Island. In December, January, and June, the X2 location must be west of Collinsville. Filling Los Vaqueros Reservoir is unconstrained in December if no delta smelt are present at the diversion location.

For the impact analysis, it is assumed that from February to June, the X2 requirement for filling Los Vaqueros Reservoir will be met by Reclamation and DWR as part of their responsibilities under RD-1641.[3] Changes in simulated Delta conditions are considered to be potentially significant only for the months of December and January, and only when all of the following conditions are met:

- The Delta is not in balanced condition[4]
- Under the basis of comparison, X2 is west of Collinsville
- Under the SLWRI alternatives, X2 is east of Collinsville

[3] When the Eight River Index is less than 8.1 MAF, the RD-1641 X2 requirements for May and June are relaxed, potentially impacting filling of Los Vaqueros Reservoir. Model simulations show that this would occur eight times during the simulated or historical record for water years 1922 to 1994, but in these circumstances the Delta would be in balanced water conditions.

[4] Balanced water conditions are periods when it is agreed by Reclamation and DWR that releases from upstream reservoirs plus unregulated flows approximately equal the water supply needed to meet Sacramento Valley in-basin uses plus required Delta outflows and exports (Reclamation and DWR 1986).

Reclamation and DWR are not authorized to use the JPOD when the Delta is in excess conditions, and when such diversions would cause the location of X2 to shift upstream and prevent CCWD from filling Los Vaqueros Reservoir under its water right permits.

Delta Excess Water Conditions

Changes from Delta excess water conditions to balanced conditions could adversely affect CCWD's ability to fill Los Vaqueros Reservoir. Under State Water Board Water Right Decision 1629, filling Los Vaqueros Reservoir is restricted to the parts of the period from November 1 to June 30 when the Delta is in excess water conditions. Changes in simulated Delta conditions are considered to be potentially significant if during this period the following conditions are met:

- Under the basis of comparison, the Delta is in excess conditions
- Under the SLWRI alternatives, the Delta is in balanced conditions

Groundwater Resources

Impacts on groundwater resources would be considered significant if actions related to the SLWRI alternatives would cause the groundwater resources impacts described in Table 6-3. Improvements in water supply reliability under the SLWRI alternatives may affect groundwater levels, budget, and quality in the primary and extended study areas. In general, potential impacts of the SLWRI in the primary and extended study areas would result from a reduction in water extraction because of increased surface water supply reliability. Currently, CVP and SWP water users in the primary and extended study areas pump groundwater to supplement surface water supply.

Potential impacts on groundwater resources, particularly groundwater levels, budget, and water quality, are evaluated qualitatively based on changes in surface water supply. This approach is based on the assumption that the actual reduction in groundwater extraction would be proportional to the increase in surface water supply reliability that would occur in the study areas under the SLWRI alternatives. According to the 2009 update to the California Water Plan (DWR 2009), groundwater pumping is approximately 2.6, 2.7, and 5.5 MAF per year in the Sacramento (CVP north of Delta area), San Joaquin (CVP south of Delta), and Tulare Lake (SWP agricultural deliveries south of Delta, or about half of total SWP south of Delta deliveries) basins respectively. Changes in groundwater pumping in the study areas would be relatively small compared to the estimated millions of acre-feet of annual groundwater pumping. Nevertheless, the SLWRI alternatives would have a positive, albeit limited, impact by reducing reliance on groundwater in the study areas. Because effects on groundwater basins would be limited and positive, groundwater impacts are discussed qualitatively.

6.3.3 Direct and Indirect Effects

This section describes the environmental consequences of the SLWRI alternatives, and proposed mitigation measures for any impacts determined to be significant or potentially significant. All alternatives are compared to a basis of comparison. For the existing condition (2005 level of development), a CalSim-II simulation for the existing condition is used. Similarly, the future condition (2030 level of development)[5] uses a CalSim-II simulation of the No-Action/No-Project Alternative as a basis of comparison. Each of the alternatives is simulated using the same level of development so that any changes from the basis of comparison in H&H can be attributed to the alternative.

Alternatives Description

The SLWRI alternatives are described in the following subsections.

No-Action Alternative Under the No-Action Alternative, the Federal government would take reasonably foreseeable actions, including actions with current authorization, secured funding for design and construction, and environmental permitting and compliance activities that are substantially complete. However, the Federal Government would not take additional actions toward implementing a plan to raise Shasta Dam to help increase anadromous fish survival in the upper Sacramento River, nor help address the growing water reliability issues in California. Shasta Dam would not be modified, and the CVP would continue operating similar to the existing condition. Changes in regulatory conditions and water supply demands would result in differences in flows on the Sacramento River and at the Delta between existing and future conditions. Possible changes include the following:

- Firm Level 2 Federal refuge deliveries[6]
- SWP deliveries based on full Table A amounts
- Full implementation of the Grassland Bypass Project
- Implementation of San Joaquin River flow requirements similar to the Vernalis Adaptive Management Plan

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[5] The level of development used for future conditions is a composite of multiple land use scenarios developed by DWR and Reclamation. The Sacramento Valley hydrology, which includes the Sacramento and Feather River basins, is based on projected 2020 land use assumptions associated with DWR Bulletin 160-98 (1998) and the San Joaquin Valley hydrology is based on the 2030 land use assumptions developed by Reclamation. Under any 2020 to 2030 level of development scenario, the majority of the CVP and SWP unmet demand is located south of the Delta, including the San Joaquin Valley. Please see Table 2-1 in the Modeling Appendix for additional information on CalSim-II modeling assumptions.

[6] Level 2 water is the refuges' most reliable annual supply of water since Reclamation provides it to refuges from the CVP's annual water supplies. IL 4 acquisitions, however, vary from year to year, depending on annual hydrology, water availability, water market pricing, and funding. Therefore, it would be speculative to predict or assume quantities and locations of annual acquisitions from willing sellers. See Chapter 3 of the EIS for a qualitative discussion of potential effects of the action alternatives on deliveries of IL 4 water.

- Implementation of the South Bay Aqueduct Improvement and Enlargement Project
- Increased San Joaquin River diversions for water users in the Stockton Metropolitan Area after completion of the Delta Water Supply Project
- Increased Sacramento River diversions by Freeport Regional Water Project agencies
- SJRRP Full Restoration Flows

This alternative is used as a basis of comparison for future condition comparisons.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP1 focuses on increasing water supply reliability and increasing anadromous fish survival. This plan primarily consists of raising Shasta Dam by 6.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir's full pool by 8.5 feet and enlarge the total storage capacity in the reservoir by 256,000 acre-feet. The existing TCD would also be extended to achieve efficient use of the expanded cold-water pool. Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 70,000 acre-feet and 35,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. CP1 would help reduce future water shortages through increasing drought year and average year water supply reliability for agricultural and M&I deliveries. In addition, the increased depth and volume of the cold-water pool in Shasta Reservoir would contribute to improving seasonal water temperatures for anadromous fish in the upper Sacramento River.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

As with CP1, CP2 focuses on increasing water supply reliability and anadromous fish survival. CP2 primarily consists of raising Shasta Dam by 12.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir's full pool by 14.5 feet and enlarge the total storage capacity in the reservoir by 443,000 acre-feet. The existing TCD would also be extended to achieve efficient use of the expanded cold-water pool. Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 120,000 acre-feet and 60,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. CP2 would help reduce future water shortages through increasing drought year and average year water supply reliability for agricultural and M&I deliveries. In addition, the increased depth and volume of the cold-water pool in Shasta Reservoir would contribute to improving seasonal water temperatures for anadromous fish in the upper Sacramento River.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

CP3 focuses on increasing agricultural water supply reliability while also increasing anadromous fish survival. This plan primarily consists of raising Shasta Dam by 18.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir's full pool by 20.5 feet and enlarge the total storage capacity in the reservoir by 634,000 acre-feet. The existing TCD would also be extended to achieve efficient use of the expanded cold-water pool. Because CP3 focuses on increasing agricultural water supply reliability, none of the increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries. Operations for water supply, hydropower, and environmental and other regulatory requirements would be similar to existing operations, with the additional storage retained for water supply reliability and to expand the cold-water pool for downstream anadromous fisheries.

Simulations of CP3 did not involve any changes to the modeling logic for deliveries or flow requirements; all rules for water operations were updated to include the new storage, but were not otherwise changed.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

CP4 and CP4A focus on increasing anadromous fish survival while also increasing water supply reliability. By raising Shasta Dam 18.5 feet, in combination with spillway modifications, both CP4 and CP4A would increase the height of the reservoir full pool by 20.5 feet and enlarge the total storage capacity in the reservoir by 634,000 acre-feet. The existing TCD would also be extended to achieve efficient use of the expanded cold-water pool. The additional storage created by the 18.5-foot dam raise would be used to improve the ability to meet temperature objectives and habitat requirements for anadromous fish during drought years and increase water supply reliability.

For CP4, about 378,000 acre-feet of the increased reservoir storage space would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. Operations for the remaining portion of increased storage (approximately 256,000 acre-feet) would be the same as in CP1, with 70,000 acre-feet and 35,000 acre-feet reserved specifically to focus on increasing M&I deliveries during dry and critical years, respectively. CP4 also includes augmenting spawning gravel and restoring riparian, floodplain, and side channel habitat in the upper Sacramento River.

For CP4A, about 191,000 acre-feet of the increased reservoir storage space would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. Operations for the remaining portion of increased storage (approximately 443,000 acre-feet) would be the same as in CP2 where Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 120,000 acre-feet and 60,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved for M&I deliveries. CP4A would help reduce future water shortages by increasing drought year and average year water supply reliability for agricultural and M&I deliveries. Like CP4, CP4A includes augmenting spawning gravel and restoring riparian, floodplain, and side channel habitat in the upper Sacramento River for fisheries benefit.

CP5 – 18.5-Foot Dam Raise, Combination Plan

CP5 primarily focuses on increasing water supply reliability, anadromous fish survival, Shasta Lake area environmental resources, and recreation opportunities. By raising Shasta Dam 18.5 feet, in combination with spillway modifications, CP5 would increase the height of the reservoir full pool by 20.5 feet and enlarge the total storage capacity in the reservoir by 634,000 acre-feet. The existing TCD would be extended to achieve efficient use of the expanded cold-water pool. Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 150,000 acre-feet and 75,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. CP5 also includes constructing additional fish habitat in and along the shoreline of Shasta Lake and along the lower reaches of its tributaries; augmenting spawning gravel and restoring riparian, floodplain, and side channel habitat in the upper Sacramento River; and increasing recreation opportunities at Shasta Lake.

CP5 would help reduce future water shortages through increasing drought year and average year water supply reliability for agricultural and M&I deliveries. In addition, the increased depth and volume of the cold-water pool in Shasta Reservoir would contribute to improving seasonal water temperatures for anadromous fish in the upper Sacramento River.

Changes to CVP/SWP Operations

Each of the SWLRI alternatives would have similar impacts on CVP and SWP operations compared to either the existing condition or the No-Action Alternative. However, the magnitude of the impacts would vary according to the alternative. Detailed tables of the estimated monthly flows and storages associated with each alternative, in addition to changes from the bases of comparison, are included in Attachment 1 of the Modeling Appendix. Results are summarized below.

The analysis assumed that the SLWRI alternatives would not alter existing operational rules or protocols; no formal changes to CVP or SWP operating criteria are associated with the SLWRI. At a base level, each action alternative would store some additional flows behind Shasta Dam during periods when the flows would have otherwise been released downstream. The resulting increase in storage would then be used to both create an expanded cold-water pool, thus benefiting fisheries, and for subsequent release downstream when there are opportunities to put the water to beneficial use.

Reductions in Shasta releases under the various SLWRI alternatives would typically occur during winter (November through March) in relatively wet years, and increases in releases would typically occur in the late spring and summer (June through September) of drier years. Shasta Dam typically makes releases for one of six purposes:

- Flood management
- Sacramento River flow requirements both below Keswick and at Wilkins Slough
- Sacramento River water temperature requirements at Bend Bridge
- Delta water quality requirements
- Senior water rights along the Sacramento River
- CVP water supply contracts needs both north and south of the Delta

However, release for one purpose may also be sufficient for meeting another; for instance, releases for Sacramento River water temperatures may also be used to both meet Delta water quality requirements and for export to south-of-Delta contractors. Although releases for flood management purposes typically occur in winter, water temperature and water quality requirements exist year-round. Releases for water supply purposes primarily occur in late spring, summer, and early fall.

Table 6-4 summarizes monthly flows and changes below Shasta Dam. Releases from Shasta Dam would typically be increased in the summer months, corresponding with the periods of greatest agricultural demands. Similarly, releases would be reduced in the winter months, when the increased storage would be used to capture additional runoff rather than releasing to the downstream river.

Table 6-4. Simulated Monthly Average Sacramento River Flows Below Shasta Dam

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alt	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	5,023	90 (2%)	209 (4%)	196 (4%)	196 (4%)	4,998	100 (2%)	147 (3%)	139 (3%)	162 (3%)
Nov	6,056	101 (2%)	171 (3%)	154 (3%)	161 (3%)	5,895	105 (2%)	183 (3%)	234 (4%)	207 (4%)
Dec	6,321	-314 (-5%)	-392 (-6%)	-556 (-9%)	-596 (-9%)	6,182	-291 (-5%)	-470 (-8%)	-661 (-11%)	-628 (-10%)
Jan	7,244	-106 (-1%)	-244 (-3%)	-276 (-4%)	-303 (-4%)	7,218	-197 (-3%)	-265 (-4%)	-354 (-5%)	-335 (-5%)
Feb	9,408	-200 (-2%)	-287 (-3%)	-304 (-3%)	-386 (-4%)	9,463	-244 (-3%)	-366 (-4%)	-384 (-4%)	-485 (-5%)
Mar	7,704	-59 (-1%)	-138 (-2%)	-189 (-2%)	-191 (-2%)	7,710	-59 (-1%)	-137 (-2%)	-214 (-3%)	-200 (-3%)
Apr	6,541	79 (1%)	93 (1%)	139 (2%)	135 (2%)	6,427	125 (2%)	154 (2%)	205 (3%)	180 (3%)
May	7,682	-36 (0%)	-60 (-1%)	-22 (0%)	-32 (0%)	7,653	-22 (0%)	-34 (0%)	32 (0%)	3 (0%)
Jun	10,223	-7 (0%)	37 (0%)	47 (0%)	74 (1%)	10,311	80 (1%)	115 (1%)	75 (1%)	127 (1%)
Jul	11,316	131 (1%)	175 (2%)	186 (2%)	266 (2%)	11,431	14 (0%)	116 (1%)	114 (1%)	196 (2%)
Aug	8,488	51 (1%)	28 (0%)	141 (2%)	75 (1%)	8,494	120 (1%)	148 (2%)	282 (3%)	188 (2%)
Sep	6,107	136 (2%)	172 (3%)	165 (3%)	288 (5%)	6,334	146 (2%)	206 (3%)	243 (4%)	290 (5%)
Total (TAF)	5,550	-8 (0%)	-14 (0%)	-19 (0%)	-18 (0%)	5,550	-7 (0%)	-12 (0%)	-17 (0%)	-17 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node C4)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Storage in Shasta Reservoir fluctuates greatly throughout a year; storage is typically highest at the end of winter, March and April, as the need for flood control reservation space in the reservoir is reduced. Storage is typically at its lowest in October and November after the irrigation season and before the winter refill begins. As a result of the increased storage capacity attributed to each alternative, and the flow reductions described above, Shasta Reservoir storage would be generally higher under the SLWRI alternatives than under the existing condition or the No-Action Alternative (future condition). This additional storage would typically be greatest in the winter (March and April), and would be lowest at the end of summer (October or November), as shown in Table 6-5. Additional runoff captured by the increased storage increment would typically remain in storage until it could be used to meet one of the purposes described above. Conversely, under either of the bases of comparison, if water in storage were insufficient to meet all of the project purposes, the first increment to be reduced would be deliveries to water service contractors. Therefore, increased releases would typically be made on a schedule providing increased reliability of deliveries to water service contractors, typically in July through October of relatively dry years.

Table 6-5. Simulated Average End-of-Month Shasta Reservoir Storage

Month	Existing Condition (2005)							Future Condition (2030)						
	Existing Condition (TAF)	Change from Base (TAF)						No-Action Alt (TAF)	Change from Base (TAF)					
		CP1	CP2	CP3	CP4	CP4A	CP5		CP1	CP2	CP3	CP4	CP4A	CP5
Oct	2,592	148	282	399	526	473	383	2,587	141	245	366	519	436	351
Nov	2,568	142	271	390	520	462	373	2,573	134	234	351	512	425	338
Dec	2,722	161	295	424	539	486	409	2,735	152	263	392	530	454	377
Jan	2,995	167	310	440	545	501	428	3,010	164	279	413	542	470	397
Feb	3,267	178	326	457	556	517	449	3,279	178	299	435	556	490	424
Mar	3,625	182	334	468	560	525	460	3,636	181	307	447	559	498	436
Apr	3,916	177	328	459	555	519	451	3,934	173	298	434	551	489	424
May	3,941	179	330	459	557	521	452	3,961	174	299	431	552	490	423
Jun	3,639	178	327	455	556	518	447	3,653	169	291	426	547	482	414
Jul	3,160	170	315	442	548	506	428	3,167	167	283	417	545	474	401
Aug	2,834	166	312	431	544	503	422	2,841	159	273	398	537	464	387
Sep	2,669	157	301	420	535	492	404	2,662	150	260	382	528	451	369

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node S4+S44)

Note:
Simulation period: 1922-2003
Key:
Alt = alternative
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

A key indicator of water temperature benefits of the SLWRI alternatives to the Sacramento River between Keswick Dam and Red Bluff is the amount of cold water available in Shasta Reservoir before the water temperature operation season, about May through October. As previously described, Shasta Reservoir generally reaches its maximum storage during late April or early May. Also, the cold-water pool volume in the lake accumulates during the winter and early spring and is not likely to increase after April. Therefore, the expected increase in spring storage for each dam raise alternative should also result in an incremental increase in the cold-water pool volume.

Reclamation operates the Shasta Dam TCD to manage water temperatures in the Sacramento River to: (1) improve habitat for the endangered winter-run Chinook salmon and other threatened runs, (2) withdraw warmer surface water in the winter and spring to preserve cold-water storage for release during the temperature operation season, and (3) enable power generation to continue while controlling release temperatures, which eliminates the need to bypass the powerplant penstocks via the low-level river outlets. Generally, to accomplish these temperature objectives during the temperature operation season, the TCD functions to select water temperatures in the 47 degrees Fahrenheit (°F) to 52°F range. Therefore, a good index of the temperature-related benefits of the alternative is the volume of the cold-water pool less than 52°F at the end of April. In the context of historical project operation, reservoir storage and cold-water pool conditions in mid-spring represent the available cold-water “bank” managed throughout the temperature operation season (July through October), as prescribed by the SRTTG. The simulated end-of-April volume of water less than 52°F for the two bases of comparison, and the change in cold-water pool volume for each of the SLWRI alternatives, are shown by Sacramento Valley Index in Table 6-6. As expected, the higher dam raise alternatives generally reflect a larger cold-water pool volume.

Table 6-6. Simulated Average Volume of Water Less than 52˚F in Shasta Reservoir at the End of April

Year Type[1]	Existing Condition (2005)							Future Condition (2030)						
	Existing Condition (TAF)	Change from Base (TAF)						No-Action Alt (TAF)	Change from Base (TAF)					
		CP1	CP2	CP3	CP4	CP4A	CP5		CP1	CP2	CP3	CP4	CP4A	CP5
Average of All Years	2,609	142	267	385	470	435	378	2,628	137	241	357	457	405	349
Wet	2,804	186	331	500	510	504	500	2,799	189	339	498	506	499	498
Above Normal	2,972	163	296	432	502	465	439	2,979	161	289	430	489	450	423
Below Normal	2,699	129	263	382	462	434	357	2,736	130	225	337	463	400	339
Dry	2,542	130	231	322	441	384	317	2,562	100	181	261	398	332	266
Critical	1,601	49	134	151	364	296	142	1,659	50	70	117	365	235	59

Source: Benchmark Study Team April 2010 Version SRWQM 2005 and 2030 simulations
Notes:
Simulation period: 1922-2003
[1] Water year types as defined by the Sacramento Valley Index
Key:
ºF = degrees Fahrenheit
Alt =alternative
CP = comprehensive plan
TAF = thousand acre-feet

Downstream from Shasta Dam, the Sacramento River combines with releases from Trinity Reservoir through Whiskeytown Reservoir and Spring Creek Tunnel above Keswick Dam. Because of the connected nature of Shasta Reservoir and Trinity Reservoir for meeting instream flow requirements and water supply demands below Keswick Dam, changes in Shasta Reservoir operations would possibly result in changes to operations of Trinity Reservoir. Table 6-7 shows changes in Trinity Reservoir storage and Trinity River flows below Lewiston that would result from SLWRI alternatives. These changes are small relative to the reservoir storage and should not result in noticeable changes at Trinity Reservoir. To limit the effect of the enlarged Shasta Reservoir on Trinity Reservoir operations, the relationship in CalSim-II between Shasta Reservoir storage and Trinity Reservoir exports to the Sacramento River was modified through interpolation to approximately maintain the export level of the basis of comparison in the action alternatives.

Table 6-7. Simulated Average End-of-Month Trinity Lake Storage and Trinity River Flow Below Lewiston

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition	Change from Base				No-Action Alt	Change from Base			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
End-of-Month Trinity Lake Storage (TAF)										
Oct	1,323	17 (1%)	19 (1%)	32 (2%)	20 (2%)	1,328	15 (1%)	6 (0%)	17 (1%)	5 (0%)
Nov	1,331	18 (1%)	21 (2%)	35 (3%)	23 (2%)	1,353	16 (1%)	8 (1%)	19 (1%)	7 (1%)
Dec	1,382	17 (1%)	19 (1%)	33 (2%)	22 (2%)	1,404	16 (1%)	7 (1%)	18 (1%)	6 (0%)
Jan	1,444	18 (1%)	22 (2%)	38 (3%)	26 (2%)	1,467	17 (1%)	11 (1%)	23 (2%)	11 (1%)
Feb	1,553	17 (1%)	21 (1%)	36 (2%)	24 (2%)	1,575	15 (1%)	9 (1%)	21 (1%)	10 (1%)
Mar	1,676	15 (1%)	18 (1%)	32 (2%)	20 (1%)	1,695	12 (1%)	7 (0%)	15 (1%)	5 (0%)
Apr	1,826	19 (1%)	23 (1%)	35 (2%)	25 (1%)	1,849	18 (1%)	13 (1%)	22 (1%)	12 (1%)
May	1,820	19 (1%)	23 (1%)	35 (2%)	24 (1%)	1,843	17 (1%)	12 (1%)	21 (1%)	12 (1%)
Jun	1,783	19 (1%)	22 (1%)	33 (2%)	23 (1%)	1,807	18 (1%)	12 (1%)	19 (1%)	11 (1%)
Jul	1,646	18 (1%)	20 (1%)	33 (2%)	23 (1%)	1,669	14 (1%)	9 (1%)	17 (1%)	9 (1%)
Aug	1,511	19 (1%)	19 (1%)	32 (2%)	22 (1%)	1,531	17 (1%)	11 (1%)	20 (1%)	10 (1%)
Sep	1,388	18 (1%)	18 (1%)	29 (2%)	20 (1%)	1,407	16 (1%)	7 (0%)	18 (1%)	6 (0%)
Trinity River Flow Below Lewiston (cfs)										
Oct	373	0 (0%)	0 (0%)	0 (0%)	0 (0%)	368	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Nov	360	4 (1%)	4 (1%)	4 (1%)	4 (1%)	360	-2 (0%)	-2 (-1%)	-1 (0%)	-2 (-1%)
Dec	518	-9 (-2%)	-14 (-3%)	-2 (0%)	-5 (-1%)	511	-8 (-2%)	-10 (-2%)	-10 (-2%)	-10 (-2%)
Jan	646	20 (3%)	18 (3%)	18 (3%)	18 (3%)	659	13 (2%)	-2 (0%)	-5 (-1%)	-7 (-1%)
Feb	648	1 (0%)	3 (0%)	15 (2%)	7 (1%)	642	8 (1%)	-1 (0%)	7 (1%)	-8 (-1%)
Mar	595	24 (4%)	19 (3%)	40 (7%)	37 (6%)	581	31 (5%)	20 (3%)	62 (11%)	57 (10%)
Apr	554	6 (1%)	6 (1%)	6 (1%)	6 (1%)	558	3 (0%)	3 (0%)	3 (0%)	-2 (0%)
May	3,779	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3,779	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jun	2,092	2 (0%)	2 (0%)	2 (0%)	2 (0%)	2,091	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jul	923	0 (0%)	0 (0%)	0 (0%)	0 (0%)	923	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Aug	450	0 (0%)	0 (0%)	0 (0%)	0 (0%)	450	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Sep	450	0 (0%)	0 (0%)	0 (0%)	0 (0%)	450	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total (TAF)	690	3 (0%)	2 (0%)	5 (1%)	4 (1%)	689	3 (0%)	1 (0%)	3 (0%)	2 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node S1)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative

Key:
Alt =alternative
cfs = cubic-feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Below Keswick Dam, Sacramento River flows would be increasingly affected by tributary inflows rather than releases from Shasta Lake. Table 6-8 shows the input monthly average tributary inflows to the Sacramento River between Keswick Dam and RBPP. The tributary inflows are consistent between the 2005 and 2030 levels of development simulations and for each alternative. Below RBPP, flow changes associated with the SLWRI alternatives would be considerably smaller relative to total flow in the river.

Table 6-8. Input Monthly Average Tributary Inflow to the Sacramento River Between Keswick Dam and Red Bluff Pumping Plant

Month	Cottonwood Creek (cfs)	Paynes Creek (cfs)
Oct	109	23
Nov	335	77
Dec	1,073	145
Jan	1,848	179
Feb	2,252	174
Mar	1,803	128
Apr	1,139	70
May	619	37
Jun	298	23
Jul	108	10
Aug	64	7
Sep	70	13
Total (AF)	584,937	53,402

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node I108 and I110)

Note:
Simulation period: 1922-2003
Key:
AF = acre-feet
cfs = cubic feet per second
SLWRI = Shasta Lake Water Resources Investigation

Tributary influence on Sacramento River monthly average flows is apparent when existing condition and No-Action Alternative total flows are compared (see Tables 6-4 and 6-9). Total flows are greater downstream from RBPP, after several tributaries have entered the Sacramento River, than they are immediately downstream from Shasta Dam.

Table 6-9. Simulated Monthly Average Sacramento River Flows Below Red Bluff Pumping Plant

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alts (cfs)	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	6,959	90 (1%)	180 (3%)	131 (2%)	179 (3%)	6,927	117 (2%)	147 (2%)	142 (2%)	180 (3%)
Nov	8,802	88 (1%)	142 (2%)	129 (1%)	114 (1%)	8,721	81 (1%)	155 (2%)	200 (2%)	165 (2%)
Dec	11,683	-291 (-2%)	-348 (-3%)	-518 (-4%)	-574 (-5%)	11,595	-280 (-2%)	-450 (-4%)	-627 (-5%)	-599 (-5%)
Jan	15,241	-138 (-1%)	-291 (-2%)	-354 (-2%)	-365 (-2%)	15,245	-228 (-1%)	-319 (-2%)	-425 (-3%)	-404 (-3%)
Feb	18,111	-189 (-1%)	-272 (-2%)	-292 (-2%)	-372 (-2%)	18,186	-212 (-1%)	-339 (-2%)	-366 (-2%)	-465 (-3%)
Mar	14,544	-48 (0%)	-121 (-1%)	-168 (-1%)	-168 (-1%)	14,586	-37 (0%)	-110 (-1%)	-179 (-1%)	-175 (-1%)
Apr	10,615	-7 (0%)	-4 (0%)	52 (0%)	33 (0%)	10,580	19 (0%)	41 (0%)	81 (1%)	50 (0%)
May	9,551	-50 (-1%)	-76 (-1%)	-73 (-1%)	-78 (-1%)	9,554	-39 (0%)	-56 (-1%)	-31 (0%)	-46 (0%)
Jun	10,903	-3 (0%)	15 (0%)	-2 (0%)	42 (0%)	10,971	56 (1%)	70 (1%)	17 (0%)	68 (1%)
Jul	12,424	107 (1%)	163 (1%)	81 (1%)	186 (1%)	12,510	48 (0%)	117 (1%)	42 (0%)	143 (1%)
Aug	9,782	22 (0%)	13 (0%)	55 (1%)	16 (0%)	9,863	57 (1%)	103 (1%)	159 (2%)	114 (1%)
Sep	8,009	141 (2%)	178 (2%)	200 (3%)	328 (4%)	8,271	151 (2%)	248 (3%)	240 (3%)	344 (4%)
Total (TAF)	8,217	-16 (0%)	-25 (0%)	-46 (-1%)	-39 (0%)	8,240	-16 (0%)	-23 (0%)	-45 (-1%)	-37 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node C112)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative

Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

In addition to the multiple tributary inflows between Keswick Dam and Red Bluff, downstream flows on the Sacramento River would be affected by diversions above RBPP. Specifically, contractors off Tehama-Colusa Canal receive supplies from above the RBPP. Because contractors off Tehama-Colusa Canal are all water service contractors, and thus would be subject to delivery shortages when CVP storage is low, the SLWRI alternatives would result in increased deliveries to Tehama-Colusa Canal contractors in relatively dry years. Table 6-10 shows simulated diversions from RBPP to Tehama-Colusa Canal in dry and critical years. Agricultural diversions typically occur between April and September, with some additional diversions in March and October; accordingly, deliveries on Tehama-Colusa Canal increase in the agricultural diversion months, but see no changes in other months with little or no irrigation.

Table 6-10. Simulated Monthly Average Diversions to Tehama-Colusa Canal in Dry and Critical Years

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alt (cfs)	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	111	2 (2%)	2 (2%)	7 (7%)	5 (4%)	106	1 (1%)	3 (3%)	8 (8%)	6 (5%)
Nov	10	0 (0%)	0 (1%)	0 (3%)	0 (2%)	10	0 (0%)	0 (1%)	0 (3%)	0 (2%)
Dec	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jan	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Feb	7	0 (1%)	0 (0%)	0 (2%)	0 (1%)	5	0 (0%)	0 (0%)	0 (1%)	0 (1%)
Mar	21	2 (10%)	2 (11%)	7 (31%)	5 (23%)	15	1 (9%)	2 (16%)	7 (47%)	5 (34%)
Apr	154	10 (6%)	15 (10%)	39 (26%)	31 (20%)	129	2 (2%)	-3 (-3%)	21 (17%)	10 (8%)
May	252	22 (9%)	28 (11%)	64 (25%)	58 (23%)	219	16 (7%)	23 (10%)	69 (31%)	50 (23%)
Jun	438	24 (6%)	30 (7%)	82 (19%)	64 (15%)	430	12 (3%)	27 (6%)	86 (20%)	64 (15%)
Jul	497	26 (5%)	32 (7%)	92 (19%)	69 (14%)	437	13 (3%)	30 (7%)	98 (22%)	70 (16%)
Aug	450	21 (5%)	26 (6%)	73 (16%)	55 (12%)	403	11 (3%)	24 (6%)	78 (19%)	56 (14%)
Sep	108	10 (9%)	20 (18%)	33 (31%)	27 (25%)	90	7 (8%)	15 (17%)	30 (34%)	26 (29%)
Total (TAF)	125	7 (6%)	9 (8%)	24 (19%)	19 (15%)	112	4 (3%)	7 (7%)	24 (22%)	17 (16%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node D112)

Notes:
Simulation period: 1922-2003
Dry and critical years as defined by the Sacramento Valley Index
(%) indicates percent change from either existing condition or No-Action Alternative

Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Although Tehama-Colusa Canal water users are the primary recipient of CVP water service contract deliveries north of the Delta, other north-of-the-Delta users are subject to changes in water supply, including wildlife refuges. Average monthly deliveries to CVP water service contractors and refuges north of the Delta are included in Table 6-11.

Table 6-11. Simulated Monthly Average Deliveries to North-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition	Change from Base				No-Action Alt	Change from Base			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
North-of-Delta CVP Water Service Contractors Deliveries (cfs)										
Oct	77	3 (3%)	4 (5%)	8 (11%)	7 (9%)	74	2 (3%)	4 (6%)	9 (12%)	7 (10%)
Nov	3	0 (1%)	0 (4%)	0 (11%)	0 (8%)	2	0 (2%)	0 (5%)	0 (12%)	0 (9%)
Dec	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jan	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Feb	3	0 (2%)	0 (1%)	0 (4%)	0 (3%)	2	0 (1%)	0 (2%)	0 (5%)	0 (4%)
Mar	19	1 (5%)	2 (8%)	5 (24%)	4 (18%)	15	1 (5%)	2 (12%)	5 (32%)	4 (24%)
Apr	335	12 (3%)	19 (6%)	44 (13%)	34 (10%)	297	13 (4%)	23 (8%)	47 (16%)	38 (13%)
May	572	15 (3%)	24 (4%)	60 (10%)	46 (8%)	555	15 (3%)	30 (5%)	68 (12%)	54 (10%)
Jun	799	19 (2%)	30 (4%)	76 (10%)	58 (7%)	788	19 (2%)	37 (5%)	86 (11%)	67 (8%)
Jul	918	21 (2%)	33 (4%)	86 (9%)	64 (7%)	910	20 (2%)	40 (4%)	97 (11%)	74 (8%)
Aug	733	17 (2%)	26 (4%)	68 (9%)	50 (7%)	727	16 (2%)	31 (4%)	77 (11%)	58 (8%)
Sep	341	8 (2%)	12 (4%)	30 (9%)	22 (7%)	334	8 (2%)	15 (4%)	34 (10%)	26 (8%)
Total (TAF)	231	6 (2%)	9 (4%)	23 (10%)	17 (8%)	225	6 (3%)	11 (5%)	26 (11%)	20 (9%)
North-of-Delta Refuges Deliveries (cfs)										
Oct	177	-10 (-5%)	-8 (-4%)	-7 (-4%)	-10 (-6%)	224	2 (1%)	2 (1%)	9 (4%)	-4 (-2%)
Nov	168	2 (1%)	3 (2%)	1 (0%)	0 (0%)	219	-1 (0%)	1 (0%)	0 (0%)	1 (1%)
Dec	105	0 (0%)	0 (0%)	0 (0%)	0 (0%)	133	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jan	50	0 (0%)	0 (0%)	0 (0%)	0 (0%)	63	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Feb	45	0 (0%)	0 (0%)	0 (0%)	0 (0%)	57	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Mar	13	0 (0%)	0 (0%)	0 (0%)	0 (0%)	16	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Apr	15	0 (0%)	0 (0%)	0 (0%)	0 (0%)	18	0 (0%)	0 (-1%)	0 (-1%)	0 (-1%)
May	50	-1 (-1%)	0 (0%)	0 (0%)	0 (0%)	64	0 (0%)	0 (0%)	0 (0%)	0 (-1%)
Jun	79	-1 (-1%)	-1 (-1%)	-1 (-1%)	-1 (-1%)	96	1 (1%)	1 (1%)	1 (1%)	1 (1%)
Jul	106	-1 (-1%)	0 (0%)	-1 (-1%)	-1 (-1%)	134	-1 (-1%)	-1 (-1%)	-1 (-1%)	1 (1%)
Aug	143	0 (0%)	-1 (-1%)	-2 (-1%)	0 (0%)	180	2 (1%)	3 (2%)	1 (1%)	3 (2%)
Sep	187	0 (0%)	0 (0%)	0 (0%)	0 (0%)	237	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total (TAF)	69	-1 (-1%)	0 (-1%)	-1 (-1%)	-1 (-1%)	87	0 (0%)	0 (0%)	1 (1%)	0 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_N and DEL_CVP_PRF_N)

Notes:

Simulation period: 1922-2003

(%) indicates percent change from either existing condition or No-Action Alternative

Key:

Alt = alternative

cfs = cubic feet per second

CP = comprehensive plan

SLWRI = Shasta Lake Water Resources Investigation

TAF = thousand acre-feet

As would be expected, the change in deliveries to water service contractors increases with the greater enlargement volumes, and increases in deliveries are much greater in the dry and critical years than in average years, corresponding to the increased likelihood of shortages during drier periods. On a long-term average basis, there would be no significant change in deliveries to refuges. Minor increases and decreases in Refuge deliveries are not a true representation of real-time operations but an indication of modeling artifacts. Such reduction would not occur in real time due to efficient water allocation and management schemes that can be captured adequately in a water resources planning model such as CalSim-II. Table 6-12 shows average deliveries to water service contractors and refuges north of Delta in dry and critical years.

Table 6-12. Simulated Monthly Average Deliveries to North-of-Delta CVP Water Service Contractors and Refuges in Dry and Critical Years-updated

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition	Change from Base				No-Action Alt	Change from Base			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
North-of-Delta CVP Water Service Contractors (cfs)										
Oct	69	3 (4%)	3 (5%)	9 (13%)	6 (9%)	63	2 (3%)	4 (6%)	10 (16%)	7 (12%)
Nov	3	0 (2%)	0 (6%)	1 (16%)	0 (13%)	3	0 (2%)	0 (9%)	1 (21%)	0 (16%)
Dec	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jan	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Feb	7	0 (1%)	0 (0%)	0 (2%)	0 (1%)	5	0 (0%)	0 (0%)	0 (1%)	0 (1%)
Mar	21	2 (10%)	2 (11%)	7 (33%)	5 (24%)	14	1 (10%)	2 (17%)	7 (53%)	5 (38%)
Apr	229	14 (6%)	21 (9%)	53 (23%)	42 (18%)	181	11 (6%)	21 (12%)	57 (31%)	43 (24%)
May	316	19 (6%)	25 (8%)	69 (22%)	52 (16%)	268	11 (4%)	24 (9%)	75 (28%)	55 (20%)
Jun	425	26 (6%)	32 (8%)	90 (21%)	68 (16%)	365	13 (4%)	30 (8%)	95 (26%)	69 (19%)
Jul	480	29 (6%)	36 (7%)	101 (21%)	76 (16%)	414	15 (4%)	33 (8%)	108 (26%)	77 (19%)
Aug	386	23 (6%)	29 (7%)	81 (21%)	61 (16%)	333	12 (4%)	27 (8%)	87 (26%)	62 (19%)
Sep	170	11 (6%)	14 (8%)	36 (21%)	27 (16%)	144	6 (4%)	12 (8%)	39 (27%)	27 (19%)
Total (TAF)	128	8 (6%)	10 (8%)	27 (21%)	21 (16%)	109	4 (4%)	9 (9%)	29 (27%)	21 (19%)
North-of-Delta Refuges Deliveries (cfs)										
Oct	182	-25 (-14%)	-17 (-9%)	-13 (-7%)	-31 (-17%)	212	8 (4%)	12 (5%)	30 (14%)	-4 (-2%)
Nov	156	5 (3%)	11 (7%)	3 (2%)	4 (3%)	212	-4 (-2%)	-2 (-1%)	-4 (-2%)	0 (0%)
Dec	104	0 (0%)	0 (0%)	0 (0%)	0 (0%)	132	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jan	50	0 (0%)	0 (0%)	0 (0%)	0 (0%)	62	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Feb	45	0 (0%)	0 (0%)	0 (0%)	0 (0%)	57	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Mar	12	0 (0%)	0 (1%)	0 (-1%)	0 (-1%)	15	0 (1%)	0 (1%)	0 (-1%)	0 (1%)
Apr	14	0 (0%)	0 (1%)	0 (1%)	0 (0%)	17	0 (-1%)	0 (-1%)	0 (-2%)	0 (-2%)
May	46	-2 (-3%)	0 (0%)	0 (0%)	0 (0%)	59	0 (0%)	0 (0%)	0 (0%)	-1 (-2%)
Jun	75	-2 (-3%)	-3 (-4%)	-2 (-3%)	-2 (-3%)	87	3 (3%)	3 (3%)	4 (5%)	3 (3%)
Jul	99	-3 (-3%)	0 (0%)	-1 (-1%)	-3 (-3%)	126	-4 (-3%)	-4 (-3%)	-2 (-2%)	2 (2%)
Aug	134	0 (0%)	-2 (-2%)	-5 (-3%)	0 (0%)	165	6 (4%)	9 (6%)	3 (2%)	9 (6%)
Sep	177	0 (0%)	0 (0%)	0 (0%)	0 (0%)	226	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total (TAF)	66	-2 (-2%)	-1 (-1%)	-1 (-2%)	-2 (-3%)	83	1 (1%)	1 (1%)	2 (2%)	1 (1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_N and DEL_CVP_PRF_N)

Notes:

Simulation period: 1922-2003

(%) indicates percent change from either existing condition or No-Action Alternative

Dry and critical years as defined by the Sacramento Valley Index

Key:

Alt = alternative

cfs = cubic feet per second

CP = comprehensive plan

SLWRI = Shasta Lake Water Resources Investigation

TAF = thousand acre-feet

Table 6-13 shows the input monthly average tributary inflows to the Sacramento River below RBPP. The tributary inflows are the same in the 2005 and 2030 levels of development simulations.

Table 6-13. Input Monthly Average Tributary Inflow to the Sacramento River Below Red Bluff Pumping Plant

Month	Thomes and Elder Creeks (cfs)	Antelope, Mill, and Deer Creeks (cfs)
Oct	32	397
Nov	227	712
Dec	626	1,412
Jan	881	1,878
Feb	1,115	2,122
Mar	976	1,919
Apr	791	1,699
May	503	1,350
Jun	172	817
Jul	36	454
Aug	8	350
Sep	10	335
Total (TAF)	323,806	811,287

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node I1301 and I1305)

Note:

Simulation period: 1922-2003

Key:

AF = acre-feet

cfs = cubic feet per second

SLWRI = Shasta Lake Water Resources Investigation

TAF = thousand acre-feet

As described in Chapter 1 of the *Hydrology, Hydraulics, and Water Management Technical Report*, during high flow periods, Sacramento River flows below Red Bluff can be diverted into the Sutter Bypass near Ord Ferry, or from the Moulton, Colusa, or Tisdale weirs. Similarly, flows can be diverted into the Yolo Bypass from the Fremont and Sacramento weirs. Table 6-14 shows the recurrence of annual spills over the various Sacramento Valley weirs into the Sutter and Yolo bypasses.

Table 6-14. Simulated Number of Years of Sacramento Valley Weir Spill

Location	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition	Change from Base				No-Action Alt	Change from Base			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Spill Above Moulton Weir	2	0	0	0	0	2	0	0	0	0
Moulton Weir	15	0	0	0	0	16	-1	-1	-1	-2
Colusa Weir	39	-1	-2	-2	-3	39	-2	-2	-3	-4
Tisdale Weir	53	-1	-1	-1	-1	54	0	0	-1	-1
Fremont Weir	49	0	0	0	0	48	0	1	0	0
Sacramento Weir	50	0	0	1	0	49	0	1	1	1

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node D117, D124, D125, D126, D160, D166A)
Note:
Simulation period: 1922-2003
Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation

As the Sacramento River nears the Delta, the basis-of-comparison flow would increase considerably so that flow changes associated with SLWRI alternatives would be miniscule in most months. Table 6-15 shows the simulated monthly average Sacramento River flow below Freeport. Flow changes because of each alternative are small compared to the bases of comparison; average monthly flow changes are typically between 0 percent and 2 percent. Larger flow increases are because of operations specifically for export; since conditions typically only allow for increased exports in July, August, and September, the majority of the changes are observed during those months.

Table 6-15. Simulated Monthly Average Sacramento River Flows Below Freeport

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alt	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	11,309	80 (1%)	92 (1%)	107 (1%)	107 (1%)	11,117	67 (1%)	94 (1%)	102 (1%)	113 (1%)
Nov	15,640	37 (0%)	95 (1%)	63 (0%)	70 (0%)	15,605	25 (0%)	95 (1%)	119 (1%)	89 (1%)
Dec	23,248	-67 (0%)	-22 (0%)	-92 (0%)	-106 (0%)	23,229	-55 (0%)	-105 (0%)	-133 (-1%)	-139 (-1%)
Jan	31,139	5 (0%)	-77 (0%)	-70 (0%)	-93 (0%)	31,167	-31 (0%)	-61 (0%)	-106 (0%)	-91 (0%)
Feb	36,608	-41 (0%)	-12 (0%)	-30 (0%)	-49 (0%)	36,618	-32 (0%)	-56 (0%)	-84 (0%)	-129 (0%)
Mar	32,396	-29 (0%)	-64 (0%)	-54 (0%)	-95 (0%)	32,352	-9 (0%)	-34 (0%)	-90 (0%)	-68 (0%)
Apr	23,232	10 (0%)	14 (0%)	49 (0%)	58 (0%)	23,206	16 (0%)	41 (0%)	87 (0%)	51 (0%)
May	19,417	-48 (0%)	-76 (0%)	-65 (0%)	-68 (0%)	19,114	-45 (0%)	-68 (0%)	-49 (0%)	-59 (0%)
Jun	16,508	-54 (0%)	-53 (0%)	-33 (0%)	-56 (0%)	16,511	-23 (0%)	-48 (0%)	-62 (0%)	-90 (-1%)
Jul	19,518	12 (0%)	32 (0%)	11 (0%)	60 (0%)	19,266	37 (0%)	67 (0%)	54 (0%)	119 (1%)
Aug	14,710	33 (0%)	11 (0%)	-15 (0%)	7 (0%)	14,596	41 (0%)	67 (0%)	94 (1%)	101 (1%)
Sep	18,211	102 (1%)	127 (1%)	46 (0%)	237 (1%)	18,417	146 (1%)	251 (1%)	127 (1%)	316 (2%)
Total (TAF)	15,742	2 (0%)	4 (0%)	-5 (0%)	4 (0%)	15,696	8 (0%)	15 (0%)	4 (0%)	13 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node C169)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Because of the interconnected nature of CVP and SWP operations for meeting shared Sacramento River flow requirements and Delta water quality obligations, changes in Shasta Reservoir operations could potentially affect operations of both Oroville Reservoir on the Feather River and Folsom Reservoir on the American River. For example, an increase in Shasta Reservoir releases may create opportunities for increased SWP export of releases from Oroville Reservoir by improving Delta water quality. Tables 6-16 and 6-17 show simulated end-of-month storage at Oroville Reservoir and Feather River flow below the Thermalito Afterbay, respectively.

Table 6-16. Simulated Average End-of-Month Oroville Reservoir Storage

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (TAF)	Change from Base (TAF)				No-Action Alt (TAF)	Change from Base			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	1,789	8 (0%)	15 (1%)	2 (0%)	17 (1%)	1,737	8 (0%)	13 (1%)	2 (0%)	15 (1%)
Nov	1,845	6 (0%)	12 (1%)	0 (0%)	14 (1%)	1,796	8 (0%)	13 (1%)	2 (0%)	14 (1%)
Dec	1,965	5 (0%)	10 (0%)	1 (0%)	11 (1%)	1,929	7 (0%)	12 (1%)	0 (0%)	13 (1%)
Jan	2,173	4 (0%)	9 (0%)	0 (0%)	11 (0%)	2,143	8 (0%)	13 (1%)	0 (0%)	14 (1%)
Feb	2,381	3 (0%)	8 (0%)	0 (0%)	9 (0%)	2,365	7 (0%)	12 (1%)	1 (0%)	14 (1%)
Mar	2,591	3 (0%)	8 (0%)	-1 (0%)	9 (0%)	2,581	6 (0%)	10 (0%)	3 (0%)	11 (0%)
Apr	2,866	3 (0%)	8 (0%)	-1 (0%)	9 (0%)	2,857	6 (0%)	10 (0%)	3 (0%)	12 (0%)
May	2,998	4 (0%)	8 (0%)	-1 (0%)	9 (0%)	2,992	5 (0%)	10 (0%)	3 (0%)	11 (0%)
Jun	2,894	7 (0%)	13 (0%)	-2 (0%)	16 (1%)	2,877	9 (0%)	16 (1%)	2 (0%)	19 (1%)
Jul	2,427	9 (0%)	17 (1%)	-1 (0%)	20 (1%)	2,408	9 (0%)	14 (1%)	-1 (0%)	16 (1%)
Aug	2,150	9 (0%)	16 (1%)	0 (0%)	19 (1%)	2,113	11 (1%)	17 (1%)	3 (0%)	19 (1%)
Sep	1,856	8 (0%)	14 (1%)	4 (0%)	17 (1%)	1,794	8 (0%)	11 (1%)	2 (0%)	13 (1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node S6)

Note:

Simulation period: 1922-2003

(%) indicates percent change from either existing condition or No-Action Alternative

Key:

Alt = alternative

CP = comprehensive plan

SLWRI = Shasta Lake Water Resources Investigation

TAF = thousand acre-feet

Table 6-17. Simulated Monthly Average Feather River Flow Below the Thermalito Afterbay

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alt (cfs)	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	2,924	-15 (-1%)	-22 (-1%)	35 (1%)	-13 (0%)	2,778	-11 (0%)	-27 (-1%)	10 (0%)	-35 (-1%)
Nov	2,231	31 (1%)	36 (2%)	24 (1%)	42 (2%)	2,165	7 (0%)	11 (1%)	1 (0%)	23 (1%)
Dec	3,742	34 (1%)	46 (1%)	-18 (0%)	65 (2%)	3,523	13 (0%)	7 (0%)	27 (1%)	15 (0%)
Jan	4,551	16 (0%)	18 (0%)	18 (0%)	14 (0%)	4,453	-5 (0%)	-15 (0%)	-7 (0%)	-3 (0%)
Feb	5,582	10 (0%)	23 (0%)	-1 (0%)	25 (0%)	5,354	11 (0%)	11 (0%)	-15 (0%)	1 (0%)
Mar	5,962	0 (0%)	3 (0%)	17 (0%)	-2 (0%)	5,854	26 (0%)	34 (1%)	-20 (0%)	41 (1%)
Apr	3,058	1 (0%)	1 (0%)	1 (0%)	1 (0%)	3,063	-4 (0%)	-5 (0%)	-3 (0%)	-7 (0%)
May	3,725	-3 (0%)	-2 (0%)	-1 (0%)	0 (0%)	3,684	9 (0%)	7 (0%)	-8 (0%)	9 (0%)
Jun	3,575	-66 (-2%)	-91 (-3%)	24 (1%)	-114 (-3%)	3,746	-68 (-2%)	-104 (-3%)	22 (1%)	-135 (-4%)
Jul	7,478	-38 (-1%)	-75 (-1%)	-19 (0%)	-77 (-1%)	7,512	2 (0%)	29 (0%)	47 (1%)	41 (1%)
Aug	4,557	4 (0%)	19 (0%)	-21 (0%)	17 (0%)	4,855	-33 (-1%)	-51 (-1%)	-71 (-1%)	-55 (-1%)
Sep	5,301	14 (0%)	38 (1%)	-67 (-1%)	31 (1%)	5,699	53 (1%)	92 (2%)	26 (0%)	95 (2%)
Total (TAF)	3,178	-1 (0%)	0 (0%)	0 (0%)	-1 (0%)	3,178	0 (0%)	-1 (0%)	1 (0%)	-1 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node C203)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Similarly, an increase in Shasta Reservoir releases in a particular month may result in improved Delta water quality, allowing for a possible reduction in CVP releases from the American River, and a corresponding increase in Folsom Reservoir storage. Tables 6-18 and 6-19 show simulated end-of-month storage at Folsom Reservoir and on the American River near the H-Street Bridge, respectively.

Table 6-18. Simulated Average End-of-Month Folsom Reservoir Storage

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (TAF)	Change from Base (TAF)				No-Action Alt (TAF)	Change from Base (TAF)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	487	9 (2%)	18 (4%)	25 (5%)	19 (4%)	479	9 (2%)	13 (3%)	20 (4%)	13 (3%)
Nov	447	15 (3%)	25 (6%)	32 (7%)	27 (6%)	441	16 (4%)	20 (5%)	28 (6%)	22 (5%)
Dec	459	8 (2%)	14 (3%)	18 (4%)	14 (3%)	453	9 (2%)	11 (2%)	16 (3%)	11 (3%)
Jan	475	6 (1%)	10 (2%)	14 (3%)	10 (2%)	473	6 (1%)	6 (1%)	12 (2%)	8 (2%)
Feb	492	3 (1%)	6 (1%)	8 (2%)	6 (1%)	494	3 (1%)	2 (0%)	7 (1%)	4 (1%)
Mar	594	3 (0%)	5 (1%)	7 (1%)	5 (1%)	599	3 (1%)	2 (0%)	5 (1%)	3 (0%)
Apr	723	2 (0%)	4 (1%)	6 (1%)	4 (1%)	725	3 (0%)	1 (0%)	5 (1%)	2 (0%)
May	844	2 (0%)	4 (0%)	6 (1%)	4 (0%)	846	4 (0%)	2 (0%)	5 (1%)	3 (0%)
Jun	820	1 (0%)	3 (0%)	9 (1%)	3 (0%)	814	4 (1%)	3 (0%)	10 (1%)	5 (1%)
Jul	681	5 (1%)	6 (1%)	12 (2%)	6 (1%)	669	5 (1%)	8 (1%)	12 (2%)	8 (1%)
Aug	608	4 (1%)	7 (1%)	14 (2%)	7 (1%)	597	4 (1%)	6 (1%)	10 (2%)	5 (1%)
Sep	509	7 (1%)	13 (3%)	19 (4%)	14 (3%)	505	7 (1%)	11 (2%)	18 (3%)	12 (2%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node S8)
Note:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
Alt = alternative
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Table 6-19. Simulated Monthly Average American River Flow near the H Street Bridge

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alt (cfs)	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	1,522	-32 (-2%)	-93 (-6%)	-88 (-6%)	-81 (-5%)	1,347	-43 (-3%)	-29 (-2%)	-53 (-4%)	-34 (-3%)
Nov	2,670	-101 (-4%)	-107 (-4%)	-117 (-4%)	-123 (-5%)	2,482	-104 (-4%)	-118 (-5%)	-125 (-5%)	-143 (-6%)
Dec	3,272	109 (3%)	174 (5%)	224 (7%)	198 (6%)	3,102	116 (4%)	151 (5%)	192 (6%)	170 (5%)
Jan	4,364	43 (1%)	64 (1%)	66 (2%)	66 (2%)	4,175	46 (1%)	65 (2%)	66 (2%)	58 (1%)
Feb	5,113	45 (1%)	77 (2%)	93 (2%)	70 (1%)	4,869	46 (1%)	70 (1%)	84 (2%)	70 (1%)
Mar	3,696	6 (0%)	11 (0%)	18 (0%)	15 (0%)	3,496	-1 (0%)	8 (0%)	19 (1%)	9 (0%)
Apr	3,155	17 (1%)	15 (0%)	20 (1%)	19 (1%)	2,813	0 (0%)	5 (0%)	5 (0%)	5 (0%)
May	3,429	2 (0%)	0 (0%)	9 (0%)	10 (0%)	2,982	-11 (0%)	-13 (0%)	-8 (0%)	-17 (-1%)
Jun	3,413	8 (0%)	19 (1%)	-59 (-2%)	11 (0%)	2,955	-12 (0%)	-19 (-1%)	-101 (-3%)	-29 (-1%)
Jul	3,593	-55 (-2%)	-52 (-1%)	-50 (-1%)	-49 (-1%)	3,070	-9 (0%)	-73 (-2%)	-33 (-1%)	-67 (-2%)
Aug	2,321	12 (1%)	-19 (-1%)	-40 (-2%)	-18 (-1%)	1,754	29 (2%)	17 (1%)	15 (1%)	51 (3%)
Sep	2,898	-57 (-2%)	-97 (-3%)	-98 (-3%)	-133 (-5%)	2,378	-56 (-2%)	-96 (-4%)	-129 (-5%)	-128 (-5%)
Total (TAF)	2,371	0 (0%)	-1 (0%)	-1 (0%)	-1 (0%)	2,128	0 (0%)	-2 (0%)	-4 (0%)	-3 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node C302)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative

Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

The Delta is the confluence of the Sacramento, San Joaquin, Cosumnes, Calaveras, and Mokelumne rivers in addition to several other smaller streams and creeks. As the “central hub” of California’s water supplies, minor changes in operations in one region could result in other minor changes throughout the system. As previously described, changes in operations associated with the SLWRI alternatives could possibly result in minor changes in operations to other CVP and SWP facilities. New Melones Reservoir on the Stanislaus River is operated by the CVP to meet water quality requirements in the lower San Joaquin River only, not in the South Delta, and would not be expected to be affected by changes in Sacramento River flow or Delta exports. Simulations indicate the SLWRI alternatives would not result in any changes to New Melones operations. (See Attachment 1 of the Modeling Appendix for details about New Melones Reservoir and Stanislaus River operations.)

Besides potentially changing exports to south-of-Delta water users, changes in Delta inflow could also be reflected in changes in Delta outflow. Changes in Sacramento River flow, as shown above in Table 6-15, are typically reflected as a combination of Delta outflow and export. Table 6-20 shows changes in Delta outflow associated with each alternative.

Table 6-20. Simulated Monthly Average Change in Delta Outflow

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alt (cfs)	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	6,067	-4 (0%)	14 (0%)	-11 (0%)	5 (0%)	6,000	2 (0%)	0 (0%)	-19 (0%)	3 (0%)
Nov	11,706	-157 (-1%)	-157 (-1%)	-165 (-1%)	-175 (-1%)	11,675	-150 (-1%)	-174 (-1%)	-191 (-2%)	-209 (-2%)
Dec	21,755	-153 (-1%)	-134 (-1%)	-327 (-2%)	-318 (-1%)	21,745	-152 (-1%)	-274 (-1%)	-359 (-2%)	-421 (-2%)
Jan	42,078	-77 (0%)	-218 (-1%)	-296 (-1%)	-262 (-1%)	42,169	-198 (0%)	-277 (-1%)	-400 (-1%)	-363 (-1%)
Feb	51,618	-92 (0%)	-160 (0%)	-187 (0%)	-278 (-1%)	51,430	-156 (0%)	-235 (0%)	-303 (-1%)	-396 (-1%)
Mar	42,722	-71 (0%)	-142 (0%)	-146 (0%)	-191 (0%)	42,585	-3 (0%)	-55 (0%)	-157 (0%)	-116 (0%)
Apr	30,227	9 (0%)	12 (0%)	73 (0%)	55 (0%)	30,743	13 (0%)	39 (0%)	83 (0%)	51 (0%)
May	22,619	-52 (0%)	-80 (0%)	-67 (0%)	-71 (0%)	22,249	-53 (0%)	-79 (0%)	-40 (0%)	-70 (0%)
Jun	12,829	-52 (0%)	-69 (-1%)	-49 (0%)	-73 (-1%)	12,660	-41 (0%)	-65 (-1%)	-78 (-1%)	-110 (-1%)
Jul	7,864	0 (0%)	5 (0%)	13 (0%)	0 (0%)	7,864	5 (0%)	-3 (0%)	-1 (0%)	-9 (0%)
Aug	4,322	16 (0%)	21 (0%)	-6 (0%)	13 (0%)	4,335	14 (0%)	22 (1%)	-7 (0%)	19 (0%)
Sep	9,841	-2 (0%)	4 (0%)	-5 (0%)	25 (0%)	9,844	14 (0%)	38 (0%)	20 (0%)	53 (1%)
Total (TAF)	15,776	-38 (0%)	-54 (0%)	-71 (0%)	-76 (0%)	15,755	-42 (0%)	-64 (0%)	-87 (-1%)	-94 (-1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node C406)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative

Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

The CVP and SWP divert water via the Jones Pumping Plant and the Banks Pumping Plant, respectively. The increase in water supply from the SLWRI alternatives would typically be moved through the Jones Pumping Plant. However, even under existing conditions or No-Action Alternative (the bases of comparison), pumping capacity at Jones is often already maximized in wetter years, leaving little ability to export any additional water due to physical pumping limits or regulatory pumping restrictions. Accordingly, although unmet CVP demand south of the Delta may exist in some relatively wet years, conveyance restrictions could limit opportunities to export available water south of the Delta in those years. In drier years, however, capacity is typically available to increase pumping at Jones Pumping Plant, and with the increase in Shasta storage there is an increase in water supply available for pumping. Thus, there are greater increases in average annual pumping volumes in drier years.

Tables 6-21 and 6-22 show the average annual exports through Jones Pumping Plant in all years and dry and critical years only, respectively.

Table 6-21. Simulated Monthly Average Exports Through Jones Pumping Plant

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alt (cfs)	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	3,662	-2 (0%)	-33 (-1%)	50 (1%)	-34 (-1%)	3,566	-14 (0%)	-3 (0%)	71 (2%)	-27 (-1%)
Nov	3,793	111 (3%)	139 (4%)	146 (4%)	129 (3%)	3,670	111 (3%)	170 (5%)	213 (6%)	184 (5%)
Dec	4,008	1 (0%)	-11 (0%)	12 (0%)	-7 (0%)	3,957	4 (0%)	15 (0%)	-2 (0%)	37 (1%)
Jan	3,207	11 (0%)	57 (2%)	28 (1%)	48 (1%)	3,154	18 (1%)	5 (0%)	36 (1%)	16 (1%)
Feb	3,229	-38 (-1%)	-7 (0%)	-15 (0%)	14 (0%)	3,127	9 (0%)	14 (0%)	31 (1%)	52 (2%)
Mar	2,953	17 (1%)	37 (1%)	-9 (0%)	22 (1%)	2,967	-42 (-1%)	-33 (-1%)	-24 (-1%)	-26 (-1%)
Apr	1,082	0 (0%)	0 (0%)	2 (0%)	2 (0%)	1,179	1 (0%)	1 (0%)	2 (0%)	3 (0%)
May	1,114	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,102	1 (0%)	1 (0%)	2 (0%)	1 (0%)
Jun	2,431	-5 (0%)	11 (0%)	10 (0%)	-1 (0%)	2,453	11 (0%)	3 (0%)	-13 (-1%)	-3 (0%)
Jul	4,011	7 (0%)	10 (0%)	28 (1%)	35 (1%)	3,925	-18 (0%)	-36 (-1%)	7 (0%)	-18 (0%)
Aug	4,044	-66 (-2%)	-148 (-4%)	18 (0%)	-171 (-4%)	3,897	6 (0%)	-15 (0%)	162 (4%)	-8 (0%)
Sep	3,904	32 (1%)	15 (0%)	70 (2%)	110 (3%)	3,888	49 (1%)	65 (2%)	101 (3%)	123 (3%)
Total (TAF)	2,261	4 (0%)	4 (0%)	21 (1%)	8 (0%)	2,227	8 (0%)	11 (0%)	35 (2%)	20 (1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node D418)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Table 6-22. Simulated Monthly Average Exports Through Jones Pumping Plant in Dry and Critical Years

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alt (cfs)	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	3,591	4 (0%)	-59 (-2%)	78 (2%)	-65 (-2%)	3,448	-18 (-1%)	11 (0%)	109 (3%)	0 (0%)
Nov	3,509	105 (3%)	145 (4%)	140 (4%)	145 (4%)	3,396	157 (5%)	237 (7%)	279 (8%)	234 (7%)
Dec	3,939	14 (0%)	-57 (-1%)	4 (0%)	-41 (-1%)	3,765	-1 (0%)	23 (1%)	-23 (-1%)	67 (2%)
Jan	3,058	31 (1%)	140 (5%)	41 (1%)	120 (4%)	2,946	29 (1%)	30 (1%)	37 (1%)	18 (1%)
Feb	2,757	-10 (0%)	55 (2%)	-5 (0%)	85 (3%)	2,602	50 (2%)	93 (4%)	70 (3%)	159 (6%)
Mar	1,956	30 (2%)	84 (4%)	-19 (-1%)	44 (2%)	1,921	-36 (-2%)	-3 (0%)	-10 (-1%)	0 (0%)
Apr	931	0 (0%)	0 (0%)	0 (0%)	0 (0%)	963	1 (0%)	11 (1%)	11 (1%)	11 (1%)
May	857	1 (0%)	-1 (0%)	0 (0%)	0 (0%)	850	2 (0%)	4 (0%)	5 (1%)	4 (0%)
Jun	1,139	-15 (-1%)	-18 (-2%)	-8 (-1%)	-25 (-2%)	1,102	-15 (-1%)	-45 (-4%)	-27 (-2%)	-23 (-2%)
Jul	3,379	14 (0%)	21 (1%)	27 (1%)	67 (2%)	3,180	-26 (-1%)	-60 (-2%)	23 (1%)	-19 (-1%)
Aug	3,402	-173 (-5%)	-353 (-10%)	87 (3%)	-433 (-13%)	2,996	45 (2%)	-4 (0%)	438 (15%)	17 (1%)
Sep	3,358	78 (2%)	42 (1%)	79 (2%)	215 (6%)	3,253	81 (3%)	133 (4%)	127 (4%)	198 (6%)
Total (TAF)	1,926	5 (0%)	-1 (0%)	26 (1%)	6 (0%)	1,838	16 (1%)	25 (1%)	63 (3%)	39 (2%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node D418)

Notes:
Simulation period: 1922-2003
Dry and critical years as defined by the Sacramento Valley Index
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Recipients of exports through the Jones Pumping Plant include San Joaquin Valley Exchange Contractors, Federal wildlife refuges, and water service contractors. Because the Exchange Contractors have substantially higher levels of reliability of delivery compared to the refuges and water service contractors, their deliveries will not change under any of the SLWRI alternatives. Deliveries to the refuges and water service contractors would increase with an enlargement of Shasta Dam.

Tables 6-23 and 6-24 show the mean monthly delivery to the CVP south-of-Delta refuges and water service contractors for all years and for dry and critical years respectively. Differences in timing between exports through the Jones and Banks pumping plants and deliveries to CVP and SWP contractors are because of the ability of both projects to store water in San Luis Reservoir during winter months and to use that storage to augment Delta exports in summer months. (Attachment 1 of the Modeling Appendix includes information about San Luis Reservoir storage.)

Table 6-23. Simulated Monthly Average Deliveries to South-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition	Change from Base				No-Action Alt	Change from Base			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
South-of-Delta CVP Water Service Contractors Deliveries (cfs)										
Oct	474	3 (1%)	4 (1%)	10 (2%)	6 (1%)	464	6 (1%)	8 (2%)	19 (4%)	13 (3%)
Nov	362	3 (1%)	3 (1%)	8 (2%)	4 (1%)	354	4 (1%)	6 (2%)	15 (4%)	10 (3%)
Dec	501	3 (1%)	4 (1%)	10 (2%)	6 (1%)	490	6 (1%)	8 (2%)	20 (4%)	13 (3%)
Jan	880	6 (1%)	7 (1%)	18 (2%)	11 (1%)	860	10 (1%)	14 (2%)	35 (4%)	23 (3%)
Feb	1,100	8 (1%)	9 (1%)	23 (2%)	13 (1%)	1,076	13 (1%)	18 (2%)	44 (4%)	29 (3%)
Mar	660	13 (2%)	15 (2%)	35 (5%)	22 (3%)	634	15 (2%)	20 (3%)	49 (8%)	35 (5%)
Apr	1,079	11 (1%)	13 (1%)	31 (3%)	20 (2%)	1,052	15 (1%)	23 (2%)	54 (5%)	38 (4%)
May	1,564	11 (1%)	12 (1%)	32 (2%)	18 (1%)	1,528	19 (1%)	25 (2%)	63 (4%)	41 (3%)
Jun	2,596	28 (1%)	30 (1%)	64 (2%)	37 (1%)	2,545	32 (1%)	42 (2%)	106 (4%)	69 (3%)
Jul	3,136	20 (1%)	23 (1%)	65 (2%)	34 (1%)	3,063	37 (1%)	39 (1%)	114 (4%)	71 (2%)
Aug	2,078	1 (0%)	16 (1%)	62 (3%)	19 (1%)	2,063	9 (0%)	23 (1%)	89 (4%)	40 (2%)
Sep	735	0 (0%)	0 (0%)	9 (1%)	5 (1%)	722	10 (1%)	15 (2%)	30 (4%)	22 (3%)
Total (TAF)	916	6 (1%)	8 (1%)	22 (2%)	12 (1%)	898	11 (1%)	15 (2%)	39 (4%)	24 (3%)
South-of-Delta Refuges Deliveries (cfs)										
Oct	1,126	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,041	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Nov	729	0 (0%)	0 (0%)	0 (0%)	0 (0%)	671	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Dec	336	0 (0%)	0 (0%)	0 (0%)	0 (0%)	306	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jan	147	0 (0%)	0 (0%)	0 (0%)	0 (0%)	137	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Feb	109	0 (0%)	0 (0%)	0 (0%)	0 (0%)	102	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Mar	93	0 (0%)	0 (0%)	0 (0%)	0 (0%)	88	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Apr	217	0 (0%)	0 (0%)	0 (0%)	0 (0%)	203	0 (0%)	0 (0%)	0 (0%)	0 (0%)
May	445	0 (0%)	0 (0%)	0 (0%)	0 (0%)	407	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jun	493	0 (0%)	0 (0%)	0 (0%)	0 (0%)	456	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jul	120	0 (0%)	0 (0%)	0 (0%)	0 (0%)	112	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Aug	197	2 (1%)	0 (0%)	2 (1%)	1 (0%)	181	2 (1%)	2 (1%)	5 (3%)	3 (2%)
Sep	885	-9 (-1%)	-8 (-1%)	-11 (-1%)	-7 (-1%)	808	0 (0%)	5 (1%)	1 (0%)	5 (1%)
Total (TAF)	296	0 (0%)	0 (0%)	-1 (0%)	0 (0%)	273	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_S and DEL_CVP_PRF_S)

Notes: Simulation period: 1922-2003
Dry and critical years as defined by the Sacramento Valley Index
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
CVP = Central Valley Project
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Table 6-24. Simulated Monthly Average Deliveries to South-of-Delta CVP Water Service Contractors and Refuges in Dry and Critical Years

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition	Change from Base				No-Action Alt	Change from Base			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
South-of-Delta CVP Water Service Contractors Deliveries (cfs)										
Oct	363	6 (2%)	4 (1%)	15 (4%)	11 (3%)	343	8 (2%)	12 (3%)	27 (8%)	21 (6%)
Nov	277	4 (2%)	3 (1%)	12 (4%)	8 (3%)	262	6 (2%)	9 (3%)	21 (8%)	16 (6%)
Dec	383	6 (2%)	4 (1%)	16 (4%)	11 (3%)	362	8 (2%)	12 (3%)	29 (8%)	23 (6%)
Jan	673	10 (2%)	8 (1%)	29 (4%)	20 (3%)	636	14 (2%)	22 (3%)	51 (8%)	40 (6%)
Feb	841	13 (2%)	10 (1%)	36 (4%)	25 (3%)	794	18 (2%)	27 (3%)	63 (8%)	50 (6%)
Mar	362	15 (4%)	9 (2%)	26 (7%)	17 (5%)	302	6 (2%)	12 (4%)	53 (18%)	37 (12%)
Apr	627	-1 (0%)	-10 (-2%)	2 (0%)	-9 (-1%)	545	5 (1%)	11 (2%)	51 (9%)	34 (6%)
May	902	-2 (0%)	-14 (-2%)	2 (0%)	-11 (-1%)	794	11 (1%)	19 (2%)	72 (9%)	45 (6%)
Jun	1,467	23 (2%)	4 (0%)	30 (2%)	0 (0%)	1,310	19 (1%)	32 (2%)	122 (9%)	76 (6%)
Jul	1,809	-10 (-1%)	-34 (-2%)	0 (0%)	-30 (-2%)	1,581	19 (1%)	5 (0%)	109 (7%)	58 (4%)
Aug	1,112	-40 (-4%)	-22 (-2%)	48 (4%)	-34 (-3%)	939	31 (3%)	59 (6%)	163 (17%)	73 (8%)
Sep	428	-8 (-2%)	-12 (-3%)	-5 (-1%)	-6 (-1%)	370	7 (2%)	16 (4%)	35 (10%)	27 (7%)
Total (TAF)	558	1 (0%)	-3 (-1%)	13 (2%)	0 (0%)	497	9 (2%)	14 (3%)	48 (10%)	30 (6%)
South-of-Delta Refuges Deliveries (cfs)										
Oct	1,110	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,026	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Nov	718	0 (0%)	0 (0%)	0 (0%)	0 (0%)	661	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Dec	331	0 (0%)	0 (0%)	0 (0%)	0 (0%)	302	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jan	145	0 (0%)	0 (0%)	0 (0%)	0 (0%)	135	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Feb	107	0 (0%)	0 (0%)	0 (0%)	0 (0%)	101	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Mar	89	0 (0%)	0 (0%)	0 (0%)	0 (0%)	83	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Apr	207	0 (0%)	0 (0%)	0 (0%)	0 (0%)	193	0 (0%)	0 (0%)	0 (0%)	0 (0%)
May	423	0 (0%)	0 (0%)	0 (0%)	0 (0%)	387	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jun	468	1 (0%)	1 (0%)	1 (0%)	0 (0%)	434	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jul	114	0 (0%)	0 (0%)	0 (0%)	0 (0%)	107	0 (0%)	-1 (-1%)	0 (0%)	-1 (-1%)
Aug	185	1 (1%)	-5 (-3%)	3 (1%)	1 (1%)	161	7 (4%)	4 (3%)	13 (8%)	9 (5%)
Sep	843	-6 (-1%)	-3 (0%)	-11 (-1%)	0 (0%)	760	0 (0%)	14 (2%)	2 (0%)	13 (2%)
Total (TAF)	286	0 (0%)	0 (0%)	0 (0%)	0 (0%)	263	0 (0%)	1 (0%)	1 (0%)	1 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_S and DEL_CVP_PRF_S)

Notes: Simulation period: 1922-2003
Dry and critical years as defined by the Sacramento Valley Index
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
CVP = Central Valley Project
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

When evaluating project effects on water supply reliability, CVP south-of-Delta allocations are a valuable indicator of benefits resulting from each alternative. Tables 6-25 and 6-26 show the simulated annual allocations to south-of-Delta agricultural and M&I refuges and water service contractors for the existing condition and the No-Action Alternative, and the simulated change in allocation for each of the SLWRI alternatives. Simulated allocations are calculated by dividing annual deliveries of each contract type by the demand. The contract period for CVP allocations is assumed to be March through February; the assumed simulated demand for each contract type is as follows:

- **Agricultural water service contractors –** 1.987 MAF/year (both 2005 and 2030 level of development)
- **M&I water service contractors –** 164,200 acre-feet/year (both 2005 and 2030 level of development)
- **Federal refuges –** 304,600 acre-feet/year (2005 level of development) and 281,100 acre-feet/year (2030 level of development)

Tables 6-25 and 6-26 show that changes in allocations would typically increase, and years with small decreases in allocations could occur. More important than the average annual change in allocation is the increase in allocation in years with low allocations under either the existing condition or No-Action Alternative, such as in 1928, 1944, and 1976. Some decreases in allocations would occur during years in the latter parts of prolonged droughts. This likely is because of changes in CalSim-II north-of-Delta reservoir storage and water supply relationships.

Table 6-25. Simulated Annual Delivery Allocations to South-of-Delta CVP Water Service Contractors and Refuges for a 2005 Level of Development

Year	Existing Conditions (2005)			Change from Existing Conditions											
				CP1 and CP4 (2005)			CP2 and CP4A (2005)			CP3 (2005)			CP5 (2005)		
	Ag	Ref	M&I	Ag	Ref	M&I	Ag	Ref	M&I	Ag	Ref	M&I	Ag	Ref	M&I
1922	79%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1923	42%	100%	67%	0%	0%	0%	0%	0%	0%	-1%	0%	0%	0%	0%	0%
1924	16%	75%	61%	-2%	0%	-2%	-2%	0%	-2%	-2%	0%	-2%	-5%	0%	-5%
1925	38%	100%	67%	-2%	0%	0%	-2%	0%	0%	-2%	0%	0%	2%	0%	0%
1926	20%	100%	64%	2%	0%	2%	-2%	0%	-2%	-3%	0%	-3%	-7%	0%	-7%
1927	48%	100%	69%	-1%	0%	-1%	1%	0%	1%	1%	0%	1%	2%	0%	2%
1928	42%	100%	67%	3%	0%	0%	3%	0%	0%	3%	0%	0%	3%	0%	0%
1929	0%	100%	45%	0%	0%	0%	1%	0%	1%	0%	0%	0%	0%	0%	0%
1930	25%	100%	67%	3%	0%	0%	-4%	0%	-2%	1%	0%	0%	2%	0%	0%
1931	14%	75%	58%	-1%	0%	-1%	0%	0%	0%	1%	0%	1%	0%	0%	0%
1932	22%	75%	67%	-4%	0%	-4%	-4%	0%	-4%	-3%	0%	-2%	-6%	0%	-6%
1933	9%	75%	54%	0%	0%	0%	1%	0%	1%	0%	0%	0%	1%	0%	1%
1934	16%	75%	61%	-1%	0%	-1%	0%	0%	0%	0%	0%	0%	-1%	0%	-1%
1935	24%	100%	64%	-1%	0%	0%	-5%	0%	-1%	-5%	0%	-1%	-5%	0%	-1%
1936	41%	100%	67%	0%	0%	0%	3%	0%	0%	6%	0%	1%	1%	0%	0%
1937	31%	100%	66%	-1%	0%	0%	1%	0%	0%	2%	0%	0%	0%	0%	0%
1938	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1939	35%	98%	66%	0%	2%	-4%	0%	2%	-6%	-1%	0%	-6%	-1%	2%	-6%
1940	35%	100%	67%	1%	0%	0%	2%	0%	0%	3%	0%	0%	2%	0%	0%
1941	73%	100%	88%	1%	0%	0%	1%	0%	0%	1%	0%	0%	1%	0%	0%
1942	74%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1943	77%	100%	90%	4%	0%	0%	4%	0%	0%	4%	0%	0%	4%	0%	0%
1944	28%	100%	67%	1%	0%	0%	0%	0%	0%	3%	0%	0%	3%	0%	0%
1945	57%	100%	77%	-4%	0%	-3%	-4%	0%	-3%	0%	0%	0%	-4%	0%	-3%
1946	54%	100%	75%	3%	0%	3%	3%	0%	3%	1%	0%	1%	3%	0%	3%
1947	41%	100%	66%	-1%	0%	0%	1%	0%	0%	1%	0%	0%	0%	0%	0%
1948	23%	100%	67%	-2%	0%	-2%	-1%	0%	-1%	7%	0%	0%	3%	0%	0%
1949	53%	100%	75%	0%	0%	0%	0%	0%	0%	-1%	0%	-2%	0%	0%	-1%
1950	34%	100%	67%	3%	0%	0%	2%	0%	0%	5%	0%	0%	5%	0%	0%
1951	57%	100%	78%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1952	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1953	36%	100%	67%	2%	0%	0%	2%	0%	0%	2%	0%	0%	2%	0%	0%
1954	36%	100%	65%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1955	43%	100%	66%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1956	73%	100%	88%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1957	25%	100%	67%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1958	89%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1959	29%	100%	67%	-1%	0%	0%	-1%	0%	0%	-1%	0%	0%	-1%	0%	0%
1960	30%	100%	61%	2%	0%	0%	3%	-2%	0%	6%	0%	6%	3%	-2%	0%
1961	36%	100%	61%	-5%	-2%	-1%	-6%	-2%	-1%	-5%	0%	-1%	-6%	0%	-1%
1962	43%	100%	67%	2%	0%	0%	3%	0%	0%	2%	0%	0%	3%	0%	0%
1963	43%	100%	67%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1964	41%	100%	66%	0%	0%	0%	0%	0%	0%	1%	0%	1%	0%	0%	0%
1965	62%	100%	77%	0%	0%	-1%	0%	0%	-1%	0%	0%	0%	-1%	0%	0%
1966	39%	100%	67%	1%	0%	0%	1%	0%	0%	1%	0%	0%	1%	0%	0%
1967	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1968	32%	100%	67%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1969	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table 6-25. Simulated Annual Delivery Allocations to South-of-Delta CVP Water Service Contractors and Refuges for a 2005 Level of Development (contd.)

Year	Existing Conditions (2005)			Change from Existing Conditions											
				CP1 and CP4 (2005)			CP2 and CP4A (2005)			CP3 (2005)			CP5 (2005)		
	Ag	Ref	M&I	Ag	Ref	M&I	Ag	Ref	M&I	Ag	Ref	M&I	Ag	Ref	M&I
1970	57%	100%	77%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1971	32%	100%	67%	2%	0%	0%	5%	0%	0%	7%	0%	0%	7%	0%	0%
1972	37%	100%	67%	0%	0%	0%	-1%	0%	0%	-1%	0%	0%	-1%	0%	0%
1973	50%	100%	71%	4%	0%	3%	4%	0%	3%	4%	0%	3%	4%	0%	3%
1974	76%	100%	88%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1975	54%	100%	75%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1976	15%	100%	60%	4%	0%	3%	2%	0%	2%	7%	0%	7%	6%	0%	6%
1977	11%	75%	56%	0%	0%	0%	1%	0%	1%	1%	0%	1%	2%	0%	2%
1978	83%	100%	89%	4%	0%	0%	7%	0%	0%	8%	0%	1%	2%	0%	0%
1979	51%	100%	72%	-1%	0%	-1%	-2%	0%	-1%	-2%	0%	-1%	0%	0%	0%
1980	81%	99%	88%	4%	-11%	-10%	4%	-11%	-10%	4%	-11%	-10%	4%	-11%	-10%
1981	32%	100%	67%	-1%	0%	0%	-1%	0%	0%	-1%	0%	0%	-1%	0%	0%
1982	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1983	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1984	58%	100%	78%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1985	43%	100%	67%	2%	0%	-1%	2%	0%	-1%	2%	0%	0%	2%	0%	-6%
1986	63%	100%	83%	2%	0%	2%	6%	0%	6%	21%	0%	7%	16%	0%	7%
1987	25%	100%	66%	2%	0%	0%	1%	0%	0%	0%	0%	0%	1%	0%	0%
1988	0%	100%	45%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1989	28%	99%	58%	0%	1%	3%	-1%	-1%	7%	0%	1%	6%	-2%	1%	6%
1990	0%	100%	45%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1991	20%	75%	64%	-1%	0%	-1%	-1%	-2%	-11%	0%	0%	0%	-1%	0%	-12%
1992	22%	74%	61%	-2%	-3%	-7%	0%	0%	1%	0%	-6%	-6%	-1%	1%	5%
1993	50%	100%	73%	2%	0%	2%	1%	0%	1%	1%	0%	1%	0%	0%	-1%
1994	49%	75%	64%	-2%	0%	0%	-2%	0%	0%	0%	0%	0%	-3%	0%	0%
1995	88%	100%	90%	2%	0%	0%	3%	0%	0%	4%	0%	0%	4%	0%	0%
1996	62%	100%	83%	0%	0%	0%	-1%	0%	-1%	-1%	0%	-1%	-1%	0%	-1%
1997	66%	98%	81%	0%	2%	-2%	1%	2%	7%	1%	2%	7%	1%	0%	9%
1998	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1999	48%	100%	70%	3%	0%	2%	5%	0%	4%	6%	0%	6%	6%	0%	6%
2000	48%	100%	69%	0%	0%	0%	-1%	0%	-1%	-1%	0%	-1%	-1%	0%	-1%
2001	38%	100%	67%	2%	0%	0%	2%	0%	0%	2%	0%	0%	2%	0%	0%
2002	32%	100%	67%	-1%	0%	0%	1%	0%	0%	2%	0%	0%	0%	0%	0%
2003	36%	50%	43%	0%	0%	0%	-1%	0%	0%	-1%	0%	0%	-2%	0%	0%
Avg	**46%**	**97%**	**71%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**1%**	**0%**	**0%**	**1%**	**0%**	**0%**

Source: SLWRI 2012 Version CalSim-II model 2005 simulations (Nodes DEL_CVP_PAG_S, DEL_CVP_PRF_S, and DEL_CVP_PMI_S for delivery information, and Common Assumptions Common Model Package Version 8D Delivery Specifications for demand information)

Notes:

Simulation period: 1922-2003

(%) indicates change from either existing condition or No-Action Alternative

Key:

Ag = Agricultural Water Service Contractor

Alt = alternative

Avg = average

M&I = municipal and industrial contractor

Ref = refuge

Refuge = Level 2 Federal Refuge

SLWRI = Shasta Lake Water Resources Investigation

Table 6-26. Simulated Annual Delivery Allocations to South-of-Delta CVP Water Service Contractors and Refuges for a 2030 Level of Development

Year	No-Action/ No Project Alternative (2030)			Change from No-Action/ No Project Alternative											
				CP1 and CP4 (2030)			CP2 and CP4A (2030)			CP3 (2030)			CP5 (2030)		
	Ag	Ref	M&I	Ag	Ref	M&I	Ag	Ref	M&I	Ag	Ref	M&I	Ag	Ref	M&I
1922	80%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1923	41%	100%	67%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1924	8%	75%	53%	0%	0%	0%	-1%	0%	-1%	2%	0%	2%	-1%	0%	-1%
1925	46%	100%	68%	0%	0%	0%	-2%	0%	-1%	-2%	0%	-1%	-2%	0%	-1%
1926	17%	100%	61%	-4%	0%	-4%	-8%	0%	-8%	-7%	0%	-7%	-9%	0%	-10%
1927	50%	100%	71%	1%	0%	1%	2%	0%	2%	2%	0%	2%	-1%	0%	-1%
1928	38%	100%	67%	5%	0%	0%	6%	0%	0%	10%	0%	2%	11%	0%	3%
1929	0%	100%	45%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1930	16%	100%	60%	-3%	0%	-3%	-2%	0%	-2%	0%	0%	0%	2%	0%	1%
1931	9%	75%	53%	1%	0%	1%	0%	0%	0%	3%	0%	3%	0%	0%	0%
1932	15%	75%	59%	0%	0%	0%	0%	0%	0%	4%	0%	4%	-1%	0%	-1%
1933	4%	75%	49%	0%	0%	0%	0%	0%	0%	1%	0%	1%	0%	0%	0%
1934	9%	75%	54%	1%	0%	1%	-1%	0%	-1%	2%	0%	2%	1%	0%	1%
1935	21%	100%	63%	-4%	0%	-4%	-7%	0%	-6%	-6%	0%	-5%	-5%	0%	-4%
1936	36%	100%	67%	4%	0%	0%	1%	0%	0%	5%	0%	0%	1%	0%	0%
1937	30%	100%	66%	-2%	0%	0%	-3%	0%	-1%	-2%	0%	-1%	0%	0%	0%
1938	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1939	30%	98%	61%	2%	0%	0%	4%	0%	-1%	3%	0%	-1%	4%	0%	-1%
1940	42%	100%	67%	-3%	0%	0%	-3%	0%	0%	0%	0%	0%	-3%	0%	0%
1941	72%	100%	89%	4%	0%	0%	4%	0%	1%	4%	0%	1%	4%	0%	1%
1942	78%	100%	88%	-1%	0%	2%	-1%	0%	2%	-1%	0%	2%	-1%	0%	2%
1943	72%	100%	90%	7%	0%	0%	9%	0%	-2%	9%	0%	-2%	9%	0%	-2%
1944	23%	100%	67%	-3%	0%	-3%	-1%	0%	-1%	4%	0%	0%	3%	0%	0%
1945	57%	100%	78%	-5%	0%	-4%	-6%	0%	-5%	-1%	0%	-1%	-8%	0%	-7%
1946	57%	100%	78%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1947	37%	100%	67%	6%	0%	0%	8%	0%	0%	9%	0%	1%	9%	0%	1%
1948	27%	100%	66%	-5%	0%	0%	-6%	0%	-1%	0%	0%	0%	-4%	0%	0%
1949	52%	100%	74%	1%	0%	1%	1%	0%	1%	0%	0%	-1%	1%	0%	0%
1950	27%	100%	67%	1%	0%	0%	1%	0%	0%	11%	0%	0%	3%	0%	0%
1951	58%	100%	79%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1952	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1953	39%	100%	67%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1954	39%	100%	66%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1955	33%	100%	67%	6%	0%	0%	10%	0%	0%	12%	0%	-1%	12%	0%	-1%
1956	75%	100%	88%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1957	28%	100%	67%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1958	91%	100%	90%	-1%	0%	0%	-1%	0%	0%	-1%	0%	0%	-1%	0%	0%
1959	31%	100%	67%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1960	25%	98%	60%	3%	0%	0%	4%	0%	0%	9%	2%	-1%	7%	0%	-1%
1961	36%	98%	60%	-2%	1%	0%	-2%	1%	0%	-6%	2%	0%	-3%	2%	0%
1962	42%	100%	67%	2%	0%	0%	2%	0%	0%	3%	0%	0%	3%	0%	0%
1963	45%	100%	67%	0%	0%	0%	0%	0%	0%	-1%	0%	0%	0%	0%	0%
1964	37%	100%	67%	3%	0%	0%	9%	0%	0%	15%	0%	5%	15%	0%	5%
1965	67%	100%	84%	-1%	0%	0%	-1%	0%	0%	-3%	0%	-4%	-2%	0%	0%
1966	38%	100%	67%	-1%	0%	0%	0%	0%	0%	1%	0%	0%	1%	0%	0%
1967	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1968	34%	100%	67%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1969	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table 6-26. Simulated Annual Delivery Allocations to South-of-Delta CVP Water Service Contractors and Refuges for a 2030 Level of Development (contd.)

Key:
% = percent
Ag = Agricultural Water Service Contractor
Alt = alternative
Avg = average
CP = Comprehensive Plan
CVP = Central Valley Project
M&I = municipal and industrial contractor
Ref = refuge
Refuge = Level 2 Federal Refuge
SLWRI = Shasta Lake Water Resources Investigation

The Banks Pumping Plant provides water supply to SWP contractors, and when capacity is available may also export CVP water to support CVP deliveries. CP1, CP2, CP4, CP4A, and CP5 all include reserving a portion of the increased storage capacity in Shasta Reservoir to specifically focus on increasing M&I deliveries. For this EIS, these operations were simulated in CalSim-II by using the reserved storage capacity to provide deliveries for previously unmet SWP demands during dry and critical years. These additional water supplies for SWP deliveries are pumped through Banks Pumping Plant. Table 6-27 shows average annual exports through Banks Pumping Plant for the various SLWRI alternatives.

Table 6-27. Simulated Monthly Average Exports Through the Banks Pumping Plant

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alt (cfs)	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	3,308	46 (1%)	69 (2%)	26 (1%)	92 (3%)	3,156	71 (2%)	87 (3%)	37 (1%)	127 (4%)
Nov	3,155	64 (2%)	89 (3%)	57 (2%)	88 (3%)	3,222	17 (1%)	50 (2%)	43 (1%)	63 (2%)
Dec	4,892	-1 (0%)	7 (0%)	-4 (0%)	12 (0%)	4,949	-1 (0%)	-37 (-1%)	-59 (-1%)	-35 (-1%)
Jan	3,556	-9 (0%)	-48 (-1%)	9 (0%)	-64 (-2%)	3,589	-1 (0%)	9 (0%)	7 (0%)	5 (0%)
Feb	3,960	-2 (0%)	4 (0%)	10 (0%)	-5 (0%)	4,073	0 (0%)	-22 (-1%)	-12 (0%)	-34 (-1%)
Mar	3,936	11 (0%)	-5 (0%)	25 (1%)	14 (0%)	3,958	31 (1%)	21 (1%)	5 (0%)	16 (0%)
Apr	1,065	0 (0%)	1 (0%)	-3 (0%)	-1 (0%)	1,240	0 (0%)	-2 (0%)	-2 (0%)	-6 (0%)
May	1,099	1 (0%)	2 (0%)	-1 (0%)	0 (0%)	1,133	4 (0%)	6 (1%)	-13 (-1%)	6 (1%)
Jun	2,526	3 (0%)	6 (0%)	7 (0%)	17 (1%)	2,550	8 (0%)	14 (1%)	31 (1%)	23 (1%)
Jul	6,435	6 (0%)	15 (0%)	-30 (0%)	26 (0%)	6,274	53 (1%)	109 (2%)	34 (1%)	136 (2%)
Aug	5,597	85 (2%)	141 (3%)	-25 (0%)	169 (3%)	5,603	23 (0%)	57 (1%)	-71 (-1%)	85 (2%)
Sep	5,242	70 (1%)	107 (2%)	-19 (0%)	102 (2%)	5,449	86 (2%)	150 (3%)	2 (0%)	141 (3%)
Total (TAF)	2,706	17 (1%)	23 (1%)	3 (0%)	27 (1%)	2,730	18 (1%)	27 (1%)	0 (0%)	32 (1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node D419)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative

Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Tables 6-28 and 6-29 show the mean monthly delivery to SWP contractors south of the Delta for all years and for dry and critical years, respectively.

Table 6-28. Simulated Monthly Average Deliveries to SWP Table A Contractors

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alt (cfs)	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	3,226	1 (0%)	-7 (0%)	-25 (-1%)	-8 (0%)	3,351	17 (1%)	44 (1%)	-9 (0%)	57 (2%)
Nov	2,689	35 (1%)	51 (2%)	4 (0%)	79 (3%)	2,812	1 (0%)	18 (1%)	1 (0%)	32 (1%)
Dec	2,476	28 (1%)	33 (1%)	4 (0%)	19 (1%)	2,886	28 (1%)	38 (1%)	-1 (0%)	49 (2%)
Jan	623	9 (2%)	18 (3%)	-6 (-1%)	22 (4%)	988	31 (3%)	49 (5%)	-20 (-2%)	55 (6%)
Feb	1,106	21 (2%)	32 (3%)	-6 (-1%)	36 (3%)	1,860	27 (1%)	52 (3%)	-13 (-1%)	59 (3%)
Mar	1,804	18 (1%)	28 (2%)	-6 (0%)	27 (1%)	2,307	14 (1%)	27 (1%)	-9 (0%)	30 (1%)
Apr	4,733	18 (0%)	24 (1%)	1 (0%)	17 (0%)	5,094	27 (1%)	35 (1%)	2 (0%)	40 (1%)
May	5,837	33 (1%)	43 (1%)	17 (0%)	47 (1%)	6,335	23 (0%)	31 (0%)	5 (0%)	36 (1%)
Jun	7,433	-7 (0%)	-22 (0%)	22 (0%)	7 (0%)	7,612	38 (1%)	41 (1%)	-8 (0%)	33 (0%)
Jul	7,841	41 (1%)	49 (1%)	-6 (0%)	55 (1%)	8,147	12 (0%)	31 (0%)	-31 (0%)	27 (0%)
Aug	7,017	14 (0%)	12 (0%)	-25 (0%)	21 (0%)	7,244	-12 (0%)	-13 (0%)	-54 (-1%)	-20 (0%)
Sep	5,086	22 (0%)	47 (1%)	-4 (0%)	54 (1%)	5,322	37 (1%)	52 (1%)	4 (0%)	71 (1%)
Total (TAF)	3,020	14 (0%)	19 (1%)	-2 (0%)	23 (1%)	3,265	15 (0%)	24 (1%)	-8 (0%)	28 (1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_SWP_PAG and DEL_SWP_PMI)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
SWP = State Water Project
TAF = thousand acre-feet

Table 6-29. Simulated Monthly Average Deliveries to SWP Table A Contractors in Dry and Critical Years

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alt (cfs)	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	2,873	50 (2%)	63 (2%)	8 (0%)	73 (3%)	3,051	32 (1%)	50 (2%)	-13 (0%)	64 (2%)
Nov	2,282	54 (2%)	71 (3%)	6 (0%)	83 (4%)	2,342	2 (0%)	28 (1%)	1 (0%)	33 (1%)
Dec	2,014	82 (4%)	89 (4%)	12 (1%)	76 (4%)	2,392	71 (3%)	78 (3%)	38 (2%)	90 (4%)
Jan	389	-3 (-1%)	0 (0%)	-5 (-1%)	2 (1%)	412	13 (3%)	28 (7%)	-18 (-4%)	32 (8%)
Feb	637	29 (5%)	47 (7%)	-10 (-2%)	48 (8%)	766	21 (3%)	45 (6%)	-25 (-3%)	49 (6%)
Mar	1,041	31 (3%)	56 (5%)	-14 (-1%)	57 (5%)	1,101	30 (3%)	60 (5%)	-31 (-3%)	73 (7%)
Apr	4,156	48 (1%)	69 (2%)	-9 (0%)	47 (1%)	4,251	74 (2%)	102 (2%)	-25 (-1%)	109 (3%)
May	4,983	19 (0%)	55 (1%)	-14 (0%)	60 (1%)	5,143	72 (1%)	103 (2%)	-22 (0%)	118 (2%)
Jun	6,408	-48 (-1%)	-66 (-1%)	-11 (0%)	-24 (0%)	6,471	46 (1%)	61 (1%)	-87 (-1%)	44 (1%)
Jul	6,757	110 (2%)	146 (2%)	-9 (0%)	166 (2%)	6,933	64 (1%)	133 (2%)	-56 (-1%)	126 (2%)
Aug	5,605	45 (1%)	45 (1%)	-58 (-1%)	80 (1%)	5,679	10 (0%)	16 (0%)	-132 (-2%)	2 (0%)
Sep	4,003	62 (2%)	140 (3%)	-8 (0%)	161 (4%)	4,066	119 (3%)	175 (4%)	3 (0%)	225 (6%)
Total (TAF)	2,493	29 (1%)	43 (2%)	-7 (0%)	50 (2%)	2,581	34 (1%)	53 (2%)	-22 (-1%)	58 (2%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_SWP_PAG and DEL_SWP_PMI)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative
Dry and critical years as defined by the Sacramento Valley Index

Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
SWP = State Water Project
TAF = thousand acre-feet

Changes in Delta export operations could potentially result in changes in reservoir operations south of the Delta along the San Joaquin River due to changes in return flows from project deliveries. These changes, if they occur, would be expected to be very small. Any changes in operations of San Joaquin River basin reservoirs would be reflected in changes in San Joaquin River flows near its confluence with the Delta. The San Joaquin River at Vernalis is commonly used as the downstream end of the San Joaquin River. Table 6-30 shows simulated San Joaquin River flow at Vernalis. According to modeling, the SLWRI alternatives do not affect San Joaquin River flows at Vernalis.

Table 6-30. Simulated Monthly Average San Joaquin River Flows at Vernalis

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alt (cfs)	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	2,757	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2,753	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Nov	2,633	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2,603	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Dec	3,199	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3,263	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jan	4,770	0 (0%)	0 (0%)	0 (0%)	0 (0%)	4,764	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Feb	6,265	0 (0%)	0 (0%)	0 (0%)	0 (0%)	6,143	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Mar	7,133	0 (0%)	0 (0%)	0 (0%)	0 (0%)	7,003	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Apr	6,720	0 (0%)	0 (0%)	0 (0%)	0 (0%)	7,533	0 (0%)	0 (0%)	0 (0%)	0 (0%)
May	6,204	0 (0%)	0 (0%)	0 (0%)	0 (0%)	6,234	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jun	4,739	0 (0%)	0 (0%)	0 (0%)	0 (0%)	4,671	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jul	3,202	0 (0%)	0 (0%)	1 (0%)	0 (0%)	3,208	0 (0%)	0 (0%)	1 (0%)	1 (0%)
Aug	2,029	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2,040	0 (0%)	0 (0%)	1 (0%)	0 (0%)
Sep	2,331	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2,340	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total (TAF)	3,126	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3,161	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (NodesC639)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
SWP = State Water Project
TAF = thousand acre-feet

No-Action Alternative

For a complete list of the differences between the No-Action Alternative and the existing conditions, see Table 2-1 in the Modeling Appendix.

As described above, modeling indicates that the No-Action Alternative would continue to meet water supply demands at levels of compliance similar to the existing conditions and would not result in any appreciable changes in water supply reliability.

Shasta Lake and Vicinity The significance criteria for H&H do not apply in the Shasta Lake and vicinity geographic region; therefore, potential effects in that geographic region are not discussed further in this EIS.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact H&H-1 (No-Action): Change in Frequency of Flows above 100,000 cfs on the Sacramento River below Bend Bridge Flood management operations would not change under the No-Action Alternative as compared to the existing condition; the recurrence of flows above 100,000 cfs on the Sacramento River below Bend Bridge would remain the same as the existing condition. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact H&H-2 (No-Action): Place Housing or Other Structures within a 100-Year Flood Hazard Area as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map No new structures would be built in the floodplain under the No-Action Alternative, and flood management operations at Shasta Dam would not change under the No-Action Alternative as compared to the existing condition. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact H&H-3(No-Action): Place within a 100-Year Flood Hazard Area Structures that Would Impede or Redirect Flood Flows No new structures would be built in the floodplain under the No-Action Alternative, and flood management operations at Shasta Dam would not change under the No-Action Alternative. No impact would occur. Mitigation is not required for the No-Action Alternative.

Lower Sacramento River and Delta

Impact H&H-4 (No-Action): Change in Water Levels in the Old River near Tracy Road Bridge Water levels in the Old River near Tracy Road Bridge could be slightly lower under the No-Action Alternative than the existing condition. This impact would be less than significant.

As shown in Table 6-31, maximum monthly reductions in minimum daily water level associated with No-Action compared to the existing conditions would exceed -0.1 feet; however, the reductions would not result in water levels less than 0.0 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Table 6-31. Simulated Monthly Maximum 15-Minute Change in Water Levels at Various Locations in the South Delta at Low-Low Tide

Month	Change from Existing Condition		
	Old River near Tracy Road Bridge (feet)	Grant Line Canal near the Grant Line Canal Barrier (feet)	Middle River near the Howard Road Bridge (feet)
Apr	-0.02 (0%)	-0.02 (0%)	-0.02 (0%)
May	-0.27 (0%)	-0.37 (0%)	-0.29 (0%)
Jun	-0.42 (0%)	-0.48 (0%)	-0.45 (0%)
Jul	-0.05 (0%)	-0.04 (0%)	-0.05 (0%)
Aug	-0.05 (0%)	-0.02 (0%)	-0.05 (0%)
Sep	-0.19 (0%)	-0.08 (0%)	-0.21 (0%)
Oct	-0.08 (0%)	-0.03 (0%)	-0.08 (0%)

Source: Version8.0.6 DSM2 2005 and 2030 simulations (Node 071_3116, Node 129_5691, and Node 206_5533)

Notes:
Simulation period: 1922-2003
(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.

Impact H&H-5 (No-Action): Change in Water Levels in the Grant Line Canal near the Grant Line Canal Barrier Water levels in the Grant Line Canal near the Grant Line Canal Barrier could be slightly lower under the No-Action Alternative than the existing condition. This impact would be less than significant.

As shown in Table 6-31, maximum monthly reductions in minimum daily water level associated with No-Action compared to the existing conditions would exceed -0.1 feet; however, the reductions would not result in water levels less than 0.0 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Impact H&H-6 (No-Action): Change in Water Levels in the Middle River near the Howard Road Bridge Water levels in the Middle River near the Howard Road Bridge could be slightly lower under the No-Action Alternative than the existing condition. This impact would be less than significant.

As shown in Table 6-31, maximum monthly reductions in minimum daily water level associated with No-Action compared to the existing conditions would exceed -0.1 feet; however, the reductions would not result in water levels less than 0.3 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Impact H&H-7 (No-Action): Change in X2 Position The X2 position would not change from west to east of Collinsville in December or January when the Delta would not be in balanced conditions. Examination of simulation output indicates that compared to the existing condition, in no months would the No-

Action Alternative cause the X2 position to shift from west to east of Collinsville, when the Delta would not be in balanced conditions. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact H&H-8 (No-Action): Change in Recurrence of Delta Excess Conditions Few changes would occur from excess to balanced Delta conditions under the No-Action Alternative. This impact would be less than significant.

As shown in Table 6-32, CP1 would cause the Delta to change from excess to balanced conditions 16 times in the simulation; however, no month would change more than 5 percent of the time and at most only once during the 82-year period, according to the simulation. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Table 6-32. Simulated Number of Years the Delta Changes from Excess to Balanced Condition

Number of Years the Delta Changes from Excess to Balanced Conditions Compared to Existing Condition											
Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
0 (0%)	0 (0%)	1 (1%)	1 (1%)	1 (1%)	3 (4%)	1 (1%)	3 (4%)	1 (1%)	0 (0%)	4 (5%)	1 (1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations
Notes:
Simulation Period: 1922-2003
(%) indicates percent of months Delta condition change occurs from existing condition
Key:
SLWRI = Shasta Lake Water Resources Investigation

CVP/SWP Service Areas

Impact H&H-9 (No-Action): Change in Deliveries to North-of-Delta CVP Water Service Contractors and Refuges Average annual deliveries to North-of-Delta CVP water service contractors would decrease under the No-Action Alternative relative to the existing condition. Average annual deliveries to north-of-Delta refuges would increase under the No-Action Alternative relative to the existing condition. The impact on North-of-Delta CVP water service contractors would be potentially significant.

As shown in Table 6-33, average annual deliveries to North-of-Delta CVP water service contractors would decrease under the No-Action Alternative. Deliveries to refuges under the No-Action Alterative would be greater than under existing conditions. This impact to water service contractors would be potentially significant. Mitigation is not required for the No-Action Alternative.

Table 6-33. Simulated Monthly Average Deliveries and Percent Change of Deliveries to North-of-Delta CVP Water Service Contractors and Refuges

Month	Change from Existing Conditions	
	Average All Years (cfs (%))	**Dry and Critical Years (cfs (%))**
North-of-Delta CVP Water Service Contractors Deliveries		
Oct	-3 (-4%)	-6 (-9%)
Nov	0 (-12%)	-1 (-16%)
Dec	0 (0%)	0 (0%)
Jan	0 (0%)	0 (0%)
Feb	-1 (-28%)	-2 (-27%)
Mar	-5 (-24%)	-7 (-33%)
Apr	-37 (-11%)	-48 (-21%)
May	-17 (-3%)	-48 (-15%)
Jun	-11 (-1%)	-60 (-14%)
Jul	-8 (-1%)	-66 (-14%)
Aug	-6 (-1%)	-53 (-14%)
Sep	-7 (-2%)	-26 (-15%)
Total (TAF)	-6 (-2%)	-19 (-15%)
North-of-Delta Refuges Deliveries		
Oct	46 (26%)	30 (17%)
Nov	51 (31%)	57 (37%)
Dec	28 (27%)	28 (27%)
Jan	13 (26%)	13 (26%)
Feb	12 (27%)	12 (27%)
Mar	3 (25%)	3 (24%)
Apr	3 (22%)	3 (24%)
May	14 (27%)	13 (28%)
Jun	17 (22%)	11 (15%)
Jul	28 (27%)	28 (28%)
Aug	37 (26%)	31 (23%)
Sep	51 (27%)	49 (27%)
Total (TAF)	18 (27%)	17 (25%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_N and DEL_CVP_PRF_N)

Note:

Simulation period: 1922-2003. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index

Key:

% = percent

cfs = cubic feet per second

CVP = Central Vallye Project

SLWRI = Shasta Lake Water Resources Investigation

TAF = thousand acre-feet

Impact H&H-10 (No-Action): Change in Deliveries to South-of-Delta CVP Water Service Contractors and Refuges Average annual deliveries to south-of-Delta CVP water service contractors would decrease by more than 10 percent in dry and critical years under the No-Action Alternative, relative to the existing condition. Average annual deliveries to Refuges would decrease by 8 percent. This impact would be potentially significant.

As shown in Table 6-34, annual deliveries to south-of-Delta CVP water service contractors and refuges would decrease in average annual and dry and critical years, respectively. This impact would be potentially significant. Mitigation is not required for the No-Action Alternative.

Table 6-34. Simulated Monthly Average Deliveries and Percent Change of Deliveries to South-of-Delta CVP Water Service Contractors and Refuges

Month	Change from Existing Conditions	
	Average All Years (cfs (%))	Dry and Critical Years (cfs (%))
South-of-Delta CVP Water Service Contractors Deliveries		
Oct		
Nov	-8 (-2%)	-15 (-6%)
Dec	-11 (-2%)	-21 (-6%)
Jan	-20 (-2%)	-37 (-6%)
Feb	-25 (-2%)	-46 (-6%)
Mar	-26 (-4%)	-60 (-17%)
Apr	-27 (-3%)	-83 (-13%)
May	-35 (-2%)	-108 (-12%)
Jun	-50 (-2%)	-157 (-11%)
Jul	-73 (-2%)	-228 (-13%)
Aug	-15 (-1%)	-173 (-16%)
Sep	-13 (-2%)	-58 (-14%)
Total (TAF)	-19 (-2%)	-61 (-11%)
South-of-Delta Refuges Deliveries		
Oct	-85 (-8%)	-84 (-8%)
Nov	-58 (-8%)	-57 (-8%)
Dec	-30 (-9%)	-30 (-9%)
Jan	-10 (-7%)	-10 (-7%)
Feb	-6 (-6%)	-6 (-6%)
Mar	-6 (-6%)	-5 (-6%)
Apr	-15 (-7%)	-14 (-7%)
May	-38 (-9%)	-36 (-9%)
Jun	-37 (-7%)	-35 (-7%)
Jul	-8 (-6%)	-7 (-6%)
Aug	-16 (-8%)	-23 (-13%)
Sep	-77 (-9%)	-83 (-10%)
Total (TAF)	-23 (-8%)	-24 (-8%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_S and DEL_CVP_PRF_S)

Note:

Simulation period: 1922-2003. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index

Key:
% = percent
cfs = cubic feet per second
CVP = Central Valley Project
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Impact H&H-11 (No-Action): Change in Deliveries to SWP Table A Contractors Average deliveries to SWP Table A contractors would increase under the No-Action Alternative relative to the existing condition. This impact would be beneficial.

As shown in Table 6-35, average annual and monthly deliveries to SWP Table A contractors would increase under the No-Action Alternative relative to existing conditions for the average of all years, and for dry and critical years. This impact would be beneficial. Mitigation is not required for the No-Action Alternative.

Table 6-35. Simulated Monthly Average Deliveries and Percent Change of Deliveries to SWP Table A Contractors

Month	Change from Existing Conditions	
	Average All-Years (cfs (%))	Dry and Critical Years (cfs (%))
Oct	125 (4%)	178 (6%)
Nov	123 (5%)	60 (3%)
Dec	410 (17%)	378 (19%)
Jan	365 (59%)	22 (6%)
Feb	753 (68%)	129 (20%)
Mar	503 (28%)	60 (6%)
Apr	361 (8%)	96 (2%)
May	498 (9%)	160 (3%)
Jun	179 (2%)	63 (1%)
Jul	306 (4%)	177 (3%)
Aug	226 (3%)	73 (1%)
Sep	236 (5%)	63 (2%)
Total (TAF)	245 (8%)	88 (4%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_SWP_PAG and DEL_SWP_PMI)

Note:

Simulation period: 1922-2003. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index

Key:

% = percent

cfs = cubic feet per second

SLWRI = Shasta Lake Water Resources Investigation

SWP = State Water Project

TAF = thousand acre-feet

Impact H&H-12(No-Action): Change in Groundwater Changes in groundwater levels would not be measurable under the No-Action Alternative as compared to the existing condition. This impact would be less than significant.

As shown in Tables 6-33, 6-34, and 6-35, total surface water deliveries to CVP and SWP contractors increase for the No-Action Alternative as compared to the existing condition. However, these increases in deliveries are likely associated with increases in demands rather than increases in water supply. Although groundwater pumping would still be required, the volume of pumping in the CVP/SWP service area would not be expected to change noticeably. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Impact H&H-13 (No-Action): Change in Groundwater Quality Changes in groundwater quality under the No-Action Alternative as compared to the existing condition would not be measurable. This impact would be less than significant.

As shown in Tables 6-11, 6-12, 6-23, 6-24, 6-28, and 6-29, total surface water deliveries to CVP and SWP contractors increase for the No-Action Alternative compared to the existing condition. However, these increases in deliveries are likely associated with increases in demands rather than increases in water supply. Although groundwater pumping would still be required, the volume of pumping in the CVP/SWP service area would not be expected to change noticeably. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP1 primarily consists of raising Shasta Dam by 6.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir's full pool by 8.5 feet and enlarge the total storage capacity in the reservoir by 256,000 acre-feet. The existing TCD would also be extended to achieve efficient use of the expanded cold-water pool. Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 70,000 acre-feet and 35,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries.

Shasta Lake and Vicinity The significance criteria for H&H do not apply in the Shasta Lake and vicinity geographic region; therefore, potential effects in that geographic region are not discussed further in this EIS.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact H&H-1 (CP1): Change in Frequency of Flows above 100,000 cfs on the Sacramento River below Bend Bridge Although flood management operations would not change under CP1, a slight reduction could occur in the frequency of flows greater than 100,000 cfs. This impact would be beneficial.

SLWRI modeling uses a monthly time step, which is inappropriate for flood control analysis; however, flood management operations for downstream objectives would not change under CP1. Although a slight decrease in recurrence of high flows would be possible because of the increased storage capability, CP1 would not increase the frequency of flows above 100,000 cfs.

This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-2 (CP1): Place Housing or Other Structures within a 100-Year Flood Hazard Area as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map No new structures would be built downstream from Shasta Dam. All project construction would be completed at the Shasta Dam site, and although the reservoir area would be expanded, any structures located within the reservoir area would be removed. Because reservoir operations for downstream objectives would not change, no additional structures downstream from the dam would be located within the 100-year flood hazard area. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-3 (CP1): Place within a 100-Year Flood Hazard Area Structures that Would Impede or Redirect Flood Flows No new structures would be built downstream from Shasta Dam. All project construction would be done at the Shasta Dam site, and although the reservoir area would be expanded, any structures located within the reservoir area would be removed. Because reservoir operations for downstream objectives would not change, no additional structures downstream from the dam would be located within the 100-year flood hazard area that would impede or redirect flood flows. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta

Impact H&H-4 (CP1): Change in Water Levels in the Old River near Tracy Road Bridge Simulated water levels in the Old River near Tracy Road Bridge show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant.

As shown in Table 6-36, maximum monthly reduction in minimum daily water level associated with CP1 would be less than 0.1 foot in all months during the irrigation season, compared to the existing condition and the No-Action Alternative. The water levels would remain above 0.0 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-36. Simulated Monthly Maximum 15-Minute Change in Old River Water Levels near Tracy Road Bridge at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP1 (2005) Change (feet)	CP1 (2030) Change (feet)
Apr	0 00 (0%)	-0.01 (0%)
May	-0.01 (0%)	-0.01 (0%)
Jun	0 00 (0%)	-0.05 (0%)
Jul	-0.05 (0%)	-0.03 (0%)
Aug	-0.04 (0%)	-0.05 (0%)
Sep	-0.04 (0%)	-0.06 (0%)
Oct	-0.05 (0%)	-0.05 (0%)

Source: Version 8.0.6 DSM2 2005 and 2030 simulations (Node 071_3116)

Note:
Simulation period: 1922-2003
(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.
Key:
CP = comprehensive plan

Impact H&H-5 (CP1): Change in Water Levels in the Grant Line Canal near the Grant Line Canal Barrier Simulated water levels in the Grant Line Canal near the Grant Line Canal Barrier show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant.

As shown in Table 6-37, maximum monthly reduction in minimum daily water level associated with CP1 would be less than 0.1 foot in all months during the irrigation season, compared to the existing condition and the No-Action Alternative. The water levels would remain above 0.0 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-37. Simulated Monthly Maximum 15-Minute Change in the Grant Line Canal Water Levels near the Grant Line Canal Barrier at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP1 (2005) Change (feet)	CP1 (2030) Change (feet)
Apr	0.00 (0%)	0.00 (0%)
May	-0.01 (0%)	-0.01 (0%)
Jun	0.00 (0%)	-0.03 (0%)
Jul	-0.06 (0%)	-0.03 (0%)
Aug	-0.03 (0%)	-0.03 (0%)
Sep	-0.02 (0%)	-0.04 (0%)
Oct	-0.02 (0%)	-0.02 (0%)

Source: Version 8.0.6 DSM2 2005 and 2030 simulations (Node 129_5691)

Notes:
Simulation period: 1922-2003
(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.
Key:
CP = comprehensive plan

Impact H&H-6 (CP1): Change in Water Levels in the Middle River near the Howard Road Bridge Simulated water levels in the Middle River near the Howard Road Bridge show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant.

As shown in Table 6-38, maximum monthly reduction in minimum daily water level associated with CP1 would be less than 0.1 foot in all months during the irrigation season, compared to the existing condition and the No-Action alternative. The water levels would remain above 0.3 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-38. Simulated Monthly Maximum 15-Minute Change in Middle River Water Levels near the Howard Road Bridge at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP1 (2005) Change (feet)	CP1 (2030) Change (feet)
Apr	0 00 (0%)	-0.01 (0%)
May	-0.01 (0%)	-0.01 (0%)
Jun	0 00 (0%)	-0.05 (0%)
Jul	-0.05 (0%)	-0.03 (0%)
Aug	-0.04 (0%)	-0.04 (0%)
Sep	-0.04 (0%)	-0.07 (0%)
Oct	-0.05 (0%)	-0.05 (0%)

Source: Version 8.0.6 DSM2 2005 and 2030 simulations (Node 206_5533)

Notes:
Simulation period: 1922-2003
(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.
Key:
CP = comprehensive plan

Impact H&H-7 (CP1): Change in X2 Position The X2 position would not change from west to east of Collinsville in December or January when the Delta was not in balanced conditions. Examination of simulation output indicates that compared to the existing condition, or No-Action Alternative, CP1 shows no months when the X2 position shifts from west to east of Collinsville when the Delta would not be in balanced conditions. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-8 (CP1): Change in Recurrence of Delta Excess Conditions Changes from excess to balanced Delta conditions would be rare. This impact would be less than significant.

As shown in Table 6-39, CP1 would cause one April, one June, two Julys, three Augusts, one October, and one November to switch from excess to balanced Delta conditions when compared to the existing condition, and two Augusts, two Novembers, and one each of October and December when compared to the No-Action Alternative. Because of the low number of occurrences, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-39. Simulated Number of Years the Delta Changes from Excess to Balanced Condition

	Number of Years the Delta Changes from Excess to Balanced Conditions Compared to Existing Condition or No-Action Alternative											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
CP1 (2005)	0 (0%)	0 (0%)	0 (0%)	1 (1%)	0 (0%)	1 (1%)	2 (2%)	3 (4%)	0 (0%)	1 (1%)	1 (1%)	0 (0%)
CP1 (2030)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (2%)	0 (0%)	1 (1%)	2 (2%)	1 (1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations
Notes:
Simulation Period: 1922-2003
(%) indicates percent of months Delta condition change occurs
Key:
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation

CVP/SWP Service Areas

Impact H&H-9 (CP1): Change in Deliveries to North-of-Delta CVP Water Service Contractors and Refuges Average annual deliveries to North-of-Delta water service contractors would increase under all conditions. Average annual deliveries to Refuges would not change under all conditions. This impact would be less than significant.

As shown in Table 6-40, average annual deliveries to North-of-Delta water service contractors under both existing and future conditions would increase relative to the basis of comparison. Deliveries to Refuges North-of-Delta would not significantly change under all conditions on an annual average basis. Minor increases and decreases in Refuge deliveries are not true representation of real-time operations but an indication of modeling artifacts. Such reduction would not occur in real time due to efficient water allocation and management schemes that cannot be captured adequately in a water resources planning model such as CalSim-II. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-40. Simulated Monthly Average Deliveries and Percent Change of Deliveries to North-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP1 Change (cfs (%))	Existing Condition (cfs)	CP1 Change (cfs (%))	No-Action Alternative (cfs)	CP1 Change (cfs (%))	No-Action Alternative (cfs)	CP1 Change (cfs (%))
North-of-Delta CVP Water Service Contractors Deliveries								
Oct	77	3 (3%)	69	3 (4%)	74	2 (3%)	63	2 (3%)
Nov	3	0 (1%)	3	0 (2%)	2	0 (2%)	3	0 (2%)
Dec	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Jan	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Feb	3	0 (2%)	7	0 (1%)	2	0 (1%)	5	0 (0%)
Mar	19	1 (5%)	21	2 (10%)	15	1 (5%)	14	1 (10%)
Apr	335	12 (3%)	229	14 (6%)	297	13 (4%)	181	11 (6%)
May	572	15 (3%)	316	19 (6%)	555	15 (3%)	268	11 (4%)
Jun	799	19 (2%)	425	26 (6%)	788	19 (2%)	365	13 (4%)
Jul	918	21 (2%)	480	29 (6%)	910	20 (2%)	414	15 (4%)
Aug	733	17 (2%)	386	23 (6%)	727	16 (2%)	333	12 (4%)
Sep	341	8 (2%)	170	11 (6%)	334	8 (2%)	144	6 (4%)
Total (TAF)	231	6 (2%)	128	8 (6%)	225	6 (3%)	109	4 (4%)
North-of-Delta Refuges Deliveries								
Oct	177	-10 (-5%)	182	-25 (-14%)	224	2 (1%)	212	8 (4%)
Nov	168	2 (1%)	156	5 (3%)	219	-1 (0%)	212	-4 (-2%)
Dec	105	0 (0%)	104	0 (0%)	133	0 (0%)	132	0 (0%)
Jan	50	0 (0%)	50	0 (0%)	63	0 (0%)	62	0 (0%)
Feb	45	0 (0%)	45	0 (0%)	57	0 (0%)	57	0 (0%)
Mar	13	0 (0%)	12	0 (0%)	16	0 (0%)	15	0 (1%)
Apr	15	0 (0%)	14	0 (0%)	18	0 (0%)	17	0 (-1%)
May	50	-1 (-1%)	46	-2 (-3%)	64	0 (0%)	59	0 (0%)
Jun	79	-1 (-1%)	75	-2 (-3%)	96	1 (1%)	87	3 (3%)
Jul	106	-1 (-1%)	99	-3 (-3%)	134	-1 (-1%)	126	-4 (-3%)
Aug	143	0 (0%)	134	0 (0%)	180	2 (1%)	165	6 (4%)
Sep	187	0 (0%)	177	0 (0%)	237	0 (0%)	226	0 (0%)
Total (TAF)	69	-1 (-1%)	66	-2 (-2%)	87	0 (0%)	83	1 (1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_N and DEL_CVP_PRF_N)

Notes:

Simulation period: 1922-2003. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

(%) indicates percent change from either existing condition or No-Action Alternative

Key:

cfs = cubic feet per second

CP = comprehensive plan

CVP = Central Valley Project

SLWRI = Shasta Lake Water Resources Investigation

TAF = thousand acre-feet

Impact H&H-10 (CP1): Change in Deliveries to South-of-Delta CVP Water Service Contractors and Refuges Average annual and monthly deliveries to South-of-Delta water service contractors would increase under both existing and future conditions. Average annual deliveries to South-of-Delta refuges would not change under the project conditions. This impact would be beneficial.

As shown in Table 6-41, average annual deliveries to South-of-Delta water service contractors under both existing and future conditions would increase relative to the basis of comparison. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed. Average annual deliveries to South-of-Delta refuges would not change under all conditions. Minor increases and decreases in Refuge deliveries are not a true representation of real-time operations but an indication of modeling artifacts. Such reduction would not occur in real time due to efficient water allocation and management schemes that cannot be captured adequately in a water resources planning model such as CalSim-II. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-41. Simulated Monthly Average Deliveries and Percent Change of Deliveries to South-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP1 Change (cfs (%))	Existing Condition (cfs)	CP1 Change (cfs (%))	No-Action Alternative (cfs)	CP1 Change (cfs (%))	No-Action Alternative (cfs)	CP1 Change (cfs (%))
South-of-Delta CVP Water Service Contractors Deliveries								
Oct	474	3 (1%)	363	6 (2%)	464	6 (1%)	343	8 (2%)
Nov	362	3 (1%)	277	4 (2%)	354	4 (1%)	262	6 (2%)
Dec	501	3 (1%)	383	6 (2%)	490	6 (1%)	362	8 (2%)
Jan	880	6 (1%)	673	10 (2%)	860	10 (1%)	636	14 (2%)
Feb	1,100	8 (1%)	841	13 (2%)	1,076	13 (1%)	794	18 (2%)
Mar	660	13 (2%)	362	15 (4%)	634	15 (2%)	302	6 (2%)
Apr	1,079	11 (1%)	627	-1 (0%)	1,052	15 (1%)	545	5 (1%)
May	1,564	11 (1%)	902	-2 (0%)	1,528	19 (1%)	794	11 (1%)
Jun	2,596	28 (1%)	1,467	23 (2%)	2,545	32 (1%)	1,310	19 (1%)
Jul	3,136	20 (1%)	1,809	-10 (-1%)	3,063	37 (1%)	1,581	19 (1%)
Aug	2,078	1 (0%)	1,112	-40 (-4%)	2,063	9 (0%)	939	31 (3%)
Sep	735	0 (0%)	428	-8 (-2%)	722	10 (1%)	370	7 (2%)
Total (TAF)	916	6 (1%)	558	1 (0%)	898	11 (1%)	497	9 (2%)
South-of-Delta Refuges Deliveries								
Oct	1,126	0 (0%)	1,110	0 (0%)	1,041	0 (0%)	1,026	0 (0%)
Nov	729	0 (0%)	718	0 (0%)	671	0 (0%)	661	0 (0%)
Dec	336	0 (0%)	331	0 (0%)	306	0 (0%)	302	0 (0%)
Jan	147	0 (0%)	145	0 (0%)	137	0 (0%)	135	0 (0%)
Feb	109	0 (0%)	107	0 (0%)	102	0 (0%)	101	0 (0%)
Mar	93	0 (0%)	89	0 (0%)	88	0 (0%)	83	0 (0%)
Apr	217	0 (0%)	207	0 (0%)	203	0 (0%)	193	0 (0%)
May	445	0 (0%)	423	0 (0%)	407	0 (0%)	387	0 (0%)
Jun	493	0 (0%)	468	1 (0%)	456	0 (0%)	434	0 (0%)
Jul	120	0 (0%)	114	0 (0%)	112	0 (0%)	107	0 (0%)
Aug	197	2 (1%)	185	1 (1%)	181	2 (1%)	161	7 (4%)
Sep	885	-9 (-1%)	843	-6 (-1%)	808	0 (0%)	760	0 (0%)
Total (TAF)	296	0 (0%)	286	0 (0%)	273	0 (0%)	263	0 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_S and DEL_CVP_PRF_S)

Notes:

Simulation period: 1922-2003. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

(%) indicates percent change from either existing condition or No-Action Alternative

Key:

cfs = cubic feet per second

CP = comprehensive plan

CVP = Central Valley Project

SLWRI = Shasta Lake Water Resources Investigation

TAF = thousand acre-feet

Impact H&H-11 (CP1): Change in Deliveries to SWP Table A Contractors

Average annual deliveries would increase under both existing and future conditions, but some less than significant decreases could occur in monthly deliveries under future conditions. This impact would be less than significant.

As shown in Table 6-42, average annual deliveries to SWP Table A contractors would increase under CP1 in both existing and future conditions relative to the bases of comparison in both average years and in dry and critical years. Under both existing and future conditions some decreases could occur in deliveries under CP1.These decreases would be less than 1 percent. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-42. Simulated Monthly Average Deliveries and Percent Change of Deliveries to SWP Table A Contractors

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP1 Change (cfs (%))	Existing Condition (cfs)	CP1 Change (cfs (%))	No-Action Alternative (cfs)	CP1 Change (cfs (%))	No-Action Alternative (cfs)	CP1 Change (cfs (%))
Oct	3,226	1 (0%)	2,873	50 (2%)	3,351	17 (1%)	3,051	32 (1%)
Nov	2,689	35 (1%)	2,282	54 (2%)	2,812	1 (0%)	2,342	2 (0%)
Dec	2,476	28 (1%)	2,014	82 (4%)	2,886	28 (1%)	2,392	71 (3%)
Jan	623	9 (2%)	389	-3 (-1%)	988	31 (3%)	412	13 (3%)
Feb	1,106	21 (2%)	637	29 (5%)	1,860	27 (1%)	766	21 (3%)
Mar	1,804	18 (1%)	1,041	31 (3%)	2,307	14 (1%)	1,101	30 (3%)
Apr	4,733	18 (0%)	4,156	48 (1%)	5,094	27 (1%)	4,251	74 (2%)
May	5,837	33 (1%)	4,983	19 (0%)	6,335	23 (0%)	5,143	72 (1%)
Jun	7,433	-7 (0%)	6,408	-48 (-1%)	7,612	38 (1%)	6,471	46 (1%)
Jul	7,841	41 (1%)	6,757	110 (2%)	8,147	12 (0%)	6,933	64 (1%)
Aug	7,017	14 (0%)	5,605	45 (1%)	7,244	-12 (0%)	5,679	10 (0%)
Sep	5,086	22 (0%)	4,003	62 (2%)	5,322	37 (1%)	4,066	119 (3%)
Total (TAF)	3,020	14 (0%)	2,493	29 (1%)	3,265	15 (0%)	2,581	34 (1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_SWP_PAG and DEL_SWP_PMI)
Notes:
Simulation period: 1922-2003. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
cfs = cubic feet per second
CP = comprehensive plan
CVP = Central Valley Project
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Impact H&H-12 (CP1): Change in Groundwater Levels CP1 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. The reduction in groundwater pumping would result in increased groundwater levels. This impact would be beneficial.

With increased water supply deliveries to CVP and SWP water contractors, and an associated increase in surface water supply reliability to those contractors, shortages in deliveries would decrease under CP1. Contractor responses to shortages in surface water deliveries would vary; some may elect to fallow their land, others may buy water on the transfer market, and some may pump groundwater. An increase in surface water deliveries would result in a decrease in groundwater pumping. With less groundwater pumping, groundwater basins that were in overdraft conditions would be anticipated to improve as a result of increasing groundwater levels. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-13 (CP1): Change in Groundwater Quality CP1 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. This impact would be less than significant for groundwater quality.

With increased water supply deliveries to CVP and SWP water contractors, and an associated increase in surface water supply reliability to those contractors, shortages in deliveries would decrease under CP1. Contractor responses to shortages in surface water deliveries would vary; some may elect to fallow their land, others may buy water on the transfer market, and some may pump groundwater. An increase in surface water deliveries would result in a decrease in groundwater pumping. Because CP1 would have a positive, albeit limited, impact by reducing reliance on groundwater, the effects of CP1 on groundwater quality also would be limited. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP2 primarily consists of raising Shasta Dam by 12.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir's full pool by 14.5 feet and would enlarge the total storage capacity in the reservoir by 443,000 acre-feet. The existing TCD also would be extended to achieve efficient use of the expanded cold-water pool. Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 120,000 acre-feet and 60,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries.

Shasta Lake and Vicinity The significance criteria for H&H do not apply in the Shasta Lake and vicinity geographic region; therefore, potential effects in that geographic region are not discussed further in this EIS.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact H&H-1 (CP2): Change in Frequency of Flows above 100,000 cfs on the Sacramento River below Bend Bridge Although flood management operations would not change under CP2, a slight reduction could occur in the frequency of flows greater than 100,000 cfs. This impact would be beneficial.

SLWRI modeling uses a monthly time step, which is inappropriate for flood control analysis; however, flood management operations for downstream objectives would not change under CP2. Although a slight decrease in recurrence of high flows would be possible because of the increased storage capability, CP2 would not increase the frequency of flows above 100,000 cfs. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-2 (CP2): Place Housing or Other Structures within a 100-Year Flood Hazard Area as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map This impact would be the same as Impact H&H-2 (CP1); no new structures would be built downstream from Shasta Dam. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-3 (CP2): Place within a 100-Year Flood Hazard Area Structures that Would Impede or Redirect Flood Flows This impact would be the same as Impact H&H-3 (CP1); no new structures would be built downstream from Shasta Dam. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta

Impact H&H-4 (CP2): Change in Water Levels in Old River near Tracy Road Bridge Simulated water levels in the Old River near Tracy Road Bridge show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant.

As shown in Table 6-43, maximum monthly reduction in minimum daily water level associated with CP2 would be less than 0.1 foot in all months during the irrigation season, compared to the existing condition and the No-Action Alternative. The water levels would remain above 0.0 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-43. Simulated Monthly Maximum 15-Minute Change in Old River Water Levels near Tracy Road Bridge at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP2 (2005) Change (feet)	CP2 (2030) Change (feet)
Apr	0 00 (0%)	-0.02 (0%)
May	-0.01 (0%)	-0.02 (0%)
Jun	-0.05 (0%)	-0.05 (0%)
Jul	-0.06 (0%)	-0.06 (0%)
Aug	-0.06 (0%)	-0.05 (0%)
Sep	-0.05 (0%)	-0.08 (0%)
Oct	-0.08 (0%)	-0.04 (0%)

Source: Version 8.0.6 DSM2 2005 and 2030 simulations (Node 071_3116)
Notes:
Simulation period: 1922-2003
(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.
Key:
CP = comprehensive plan

Impact H&H-5 (CP2): Change in Water Levels in the Grant Line Canal near the Grant Line Canal Barrier Simulated water levels in the Grant Line Canal near the Grant Line Canal Barrier show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant.

As shown in Table 6-44, maximum monthly changes in minimum daily water level associated with CP2 would be less than 0.1 foot in all months during the irrigation season, compared to the existing condition and the No-Action Alternative. The water levels would remain above 0.0 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-44. Simulated Monthly Maximum 15-Minute Change in Grant Line Canal Water Levels near the Grant Line Canal Barrier at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP2 (2005) Change (feet)	CP2 (2030) Change (feet)
Apr	0.00 (0%)	-0.02 (0%)
May	-0.02 (0%)	-0.02 (0%)
Jun	-0.04 (0%)	-0.03 (0%)
Jul	-0.07 (0%)	-0.06 (0%)
Aug	-0.04 (0%)	-0.03 (0%)
Sep	-0.03 (0%)	-0.05 (0%)
Oct	-0.03 (0%)	-0.02 (0%)

Source: Version 8.0.6 DSM2 2005 and 2030 simulations (Node 129_5691)
Notes:
Simulation period: 1922-2003
(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.
Key:
CP = comprehensive plan

Impact H&H-6 (CP2): Change in Water Levels in the Middle River near the Howard Road Bridge Simulated water levels in the Middle River near the Howard Road Bridge show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant.

As shown in Table 6-45, maximum monthly changes in minimum daily water level associated with CP2 would be less than 0.1 foot in all months during the irrigation season, compared to the existing condition and the No-Action Alternative. The water levels would remain above 0.3 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-45. Simulated Monthly Maximum 15-Minute Change in Middle River Water Levels near the Howard Road Bridge at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP2 (2005) Change (feet)	CP2 (2030) Change (feet)
Apr	0.00 (0%)	-0.02 (0%)
May	-0.01 (0%)	-0.02 (0%)
Jun	-0.05 (0%)	-0.05 (0%)
Jul	-0.06 (0%)	-0.06 (0%)
Aug	-0.06 (0%)	-0.05 (0%)
Sep	-0.05 (0%)	-0.09 (0%)
Oct	-0.08 (0%)	-0.05 (0%)

Source: Version 8.0.6 DSM2 2005 and 2030 simulations (Node 206_5533)
Notes:
Simulation period: 1922-2003
(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.
Key:
CP = comprehensive plan

Impact H&H-7 (CP2): Change in X2 Position The X2 position would change from west to east of Collinsville in one December compared to the existing conditions, when the Delta would not be in balanced conditions. This impact would be less than significant.

Examination of simulation output indicates that compared to the existing condition, only in one month, December 1979, would the X2 position change from west to east of Collinsville. Under the existing conditions, the X2 position would be at 78.25 kilometers (km), and under CP2, it would be at 81.27 km, a 3.03 km shift; however, the Delta was not in balanced conditions. When compared to the No-Action Alternative, CP2 shows no months when the No-Action Alternative would cause the X2 position to shift from west of Collinsville to east of Collinsville when the Delta is not in balanced conditions.

This single month change would not significantly limit CCWD's ability to fill Los Vaqueros Reservoir. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-8 (CP2): Change in Recurrence of Delta Excess Conditions Changes from excess to balanced Delta conditions would be rare. This impact would be less than significant.

As shown in Table 6-46, CP2 would cause few changes from excess to balanced Delta conditions when compared to the existing condition and the No-Action Alternative. Because of the low number of occurrences, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-46. Simulated Number of Years the Delta Changes from Excess to Balanced Condition

	Number of Years the Delta Changes from Excess to Balanced Conditions Compared to Existing Condition or No-Action Alternative											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
CP2 (2005)	1 (1%)	0 (0%)	1 (1%)	0 (0%)	0 (0%)	1 (1%)	0 (0%)	2 (2%)	0 (0%)	1 (1%)	2 (2%)	0 (0%)
CP2 (2030)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (1%)	2 (2%)	0 (0%)	3 (4%)	3 (4%)	1 (1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations
Notes:
Simulation Period: 1922-2003
(%) indicates percent of months Delta condition change occurs
Key:
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation

CVP/SWP Service Areas

Impact H&H-9 (CP2): Change in Deliveries to North-of-Delta CVP Water Service Contractors and Refuges Average annual deliveries to North-of-Delta CVP Water Service Contractors would increase under all conditions. This impact would be beneficial. Annual average deliveries to North-of-Delta refuges would not change under all conditions. This impact would be less than significant.

As shown in Table 6-47, average annual deliveries to North-of-Delta CVP Service Water Contractors under both existing and future conditions would increase relative to the basis of comparison. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed. Average annual deliveries to North-of-Delta refuges would not change under all conditions. Minor increases and decreases in Refuge deliveries are not a true representation of real-time operations but an indication of modeling artifacts. Such reduction would not occur in real time due to efficient water allocation and management schemes that cannot be captured adequately in a water resources planning model such as CalSim-II. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-47. Simulated Monthly Average Deliveries and Percent Change of Deliveries to North-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP2 Change (cfs (%))	Existing Condition (cfs)	CP2 Change (cfs (%))	No-Action Alternative (cfs)	CP2 Change (cfs (%))	No-Action Alternative (cfs)	CP2 Change (cfs (%))
North-of-Delta CVP Water Service Contractors Deliveries								
Oct	77	4 (5%)	69	3 (5%)	74	4 (6%)	63	4 (6%)
Nov	3	0 (4%)	3	0 (6%)	2	0 (5%)	3	0 (9%)
Dec	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Jan	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Feb	3	0 (1%)	7	0 (0%)	2	0 (2%)	5	0 (0%)
Mar	19	2 (8%)	21	2 (11%)	15	2 (12%)	14	2 (17%)
Apr	335	19 (6%)	229	21 (9%)	297	23 (8%)	181	21 (12%)
May	572	24 (4%)	316	25 (8%)	555	30 (5%)	268	24 (9%)
Jun	799	30 (4%)	425	32 (8%)	788	37 (5%)	365	30 (8%)
Jul	918	33 (4%)	480	36 (7%)	910	40 (4%)	414	33 (8%)
Aug	733	26 (4%)	386	29 (7%)	727	31 (4%)	333	27 (8%)
Sep	341	12 (4%)	170	14 (8%)	334	15 (4%)	144	12 (8%)
Total (TAF)	231	9 (4%)	128	10 (8%)	225	11 (5%)	109	9 (9%)
North-of-Delta Refuges Deliveries								
Oct	177	-8 (-4%)	182	-17 (-9%)	224	2 (1%)	212	12 (5%)
Nov	168	3 (2%)	156	11 (7%)	219	1 (0%)	212	-2 (-1%)
Dec	105	0 (0%)	104	0 (0%)	133	0 (0%)	132	0 (0%)
Jan	50	0 (0%)	50	0 (0%)	63	0 (0%)	62	0 (0%)
Feb	45	0 (0%)	45	0 (0%)	57	0 (0%)	57	0 (0%)
Mar	13	0 (0%)	12	0 (1%)	16	0 (0%)	15	0 (1%)
Apr	15	0 (0%)	14	0 (1%)	18	0 (-1%)	17	0 (-1%)
May	50	0 (0%)	46	0 (0%)	64	0 (0%)	59	0 (0%)
Jun	79	-1 (-1%)	75	-3 (-4%)	96	1 (1%)	87	3 (3%)
Jul	106	0 (0%)	99	0 (0%)	134	-1 (-1%)	126	-4 (-3%)
Aug	143	-1 (-1%)	134	-2 (-2%)	180	3 (2%)	165	9 (6%)
Sep	187	0 (0%)	177	0 (0%)	237	0 (0%)	226	0 (0%)
Total (TAF)	69	0 (-1%)	66	-1 (-1%)	87	0 (0%)	83	1 (1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_N and DEL_CVP_PRF_N)

Notes:

Simulation period: 1922-2003. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

(%) indicates percent change from either existing condition or No-Action Alternative

Key:

cfs = cubic feet per second

CP = comprehensive plan

CVP = Central Valley Project

SLWRI = Shasta Lake Water Resources Investigation

TAF = thousand acre-feet

Impact H&H-10 (CP2): Change in Deliveries to South-of-Delta CVP Water Service Contractors and Refuges Average annual deliveries to South-of-Delta CVP Water Service Contractors would increase under all conditions. This impact would be beneficial. Annual average deliveries to South-of-Delta refuges would not change under all conditions. This impact would be less than significant.

As shown in Table 6-48, average annual deliveries to South-of-Delta CVP Water Service Contractors under both existing and future conditions would increase relative to the basis of comparison. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed. Average annual deliveries to South-of-Delta refuges would not change under all conditions. Minor increases and decreases in Refuge deliveries are not a true representation of real-time operations but an indication of modeling artifacts. Such reduction would not occur in real time due to efficient water allocation and management schemes that cannot be captured adequately in a water resources planning model such as CalSim-II. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-48. Simulated Monthly Average Deliveries and Percent Change of Deliveries to South-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP2 Change (cfs (%))	Existing Condition (cfs)	CP2 Change (cfs (%))	No-Action Alternative (cfs)	CP2 Change (cfs (%))	No-Action Alternative (cfs)	CP2 Change (cfs (%))
South-of-Delta CVP Water Service Contractors Deliveries								
Oct	474	10 (2%)	363	15 (4%)	464	19 (4%)	343	27 (8%)
Nov	362	8 (2%)	277	12 (4%)	354	15 (4%)	262	21 (8%)
Dec	501	10 (2%)	383	16 (4%)	490	20 (4%)	362	29 (8%)
Jan	880	18 (2%)	673	29 (4%)	860	35 (4%)	636	51 (8%)
Feb	1,100	23 (2%)	841	36 (4%)	1,076	44 (4%)	794	63 (8%)
Mar	660	35 (5%)	362	26 (7%)	634	49 (8%)	302	53 (18%)
Apr	1,079	31 (3%)	627	2 (0%)	1,052	54 (5%)	545	51 (9%)
May	1,564	32 (2%)	902	2 (0%)	1,528	63 (4%)	794	72 (9%)
Jun	2,596	64 (2%)	1,467	30 (2%)	2,545	106 (4%)	1,310	122 (9%)
Jul	3,136	65 (2%)	1,809	0 (0%)	3,063	114 (4%)	1,581	109 (7%)
Aug	2,078	62 (3%)	1,112	48 (4%)	2,063	89 (4%)	939	163 (17%)
Sep	735	9 (1%)	428	-5 (-1%)	722	30 (4%)	370	35 (10%)
Total (TAF)	916	22 (2%)	558	13 (2%)	898	39 (4%)	497	48 (10%)

Table 6-48. Simulated Monthly Average Deliveries and Percent Change of Deliveries to South-of-Delta CVP Water Service Contractors and Refuges (contd.)

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP2 Change (cfs (%))	Existing Condition (cfs)	CP2 Change (cfs (%))	No-Action Alternative (cfs)	CP2 Change (cfs (%))	No-Action Alternative (cfs)	CP2 Change (cfs (%))
South-of-Delta Refuges Deliveries								
Oct	1,126	0 (0%)	1,110	0 (0%)	1,041	0 (0%)	1,026	0 (0%)
Nov	729	0 (0%)	718	0 (0%)	671	0 (0%)	661	0 (0%)
Dec	336	0 (0%)	331	0 (0%)	306	0 (0%)	302	0 (0%)
Jan	147	0 (0%)	145	0 (0%)	137	0 (0%)	135	0 (0%)
Feb	109	0 (0%)	107	0 (0%)	102	0 (0%)	101	0 (0%)
Mar	93	0 (0%)	89	0 (0%)	88	0 (0%)	83	0 (0%)
Apr	217	0 (0%)	207	0 (0%)	203	0 (0%)	193	0 (0%)
May	445	0 (0%)	423	0 (0%)	407	0 (0%)	387	0 (0%)
Jun	493	0 (0%)	468	1 (0%)	456	0 (0%)	434	0 (0%)
Jul	120	0 (0%)	114	0 (0%)	112	0 (0%)	107	0 (0%)
Aug	197	2 (1%)	185	3 (1%)	181	5 (3%)	161	13 (8%)
Sep	885	-11 (-1%)	843	-11 (-1%)	808	1 (0%)	760	2 (0%)
Total (TAF)	296	-1 (0%)	286	0 (0%)	273	0 (0%)	263	1 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_S and DEL_CVP_PRF_S)

Notes:

Simulation period: 1922-2003. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

(%) indicates percent change from either existing condition or No-Action Alternative

Key:

cfs = cubic feet per second

CP = comprehensive plan

CVP = Central Valley Project

SLWRI = Shasta Lake Water Resources Investigation TAF = thousand acre-feet

Impact H&H-11 (CP2): Change in Deliveries to SWP Table A Contractors
Average annual and monthly deliveries would increase under both existing and future conditions. This impact would be less than significant.

As shown in Table 6-49, average annual deliveries to SWP Table A contractors would increase under CP2 in both existing and future conditions relative to the bases of comparison in both average years and in dry and critical years. Some decreases in monthly average deliveries could occur under CP2 relative to existing conditions and the No-Action Alternative in both average annual and dry and critical years. These decreases would be less than 1 percent. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-49. Simulated Monthly Average Deliveries and Percent Change of Deliveries to SWP Table A Contractors

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP2 Change (cfs (%))	Existing Condition (cfs)	CP2 Change (cfs (%))	No-Action Alternative (cfs)	CP2 Change (cfs (%))	No-Action Alternative (cfs)	CP2 Change (cfs (%))
Oct	3,226	-7 (0%)	2,873	63 (2%)	3,351	44 (1%)	3,051	50 (2%)
Nov	2,689	51 (2%)	2,282	71 (3%)	2,812	18 (1%)	2,342	28 (1%)
Dec	2,476	33 (1%)	2,014	89 (4%)	2,886	38 (1%)	2,392	78 (3%)
Jan	623	18 (3%)	389	0 (0%)	988	49 (5%)	412	28 (7%)
Feb	1,106	32 (3%)	637	47 (7%)	1,860	52 (3%)	766	45 (6%)
Mar	1,804	28 (2%)	1,041	56 (5%)	2,307	27 (1%)	1,101	60 (5%)
Apr	4,733	24 (1%)	4,156	69 (2%)	5,094	35 (1%)	4,251	102 (2%)
May	5,837	43 (1%)	4,983	55 (1%)	6,335	31 (0%)	5,143	103 (2%)
Jun	7,433	-22 (0%)	6,408	-66 (-1%)	7,612	41 (1%)	6,471	61 (1%)
Jul	7,841	49 (1%)	6,757	146 (2%)	8,147	31 (0%)	6,933	133 (2%)
Aug	7,017	12 (0%)	5,605	45 (1%)	7,244	-13 (0%)	5,679	16 (0%)
Sep	5,086	47 (1%)	4,003	140 (3%)	5,322	52 (1%)	4,066	175 (4%)
Total (TAF)	3,020	19 (1%)	2,493	43 (2%)	3,265	24 (1%)	2,581	53 (2%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_SWP_PAG and DEL_SWP_PMI)

Note:

Simulation period: 1922-2003. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

(%) indicates percent change from either existing condition or No-Action Alternative

Key:

cfs = cubic feet per second

CP = comprehensive plan

SLWRI = Shasta Lake Water Resources Investigation

SWP = State Water Project

TAF = thousand acre-feet

Impact H&H-12 (CP2): Change in Groundwater Levels CP2 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. The reduction in groundwater pumping would result in increased groundwater levels. This impact would be beneficial.

With increased water supply deliveries to CVP and SWP water contractors, and with an associated increase in surface water supply reliability to those contractors, shortages in deliveries would decrease under CP2. Contractor responses to shortages in surface water deliveries would vary; some may elect to fallow their land, others may buy water on the transfer market, and some may pump groundwater. An increase in surface water deliveries would result in a decrease in groundwater pumping. With less groundwater pumping, groundwater basins that were in overdraft conditions would be anticipated to improve as a result of increasing groundwater levels. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-13 (CP2): Change in Groundwater Quality CP2 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. This impact would be less than significant.

With increased water supply deliveries to CVP and SWP water contractors, and with an associated increase in surface water supply reliability to those contractors, shortages in deliveries would decrease under CP2. Contractor responses to shortages in surface water deliveries would vary; some may elect to fallow their land, others may buy water on the transfer market, and some may pump groundwater. An increase in surface water deliveries could result in a decrease in groundwater pumping. Because CP2 could have a positive, albeit limited, impact by reducing reliance on groundwater, the effects of CP2 on groundwater quality also would be limited. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP3 – 18.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP3 primarily consists of raising Shasta Dam by 18.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir's full pool by 20.5 feet and would enlarge the total storage capacity in the reservoir by 634,000 acre-feet. The existing TCD also would be extended to achieve efficient use of the expanded cold-water pool. Because CP3 would focus on increasing agricultural water supply reliability, none of the increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries.

Shasta Lake and Vicinity The significance criteria for H&H do not apply in the Shasta Lake and vicinity geographic region; therefore, potential effects in that geographic region are not discussed further in this EIS.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact H&H-1 (CP3): Change in Frequency of Flows above 100,000 cfs on the Sacramento River below Bend Bridge Although flood management operations would not change under CP3, a slight reduction could occur in the frequency of flows greater than 100,000 cfs. This impact would be beneficial.

SLWRI modeling uses a monthly time step, which is inappropriate for flood control analysis; however, flood management operations for downstream objectives would not change under CP3. Although a slight decrease in recurrence of high flows would be possible because of the increased storage capability, CP3 would not increase the frequency of flows above 100,000 cfs. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-2 (CP3): Place Housing or Other Structures within a 100-Year Flood Hazard Area as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map This impact would be the same as Impact H&H-2 (CP1); no new structures would be built downstream from Shasta Dam. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-3 (CP3): Place Within a 100-Year Flood Hazard Area Structures that Would Impede or Redirect Flood Flows This impact would be the same as Impact H&H-3 (CP1); no new structures would be built downstream from Shasta Dam. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta

Impact H&H-4 (CP3): Change in Water Levels in the Old River near Tracy Road Bridge Simulated water levels in the Old River near Tracy Road Bridge show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant.

As shown in Table 6-50, maximum monthly reduction in minimum daily water level associated with CP3 would be less than 0.1 foot in all months during the irrigation season, compared to the existing condition and the No-Action Alternative. The water levels would remain above 0.0 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-50. Simulated Monthly Maximum 15-Minute Change in Old River Water Levels near Tracy Road Bridge at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP3 (2005) Change (feet)	CP3 (2030) Change (feet)
Apr	-0.01 (0%)	-0.02 (0%)
May	-0.02 (0%)	-0.02 (0%)
Jun	-0.05 (0%)	-0.05 (0%)
Jul	-0.02 (0%)	-0.03 (0%)
Aug	-0.02 (0%)	-0.05 (0%)
Sep	-0.10 (0%)	-0.07 (0%)
Oct	-0.06 (0%)	-0.05 (0%)

Source: Version 8.0.6 DSM2 2005 and 2030 simulations (Node 071_3116)

Notes:

Simulation period: 1922-2003

(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.

Key:

CP = comprehensive plan

Impact H&H-5 (CP3): Change in Water Levels in the Grant Line Canal near the Grant Line Canal Barrier Similar to Impact H&H-5 (CP1), CP3 would have the potential to affect water levels in the Grant Line Canal above the Grant Line Canal Barrier. This impact would be less than significant.

As shown in Table 6-51, maximum monthly changes in minimum daily water level associated with CP3 would be less than 0.1 foot in all months during the irrigation season, compared to the existing condition. Similarly, when compared to the No-Action Alternative, maximum monthly changes would be less than 0.1 foot in all months during the irrigation season.

Table 6-51 also shows the percentage of months when the maximum decreases in water levels are greater than 0.1 feet when the water levels under the baseline conditions are below the identified limit of 0.3 feet in the Grant Line Canal near the Grant Line Canal Barrier. These maximum decreases in water lever would not violate the threshold and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-51. Simulated Monthly Maximum 15-Minute Change in Grant Line Canal Water Levels near the Grant Line Canal Barrier at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP3 (2005) Change (feet)	CP3 (2030) Change (feet)
Apr	0 00 (0%)	-0.02 (0%)
May	-0.02 (0%)	-0.02 (0%)
Jun	-0.04 (0%)	-0.03 (0%)
Jul	-0.02 (0%)	-0.03 (0%)
Aug	-0.01 (0%)	-0.03 (0%)
Sep	-0.04 (0%)	-0.04 (0%)
Oct	-0.03 (0%)	-0.02 (0%)

Source: Version 8.0.6 DSM2 2005 and 2030 simulations (Node 129_5691)

Notes:
Simulation period: 1922-2003
(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.
Key:
CP = comprehensive plan

Impact H&H-6 (CP3): Change in Water Levels in the Middle River near the Howard Road Bridge This impact is similar to Impact H&H-6 (CP1). During the agricultural season (April through October), the maximum change in water level at low-low tide compared to the existing condition would exceed 0.1 foot in one month, September 1986. This impact would be less than significant.

As shown in Table 6-52, when compared to the No-Action Alternative, maximum monthly changes would be less than 0.1 foot in all months during the irrigation season. Table 6-52 also shows the percentage of months when the maximum decreases in water levels would be greater than 0.1 feet when the water levels under the baseline conditions were below the identified limit of 0.3 feet in the Middle River near the Howard Road Bridge. These maximum decreases in water lever would not violate the threshold and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-52. Simulated Monthly Maximum 15-Minute Change in Middle River Water Levels near the Howard Road Bridge at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP3 (2005) Change (feet)	CP3 (2030) Change (feet)
Apr	-0.01 (0%)	-0.02 (0%)
May	-0.02 (0%)	-0.02 (0%)
Jun	-0.05 (0%)	-0.05 (0%)
Jul	-0.02 (0%)	-0.03 (0%)
Aug	-0.02 (0%)	-0.04 (0%)
Sep	-0.11 (0%)	-0.07 (0%)
Oct	-0.07 (0%)	-0.05 (0%)

Source: Version 8.0.6 DSM2 2005 and 2030 simulations (Node 206_5533)

Notes:
Simulation period: 1922-2003
(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.
Key:
CP = comprehensive plan

Impact H&H-7 (CP3): Change in X2 Position The X2 position would change from west to east of Collinsville in one December, compared with existing conditions and the No-Action Alternative, when the Delta would not be in balanced conditions. This impact would be less than significant.

Examination of simulation output indicates that compared to the existing condition, only in one month, December 1979, would the X2 position shift from west to east of Collinsville. Under existing conditions, the X2 position would be at 78.25 km, and under CP3, it would be at 81.37 km, a 3.12 km shift.

Compared with the No-Action Alternative, only in one month, December 1979, would the X2 position change from west to east of Collinsville. Under the No-Action Alternative, the X2 position would be at 78.63 km, and under CP3, it would be at 81.08 km, a 2.45 km shift.

This single month change would not substantially limit CCWD's ability to fill Los Vaqueros Reservoir. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-8 (CP3): Change in Recurrence of Delta Excess Condition
Under CP3, changes from excess to balanced Delta conditions would be rare. This impact would be less than significant.

As shown in Table 6-53, CP3 would cause few changes from excess to balanced Delta conditions when compared to the existing condition and to the No-Action Alternative. Because of the low number of occurrences, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-53. Simulated Number of Years the Delta Changes from Excess to Balanced Condition

	Number of Years the Delta Changes from Excess to Balanced Conditions Compared to Existing Condition or No-Action Alternative											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
CP3 (2005)	1 (1%)	0 (0%)	1 (1%)	0 (0%)	0 (0%)	0 (0%)	2 (2%)	2 (2%)	0 (0%)	0 (0%)	1 (1%)	1 (1%)
CP3 (2030)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	4 (5%)	1 (1%)	0 (0%)	2 (2%)	2 (2%)	0 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations
Notes:
Simulation Period: 1922-2003
(%) indicates percent of months Delta condition change occurs.
Key:
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation

CVP/SWP Service Areas

Impact H&H-9 (CP3): Change in Deliveries to North-of-Delta CVP Water Service Contractors and Refuges Average annual deliveries to North-of-Delta CVP Water Service Contractors would increase under all conditions. This impact would be beneficial. Annual average deliveries to North-of-Delta refuges would not change under all conditions. This impact would be less than significant.

As shown in Table 6-54, average annual deliveries to North-of-Delta CVP Water Service Contractors under both existing and future conditions would increase relative to the basis of comparison. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed. Average annual deliveries to North-of-Delta refuges would not change under all conditions. Minor increases and decreases in Refuge deliveries are not a true representation of real-time operations but an indication of modeling artifacts. Such reduction would not occur in real time due to efficient water allocation and management schemes that cannot be captured adequately in a water resources planning model such as CalSim-II. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-54. Simulated Monthly Average Deliveries and Percent Change of Deliveries to North-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP3 Change (cfs (%))	Existing Condition (cfs)	CP3 Change (cfs (%))	No-Action Alternative (cfs)	CP3 Change (cfs (%))	No-Action Alternative (cfs)	CP3 Change (cfs (%))
North-of-Delta CVP Water Service Contractors Deliveries								
Oct	77	8 (11%)	69	9 (13%)	74	9 (12%)	63	10 (16%)
Nov	3	0 (11%)	3	1 (16%)	2	0 (12%)	3	1 (21%)
Dec	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Jan	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Feb	3	0 (4%)	7	0 (2%)	2	0 (5%)	5	0 (1%)
Mar	19	5 (24%)	21	7 (33%)	15	5 (32%)	14	7 (53%)
Apr	335	44 (13%)	229	53 (23%)	297	47 (16%)	181	57 (31%)
May	572	60 (10%)	316	69 (22%)	555	68 (12%)	268	75 (28%)
Jun	799	76 (10%)	425	90 (21%)	788	86 (11%)	365	95 (26%)
Jul	918	86 (9%)	480	101 (21%)	910	97 (11%)	414	108 (26%)
Aug	733	68 (9%)	386	81 (21%)	727	77 (11%)	333	87 (26%)
Sep	341	30 (9%)	170	36 (21%)	334	34 (10%)	144	39 (27%)
Total (TAF)	231	23 (10%)	128	27 (21%)	225	26 (11%)	109	29 (27%)
North-of-Delta Refuges Deliveries								
Oct	177	-7 (-4%)	182	-13 (-7%)	224	9 (4%)	212	30 (14%)
Nov	168	1 (0%)	156	3 (2%)	219	0 (0%)	212	-4 (-2%)
Dec	105	0 (0%)	104	0 (0%)	133	0 (0%)	132	0 (0%)
Jan	50	0 (0%)	50	0 (0%)	63	0 (0%)	62	0 (0%)
Feb	45	0 (0%)	45	0 (0%)	57	0 (0%)	57	0 (0%)
Mar	13	0 (0%)	12	0 (-1%)	16	0 (0%)	15	0 (-1%)
Apr	15	0 (0%)	14	0 (1%)	18	0 (-1%)	17	0 (-2%)
May	50	0 (0%)	46	0 (0%)	64	0 (0%)	59	0 (0%)
Jun	79	-1 (-1%)	75	-2 (-3%)	96	1 (1%)	87	4 (5%)
Jul	106	-1 (-1%)	99	-1 (-1%)	134	-1 (-1%)	126	-2 (-2%)
Aug	143	-2 (-1%)	134	-5 (-3%)	180	1 (1%)	165	3 (2%)
Sep	187	0 (0%)	177	0 (0%)	237	0 (0%)	226	0 (0%)
Total (TAF)	69	-1 (-1%)	66	-1 (-2%)	87	1 (1%)	83	2 (2%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_N and DEL_CVP_PRF_N)
Notes:
Simulation period: 1922-2003. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
cfs = cubic feet per second
CP = comprehensive plan
CVP = Central Valley Project
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Impact H&H-10 (CP3): Change in Deliveries to South-of-Delta CVP Water Service Contractors and Refuges Average annual deliveries to South-of-Delta CVP Water Service Contractors would increase under all conditions. This impact would be beneficial. Annual average deliveries to South-of-Delta refuges would not change under all conditions. This impact would be less than significant.

As shown in Table 6-55, average annual deliveries to South-of-Delta Water Service Contractors under both existing and future conditions would increase relative to the basis of comparison. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed. Average annual deliveries to South-of-Delta refuges would not change under all conditions. Minor increases and decreases in Refuge deliveries are not a true representation of real-time operations but an indication of modeling artifacts. Such reduction would not occur in real time due to efficient water allocation and management schemes that cannot be captured adequately in a water resources planning model such as CalSim-II. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-55. Simulated Monthly Average Deliveries and Percent Change of Deliveries to South-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP3 Change (cfs (%))	Existing Condition (cfs)	CP3 Change (cfs (%))	No-Action Alternative (cfs)	CP3 Change (cfs (%))	No-Action Alternative (cfs)	CP3 Change (cfs (%))
South-of-Delta CVP Water Service Contractors Deliveries								
Oct	474	10 (2%)	363	15 (4%)	464	19 (4%)	343	27 (8%)
Nov	362	8 (2%)	277	12 (4%)	354	15 (4%)	262	21 (8%)
Dec	501	10 (2%)	383	16 (4%)	490	20 (4%)	362	29 (8%)
Jan	880	18 (2%)	673	29 (4%)	860	35 (4%)	636	51 (8%)
Feb	1,100	23 (2%)	841	36 (4%)	1,076	44 (4%)	794	63 (8%)
Mar	660	35 (5%)	362	26 (7%)	634	49 (8%)	302	53 (18%)
Apr	1,079	31 (3%)	627	2 (0%)	1,052	54 (5%)	545	51 (9%)
May	1,564	32 (2%)	902	2 (0%)	1,528	63 (4%)	794	72 (9%)
Jun	2,596	64 (2%)	1,467	30 (2%)	2,545	106 (4%)	1,310	122 (9%)
Jul	3,136	65 (2%)	1,809	0 (0%)	3,063	114 (4%)	1,581	109 (7%)
Aug	2,078	62 (3%)	1,112	48 (4%)	2,063	89 (4%)	939	163 (17%)
Sep	735	9 (1%)	428	-5 (-1%)	722	30 (4%)	370	35 (10%)
Total (TAF)	916	22 (2%)	558	13 (2%)	898	39 (4%)	497	48 (10%)

Table 6-55. Simulated Monthly Average Deliveries and Percent Change of Deliveries to South-of-Delta CVP Water Service Contractors and Refuges (contd.)

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP3 Change (cfs (%))	Existing Condition (cfs)	CP3 Change (cfs (%))	No-Action Alternative (cfs)	CP3 Change (cfs (%))	No-Action Alternative (cfs)	CP3 Change (cfs (%))
South-of-Delta Refuges Deliveries								
Oct	1,126	0 (0%)	1,110	0 (0%)	1,041	0 (0%)	1,026	0 (0%)
Nov	729	0 (0%)	718	0 (0%)	671	0 (0%)	661	0 (0%)
Dec	336	0 (0%)	331	0 (0%)	306	0 (0%)	302	0 (0%)
Jan	147	0 (0%)	145	0 (0%)	137	0 (0%)	135	0 (0%)
Feb	109	0 (0%)	107	0 (0%)	102	0 (0%)	101	0 (0%)
Mar	93	0 (0%)	89	0 (0%)	88	0 (0%)	83	0 (0%)
Apr	217	0 (0%)	207	0 (0%)	203	0 (0%)	193	0 (0%)
May	445	0 (0%)	423	0 (0%)	407	0 (0%)	387	0 (0%)
Jun	493	0 (0%)	468	1 (0%)	456	0 (0%)	434	0 (0%)
Jul	120	0 (0%)	114	0 (0%)	112	0 (0%)	107	0 (0%)
Aug	197	2 (1%)	185	3 (1%)	181	5 (3%)	161	13 (8%)
Sep	885	-11 (-1%)	843	-11 (-1%)	808	1 (0%)	760	2 (0%)
Total (TAF)	296	-1 (0%)	286	0 (0%)	273	0 (0%)	263	1 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_S and DEL_CVP_PRF_S)
Notes:
Simulation period: 1922-2003.
(%) indicates percent change from either existing condition or No-Action Alternative Dry and critical years as defined by the Sacramento Valley Index.
Key:
cfs = cubic feet per second
CP = comprehensive plan
CVP = Central Valley Project
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Impact H&H-11 (CP3): Change in Deliveries to SWP Table A Contractors
Average annual and monthly deliveries would decrease under both existing and future conditions. This decrease would be larger than what would occur under other action alternatives because no storage space would be reserved for increasing M&I deliveries under CP3. Accordingly, SWP deliveries were affected. This decrease would be less than 5 percent. This impact would be less than significant.

As shown in Table 6-56, average annual deliveries to SWP Table A contractors would decrease under CP3 in both existing and future conditions relative to the bases of comparison in both average years and in dry and critical years. Under both existing conditions and future conditions, the average monthly deliveries would decrease less than 5 percent in most months in both average annual and dry and critical years. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-56. Simulated Monthly Average Deliveries and Percent Change of Deliveries to SWP Table A Contractors

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP3 Change (cfs (%))	Existing Condition (cfs)	CP3 Change (cfs (%))	No-Action Alternative (cfs)	CP3 Change (cfs (%))	No-Action Alternative (cfs)	CP3 Change (cfs (%))
Oct	3,226	-25 (-1%)	2,873	8 (0%)	3,351	-9 (0%)	3,051	-13 (0%)
Nov	2,689	4 (0%)	2,282	6 (0%)	2,812	1 (0%)	2,342	1 (0%)
Dec	2,476	4 (0%)	2,014	12 (1%)	2,886	-1 (0%)	2,392	38 (2%)
Jan	623	-6 (-1%)	389	-5 (-1%)	988	-20 (-2%)	412	-18 (-4%)
Feb	1,106	-6 (-1%)	637	-10 (-2%)	1,860	-13 (-1%)	766	-25 (-3%)
Mar	1,804	-6 (0%)	1,041	-14 (-1%)	2,307	-9 (0%)	1,101	-31 (-3%)
Apr	4,733	1 (0%)	4,156	-9 (0%)	5,094	2 (0%)	4,251	-25 (-1%)
May	5,837	17 (0%)	4,983	-14 (0%)	6,335	5 (0%)	5,143	-22 (0%)
Jun	7,433	22 (0%)	6,408	-11 (0%)	7,612	-8 (0%)	6,471	-87 (-1%)
Jul	7,841	-6 (0%)	6,757	-9 (0%)	8,147	-31 (0%)	6,933	-56 (-1%)
Aug	7,017	-25 (0%)	5,605	-58 (-1%)	7,244	-54 (-1%)	5,679	-132 (-2%)
Sep	5,086	-4 (0%)	4,003	-8 (0%)	5,322	4 (0%)	4,066	3 (0%)
Total (TAF)	3,020	-2 (0%)	2,493	-7 (0%)	3,265	-8 (0%)	2,581	-22 (-1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_SWP_PAG and DEL_SWP_PMI)

Notes:

Simulation period: 1922-2003.

(%) indicates percent change from either existing condition or No-Action Alternative Dry and critical years as defined by the Sacramento Valley Index.

Key:

cfs = cubic feet per second

CP = comprehensive plan

SLWRI = Shasta Lake Water Resources Investigation

SWP = State Water Project

TAF = thousand acre-feet

Impact H&H-12 (CP3): Change in Groundwater Levels CP3 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. The reduction in groundwater pumping would result in increased groundwater levels. This impact would be beneficial.

With increased water supply deliveries to CVP and SWP water contractors, and with an associated increase in surface water supply reliability to those contractors, shortages in deliveries would decrease under CP3. Contractor responses to shortages in surface water deliveries would vary; some may elect to fallow their land, others may buy water on the transfer market, and some may pump groundwater. An increase in surface water deliveries would result in a decrease in groundwater pumping. With less groundwater pumping, groundwater basins that were in overdraft conditions would be anticipated to improve as a result of increasing groundwater levels. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-13 (CP3): Change in Groundwater Quality CP3 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. The reduction in groundwater pumping could improve groundwater quality. This impact would less than significant.

With increased water supply deliveries to CVP and SWP water contractors, and with an associated increase in surface water supply reliability to those contractors, shortages in deliveries would decrease under CP3. Contractor responses to shortages in surface water deliveries would vary; some may elect to fallow their land, others may buy water on the transfer market, and some may pump groundwater. An increase in surface water deliveries would result in a decrease in groundwater pumping. Because CP3 would have a positive, albeit limited, impact by reducing reliance on groundwater, the effects of CP3 on groundwater quality also would be limited. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP4 and CP4A– 18.5-Foot Dam Raise, Anadromous Fish Focus With Water Supply Reliability

CP4 and CP4A focus on increasing anadromous fish survival while also increasing water supply reliability. By raising Shasta Dam 18.5 feet, in combination with spillway modifications, CP4 or CP4A would increase the height of the reservoir full pool by 20.5 feet and would enlarge the total storage capacity in the reservoir by 634,000 acre-feet. The existing TCD also would be extended to achieve efficient use of the expanded cold-water pool.

For CP4, about 378,000 acre-feet of the increased reservoir storage space would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. Operations for the remaining portion of increased storage (approximately 256,000 acre-feet) would be the same as under CP1, with 70,000 acre-feet and 35,000 acre-feet reserved to specifically focus on increasing M&I deliveries during dry and critical years, respectively. Because CP4 would increase the active or useable storage in Shasta Reservoir by the same amount as under CP1, and the storage would be used under the same operational rules, releases from Shasta would be the same as under CP1.

For CP4A, about 191,000 acre-feet of the increased reservoir storage space would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. Operations for the remaining portion of increased storage (approximately 443,000 acre-feet) would be the same as under CP2, when in dry years and critical years, 120,000 acre-feet and 60,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. Because CP4A would increase the active or usable storage in Shasta Reservoir by the same amount as under CP2, and the storage would be used under the same operational rules, releases from Shasta would be the same as under CP2.

For CP4 or CP4A, the additional storage that would be dedicated to increasing the supply of cold water, or the cold-water pool, would result in different Shasta storages, elevations, and release temperatures but not in any other downstream water operations.

Shasta Lake and Vicinity The significance criteria for H&H do not apply in the Shasta Lake and vicinity geographic region; therefore, potential effects in that geographic region are not discussed further in this EIS.

Upper Sacramento River (Shasta Dam to Red Bluff)
Impact H&H-1 (CP4 and CP4A). Change in Frequency of Flows above 100,000 cfs on the Sacramento River below Bend Bridge For CP4, this impact would be the same as Impact H&H-1 (CP1). Although flood management operations would not change under CP4, a slight reduction could occur in the frequency of flows greater than 100,000 cfs. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact H&H-1 (CP2). Although flood management operations would not change under CP4A, a slight reduction could occur in the frequency of flows greater than 100,000 cfs. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-2 (CP4 and CP4A). Place Housing or Other Structures within a 100-Year Flood Hazard Area as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map For CP4, this impact would be the same as Impact H&H-2 (CP1). No new structures would be built downstream from Shasta Dam. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as H&H-2 (CP2), which is the same as Impact H&H-2 (CP1); no new structures would be built downstream from Shasta Dam. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-3 (CP4 and CP4A). Place Within a 100-Year Flood Hazard Area Structures that Would Impede or Redirect Flood Flows For CP4, this impact would be the same as Impact H&H-3 (CP1). No new structures would be built downstream from Shasta Dam. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact H&H-3 (CP2), which is the same as Impact H&H-3 (CP1); no new structures would be built downstream from Shasta Dam. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta

Impact H&H-4 (CP4 and CP4A). Change in Water Levels in Old River near Tracy Road Bridge For CP4, this impact would be the same as Impact H&H-4 (CP1). Simulated water levels in the Old River near Tracy show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact H&H-4 (CP2). Simulated water levels in the Old River near Tracy Road Bridge show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-5 (CP4 and CP4A). Change in Water Levels in the Grant Line Canal near the Grant Line Canal Barrier For CP4, this impact would be the same as Impact H&H-5 (CP1). Simulated water levels in the Grant Line Canal near the Grant Line Canal Barrier show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact H&H-5 (CP2). Simulated water levels in the Grant Line Canal near the Grant Line Canal Barrier show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-6 (CP4 and CP4A). Change in Water Levels in Middle River near the Howard Road Bridge For CP4, this impact would be the same as Impact H&H-6 (CP1). Simulated water levels in the Middle River near the Howard Road Bridge show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact H&H-6 (CP2). Simulated water levels in the Middle River near the Howard Road Bridge show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-7 (CP4 and CP4A): Change in X2 Position For CP4, this impact would be the same as Impact H&H-7 (CP1). The X2 position would not change from west to east of Collinsville in December or January, when the Delta would not be in balanced conditions. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact H&H-7 (CP2). The X2 position would change from west to east of Collinsville in one December compared to the existing conditions, when the Delta would not be in balanced conditions. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-8 (CP4 and CP4A): Change in Recurrence of Delta Excess Conditions For CP4, this impact would be the same as Impact H&H-8 (CP1); changes from excess to balanced Delta conditions would be rare. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact H&H-8 (CP2). Changes from excess to balanced Delta conditions would be rare. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CVP/SWP Service Areas

Impact H&H-9 (CP4 and CP4A): Change in Deliveries to North-of-Delta CVP Water Service Contractors and Refuges For CP4, this impact would be the same as Impact H&H-9 (CP1). Average annual and monthly deliveries to North-of-Delta CVP water service contractors would increase under both existing and future conditions, but some small decreases could occur in monthly deliveries under both existing and future conditions. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed. Average annual deliveries to North-of-Delta refuges would not change under all conditions. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact H&H-9 (CP2). Average annual deliveries to North-of-Delta CVP water service contractors would increase under all conditions. Average monthly deliveries would generally increase but could show small decreases in October and November of less than the significance criteria. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed. Average annual deliveries to North-of-Delta refuges would not change under all conditions. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-10 (CP4 and CP4A): Change in Deliveries to South-of-Delta CVP Water Service Contractors and Refuges For CP4, this impact would be the same as Impact H&H-10 (CP1). Average annual and monthly deliveries would increase under both existing and future conditions. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact H&H-10 (CP2), which is similar to Impact H&H-10 (CP1). Average annual and monthly deliveries would increase under both existing and future conditions, except the increase in deliveries would be greater under CP2. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-11 (CP4 and CP4A): Change in Deliveries to SWP Table A Contractors For CP4, this impact would be the same as Impact H&H-11 (CP1). Average annual deliveries would increase under both existing and future conditions, but some less than significant decreases could occur in monthly deliveries under future conditions. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact H&H-11 (CP2). Average annual and monthly deliveries would increase under both existing and future conditions. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-12 (CP4 and CP4A). Change in Groundwater Levels For CP4, this impact would be the same as Impact H&H-12 (CP1). CP4 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. The reduction in groundwater pumping would result in increased groundwater levels. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact H&H-12 (CP2). CP4A would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. The reduction in groundwater pumping would result in increased groundwater levels. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-13 (CP4 and CP4A). Change in Groundwater Quality For CP4, this impact would be the same as Impact H&H-13 (CP1). CP4 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact H&H-13 (CP2). CP4A would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP5 – 18.5-Foot Dam Raise, Combination Plan

CP5 primarily would consist of raising Shasta Dam by 18.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir’s full pool by 20.5 feet and would enlarge the total storage capacity in the reservoir by 634,000 acre-feet. The existing TCD also would be extended to achieve efficient use of the expanded cold-water pool. Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 150,000 acre-feet and 75,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries.

Shasta Lake and Vicinity The significance criteria for H&H do not apply in the Shasta Lake and vicinity geographic region; therefore, potential effects in that geographic region are not discussed further in this EIS.

Upper Sacramento River (Shasta Dam to Red Bluff)
Impact H&H-1 (CP5): Change in Frequency of Flows above 100,000 cfs on the Sacramento River below Bend Bridge Although flood management operations would not change under CP5, a slight reduction could occur in the frequency of flows greater than 100,000 cfs. This impact would be beneficial.

SLWRI modeling uses a monthly time step, which is inappropriate for flood control analysis; however, flood management operations for downstream objectives would not change under CP5. Although a slight decrease in recurrence of high flows would be possible because of the increased storage capability, CP5 would not increase the frequency of flows above 100,000 cfs. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-2 (CP5): Place Housing or Other Structures within a 100-Year Flood Hazard Area as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map This impact would be the same as Impact H&H-2 (CP1). No new structures would be built downstream from Shasta Dam. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-3 (CP5): Place within a 100-Year Flood Hazard Area Structures that Would Impede or Redirect Flood Flows This impact would be the same as Impact H&H-3 (CP1). No new structures would be built downstream from Shasta Dam. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta
Impact H&H-4 (CP5): Change in Water Levels in Old River near Tracy Road Bridge Simulated water levels in the Old River near Tracy Road Bridge show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant.

As shown in Table 6-57, maximum monthly reduction in minimum daily water level associated with CP5 would be less than 0.1 foot in all months during the irrigation season, compared to the existing condition and the No-Action Alternative. The water levels would remain above 0.0 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-57. Simulated Monthly Maximum 15-Minute Change in Old River Water Levels near Tracy Road Bridge at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP5 (2005) Change (feet)	CP5 (2030) Change (feet)
Apr	-0.01 (0%)	-0.02 (0%)
May	-0.02 (0%)	-0.02 (0%)
Jun	-0.05 (0%)	-0.05 (0%)
Jul	-0.06 (0%)	-0.09 (0%)
Aug	-0.07 (0%)	-0.08 (0%)
Sep	-0.07 (0%)	-0.08 (0%)
Oct	-0.07 (0%)	-0.06 (0%)

Source: Version 8.0.6 DSM2 2005 and 2030 simulations (Node 071_3116)
Notes:
Simulation period: 1922-2003
(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.
Key:
CP = comprehensive plan

Impact H&H-5 (CP5): Change in Water Levels in the Grant Line Canal near the Grant Line Canal Barrier Simulated water levels in the Old River near Tracy show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant.

As shown in Table 6-58, maximum monthly reduction in minimum daily water level associated with CP5 would be less than 0.1 foot in all months during the irrigation season, compared to the existing condition and the No-Action Alternative. The water levels would remain above 0.0 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-58. Simulated Monthly Maximum 15-Minute Change in Grant Line Canal Water Levels near the Grant Line Canal Barrier at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP5 (2005) Change (feet)	CP5 (2030) Change (feet)
Apr	0.00 (0%)	-0.02 (0%)
May	-0.02 (0%)	-0.02 (0%)
Jun	-0.04 (0%)	-0.03 (0%)
Jul	-0.07 (0%)	-0.08 (0%)
Aug	-0.05 (0%)	-0.05 (0%)
Sep	-0.03 (0%)	-0.05 (0%)
Oct	-0.03 (0%)	-0.03 (0%)

Source: Version 8.0.6 DSM2 2005 and 2030 simulations (Node 129_5691)

Notes:
Simulation period: 1922-2003
(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.
Key:
CP = comprehensive plan

Impact H&H-6 (CP5): Change in Water Levels in the Middle River near the Howard Road Bridge Simulated water levels in the Middle River near the Howard Road Bridge show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant.

As shown in Table 6-59, maximum monthly reduction in minimum daily water level associated with CP5 would be less than 0.1 foot in all months during the irrigation season, compared to the existing condition and the No-Action Alternative. The water levels would remain above 0.3 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-59. Simulated Monthly Maximum 15-Minute Change in Middle River Water Levels near the Howard Road Bridge at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP5 (2005) Change (feet)	CP5 (2030) Change (feet)
Apr	-0.01 (0%)	-0.02 (0%)
May	-0.02 (0%)	-0.02 (0%)
Jun	-0.05 (0%)	-0.05 (0%)
Jul	-0.06 (0%)	-0.08 (0%)
Aug	-0.07 (0%)	-0.08 (0%)
Sep	-0.07 (0%)	-0.09 (0%)
Oct	-0.08 (0%)	-0.07 (0%)

Source: Version 8.0.6 DSM2 2005 and 2030 simulations (Node 206_5533)

Notes:
Simulation period: 1922-2003
(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.
Key:
CP = comprehensive plan

Impact H&H-7 (CP5): Change in X2 Position The X2 position would change from west to east of Collinsville in one December, compared with existing conditions and the No-Action Alternative when the Delta would not be in balanced conditions. This impact would be less than significant.

Examination of simulation output indicates that compared to the existing condition, only in one month, December 1979, would the X2 position shift from west to east of Collinsville. Under existing conditions, the X2 position would be at 78.25 km, and under CP5, it would be at 81.36 km, a 3.11 km shift. Compared to the No-Action Alternative, only in one month, December 1979, would the X2 position change from west to east of Collinsville. Under the No-Action Alternative, the X2 position would be at 78.63 km, and under CP5, it would be at 81.08 km, a 2.45 km shift. This single month change would not significantly limit CCWD's ability to fill Los Vaqueros Reservoir. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-8 (CP5): Change in Recurrence of Delta Excess Condition Under CP5, changes from excess to balanced Delta conditions would be rare. This impact would be less than significant.

As shown in Table 6-60, CP5 would cause one March, one June, one August, one October, three Novembers, and one December to change from excess to balanced Delta conditions, when compared to the existing condition, and four Julys, one August, five Octobers , and three Novembers when compared to the No-Action Alternative. Because of the low number of occurrences, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-60. Simulated Number of Years the Delta Changes from Excess to Balanced Condition

	Number of Years the Delta Changes from Excess to Balanced Conditions Compared to Existing Condition or No-Action Alternative											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
CP5 (2005)	0 (0%)	0 (0%)	1 (1%)	0 (0%)	0 (0%)	0 (0%)	1 (1%)	1 (1%)	0 (0%)	1 (1%)	3 (4%)	1 (1%)
CP5 (2030)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	4 (5%)	1 (1%)	0 (0%)	5 (6%)	3 (4%)	0 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations
Notes:
Simulation Period: 1922-2003
(%) indicates percent of months Delta condition change occurs.
Key:
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation

CVP/SWP Service Areas

Impact H&H-9 (CP5): Change in Deliveries to North-of-Delta CVP Water Service Contractors and Refuges Average annual deliveries to North-of-Delta CVP Water Service Contractors would increase under all conditions. This impact would be beneficial. Annual average deliveries to North-of-Delta refuges would not change under all conditions. This impact would be less than significant.

As shown in Table 6-61, average annual deliveries to North-of-Delta Water Service Contractors under both existing and future conditions would increase relative to the basis of comparison. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed. Average annual deliveries to North-of-Delta refuges would not change under all conditions. Minor increases and decreases in Refuge deliveries are not true a representation of real-time operations but an indication of modeling artifacts. Such reduction would not occur in real time due to efficient water allocation and management schemes that cannot be captured adequately in a water resources planning model such as CalSim-II. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-61. Simulated Monthly Average Deliveries and Percent Change of Deliveries to North-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP5 Change (cfs (%))	Existing Condition (cfs)	CP5 Change (cfs (%))	No-Action Alternative (cfs)	CP5 Change (cfs (%))	No-Action Alternative (cfs)	CP5 Change (cfs (%))
North-of-Delta CVP Water Service Contractors Deliveries								
Oct	77	7 (9%)	69	6 (9%)	74	7 (10%)	63	7 (12%)
Nov	3	0 (8%)	3	0 (13%)	2	0 (9%)	3	0 (16%)
Dec	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Jan	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Feb	3	0 (3%)	7	0 (1%)	2	0 (4%)	5	0 (1%)
Mar	19	4 (18%)	21	5 (24%)	15	4 (24%)	14	5 (38%)
Apr	335	34 (10%)	229	42 (18%)	297	38 (13%)	181	43 (24%)
May	572	46 (8%)	316	52 (16%)	555	54 (10%)	268	55 (20%)
Jun	799	58 (7%)	425	68 (16%)	788	67 (8%)	365	69 (19%)
Jul	918	64 (7%)	480	76 (16%)	910	74 (8%)	414	77 (19%)
Aug	733	50 (7%)	386	61 (16%)	727	58 (8%)	333	62 (19%)
Sep	341	22 (7%)	170	27 (16%)	334	26 (8%)	144	27 (19%)
Total (TAF)	231	17 (8%)	128	21 (16%)	225	20 (9%)	109	21 (19%)
North-of-Delta Refuges Deliveries								
Oct	177	-10 (-6%)	182	-31 (-17%)	224	-4 (-2%)	212	-4 (-2%)
Nov	168	0 (0%)	156	4 (3%)	219	1 (1%)	212	0 (0%)
Dec	105	0 (0%)	104	0 (0%)	133	0 (0%)	132	0 (0%)
Jan	50	0 (0%)	50	0 (0%)	63	0 (0%)	62	0 (0%)
Feb	45	0 (0%)	45	0 (0%)	57	0 (0%)	57	0 (0%)
Mar	13	0 (0%)	12	0 (-1%)	16	0 (0%)	15	0 (1%)
Apr	15	0 (0%)	14	0 (0%)	18	0 (-1%)	17	0 (-2%)
May	50	0 (0%)	46	0 (0%)	64	0 (-1%)	59	-1 (-2%)
Jun	79	-1 (-1%)	75	-2 (-3%)	96	1 (1%)	87	3 (3%)
Jul	106	-1 (-1%)	99	-3 (-3%)	134	1 (1%)	126	2 (2%)
Aug	143	0 (0%)	134	0 (0%)	180	3 (2%)	165	9 (6%)
Sep	187	0 (0%)	177	0 (0%)	237	0 (0%)	226	0 (0%)
Total (TAF)	69	-1 (-1%)	66	-2 (-3%)	87	0 (0%)	83	1 (1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_N and DEL_CVP_PRF_N)
Note:
Simulation period: 1922-2003. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
cfs = cubic feet per second
CP = comprehensive plan
CVP = Central Valley Project
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Impact H&H-10 (CP5): Change in Deliveries to South-of-Delta CVP Water Service Contractors and Refuges Average annual deliveries to South-of-Delta CVP Water Service Contractors would increase under all conditions. This impact would be beneficial. Annual average deliveries to South-of-Delta refuges would not change under all conditions. This impact would be less than significant.

As shown in Table 6-62, average annual deliveries to South-of-Delta Water Service Contractors under both existing and future conditions would increase relative to the basis of comparison. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed. Average annual deliveries to South-of-Delta refuges would not change under all conditions. Minor increases and decreases in Refuge deliveries are not a true representation of real-time operations but an indication of modeling artifacts. Such reduction would not occur in real time due to efficient water allocation and management schemes that cannot be captured adequately in a water resources planning model such as CalSim-II. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-62. Simulated Monthly Average Deliveries and Percent Change of Deliveries to South-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP5 Change (cfs (%))	Existing Condition (cfs)	CP5 Change (cfs (%))	No-Action Alternative (cfs)	CP5 Change (cfs (%))	No-Action Alternative (cfs)	CP5 Change (cfs (%))
South-of-Delta CVP Water Service Contractors Deliveries								
Oct	474	6 (1%)	363	11 (3%)	464	13 (3%)	343	21 (6%)
Nov	362	4 (1%)	277	8 (3%)	354	10 (3%)	262	16 (6%)
Dec	501	6 (1%)	383	11 (3%)	490	13 (3%)	362	23 (6%)
Jan	880	11 (1%)	673	20 (3%)	860	23 (3%)	636	40 (6%)
Feb	1,100	13 (1%)	841	25 (3%)	1,076	29 (3%)	794	50 (6%)
Mar	660	22 (3%)	362	17 (5%)	634	35 (5%)	302	37 (12%)
Apr	1,079	20 (2%)	627	-9 (-1%)	1,052	38 (4%)	545	34 (6%)
May	1,564	18 (1%)	902	-11 (-1%)	1,528	41 (3%)	794	45 (6%)
Jun	2,596	37 (1%)	1,467	0 (0%)	2,545	69 (3%)	1,310	76 (6%)
Jul	3,136	34 (1%)	1,809	-30 (-2%)	3,063	71 (2%)	1,581	58 (4%)
Aug	2,078	19 (1%)	1,112	-34 (-3%)	2,063	40 (2%)	939	73 (8%)
Sep	735	5 (1%)	428	-6 (-1%)	722	22 (3%)	370	27 (7%)
Total (TAF)	916	12 (1%)	558	0 (0%)	898	24 (3%)	497	30 (6%)

Table 6-62. Simulated Monthly Average Deliveries and Percent Change of Deliveries to South-of-Delta CVP Water Service Contractors and Refuges (contd.)

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP5 Change (cfs (%))	Existing Condition (cfs)	CP5 Change (cfs (%))	No-Action Alternative (cfs)	CP5 Change (cfs (%))	No-Action Alternative (cfs)	CP5 Change (cfs (%))
South-of-Delta Refuges Deliveries								
Oct	1,126	0 (0%)	1,110	0 (0%)	1,041	0 (0%)	1,026	0 (0%)
Nov	729	0 (0%)	718	0 (0%)	671	0 (0%)	661	0 (0%)
Dec	336	0 (0%)	331	0 (0%)	306	0 (0%)	302	0 (0%)
Jan	147	0 (0%)	145	0 (0%)	137	0 (0%)	135	0 (0%)
Feb	109	0 (0%)	107	0 (0%)	102	0 (0%)	101	0 (0%)
Mar	93	0 (0%)	89	0 (0%)	88	0 (0%)	83	0 (0%)
Apr	217	0 (0%)	207	0 (0%)	203	0 (0%)	193	0 (0%)
May	445	0 (0%)	423	0 (0%)	407	0 (0%)	387	0 (0%)
Jun	493	0 (0%)	468	0 (0%)	456	0 (0%)	434	0 (0%)
Jul	120	0 (0%)	114	0 (0%)	112	0 (0%)	107	-1 (-1%)
Aug	197	1 (0%)	185	1 (1%)	181	3 (2%)	161	9 (5%)
Sep	885	-7 (-1%)	843	0 (0%)	808	5 (1%)	760	13 (2%)
Total (TAF)	296	0 (0%)	286	0 (0%)	273	0 (0%)	263	1 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_S and DEL_CVP_PRF_S)
Notes:
Simulation period: 1922-2003.
(%) indicates percent change from either existing condition or No-Action Alternative Dry and critical years as defined by the Sacramento Valley Index.
Key:
cfs = cubic feet per second
CP = comprehensive plan
CVP = Central Valley Project
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Impact H&H-11 (CP5): Change in Deliveries to SWP Table A Contractors
This impact would be similar to Impact H&H-11 (CP1), except the increase in average annual deliveries would be greater, and potential decreases in average monthly deliveries in some months could be slightly larger under CP5. This impact would be less than significant.

As shown in Table 6-63, average annual deliveries to SWP Table A contractors would increase under CP5, in both existing and future conditions relative to the bases of comparison in both average years and in dry and critical years. Some monthly average decreases around 1 percent could occur in deliveries relative to the No-Action Alternative under existing and future conditions in both average annual and dry and critical years. The average monthly deliveries would increase in all months under CP5 relative to the No-Action Alternative under future conditions. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-63. Simulated Monthly Average Deliveries and Percent Change of Deliveries to SWP Table A Contractors

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP5 Change (cfs (%))	Existing Condition (cfs)	CP5 Change (cfs (%))	No-Action Alternative (cfs)	CP5 Change (cfs (%))	No-Action Alternative (cfs)	CP5 Change (cfs (%))
Oct	3,226	-8 (0%)	2,873	73 (3%)	3,351	57 (2%)	3,051	64 (2%)
Nov	2,689	79 (3%)	2,282	83 (4%)	2,812	32 (1%)	2,342	33 (1%)
Dec	2,476	19 (1%)	2,014	76 (4%)	2,886	49 (2%)	2,392	90 (4%)
Jan	623	22 (4%)	389	2 (1%)	988	55 (6%)	412	32 (8%)
Feb	1,106	36 (3%)	637	48 (8%)	1,860	59 (3%)	766	49 (6%)
Mar	1,804	27 (1%)	1,041	57 (5%)	2,307	30 (1%)	1,101	73 (7%)
Apr	4,733	17 (0%)	4,156	47 (1%)	5,094	40 (1%)	4,251	109 (3%)
May	5,837	47 (1%)	4,983	60 (1%)	6,335	36 (1%)	5,143	118 (2%)
Jun	7,433	7 (0%)	6,408	-24 (0%)	7,612	33 (0%)	6,471	44 (1%)
Jul	7,841	55 (1%)	6,757	166 (2%)	8,147	27 (0%)	6,933	126 (2%)
Aug	7,017	21 (0%)	5,605	80 (1%)	7,244	-20 (0%)	5,679	2 (0%)
Sep	5,086	54 (1%)	4,003	161 (4%)	5,322	71 (1%)	4,066	225 (6%)
Total (TAF)	3,020	23 (1%)	2,493	50 (2%)	3,265	28 (1%)	2,581	58 (2%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_SWP_PAG and DEL_SWP_PMI)

Notes:

Simulation period: 1922-2003.

(%) indicates percent change from either existing condition or No-Action Alternative Dry and critical years as defined by the Sacramento Valley Index.

Key:

cfs = cubic feet per second

CP = comprehensive plan

SLWRI = Shasta Lake Water Resources Investigation

SWP = State Water Project

TAF = thousand acre-feet

Impact H&H-12 (CP5): Change in Groundwater Levels CP5 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. The reduction in groundwater pumping would result in increased groundwater levels. This impact would be beneficial.

With increased water supply deliveries to CVP and SWP water contractors, and with an associated increase in surface water supply reliability to those contractors, shortages in deliveries would decrease under CP5. Contractor responses to shortages in surface water deliveries would vary; some may elect to fallow their land, others may buy water on the transfer market, and some may pump groundwater. An increase in surface water deliveries would result in a decrease in groundwater pumping. With less groundwater pumping, groundwater basins that were in overdraft conditions would be anticipated to improve as a result of increasing groundwater levels. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-13 (CP5): Change in Groundwater Quality CP5 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. The reduction in groundwater pumping could improve groundwater quality. This impact would less than significant.

With increased water supply deliveries to CVP and SWP water contractors, and an associated increase in surface water supply reliability to those contractors, shortages in deliveries would decrease under CP5. Contractor responses to shortages in surface water deliveries would vary; some may elect to fallow their land, others may buy water on the transfer market, and some may pump groundwater. An increase in surface water deliveries would result in a decrease in groundwater pumping. Because CP5 would have a positive, albeit limited, impact by reducing reliance on groundwater, the effects of CP5 on groundwater quality also would be limited. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

6.3.4 Mitigation Measures

Table 6-64 presents a summary of mitigation measures for H&H. No potentially significant impacts have been identified, and therefore no mitigation measures are proposed.

No-Action Alternative

No mitigation measures are required for this alternative.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation measures are required for this alternative.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation measures are required for this alternative.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

No mitigation measures are required for this alternative.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

No mitigation measures are required for CP4 or CP4A.

CP5 – 18.5-Foot Dam Raise, Combination Plan

No mitigation measures are required for this alternative.

Table 6-64. Summary of Mitigation Measures for Hydrology, Hydraulics, and Water Management

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact H&H-1: Change in Frequency of Flows above 100,000 cfs on the Sacramento River below Bend Bridge	LOS before Mitigation	NI	B	B	B	B	B
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	NI	B	B	B	B	B
Impact H&H-2: Place Housing or Other Structures within a 100-Year Flood Hazard Area as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map	LOS before Mitigation	NI	NI	NI	NI	NI	NI
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	NI	NI	NI	NI	NI	NI
Impact H&H-3: Place within a 100-Year Flood Hazard Area Structures that Would Impede or Redirect Flood Flows	LOS before Mitigation	NI	NI	NI	NI	NI	NI
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	NI	NI	NI	NI	NI	NI
Impact H&H-4: Change in Water Levels in the Old River near Tracy Road Bridge	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact H&H-5: Change in Water Levels in the Grant Line Canal near the Grant Line Canal Barrier	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact H&H-6: Change in Water Levels in the Middle River near the Howard Road Bridge	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact H&H-7: Change in X2 Position	LOS before Mitigation	NI	NI	LTS	LTS	NI	LTS
	Mitigation Measure	None required	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	NI	NI	LTS	LTS	NI	LTS

Table 6-64. Summary of Mitigation Measures for Hydrology, Hydraulics, and Water Management (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact H&H-8: Change in Recurrence of Delta Excess Conditions	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact H&H-9: Change in Deliveries to North-of-Delta CVP Water Service Contractors and Refuges	LOS before Mitigation	PS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	PS	LTS	LTS	LTS	LTS	LTS
Impact H&H-10: Change in Deliveries to South-of-Delta CVP Water Service Contractors and Refuges	LOS before Mitigation	PS	B	LTS	B	B	B
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	PS	B	LTS	B	B	B
Impact H&H-11: Change in Deliveries to SWP Table A, Contractors	LOS before Mitigation	B	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	B	LTS	LTS	LTS	LTS	LTS
Impact H&H-12: Change in Groundwater	LOS before Mitigation	LTS	B	B	B	B	B
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	LTS	B	B	B	B	B
Impact H&H-13: Change in Groundwater Quality	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS

Key:
B = beneficial
CP = Comprehensive Plan
CVP = Central Valley Project
LOS = level of significance
LTS = less than significant
NI = no impact
PS = potentially significant

6.3.5 Cumulative Effects

Chapter 3, “Considerations for Describing the Affected Environment and Environmental Consequences,” discusses overall cumulative impacts methodology related to the action alternatives, including the relationship to the CALFED Bay-Delta Program Programmatic EIS/EIR cumulative impacts analysis, qualitative and quantitative assessment, past and future actions in the study area, and significance criteria. Table 3-1, “Present and Reasonably Foreseeable Future Actions Included in the Analysis of Cumulative Impacts, by Resource Area” lists the present and reasonably foreseeable future projects considered quantitatively and qualitatively within the cumulative impacts analysis. This cumulative impacts analysis accounts for potential project impacts combined with the impacts of existing facilities, conditions, land uses, and reasonably foreseeable actions expected to occur in the study area on a qualitative and quantitative level. Past impacts to these resources include dam construction and altered flow regimes, water diversions, flood control facilities, and land use changes.

Actions which are included quantitatively in this cumulative effects analysis are those that are reasonably foreseeable, including actions with current authorization, secured funding for design and construction, and environmental permitting and compliance activities that are substantially complete. As described in Chapter 2, “Alternatives,” Section 2.2, “No-Action Alternative,” the NEPA No-Action alternative includes all reasonably foreseeable actions included quantitatively in the cumulative effects analysis, but excludes effects for project actions. The future with-project conditions combine project actions with the actions included in the No-Action Alternative (2030 baseline). Therefore, quantitative impact assessments for the future with-project conditions presented in this chapter in Section 6.3.3, “Direct and Indirect Effects,” also serve as the quantitative impacts assessments for the cumulative effects analysis. A list of projects included in the Final EIS No-Action Alternative and future with-project impact analyses is located in the Modeling Appendix, Chapter 2, Table 2-1.

Projects which do not meet the parameters of reasonably foreseeable for inclusion in this quantitative cumulative effects analysis but which may have past, present, or reasonably foreseeable cumulative impacts in combination with the proposed project may be included in the cumulative impacts analysis qualitatively. Projects and actions considered include, but are not limited to, North of Delta Offstream Storage Investigation, Bay-Delta Conservation Plan, SJRRP, Davis Woodland Water Supply Project and Central Valley Flood Protection Plan. This section provides an analysis of overall cumulative impacts of the project alternatives with other past, present, and reasonably foreseeable future projects producing related impacts.

The effects of climate change on operations at Shasta Lake could result in changes to H&H. As described in the Climate Change Modeling Appendix, climate change could result in higher reservoir releases in the winter and early spring because of an increase in runoff during these times. The change in winter and early spring releases could necessitate managing flood events resulting from potentially larger storms. Similarly, climate change could result in lower reservoir inflows and Sacramento tributary flows during the late spring and summer because of a decreased snow pack. This reduction in inflow and tributary flow could result in Shasta Lake storage being reduced because of both a reduced ability to capture flows and an increased need to make releases to meet downstream requirements.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

As described in Section 6.3.3, no potentially significant impacts would occur under CP1.

When combined with other past, present, and reasonably foreseeable future projects, a change in the Sacramento River flows would be likely. Because Shasta Reservoir is operated to meet flow and water quality requirements in the Sacramento River and the Delta, a new project or program along the Sacramento River and in the Delta could affect H&H resources under CP1. With the implementation of the other past, present, and reasonably foreseeable future projects, it is reasonable to assume that there would not be a reduction in flow requirements or a reduction in the level of protection from current water quality requirements. Therefore, during periods when the CVP and SWP are operated to meet regulatory constraints, the effects of the implementation of the projects described above would be limited.

Water levels in the south Delta could be affected by changes in Delta inflow and export pumping. Although regulatory requirements restrict export pumping when water levels in the south Delta reach certain levels, CP1 combined with other projects could result in changes to water levels during the irrigation season, at a magnitude and frequency that would affect south Delta water users. Accordingly, CP1 combined with a number of other projects and on-going actions could result in potentially significant and unavoidable impacts to south Delta water levels.

Both the X2 position and the Delta outflow are primarily products of Delta inflow and export pumping. As previously mentioned, CP1 combined with other projects could result in changes to Delta inflow and export pumping. Although CP1 would result in rare changes to either the X2 position or the Delta outflow of a magnitude affecting CCWD’s ability to fill Los Vaqueros Reservoir, and would result in a less-than-significant impact on the X2 position, CP1 combined with other projects could result in potentially significant and unavoidable impacts.

As previously described, CP1 would have a beneficial impact on groundwater resources in the CVP/SWP service areas. Similarly, it is unlikely that CP1, when combined with other projects, would result in a decrease in surface water deliveries and an increased reliance on groundwater pumping relative to existing conditions or the No-Action Alternative. Accordingly, no impact on groundwater levels or groundwater quality would occur. Therefore, CP1, combined with other projects, would be likely to have a beneficial effect.

None of the other past, present, and reasonably foreseeable future projects would negatively affect downstream flood management. Consequently, when combined with CP1, either no cumulative impact or a beneficial impact on flood management would occur from past, present or reasonably foreseeable future projects.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased inflows at other times. The additional storage associated with CP1 potentially would diminish these effects and allow Shasta Lake to capture some of the increased runoff in the winter and early spring for release in late spring and summer. Under climate change, additional impacts from CP1 on flood management, water supply, south Delta water levels, and groundwater management would be less adverse (or beneficial) than without climate change, and would be less than significant. Therefore, under the anticipated effects of climate change, CP1 would not have a significant cumulative effect, and could be beneficial.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

As described in Section 6.3.3, no potentially significant impacts would occur under CP2.

When combined with the other past, present, and reasonably foreseeable future projects, a change in the Sacramento River flows would be likely. Because Shasta Reservoir is operated to meet flow and water quality requirements in the Sacramento River and the Delta, a new project or program along the Sacramento River and in the Delta could affect the H&H resources under CP2. With the implementation of the other past, present, and reasonably foreseeable future projects, it is reasonable to assume that there would not be a reduction in flow requirements or a reduction in the level of protection from current water quality requirements. Therefore, during periods when the CVP and SWP are operated to meet regulatory constraints, the effects of the implementation of the projects described above would be limited.

Water levels in the south Delta could be affected by changes in Delta inflow and export pumping. Although regulatory requirements restrict export pumping when water levels in the south Delta reach certain levels, CP2 combined with other projects could result in changes to water levels during the irrigation season, at a magnitude and frequency that would affect south Delta water users. Accordingly, CP2 combined with other projects could result in potentially significant and unavoidable impacts to south Delta water levels.

Both the X2 position and the Delta outflow are primarily products of Delta inflow and export pumping. As previously mentioned, CP2 combined with other projects could result in changes to Delta inflow and export pumping. Although CP2 would result in rare changes to either the X2 position or the Delta outflow of a magnitude affecting CCWD's ability to fill Los Vaqueros Reservoir, and would result in a less-than-significant impact on the X2 position, CP2 combined with other projects possibly could result in potentially significant and unavoidable impacts.

As previously described, CP2 would have a beneficial impact on groundwater resources in the CVP/SWP service areas. Similarly, it is unlikely that CP2, when combined with other projects, would result in a decrease in surface water deliveries and an increased reliance on groundwater pumping relative to existing conditions or the No-Action Alternative. Accordingly, no impact on groundwater levels or groundwater quality would occur. Therefore, CP2, combined with other projects, would be likely to have a beneficial effect.

None of the other past, present, and reasonably foreseeable future projects would negatively affect downstream flood management. Consequently, when combined with CP2, either no cumulative impact or a beneficial impact on flood management would occur from past, present or reasonably foreseeable future projects.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased inflows at other times. The additional storage associated with CP2 potentially would diminish these effects and allow Shasta Lake to capture some of the increased runoff in the winter and early spring for release in late spring and summer. Under climate change, additional impacts from CP2 on flood management, water supply, south Delta water levels, and groundwater management would be less adverse (or beneficial) than without climate change, and would be less than significant. Therefore, even under the anticipated effects of climate change, CP2 would not have a significant cumulative effect, and could be beneficial.

CP3 – 18.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply

As described in Section 6.3.3, no potentially significant impacts would occur under CP3.

When combined with the other past, present, and reasonably foreseeable future projects, a change in the Sacramento River flows would be likely. Because Shasta Reservoir is operated to meet flow and water quality requirements in the Sacramento River and the Delta, a new project or program along the Sacramento River and in the Delta could affect the H&H resources under CP3. With the implementation of the other past, present, and reasonably foreseeable future projects, it is reasonable to assume that there would not be a reduction in flow requirements or a reduction in the level of protection from current water quality requirements. Therefore, during periods when the CVP and SWP are operated to meet regulatory constraints, the effects of the implementation of the projects described above would be limited.

Water levels in the south Delta could be affected by changes in Delta inflow and export pumping. Although regulatory requirements restrict export pumping when water levels in the south Delta reach certain levels, CP3 combined with other projects could result in changes to water levels during the irrigation season, at a magnitude and frequency that would affect south Delta water users. Accordingly, CP3 combined with other projects could result in potentially significant and unavoidable impacts to south Delta water levels.

Both the X2 position and the Delta outflow are primarily products of Delta inflow and export pumping. As previously mentioned, CP3 combined with other projects could result in changes to Delta inflow and export pumping. Although CP3 would result in rare changes to either the X2 position or the Delta outflow of a magnitude affecting CCWD's ability to fill Los Vaqueros Reservoir, and would result in a less-than-significant impact on the X2 position, CP3 combined with other projects possibly could result in potentially significant and unavoidable impacts.

As previously described, CP3 would have a beneficial impact on groundwater resources in the CVP/SWP service areas. Similarly, it is unlikely that CP3, when combined with a number of other projects, would result in a decrease in surface water deliveries and an increased reliance on groundwater pumping relative to existing conditions or the No-Action Alternative. Accordingly, no impact on groundwater levels or groundwater quality would occur. Therefore, CP3, combined with a number of other projects, would be likely to have a beneficial effect.

None of the other past, present, and reasonably foreseeable future projects would negatively affect downstream flood management. Consequently, when combined with CP3, either no cumulative impact or a beneficial impact on flood management would occur from past, present or reasonably foreseeable future projects.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased inflows at other times. The additional storage associated with CP3 potentially would diminish these effects and allow Shasta Lake to capture some of the increased runoff in the winter and early spring for release in late spring and summer. Under climate change, additional impacts from CP3 on flood management, water supply, south Delta Water levels, and groundwater management would be less adverse (or beneficial) than without climate change, and would be less than significant. Therefore, under the anticipated effects of climate change, CP3 would not have a significant cumulative effect, and could be beneficial.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus With Water Supply Reliability

As described in Section 6.3.3, no potentially significant impacts would occur under CP4 or CP4A.

When combined with the other past, present, and reasonably foreseeable future projects, a change in the Sacramento River flows would be likely. Because Shasta Reservoir is operated to meet flow and water quality requirements in the Sacramento River and the Delta, a new project or program along the Sacramento River and in the Delta could affect the H&H resources under CP4 or CP4A. With the implementation of the other past, present, and reasonably foreseeable future projects, it is reasonable to assume that there would not be a reduction in flow requirements or a reduction in the level of protection from current water quality requirements. Therefore, during periods when the CVP and SWP are operated to meet regulatory constraints, the effects of the implementation of the projects described above would be limited.

Water levels in the south Delta could be affected by changes in Delta inflow and export pumping. Although regulatory requirements restrict export pumping when water levels in the south Delta reach certain levels, CP4 or CP4A combined with other projects could result in changes to water levels during the irrigation season, at a magnitude and frequency that would affect south Delta water users. Accordingly, CP4 or CP4A combined with other projects could result in potentially significant and unavoidable impacts to south Delta water levels.

Both the X2 position and the Delta outflow are primarily products of Delta inflow and export pumping. As previously mentioned, CP4 or CP4A combined with other projects could result in changes to Delta inflow and export pumping. Although CP4 or CP4A would result in rare changes to either the X2 position or the Delta outflow of a magnitude affecting CCWD’s ability to fill Los Vaqueros Reservoir, and would result in a less-than-significant impact on the X2 position, CP4 or CP4A combined with other projects possibly could result in potentially significant and unavoidable impacts.

As previously described, CP4 or CP4A would have a beneficial impact on groundwater resources in the CVP/SWP service areas. Similarly, it is unlikely that CP4 or CP4A, when combined with other projects, would result in a decrease in surface water deliveries and an increased reliance on groundwater pumping relative existing conditions or the No-Action Alternative. Accordingly, no impact on groundwater levels or groundwater quality would occur. Therefore, CP4 or CP4A, combined with other projects, would be likely to have a beneficial effect.

None of the other past, present, and reasonably foreseeable future projects would negatively affect downstream flood management. Consequently, when combined with CP4 or CP4A, either no cumulative impact or a beneficial impact on flood management would occur from past, present and reasonably foreseeable future projects.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased inflows at other times. The additional storage associated with CP4 or CP4A could potentially would diminish these effects and allow Shasta Lake to capture some of the increased runoff in the winter and early spring for release in late spring and summer. Under climate change, additional impacts from CP4 or CP4A on flood management, water supply, south Delta water levels, and groundwater management would be less adverse (or beneficial) than without climate change, and would be less than significant. Therefore, under the anticipated effects of climate change, CP4 or CP4A would not have a significant cumulative effect, and could be beneficial.

CP5 – 18.5-Foot Dam Raise, Combination Plan

As described in Section 6.3.3, no potentially significant impacts would occur under CP5.

When combined with the other past, present, and reasonably foreseeable future projects, a change in the Sacramento River flows would be likely. Because Shasta Reservoir is operated to meet flow and water quality requirements in the Sacramento River and the Delta, a new project or program along the Sacramento River and in the Delta could affect the H&H resources under CP5. With the implementation of the other past, present, and reasonably foreseeable future projects, it is reasonable to assume that there would not be a reduction in flow requirements or a reduction in the level of protection from current water quality requirements. Therefore, during periods when the CVP and SWP are operated to meet regulatory constraints, the effects of the implementation of the projects described above would be limited.

Water levels in the south Delta could be affected by changes in Delta inflow and export pumping. Although regulatory requirements restrict export pumping when water levels in the south Delta reach certain levels, CP5 combined with other projects could result in changes to water levels during the irrigation season, at a magnitude and frequency that would affect south Delta water users. Accordingly, CP5 combined with other projects could result in potentially significant and unavoidable impacts to south Delta water levels.

Both the X2 position and the Delta outflow are primarily products of Delta inflow and export pumping. As previously mentioned, CP5 combined with other projects could result in changes to Delta inflow and export pumping. Although CP5 would result in rare changes to either the X2 position or the Delta outflow of a magnitude affecting CCWD's ability to fill Los Vaqueros Reservoir, and would result in a less-than-significant impact on the X2 position, CP5 combined with other projects could result in potentially significant and unavoidable impacts.

As previously described, CP5 would have a beneficial impact on groundwater resources in the CVP/SWP service areas. Similarly, it is unlikely that CP5, when combined with other projects, would result in a decrease in surface water deliveries and an increased reliance on groundwater pumping relative to existing conditions or the No-Action Alternative. Accordingly, no impact on groundwater levels or groundwater quality would occur. Therefore, CP5, combined with other projects, would be likely to have a beneficial effect.

None of the other past, present, and reasonably foreseeable future projects would negatively affect downstream flood management. Consequently, when combined with CP5, either no cumulative impact or a beneficial impact on flood management would occur from past, present or reasonably foreseeable future projects.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased inflows at other times. The additional storage associated with CP5 potentially would diminish these effects and allow Shasta Lake to capture some of the increased runoff in the winter and early spring for release in late spring and summer. Under climate change, additional impacts from CP5 on flood management, water supply, south Delta water levels, and groundwater management would be less adverse (or beneficial) than without climate change, and would be less than significant. Therefore, under the anticipated effects of climate change, CP5 would not have a significant cumulative effect, and could be beneficial.

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