Chapter 13
Hydrology – Groundwater

This chapter describes the affected environment for groundwater, as well as potential environmental consequences and associated mitigation measures, as they pertain to implementing the alternatives. It focuses primarily on identified groundwater basins that occur in the extended study area (San Joaquin River from Friant Dam to the Merced River, the San Joaquin River from the Merced River to the Delta, the Delta, and the CVP and SWP water service areas).

Affected Environment

This section describes the affected environment related to groundwater resources in the San Joaquin River and Tulare Lake hydrologic regions (see Figure 13-1). Both of these regions have historically relied greatly on groundwater extracted from the San Joaquin Valley Groundwater Basin.

The San Joaquin River Hydrologic Region consists of surface water basins draining into the San Joaquin River system, from the Cosumnes River Basin on the north through the southern boundary of the San Joaquin River Basin (DWR 2009). In addition to the San Joaquin Valley Groundwater Basin, the San Joaquin River Hydrologic Region also includes Yosemite Valley, Los Banos, and Creek Valley groundwater basins (DWR 2009). The Yosemite, Los Banos, and Creek Valley groundwater basins are discrete, peripheral basins, unconnected to the San Joaquin Valley Groundwater Basin, and will not be further discussed in this chapter.

The Tulare Lake Hydrologic Region is a closed drainage basin at the southern end of the San Joaquin Valley, south of the San Joaquin River Basin, encompassing surface water basins draining to the Kern Lake bed, Tulare Lake bed, and Buena Vista Lake bed (DWR 2009). The Tulare Lake Hydrologic Region includes 12 distinct groundwater basins and 7 subbasins of the San Joaquin Valley Groundwater Basin Groundwater use in this hydrologic region has historically accounted for 41 percent of the total annual water supply in the region and represents 35 percent of all groundwater use in the State (DWR 2009).

The primary study area, including the area of project features, the Temperance Flat Reservoir Area, and Millerton Lake, are all outside of mapped alluvial groundwater basins as defined by DWR. Groundwater in those areas occurs primarily in fractured bedrock, and in-depth understanding of the resource (e.g., from detailed field studies) does not exist (Millerton Area Watershed Coalition 2003). It is expected that any groundwater wells that do exist in the primary study area are used for domestic purposes.

The focus of this chapter is the San Joaquin Valley Groundwater Basin, whose subbasins encompass most of the extended study area, including the San Joaquin River downstream from Friant Dam, the San Joaquin River from the Merced River confluence to the Delta, the Delta, and much of the CVP/SWP water service areas. The San Joaquin Valley Groundwater Basin is the primary groundwater basin in the San Joaquin River and Tulare Lake hydrologic regions and makes up the southern two-thirds of the 400-mile-long, northwest trending asymmetric trough of the Central Valley regional aquifer system in the southern extent of the Great Valley Geomorphic Province (Page 1986). The San Joaquin Valley Groundwater Basin is bounded to the west by the Coast Ranges, to the south by the San Emigidio and Tehachapi mountains, to the east by the Sierra Nevada, and to the north by the Delta and Sacramento Valley (DWR 2003).

Nine subbasins of the San Joaquin Valley Groundwater basin are located in the San Joaquin River Hydrologic Region (including Eastern San Joaquin, Modesto, Turlock, Merced, Chowchilla, Madera, Delta-Mendota, Tracy, and Cosumnes) and seven subbasins (including Kings, Westside, Pleasant Valley, Kaweah, Tulare Lake, Tule, and Kern County) are in the Tulare Lake Hydrologic Region (DWR 2003). Detailed site-specific information on all groundwater subbasins in the extended study area is limited and is not uniformly available or always current; but where available, such information is included in this chapter.

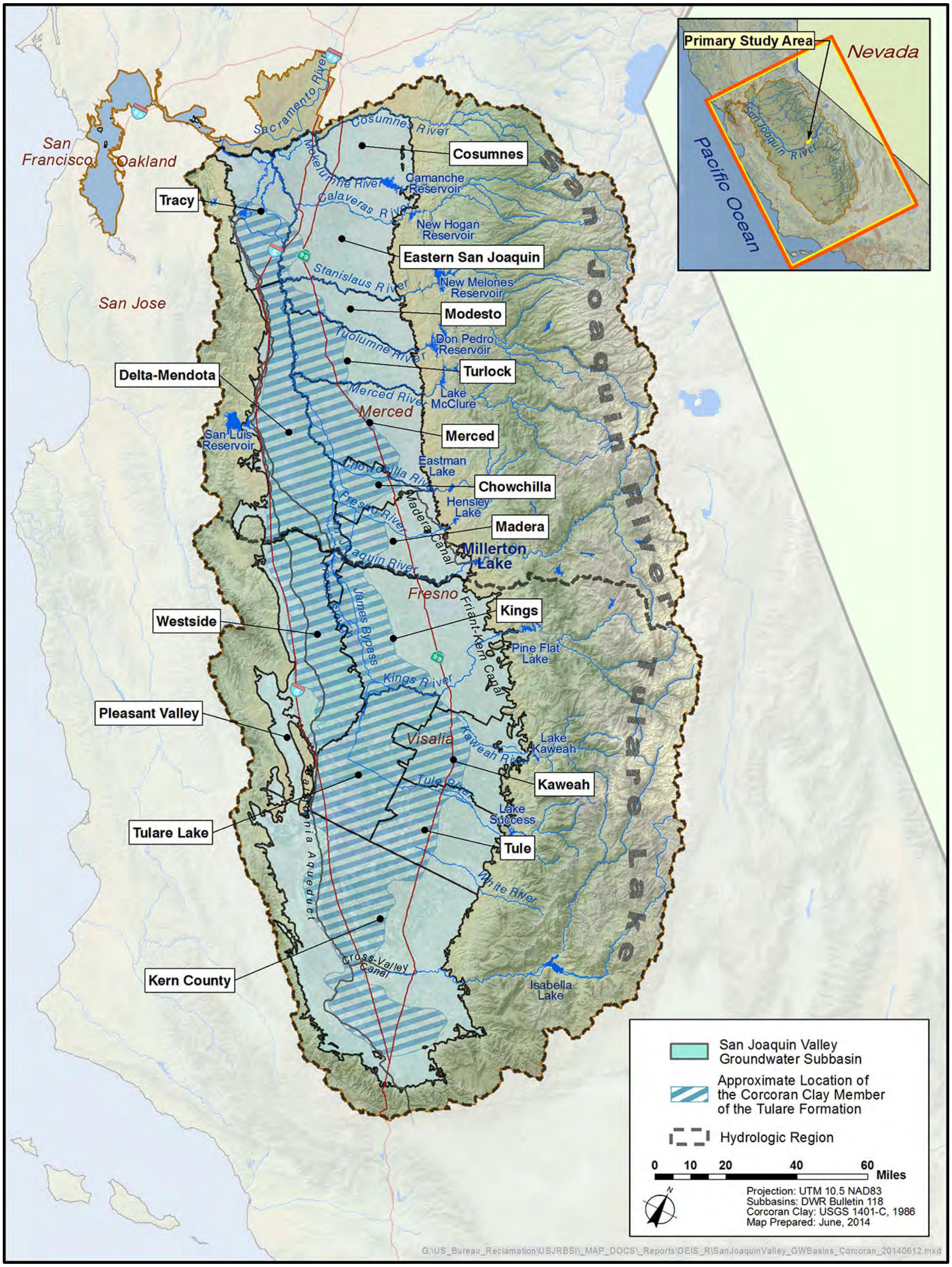


Figure 13-1. Subbasins of the San Joaquin Valley Groundwater Basin

Groundwater Resources of the San Joaquin River Hydrologic Region

This section describes regional and subbasin hydrogeology, groundwater storage and production, groundwater levels, land subsidence, groundwater quality, agriculture subsurface drainage, and seepage and water-logging in the portion of the San Joaquin Valley Groundwater Basin within the San Joaquin River Hydrologic Region.

Hydrogeology

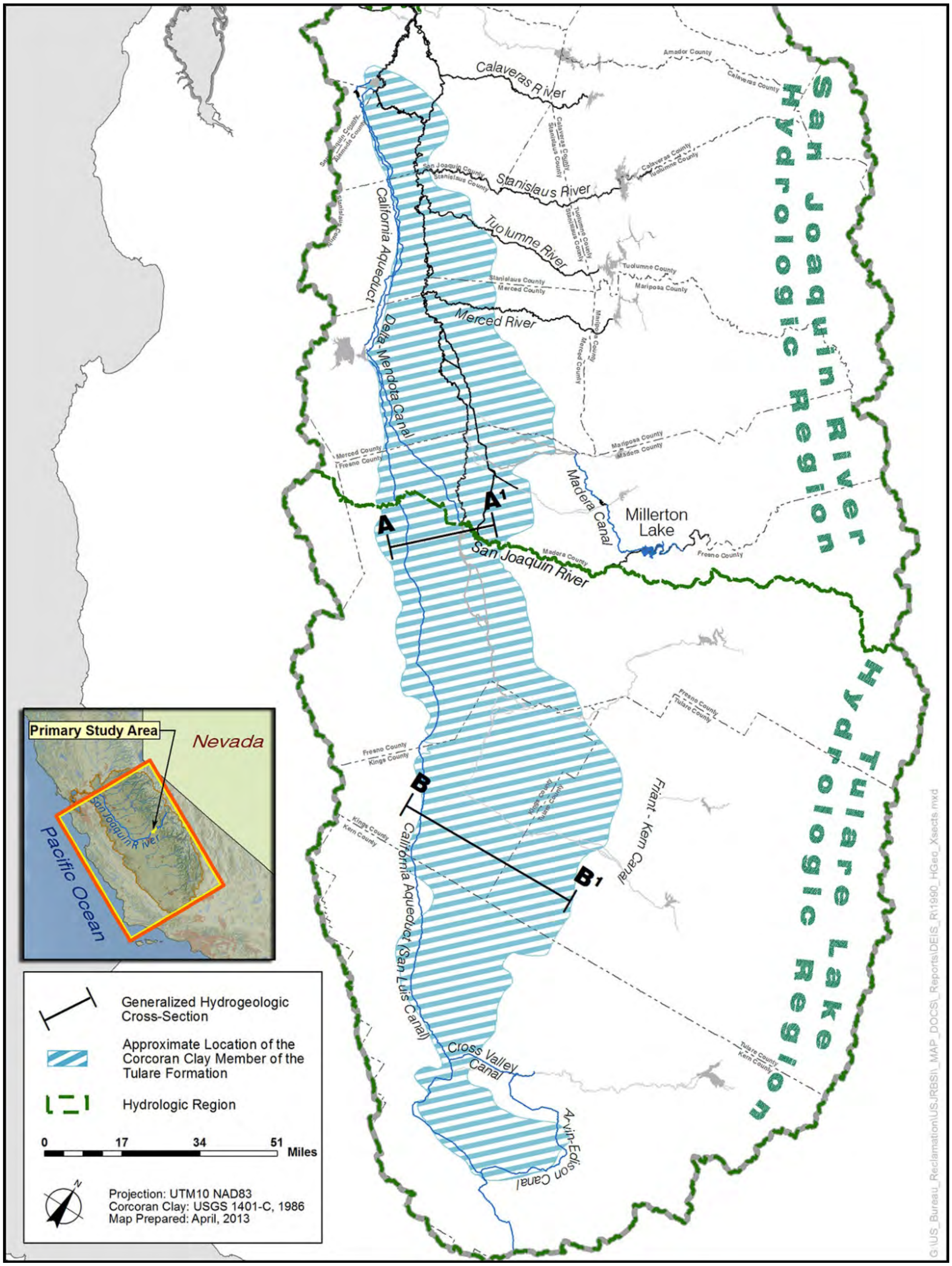
The following sections describe regional hydrogeology and subbasin hydrogeology in the San Joaquin River Hydrologic Region.

Regional Hydrogeology As reported in the Draft CVPIA Programmatic EIS (Reclamation 1997), groundwater in the San Joaquin River Hydrologic Region historically flowed from the valley flanks to the axis of the valley during predevelopment conditions, then north toward the Delta. In the 1920s, development of deep-well turbine pumps and increased availability of electricity led to expansion of agriculture which ultimately led to declining groundwater levels between 1920 and 1950 (DWR 2003).

Groundwater pumping and recharge from imported irrigation water have resulted in a change in regional flow patterns. Flow largely occurs from areas of recharge toward areas of lower groundwater levels because of groundwater pumping (Bertoldi et al. 1991). Vertical movement of water in the aquifer has been altered in this region as a result of thousands of wells constructed with perforations above and below the confining unit (Corcoran Clay) where present, providing a direct hydraulic connection (Bertoldi et al. 1991).

The San Joaquin Valley is located in an asymmetric structural trough in the Central Valley, and it has accumulated up to 6 vertical miles of sediment, including marine and continental rocks and deposits (Page 1986). The eastern side of the valley is underlain by granitic and metamorphic rocks that slope gently from the outcrops of the Sierra Nevada. The western side and part of the eastern side of the valley are underlain by a mafic and ultramafic (high in mafic minerals including those containing high concentrations of magnesium and iron) complex that is also part of the Sierra Nevada. The continental and marine rocks deposited in the San Joaquin Valley range in thickness from tens of feet to more than 2,000 feet (Page 1986).

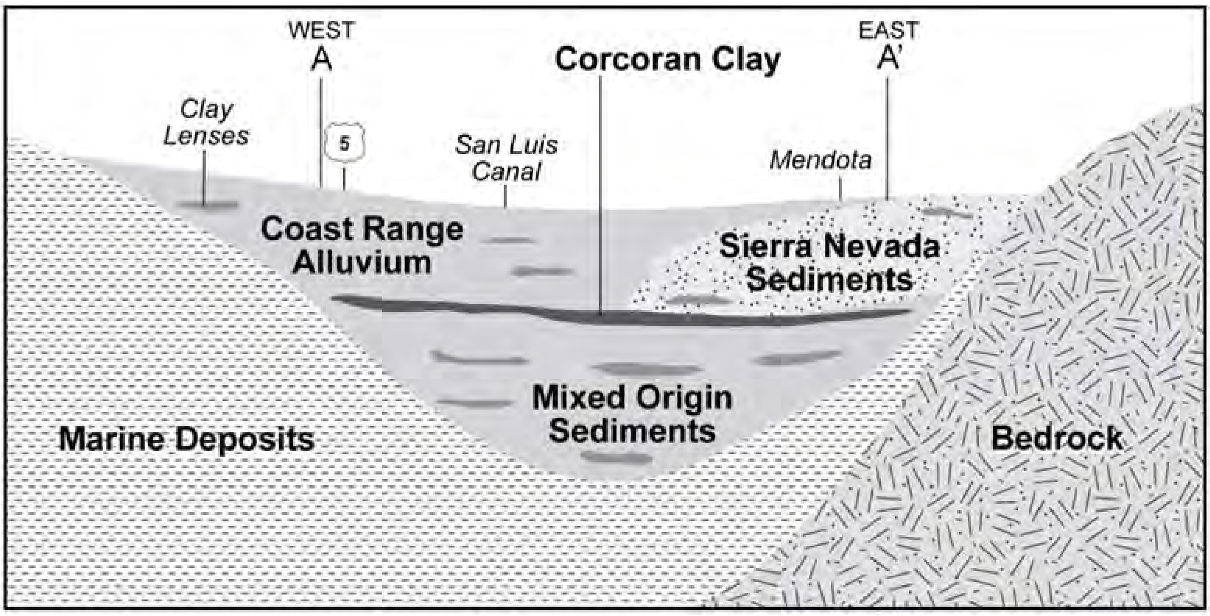
The aquifer system of the San Joaquin Valley Groundwater Basin is divided into two major aquifers: an unconfined-to-semiconfined aquifer above the Corcoran Clay (E-clay) and a confined aquifer beneath the Corcoran (Mitten et al. 1970, Williamson et al. 1989). The unconfined-to-semiconfined aquifer can generally be divided into three hydrogeologic units based on the source of the sediment: Coast Ranges alluvium, Sierra Nevada sediments, and flood-basin deposits (see Figure 13-2 and Figure 13-3). The Tulare Lake Hydrologic Region also contains Tulare Lake sediments, which demonstrate the presence of several dry lakebeds in the region.



Source: Modified from Page 1986 and Reclamation et al. 1990a

Figure 13-2. Approximate Boundary of Corcoran Clay and Transect Lines for Hydrogeologic Cross Sections

San Joaquin River Hydrologic Region



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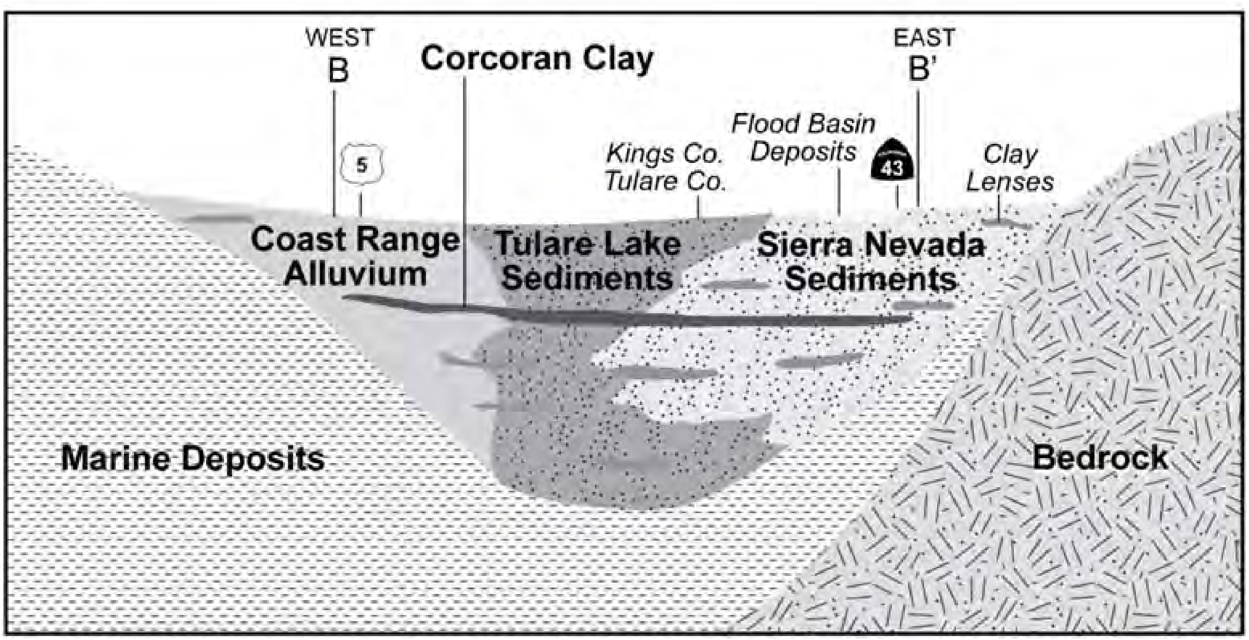
Tulare Lake Hydrologic Region



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Source: Reclamation et al. 1990a

Figure 13-3. Generalized Hydrogeologic Cross Sections in San Joaquin River and Tulare Lake Hydrologic Regions

The alluvial deposits from the Coast Ranges are derived largely from the erosion of marine rocks from the Coast Ranges. These deposits are up to 850 feet thick along the western edge of the valley and taper off to the east as they approach the center of the valley floor (Belitz and Heimes 1990). The alluvial deposits contain a large proportion of silt and clay, are high in salts, and also contain elevated concentrations of selenium and other trace elements.

The Sierra Nevada sediments on the eastern side of the region are derived primarily from granitic rock and consist of predominantly well-sorted micaceous sand (Miller et al. 1971). These deposits make up most of the total thickness of sediments along the valley axis and gradually thin to the west until pinching out near the western boundary. The Sierra Nevada sediments are relatively permeable with hydraulic conductivities three times the conductivities of deposits from the Coast Ranges (Belitz and Heimes 1990).

The flood-basin deposits are relatively thin and were derived in recent time from sediments of the Coast Ranges to the west and from sediments of the Sierra Nevada to the east. These deposits occur along the center of the valley floor and consist primarily of moderately to densely compacted clays ranging between 5 and 35 feet thick (Belitz and Heimes 1990).

On a regional scale, the Corcoran Clay (E-clay) member of the Tulare Formation divides the groundwater system. The Corcoran Clay ranges from 0 to 160 feet thick, and is found between 80 feet deep near Chowchilla, to 400 feet below the land surface to the southwest (Mitten et al. 1970). The confined aquifer is overlain by the Corcoran Clay and consists of mixed origin sediments.

The unconfined to semiconfined aquifer system of the San Joaquin Valley has historically been recharged by mountain rain and snowmelt along the valley margins (McBain and Trush 2002). Recharge has generally occurred by stream seepage, deep percolation of rainfall, and subsurface inflow along basin boundaries. As agricultural practices expanded in the region, recharge was augmented with deep percolation of applied agricultural water and seepage from the distribution systems used to convey this water. Recharge of the lower confined aquifer consists of subsurface inflow from the valley floor and foothill areas to the east of the eastern boundary of the Corcoran Clay. Present information indicates that the clay layers, including the Corcoran Clay, are not continuous in some areas, and some seepage from the semiconfined aquifer above does occur through the confining layer. It has been reported that the hydraulic head in the semiconfined aquifer was less than that in the confined aquifer, and the pressure differential has led to an upward gradient (artesian condition), allowing groundwater to discharge at the surface to the river and valley (McBain and Trush 2002).

Subbasin Hydrogeology The primary water-bearing units of the San Joaquin Valley Groundwater Basin subbasins in the San Joaquin River Hydrologic Region (see Figure 13-1) are described by DWR in California's Groundwater – Bulletin 118 (DWR 2003). The water-bearing formations of the Tracy and Delta-Mendota subbasins in the northwestern portion of the San Joaquin Valley Groundwater Basin consist of continental deposits of Late Tertiary to Quaternary age, and include the Tulare Formation, older alluvium, flood-basin deposits, and younger alluvium (DWR 2003). Water-bearing formations of the Delta-Mendota Subbasin also include terrace deposits. Deposits in the subbasins range in thickness from a few hundred feet at the foothills of the Coast Ranges to approximately 3,000 feet along the eastern edge of the subbasins.

Table 13-1. Net Changes in Annual Groundwater Storage for Water Years 1998 Through 2005

Water Year	Net Change in Annual Storage (TAF)
1998	-444
1999	-1,858
2000	-96
2001	-1,260
2002	-1,839
2003	-992
2004	-2,976
2005	-1,251

Source: DWR 2009

Key:
TAF = thousand acre-feet

To the east, the Cosumnes Subbasin also consists of continental deposits of similar age and Miocene/Pliocene Volcanics of the Mehrten Formation. The older alluvium of the Cosumnes Subbasin consists of sediments of the Modesto, Riverbank, Victor, and Laguna formations. South of the Cosumnes Subbasin, the Eastern San Joaquin Subbasin consists of alluvium and the Modesto/Riverbank formations, flood-basin deposits, the Laguna Formation, and the Mehrten Formation

(DWR 2003). Water-bearing deposits of the Modesto, Turlock, and Merced subbasins consist of consolidated and unconsolidated sedimentary deposits of the Ione, Valley Springs, and Mehrten formations. The Chowchilla and Madera subbasins consist of unconsolidated water-bearing deposits of Pleistocene and Holocene age. The unconsolidated deposits consist of continental deposits of Tertiary and Quaternary age.

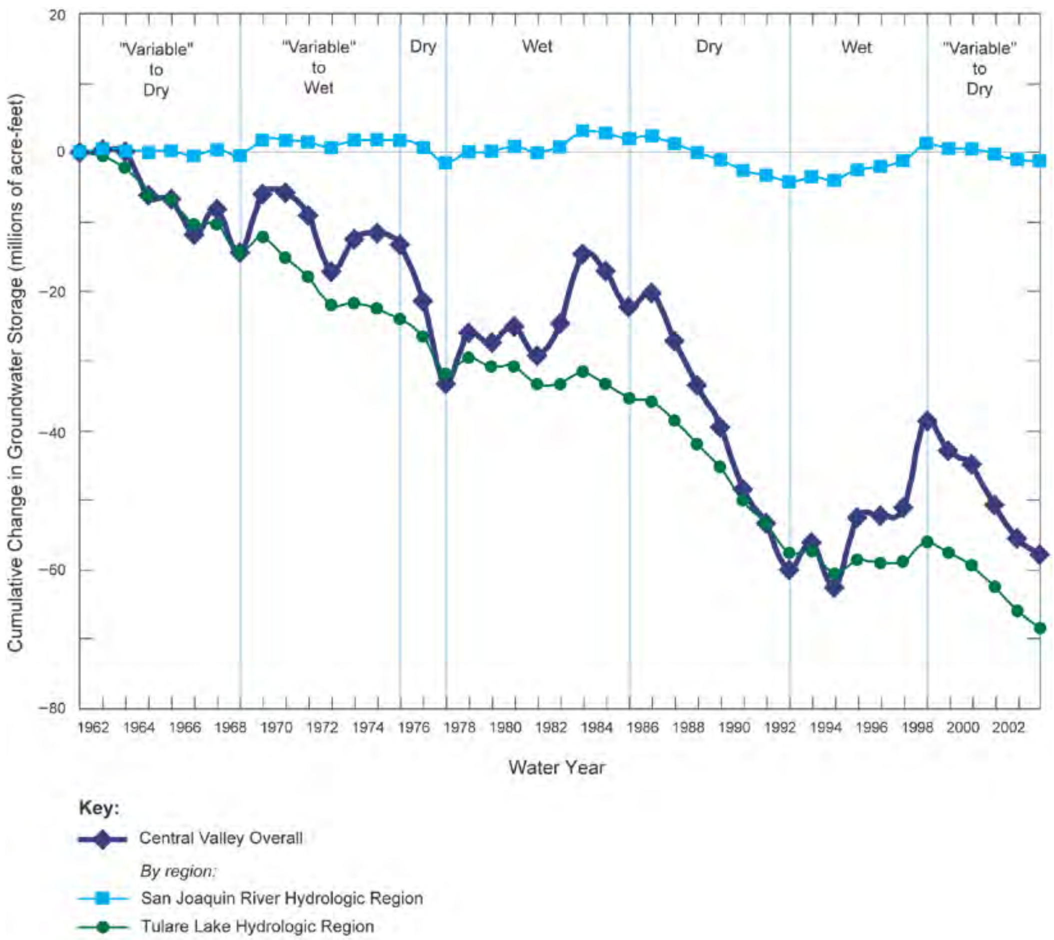
Groundwater Storage and Production

The following sections describe historical and existing groundwater storage and production conditions in the San Joaquin River Hydrologic Region.

Groundwater Storage Using the Central Valley Hydrologic Model (CVHM), the USGS simulated historical cumulative change in groundwater storage in the Central Valley, including the San Joaquin River and Tulare Lake hydrologic regions (see Figure 13-4) (Faunt 2009). Groundwater storage in the San Joaquin Valley reached a low point in 1978 in response to the 1976-through-1977 drought. However, by the early 1980s, groundwater storage had returned to pre-drought conditions. Groundwater storage declined again as a result of the drought from 1987 through 1992, which resulted in continued declines in groundwater storage in 1991 and 1992 to levels lower than recorded during the previous low in 1978. Results from the USGS CVHM study of simulated annual recharge and discharge between 1962 and 2003 indicate an estimated net loss of 57.7 MAF from aquifer storage in the Central Valley (Faunt 2009). Table 13-1 presents the net changes in groundwater storage for Water Years 1998 through 2005 (DWR 2009).

Analysis of data from the Gravity Recovery and Climate Experiment satellite mission from October 2003 to March 2010 indicates a 20.3 cubic kilometer (approximately 16.5 MAF) loss of groundwater storage in the Central Valley (Sacramento and San Joaquin river basins, including the Tulare Basin) (Famiglietti et al. 2011).

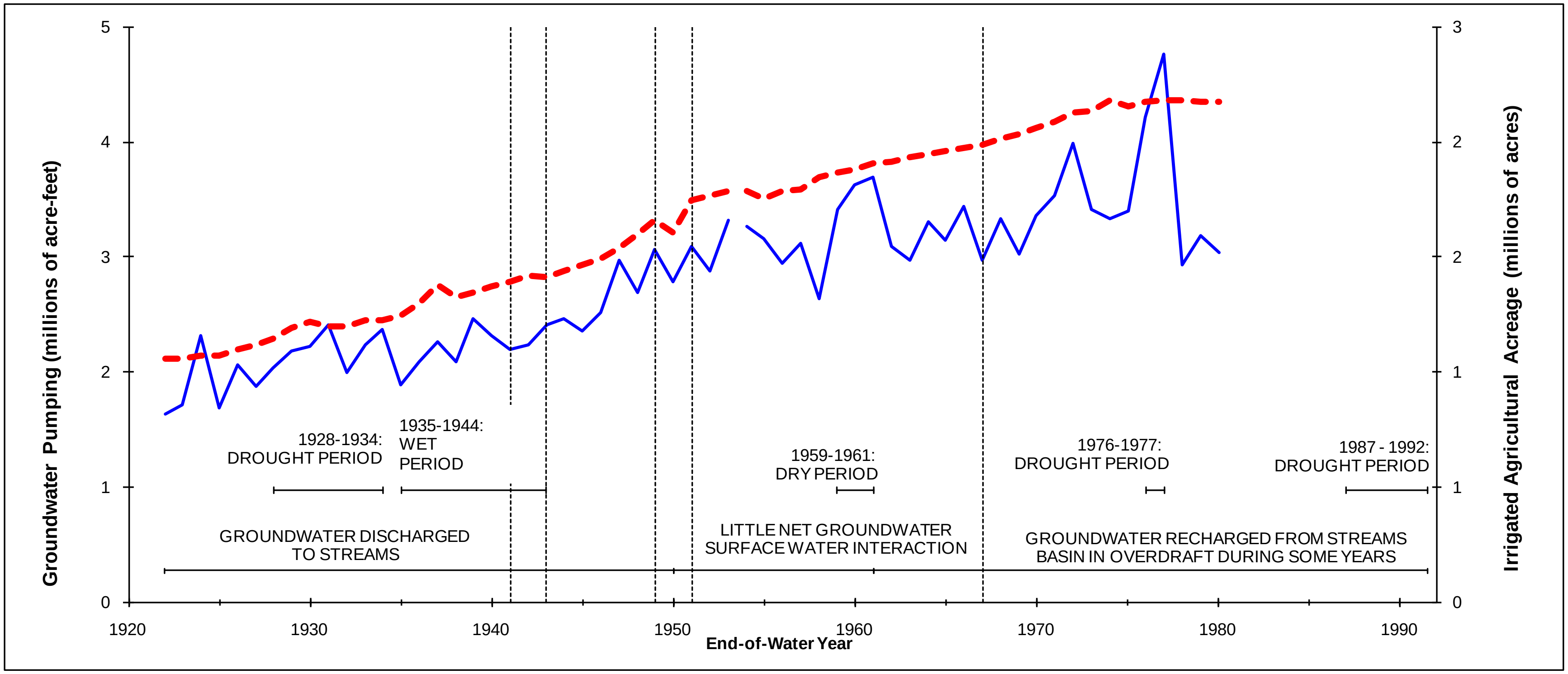
For the San Joaquin River Hydrologic Region, DWR Bulletin 160-93 estimated the available groundwater storage capacity to be 24 MAF. DWR’s definition of usable storage capacity is based on aquifer properties (i.e., permeability), groundwater quality, and economic considerations such as the cost of well drilling and energy costs (DWR 1994). DWR Bulletin 160-93 defined perennial yield as “…the amount of groundwater that can be extracted without lowering groundwater levels over the long-term" and determined perennial yield to be 3.3 MAF (DWR 1994). This estimated perennial yield is directly dependent on the amount of recharge received by the groundwater basin, which can change over time.



Source: Faunt 2009

Figure 13-4. Simulated Cumulative Change in Groundwater Storage by Water Year for the Central Valley and San Joaquin River and Tulare Lake Hydrologic Regions from 1962 Through 2003

Groundwater Production Figure 13-5 illustrates the close correlation between increasing agricultural acreage and increasing groundwater production in the San Joaquin River Hydrologic Region from 1922 through 1980 using data developed as part of the Central Valley Ground-Surface Water Model (GSM) (Reclamation et al. 1990b). Table 13-2 highlights the timeline of events that have affected groundwater production in the San Joaquin River Hydrologic Region for the period shown in Figure 13-5.The data presented in Figure 13-5 extend through 1980; however, a recent study by USGS (Faunt 2009) reports simulated groundwater pumping for the whole Central Valley using CVHM from 1962 through 2003, as illustrated in Figure 13-6.



Source: Reclamation 1997

Note:

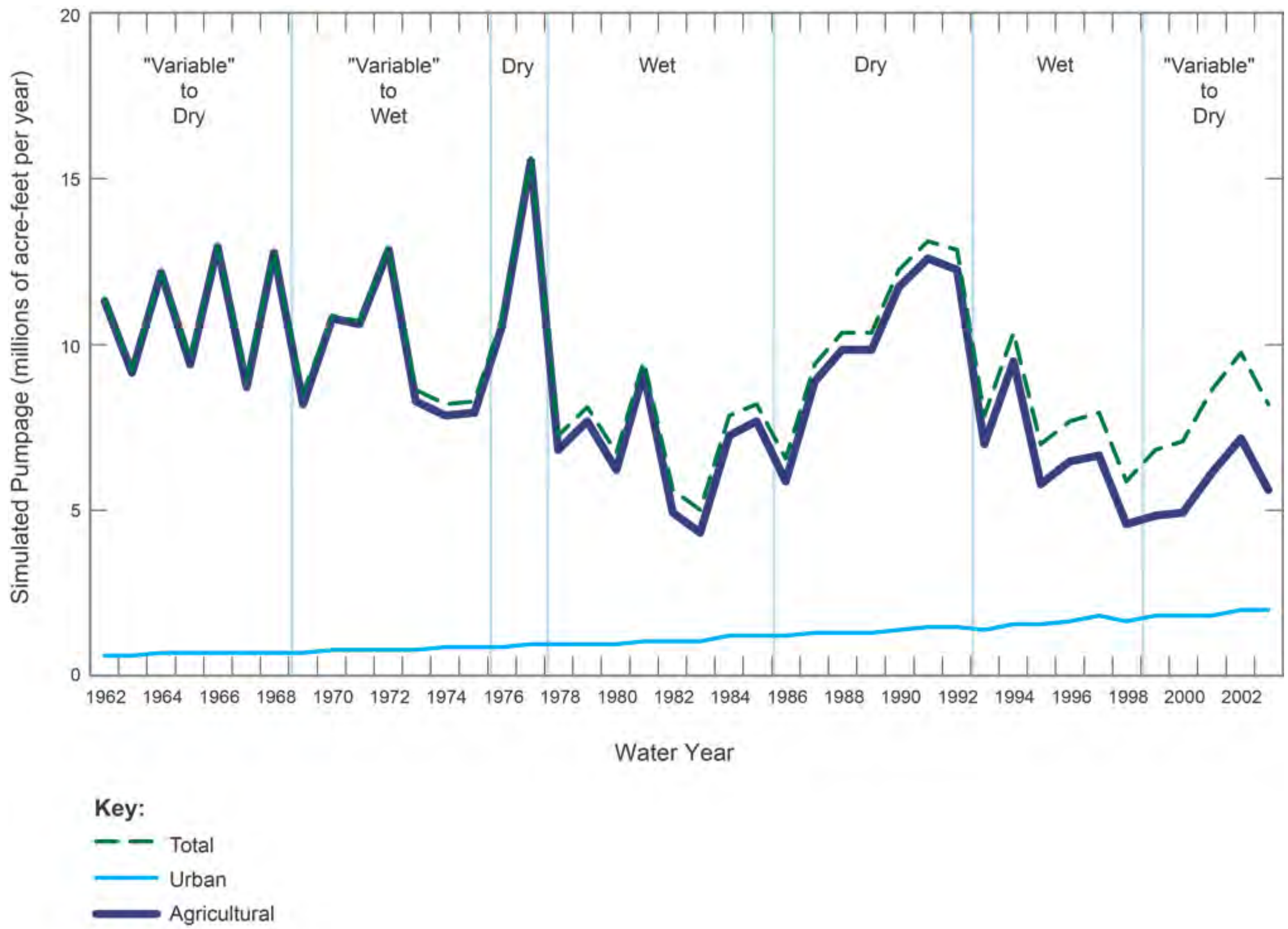
Data available for 1922 through 1980. Data developed as part of the Central Valley Ground-Surface Water Model (Reclamation et al. 1990b).

Legend:

Irrigated Agricultural Acreage

Groundwater Pumping

Figure 13-5. Historical Annual Groundwater Pumping and Irrigated Agricultural Acreage for San Joaquin River Hydrologic Region from 1922–1980



Source: Faunt 2009

Figure 13-6. Simulated Groundwater Pumping in Central Valley from 1962–2003

Table 13-2. Timeline of Historical Events Affecting Groundwater Production in the San Joaquin River Hydrologic Region

Date	Historical Event
1928–1934	Drought Period
1935–1944	Wet Period
1941	Friant Dam Online
1943	Madera Canal Online
1949	Friant-Kern Canal Online
1951	Delta-Mendota Canal Online
1967	San Luis Dam/Canal Online
1967	California Aqueduct Online
1967	Oroville Dam Online
1976–1977	Drought Period
1987–1992	Drought Period

The groundwater pumping data presented in Figure 13-5 are based on estimated pumping, water demands, and historical surface water supplies. The agricultural acreage data used in the analysis were based on DWR estimates developed as part of depletion studies. Annual groundwater pumping in the San Joaquin Hydrologic Region from 1922 through 1980 ranged between 1.6 MAF in 1922 and 4.7 MAF in 1977. Groundwater pumping in the San Joaquin Hydrologic Region and the whole Central Valley rose steadily through the 1970s, but varied greatly depending on hydrologic conditions, and reached a peak during the 1976-through-1977 drought period. Hydrologic conditions for the years immediately following the drought (1978, 1979, and 1980) were relatively wet, which allowed for a reduction in pumping following the drought period because more surface water was available.

As illustrated in Figure 13-6, reduced surface water deliveries and critically dry hydrologic conditions during the 1987-through-1992 drought period also resulted in increased pumping in the 1990s. In 1990, an estimated 3.5 MAF of groundwater were pumped from the San Joaquin River Hydrologic Region. The groundwater pumped from the region in 1990 exceeded the estimated perennial yield by approximately 200 TAF (DWR 1994). Groundwater extractions in the San Joaquin Valley during the first 5 years of the 1987-through-1992 drought exceeded recharge by 11 MAF, causing land subsidence in some areas (DWR 2005b). All of the subbasins in the San Joaquin River Hydrologic Region experienced some overdraft (DWR 1994). Groundwater overdraft describes the condition of a basin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years during which water supply conditions approximate average conditions (DWR 2005b). At a 1995 level of development, annual average groundwater overdraft was estimated at about 240 TAF in the San Joaquin River Hydrologic Region (DWR 1998).

Although a comprehensive assessment of overdraft in California's subbasins has not been completed since 1980, the *California Water Plan Update 2009* reports that three of the subbasins in the San Joaquin River Hydrologic Region (Chowchilla, Eastern San Joaquin, and Madera) are in critical overdraft conditions (DWR 2009).

Following the 1987-through-1992 drought, USGS simulated a reduction in groundwater pumping in the Central Valley during a Wet hydrologic period from 1993 through 1998 (Faunt 2009). Groundwater pumping in the Central Valley began to increase in 1998 at the start of a variable to Dry hydrologic period, as illustrated in Figure 13-6.

Typical production in the subbasins in the San Joaquin River Hydrologic Region is shown in Table 13-3 (DWR 1998, 2003). Burt developed estimates of gross irrigation well pumping for some of the Friant Division contractors for 1987 through 2003 (Burt 2005). Gross irrigation well pumping is not equivalent to net groundwater extraction volumes because inefficiencies associated with pumping a groundwater well are not accounted for with this estimation method. In the San Joaquin River Hydrologic Region, Burt estimated gross groundwater pumping for the Chowchilla Water District (WD), Gravelly Ford WD, and Madera ID (2005). Information was not available for other Friant Division contractors in the San Joaquin River Hydrologic Region, including Fresno County Water Works No. 18 and Hidden Lakes Estates. Table 13-4 summarizes average annual gross groundwater pumping by some Friant Division contractors, as described above.

Table 13-3. Typical Annual Groundwater Production in San Joaquin River Hydrologic Region

Subbasin	Extraction (TAF/year)
Chowchilla	260
Delta-Mendota	510
Madera	570
Merced	560
Modesto	230
Turlock	450

Source: DWR 1998 and 2003
Key:
TAF = thousand acre-feet

Table 13-4. Average Annual Gross Groundwater Pumping for Friant Division Contractors in San Joaquin River Hydrologic Region

District	Average Gross Groundwater Pumping (TAF/year) 1987–1992	Average Gross Groundwater Pumping (TAF/year) 1987–1999	Average Gross Groundwater Pumping (TAF/year) 1987–2003
Chowchilla WD	137	104	107
Gravelly Ford WD	25	20	20
Madera ID	215	157	165

Source: Burt 2005
Key:
ID = Irrigation District
TAF = thousand acre-feet
WD = Water District

Estimates of gross groundwater pumping for Friant Division long-term contractors in Table 13-4 potentially overestimate actual groundwater pumping, but no historical pumping records were publicly available to validate the estimates. Because these estimates are based on cropping patterns, changes to the crops in production could result in changes to gross groundwater pumping estimated in more recent years.

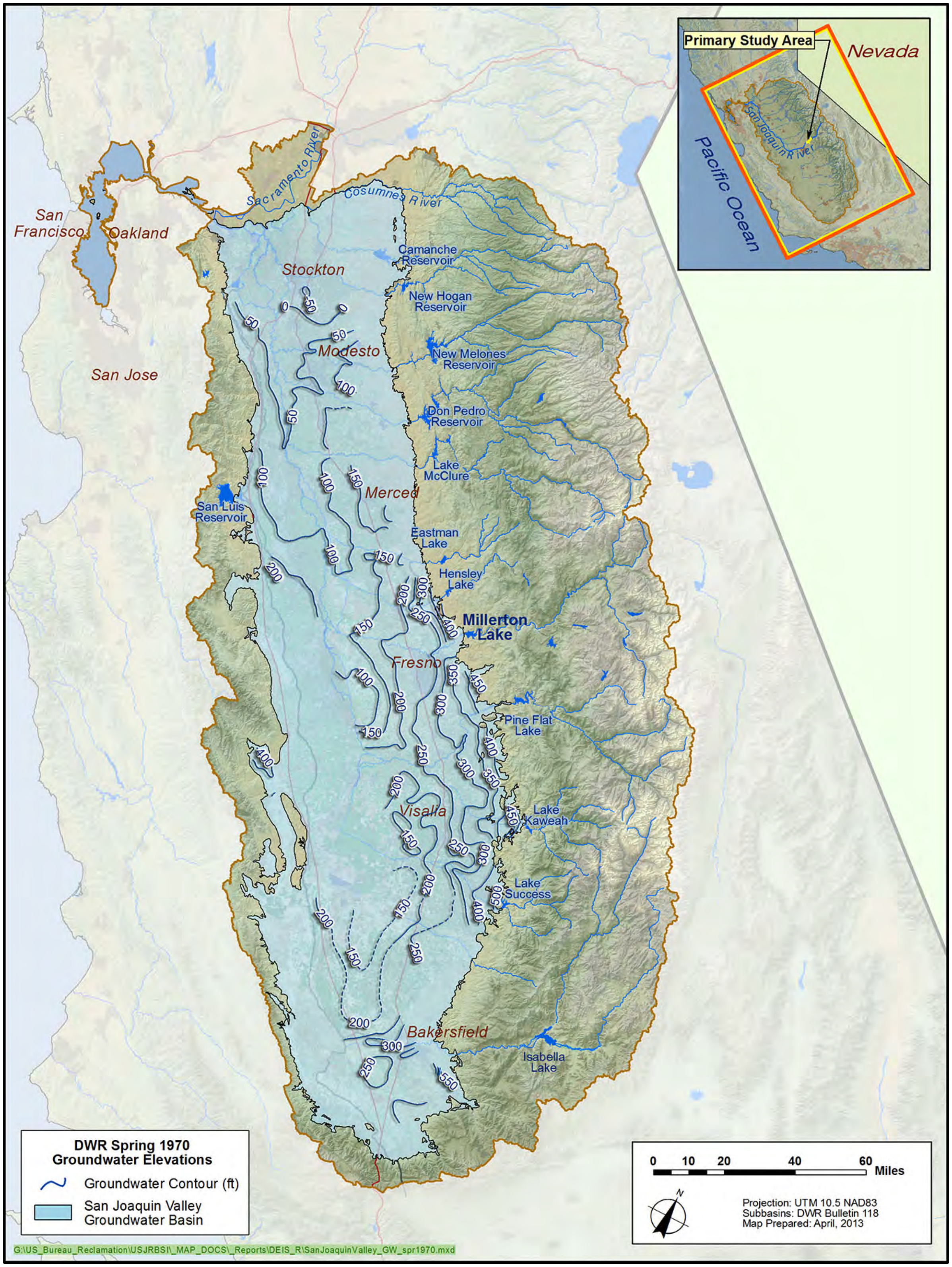
Groundwater Levels

Between 1920 and 1950, expansion of agricultural practices caused declines in groundwater levels in many areas of the San Joaquin River Hydrologic Region. Along the east side of the region, declines have ranged between 40 and 80 feet since predevelopment conditions (estimated conditions for 1860) (Williamson et al. 1989). Groundwater levels declined substantially in Chowchilla, Madera, western Kings, Pleasant

Valley, Tule, and Kern counties, which depended heavily on groundwater for irrigation (Williamson et al. 1989). However, in 1950, the Friant-Kern Canal began delivering surface water to part of the eastern side of the San Joaquin Valley and, as a result, water-level declines reversed because of the decrease in groundwater pumping (Williamson et al. 1989).

Beginning in the 1940s, water levels declined along the west side of the San Joaquin River Hydrologic Region, dropping more than 30 feet by 1960. Groundwater levels in deeper wells drilled into the confined aquifer of northwestern Fresno County were recorded as ranging from 200 feet below msl to sea level in spring 1960 (reported by Reclamation 1997). Groundwater levels in this area were recorded as ranging between 200 feet and 100 feet below msl by spring 1970. In central San Joaquin County, groundwater levels reached 50 feet below msl in spring 1970, which led to saline groundwater intrusion problems for the City of Stockton (Reclamation 1997). Pre-drought groundwater levels in spring 1970 in the San Joaquin River and Tulare Lake hydrologic regions are presented in Figure 13-7.

Beginning in 1967, surface water from the California Aqueduct became the primary source of irrigation supply to the area south of Mendota, replacing groundwater as the primary source (Belitz and Heimes 1990). Groundwater levels in the unconfined-to-semiconfined aquifer were impacted by drought conditions that occurred in 1976 and 1977, and were lower between spring 1970 (Figure 13-7) and spring 1980, but had recovered to near pre-drought levels by the end of 1980 (Reclamation 1997). The decrease in groundwater pumping allowed time for the confined aquifer to recover from extensive pumping. Between 1967 and 1984, the hydraulic head in the confined aquifer rose between 200 and 300 feet along the western boundary of the Study Area in Fresno County (Belitz and Heimes 1990). The confined aquifer groundwater levels in northwestern Fresno County and western Merced County increased up to 100 feet by spring 1980.



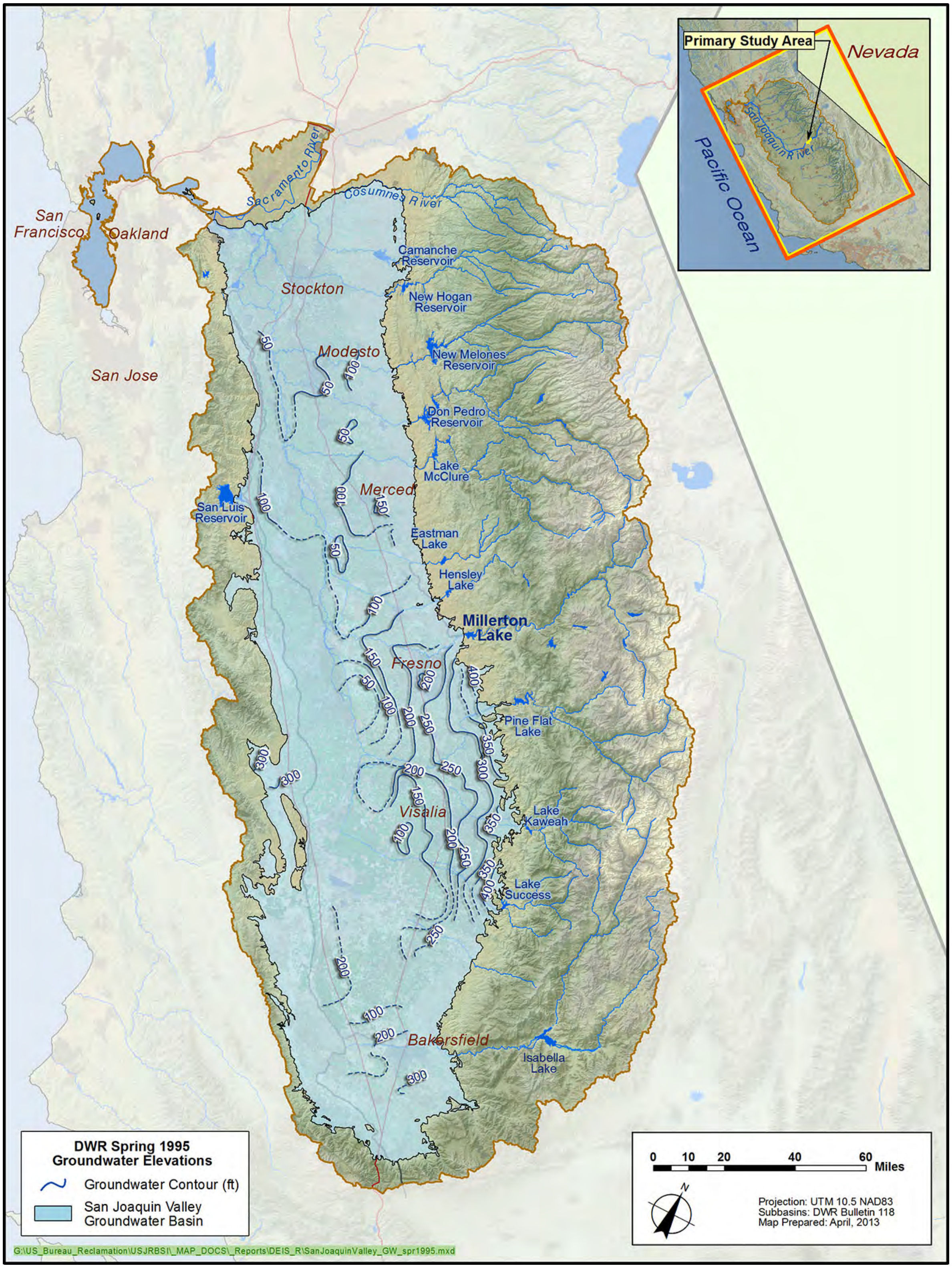
Source: DWR 2007b

Figure 13-7. Groundwater Elevations in Spring 1970, San Joaquin Valley Groundwater Basin

During the drought of the late 1980s and early 1990s (1987 through 1992), surface water deliveries to WDs in the San Joaquin Valley were substantially lower than water demands , resulting in increased groundwater pumping of the unconfined-to-semiconfined and confined units of the aquifer system in the San Joaquin Valley Groundwater Basin (Groundwater Management Technical Committee 1999, Reclamation 1997). A regional response to the drought was evident in the basin, with water levels in the central and eastern portions declining by 20 to 30 feet (Westlands WD 1995). Following the drought, groundwater depression areas were present on the east side of the San Joaquin River Hydrologic Region in Merced and Madera counties, where groundwater was less than 50 feet above msl. Groundwater levels declined on the eastern side of the San Joaquin River Hydrologic Region until 1995 (DWR 2003).

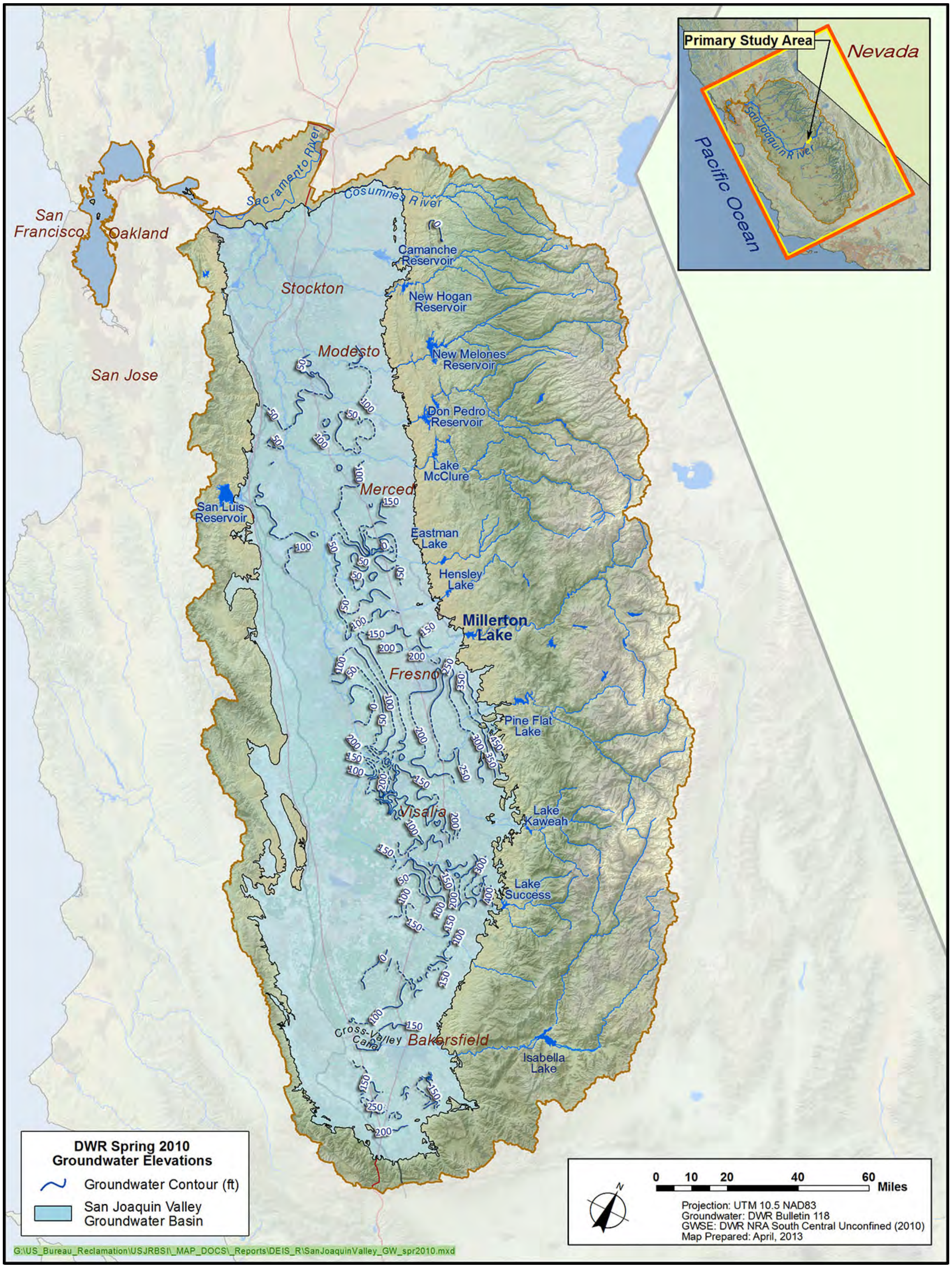
Post-drought conditions in the basin in 1995 are presented in Figure 13-8. The groundwater contours illustrated in Figure 13-8 depict groundwater elevations in the unconfined-to-semiconfined aquifers of the San Joaquin Valley Groundwater Basin.

Figure 13-9 presents the most recent (spring 2010) publically available groundwater-level conditions in the San Joaquin River and Tulare Lake hydrologic regions, as reported by DWR (DWR 2012). These groundwater contours illustrate groundwater elevations in the unconfined to semiconfined aquifers of the San Joaquin Valley. The groundwater elevations indicate that the San Joaquin Valley Groundwater Basin had substantially recovered from the previous drought (1987 through 1992). Table 13-5 summarizes the ranges in groundwater elevations in the unconfined aquifer reported on the groundwater basin contour maps available on the DWR Web site.



Source: DWR 2007c

Figure 13-8. Groundwater Elevations in Spring 1995, San Joaquin Valley Groundwater Basin



Source: DWR 2012

Figure 13-9. Groundwater Elevations in Spring 2010, San Joaquin Valley Groundwater Basin

Table 13-5. Spring 2010 Unconfined Aquifer Contour Map Groundwater Elevations in Subbasins of San Joaquin River Hydrologic Region

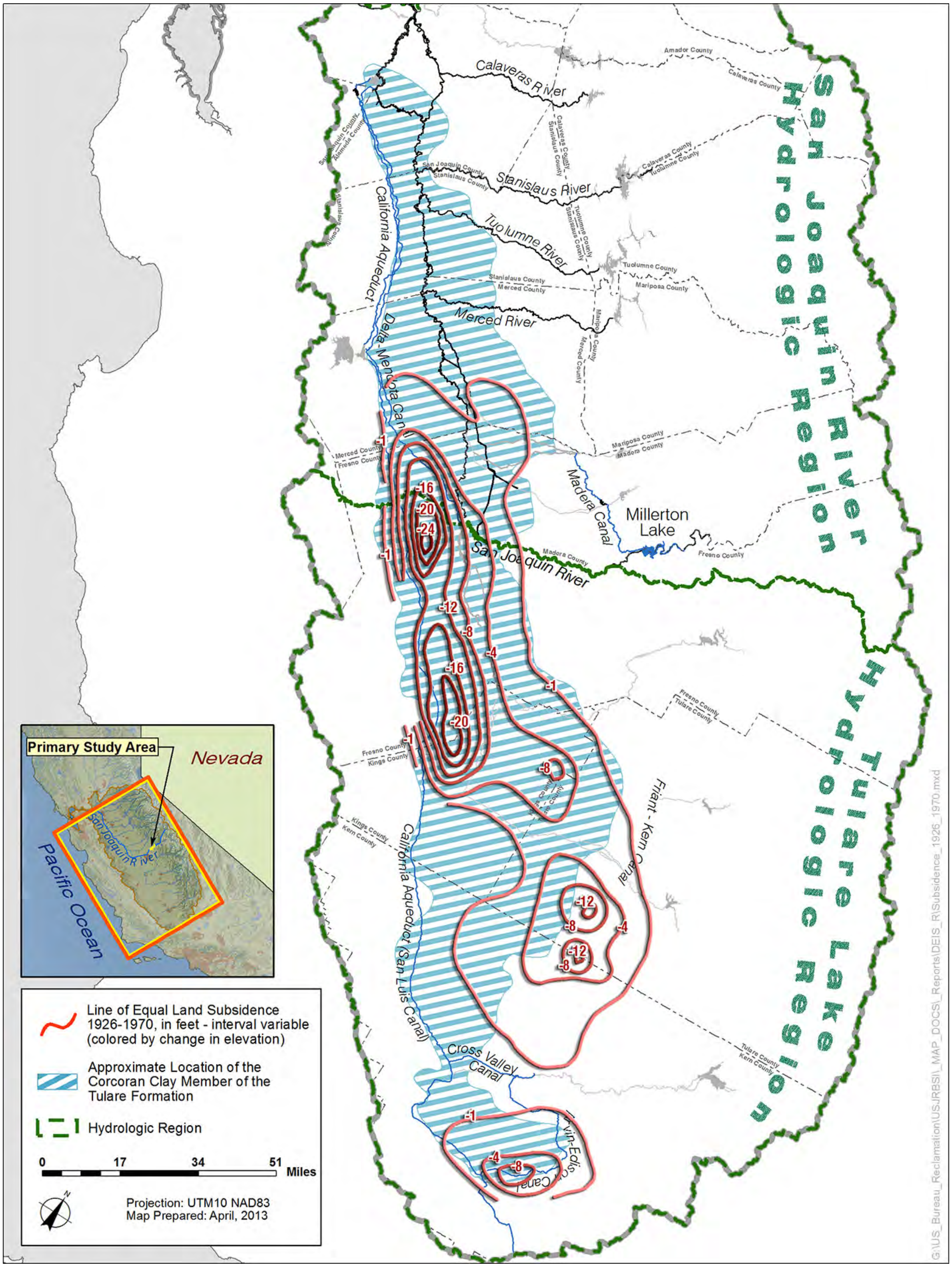
Subbasin	Range in Groundwater Elevations (feet above msl)	
Chowchilla	10	130
Delta-Mendota	30	130
Madera	10	200
Merced[1]	0	170
Modesto[2]	30	120
Turlock	20	110

Source: DWR 2012
Notes:
[1] Elevations generally increased from west to east towards the Sierra Nevada, with localized cones of depression.
[2] Elevations increased from west to east towards the Sierra Nevada.
Key:
msl = mean sea level

Land Subsidence

Four types of land subsidence occur in the San Joaquin Valley: aquifer-system compaction due to groundwater-level decline, near-surface hydrocompaction, subsidence due to fluid withdrawal from oil and gas fields, and subsidence caused by deep-seated tectonic movements (Ireland et al. 1984). The first two types are the primary causes of subsidence in the region; therefore, the latter two types of subsidence are not discussed below (subsidence due to tectonic movement is discussed in Chapter 11, “Geology and Soils”). Land subsidence contours in the San Joaquin River and Tulare Lake hydrologic regions from 1926 through 1970 are shown in Figure 13-10.

Aquifer-System Compaction Groundwater-level decline resulting in compaction of aquifer sediments has been one of the primary causes of land subsidence in the San Joaquin Valley Groundwater Basin. In the mid-1920s, land subsidence began to occur as a result of increased groundwater pumping for irrigation of crops (Ireland 1986). By the mid-1970s, the maximum land subsidence in the San Joaquin Valley Groundwater Basin exceeded 28 feet (Poland et al. 1975). The decline in groundwater levels in the Central Valley caused at least 1 foot of land subsidence across more than 5,200 square miles, affecting nearly half of the irrigated land in the San Joaquin River and Tulare Lake hydrologic regions by 1977 (Ireland 1986). The most seriously affected areas were located in the southern and western parts of the Central Valley.



Source: Williamson et al. 1989

Figure 13-10. Land Subsidence in the San Joaquin River and Tulare Lake Hydrologic Regions from 1926 to 1970

In the late 1960s and early 1970s, surface water was imported via canals, and the California Aqueduct began importing supplies to the subsiding areas, reducing groundwater pumping and reducing new land subsidence in the western and southern portions of the San Joaquin Valley Groundwater Basin (Ireland 1986). However, drought conditions during 1976 and 1977 resulted in high groundwater pumping rates, inducing land subsidence in areas where it had been observed previously. Significant land subsidence was detected again in the San Joaquin Valley Groundwater Basin due to increased groundwater pumping during the 1987-through-1992 drought. Land subsidence was also reported between 1984 and 1996 along the DMC. Subsidence in this area affected operations of the Mendota Dam and Sack Dam and, consequently, the conveyance of flows in the San Joaquin River (Sneed et al. 2013). Land subsidence measured by DWR between 1990 and 1995 of up to 2 feet was reported along the California Aqueduct in Westlands WD (Reclamation 1997). Land subsidence in the San Joaquin River and Tulare Lake hydrologic regions occurred primarily in western Fresno County, but extended from Merced County to Kings County. Maximum land subsidence levels in the Central Valley were recorded in this area of the San Joaquin Valley Groundwater Basin. In parts of northwestern Fresno County, land subsidence levels as great as 30 feet have been measured (Ireland et al. 1984).

Because of the slow drainage of fine-grained deposits, subsidence at a particular time is typically more closely related to past groundwater-level changes than to current change. In the San Joaquin Valley Groundwater Basin, groundwater extraction increased until large amounts of surface water were imported through various canals. Although water levels in the area started to rise, the rate of subsidence began to decrease 3 years after the groundwater levels began to recover (Reclamation 1997).

Recent changes in groundwater use within the extended study area are thought to have caused subsidence between the Eastside Bypass and San Joaquin River near Sack Dam. SLCC reported subsidence of Sack Dam at rates exceeding 0.5 feet per year, as well as a cumulative subsidence of approximately 4.5 feet along the Eastside Bypass from 2008 to 2013 (SLCC 2013). Both CCID and SLCC are working with growers in the western portion of Madera County to develop potential solutions to subsidence in those areas that directly impact Sack

Dam and other physical infrastructure (Exchange Contractors 2013 and CCID 2012).

A 2013 study by the USGS that examined the period from 2003 to 2010 found a large subsidence feature centered south of the town of El Nido (Sneed et al. 2013). The feature, defined by the area experiencing 0.06 feet (20 millimeters) or more of subsidence, extended 50 miles (80 kilometers) east to west (from Check 17 on the DMC to the town of Madera) and 25 miles (40 kilometers) north to south (from near Merced to near Mendota). According to the study, a maximum 1.77 feet (540 millimeters) of subsidence was observed during 2008 to 2010.

Near-Surface Hydrocompaction Hydrocompaction occurs when moisture-deficient deposits, which can be unconsolidated, porous semiarid, or arid, lose strength after wetting. The wetting process results in a decrease in volume and an increase in density, which occur when dry deposits become wet and spontaneously slump, crack, or collapse (Prokopovich undated). A few areas, totaling about 210 square miles, on the western and southern ends of the San Joaquin Valley have been affected by near-surface hydrocompaction (Williamson et al. 1989). Subsidence in these areas has been reported to be from 5 to 15 feet (Poland and Evenson 1966).

Groundwater Quality

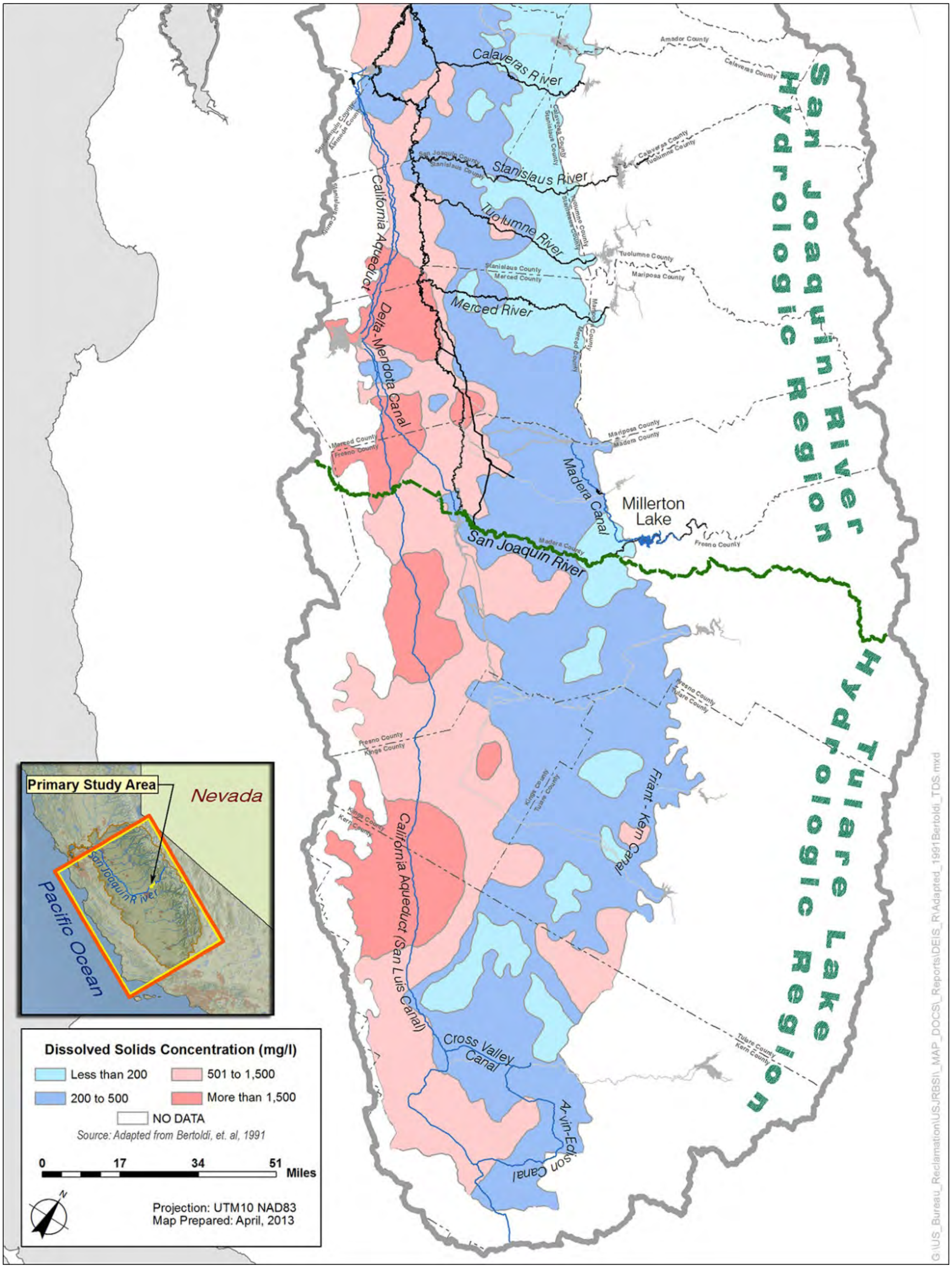
Groundwater quality in the San Joaquin Valley Groundwater Basin varies considerably. In general, groundwater quality is suitable for most urban and agricultural uses, with the exception of localized problematic areas in the San Joaquin River Hydrologic Region (DWR 2003). Primary constituents of concern include total dissolved solids (TDS), boron, chloride, nitrates, arsenic, selenium, dibromochloropropane (DBCP), radon, and uranium, which are discussed in this section

Detailed groundwater quality studies have been conducted sporadically on a localized scale, often as a result of regulatory requirements, throughout the San Joaquin Valley Groundwater Basin. USGS released groundwater quality data collected as part of the Groundwater Ambient Monitoring Assessment (GAMA) program for the Northern San Joaquin Basin GAMA and the Central Eastside San Joaquin Basin GAMA study areas (USGS 2005). The Northern San Joaquin Basin GAMA study area includes the Tracy, Eastern San Joaquin, and Cosumnes subbasins, and the USGS defined Uplands area including portions of the Cosumnes and Eastern San Joaquin subbasins (Bennett et al. 2006). The Central Eastside San Joaquin Basin

GAMA study area includes the Modesto, Turlock, and Merced subbasins, which are located in Stanislaus and Merced counties (Landon and Belitz 2008). In the future, greater quantitative and qualitative regional groundwater quality understanding is anticipated for the remaining areas of both the San Joaquin River Hydrologic Region and the Tulare Lake Hydrologic Region through use of USGS GAMA data.

Total Dissolved Solids TDS concentrations vary considerably throughout the San Joaquin River Hydrologic Region but, in general, concentrations are highest along the west side of the region. These higher concentrations are a result of recharged streamflow originating from marine deposits in the west, and the concentration of salt due to evaporation and poor drainage in the center of the hydrologic region (DWR 2003). On the west side of the Central Valley, TDS concentrations generally exceed 500 mg/L, and are in excess of 2,000 mg/L along portions of the western margin of the valley (Bertoldi et al. 1991). Figure 13-11 illustrates TDS concentrations in the entire Central Valley Groundwater Basin. TDS concentrations above the secondary maximum contaminant level (MCL) of 500 mg/L have been reported in the Tracy, Merced, Modesto, and Turlock subbasins (Bennett et al. 2006, Landon and Belitz 2008).

Boron Boron is an essential micronutrient found at low concentrations in irrigation water (Bertoldi et al. 1991). However, boron is toxic to most crops at concentrations exceeding 4.0 mg/L (Bertoldi et al. 1991). Boron concentrations above the California Department of Public Health (CDPH) notification limit (NL) of 1,000 micrograms per liter (µg/L) have been documented in the northwestern portion of the San Joaquin River Hydrologic Region in the Tracy Subbasin, extending from the northernmost edge of the valley west of the San Joaquin River to the Kings-Fresno county line (Bertoldi et al. 1991, DWR 2003, Landon and Belitz 2008). DWR reported that it has identified localized areas with “high” concentrations of boron in the Delta-Mendota, Modesto, and Turlock subbasins (DWR 2003).



Source: Adapted from Bertoldi et al. 1991

Figure 13-11. Total Dissolved Solids Concentrations in Central Valley Groundwater Basin

Chloride Chloride concentrations can be toxic to crops typically at concentrations higher than 700 mg/L. However, salinity usually is the primary toxin to plants before chloride alone reaches toxic levels. In the northwest and north-central portion of the San Joaquin River Hydrologic Region, along the course of the San Joaquin River and adjacent lowlands, chloride concentrations are typically highest. High chloride in shallow groundwater is predominantly caused by an upward flow of saline-concentrated groundwater (Bertoldi et al. 1991). DWR reported that areas of elevated chloride concentrations have been identified in localized areas of the Tracy, Modesto, Turlock, Merced, Chowchilla, and Madera subbasins (DWR 2003). Chloride concentrations have been reported above the secondary MCL of 250 mg/L in the Modesto and Tracy subbasins (Landon and Belitz 2008, Bennett et al. 2006).

Nitrates Nitrates are prevalent typically in shallow, younger groundwater throughout the San Joaquin River Hydrologic Region as a result of disposal of human and animal waste products and fertilizers. Higher nitrate concentrations, ranging from 5 to 30 mg/L, may adversely affect select crops. The MCL for nitrate in drinking water is 10 mg/L. Elevated concentrations of nitrate have been reported in the Tracy, Delta-Mendota, Modesto, Turlock, Merced, Chowchilla, and Madera subbasins (DWR 2003). Nitrate concentrations have been reported above the MCL in the Merced, Modesto, and Turlock subbasins (Landon and Belitz 2008). One recent study tracking historical nitrogen balances suggests that major reductions in nitrogen loadings from California agriculture will be required to safeguard groundwater quality (Rosenstock et al. 2014).

Arsenic Arsenic is widely detected and naturally occurring in the San Joaquin Valley deposits (Burrow et al. 2004, Izbicki et al. 2008). Arsenic concentrations have been reported above the MCL of 10 µg/L in the Merced, Turlock, Modesto, Eastern San Joaquin, and Tracy subbasins (Bennett et al. 2006, Landon and Belitz 2008).

Selenium In the southwestern portion of the San Joaquin River Hydrologic Region, selenium can be found as a naturally occurring element in soils and groundwater, and is considered nontoxic to humans and animals below the MCL of 0.05 mg/L. However, the southwestern portion of this hydrologic region has been the subject of extensive selenium studies because of the high rate of waterfowl mortality and embryo malformations in birds nesting in selenium-enriched drainage areas. A median concentration of 10 to 11 mg/L was highest in the central and southern parts of the hydrologic region (south of Los Banos and south of Mendota) (Bertoldi et al. 1991).

Dibromochloropropane The most notable agricultural groundwater contaminant in the hydrologic region is DBCP. DBCP is a soil fumigant and known carcinogen that is now banned, but was extensively used on grapes and cotton (DWR 2003). The presence of this pesticide coincides with agricultural land-use patterns and is prevalent in groundwater at levels above 0.0005 mg/L north of Merced and Stockton. DBCP is typically observed in shallow, younger groundwater recharged after 1980 in areas occupied by orchards and vineyards, where DBCP was commonly used (Bertoldi et al. 1991). DBCP has been reported above the MCL of 0.0002 mg/L in the Merced, Turlock, Cosumnes, and Eastern San Joaquin subbasins (Bennett et al. 2006, Landon and Belitz 2008). DWR reported that elevated concentrations of DBCP have also been found in localized areas in the Modesto and Madera subbasins (DWR 2003).

Radon Radon, a naturally occurring radioactive element, has received more attention in recent years because of adverse health effects documented in human occupancy areas, such as basements or cellars. No current water quality standards exist for this element; however, the proposed MCL for radon-222 is 300 picocuries per liter (pCi/L). Radon concentrations have been reported above the proposed MCL in the Merced, Modesto, Turlock, Eastern San Joaquin, and Tracy subbasins (Bennett et al. 2006, Landon and Belitz 2008).

Uranium Uranium is naturally occurring in the eastern San Joaquin Valley, having been derived from granitic rocks of the Sierra Nevada. Uranium concentrations in groundwater have exceeded Federal and State drinking water standards in the eastern San Joaquin Valley for the last 20 years. Uranium concentrations have been reported above the MCL, 20 picocuries per liter, with most of the reports of exceedance of the MCL within Modesto, Fresno, and Bakersfield (Jurgens et al. 2009).

Agriculture Subsurface Drainage

Inadequate drainage and salt accumulation have been persistent problems for irrigated agricultural lands along the west side and in parts of the east side of the San Joaquin River Hydrologic Region for more than a century. The most extensive problems exist on the west side of the San Joaquin

River and Tulare Lake hydrologic regions. The drainage problems developed as a result of imported water from human-made infrastructure, naturally occurring saline soils, and distinctive geology that prevents natural drainage.

Soils on the west side of the San Joaquin River Hydrologic Region are derived from marine sediments that make up the Coast Ranges and are high in salts and trace elements. Irrigation of these soils has mobilized salts and trace elements and facilitated their movement into the shallow groundwater. Much of the irrigation has been with imported water, which has resulted in inadequate drainage, rising groundwater, and increasing soil salinity. Where agricultural drains have been installed to control rising water tables, drainage water frequently contains high concentrations of salts and trace elements (Reclamation et al. 1990a). Events affecting drainage conditions on the west side of the San Joaquin Valley are described in Table 13-6.

Subsurface drainage problems extend along the western side of the San Joaquin River and Tulare Lake hydrologic regions from the Delta on the north to the Tehachapi Mountains south of Bakersfield. In some portions of this hydrologic region, natural drainage conditions are inadequate to remove the quantities of deep percolation that accrue to the water table where the upper, semiconfined aquifer is shallow. Therefore, groundwater levels often encroach on the root zone of agricultural crops, and subsurface drainage must be supplemented by constructed facilities for irrigation to be sustained. Present problem areas were defined in the San Joaquin Valley Drainage Program (SJVDP) (DWR 2005a) as locations where the water table is within 5 feet of the ground surface at any time during the year. Potential problem areas were defined in the SJVDP at locations where the water table is between 5 and 20 feet below the ground surface (DWR 2005a). To better understand the problem areas, water-level data were collected, beginning in 1991, from a network of monitoring wells in designated study areas to establish acreage areas of particular depth-to-water intervals (DWR 2005a).

Few wells pump from this shallow depth to groundwater zone because of high salinity concentrations. The term “salinity” is referred to here as the salt content of solutions containing dissolved mineral salts. Salinity is commonly measured as either TDS in parts per million (ppm) or electrical conductivity (EC) in microsiemens per centimeter (µS/cm). Salinity levels in shallow groundwater in the San Joaquin River Hydrologic

Region range from approximately 1,500 to 48,000 µS/cm (DWR 2005a).

Table 13-6. Events Affecting Drainage Conditions on West Side of San Joaquin Valley

Year	Event
1870s	Widespread planting of grain on the western side of the San Joaquin Valley. Crops irrigated with water from the San Joaquin and Kings rivers. Poor natural drainage, rising groundwater, and increasing soil salinity results in the removal or abandonment of farm land in production.
1900–1950	Heavy pumping of groundwater results in overdrafts and widespread land subsidence.
1951	CVP water transported through the Delta-Mendota Canal to irrigate 600,000 acres of land in the northern San Joaquin Valley. This water primarily replaces and supplements San Joaquin River water diverted at Friant Dam to the southern San Joaquin Valley.
1960	SWP authorized. San Luis Unit of the CVP authorized, which mandates construction of an interceptor drain to collect irrigation drainage water and transport it to the Delta. Reclamation's feasibility report for the San Luis Unit describes the drain as an earthen ditch that would drain 96,000 acres.
1962	Reclamation changes plans for the drain to a concrete-lined canal to drain 300,000 acres.
1964	Reclamation adds a regulating reservoir to the drain plans to temporarily retain drainage.
1965	Concerns raised about the potential effects of the discharge of untreated agricultural drainage water in the Delta and San Francisco Bay. A rider added to CVP appropriations act by Congress in 1965 that requires the final point of discharge of the interceptor drain for the San Luis Unit to conform to water quality standards set by California and EPA.
1968	CVP San Luis Unit and the SWP begin delivering water to approximately 1,000,000 acres of agricultural lands in southern San Joaquin Valley. Construction of San Luis Drain begins. Kesterson Reservoir becomes part of a new National Wildlife Refuge managed jointly by Reclamation and USFWS.
Mid-1970	Reclamation decides to use the drainage reservoir to store and evaporate drainage water until the drainage canal to the Delta is completed.
1975	The first phase of Kesterson Reservoir, 85 miles of the main drain, and 120 miles of collector drains completed. Budget and environmental concerns halt work on the reservoir and drain. Reclamation, DWR, and the State Water Board form the SJVDP to find a solution to valley drainage problems. Group recommends completing the drain to a discharge point in the Delta near Chipps Island.
1981	Reclamation begins a special study to fulfill requirements for a discharge permit from the State Water Board.
1983	Selenium poisoning identified as the probable cause of deformities and mortalities of migratory waterfowl at Kesterson Reservoir.
1984	The SJVDP is established as a joint Federal and State effort to investigate drainage and related problems and identify possible solutions.
1985	The Secretary of the Interior halts the discharge of subsurface drainage water to Kesterson Reservoir.
1986	Feeder drains to the San Luis Drain and reservoir plugged.
1988	Kesterson Reservoir closed. Vegetation plowed under and low-lying areas filled. Contamination-related problems similar to Kesterson appear in parts of the Tulare Lake Hydrologic Region. Wildlife deformities and mortalities observed at several agricultural drainage evaporation ponds.
1990	SJVDP submits final report.

Source: Reclamation et al. 1990a.

Key:
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
DWR = California Department of Water Resources
EPA = U.S. Environmental Protection Agency
Reclamation = U.S. Department of the Interior, Bureau of Reclamation
SJVDP = San Joaquin Valley Drainage Program
SWP = State Water Project
State Water Board = State Water Resources Control Board
USFWS = U.S. Department of the Interior, Fish and Wildlife Service

Toxic and potentially toxic trace elements in some soil and shallow groundwater on the western side of the San Joaquin River and Tulare Lake hydrologic regions are also of concern. These trace elements greatly complicate the disposal of subsurface drainage waters. Elements of primary concern are selenium, boron, molybdenum, and arsenic. Selenium is of greatest concern because of the wide distribution and known toxicity of selenium to aquatic animals and waterfowl, and was the only trace element sampled for in 2001 (DWR 2005a). The three areas in the western San Joaquin Valley with the highest concentrations of selenium are (1) alluvial fans near Panoche and Cantua creeks in the central western valley, (2) an area west of the town of Lost Hills, and (3) the Buena Vista Lake bed area (DWR 2005a).

Seepage and Waterlogging

Seepage and waterlogging of crops along the lower reaches of the San Joaquin River have historically been issues. High periodic streamflows and local flooding combined with shallow groundwater near the San Joaquin River, and in the vicinity of its confluence with major tributaries, have resulted in seepage-induced waterlogging damage to low-lying farmland (Reclamation 1997). During flood-flow events, lateral seepage and structural stability issues with existing project and nonproject levees have been identified (RMC 2003, 2007).

In the western portion of the Stanislaus River watershed, groundwater pumping has historically been used to control high groundwater levels and seepage-induced waterlogging conditions. The seepage-induced waterlogging places neighboring crops and farmland at risk and prevents cultivation of the land until summer, placing annual crop production at risk. Concern has been raised that San Joaquin River flows in excess of 16,000 cfs at Vernalis can result in seepage-induced waterlogging damage of adjacent low-lying farmland in the south Delta area (Reclamation 1997).

Conditions that generally govern whether seepage may occur are shown schematically in Figure 13-12, Figure 13-13, and Figure 13-14. Figure 13-12 depicts a condition under which vertical infiltration and lateral seepage could occur into surrounding lands. Figure 13-13, like Figure 13-12, depicts physical characteristics for which vertical infiltration and lateral seepage could occur if soil conditions were favorable, because the surface water elevation in the river is greater than the surrounding ground surface elevation. The conditions illustrated in Figure 13-13 would require site-specific review of the shallow soil conditions beneath the river and along the levees to verify that impermeable features existed that would prevent vertical infiltration and lateral seepage from occurring. Figure 13-14 depicts physical characteristics where lateral seepage would not be expected to occur.

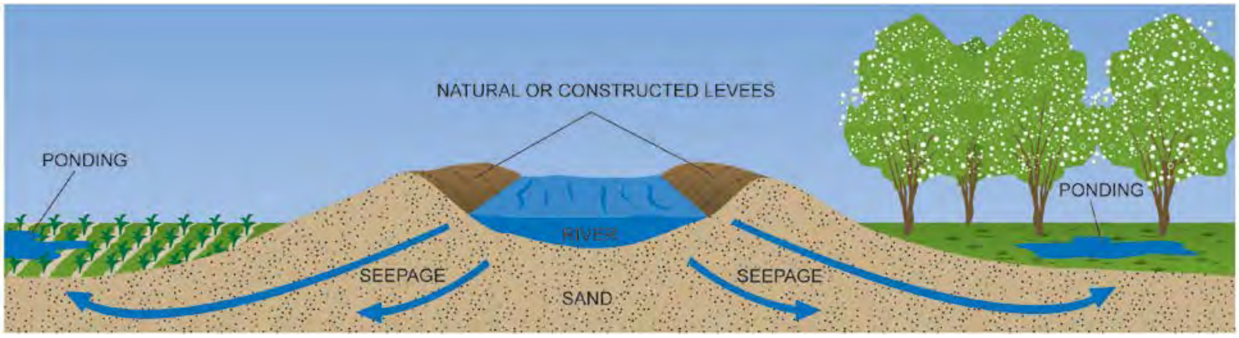


Figure 13-12. River Surface Elevation above Adjacent Land Surface Elevation

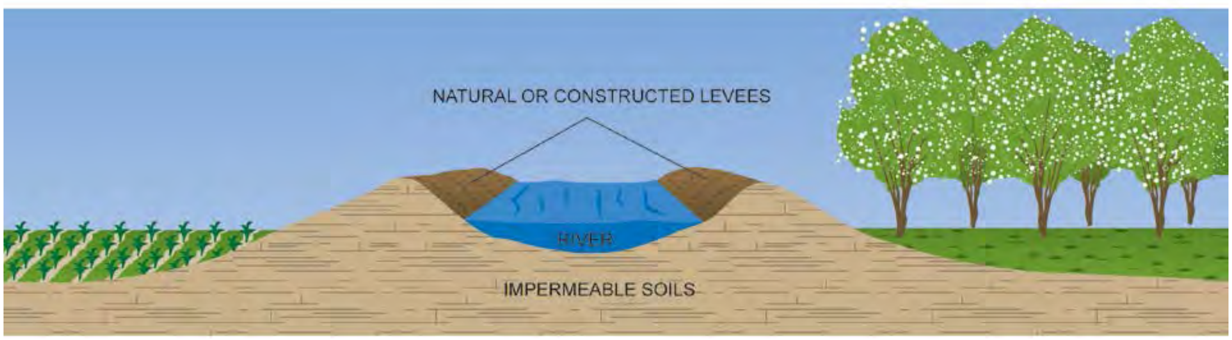


Figure 13-13. Physical Barrier to Subsurface Flow Prevents Seepage

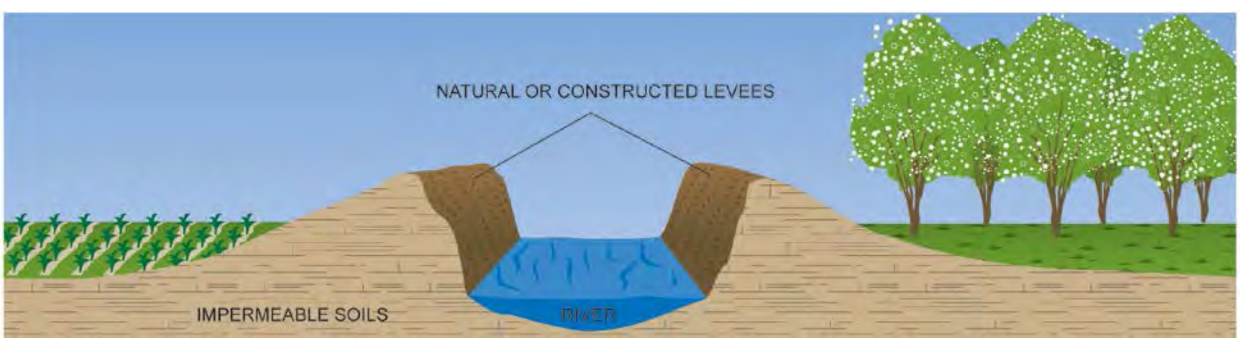


Figure 13-14. River Surface Elevation below Adjacent Land Surface Elevation

Reclamation currently monitors shallow groundwater within the Restoration Area as part of its Seepage Management Plan (SMP) for the SJRRP. The SMP describes Reclamation's monitoring and operating guidelines for reducing Restoration Flows to the extent necessary to address any material adverse impacts caused by Restoration Flows in the San Joaquin River identified by the SJRRP groundwater monitoring program and the prioritization of potential seepage impact areas for projects to increase channel capacity. The SJRRP currently (as of April 9, 2014) monitors over 200 groundwater wells within the Restoration Area; most are screened between 10 feet and 25 feet to monitor shallow groundwater conditions (K. Harrison, personal communication, April 9, 2014). Thresholds for actions to reduce flows are established for each well based primarily on agricultural practices (root zone and capillary fringe) and historical groundwater levels (SJRRP 2013).

Groundwater Resources of Tulare Lake Hydrologic Region

This section describes regional and subbasin hydrogeology, groundwater storage and production, groundwater levels, land subsidence, groundwater quality, agriculture subsurface drainage, and seepage and water-logging in the Tulare Lake Hydrologic Region.

Hydrogeology

The following sections describe regional hydrogeology and subbasin hydrogeology in the Tulare Lake Hydrologic Region.

Regional Hydrogeology Arid conditions and early agricultural development (pre-1900s) in the Tulare Lake Hydrologic Region have caused groundwater-level declines, changes in stream-aquifer dynamics. Under predevelopment conditions, groundwater-surface water interactions were very dynamic and depended on hydrologic conditions. Rapid growth in the agricultural sector in the Tulare Lake Hydrologic Region has resulted in groundwater development with increased groundwater pumping and subsequent groundwater-level declines. In some areas of critical overdraft, such as in Kings and Kern counties, a complete disconnection between groundwater and overlying surface water systems has occurred.

The semiconfined aquifer in the Tulare Lake Hydrologic Region contains the same hydrogeologic units as the San Joaquin River Hydrologic Region (alluvial deposits of the Coast Ranges, Sierra Nevada sediments, and flood-basin deposits), but the region also contains Tulare Lake sediments in the axis of the valley (see Figure 13-3). The Corcoran Clay layer occurs at depths between 300 and 900 feet below ground surface in the Tulare Lake Hydrologic Region. The confined aquifer is overlain by the Corcoran Clay, but consists of the same hydrogeologic units as the unconfined-to-semiconfined aquifer. The Tulare Lake Hydrologic Region has semiconfined aquifer conditions to the west above the Corcoran Clay layer, and on the east side of the region where the clay is not present. Tulare Lake sediments present in the axis of the San Joaquin Valley have similar characteristics to flood-basin deposits present in the San Joaquin River Hydrologic Region (Figure 13-3).

The semiconfined aquifer in the Tulare Lake Hydrologic Region is recharged by seepage from streams and canals, infiltration of applied water, and subsurface inflow. Precipitation is a source of recharge to the semiconfined aquifer only in Wet years (Reclamation 1997). Seepage from streams and canals is highly variable and depends on annual hydrologic conditions. Some of the water recharged to the semiconfined aquifer seeps through the confining clay layers, including the Corcoran Clay, which are discontinuous in some areas. Lateral flow from the semiconfined aquifer also recharges the lower confined aquifer.

Subbasin Hydrogeology

The unconfined-to-semiconfined and confined groundwater aquifer in the Kings and Westside subbasins consists of Tertiary and Quaternary age unconsolidated continental deposits. The Quaternary deposits consist of older alluvium, lacustrine and marsh deposits, younger alluvium, and flood-basin deposits. The lacustrine and marsh deposits are part of the Corcoran Clay Member of the Tulare Formation (DWR 2003). To the south, the Kaweah Subbasin aquifers are made up of unconsolidated deposits of Pliocene, Pleistocene, and Holocene age. The deposits comprise arkosic sediments derived from the Sierra Nevada on the eastern side of the subbasin and are generally unconfined-to-semiconfined. The arkosic sediments consist of continental deposits, older alluvium, and younger alluvium. The unconsolidated deposits in the western portion of the subbasin near the Tulare Lake beds are confined below the Corcoran Clay and consist of flood deposits and lacustrine and marsh deposits that interfinger with the east side deposits (DWR 2003). To the south of the Kaweah Subbasin, the Pleasant Valley Subbasin consists of unconfined Holocene age alluvium, the Plio-Pleistocene Tulare Formation, and possibly part of the uppermost San Joaquin Formation.

South of the Kaweah Subbasin, the unconfined-to-semiconfined and confined aquifers of the Tule Subbasin comprise continental deposits of Tertiary to Quaternary age. The continental deposits consist of flood-basin deposits, younger alluvium, older alluvium, the Tulare Formation, and undifferentiated continental deposits (DWR 2003). West of the Tule Subbasin, the unconfined-to-semiconfined aquifer of the Tulare Lake Subbasin includes younger and older alluvium, flood-basin deposits, lacustrine and marsh deposits, and continental deposits. The younger alluvium is a very permeable, interstratified unit consisting of well-sorted clay, silt, sand, and gravel that is largely above the water table. The older alluvium is moderately permeable and consists of poorly sorted clay, silt, sand, and gravel, and yields large quantities of water to wells (DWR 2003). In the southernmost portion of the Tulare Lake Hydrologic Region in the San Joaquin Valley Groundwater Basin, the Kern County Subbasin consists primarily of unconfined-to-semiconfined and confined continental deposits of Tertiary and Quaternary age. The deposits, from oldest to youngest, include the Olcese and Santa Margarita formations, the Tulare Formation, the Kern River Formation, older alluvium/stream deposits, younger alluvium, and flood-basin deposits (DWR 2003).

Groundwater Storage and Production

The following sections describe historical and existing groundwater storage and production conditions in the Tulare Lake Hydrologic Region.

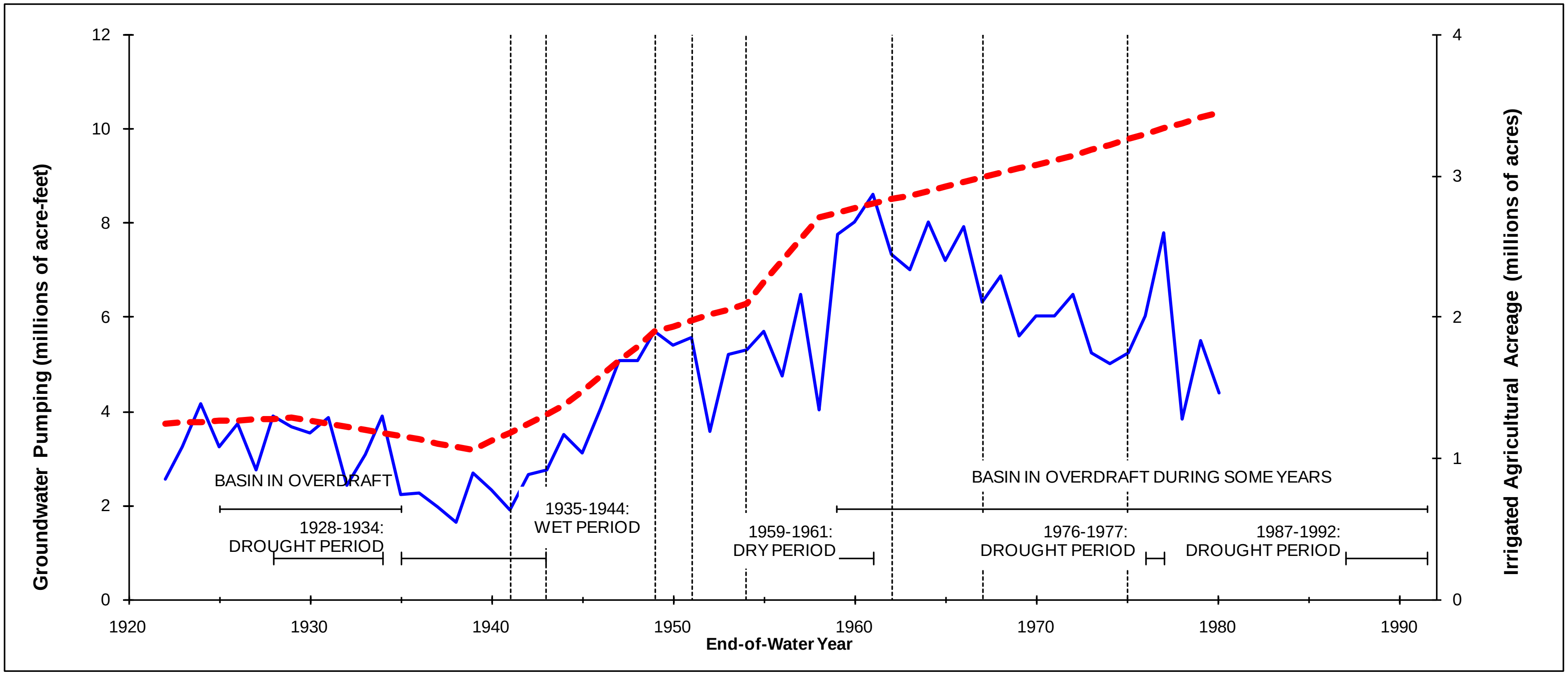
Groundwater Storage Usable groundwater storage capacity within the Tulare Lake Hydrologic Region was estimated to be 28 MAF in 1993 (DWR 1994). The perennial yield of the Tulare Lake Hydrologic Region was estimated by DWR to be 4.6 MAF, and was considered directly dependent on the amount of recharge received by the groundwater basin (DWR 1994).

Figure 13-4 illustrates changes in groundwater storage from 1962 through 2003 for the Central Valley, including the San Joaquin River and Tulare Lake hydrologic regions, as simulated using CVHM (Faunt 2009). These groundwater storage fluctuations represent average regional fluctuations that likely occurred in the San Joaquin Valley Groundwater Basin.

According to DWR Bulletin 160-09, the net change in groundwater storage for Water Years 1998 to 2005 was predominantly negative, ranging from -4,002 TAF to 263 TAF

(DWR 2009). According to DWR Bulletin 160-05 (DWR 2005b), five subbasins (Kings, Tulare, Kern County, Kaweah, and Tule) in the Tulare Lake Hydrologic Region are in critical overdraft conditions.

Groundwater Production Agricultural development in the Tulare Lake Hydrologic Region began in the 1800s, and by 1922, more than 1.2 million acres of land were used for agriculture. Groundwater has been the primary source of irrigation water for the region. Figure 13-15 illustrates changes in groundwater pumping and irrigated agricultural acreage for the Tulare Lake Hydrologic Region from 1922 to 1980 (the source for the data was discussed in the San Joaquin River Hydrologic Region, Groundwater Storage and Production section). Annual groundwater pumping ranged from 2 MAF in the 1920s and 1930s to 8 MAF in the 1960s. Groundwater pumping increased from the 1920s through 1949, when surface water deliveries began via the Friant-Kern Canal to the east side of the region. Groundwater pumping continued to increase through the early 1960s until local surface water facilities, import of CVP water from the San Luis Division, and SWP water from the California Aqueduct resulted in a reduction in regional groundwater pumping. In the mid-1970s following construction of the Cross Valley Canal, additional CVP supplies were imported to the southern half of the Tulare Lake Hydrologic Region. This reduction in groundwater pumping worked to reduce overdraft conditions in the region. However, an increase in groundwater pumping occurred in the late 1980s and early 1990s in response to reduced surface water deliveries during the drought period of 1987 to 1992. Table 13-7 highlights the timeline of events that have affected groundwater production in the Tulare Lake Hydrologic Region for the period shown in Figure 13-15. Figure 13-6 illustrates simulated groundwater pumping for the entire Central Valley, including the San Joaquin River and Tulare Lake hydrologic regions, from 1962 to 2003.



Source: Reclamation 1997.

Note:

Data available from 1922 to 1980. Data developed as part of the Central Valley Ground-Surface Water Model (Reclamation et al, 1990b)

Legend:

Groundwater Pumping

Irrigated Agricultural Acreage

Figure 13-15. Historical Annual Groundwater Pumping and Irrigated Agricultural Acreage for Tulare Lake Hydrologic Region from 1922 Through 1980

Table 13-7. Timeline of Historical Events Affecting Groundwater Production in Tulare Lake Hydrologic Region

Date	Historical Event
1928–1934	Drought Period
1935–1944	Wet Period
1943	Friant Dam Online
1949	Friant-Kern Canal Online
1954	Isabella Dam Online
1956	Madera Canal Online
1959–1961	Dry Period
1962	Success Dam Online, Terminus Dam Online
1967	San Luis Dam/Canal Online
1967	California Aqueduct Online
1967	Oroville Dam Online
1975	Cross Valley Canal Online
1976–1977	Drought Period
1987–1992	Drought Period

Groundwater pumped in the Tulare Lake Hydrologic Region accounts for about 33 percent of the total annual water supply in the region, represents 35 percent of all groundwater use in the State, and 10 percent off all agricultural and urban water use in the State (DWR 2005a).

In 1990, an estimated 5.2 MAF of groundwater was pumped from the Tulare Lake Hydrologic Region (DWR 1994). This was approximately 630 TAF greater than the estimated perennial yield of the region (DWR 1994).

Typical groundwater production within the subbasins in the Tulare Lake Hydrologic Region is presented in Table 13-8 (DWR 1998). As discussed in the San Joaquin River Hydrologic Region section, Burt estimated gross irrigation well pumping for some of the Friant Division contractors between 1987 and 2003 (Burt 2005). The estimated gross groundwater pumping for numerous WDs and IDs in the Tulare Lake Hydrologic Region is shown in Table 13-9 (Burt 2005). Gross pumping estimates for Friant Division M&I users, including the City of Fresno, City of Orange Cove, City of Lindsay, and Fresno County Water Works District Number 18, were not available (Burt 2005). The City of Fresno reports that using 250 wells, the Water Division of the City of Fresno pumps approximately 146 million gallons or 448 acre-feet of water per day, which is roughly equivalent to 164 TAF/year (City of Fresno 2009).

Table 13-8. Average Annual Groundwater Production in Tulare Lake Hydrologic Region

Subbasin	Extraction (TAF/year)
Kings	1,790
Kern	1,400
Kaweah	760
Tulare Lake	670
Tule	660
Westside	210
Pleasant Valley	100

Source: DWR 1998, 2003
Key:
TAF/year = thousand acre-feet per year

Table 13-9. Average Annual Gross Groundwater Pumping for Friant Division Contractors in Tulare Lake Hydrologic Region

District	Average Gross Groundwater Pumping (TAF/year)		
	1987–1992	1987–1999	1987–2003
Arvin-Edison WSD	207	184	190
Delano-Earlimart ID	53	35	33
Exeter ID	27	22	22
Fresno ID	224	135	123
Garfield ID	0.3	0.3	0.3
International ID	1	0.6	0.6
Ivanhoe ID	21	17	17
Lewis Creek WD	1	0.9	1
Lindmore ID	44	36	36
Lindsay-Strathmore ID	13	12	13
Lower Tule River ID	203	131	137
Orange Cove ID	44	41	42
Porterville ID	31	26	26
Saucelito ID	25	18	17
Shafter-Wasco ID	74	62	60
Southern San Joaquin MUD	93	72	66
Stone Corral ID	9	9	9
Tea Pot Dome WD	3	2	2

Table 13-9. Average Annual Gross Groundwater Pumping for Friant Division Contractors in Tulare Lake Hydrologic Region (contd.)

District	Average Gross Groundwater Pumping (TAF/year)		
	1987–1992	1987–1999	1987–2003
Terra Bella ID	14	13	13
Tulare ID	181	102	98

Source: Burt 2005
Key:
ID = Irrigation District
MUD = Municipal Utilities District
TAF/year = thousand acre-feet per year
WD = Water District
WSD = Water Storage District

Groundwater Levels

Groundwater-level declines in shallow wells in central Fresno County have been substantial, beginning in the early 1940s and decreasing approximately 50 to 100 feet through the 1980s (Williamson et al. 1989). Large groundwater-level declines occurred in the southwestern corner of the Westside Subbasin until the late 1960s. Beginning in 1967, groundwater levels declined more than 100 feet but made a near full recovery because of decreases in pumping in response to surface water supplies imported through the San Luis Canal (Williamson et al. 1989).

Groundwater levels in the lower confined aquifer in the west side of the Tulare Lake Hydrologic Region declined as much as 400 feet from predevelopment to the 1960s (Williamson et al. 1989). Groundwater levels measured in the Tulare Lake Subbasin fluctuated and, in general, increased by more than 24 feet in some areas during the 10-year period of spring 1978 to spring 1988 (DWR 2003). The Tulare Lake bed area has experienced the greatest groundwater-level fluctuations, including both increases and decreases (DWR 2003).

Figure 13-7 presents groundwater contours of the semiconfined aquifer in spring 1970, adapted from DWR’s spring 1970 map (DWR 2007b). Groundwater levels in the semiconfined aquifer of the Tulare Lake Hydrologic Region generally decreased during the 10-year period of spring 1970 to spring 1980. The semiconfined groundwater aquifer levels decreased as much as 50 feet in the same 10-year period in portions of Fresno, Kings, Kern, and Tulare counties.

The 1987-through-1992 drought resulted in increased groundwater pumping due to deficiencies in surface water deliveries. Water levels declined by 20 to 30 feet throughout most of the central and eastern parts of the San Joaquin Valley (Westlands WD 1995).

Groundwater conditions in the semiconfined aquifer for spring 1995 are shown in Figure 13-8. Following the 1987-through-1992 drought, groundwater levels in the San Joaquin Valley continued to decline. In spring 1993, a groundwater-level contour map of the San Joaquin Valley showed depression areas resulting from groundwater withdrawals in the mid-valley area near the center of Fresno County, near the City of Fresno, along the county border between Tulare and Kings counties, in southwestern Kings County, and in parts of Kern County. Groundwater conditions in spring 1995 indicate that groundwater levels in the unconfined-to-semiconfined aquifer were beginning to recover.

Groundwater conditions in the unconfined aquifers of the San Joaquin Valley Groundwater Basin for spring 2010 are illustrated in Figure 13-9. The groundwater elevation contours in Figure 13-9 were adapted from the spring 2010 contour map of the unconfined aquifers available on the DWR Web site (DWR 2012). The groundwater elevation contours indicate that groundwater levels had nearly recovered to pre-drought conditions in the basin. Table 13-10 summarizes the ranges in groundwater elevations reported on the groundwater subbasin contour maps of the unconfined-to-semiconfined aquifer in the Tulare Lake Hydrologic Region for spring 2010.

Table 13-10. Spring 2010 Unconfined Aquifer Contour Map Groundwater Elevations in Subbasins of Tulare Lake Hydrologic Region

Subbasin	Range in Groundwater Elevations (feet above msl)	
Kaweah[1]	50	400
Kern County	0	230
Kings[1]	0	450
Pleasant Valley[3]	250	400
Tulare Lake[4]	100	220
Tule[5]	30	500
Westside[2]	40	300

Source: DWR 2012

Notes:

[1] Elevations increased from west to east towards the Sierra Nevada

[2] Last map available in 1996

[3] Last map available in 2004

[4] Only available in northern part of subbasin

[5] Elevations increased from west to east

Key:

msl = mean sea level

Land Subsidence

Figure 13-10 shows land subsidence contours from 1926 through 1970 for the San Joaquin River and Tulare Lake hydrologic regions. The Arvin-Maricopa area is 700 square miles, and is located 20 miles south of Bakersfield, mostly in Kern County. Two confining beds, the A-clay and the C-clay, underlie the area; the C-clay is the more extensive of the two beds. Maximum land subsidence in the Arvin-Maricopa area exceeds 9 feet. Land subsidence in parts of the Arvin-Maricopa area has also been influenced by oil and gas withdrawal and near-surface hydrocompaction. The Tulare-Wasco area between Fresno and Bakersfield in the Tulare Lake Hydrologic Region experienced land subsidence that exceeded 12 feet between 1926 and 1970 (Williamson et al. 1989). Additional information on land subsidence is available in the Groundwater Resources of San Joaquin River Hydrologic Region section on land subsidence.

Groundwater Quality

Similar to the San Joaquin River Hydrologic Region, groundwater quality in the Tulare Lake Hydrologic Region varies considerably throughout the area, but in general, is suitable for most urban and agricultural uses (DWR 2003). Primary constituents of concern on a regional level include TDS, boron, nitrates, arsenic, selenium, DBCP, radon, and uranium. USGS GAMA program data are currently available for the Southeast San Joaquin Valley and the Kern County

Subbasin study areas in the Tulare Lake Hydrologic Region (Burton and Belitz 2008, Shelton et al. 2008). The Southeast San Joaquin Valley study area, as defined by the GAMA study, includes portions of Fresno, Tulare, and King counties, which in turn include the Kings, Kaweah, Tulare Lake, and Tule subbasins (Burton and Belitz 2008).

Total Dissolved Solids TDS concentrations vary considerably in the Tulare Lake Hydrologic Region and depend on the depth to groundwater. In general, TDS concentrations exceeding the secondary MCL of 500 mg/L are primarily found along the west side and trough portions of this hydrologic region. Along the west side, these higher concentrations are a result of recharged streamflow originating from marine deposits. In the trough, or center portions, the concentrations are a result of the buildup of salt because of evaporation and poor drainage (DWR 2003). These higher concentrations above the Corcoran Clay layer limit groundwater use as an agricultural water supply in the western portion of Fresno and Kings counties. TDS concentrations have been reported above the MCL of 500 mg/L in the Kaweah, Kings, and Kern County subbasins (Burton and Belitz 2008, Shelton et al. 2008). Elevated concentrations of TDS have been reported in the Westside, Pleasant Valley, and Kern County subbasins (DWR 2003).

TDS concentrations for the entire Central Valley are discussed in the San Joaquin River Hydrologic Region groundwater quality section, and are shown in Figure 13-11 (this figure does not show vertical variations in TDS).

Boron High concentrations of boron have been reported in the southern portion of the Tulare Lake Hydrologic Region and in the northernmost edge of the greater San Joaquin Valley west of the San Joaquin River to the Kings-Fresno county line (Bertoldi et al. 1991). Elevated concentrations of boron have been reported in the Kings and Westside subbasins (DWR 2003). Boron concentrations above the CDPH NL of 1,000 µg/L have been reported in Tulare Lake Subbasin (Burton and Belitz 2008).

Nitrates Nitrates are prevalent typically in shallow younger groundwater throughout the Tulare Lake Hydrologic Region as a result of disposal of human and animal waste products and the applications of fertilizers. Higher nitrate concentrations, ranging from 5 to 30 mg/L, may adversely affect select crops. The MCL for nitrate (as nitrogen) in drinking water is 10 mg/L.

Areas of higher nitrate concentrations have been observed near the town of Shafter, and concentrations exceeding the MCL of 10 mg/L have been documented in areas south of Bakersfield and the greater Fresno metropolitan area, indicating surface contamination (DWR 2003). Elevated concentrations of nitrate have also been found in the Kings, Kaweah, Tule, and Kern County subbasins (DWR 2003). Recently, nitrate concentrations were reported above the MCL of 10 mg/L in groundwater in the Kings and Kern County subbasins (Burton and Belitz 2008, Shelton et al. 2008). As previously mentioned, one recent study tracking historical nitrogen balances suggests that major reductions in nitrogen loadings from California agriculture will be required to safeguard groundwater quality (Rosenstock et al. 2014).

Arsenic Arsenic concentrations have been reported above the MCL of 10 µg/L in groundwater in the southwestern corner of the Tulare Lake Hydrologic Region, particularly in the Kern Subbasin near Bakersfield (State Water Board 1991). Arsenic levels above the MCL have also been reported in the Kings, Tulare Lake, and Tule subbasins (Burton and Belitz 2008).These high-level areas of arsenic often occur locally and appear to be associated with lake bed deposits.

Selenium In the western portion of the Tulare Lake Hydrologic Region, selenium can be found as a naturally occurring element where soils are formed from marine sediments of the Coast Ranges (DWR 2007a). Selenium concentrations reported from a location on the Kern Lake bed are above the MCL of 50 µg/L (DWR 2007a).

Dibromochloropropane The most notable agricultural groundwater contaminant in the Tulare Lake Hydrologic Region is DBCP. The presence of this pesticide coincides with land-use patterns and is prevalent in groundwater at levels above 0.0005 mg/L near Bakersfield and Fresno. DBCP is typically observed in shallow, younger groundwater recharged after 1980 in areas occupied by orchards and vineyards, where DBCP was commonly used (Bertoldi et al. 1991). DBCP has been reported above the MCL of 0.2 µg/L in the Kings, Tule, and Kern County subbasins (Burton and Belitz 2008, Shelton et al. 2008).

Radon No current water quality standards exist for radon, a naturally occurring radioactive element; however, the proposed MCL for radon-222 is 300 pCi/L. Radon has been reported above the MCL, but below the alternative MCL of 4,000 pCi/L, in the Kings, Kaweah, Tule, Tulare Lake, and Kern County subbasins (Burton and Belitz 2008, Shelton et al. 2008). The alternative MCL would be applicable if the State were to develop a multimedia program to address radon risks in indoor air program to address radon risks in indoor air.

Uranium Uranium is naturally occurring in the eastern San Joaquin Valley, and is derived from granitic rocks of the Sierra Nevada. Uranium concentrations in groundwater have been reported above the MCL in Bakersfield (Jurgens et al. 2009).

Agricultural Subsurface Drainage

As described for the San Joaquin River Hydrologic Region, salinity and trace elements in some soil and shallow groundwater on the western side of the Tulare Lake Hydrologic Region are also of concern. In the Tulare Lake Hydrologic Region, the San Joaquin Valley Groundwater Basin is an internally drained and closed basin. It has no appreciable surface or subsurface outflow, except in extremely wet years. Salts (generally measured as TDS) are introduced into the basin with imported water supplies. In addition, many of the naturally occurring geologic deposits along the western portion of the region are of marine origin and, therefore, have high salt content. A number of regulated point sources discharge treated wastewater into the region's surface waters, including municipal sewage treatment plants and food processing, manufacturing, and oil and gas facilities (DWR 2009).

Seepage and Waterlogging

The northern boundary of the Tulare Lake Hydrologic Region is defined by the San Joaquin River. Seepage problems identified influence local groundwater conditions in the Kings Subbasin in the Tulare Lake Hydrologic Region (see Figure 13-12 through Figure 13-14). See the Groundwater Resources of San Joaquin River Hydrologic Region section, above, for additional discussion on seepage and waterlogging along the San Joaquin River.

Environmental Consequences and Mitigation Measures

This section describes environmental consequences on groundwater resources associated with implementing the alternatives. It also describes potential mitigation measures associated with impacts on groundwater resources that are significant or potentially significant. The potential direct and indirect effects to groundwater and associated mitigation measures are summarized in Table 13-11.

Table 13-11. Summary of Impacts and Mitigation Measures for Groundwater

Impact	Study Area	Alternative	Level of Significance Before Mitigation	Mitigation Measure	Level of Significance After Mitigation
GRW-1: Change in Groundwater Levels	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI
	Extended Study Area	No Action Alternative	PS	None Required	PSU
		Alternative Plan 1	LTS		LTS
		Alternative Plan 2	LTS and Beneficial		LTS and Beneficial
		Alternative Plan 3	LTS and Beneficial		LTS and Beneficial
		Alternative Plan 4	LTS and Beneficial		LTS and Beneficial
		Alternative Plan 5	LTS		LTS
GRW-2: Change in Groundwater Quality	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI
	Extended Study Area	No Action Alternative	PS	None Required	PSU
		Alternative Plan 1	LTS		LTS
		Alternative Plan 2	LTS and Beneficial		LTS and Beneficial
		Alternative Plan 3	LTS and Beneficial		LTS and Beneficial
		Alternative Plan 4	LTS and Beneficial		LTS and Beneficial
		Alternative Plan 5	LTS		LTS

Key:
B = beneficial
LTS = less than significant
NI = no impact
PS = potentially significant
PSU = potentially significant and unavoidable

Methods and Assumptions

The analysis presented in this section is qualitative and based on the premise that increased surface water deliveries would result in reduced groundwater pumping and, similarly, that reductions in surface water deliveries would be offset by increased groundwater pumping. Quantitative relationships between groundwater pumping and groundwater-level change were developed by Dr. Ken Schmidt (2005) and are discussed in the Modeling Appendix. However, these relationships, known as the Schmidt Tool, have only been developed for portions of the Friant Division of the CVP and cannot be applied to the entire extended study area.

Criteria for Determining Significance of Impacts

An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental impacts that would be caused by, or result from, implementing the No Action Alternative and other alternatives. Under NEPA, the severity and context of an impact must be characterized. An environmental document prepared to comply with CEQA must identify the potentially significant environmental impacts of a proposed project. A "[s]ignificant 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 impacts (State CEQA Guidelines, Section 15126.4(a)).

The following significance criteria were developed based on guidance provided by the State CEQA Guidelines, and consider the context and intensity of the environmental impacts as required under NEPA. Impacts of an alternative on groundwater would be significant if project implementation would result in 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 basin.
- A change groundwater quality resulting in substantially adverse impacts to designated beneficial uses of groundwater.

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

Topics Eliminated from Further Consideration

Groundwater resources in the primary study area, to the extent they exist, are not well documented or well understood. The primary study area is outside of the mapped groundwater basins defined by DWR in Bulletin 118 (2003). Groundwater present in the primary study area is expected to occur in fractured rock. As such, any impacts in that area would be highly dependent on the fracture properties (e.g., aperture, interconnectedness) and would be highly variable in space due to the discontinuous nature of fracture networks. Because of the speculative nature of impacts to groundwater resources in the primary study area, these impacts are not considered in the impact assessment below.

Potential for seepage along the San Joaquin River as result of the implantation of the No Action Alternative or action alternatives is also not considered in the impact assessment below. Impacts from potential seepage along the San Joaquin River are discussed in Chapter 12, "Hydrology – Flood Management."

Direct and Indirect Effects

The following section describes potential environmental consequences of the alternatives.

Impact GRW-1: Change in Groundwater Levels

Extended Study Area

No Action Alternative   Under the No Action Alternative, the current state of overdraft and declining groundwater levels in portions of the extended study area would continue.

Simulated deliveries of surface water to various users would change, as shown in Table 13-12. While simulated deliveries to some groups increased (e.g., total SWP SOD), simulated deliveries in other areas decreased. Averaged over all years, simulated deliveries to Friant Division agricultural users decreased by 56 TAF/year and simulated deliveries to CVP SOD users decreased by 35 TAF/year. While the simulated reductions represent only a small fraction of estimated average future deliveries (1,055 and 2,323 TAF/year, respectively, for Friant Division agricultural and CVP SOD contractors), they indicate a potential for increased groundwater extraction, contributing to the current state of overdraft and declining water levels in portions of the extended study area.

This impact would be **potentially significant** under the No Action Alternative.

Alternative Plan 1 As documented in the Modeling Appendix, Alternative Plan 1 would result in a reduction in average simulated CVP SOD deliveries of 11 TAF per year relative to the No Action Alternative. Reduction of surface water deliveries may be offset by groundwater pumping, although other options (e.g., land fallowing or obtaining water on the transfer market) would also be available. The simulated reduction of 11 TAF/year would be less than 0.5 percent of the total deliveries to CVP SOD users. The impact of reduced surface water deliveries on groundwater levels would not likely be measurable.

As described in Chapter 14, "Hydrology – Surface Water Supplies and Facilities Operations," changes in San Joaquin River flow volumes and timing would be within typical historical ranges for the action alternatives. Flows in Wet years would be reduced when Temperance Flat RM 274 Reservoir captures flood flows, but flows in other year types would generally increase. The overall impact of these flow changes is not likely to adversely impact groundwater levels for near-river users.

This impact would be **less than significant** under Alternative Plan 1. Mitigation for this impact is not needed, and thus not proposed.

Table 13-12. Long-Term Average Annual Change in Deliveries (TAF) for No Action Alternative as Compared with Existing Conditions[1]

WY Type San Joaquin Index [2]	Change in System-wide Delivery	Total Friant Division Ag	Class 1	Class 2	Section 215	Total SWP SOD	SWP Ag SOD	SWP M&I SOD	Total CVP SOD[2]	CVP Ag SOD	CVP M&I SOD
Wet	493	(54)	(1)	(6)	(47)	552	43	510	(5)	(7)	0
Above Normal	111	(82)	(0)	(31)	(51)	213	12	201	(20)	(7)	(0)
Below Normal	89	(60)	(10)	(41)	(9)	140	2	139	9	24	(0)
Dry	(25)	(40)	(20)	(14)	(6)	81	(8)	89	(66)	(48)	(1)
Critical	(132)	(46)	(43)	(0)	(3)	17	(10)	27	(104)	(77)	(5)
All Years	**151**	**(56)**	**(13)**	**(16)**	**(27)**	**243**	**12**	**231**	**(35)**	**(23)**	**(1)**

Note:

[1] Changes in deliveries as simulated with CalSim II March 2012 Benchmark with future (2030) level of development and 82 year hydrologic period of record from October 1921 to September 2003.

[2] San Joaquin Year Type or 60-20-20 Year Type –This water year classification system is based on the historical and forecasted unimpaired inflows of the Stanislaus, Tuolumne, Merced, and San Joaquin rivers to the San Joaquin River Basin, as defined in State Water Board Decision 1641. The classification consists of five year types: Wet, Above Normal, Below Normal, Dry, and Critical. Average for all years is weighted average based on proportion of each year type out of 82-year period of record.

Key:
Ag = agricultural
CVP = Central Valley Project
M&I = municipal and industrial
RM = river mile
SOD = south-of-Delta
SWP = State Water Project
TAF = thousand acre-feet
WY = water year

Alternative Plans 2 through 4 As documented in the Modeling Appendix, Alternative Plans 2 through 4 resulted in increased average simulated surface water deliveries to Friant agricultural, SWP SOD, and CVP SOD users. Increased surface water deliveries would reduce the need to pump groundwater relative to the No Action Alternative.

As described in Chapter 14, “Hydrology – Surface Water Supplies and Facilities Operations,” changes in San Joaquin River flow volumes and timing would be within typical historical ranges for the action alternatives. Flows in Wet years would be reduced when Temperance Flat RM 274 Reservoir captures flood flows, but flows in other year types would generally increase. The overall impact of these flow changes is not likely to adversely impact groundwater levels for near-river users.

This impact would be **less than significant and beneficial** under Alternative Plans 2 through 4. Mitigation for this impact is not needed, and thus not proposed.

Alternative Plan 5 As documented in the Modeling Appendix, Alternative Plan 5 would result in a reduction in average simulated total SWP SOD deliveries of 10 TAF per year relative to the No Action Alternative. Reduction of surface water deliveries may be offset by groundwater pumping, although other options (e.g., land fallowing or obtaining water on the transfer market) would also be available. The simulated reduction of 10 TAF/year would be less than 0.4 percent of the total deliveries to SWP SOD users. The impact of reduced surface water deliveries on groundwater levels would not likely be measurable.

As described in Chapter 14, “Hydrology – Surface Water Supplies and Facilities Operations,” changes in San Joaquin River flow volumes and timing would be within typical historical ranges for the action alternatives. Flows in Wet years would be reduced when Temperance Flat RM 274 Reservoir captures flood flows, but flows in other year types would generally increase. The overall impact of these flow changes is not likely to adversely impact groundwater levels for near-river users.

This impact would be **less than significant** under Alternative Plan 5. Mitigation for this impact is not needed, and thus not proposed.

Impact GRW-2: Change in Groundwater Quality

Extended Study Area

No Action Alternative Under the No Action Alternative, the current state of overdraft declining groundwater levels in portions of the extended study area would continue. This in turn could lead to upwelling of poorer quality groundwater.

This impact would be **potentially significant** under the No Action Alternative.

Alternative Plan 1 As described for Impact GRW-1, Alternative Plan 1 would result in reduced CVP SOD deliveries and could result in increased groundwater pumping. However, the simulated reduction in surface water deliveries is less than 0.5 percent of the total deliveries to CVP SOD users. Changes to groundwater quality from this small change would not likely be measureable.

This impact would be **less than significant** under Alternative Plan 1. Mitigation for this impact is not needed, and thus not proposed.

Alternative Plans 2 Through 4 As described for Impact GRW-1, Alternative Plans 2 through 4 would reduce the need to pump groundwater relative to the No Action Alternative. Reduced groundwater pumping could reduce upwelling of poor quality groundwater and could slow or reverse the historical degradation of groundwater quality.

This impact would be **less than significant and beneficial** under Alternative Plans 2 through 4. Mitigation for this impact is not needed, and thus not proposed.

Alternative Plan 5 As described for Impact GRW-1, Alternative Plan 5 would result in reduced total SWP SOD deliveries and could result in increased groundwater pumping. However, the simulated reduction in surface water deliveries is less than 0.4 percent of the total deliveries to SWP SOD users. Changes to groundwater quality from this small change would not likely be measureable.

This impact would be **less than significant** under Alternative Plan 5. Mitigation for this impact is not needed, and thus not proposed.

Mitigation Measures

This section discusses mitigation measures for each significant impact described in the environmental consequences section, as presented in Table 13-11

No mitigation is required for Impacts GRW-1 or GRW-2 within the extended study area under the action alternatives, as these impacts would be less than significant or less than significant and beneficial.

Chapter 14
Surface Water Supplies and Facilities Operations

This chapter describes the affected environment for surface water supplies and facilities operations, as well as potential environmental consequences and associated mitigation measures, as they pertain to implementing the alternatives. This chapter presents both information on the primary study area (area of project features, the Temperance Flat Reservoir Area, and Millerton Lake below RM 274) and the extended study area (San Joaquin River from Friant Dam to the Merced River, the San Joaquin River from the Merced River to the Delta, the Delta, and the CVP and SWP water service areas).

Affected Environment

The affected environment for surface water supplies and facilities operations encompasses the entire study area, including the San Joaquin River, the Delta, and CVP and SWP water service areas. Implementing the action alternatives would change surface water supplies and facilities operations of the San Joaquin River from Friant Dam to the Delta, in the Delta, and in CVP and SWP water service areas.

Flows in the San Joaquin River downstream from Friant Dam are affected by water projects operating on the river's tributaries, imports to the river from other regions, diversions out of the river, return flows, and Friant Dam operations. Flows have most recently been affected by release of Interim Flows, which began in 2009, and Restoration Flows, which began in 2014. This section includes historical San Joaquin River flow information from the last several decades, as well as information on flows beginning with the 2009 water year. Post-2009 flows are most representative of the affected environment.

Primary Study Area

The following is a description of surface water supplies and facilities operations in the primary study area. The primary study area includes surface water supplies and facilities in the area of project features (Temperance Flat RM 274 Reservoir

Area) and Millerton Lake, which are discussed in the respective sections below.

Temperance Flat Reservoir Area

The San Joaquin River upstream from and including Millerton Lake above RM 274 drains approximately 1,675 square miles and has an annual average unimpaired runoff of 1,818 TAF (Water Year 1901–2011), with a range of 362 to 4,642 TAF. Upstream from RM 274, Kerckhoff Dam is located at RM 292.5. The San Joaquin River flows through the gorge from Kerckhoff Dam to Kerckhoff No.2 Powerhouse, and then becomes Millerton Lake. Several reservoirs exist in the upper San Joaquin River watershed, used primarily for hydropower generation. Operation of these reservoirs affects the timing of inflow to the Temperance Flat Reservoir Area and Millerton Lake, but would not substantially affect Temperance Flat RM 274 Dam operations. Table 14-1 lists the Reclamation water rights on the San Joaquin River at Friant Dam.

Table 14-1. U.S. Department of the Interior, Bureau of Reclamation Water Rights on the San Joaquin River at Friant Dam

Application	A000023	A000234	A001465	A005638	Combined Maximum
Application Date	3/27/1915	1/19/1916	9/26/1919	7/30/1927	--
Permit	000273	011885	011886	011887	--
Permit Date	5/3/1917	6/29/1959	6/29/1959	6/29/1959	--
License	001986	--	--	--	--
License Date	10/17/1939	--	--	--	--
Maximum Diversion (cubic feet per second)	373	3,000	3,000	5,000	6,500 (A234, A1465, A5638)
Maximum Storage (AF/year)	--	500,000	500,000	1,210,000	2,210,000
Maximum Use (AF/year)	44,340	2,124,487	2,124,487	3,917,478	--
Direct Diversion Season	4/1 – 7/1	2/1 – 10/31	2/1 – 10/31	2/1 – 10/31	--
Storage Season	--	11/1 – 8/1	11/1 – 8/1	11/1 – 8/1	--
Purposes of Use	Municipal, Domestic, Irrigation, Incidental Domestic, Stockwatering, Preservation and Enhancement of Fish and Wildlife, Recreational	Municipal, Domestic, Irrigation, Incidental Domestic, Stockwatering, Preservation and Enhancement of Fish and Wildlife, Recreational	Municipal, Domestic, Irrigation, Incidental Domestic, Stockwatering, Preservation and Enhancement of Fish and Wildlife, Recreational	Municipal, Domestic, Irrigation, Incidental Domestic, Stockwatering, Preservation and Enhancement of Fish and Wildlife, Recreational	--

Table 14-1. U.S. Department of the Interior, Bureau of Reclamation Water Rights on the San Joaquin River at Friant Dam (contd.)

Application	A000023	A000234	A001465	A005638	Combined Maximum
Places of Use	Gross area of 5,431,000 acres as shown on Maps 214-212-37, 214-208-3331, 1785-202-14, and 1785-202-50 (all authorized purposes); San Joaquin River and designated bypass system from Friant Dam to the Sacramento-San Joaquin River Delta (Delta) and through the Delta Channels to the Jones and Banks Pumping Plants, as shown on Map 1785-202-50 (Recreational, Fish and Wildlife).	Gross area of 5,431,000 acres as shown on Maps 214-212-37,214-208-3331, 1785-202-14, and 1785-202-50 (all authorized purposes); San Joaquin River and designated bypass system from Friant Dam to the Sacramento-San Joaquin River Delta (Delta) and through the Delta Channels to the Jones and Banks Pumping Plants, as shown on Map 1785-202-50 (Recreational, Fish and Wildlife); Millerton Reservoir (Stockwatering, Recreational)	Gross area of 5,431,000 acres as shown on Maps 214-212-37, 214-208-3331,1785-202-14, and 1785-202-50 (all authorized purposes); San Joaquin River and designated bypass system from Friant Dam to the Sacramento-San Joaquin River Delta (Delta) and through the Delta Channels to the Jones and Banks Pumping Plants, as shown on Map 1785-202-50 (Recreational, Fish and Wildlife); Millerton Reservoir (Stockwatering, Recreational)	Gross area of 5,431,000 acres as shown on Maps 214-212-37, 214-208-3331,1785-202-14, and 1785-202-50 (all authorized purposes); San Joaquin River and designated bypass system from Friant Dam to the Sacramento-San Joaquin River Delta (Delta) and through the Delta Channels to the Jones and Banks Pumping Plants, as shown on Map 1785-202-50 (Recreational, Fish and Wildlife); Millerton Reservoir (Stockwatering, Recreational)	--

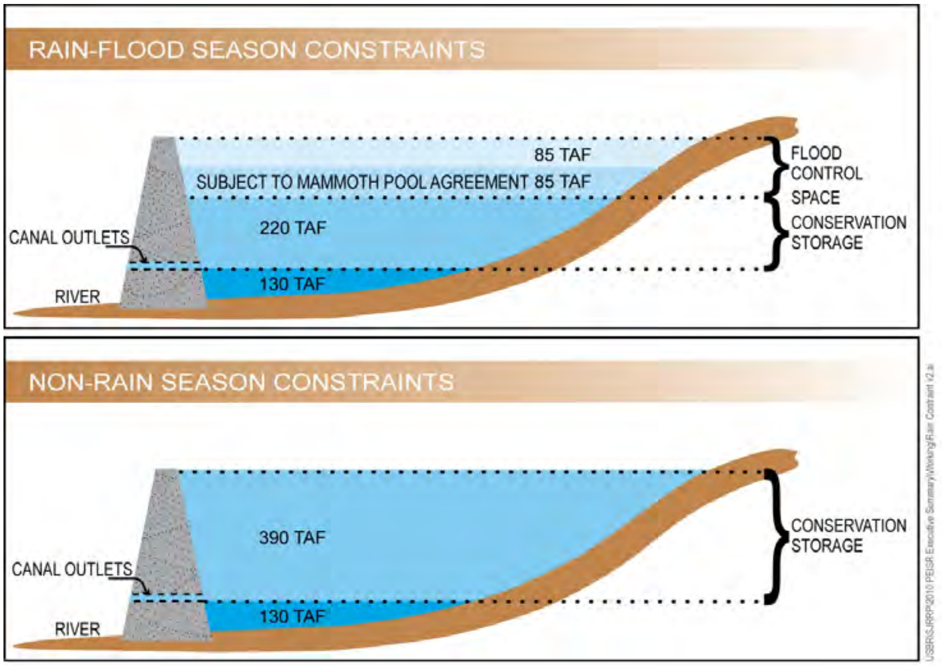
Source: State Water Board 2014
Key:
-- = not applicable
AF = acre-feet
State Water Board = California State Water Resources Control Board

Millerton Lake

Millerton Lake was formed by Friant Dam in 1942. It is the largest reservoir, by volume and surface area, on the San Joaquin River. Big Sandy Creek, Fine Gold Creek, and several ephemeral streams flow directly into Millerton Lake. Friant Dam is a 319-foot-high concrete gravity dam. Outlets to the Madera Canal (elevation 448.6) are located on the right abutment; outlets to the Friant-Kern Canal (elevation 466.6) are located on the left abutment. The spillway consists of an ogee overflow section, chute, and stilling basin at the center of the dam. The spillway is controlled by one 18-foot-high by 100-foot-wide drum gate, and two comparably sized Obermeyer gates. A river outlet works (elevation 382.6) is located to the left of the spillway within the lower portion of the dam. Information regarding power features on Friant Dam is found in Chapter 20, “Power and Energy.”

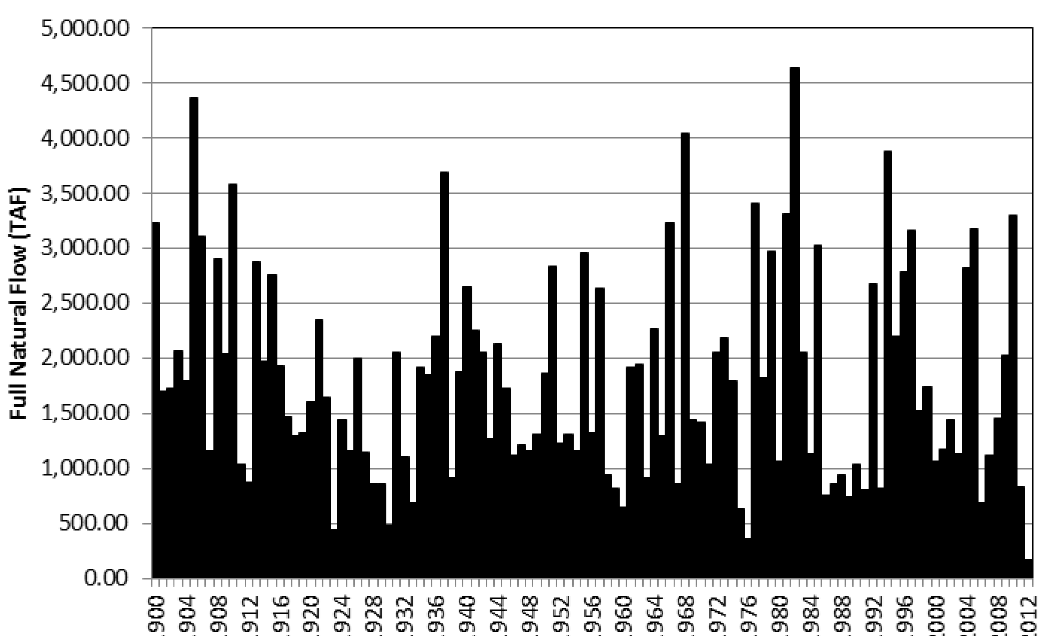
When full, the reservoir extends 16 miles up into the river canyon from Friant Dam, located at RM 267.6, and has more than 41 miles of shoreline. Millerton Lake has a volume of 524 TAF, a surface area of 4,905 acres, and an elevation of 580.6 feet above msl (NAVD 1988 datum) at top of active storage. At top of active storage, the reservoir has a maximum depth of 287 feet. Figure 14-1 shows a conceptual representation of an active conservation space of 390 TAF during April through September, when there is little risk of rain floods. Inactive storage is 130 TAF. During the rainy season of October through March, up to 170 TAF of space in Millerton Lake is maintained for rain flood management (USACE 1980). Under present operating rules, up to 85 TAF of the flood management storage required in Millerton Lake may be provided by an equal amount of space in Mammoth Pool, located on the San Joaquin River upstream from Millerton Lake. Chapter 12, “Hydrology – Flood Management,” discusses water releases made for flood management purposes at Friant Dam in detail.

Figure 14-2 shows the historical annual unimpaired runoff for the gage directly below Friant Dam.



Key:
TAF = thousand acre-feet
Note: Reservoir volumes are approximate

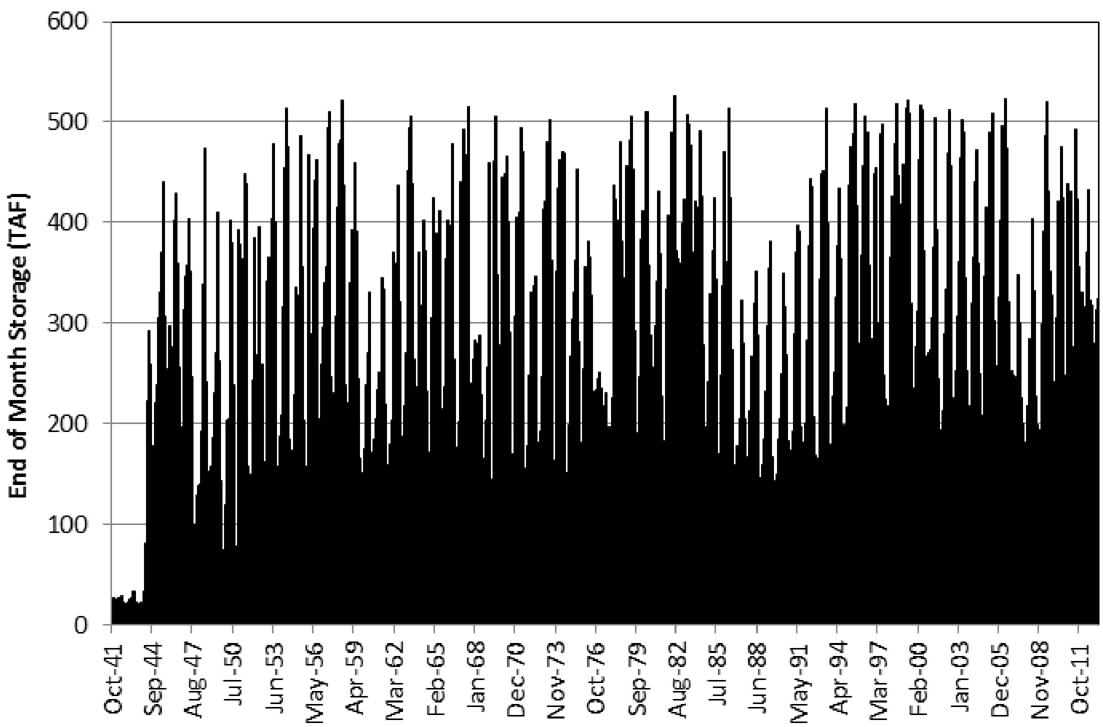
Figure 14-1. Conceptual Representation of Millerton Lake Storage Requirements



Source: DWR 2013a, Gage ID SJF
Key:
TAF = thousand acre-feet

Figure 14-2. Historical Annual Unimpaired Runoff Below Friant Dam, by Water Year

Millerton Lake is operated as an annual reservoir, in that most water supplies available in a given year are allocated with the expectation of delivery. Stored water carried over from a previous year usually occurs when water users request it, but is done so at Reclamation's discretion. Median reservoir water-level ranges from elevation 564 in late spring to elevation 497 in late summer. Figure 14-3 shows historical end-of-month storage of Millerton Lake.



Source: DWR 2013a, Gage ID MIL
Key:
EOM = End-of-Month
TAF = thousand acre-feet

Figure 14-3. Historical Millerton Lake End-of-Month Storage, Water Years 1941–2012

Water deliveries, principally for irrigation, are made through outlet works to the Friant-Kern and Madera canals, completed in 1949 and 1944, respectively. A river outlet works is located within the dam's lower portion. Additional physical data pertaining to Friant Dam and Millerton Lake are presented in Table 14-2. River releases are made to comply with Holding Contract requirements, which are contracts between Reclamation and riparian water right holders between Friant Dam and Gravelly Ford. Consistent with the Holding Contracts, Reclamation makes river releases to maintain streamflow of at least 5 cfs past each Holding Contract control point, with the last being near Gravelly Ford. Contract water deliveries are further described below, for the CVP and SWP water service areas. Under current conditions, San Joaquin River releases are also made downstream from Friant Dam in accordance with the Settlement and the Act.

Table 14-2. Pertinent Physical Data – Millerton Lake and Friant Dam

Millerton Lake

Elevation[1]		*Unimpaired Flows of Friant Dam*	
Minimum operating level[2]	468.7 feet above msl	Average annual runoff (1901–2012)	1,800,530 acre-feet
Top of active storage	580.6 feet above msl	Average flow	2,491 cfs
Spillway flood pool	587.6 feet above msl	Minimum average daily inflow (October 10, 1977)	0 cfs
Area		Maximum average daily inflow (December 23, 1955)	61,700 cfs
Minimum operating level[2]	2,108 acres	Maximum instantaneous inflow (December 23, 1955)	97,000 cfs
Top of active storage	4,905 acres	Maximum average daily outflow (June 6, 1969)	12,400 cfs
Spillway flood pool	5,085 acres	Minimum average daily outflow (October 20, 1940)	5.5 cfs
Drainage area	1,675 square miles		
Storage Capacity			
Minimum operating level[2]	130,740 acre-feet		
Top of active storage	524,250 acre-feet		
Spillway flood pool	559,300 acre-feet		

Friant Dam (concrete gravity) and Outlet Works

Elevation[1]*/ Height*		*River Outlets*	
Elevation, top of parapet	587.6 feet above msl	Number and elevation[1]	4 at 382.6 feet above msl
Freeboard above spillway flood pool	3.25 feet	Size	110-inch diameter with 96-inch hollow jet valves
Elevation, crown of roadway	583.8 feet above msl		
Max height, foundation to crown of roadway	319 feet	Capacity at minimum pool	12,400 cfs
Total concrete in dam and appurtenances	2,135,000 cubic yards	Capacity at top of active storage	16,400 cfs
Dam Crest Length		*Madera Outlets and Canal*	
Left abutment, non-overflow section	1,478 feet	Outlet number and elevation[1]	2 at 448.6 feet above msl
Overflow river section	332 feet	Size	91-inch diameter with 86-inch needle valve
Right abutment, non-overflow section	1,678 feet	Canal length	35.9 miles
Total length	3,488 feet		
Width of crest at elevation 581.25	20.0 feet	Canal operating capacity below Friant Dam	1,000 cfs
Crest Gates (1 drum and 2 Obermeyer)			
Number and size	3 at 100 feet by 18 feet	Canal operating capacity at terminus of canal	625 cfs
Top elevation when lowered[1]	562.6 feet above msl		
Top elevation when raised[1]	580.6 feet above msl	*Friant-Kern Outlets and Canal*	
Spillway (gated ogee)		Outlet number and elevation[1]	4 at 466.6 feet above msl
Gross length	332 feet	Size	110-inch diameter w/ 96-inch hollow jet valve
Net length	300 feet		
Crest elevation[1]	562.6 feet above msl	Canal length	151.8 miles
Discharge capacity (height = 18.0 feet)	83,160 cfs	Canal operating capacity below Friant Dam	5,000 cfs
Design flood peak inflow	197,000 cfs	Canal operating capacity at terminus of canal	2,000 cfs
Design flood peak outflow	158,500 cfs		

Source: USACE 1980, with elevations revised to NAVD 1988
Notes:
[1] Elevations are given in North American Vertical Datum (NAVD) 1988.
[2] Minimum operating level generally corresponds with elevation of Friant-Kern Canal outlets.
Key:
cfs = cubic feet per second
msl = mean sea level

Extended Study Area

This section describes surface water supply and facility operations in the extended study area, which includes the San Joaquin River from Friant Dam to Merced River and from Merced River to the Delta, the Delta, and the CVP and SWP water service areas.

San Joaquin River from Friant Dam to Merced River

This section describes water operations within the extended study area for five distinct river reaches (including seven subreaches), and several flood bypasses. A map of the river reaches and flood bypass system is provided in Chapter 5, "Biological Resources – Fisheries and Aquatic Resources." Flood bypasses are discussed in further detail in Chapter 12, "Hydrology – Flood Management."

Reach 1 Reach 1 conveys continuous flows through an incised, gravel-bedded channel to Gravelly Ford, forming part of the boundary between Fresno and Madera counties. Releases are made at Friant Dam (Figure 14-4) to comply with Holding Contract requirements along Reach 1 and to meet the requirements of the SJRRP. Streamflow of at least 5 cfs for Holding Contracts is maintained past the last diversion near Gravelly Ford, with no Holding Contract requirements for streamflow into Reach 2.

The objective release from Friant Dam into Reach 1 is 8,000 cfs. Reach 1 of the San Joaquin River is hydraulically connected to 190 acres of sand and aggregate mining pits, with an additional 1,170 acres of pits in the surrounding floodplain (McBain and Trush 2002). These pits can attenuate flow and increase evaporation through ponding. There are no storage facilities in Reach 1. Ten major road crossings in this reach can affect flow stage (McBain and Trush 2002). Agricultural return flows in Reach 1 are minor, but have reached up to 300 cfs on occasion (EPA 2007). Stormwater runoff from the Fresno metropolitan area is managed by the Fresno Metropolitan Flood Control District. All but 5 of the District’s 161 drainage basins route stormwater to retention and detention facilities, limiting the urban surface runoff into Reach 1.

Reach 1 is subdivided into two subreaches, 1A and 1B, at State Route (SR) 99. These subreaches are described below.

Reach 1A Flows within Reach 1A are predominantly influenced by releases from Friant Dam, along with diversions and seepage losses. Mining pits in Reach 1 are primarily located in Reach 1A. Eighty-four water diversions are located along this reach, some of which are active on a regular basis. Cottonwood Creek and Little Dry Creek, two intermittent streams, join the San Joaquin River in Reach 1A. Cottonwood Creek, draining 35.6 square miles, flows in from the north near the base of Friant Dam. Little Dry Creek, draining 57.9 square miles, joins the San Joaquin River from the south approximately 8 miles downstream from Friant Dam. Flows in Little Dry Creek can be augmented from Big Dry Creek Dam and Reservoir, a 30 TAF flood control reservoir operated by the Fresno Metropolitan Flood Control District (McBain and Trush 2002). Flows from these two creeks must be included in the 8,000 cfs Reach 1A objective release when determining releases from Friant Dam.

Since 1949, Reclamation has made average annual releases of approximately 117 TAF from Friant Dam to the San Joaquin River to comply with Holding Contract requirements upstream from Gravelly Ford. Since 2009, Reclamation has also made releases for the SJRRP, which has increased average annual releases. Additional river flows occur during years when releases are made to the San Joaquin River for flood management purposes which can range up to 25,000 cfs (see Chapter 12, “Hydrology – Flood Management”). Releases made from Friant Dam for water diversions typically range from 40 cfs to 250 cfs (McBain and Trush 2002). Table 14-3 lists the streamflow gages located in or near this reach segment, their period of record, average streamflow, and maximum daily average flow. Figure 14-4, Figure 14-5, Figure 14-6, and Figure 14-7 show monthly average flows at the gages.

Table 14-3. Streamflow Gages in San Joaquin River Reach 1A

Gage Name	USGS Gage Station No. or CDEC ID	Milepost	Drainage Area (square miles)	Period of Record[1]	Average Streamflow (cfs)[2]	Maximum Daily Average Streamflow (cfs) (date measured)
San Joaquin River release from Friant Dam	MIL	267.6	1,675	1975–2012	926	25,556 (January 4, 1997)
San Joaquin River below Friant Dam	11251000	266.0	1,676	1975–2011[3]	1,241	36,800 (January 3, 1997)
Cottonwood Creek near Friant Dam	CTK	NA	35.6	1975–2012	9	783 (January 27, 1983)
Little Dry Creek near Friant Dam	LDC	NA	57.9	1975–2012	26	2,457 (March 11, 1995)

Source: DWR 2013a; USGS 2013; SJRRP 2013

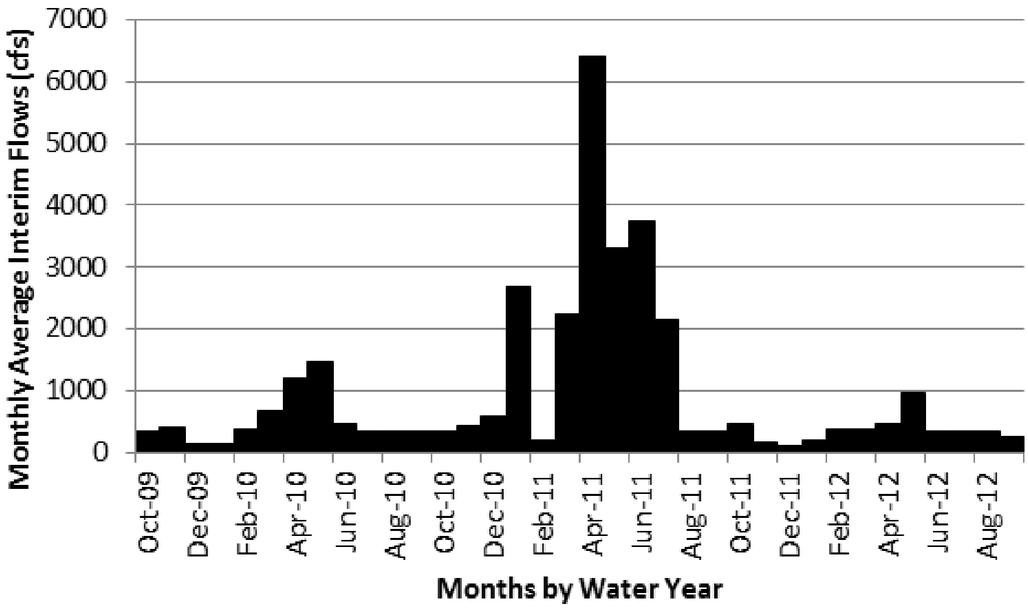
Notes:

[1] Period of record is expressed by Water Year.

[2] Average streamflow data is reported for the referenced period of record, including Interim Flows, which began in Water Year 2009.

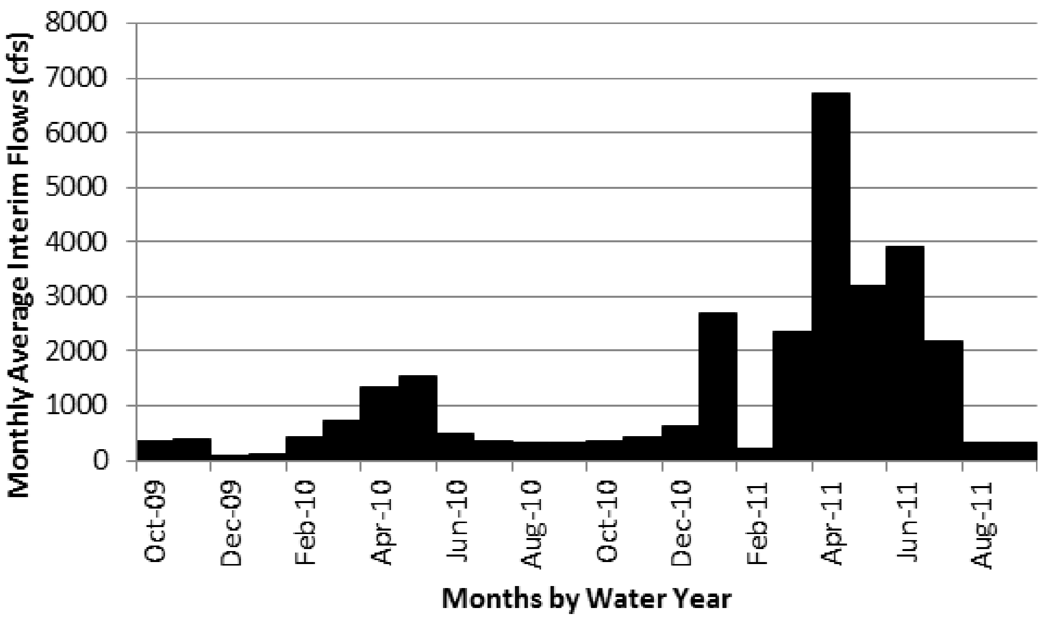
[3] Difference between Friant Dam releases and gage flow below dam caused by minor inflows and depletions between the two locations, and by difference in extent of period of record through Water Year 2011 or Water Year 2012.

Key:
CDEC = California Data Exchange Center
cfs = cubic feet per second
ID = identification
NA = not applicable
No. = number
USGS = U.S. Geological Survey



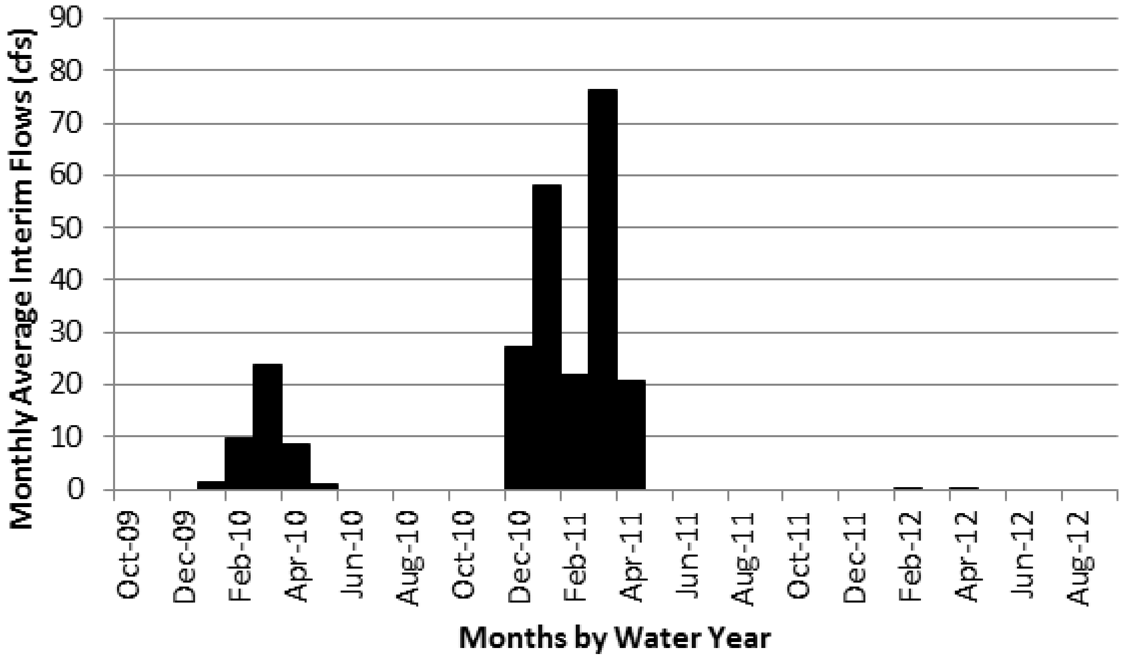
Source: SJRRP 2013, Gage ID SJF
Key: cfs = cubic feet per second

Figure 14-4. Monthly Average Friant Dam Releases (Post-Interim Flows)



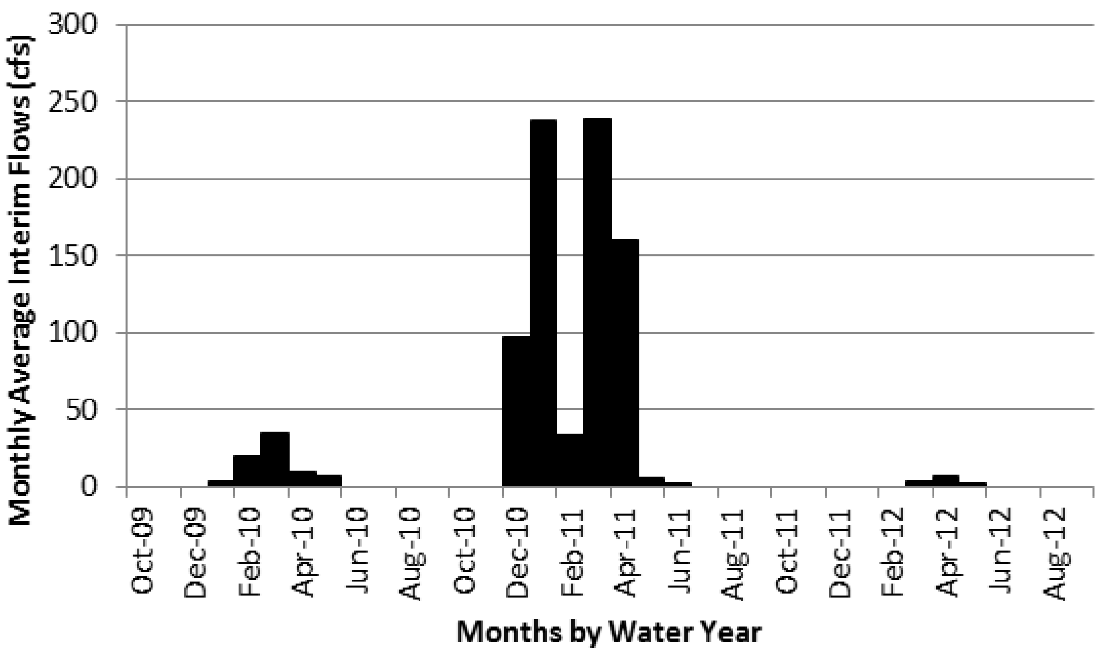
Source: USGS 2013, Gage Station No. 11251000
Key: cfs = cubic feet per second

Figure 14-5. Monthly Average Flows for San Joaquin River Below Friant Dam (Post-Interim Flows)



Source: SJRRP 2013, Gage ID CTK
Key: cfs = cubic feet per second

Figure 14-6. Monthly Average Flows for Cottonwood Creek Near Friant Dam (Post-Interim Flows)



Source: SJRRP 2013, Gage ID LDC
Key: cfs = cubic feet per second

Figure 14-7. Monthly Average Flows for Little Dry Creek Near Friant Dam (Post-Interim Flows)

Reach 1B Flows within Reach 1B are predominantly influenced by inflow from Reach 1A, diversions, and seepage losses. Fifteen water diversions are located along this reach, some of which are regularly active. Table 14-4 lists the gages located in or near this reach segment, their periods of record, and average and maximum daily average streamflows. Figure 14-8 and Figure 14-9 show monthly average flows at the gages. Note that the Donny Bridge gage has several missing monthly of flow data that can be seen in the Skaggs Bridge gage figure.

Table 14-4. Streamflow Gages in San Joaquin River Reach 1B

Gage Name	USGS Gage Station No. or CDEC ID	Milepost	Drainage Area (square miles)	Period of Record[1]	Average Streamflow (cfs)[2]	Maximum Daily Average Streamflow (cfs) (date measured)
San Joaquin River at Donny Bridge	DNB	240.7	NA	1989–2012	336	7,900 (December 30, 1996)[3]
San Joaquin River at Skaggs Bridge	Skaggs[4]	232.1	NA	1975–2012	855	7,900 (December 30, 1996)[3]

Source: SJRRP 2013

Notes:

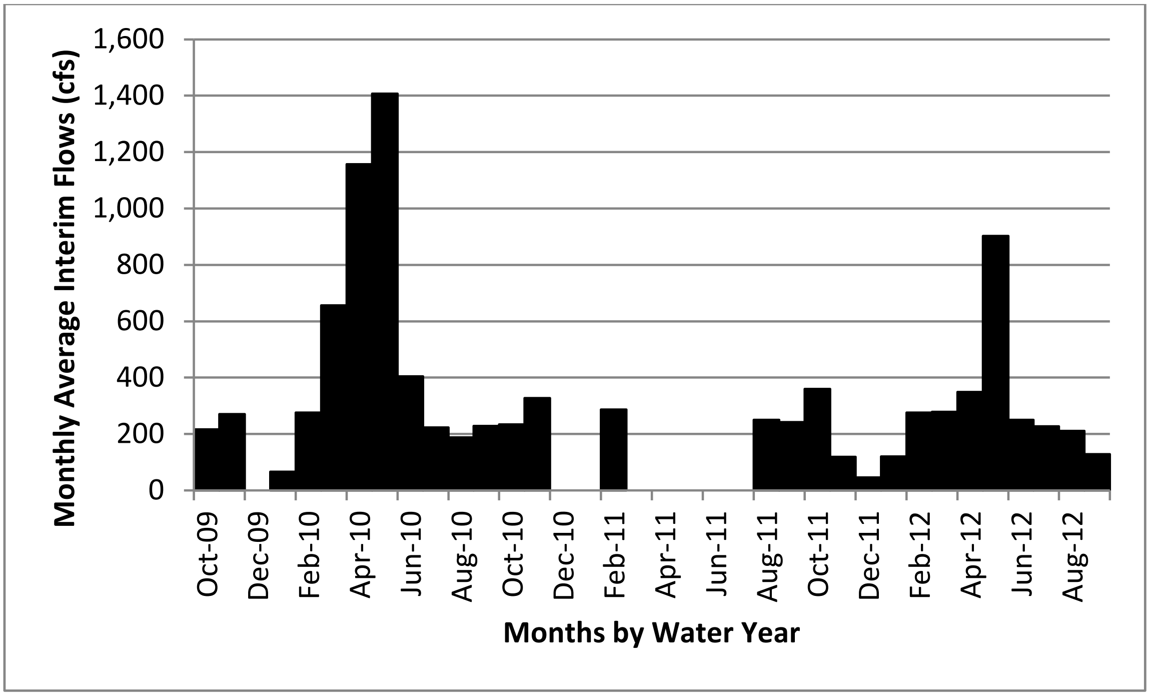
1 Period of record is expressed by Water Year.

2 Average streamflow data is reported for the referenced period of record including Interim Flows, which began in Water Year 2009.

3 This maximum daily average streamflow was exceeded in the January 1997 flood event.

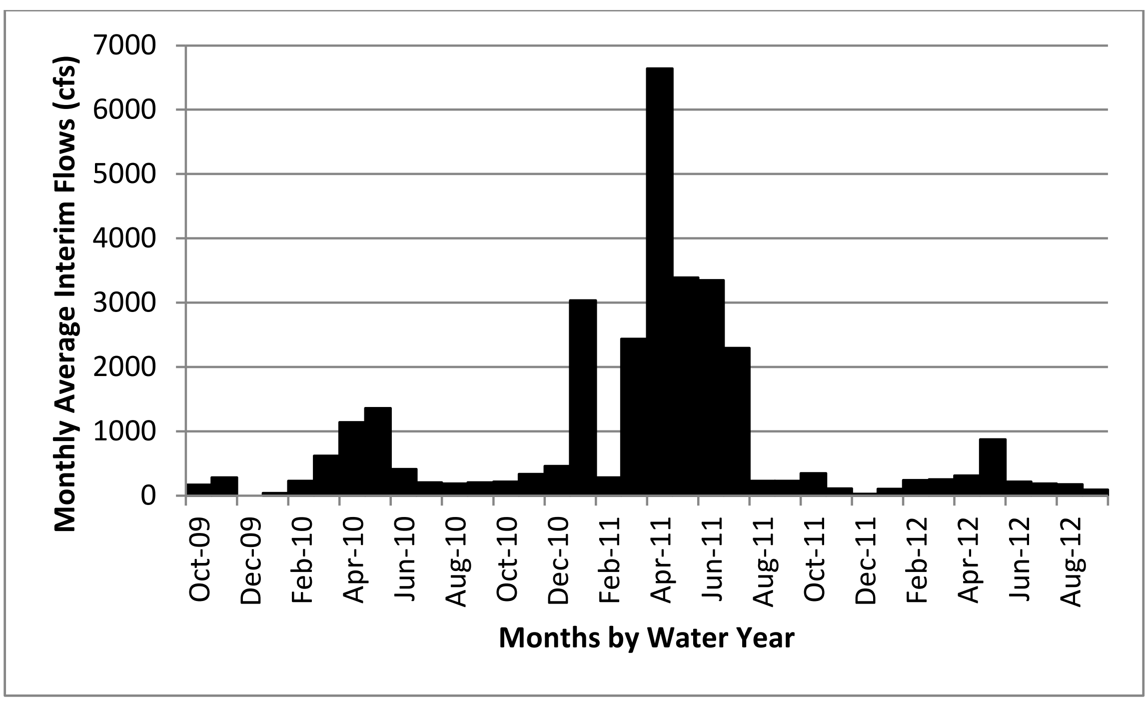
4 San Joaquin River Restoration Program gage ID.

Key:
CDEC = California Data Exchange Center
cfs = cubic feet per second
ID = identification
NA = not applicable/not available
No. = number
USGS = U.S. Geological Survey



Source: SJRRP 2013, Gage ID DNB
Key: cfs = cubic feet per second

Figure 14-8. Monthly Average Flows for San Joaquin River at Donny Bridge (Post-Interim Flows)



Source: SJRRP 2013, Gage ID Skaggs
Key: cfs = cubic feet per second

Figure 14-9. Monthly Average Flows for San Joaquin River at Skaggs Bridge (Post-Interim Flows)

Reach 2 Reach 2 of the San Joaquin River marks the end of the incised channel, and is characterized by a meandering channel of low gradient. Reach 2 ends at Mendota Dam, and the Mendota Pool backwater extends upstream along a portion of this reach.

Before the release of Interim and Restoration flows began, Reach 2 was typically dry and flows only reached Mendota Pool from Reach 2B or from the Fresno Slough during periods of flood management releases. Flood flows most recently reached Mendota Pool from the San Joaquin and/or Kings rivers in 1997, 2001, 2005, 2006, and 2011. Restoration Flows will continue to flow through this reach and be recaptured at Mendota Pool while channel capacity constraints exist downstream.

In addition to Restoration Flows, Mendota Pool regularly receives water from the DMC, delivering water to the Exchange Contractors, other CVP contractors, and wildlife refuges and management areas. Mendota Pool provides no long-term storage for water supply operations or flood management.

The Mendota Pool averages about 400 feet wide, is generally less than 10 feet deep, and has a total capacity of about 8,500 acre-feet (Reclamation 2004). Mendota Dam, built in 1917, is owned and operated by the Central California ID. Mendota Dam is a flashboard-and-buttress dam, 23 feet high and 485 feet long; the crest elevation is 168.5 feet. Mendota Pool distributes water from the DMC and San Joaquin River to local diversion points. Manual gates and flashboards on the dam are opened or removed during periods of high flow to reduce seepage impacts on land surrounding Mendota Pool.

The reach is subdivided into two subreaches, 2A and 2B, at the Chowchilla Bypass Bifurcation Structure. These subreaches are described below.

Reach 2A Reach 2A is typified by the accumulation of sand, caused in part by backwater effects of the Chowchilla Bypass Bifurcation Structure and by a lower gradient relative to Reach 1. Reach 2A has high percolation losses; under steady-state conditions (i.e., losses are calculated under extended periods of steady flow), flow does not reach the Chowchilla Bypass Bifurcation Structure when flow at Gravelly Ford is less than 75 cfs (McBain and Trush 2002). Reach 2A has a design channel capacity of 8,000 cfs to accommodate controlled releases from Friant Dam. Agricultural return flows within this reach are minor. Ten water diversions are located along this reach. Table 14-5 lists the gage located in this reach segment, the period of record, and average and maximum daily average streamflow. Figure 14-10 shows monthly average flows at the gage.

Table 14-5. Streamflow Gage in San Joaquin River Reach 2A

Gage Name	USGS Gage Station No. or CDEC ID	Milepost	Drainage Area (square miles)	Period of Record[1]	Average Streamflow (cfs)[2]	Maximum Daily Average Streamflow (cfs) (date measured)
San Joaquin River at Gravelly Ford	GRF	236.9	NA	1975–2012	798	37,843 (January 4, 1997)

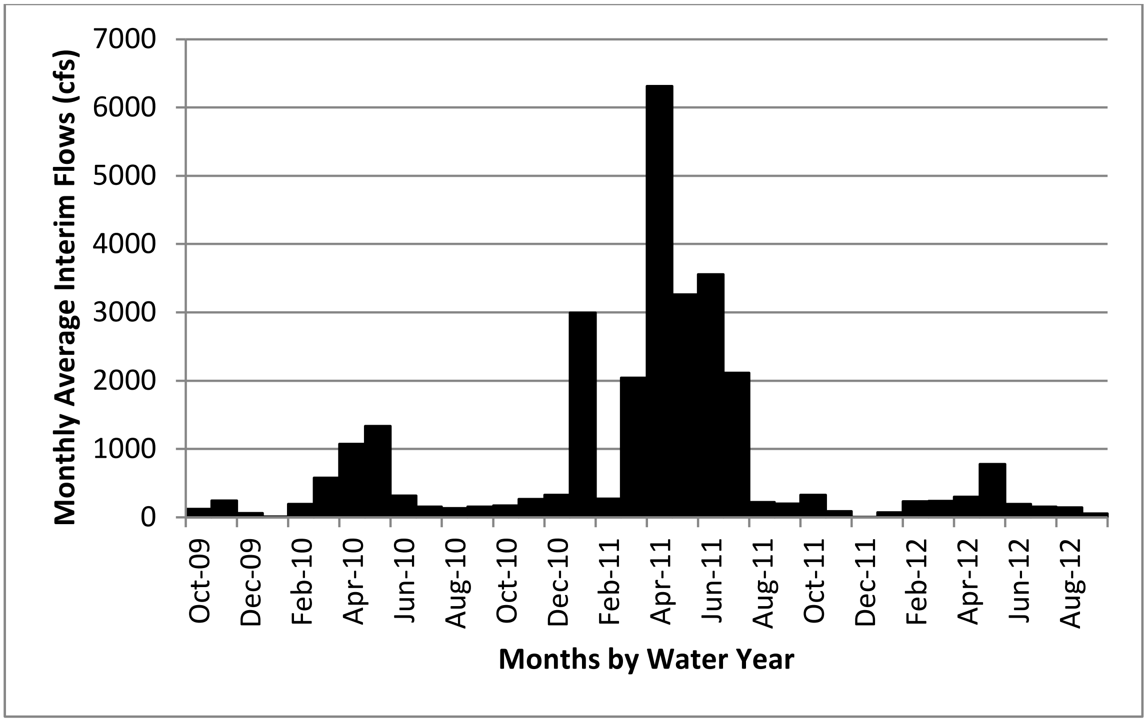
Source: SJRRP 2013

Notes:

[1] Period of record is expressed by Water Year.

[2] Average streamflow data is reported for the referenced period of record including Interim Flows, which began in Water Year 2009.

Key:
CDEC = California Data Exchange Center
cfs = cubic feet per second
ID = identification
NA = not available
No. = number
USGS = U.S. Geological Survey



Source: SJRRP 2013, Gage ID GRF
Key: cfs = cubic feet per second

Figure 14-10. Monthly Average Flows for San Joaquin River at Gravelly Ford (Post-Interim Flows)

Reach 2B Reach 2B is a sandy channel extending into Mendota Pool, bordered by levees. The design conveyance capacity of this subreach is 2,500 cfs, but significant levee seepage has been observed at flows above 1,300 cfs (RMC 2007). Agricultural return flows within this reach are minor. A set of gates and flashboards at Mendota Dam may be manually opened or removed in advance of high-flow conditions. This process lowers the water level in the pool and reduces seepage impacts to adjacent lands, but hinders distribution of flows into canals diverting from Mendota Pool. Twenty-nine water diversions are located along this reach. One major road crossing in this reach can affect flow stage. The DMC typically conveys 2,500 to 3,000 cfs to Mendota Pool, and is the major source of pool inflow during the irrigation season. Table 14-6 shows the gage located in this reach segment, its period of record, and average and maximum daily average streamflow. Figure 14-11 shows monthly average flows at the gage and demonstrates the dry conditions within Reach 2B.

Channel capacity limitations below Mendota Pool have required recapture of most of the Interim and Restoration flows at Mendota Pool. As the capacity of the San Joaquin River downstream from Mendota Pool is gradually increased, Restoration Flows will increase downstream from Mendota Pool, and recapture at Mendota Pool would only occur as needed (e.g., during scheduled construction activities downstream from Mendota Dam, such as in Reach 4B).

Table 14-6. Streamflow Gage in San Joaquin River Reach 2B

Gage Name	USGS Gage Station No. or CDEC ID	Milepost	Drainage Area (square miles)	Period of Record[1]	Average Streamflow (cfs)[2]	Maximum Daily Average Streamflow (cfs) (date measured)
San Joaquin River below Chowchilla Bypass Bifurcation Structure	SJB	217.8	NA	1975–1986, 1989–1997, 2006–2012	277	2,660 (May 23, 1978)

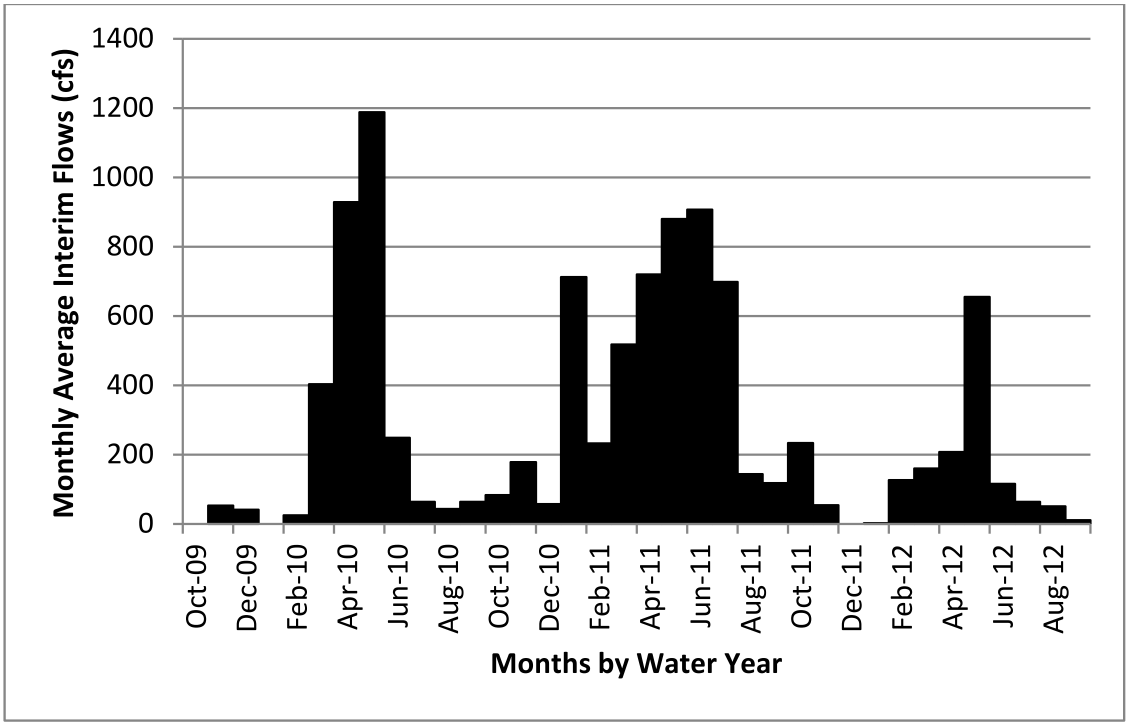
Source: SJRRP 2013

Notes:

[1] Period of record is expressed by Water Years.

[2] Average streamflow data is reported for the referenced period of record including Interim Flows, which began in Water Year 2009.

Key:
CDEC = California Data Exchange Center
cfs = cubic feet per second
ID = identification
NA = not available
No. = number
USGS = U.S. Geological Survey



Source: SJRRP 2013, Gage ID SJB
Key: cfs = cubic feet per second

Figure 14-11. Monthly Average Flows for San Joaquin River Below Chowchilla Bypass Bifurcation Structure (Post-Interim Flows)

Reach 3 Reach 3 of the San Joaquin River flows 23 miles along a sandy channel from Mendota Dam to Sack Dam. The design capacity of Reach 3 is 4,500 cfs; however, observations suggests that seepage and associated flooding may begin in this reach at sustained flows above 800 cfs (RMC 2007). The estimated existing capacity of Reach 3 is 2,760 cfs without any flows on the levees (SJRRP 2014). Flows within this reach predominantly consist of water conveyed from the Delta by the DMC and released into the Mendota Pool for subsequent diversion at Arroyo Canal.

Sack Dam is a 5-foot-high concrete and wood diversion structure delivering water to the Arroyo Canal on the west side of the river (RMC 2003). During the last decade changes in groundwater use within this reach are thought to be causing subsidence between the Eastside Bypass and Reach 3. SLCC reports recent subsidence of Sack Dam at rates exceeding 0.5 feet per year (SLCC 2013). Both CCID and SLCC are working with growers in the western portion of Madera County to develop potential solutions to subsidence in those areas that directly impact Sack Dam and other physical infrastructure (Exchange Contractors 2013, CCID 2012).

Flows of 500 to 600 cfs are typically released from the Mendota Pool for downstream diversions at Sack Dam. Flows greater than required for diversions (such as during flood events) spill over Sack Dam and into the San Joaquin River downstream into Reach 4A. The existing fish passage facility at Sack Dam is inoperable. Seven water diversions are located in this reach. One major road crossing in this reach can affect flow stage.

Table 14-7 lists the gage located in this reach segment, its period of record, and average and maximum daily average streamflow. Figure 14-12 shows monthly average flows at the gage.

Table 14-7. Streamflow Gage in San Joaquin River Reach 3

Gage Name	USGS Gage Station No. or CDEC ID	Milepost	Drainage Area (square miles)	Period of Record[1]	Average Streamflow (cfs)[3]	Maximum Daily Average Streamflow (cfs) (date measured)
San Joaquin River near Mendota	11254000	217.8	3,940	1951–1954, 1975–2011[2]	617	8,770 (May 29, 1952)

Source: USGS 2013

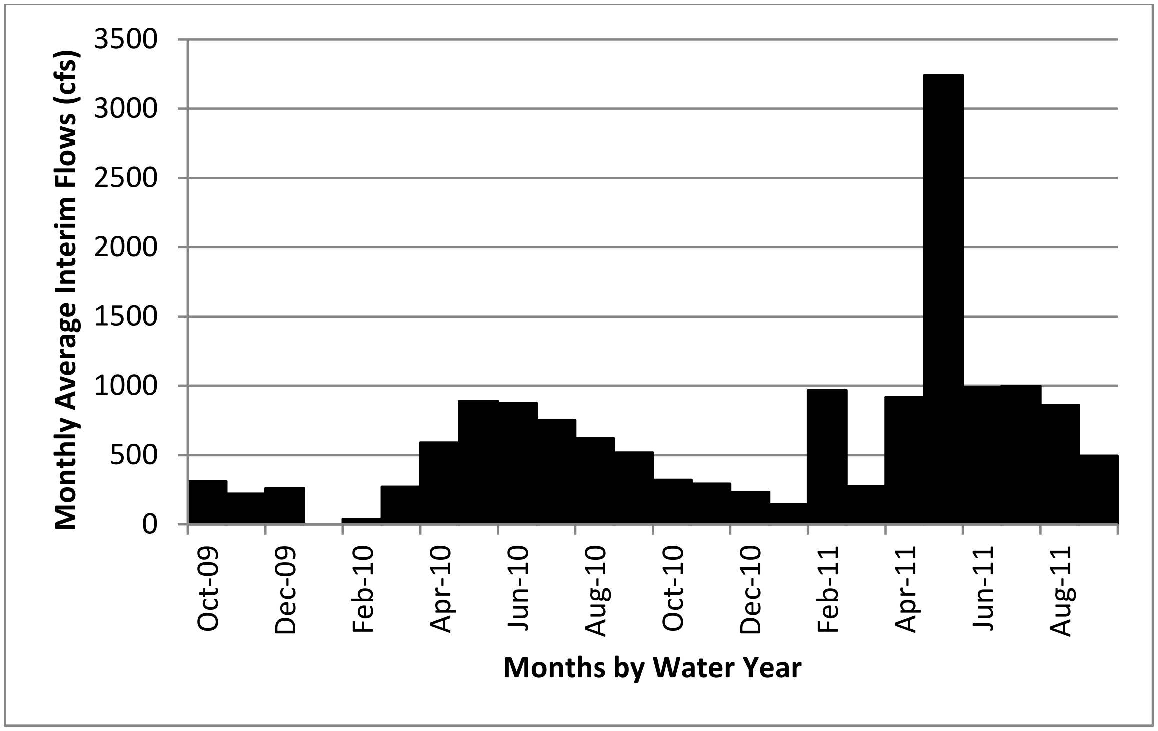
Notes:

[1] Period of record is expressed in Water Years.

[2] Period of record coincides with the start of diversions from Friant Dam (1950).

[3] Average streamflow data is reported for the referenced period of record including Interim Flows, which began in Water Year 2009.

Key:
CDEC = California Data Exchange Center
cfs = cubic feet per second
ID = identification
No. = number
USGS = U.S. Geological Survey



Source: USGS 2013, Gage Station No. 11254000
Key: cfs = cubic feet per second

Figure 14-12. Monthly Average Flows for San Joaquin River near Mendota (Post-Interim Flows)

Reach 4 Reach 4 of the San Joaquin River runs approximately 46 miles from Sack Dam to the confluence of the Eastside Bypass. Flows within much of this reach are predominantly agricultural return flows, although large sections of this reach are dry. Reach 4 is subdivided into three subreaches: Reach 4A, Reach 4B1, and Reach 4B2 (see Chapter 5, "Biological Resources – Fisheries and Aquatic Resources" for a map of these reaches) Reach 4A begins at Sack Dam and extends to the Sand Slough Control Structure; Reach 4B1 extends from the Sand Slough Control Structure to the Mariposa Bypass confluence; and Reach 4B2 begins at the confluence of the Mariposa Bypass and extends to the confluence of the Eastside Bypass.

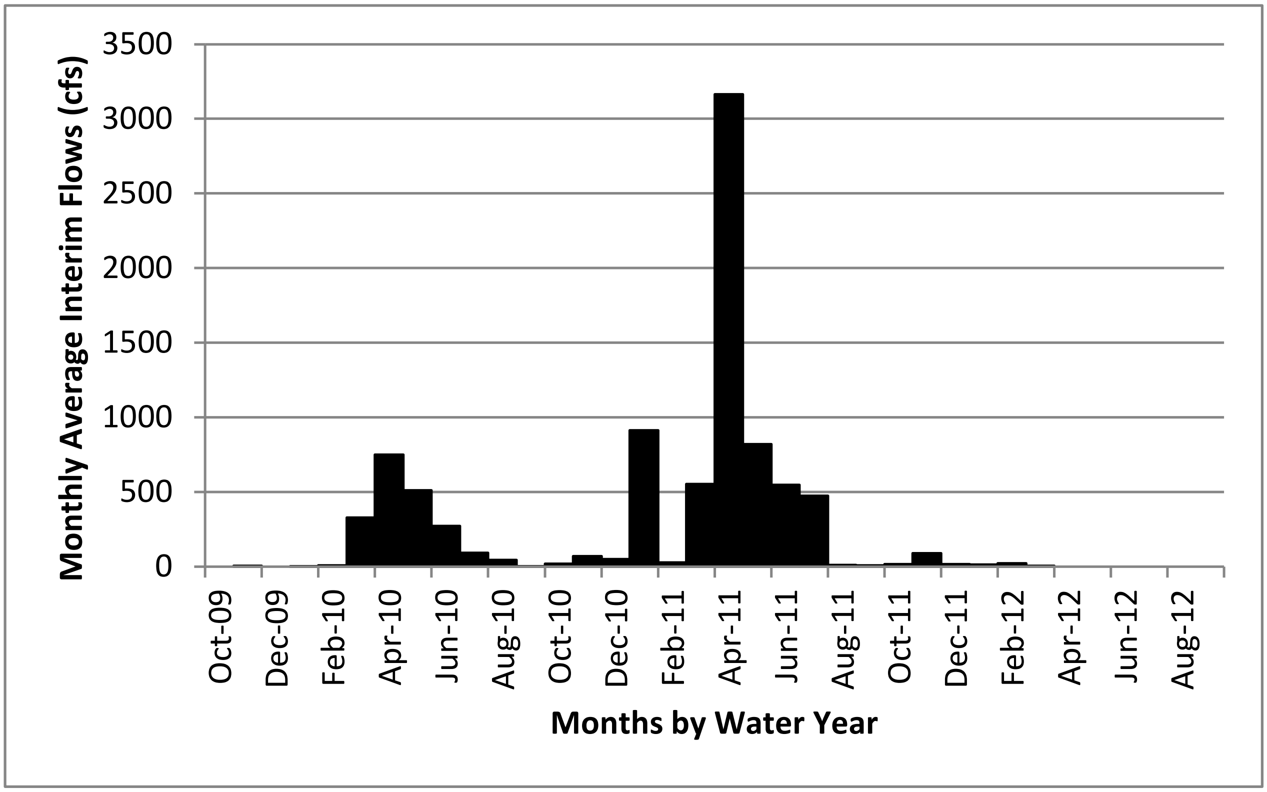
Reach 4 subreaches have different characteristics and design capacities, as discussed below. Several road crossings exist in Reach 4; however, the dry conditions in this reach minimize their effect on stage and flow under current flow regimes.

Reach 4A The design channel capacity in this subreach is approximately 4,500 cfs, beginning at Sack Dam and extending to the Sand Slough Control Structure. The channel below Sack Dam has flow during the agricultural season (agricultural return flows) and during times of upstream flood releases. Four water diversions are located along this subreach. Table 14-8 lists the gage located in this reach segment, its period of record, and average and maximum daily average streamflow. Figure 14-13 shows monthly average flows at the gage.

Table 14-8. Streamflow Gage in San Joaquin River Reach 4A

Gage Name	USGS Gage Station No. or CDEC ID	Mile post	Drainage Area (square miles)	Period of Record[1]	Average Streamflow (cfs)[2]	Maximum Daily Average Streamflow (cfs) (date measured)
San Joaquin River at Sack Dam near Dos Palos	SDP	NA	NA	NA	294	2,660 (May 23, 1978)

Source: SJRRP 2013
Notes:
[1] Water year.
[2] Average streamflow data is reported for the referenced period of record including Interim Flows, which began in Water Year 2009.
Key:
CDEC = California Data Exchange Center
cfs = cubic feet per second
ID = identification
NA = not applicable/not available
No. = number
USGS = U.S. Geological Survey



Source: SJRRP 2013; Gage SDP
Key: cfs = cubic feet per second

Figure 14-13. Monthly Average Flows for San Joaquin River at Sack Dam near Dos Palos (Post-Interim Flows)

Reach 4B1 This subreach has a design capacity of 1,500 cfs, and the Sand Slough Control Structure, which controls the flow split between the main stem of the San Joaquin River and Eastside Bypass, is designed to maintain this design discharge. Current practice, however, keeps the San Joaquin River headgates closed at the Sand Slough Control Structure, diverting all flow from Reach 4B1 to the Eastside Bypass (McBain and Trush 2002). Reach 4B1, therefore, is dry until downstream agricultural return flows contribute a baseflow, although this flow is often pumped and reused for irrigation. No streamflow gages are located in this subreach.

Reach 4B2 The design channel capacity of Reach 4B2 is 10,000 cfs. The channel carries tributary and flood flows from the Mariposa Bypass. No operational storage for water supply exists within this reach. Two water diversions are located along this reach. No streamflow gages are located in this subreach.

Reach 5 Reach 5 of the San Joaquin River extends from the confluence of the Eastside Bypass downstream to the Merced River confluence. The design capacity of Reach 5 is 26,000 cfs; no significant capacity constraints have been identified in this reach. Reach 5 receives flow from Reach 4B2 and the Eastside Bypass. Agricultural and wildlife management area return flows also enter Reach 5 via Mud and Salt sloughs, which drain the west side of the San Joaquin Valley. Three major road crossings within this reach can affect flow stage.

Table 14-9 lists the gages located in or near this reach segment, their periods of record, and average and maximum daily average streamflows. Figure 14-14, Figure 14-15, Figure 14-16, and Figure 14-17 show monthly average flows since Interim Flows began in 2009.

Table 14-9. Streamflow Gages in San Joaquin River Reach 5

Gage Name	USGS Gage Station No. or CDEC ID	Milepost	Drainage Area (square miles)	Period of Record[1]	Average Streamflow (cfs)[2]	Maximum Daily Average Streamflow (cfs) (date measured)
San Joaquin River near Stevinson	SJS	118.2	NA	1982–2011	740	23,900 (January 28, 1997)
Salt Slough at HW 165 near Stevinson	11261100	NA	NA	1986–2012	181	810 (February 20, 1986)
San Joaquin River at Fremont Ford Bridge	11261500	118.2	7,615	1951–1971, 1986–1989, 2002–2011[3]	1025	22,500 (April 8, 2006)
Mud Slough near Gustine	11262900	NA	NA	1986–2012	101	1,060 (February 9, 1998)

Source: DWR 2013a; USGS 2013

Notes:

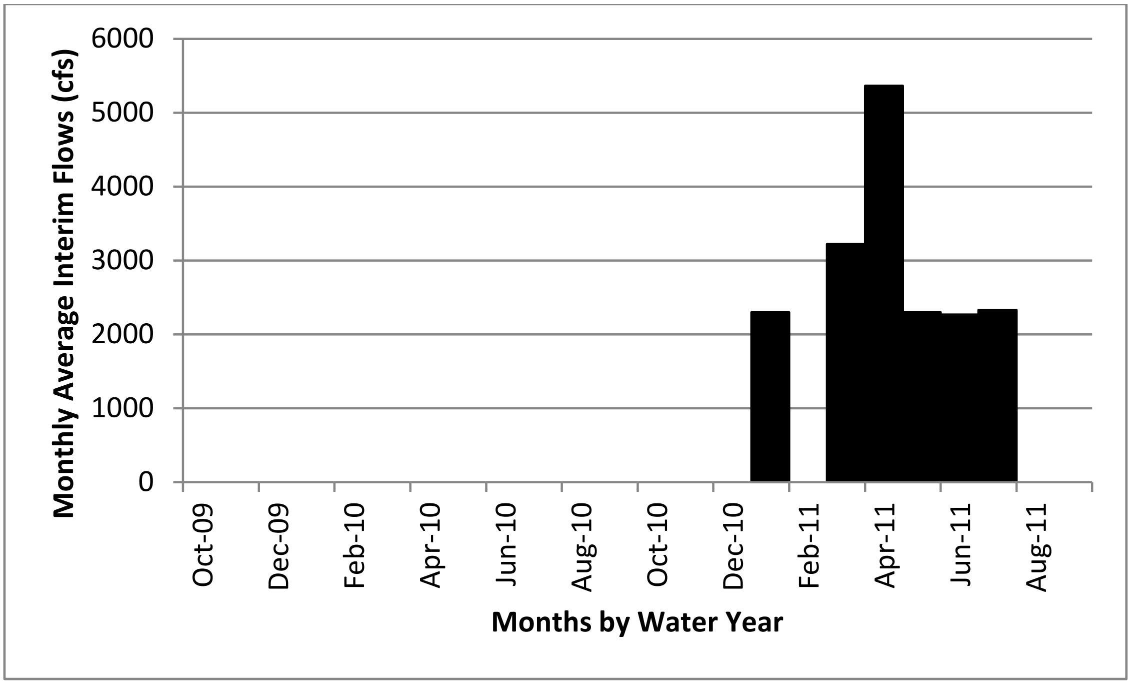
[1] Water year.

[2] Average streamflow data is reported for the referenced period of record including Interim Flows, which began in Water Year 2009.

[3] Period of record coincides with start of diversions from Friant Dam (1950).

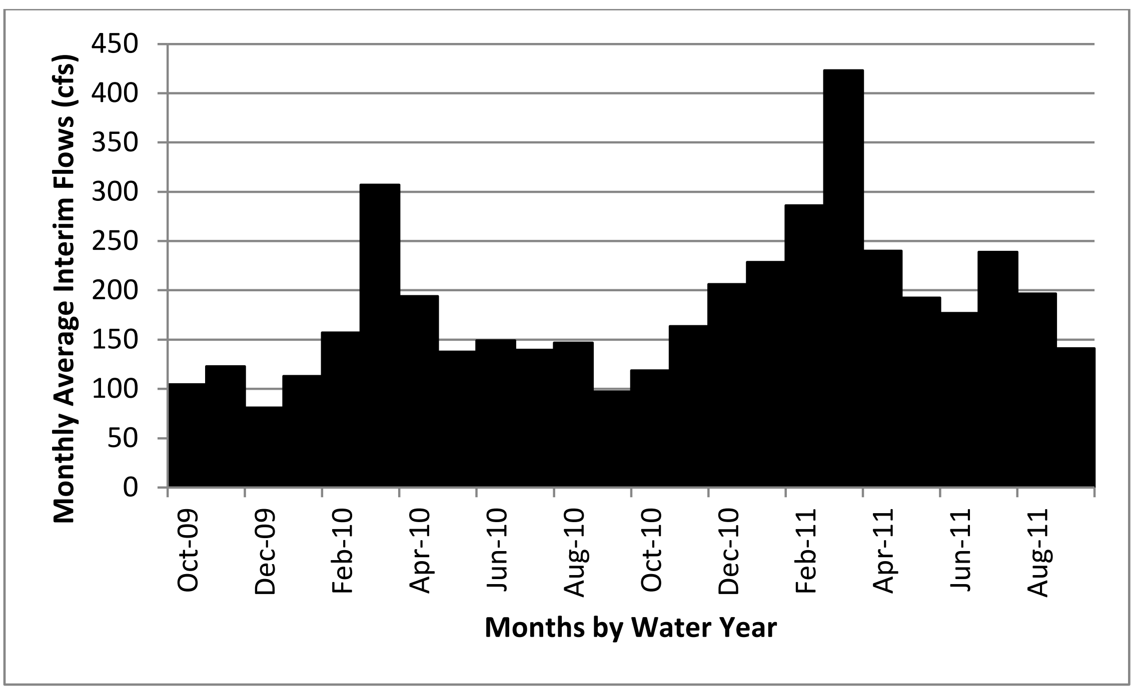
Key:

CDEC = California Data Exchange Center
cfs = cubic feet per second
HW = highway
ID = identification
NA = not applicable/not available
No. = number
USGS = U.S. Geological Survey



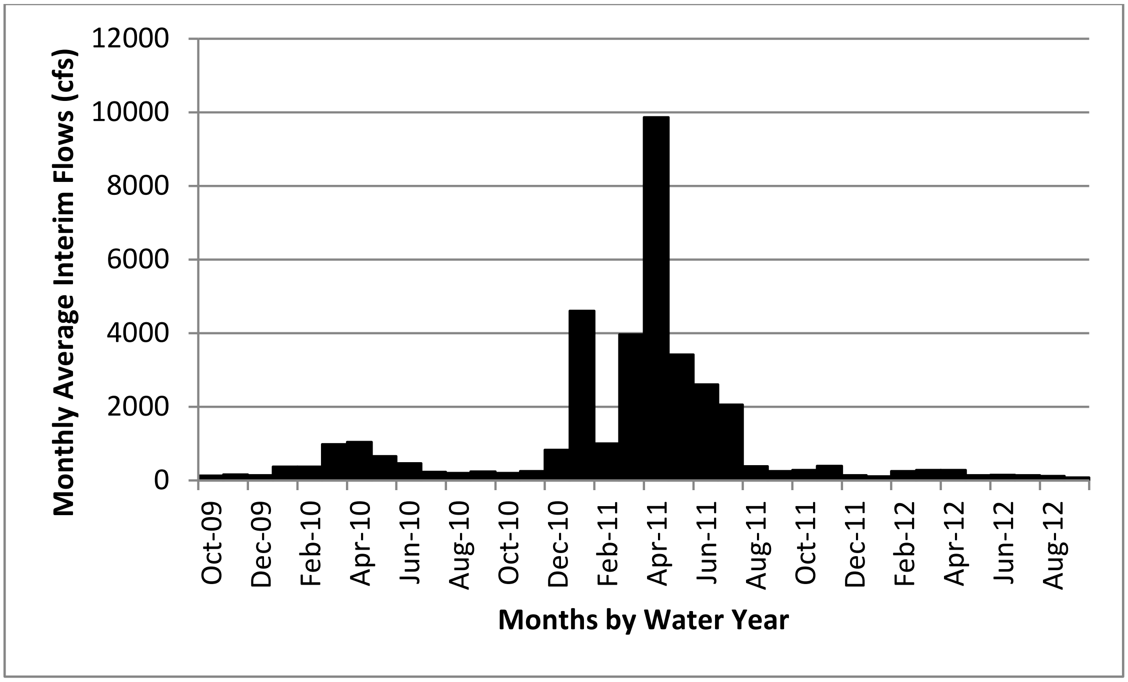
Source: DWR 2013a, Gage ID SJS
Key: cfs = cubic feet per second

Figure 14-14. Monthly Average Flows for San Joaquin River near Stevinson (Post-Interim Flows)



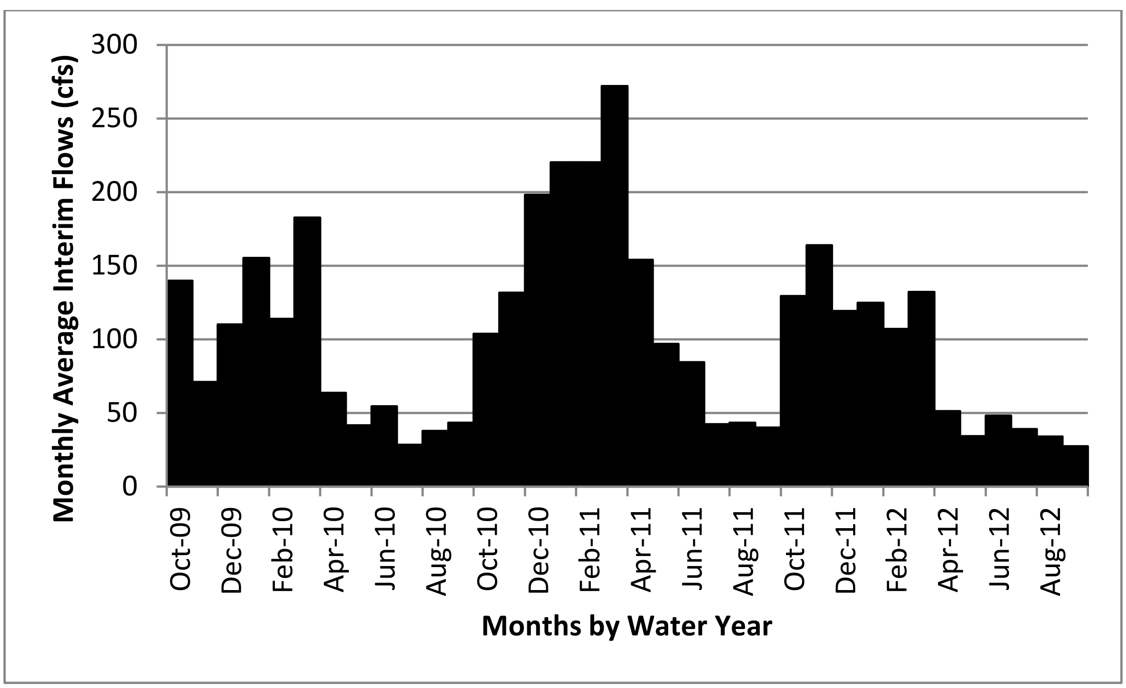
Source: USGS 2013, Gage Station No. 11261100
Key: cfs = cubic feet per second

Figure 14-15. Monthly Average Flows for Salt Slough at Highway 165 near Stevinson (Post-Interim Flows)



Source: USGS 2013, Gage Station No. 11261500
Key: cfs = cubic feet per second

Figure 14-16. Monthly Average Flows for San Joaquin River at Fremont Ford Bridge (Post-Interim Flows)



Source: USGS 2013, Gage Station No. 11262900
Key: cfs = cubic feet per second

Figure 14-17. Monthly Average Flows for Mud Slough near Gustine (Post-Interim Flows)

Fresno Slough/James Bypass The Fresno Slough/James Bypass conveys Kings River flood flows into the San Joaquin River from the south, via the Mendota Pool. Flows from the Kings River are regulated by Pine Flat Dam and the Crescent Weir, which are operated by the Kings River Conservation District. More details regarding Fresno Slough/James Bypass effects on San Joaquin River flood operations can be found in Chapter 12, “Hydrology – Flood Management.” Reclamation supplements natural flow from the Fresno Slough/James Bypass and San Joaquin River into the Mendota Pool with deliveries from the DMC to satisfy water supply contracts. The CVP and SWP Water Service Areas section below describes the effects of Fresno Slough/James Bypass flows on water deliveries at the Mendota Pool.

Chowchilla Bypass and Tributaries The Chowchilla Bypass extends from the Chowchilla Bypass Bifurcation Structure to the Eastside Bypass at the confluence of the Fresno River. More details regarding flood control operations of the Chowchilla Bypass are discussed in Chapter 12, “Hydrology – Flood Management.” The design channel capacity of the bypass is 5,500 cfs. The bypass was constructed in highly permeable soils, and much of the initial flood flows infiltrate and recharge groundwater.

Eastside Bypass, Mariposa Bypass, and Tributaries The Eastside Bypass is divided into three reaches with design channel capacities of 17,000 cfs, 16,500 cfs, and 13,500 cfs, respectively. The channel capacity in Eastside Bypass Reach 3 increases to 18,500 cfs at the confluence of Bear Creek. Flow within Eastside Bypass Reach 3 is controlled by the Eastside Bypass Control Structure. The Mariposa Bypass has a design channel capacity of 8,500 cfs. Flow within the Mariposa Bypass is controlled by the Mariposa Bypass Control Structure, which diverts water from the Eastside Bypass back to Reach 4 of the San Joaquin River. Channel capacities in both bypasses may be less than design capacities because of subsidence of the Eastside Bypass levees, including a cumulative subsidence of approximately 4.5 feet along the Eastside Bypass over the last 5 years due to changes in groundwater use (SLCC 2013). Flood control operations of the Eastside Bypass and Mariposa Bypass are discussed in Chapter 12, “Hydrology – Flood Management.”

Storage on Eastside Bypass tributaries (e.g., Buchanan Dam, Hidden Dam) can be coordinated with CVP Friant Division operations to meet contract deliveries on the Madera Canal

(Reclamation 1997). Hidden Dam forms Hensley Lake on the Fresno River upstream from the Eastside Bypass. USACE operates Hidden Dam for flood control; the total storage of Hensley Lake is 90,600 acre-feet. Buchanan Dam forms Eastman Lake on the Chowchilla River upstream from the Eastside Bypass. USACE operates Buchanan Dam for flood control; the total storage of Eastman Lake is 150,600 acre-feet.

San Joaquin River from Merced River to the Delta

Flows in the San Joaquin River below the Merced River confluence to the Delta are controlled in large part by releases from reservoirs located on tributary systems, including the Merced, Tuolumne, and Stanislaus rivers, to satisfy contract deliveries and instream flow requirements, as well as operational agreements, such as the Vernalis Adaptive Management Program (VAMP) up through 2011.

VAMP was a 12-year experimental management program initiated in 2000, which the State Water Board accepted as the implementation of the San Joaquin River flow standard pursuant to D-1641. It 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 (see Chapter 27, "Cumulative Effects," for more details on VAMP).

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 in the interim until new San Joaquin River flow standards are identified. Merced Irrigation District has and will continue to meet its pulse flow requirements and commitments. Reclamation entered into a two-year agreement with Merced Irrigation District to continue to provide VAMP-like spring pulse flows in the San Joaquin River at Vernalis. However, that agreement expired on December 31, 2013. It is unclear whether Reclamation will be able to continue to acquire water from willing sellers to meet VAMP-like spring pulse flow targets in the San Joaquin River. Concurrently, Reclamation is participating in the San Joaquin Tributary Settlement Process (SJTSP). The goal of the SJTSP is to collaboratively develop an implementation plan for San Joaquin River flow objectives that satisfies all requirements set by regulatory agencies and their ongoing regulatory processes, including the State Water Board's Bay-Delta Plan update and ongoing FERC processes on the Merced and Tuolumne rivers while minimizing impacts to water supply and other beneficial uses. Although VAMP expired in 2011, a VAMP-like operating condition is included in both the Existing Condition and Future No Action Condition of the Reclamation March 2012 Benchmark CalSim II model, as described in the Modeling Appendix.

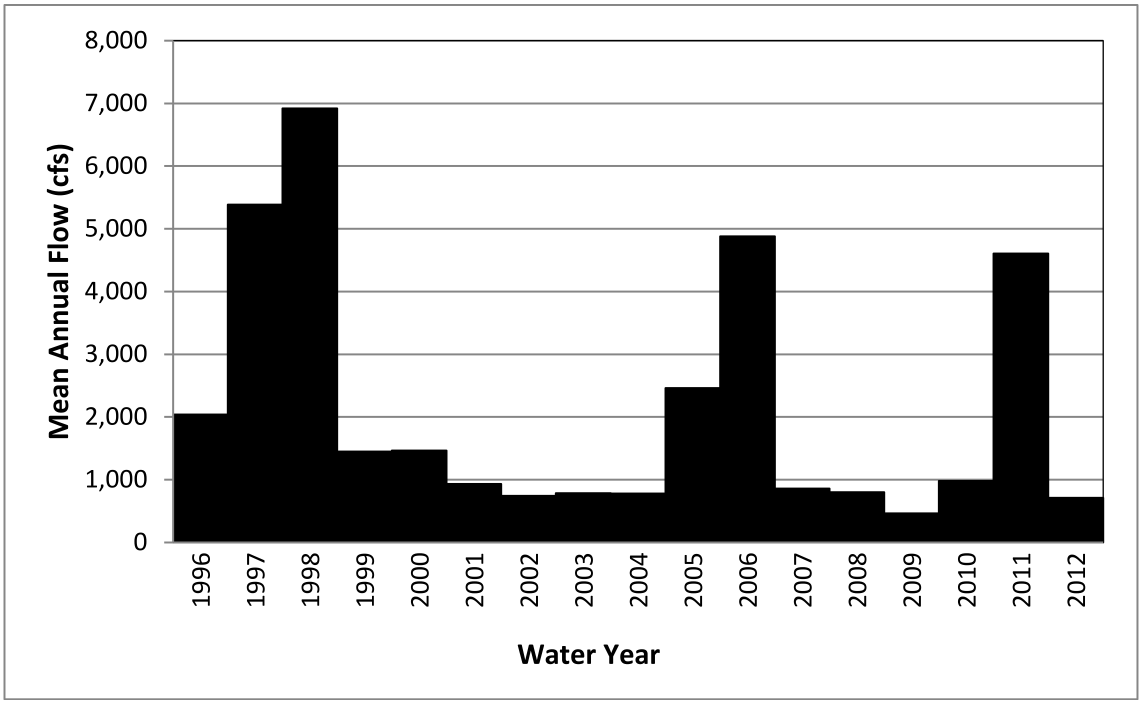
The hydrology and hydraulics of the San Joaquin River downstream from the Merced River return to a more natural state because there is no extensive flood bypass system, and there is continuous tributary flow from the Merced, Tuolumne, and Stanislaus rivers. Table 14-10 lists gages in or near the San Joaquin River downstream from the Merced River, their periods of record, and average and maximum daily average streamflows. Figure 14-18, Figure 14-19, and Figure 14-20 show historical annual average flows at the gages. Table 14-11, Table 14-12, and Table 14-13 show historical average monthly flows at the gages.

Table 14-10. San Joaquin River Streamflow Gages Downstream from the Merced River

Gage Name	USGS Gage Station Number	Milepost	Drainage Area (square miles)	Period of Record[1]	Average Streamflow (cfs)	Maximum Daily Average Streamflow (cfs) (date measured)
San Joaquin River near Crows Landing	11274550	118.2	9,694	1996–2012	2,132	37,600 (January 28, 1997)
San Joaquin River near Vernalis	11303500	NA	13,536	1951–2012[2]	4,401	70,000 (December 9-10, 1950)
Stanislaus River at Ripon	11303000	NA	1,075	1941–2012	956	47,000 (December 24, 1955)

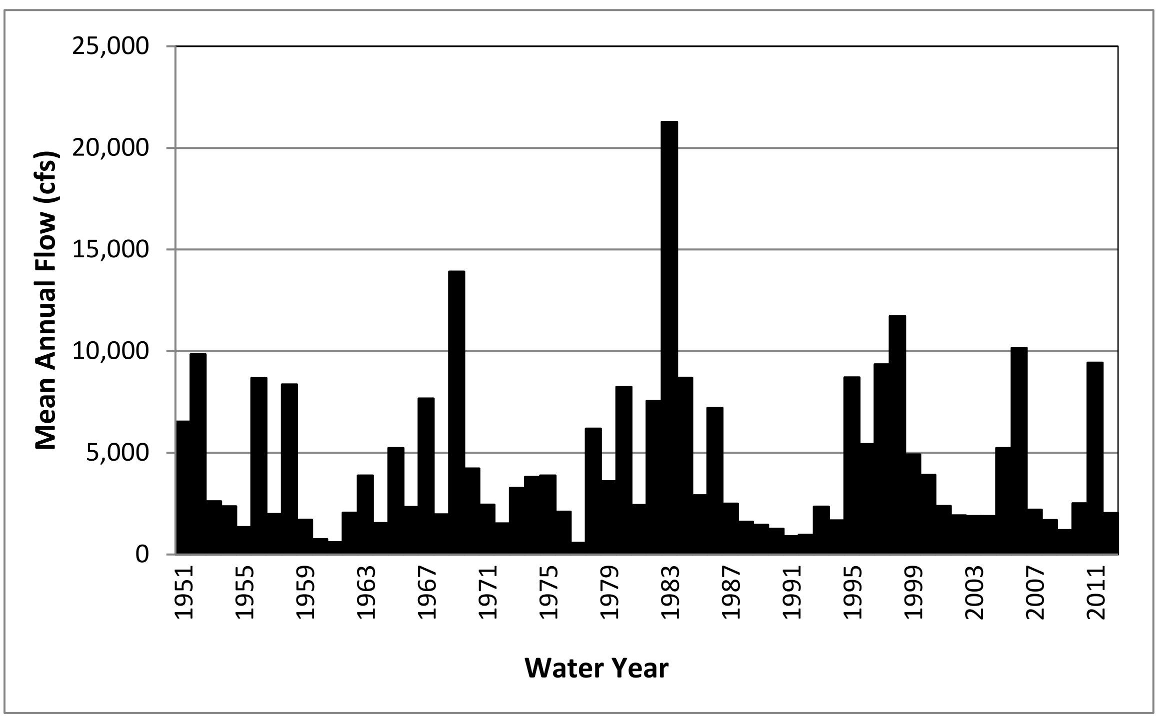
Source: USGS 2013

Notes:
[1] Water year.
[2] Period of record coincides with start of diversions from Friant Dam (1950).
Key:
cfs = cubic feet per second
NA = not available
USGS = U.S. Geological Survey



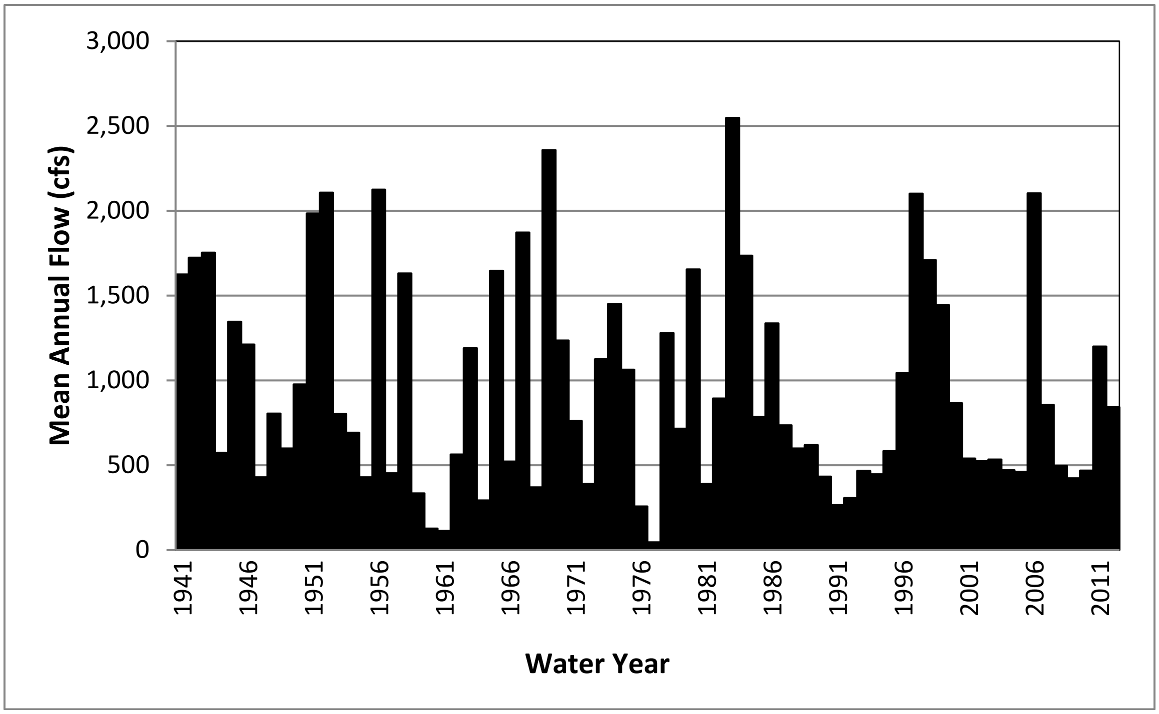
Source: USGS 2013, Gage Station No. 11274550
Key: cfs = cubic feet per second

Figure 14-18. Historical Annual Average Flow for San Joaquin River near Crows Landing



Source: USGS 2013, Gage Station No. 11303500
Key: cfs = cubic feet per second

Figure 14-19. Historical Annual Average Flow for San Joaquin River near Vernalis



Source: USGS 2013, Gage Station No. 11303000
Key: cfs = cubic feet per second

Figure 14-20. Historical Annual Average Flow for Stanislaus River at Ripon

Table 14-11. Historical Average Monthly Flows for San Joaquin River near Crows Landing

Year Type[2]	Average Monthly Flow (cfs)[1]											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Years	1,042	913	1,168	3,187	4,170	3,138	3,859	3,164	2,321	1,370	717	691
Wet	1,102	891	1,752	7,184	9,272	6,082	8,931	6,951	5,455	3,034	1,191	1,133
Above-Normal	1,219	908	940	1,213	2,564	2,724	1,816	1,438	874	619	610	729
Below-Normal	543	677	804	755	833	973	728	769	447	357	334	289
Dry	1,040	1,004	795	914	917	1,163	885	1,031	513	440	436	361
Critical	1,097	1,043	869	1,136	1,224	1,035	789	1,058	574	379	404	368

Source: USGS 2013, Gage Station No. 11274550
Notes:
[1] Period of record Water Years 1996–2012; some years may be missing data.
[2] San Joaquin Valley Water Year Types as defined in Modeling Appendix.
Key:
cfs = cubic feet per second

Table 14-12. Historical Average Monthly Flows for San Joaquin River near Vernalis

Year Type[2]	Average Monthly Flow (cfs)[1]											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Years	2,509	2,383	3,709	5,515	6,778	6,975	7,096	6,788	5,134	2,513	1,627	1,967
Wet	2,349	2,128	4,364	9,479	12,878	14,126	16,278	15,080	11,591	5,384	2,869	3,517
Above-Normal	4,045	4,178	7,039	7,433	8,431	7,187	4,518	4,710	3,291	1,585	1,447	1,812
Below-Normal	1,657	1,850	2,879	2,977	3,170	2,841	2,140	2,803	2,435	914	753	1,008
Dry	2,843	2,571	2,698	2,751	2,506	2,312	1,893	1,844	1,187	968	982	1,139
Critical	1,945	1,719	1,709	1,684	1,666	1,765	1,503	1,469	981	811	827	863

Source: USGS 2013, Gage Station No. 11303500
Notes:
[1] Period of record Water Years 1951–2012; some years may be missing data.
[2] San Joaquin Valley Water Year Types as defined in Modeling Appendix.
Key:
cfs = cubic feet per second

Table 14-13. Historical Average Monthly Flows for Stanislaus River at Ripon

Year Type[2]	Average Monthly Flow (cfs)[1]											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Years	454	462	830	1,152	1,189	1,324	1,487	1,926	1,344	542	402	378
Wet	369	357	972	1,836	1,988	2,317	2,690	3,285	2,358	954	651	625
Above-Normal	649	995	1,702	1,845	1,960	1,694	1,471	2,150	1,172	332	288	316
Below-Normal	272	338	521	623	613	672	937	1,723	1,327	275	194	210
Dry	608	413	579	585	432	438	649	690	474	371	316	227
Critical	472	363	345	314	303	595	559	553	437	365	308	266

Source: USGS 2013, Gage Station No. 11303000
Notes:
[1] Period of record Water Years 1941–2012; some years may be missing data; New Melones Dam constructed by 1978.
[2] San Joaquin Valley Water Year Types as defined in Modeling Appendix.
Key:
cfs = cubic feet per second

Merced River The Merced River flows west out of the Sierra Nevada to its confluence with the San Joaquin River at the end of Reach 5. Merced River streamflows are regulated primarily by New Exchequer and McSwain dams, which form Lake

McClure and Lake McSwain, respectively. The Crocker-Hoffman Diversion Dam is located downstream from New Exchequer and McSwain dams. Lake McClure is a water supply, hydropower, and flood control reservoir. Lake McSwain is a regulating reservoir approximately 6 miles downstream from Lake McClure. Both reservoirs are owned and operated by the Merced ID. Minimum flow standards were established in 1964 (Project No. 2179) by a FERC license and the Davis-Grunsky Contract No. D-GGR17 between Merced ID and DWR. During high-flow events, a portion of Merced River flows are conveyed to the San Joaquin River through Merced Slough.

Tuolumne River The Tuolumne River enters the San Joaquin River downstream from the Merced River. The largest reservoir on the Tuolumne River is New Don Pedro Lake, owned and operated by the Turlock ID and Modesto ID for water supply, hydropower, and flood control purposes. La Grange Reservoir below New Don Pedro Lake is also jointly owned by the two irrigation districts and is operated as a diversion dam. The *1995 New Don Pedro Settlement Agreement* contains instream flow requirements on the Tuolumne River for the anadromous fishery downstream from the project (CDFW et al. 1995).

Stanislaus River The Stanislaus River flows into the San Joaquin River just upstream from Vernalis. New Melones Reservoir is the largest reservoir on the Stanislaus River, operated as part of the CVP for water supply, hydropower, flood control, water quality, and environmental purposes. Downstream from New Melones Reservoir is Tulloch Reservoir, operated as part of the Tri-Dam Project, and Goodwin Reservoir. Both dams are operated by Oakdale Irrigation District and the South San Joaquin Irrigation District.

A 1987 study agreement between CDFW and Reclamation contains Stanislaus River instream flow standards (CDFW and Reclamation 1987). The agreement specifies interim annual water allocations of 98,300 – 302,000 acre-feet, depending on New Melones Reservoir carryover storage and inflow. Annual flow schedules are determined by CDFW. State Water Board Decision 1422 (D-1422) required New Melones storage to be used for meeting a TDS objective of 500 ppm at Vernalis on the San Joaquin River. D-1422 also states water quality goals for DO in the Stanislaus River. A subsequent State Water Board decision, D-1641, revised water quality standards at Vernalis (via the *1995 Bay-Delta Plan*) to an average monthly conductivity of 0.7 µS/cm from April through August, and 1 µS/cm from September through March (State Water Board 2000).

Sacramento-San Joaquin Delta

The hydraulics of the Delta are complicated by tidal influences, a multitude of agricultural and M&I diversions for use within the Delta itself, and by CVP and SWP operations and exports. Principal factors affecting Delta hydrodynamics are (1) river inflow from the Sacramento, San Joaquin River, Mokelumne, and Cosumnes rivers and other smaller eastside tributaries; (2) daily tidal inflow and outflow through San Francisco Bay; and (3) export pumping from the south Delta, primarily through the Banks and Jones pumping plants. Historical average monthly total Delta inflow is shown in Table 14-14 by year type.

Table 14-14. Historical Average Monthly Sacramento-San Joaquin Delta Inflow

Year Type[2]	Average Monthly Inflow (cfs)[1]											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
All Years	15,974	18,986	35,174	55,667	63,789	57,610	42,701	32,288	24,846	19,903	17,986	18,141
Wet	18,972	25,159	61,626	97,084	106,684	92,290	77,677	53,943	39,662	25,702	21,850	23,621
Above-Normal	12,717	15,297	21,482	65,912	74,084	74,818	37,090	33,465	23,817	19,602	18,647	18,497
Below-Normal	16,291	16,045	20,588	30,082	44,193	37,739	24,312	21,703	18,119	17,263	16,515	16,043
Dry	13,652	16,370	20,294	20,787	26,815	27,825	17,701	15,526	13,650	16,884	15,695	14,005
Critical	13,750	13,283	16,409	17,924	18,340	17,306	13,158	10,694	10,654	12,395	12,249	11,756

Source: calculated value, DWR 2013b
Notes:
[1] Period of record Water Years 1956–2012.
[2] Sacramento Valley Water Year Types as defined in Modeling Appendix.
Key:
cfs = cubic feet per second

Average winter outflow from the Delta is about 32,000 cfs, while the average summer outflow is 6,000 cfs. Because of tidal factors and changing channel geometry, Delta outflow is typically calculated rather than a directly measured. Table 14-15 shows the calculated average monthly Delta outflow by year type.

Table 14-15. Historical Average Monthly Sacramento-San Joaquin Delta Outflow

Year Type[2]	Average Monthly Outflow (cfs)[1]											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Years	9,416	14,265	30,524	51,788	60,313	53,174	37,726	26,598	16,136	8,464	6,575	9,146
Wet	12,587	21,391	58,629	94,595	103,949	89,633	73,810	48,198	30,735	14,277	10,408	15,036
Above-Normal	6,764	10,939	17,088	61,808	69,422	70,412	32,302	27,895	13,479	7,188	6,008	7,877
Below-Normal	10,394	11,745	16,201	26,774	42,353	32,811	19,423	15,722	8,450	5,472	4,970	6,932
Dry	6,894	10,770	14,135	16,013	22,610	22,532	11,215	9,814	5,711	4,378	3,557	4,853
Critical	5,660	6,426	8,947	11,110	12,925	9,971	7,087	5,435	4,079	3,675	3,167	3,463

Source: calculated value, DWR 2013b
Notes:
[1] Period of record Water Years 1956–2012.
[2] Sacramento Valley Water Year Types as defined in Modeling Appendix.
Key:
cfs = cubic feet per second

The San Joaquin River enters the Delta downstream from Vernalis and splits into several channels including the main river channel, Middle River, and Old River. In the south Delta, CVP and SWP export pumping in Middle and Old rivers can further reduce the minimum water levels such that sufficient pump draft cannot be maintained, and irrigation diversions for local agriculture can be interrupted. Historically, the Middle River, which contains a temporary barrier to facilitate adequate water levels and water quality for agricultural diversions, has its highest monthly minimum stage in February and is about 0.1 foot below msl. The lowest monthly minimum stage typically occurs in August and is about 0.8 feet below msl. During dry and critical years, under existing conditions, the highest minimum stage in the Middle River typically occurs in April and is about 0.6 feet below msl.

The CVP pumping facility is the Jones Pumping Plant, formerly called the Tracy Pumping Plant. The Jones Pumping Plant is at the end of an earth-lined intake channel about 2.5 miles long. The Jones Pumping Plant consists of six pumps, with a nominal and permitted pumping capacity of 4,600 cfs during the irrigation season, and 4,200 cfs during the winter nonirrigation season. Limitations at the Jones Pumping Plant are the result of a DMC freeboard constriction near the O'Neill Forebay at San Luis Reservoir, and current water demand in the upper sections of the DMC. The SWP pumping facility is the Banks Pumping Plant. The Banks Pumping Plant supplies water for the South Bay Aqueduct and the California

Aqueduct, and consists of 11 pumps that have a total combined installed capacity of 10,300 cfs. Under current operational constraints, exports from the 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 TAF 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.

Recent historical average monthly pumping, by year type, at the Jones and Banks pumping plants are shown in Table 14-16 and Table 14-17, respectively.

Table 14-16. Historical Average Monthly Exports from the Jones Pumping Plant

Year Type[2]	Average Monthly Exports (cfs)[1]											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Years	2,943	2,394	2,120	2,384	2,769	2,876	2,544	2,333	3,040	3,952	3,952	3,363
Wet	2,857	2,110	1,767	2,135	2,672	2,713	2,303	2,491	3,222	4,005	4,134	3,182
Above-Normal	2,532	1,697	1,332	2,407	2,985	3,062	2,618	2,262	3,458	4,287	4,186	3,695
Below-Normal	2,825	2,301	1,991	1,753	2,150	2,719	2,467	2,464	3,450	4,289	4,121	3,495
Dry	3,212	2,858	2,664	2,765	2,907	2,880	2,971	2,193	2,993	4,342	4,185	3,558
Critical	3,305	3,227	3,148	3,286	3,416	3,334	2,624	2,010	1,747	2,564	2,737	3,118

Source: calculated value, DWR 2013b
Notes:
[1] Period of record Water Years 1956–2012.
[2] Sacramento Valley Water Year Types as defined in Modeling Appendix.
Key:
cfs = cubic feet per second

Table 14-17. Historical Average Monthly Exports from the Banks Pumping Plant

Year Type[2]	Average Monthly Exports (cfs)[1]											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Years	2,313	2,284	2,826	3,029	2,582	2,369	1,753	1,233	1,732	2,953	3,521	3,093
Wet	2,331	2,215	2,643	2,472	2,102	1,543	1,522	1,297	1,938	2,925	3,357	2,870
Above-Normal	2,040	2,636	3,359	4,781	4,162	2,443	1,605	1,287	3,078	3,635	4,496	4,183
Below-Normal	1,738	1,564	2,036	2,463	1,834	2,170	1,484	1,199	1,758	3,022	3,555	3,296
Dry	2,077	2,531	2,926	2,747	2,513	2,918	2,177	1,129	1,052	3,540	3,992	3,108
Critical	3,549	2,720	3,690	4,053	3,481	3,966	2,239	1,203	912	1,539	2,405	2,449

Source: calculated value, DWR 2013b

Notes:

[1] Period of record Water Years 1968–2012.

[2] Sacramento Valley Water Year Types as defined in Modeling Appendix.

Key:

cfs = cubic feet per second

A number of agreements exist between Reclamation and DWR regarding how the CVP and SWP will jointly operate to meet the goals and needs of the projects, and to meet shared responsibilities for in-basin flow and water quality requirements in the Delta. Both projects export water from the Delta for use in areas to the south. This has led to issues involving how the requirements would be met by the two projects, and which project could export any naturally occurring water in excess of the requirements. For example, the *Coordinated Operation Agreement* (COA), signed in November 1986, contains joint operations rules that the CVP and SWP have agreed to follow to allow operations while meeting in-basin flow and/or water quality standards in the Delta (Reclamation and DWR 1986).

CVP and SWP operations are also constrained by a number of flow and quality regulations throughout the Sacramento River Basin that have occurred since the COA was signed. These other operational agreements have been developed to define how the CVP and SWP will share these responsibilities. Many of these agreements restrict maximum allowable export from the Delta at any time and can be impacted by changes in Delta inflow. Typically, the CVP and SWP attempt to maximize their export pumping from the Delta within these operational constraints (see Modeling Appendix for a description of operational constraints considered in this study).

Contra Costa Water District (CCWD) supplies CVP water to its users via several Delta intakes. At the Rock Slough pumping plant, the water is lifted 127 feet into the Contra Costa Canal by a series of four pumping plants. The 47.5-mile-long canal terminates in Martinez Reservoir. The canal capacity gradually decreases from the Rock Slough diversion capacity of 350 cfs to 22 cfs at the terminus. Table 14-18 shows historical average monthly exports from the CCWD Rock Slough Pumping Plant by year type.

CCWD also constructed and operates the 160,000-acre-foot Los Vaqueros Reservoir, which has an intake and pumping plant on the Old River for diverting surplus Delta flows to reservoir storage, or CVP contract water to CCWD users. CCWD constructed an alternate intake on Victoria Canal for this diversion in 2010. CCWD also has a fourth diversion facility in the Delta, at the southern end of a 3,000-foot-long channel running due south of Suisun Bay, near Mallard Slough. This facility has a capacity of 39.3 cfs.

Los Vaqueros Reservoir is refilled by diversions only when source water chloride concentration is relatively low. Los Vaqueros water is used for water quality blending and delivery during low Delta outflow periods, when the chloride concentration at Rock Slough and the Old River is greater than 65 mg/L. The Old River and Victoria Canal facilities allow CCWD to divert up to 250 cfs to a blending facility with the Contra Costa Canal, and to divert up to 200 cfs of CVP and Los Vaqueros water rights water for storage in Los Vaqueros Reservoir. The Mallard Slough facility is only used during periods of very high Delta outflow.

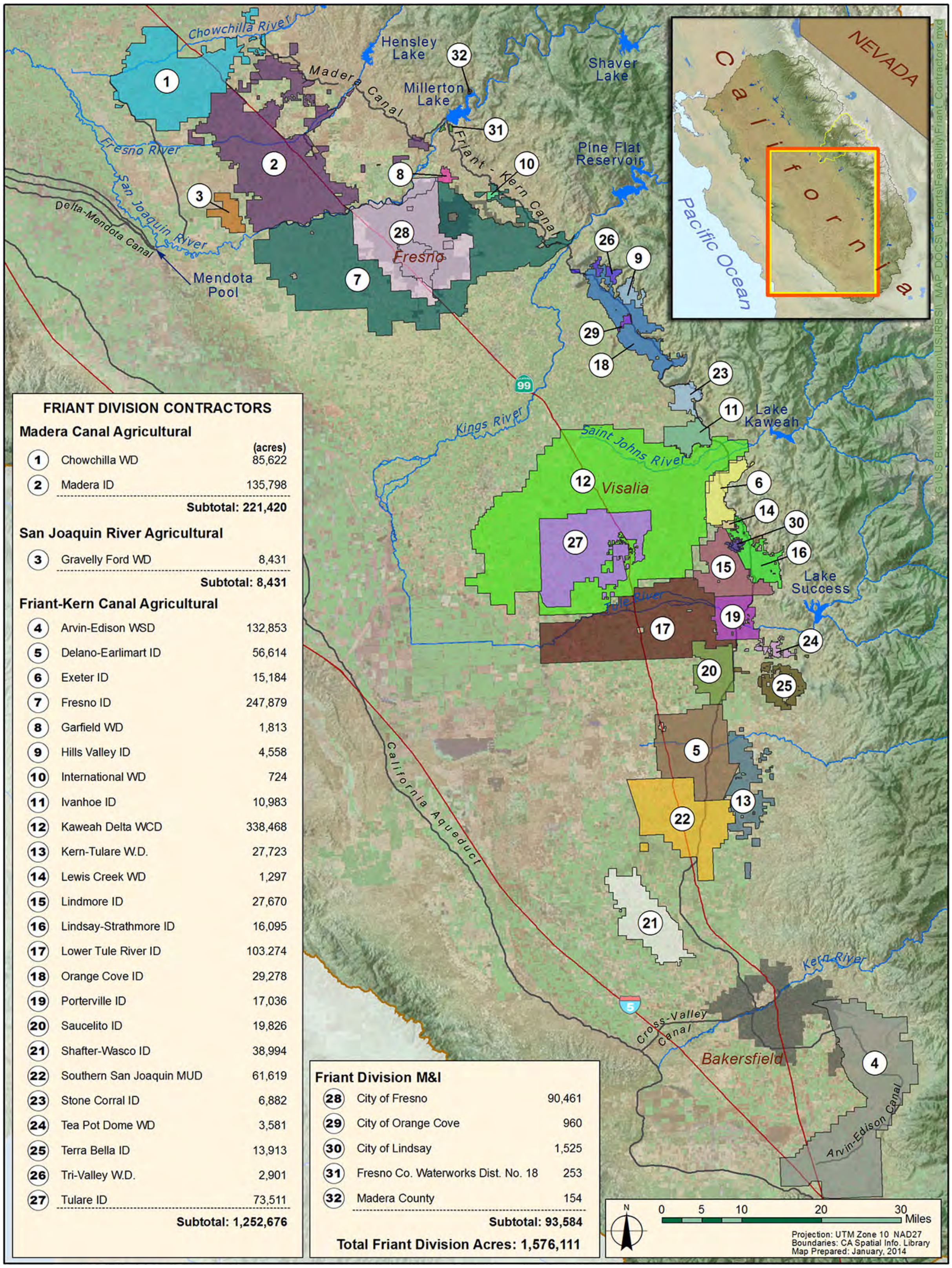
Table 14-18. Historical Average Monthly Exports from the Contra Costa Water District Rock Slough Pumping Plant by Year Type

Year Type[2]	Average Monthly Exports (cfs)[1]											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
All Years	125	104	81	86	95	99	113	151	212	218	199	159
Wet	130	98	73	72	72	79	89	128	173	186	202	160
Above-Normal	113	88	72	95	96	97	129	137	191	207	196	165
Below-Normal	103	109	91	86	104	83	111	157	233	238	221	156
Dry	126	98	72	86	91	124	131	179	270	257	175	145
Critical	147	131	113	117	152	140	136	176	222	232	199	172

Source: calculated value, DWR 2013b
Notes:
[1] Period of record Water Years 1956–2012.
[2] Sacramento Valley Water Year Types as defined in Modeling Appendix.
Key:
cfs = cubic feet per second

Central Valley Project Friant Division Water Service Area and Facilities

Friant Division facilities include Friant Dam and Millerton Lake, and the Madera and Friant-Kern canals, which convey water north and south, respectively, to agricultural and urban water contractors. These facilities are described in the San Joaquin River System Upstream from Friant Dam section, above. Historically, the Friant Division has delivered an average of about 1,300 TAF of water annually. Figure 14-21 shows the locations and acreage of the 28 Friant Division long-term contractors.



Note: Includes Friant Division Long-Term Contractors as of 2013.

Figure 14-21. Central Valley Project Friant Division Long-Term Contractors

The Friant Division was designed and is operated to support conjunctive water management in an area that was subject to groundwater overdraft. Chapter 13, “Hydrology – Groundwater,” discusses the current state of groundwater use and overdraft in the region. Reclamation employs a two-class system of water allocation to support conjunctive water management and take advantage of water during wetter years:

- Class 1 supplies, which are based on a firm water supply, are generally assigned to M&I and agricultural water users who have limited access to quality groundwater, although most Friant Division long-term contractors have contracted for a combination of Class 1 and Class 2 supplies. During project operations, the first 800 TAF of annual water supply are delivered as Class 1 water.

- Class 2 water is a supplemental supply and is delivered directly for agricultural use or for groundwater recharge, generally in areas that experience groundwater overdraft. Larger Class 2 contractors typically have access to good quality groundwater supplies and can use groundwater during periods of surface water deficiency. Many Class 2 contractors are in areas with high groundwater recharge capability and operate dedicated groundwater recharge facilities. Total Class 2 contracts equal 1.4 MAF.

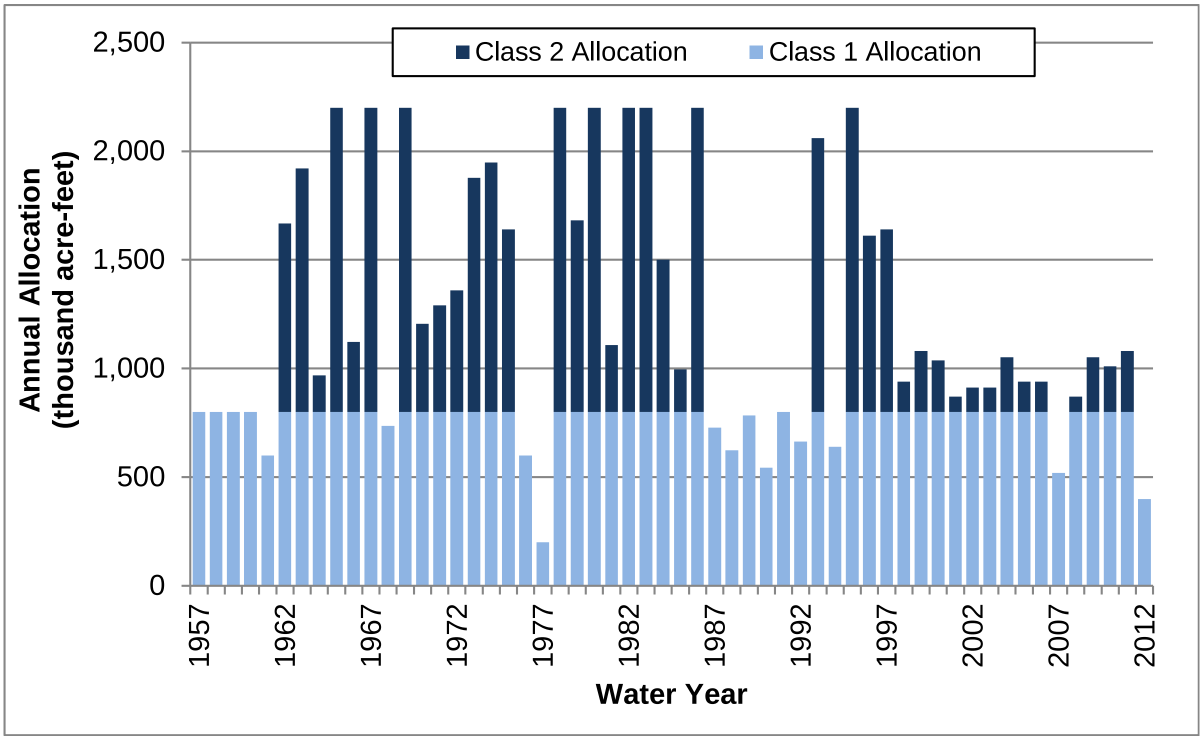
- In addition to Class 1 and Class 2 water deliveries, water can be provided in accordance with Section 215 of the Reclamation Reform Act of 1982, which authorizes delivery of unstorable water that would otherwise be released in accordance with flood management criteria or unmanaged flood flows. Delivery of such water has enabled San Joaquin Valley groundwater to be replenished at levels higher than otherwise could be supported with Class 1 and Class 2 contract deliveries.

- The RWA program also makes water available, in wet hydrologic conditions, to all Friant Division long-term contractors who provide water to meet Restoration Flows, at a total cost of $10 per acre-foot. The reduction in water deliveries caused by Restoration Flows is monitored and recorded in the RWA.

Figure 14-22 shows the historical declared allocation of water to Friant Division contractors. Actual historical delivery of Class 2 water supplies may be less than but do not exceed declared allocations. As shown, annual allocation of Class 1 and Class 2 water varies widely in response to hydrologic conditions.

From 1957 through 2012, annual allocations of Class 1 water were typically at or above 75 percent of contract amounts, except in 4 extremely dry years. In this same period, full allocation of Class 2 water supplies occurred in about 20 percent of years. During the extended drought of 1987 through 1992, no Class 2 water was available and Class 1 allocations were below full contract amounts, except in 1 year (1991). During this and other historical drought periods, water contractors relied heavily on groundwater to meet water demands.

In addition to the Class 1, Class 2, and conjunctive management aspects of Friant Division operations, a program of transfers between districts takes place annually. This program provides opportunities to improve water management within the Friant Division Water Service Area. In wet years, water surplus to one district's need can be transferred to other districts with the ability to recharge groundwater. Conversely, in dry years, water is returned to districts with little or no groundwater supply, thereby providing an ongoing informal groundwater banking program within the Friant Division.



Note: Actual historical delivery of Class 2 water supplies may be less than but does not exceed declared allocations shown in figure.

Figure 14-22. Historical Water Allocation to Friant Division Contractors

The Cross Valley Canal is a privately owned canal that was constructed in the mid-1970s through a collaborative effort of several water agencies. The Cross Valley Canal is operated by the Kern County Water Agency (KCWA), which completed the Cross Valley Canal Expansion Project in 2012, increasing capacity to 1,422 cfs. The Cross Valley Canal allows water to be conveyed between the California Aqueduct and the Friant Kern Canal, for delivery to seven CVP contractors located in the east side of the southern San Joaquin Valley. CVP water supply from the Delta was designed to be delivered to Arvin-Edison Water Storage District (WSD) in exchange for a portion of their Friant Division CVP water supply available through Millerton Lake. Recently, Pixley ID and Lower Tule River ID have discontinued the exchange with Arvin-Edison WSD and have transferred their CVP water to other CVP WDs and purchased local supplies.

Other Central Valley Project Water Service Areas and Facilities

The CVP provides water to about 273 contractors, including Settlement Contractors in the Sacramento Valley, the 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. Several of the Federal contractors have water service areas located south of the Delta; most of their CVP supplies must be conveyed through the Delta before delivery.

Through an Exchange Contract, Reclamation provides a substitute water supply to the Exchange Contractors (CCID, Columbia Canal Company, SLCC, and the Firebaugh Canal WD), in exchange for the use of San Joaquin River water within the Friant Division. Each of the four Exchange Contractor entities has separate conveyance and delivery systems operated independently, although their combined water supply is managed as one unit for performance under the Exchange Contract. The Exchange Contractors, along with eight additional water right contractors, have conveyance and delivery systems that generally divert water from the DMC or Mendota Pool, convey water to customer delivery turnouts, and at times discharge to tributaries of the San Joaquin River.

Each February, and monthly thereafter, Reclamation evaluates hydrologic conditions throughout California to forecast CVP operations and to estimate the amount of water to be made available to Federal water service contractors for the contract year. Allocations vary from year to year, and are based on unimpaired inflow to Shasta Lake. In general, allocations to CVP water service contractors south of the Delta are lower than allocations to service contractors in the Sacramento Valley.

The CVP water service contracts have varying water shortage provisions. In 2001, Reclamation developed a draft CVP M&I Water Shortage Policy in consultation with the CVP M&I water service contractors (Reclamation 2001). This policy provides M&I water supplies with a 75 percent water supply reliability based on a contractor’s historical use, as defined by the last 3 years of water deliveries unconstrained by the availability of CVP water. Before M&I supplies are reduced, irrigation water supplies would be reduced below 75 percent of contract entitlement. The policy also provides that when the allocation of irrigation water is reduced below 25 percent of contract entitlement, Reclamation will reassess the availability of CVP water and CVP water demand and, because of limited water supplies, M&I water supplies may be reduced below 75 percent of adjusted historical use. Table 14-19 shows historical CVP annual allocations since 1997.

Table 14-19. Historical Central Valley Project Annual Allocations

Year	Year Type[1]	CVP Contract Allocation (%)						
		Agricultural		Urban		Wildlife Refuges		Settlement/ Exchange
		North of Delta	South of Delta	North of Delta	South of Delta	North of Delta	South of Delta	
1997	Wet	90	90	90–100	90–100	As scheduled	As scheduled	100
1998	Wet	100	100	100	100	100	100	100
1999	Wet	100	70	95	95	100	100	100
2000	Above-Normal	100	65	100	90	100	100	100
2001	Dry	60	49	85	77	100	100	100
2002	Dry	100	70	100	95	100	100	100
2003	Above-Normal	100	75	100	100	100	100	100
2004	Below-Normal	100	70	100	95	100	100	100
2005	Above-Normal	100	85	100	100	100	100	100
2006	Wet	100	100	100	100	100	100	100
2007	Dry	100	50	100	75	100	100	100
2008	Critical	40	40	75	75	100	100	100
2009	Dry	40	10	75–100	60	100	100	100
2010	Below-Normal	100	45	100	75	100	100	100
2011	Wet	100	80	100	100	100	100	100
2012	Below-Normal	100	40	100	75	100	100	100

Source: Reclamation 2013
Note:
[1] Sacramento Valley Water Year Types as defined in Modeling Appendix.
Key:
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta

The following subsections describe major SOD CVP facilities outside the Friant Division.

New Melones Reservoir New Melones Dam, completed in 1979, is the newest major facility of the CVP. The reservoir is located on the Stanislaus River and has a storage capacity of 2.4 MAF. New Melones Reservoir is operated for flood control on the lower Stanislaus River and in the Delta, irrigation and municipal supplies, hydropower, recreation, and fish and wildlife enhancement. Downstream from New Melones Reservoir are the Tulloch and Goodwin reservoirs, operated by the Oakdale and South San Joaquin irrigation districts. Table 14-20 shows recent historical average monthly storage operations at New Melones Reservoir.

Table 14-20. Historical Average End-of-Month New Melones Reservoir Storage

Year Type[2]	Average End-of-Month Storage (TAF)[1]											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Years	1,117	1,133	1,164	1,208	1,256	1,301	1,305	1,326	1,342	1,282	1,205	1,164
Wet	1,041	1,065	1,123	1,233	1,333	1,433	1,485	1,595	1,721	1,691	1,594	1,541
Above-Normal	1,395	1,411	1,425	1,418	1,440	1,465	1,475	1,523	1,550	1,482	1,414	1,373
Below-Normal	1,196	1,214	1,252	1,287	1,317	1,357	1,349	1,396	1,373	1,297	1,231	1,194
Dry	1,432	1,453	1,481	1,500	1,522	1,557	1,534	1,477	1,393	1,291	1,207	1,169
Critical	896	898	904	908	924	919	882	824	765	699	644	617

Source: DWR 2013a, Gage ID NML
Notes:
[1] Period of record Water Years 1976–2012; some years may be missing data.
[2] San Joaquin River Water Year Types as defined in Modeling Appendix.
Key:
TAF = thousand acre-feet

San Luis Reservoir/O'Neill Forebay Downstream from the Jones Pumping Plant, CVP water flows in the DMC and can be either diverted by the O'Neill Pumping-Generating Plant into the O'Neill Forebay, or can continue down the DMC for delivery to CVP contractors. The O'Neill Pumping-Generating Plant generates power from releases from the O'Neill Forebay back to the DMC. The O'Neill Pumping-Generating Plant consists of six pump-generating units, each with a capacity of 700 cfs.

The O'Neill Forebay is a joint CVP and SWP facility, with a storage capacity of about 56,000 acre-feet. In addition to its interactions with the DMC via the O'Neill Pumping-Generating Plant, it is part of the SWP California Aqueduct. Several WDs receive diversions directly from the O'Neill Forebay.

The William R. Gianelli Pumping-Generating Plant (Gianelli Pumping-Generating Plant), also a joint CVP and SWP facility, can pump water from the O'Neill Forebay into San Luis Reservoir, and generate power from releases from San Luis Reservoir to the O'Neill Forebay. The Gianelli Pumping-Generating Plant consists of eight units, each with a capacity of 1,375 cfs.

San Luis Reservoir lies at the base of foothills on the west side of the San Joaquin Valley. The reservoir provides offstream storage for excess winter and spring flows diverted from the Delta. It was sized to reregulate and match Delta pumping to demands, with a total capacity of 2.0 MAF.

The CVP share of the storage at San Luis Reservoir is 965,660 acre-feet; the remaining 1,062,180 acre-feet is the SWP share. During late spring, summer, and early fall, 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. Since San Luis Reservoir receives very little natural inflow, water must be stored during late fall through early spring when the two Delta pumping plants can pump more water from the Delta than is needed to meet immediate water demands. The CVP share of San Luis Reservoir is typically at its lowest in August and September, and at its maximum in April.

Reclamation and DWR have the ability to use or exchange the diversion capacity capabilities of the CVP and SWP (i.e., Delta pumping into San Luis Reservoir) to enhance the beneficial uses of both projects. The Joint Point of Diversion (JPOD) capabilities are based on a staged implementation and conditional requirements for each stage of implementation. The stages of the JPOD are:

- **Stage 1 –** For water service to Cross Valley Canal contractors, Tracy Veterans Cemetery, and Musco Olive, and to recover export reductions taken to benefit fish
- **Stage 2 –** For any purpose authorized under the current project water right permits
- **Stage 3 –** For any purpose authorized up to the physical capacity of the diversion facilities

Each stage has regulatory terms and conditions that must be satisfied to implement the JPOD.

The San Felipe Division of the CVP supplies water to customers in Santa Clara and San Benito counties from San Luis Reservoir. Operation of San Luis Reservoir has the potential to affect the water quality and reliability of these supplies if reservoir storage drops below 300 TAF. Low CVP and SWP water levels can affect water quality and reliability by creating conditions for algae growth, or by exposing intake structures.

Table 14-21 shows historical average monthly storage in the CVP share of San Luis Reservoir by year type.

Table 14-21. Historical Average End-of-Month Central Valley Project San Luis Reservoir Storage

Year Type[2]	Average End-of-Month Storage (TAF)[1]											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Years	441	553	648	749	805	868	862	752	577	399	312	364
Wet	352	455	545	675	782	873	907	858	767	586	465	500
Above-Normal	677	742	767	811	884	948	925	791	612	454	380	432
Below-Normal	437	518	590	688	714	766	736	633	518	402	347	413
Dry	533	675	796	890	893	907	861	673	405	245	207	274
Critical	365	505	644	744	758	813	790	656	405	189	102	168

Source: DWR 2013a, Gage SLF
Notes:
[1] Period of record Water Years 1969–2012.
[2] Sacramento Valley Water Year Types as defined in Modeling Appendix.
Key:
TAF = thousand acre-feet

Delta-Mendota Canal The DMC, completed in 1951, carries water from the Jones Pumping Plant to the San Luis–O'Neil reservoir complex and then along the west side of the San Joaquin Valley to Mendota Pool. Water is delivered along the DMC and at Mendota Pool to the Delta, West San Joaquin, and San Felipe divisions of the CVP (via San Luis Reservoir); to wildlife refuges; and to replace San Joaquin River water stored at Friant Dam and diverted into the Friant-Kern and Madera canals consistent with the San Joaquin River Exchange Contracts. The canal is about 117 miles long and has an initial diversion capacity of 4,600 cfs, which decreases to 3,211 cfs at the terminus.

Central Valley Project Contractor Facilities Exchange Contractors (Figure 14-23) provide water deliveries to over 240,000 acres of irrigable land on the west side of the San Joaquin Valley, from roughly the town of Mendota in the south, to the town of Crows Landing in the north. Deliveries are also made to the San Luis Wildlife Refuge Complex and the State WMAs.

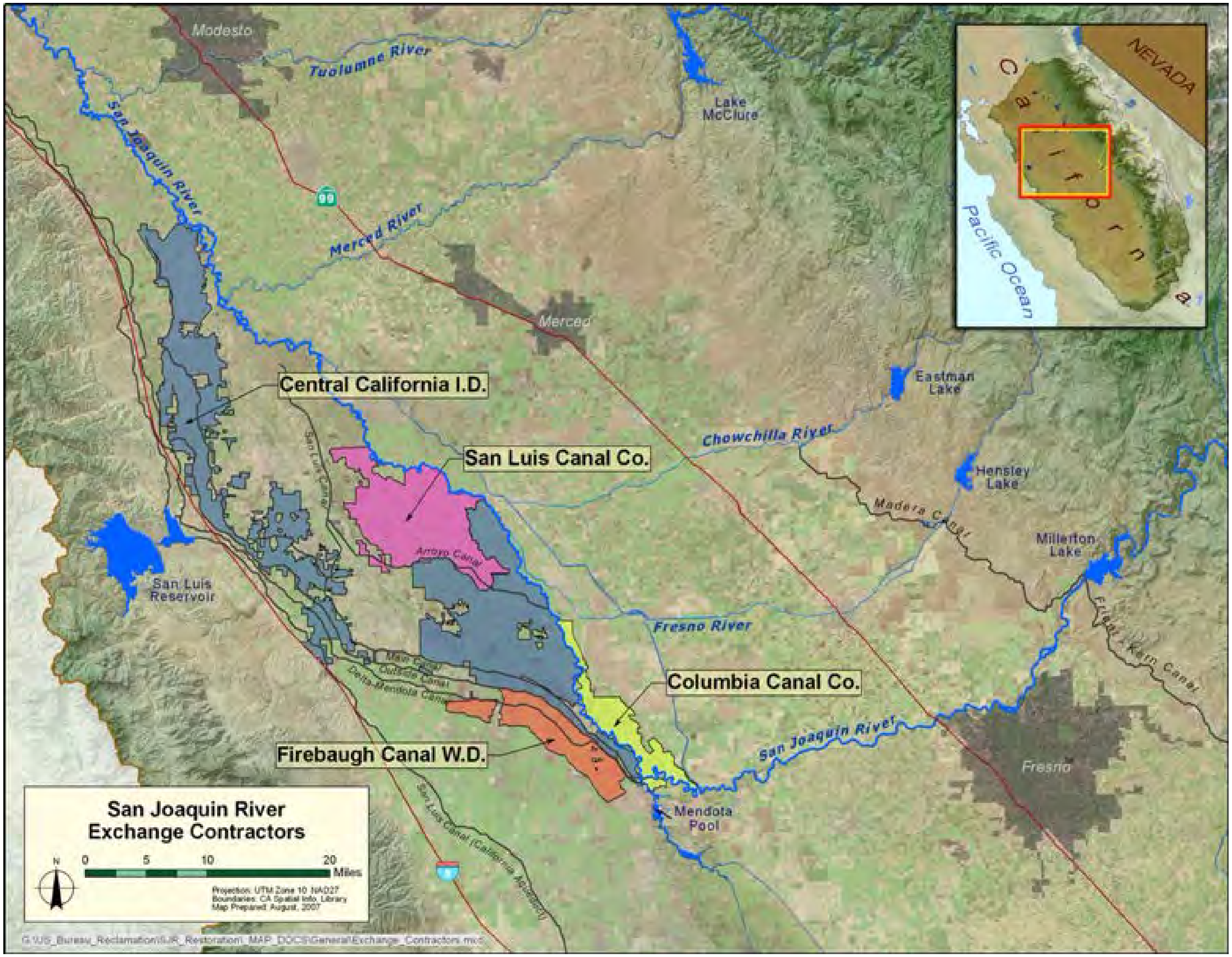


Figure 14-23. San Joaquin River Exchange Contractors

Although unique for each entity, operations generally consist of diverting sufficient flow from the DMC and Mendota Pool to the Exchange Contractors' main distribution systems. Depending on the particular Exchange Contractor entity, water is either directly delivered to community ditch systems of the customers from the main canal systems, or water is further conveyed through entity-owned and -maintained community ditch systems to ultimate points of delivery. Once delivered, the entities lose control of the water until the farmers' drainage, if any, is intercepted by district facilities.

State Water Project Water Service Areas and Facilities

The SWP operates under long-term contracts with 29 public water agencies throughout California. To provide water for the SWP, DWR negotiated settlement agreements to obtain water rights in the Feather River, and to divert that water from the Delta. DWR administers these settlement agreements with Feather River and Delta interests, and delivers about 900 TAF of water each year to Feather River agencies that hold senior water rights.

The SWP contracts between DWR and individual State water contractors define several classifications of water available for delivery under specific circumstances. All classifications are considered "project water." Table A is an exhibit to the SWP long-term water supply contracts. Table A amounts are used to define each contractor's proportion of the available water supply that DWR will allocate and deliver to that contractor. Each year, contractors may request an amount not to exceed their Table A amount. Table A amounts are used as a basis for allocations to contractors, but the actual annual supply to contractors varies, and depends on the amount of water available.

Although Table A is given first priority, water delivery capabilities of the SWP are frequently lower than Table A amounts. Each SWP contactor receives a percentage of its Table A contract amount, depending on hydrologic conditions and available SWP water in the system. Table A amounts were designed to increase gradually until the total combined maximum annual Table A amount for all water contracting agencies was achieved.

Currently, regardless of location in the SWP system, each contractor is entitled to the same percentage of Table A water. In September 2013, DWR released a Negative Declaration of a settlement with four North-of-Delta (NOD) contractors that would modify the four NOD contractors' SWP contracts to improve water supply and reliability that has been reduced due to SOD export limitations. Implementation of the Settlement would allow the NOD plaintiffs to receive higher allocations of SWP water when SOD allocations are reduced due to environmental restrictions on pumping. Annual Table A allocations were initially for 4.23 MAF, assuming full SWP development (DWR 2013c), but have been reduced to 4.17 MAF as the result of amendments to water supply contracts in the 1990s (DWR 2013d).

The Monterey Agreement (State Water Contractors and DWR 1994), signed by 27 of the 29 SWP water contractors in 1994, restructured the SWP contracts to allocate water based on contractual Table A amounts instead of the amount of water requested for a given year. In times of shortages, the water supply to SWP agricultural and M&I contractors are reduced equally.

Many contractors also make frequent use of additional contract water types for deliveries over the approved and scheduled amount allocated to the contractors under Table A. Other contract types of water include Article 21 Water (surplus water available after operational requirements of SWP water deliveries, water quality, and Delta requirements are met), turn-back pool water (accounting of SWP supplies is used early in the year for later purchase by other SWP contractors at a set price), and carryover water (unused SWP allocation from the previous year).

The SWP allocation (proportion of Table A to be delivered) for any specific year is made based on a number of factors, including existing storage, current regulatory constraints, projected hydrologic conditions, and desired carryover storage. Since 1997, annual delivery of Table A water has varied between 1.233 MAF (in 2009) to 3.201 MAF (in 2000). Article 21 deliveries have varied between about 3 TAF (in 2008) to 731 TAF (in 2005) (DWR 2013c). Table 14-22 shows historical SWP deliveries since 1997 by year.

Table 14-22. Historical Annual State Water Project Deliveries

Year	Year Type[1]	Table A Amounts (TAF)	Article 21 (TAF)	Water Rights and Other Contractors[2] (TAF)	Fish and Wildlife (TAF)
1997	Wet	2,326	21	1,315	4
1998	Wet	1,726	20	1,007	2
1999	Wet	2,739	158	1,194	4
2000	Above-Normal	3,201	309	1,419	4
2001	Dry	1,691	43	1,556	3
2002	Dry	2,573	37	1,440	4
2003	Above-Normal	2,901	60	322	3
2004	Below-Normal	2,600	218	1,560	3
2005	Above-Normal	2,828	731	1,172	2
2006	Wet	2,973	621	1,232	2
2007	Dry	2,081	310	1,668	3
2008	Critical	1,234	3	1,598	3
2009	Dry	1,233	6	1,675	2

Source: DWR 2013c

Note:

[1] Sacramento Valley Water Year Types as defined in Modeling Appendix.

[2] Includes other State Water Project and non-State Water Project water contractors, and Feather River Water Service Area diversions.

Key:

TAF = thousand acre-feet

The following subsections describe major SOD SWP facilities.

San Luis Reservoir/O'Neill Forebay Downstream from the Banks Pumping Plant, SWP water flows in the California Aqueduct and into the O'Neill Forebay. The O'Neill Forebay and San Luis Reservoir are described in the Other Central Valley Project Water Service Areas and Facilities section of this chapter. Table 14-23 shows historical average monthly storage in the SWP share of San Luis Reservoir by year type.

Table 14-23. Historical Average End-of-Month State Water Project San Luis Reservoir Storage

Year Type[2]	Average End-of-Month Storage (TAF)[1]											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Years	639	674	753	860	936	980	963	872	741	631	581	620
Wet	586	642	743	904	995	1,011	1,005	954	890	819	785	850
Above-Normal	832	862	901	973	1,008	1,025	1,005	919	791	688	645	679
Below-Normal	436	470	527	665	785	872	850	739	647	642	634	619
Dry	734	760	831	908	965	1,029	989	842	655	516	464	489
Critical	588	602	680	752	826	902	889	778	573	391	304	330

Source: DWR 2013a, Gage LUS

Notes:

[1] Period of record Water Years 1969–2012.

[2] Sacramento Valley Water Year Types as defined in Modeling Appendix.

Key:

TAF = thousand acre-feet

California Aqueduct The California Aqueduct carries water 443 miles from the Banks Pumping Plant to areas in Southern California. The concrete-lined canal includes several pumping plants and branches to enable delivery to various agricultural and urban contractors, including the South Bay Aqueduct and coastal branch. South of the O'Neill Forebay, parallel to the DMC, the San Luis Canal (the central portion of the 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. The California Aqueduct has a capacity ranging from 8,350 cfs to 13,100 cfs.

State Water Project Contractor Facilities 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. These deliveries are made via a variety of entity-owned and -maintained facilities.

Environmental Consequences and Mitigation Measures

This section discusses environmental consequences on surface water supplies and facilities operations associated with implementation of the alternatives. It also describes potential mitigation measures associated with impacts on surface water that are significant or potentially significant. The potential direct and indirect effects to surface water supplies and facilities operations and associated mitigation measures are summarized in Table 14-24.

Table 14-24. Summary of Impacts and Mitigation Measures for Surface Water Supplies and Facilities Operations

Impact	Study Area	Alternative	Level of Significance Before Mitigation	Mitigation Measure	Level of Significance After Mitigation
SWS-1: Changes in Ability to Divert Water from Friant Dam	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI
	Extended Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI
SWS-2: Changes in Ability to Divert Water from San Joaquin River	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI
	Extended Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI
SWS-3: Change in Water Levels in the Old River near the Tracy Road Bridge	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI
	Extended Study Area	No Action Alternative	LTS	None Required	LTS
		Alternative Plan 1	LTS		LTS
		Alternative Plan 2	LTS		LTS
		Alternative Plan 3	LTS		LTS
		Alternative Plan 4	LTS		LTS
		Alternative Plan 5	LTS		LTS

Table 14-24. Summary of Impacts and Mitigation Measures for Surface Water Supplies and Facilities Operations (contd.)

Impact	Study Area	Alternative	Level of Significance Before Mitigation	Mitigation Measure	Level of Significance After Mitigation
SWS-4: Change in Water Levels in the Grant Line Canal Above the Grant Line Canal Barrier	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI
	Extended Study Area	No Action Alternative	LTS	None Required	LTS
		Alternative Plan 1	LTS		LTS
		Alternative Plan 2	LTS		LTS
		Alternative Plan 3	LTS		LTS
		Alternative Plan 4	LTS		LTS
		Alternative Plan 5	LTS		LTS
SWS-5: Change in Water Levels in the Middle River near the Howard Road Bridge	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI
	Extended Study Area	No Action Alternative	LTS	None Required	LTS
		Alternative Plan 1	LTS		LTS
		Alternative Plan 2	LTS		LTS
		Alternative Plan 3	LTS		LTS
		Alternative Plan 4	LTS		LTS
		Alternative Plan 5	LTS		LTS

Key:
LTS = less than significant
NI = no impact

Methods and Assumptions

This section describes the modeling and assumptions used to assess potential impacts to surface water supply and facilities operations.

A suite of modeling tools was used to evaluate the potential effects of Temperance Flat RM 274 Dam and Reservoir on surface water supplies and facilities operations, and to quantify potential benefits. CalSim II was used to simulate CVP and SWP operations, estimating the surface water flows, storages, and deliveries that could be expected with each alternative. The San Joaquin River Temperature Model (SJR5Q) provides a method to evaluate the flows and temperatures in the San Joaquin River downstream from Millerton Lake to the Merced River confluence. The Delta Simulation Model 2 (DSM2) was used to simulate Delta hydrodynamics, providing the data used to evaluate the water-level-related impacts in the Delta of each alternative. Analysis and modeling results are summarized below; more detailed explanations, assumptions, and results of these models are found in the Modeling Appendix.

All action alternatives are evaluated under existing and future conditions and compared to the No Action Alternative under existing and future conditions. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. Each of the alternatives is simulated using the same levels of development so that any changes from the basis of comparison in surface water supply and facilities operations can be attributed to the alternative.

Each of the modeling tools used for the analysis in this chapter (CalSim II, SJR5Q, and DSM2) is briefly described below, followed by a summary of the magnitude and timing of changes San Joaquin River flows and CVP and SWP operations under each action alternative compared to the existing conditions and No Action Alternative.

CalSim II

CalSim II is the application of the Water Resources Integrated Modeling System software to the CVP and SWP. This application was jointly developed by Reclamation and DWR for planning studies relating to CVP and 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 and SWP exports to the San Francisco Bay Area, San Joaquin Valley, Central Coast, and Southern California.

CalSim II typically simulates system operations for an 82-year period using a monthly time step. The alternatives assessed by CalSim, including No Action, have similar model structure and assumptions. All action alternatives include operation of Temperance Flat RM 274 Dam and Reservoir, as defined in Chapter 2, “Alternatives Description.”

This analysis started with the future condition in the Shasta Lake Water Resources Investigation (SLWRI) 2012 Benchmark Version of the CalSim II model. This model version was selected both for consistency with the SLWRI and because it included the most recent set of updates to the CalSim II model.

As described in Chapter 3, “Considerations for Describing Affected Environment and Environmental Consequences,” if ongoing CVP and SWP long-term operations re-consultation results in operational conditions that deviate substantially from the 2008 Long-Term Operations BA (Reclamation 2008) and the 2008/2009 BOs (USFWS 2008, NMFS 2009), these changes may be considered in future Investigation documents.

SJR5Q

SJR5Q covers the San Joaquin River downstream from Millerton Lake to the confluence with the Merced River. The model was developed using the USACE HEC-5Q modeling tool, which can be used for simulating water flow and quality of both reservoirs and streams. SJR5Q uses the river modeling capabilities of HEC-5Q to model both flow and temperature in the San Joaquin River from Millerton Lake to the Merced River confluence. The HEC-5Q user manual (USACE 1998) describes more completely the water quality relationships included in the model.

DSM2

DSM2 is a branched one-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. Impact analysis for planning studies of the Delta is typically performed for an 82-year period (1922 to 2003).

Changes to Study Area Flows and CVP and SWP Operations

Each action alternative would affect San Joaquin River flows and CVP and SWP operations compared to either the existing conditions or the No Action Alternative. The magnitude and timing of changes vary according to each action alternative. Results are summarized below and represent changes to flows, storages, and diversions. These results are presented in more detail (e.g., year type tables) in the Modeling Appendix. While these results do not directly affect the analysis of impacts in this chapter, these results may be post-processed to meet the needs for analysis of significant impacts of alternatives in additional resource areas (e.g., impacts to Friant Division water supply in Chapter 23, “Socioeconomics, Population, and Housing”). These processes are described in corresponding sections of this Draft EIS.

San Joaquin River Upstream from Friant Dam Under the No Action Alternative, releases and diversions are made from Millerton Lake to satisfy downstream Holding Contract requirements, Friant Division demands, flood management requirements, and Restoration Flows. The action alternatives would affect average end-of-month storages in Millerton Lake, as seen in Table 14-25 and Table 14-26, by changing how water is stored between Millerton Lake and Temperance Flat RM 274 Reservoir. Wet winter and spring months would have less water stored in Millerton Lake compared to the existing conditions or No Action Alternative because water above the Millerton Lake minimum carryover storage targets would instead be stored in Temperance Flat RM 247 Reservoir. Dry months would have more water stored in Millerton Lake because Temperance Flat RM 274 Reservoir water storage would be delivered instead. Changes in reservoir levels would remain within historical operational levels.

Table 14-25. Average Simulated End-of-Month Millerton Lake Storage

Month	Existing Level (2005)[1]						Future Level (2030)[1]					
	Existing Condition	Change from Existing Condition (TAF)[2]					No Action	Change from No Action (TAF)[3]				
	(TAF)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt (TAF)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	223	117 (52%)	117 (52%)	117 (52%)	117 (52%)	-88 (-39%)	219	121 (55%)	121 (55%)	121 (55%)	121 (55%)	-86 (-39%)
November	245	95 (39%)	96 (39%)	95 (39%)	96 (39%)	-109 (-44%)	240	100 (42%)	100 (42%)	100 (42%)	100 (42%)	-107 (-45%)
December	295	45 (15%)	45 (15%)	45 (15%)	45 (15%)	-159 (-54%)	279	61 (22%)	61 (22%)	61 (22%)	61 (22%)	-145 (-52%)
January	347	-7 (-2%)	-7 (-2%)	-6 (-2%)	-7 (-2%)	-206 (-59%)	325	15 (5%)	15 (5%)	15 (5%)	15 (5%)	-185 (-57%)
February	377	-36 (-10%)	-36 (-10%)	-36 (-10%)	-36 (-10%)	-234 (-62%)	360	-20 (-5%)	-20 (-5%)	-20 (-5%)	-20 (-5%)	-219 (-61%)
March	384	-42 (-11%)	-42 (-11%)	-42 (-11%)	-42 (-11%)	-239 (-62%)	375	-33 (-9%)	-33 (-9%)	-33 (-9%)	-32 (-9%)	-231 (-61%)
April	394	-52 (-13%)	-52 (-13%)	-53 (-13%)	-52 (-13%)	-252 (-64%)	345	-5 (-1%)	-5 (-1%)	-5 (-1%)	-5 (-1%)	-208 (-60%)
May	419	-74 (-18%)	-74 (-18%)	-75 (-18%)	-74 (-18%)	-272 (-65%)	390	-47 (-12%)	-48 (-12%)	-48 (-12%)	-47 (-12%)	-250 (-64%)
June	422	-73 (-17%)	-73 (-17%)	-76 (-18%)	-70 (-17%)	-258 (-61%)	403	-58 (-14%)	-58 (-14%)	-58 (-14%)	-56 (-14%)	-253 (-63%)
July	332	19 (6%)	19 (6%)	16 (5%)	20 (6%)	-173 (-52%)	319	28 (9%)	28 (9%)	28 (9%)	30 (10%)	-167 (-52%)
August	236	106 (45%)	106 (45%)	105 (45%)	106 (45%)	-88 (-37%)	229	113 (49%)	113 (49%)	112 (49%)	113 (49%)	-85 (-37%)
September	221	119 (54%)	119 (54%)	119 (54%)	119 (54%)	-83 (-38%)	217	123 (57%)	123 (57%)	123 (57%)	124 (57%)	-80 (-37%)

Source: Summarized from CalSim II 2005 and 2030 simulations (Node S18)

Notes:

1 Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

2 (%) indicates percent change from existing conditions. Negative value represents a decrease in storage, and positive value represents an increase in storage.

3 (%) indicates percent change from No Action Alternative. Negative value represents a decrease in storage, and positive value represents an increase in storage.

Key:
Alt = Alternative
TAF = thousand acre-feet

Table 14-26. Average Simulated End-of-Month Millerton Lake Storage in Dry and Critical Years

Month	Existing Level (2005)[1,2]						Future Level (2030)[1,2]					
	Existing Condition (TAF)	Change from Existing Condition (TAF)[3]					No Action Alt (TAF)	Change from No Action (TAF)[4]				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	210	130 (62%)	130 (62%)	130 (62%)	130 (62%)	-80 (-38%)	205	135 (66%)	135 (66%)	135 (66%)	135 (66%)	-75 (-37%)
November	224	116 (52%)	116 (52%)	116 (52%)	116 (52%)	-94 (-42%)	218	122 (56%)	122 (56%)	122 (56%)	122 (56%)	-88 (-40%)
December	259	81 (31%)	81 (31%)	81 (31%)	81 (31%)	-129 (-50%)	241	99 (41%)	99 (41%)	99 (41%)	99 (41%)	-111 (-46%)
January	297	43 (14%)	43 (14%)	43 (14%)	43 (14%)	-167 (-56%)	266	74 (28%)	74 (28%)	74 (28%)	74 (28%)	-136 (-51%)
February	313	27 (9%)	27 (9%)	27 (9%)	27 (9%)	-183 (-58%)	283	57 (20%)	57 (20%)	57 (20%)	57 (20%)	-153 (-54%)
March	315	25 (8%)	25 (8%)	25 (8%)	25 (8%)	-185 (-59%)	287	53 (19%)	53 (19%)	53 (19%)	53 (19%)	-157 (-55%)
April	359	-18 (-5%)	-18 (-5%)	-18 (-5%)	-18 (-5%)	-228 (-64%)	319	21 (7%)	21 (7%)	21 (7%)	21 (7%)	-189 (-59%)
May	383	-43 (-11%)	-43 (-11%)	-43 (-11%)	-43 (-11%)	-253 (-66%)	349	-9 (-2%)	-9 (-2%)	-9 (-2%)	-9 (-2%)	-219 (-63%)
June	333	7 (2%)	7 (2%)	7 (2%)	7 (2%)	-203 (-61%)	310	30 (10%)	30 (10%)	30 (10%)	30 (10%)	-180 (-58%)
July	229	111 (48%)	111 (48%)	111 (48%)	111 (48%)	-99 (-43%)	215	125 (58%)	125 (58%)	125 (58%)	125 (58%)	-85 (-40%)
August	165	175 (107%)	175 (107%)	175 (107%)	175 (107%)	-35 (-21%)	159	181 (114%)	181 (114%)	181 (114%)	181 (114%)	-29 (-18%)
September	177	163 (92%)	163 (92%)	163 (92%)	163 (92%)	-47 (-26%)	174	166 (95%)	166 (95%)	166 (95%)	166 (95%)	-44 (-25%)

Source: Summarized from CalSim II 2005 and 2030 simulations (Node S18)

Notes:

[1] Values presented for dry and critical year types as defined by the San Joaquin River Water Year Hydrologic Classification Indices.

[2] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[3] (%) indicates percent change from existing conditions. Negative value represents a decrease in storage, and positive value represents an increase in storage.

[4] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in storage, and positive value represents an increase in storage.

Key:
Alt = Alternative
TAF = thousand acre-feet

San Joaquin River from Friant Dam to the Merced River

All action alternatives would reduce Reach 1 average streamflow in wetter winter and spring months (Table 14-27 and Table 14-28). This reduced flow is primarily caused in wet years when Temperance Flat RM 274 Reservoir would store large runoff events that otherwise would be released from Millerton Lake as flood flows. This storage would then be released in drier months and years, increasing flows in those months compared to the existing conditions or No Action Alternative (Table 14-27 and Table 14-28). Different beneficiaries, as outlined in Chapter 2, “Alternatives”, would cause changes in water supply routing (Friant-Kern Canal versus the river) and timing (agricultural water supply would be delivered on an irrigation schedule that is different from an M&I delivery schedule).

Flow changes in Reach 2A would be caused by similar operations described for Reach 1 (Table 14-29 and Table 14-30). Decreases in Reach 2B flows would be less than upstream because most flood flows bypass this reach; consequently, Reach 2B flows would be less sensitive to flood release changes at Friant Dam (Table 14-31 and Table 14-32). Increases in Reach 2B flows would be caused by releases from Temperance Flat Rm 274 storage for deliveries or exchanges at Mendota Pool.

Table 14-27. Average Simulated Monthly Flow, San Joaquin River at Head of Reach 1

Month	Existing Level (2005)[1]						Future Level (2030)[1]					
	Existing Conditions	Change from Existing Condition (cfs)[2]					No Action Alt	Change from No Action (cfs)[3]				
	(cfs)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	(cfs)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	349	115 (33%)	170 (49%)	8 (2%)	85 (24%)	22 (6%)	350	103 (30%)	131 (37%)	3 (1%)	68 (19%)	21 (6%)
November	464	110 (24%)	208 (45%)	-5 (-1%)	88 (19%)	25 (5%)	465	99 (21%)	156 (34%)	-7 (-1%)	60 (13%)	8 (2%)
December	288	15 (5%)	49 (17%)	-76 (-26%)	-1 (0%)	-53 (-18%)	484	-9 (-2%)	11 (2%)	-95 (-20%)	-6 (-1%)	-72 (-15%)
January	474	-160 (-34%)	-164 (-35%)	-239 (-50%)	-161 (-34%)	-198 (-42%)	639	-122 (-19%)	-132 (-21%)	-188 (-29%)	-129 (-20%)	-162 (-25%)
February	741	-331 (-45%)	-304 (-41%)	-284 (-38%)	-289 (-39%)	-274 (-37%)	692	-307 (-44%)	-288 (-42%)	-275 (-40%)	-254 (-37%)	-235 (-34%)
March	1,385	-297 (-21%)	-273 (-20%)	-246 (-18%)	-228 (-16%)	-219 (-16%)	1,326	-246 (-19%)	-229 (-17%)	-222 (-17%)	-220 (-17%)	-194 (-15%)
April	1,552	-253 (-16%)	-223 (-14%)	-212 (-14%)	-224 (-14%)	-205 (-13%)	2,385	-242 (-10%)	-225 (-9%)	-215 (-9%)	-181 (-8%)	-174 (-7%)
May	1,205	-452 (-38%)	-419 (-35%)	-394 (-33%)	-388 (-32%)	-357 (-30%)	1,085	-252 (-23%)	-227 (-21%)	-208 (-19%)	-204 (-19%)	-162 (-15%)
June	1,047	-160 (-15%)	-157 (-15%)	-195 (-19%)	-95 (-9%)	-110 (-10%)	1,053	-102 (-10%)	-107 (-10%)	-142 (-14%)	-75 (-7%)	-43 (-4%)
July	633	32 (5%)	57 (9%)	27 (4%)	136 (21%)	112 (18%)	624	-27 (-4%)	-19 (-3%)	-43 (-7%)	60 (10%)	52 (8%)
August	343	131 (38%)	117 (34%)	94 (27%)	163 (47%)	160 (47%)	343	118 (35%)	91 (27%)	69 (20%)	136 (40%)	155 (45%)
September	343	135 (39%)	127 (37%)	21 (6%)	103 (30%)	35 (10%)	344	122 (36%)	99 (29%)	15 (4%)	84 (24%)	34 (10%)
Average Annual	734	-92 (-12%)	-66 (-9%)	-124 (-17%)	-66 (-9%)	-87 (-12%)	814	-71 (-9%)	-60 (-7%)	-108 (-13%)	-54 (-7%)	-63 (-8%)

Source: CalSim II 2005 and 2030 simulations (Node C18)

Notes:

1 Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

2 (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

3 (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:

Alt = Alternatives

cfs = cubic feet per second

Table 14-28. Average Simulated Monthly Flow in Dry and Critical Years, San Joaquin River at Head of Reach 1

Month	Existing Level (2005)[1,2]						Future Level (2030)[1,2]					
	Existing Conditions (cfs)	Change from Existing Condition (cfs)[3]					No Action Alt (cfs)	Change from No Action (cfs)[4]				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	330	39 (12%)	64 (20%)	7 (2%)	30 (9%)	27 (8%)	317	23 (7%)	33 (10%)	4 (1%)	19 (6%)	24 (8%)
November	427	37 (9%)	78 (18%)	2 (0%)	26 (6%)	21 (5%)	404	24 (6%)	41 (10%)	3 (1%)	18 (4%)	17 (4%)
December	192	-33 (-17%)	-14 (-7%)	-62 (-32%)	-40 (-21%)	-36 (-19%)	374	-41 (-11%)	-32 (-9%)	-58 (-16%)	-44 (-12%)	-32 (-8%)
January	338	-206 (-61%)	-202 (-60%)	-225 (-67%)	-206 (-61%)	-179 (-53%)	506	-180 (-36%)	-180 (-36%)	-190 (-37%)	-179 (-35%)	-145 (-29%)
February	727	-345 (-47%)	-335 (-46%)	-329 (-45%)	-328 (-45%)	-334 (-46%)	697	-389 (-56%)	-385 (-55%)	-380 (-55%)	-336 (-48%)	-336 (-48%)
March	984	0 (0%)	5 (1%)	8 (1%)	7 (1%)	44 (4%)	985	0 (0%)	5 (0%)	4 (0%)	4 (0%)	38 (4%)
April	584	0 (0%)	9 (2%)	15 (3%)	12 (2%)	56 (10%)	735	0 (0%)	5 (1%)	9 (1%)	8 (1%)	50 (7%)
May	325	0 (0%)	14 (4%)	24 (7%)	20 (6%)	90 (28%)	321	0 (0%)	7 (2%)	15 (5%)	13 (4%)	81 (25%)
June	325	40 (12%)	50 (15%)	42 (13%)	61 (19%)	158 (49%)	321	24 (7%)	26 (8%)	26 (8%)	39 (12%)	142 (44%)
July	332	39 (12%)	55 (17%)	51 (15%)	67 (20%)	189 (57%)	330	23 (7%)	28 (9%)	31 (9%)	43 (13%)	169 (51%)
August	332	39 (12%)	39 (12%)	34 (10%)	53 (16%)	126 (38%)	330	23 (7%)	21 (6%)	21 (6%)	34 (10%)	113 (34%)
September	332	40 (12%)	42 (13%)	7 (2%)	31 (9%)	28 (8%)	333	24 (7%)	22 (7%)	5 (1%)	19 (6%)	25 (8%)
Average Annual	434	-27 (-6%)	-14 (-3%)	-34 (-8%)	-20 (-5%)	18 (4%)	470	-37 (-8%)	-32 (-7%)	-40 (-9%)	-28 (-6%)	15 (3%)

Source: CalSim II 2005 and 2030 simulations (Node C18)

Notes:

1 Values presented for dry and critical year types as defined by the San Joaquin River Water Year Hydrologic Classification Indices.

2 Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

3 (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

4 (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:
Alt = Alternatives
cfs = cubic feet per second

Table 14-29. Average Simulated Monthly Flow, San Joaquin River at Head of Reach 2A

Month	Existing Level (2005)[1]						Future Level (2030)[1]					
	Existing Conditions	Change from Existing Condition (cfs)[2]					No Action Alt	Change from No Action (cfs)[3]				
	(cfs)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	(cfs)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	190	115 (61%)	170 (90%)	8 (4%)	85 (45%)	22 (12%)	191	103 (54%)	131 (69%)	3 (2%)	68 (35%)	21 (11%)
November	341	110 (32%)	208 (61%)	-5 (-2%)	88 (26%)	25 (7%)	342	99 (29%)	156 (46%)	-7 (-2%)	60 (18%)	8 (2%)
December	168	15 (9%)	49 (29%)	-76 (-45%)	-1 (-1%)	-53 (-32%)	363	-9 (-2%)	11 (3%)	-95 (-26%)	-6 (-2%)	-72 (-20%)
January	375	-160 (-43%)	-164 (-44%)	-239 (-64%)	-161 (-43%)	-198 (-53%)	540	-122 (-23%)	-132 (-25%)	-188 (-35%)	-129 (-24%)	-162 (-30%)
February	641	-331 (-52%)	-304 (-47%)	-284 (-44%)	-289 (-45%)	-274 (-43%)	592	-307 (-52%)	-288 (-49%)	-275 (-46%)	-254 (-43%)	-235 (-40%)
March	1,255	-297 (-24%)	-273 (-22%)	-246 (-20%)	-228 (-18%)	-219 (-17%)	1,196	-246 (-21%)	-229 (-19%)	-222 (-19%)	-220 (-18%)	-194 (-16%)
April	1,403	-253 (-18%)	-223 (-16%)	-212 (-15%)	-224 (-16%)	-205 (-15%)	2,235	-242 (-11%)	-225 (-10%)	-215 (-10%)	-181 (-8%)	-174 (-8%)
May	1,015	-452 (-45%)	-419 (-41%)	-394 (-39%)	-388 (-38%)	-357 (-35%)	895	-252 (-28%)	-227 (-25%)	-208 (-23%)	-204 (-23%)	-162 (-18%)
June	857	-160 (-19%)	-157 (-18%)	-195 (-23%)	-95 (-11%)	-110 (-13%)	863	-102 (-12%)	-107 (-12%)	-142 (-16%)	-75 (-9%)	-43 (-5%)
July	404	32 (8%)	57 (14%)	27 (7%)	136 (34%)	112 (28%)	395	-27 (-7%)	-19 (-5%)	-43 (-11%)	60 (15%)	52 (13%)
August	114	131 (115%)	117 (103%)	94 (83%)	163 (143%)	160 (140%)	113	118 (104%)	91 (80%)	69 (61%)	136 (120%)	155 (137%)
September	133	135 (102%)	127 (96%)	21 (16%)	103 (77%)	35 (27%)	134	122 (91%)	99 (74%)	15 (11%)	84 (63%)	34 (26%)
Average Annual	573	-92 (-16%)	-66 (-12%)	-124 (-22%)	-66 (-12%)	-87 (-15%)	653	-71 (-11%)	-60 (-9%)	-108 (-17%)	-54 (-8%)	-63 (-10%)

Source: CalSim II 2005 and 2030 simulations (Node C18)

Notes:

1 Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

2 (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

3 (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:
Alt = Alternatives
cfs = cubic feet per second

Table 14-30. Average Simulated Monthly Flow in Dry and Critical Years, San Joaquin River at Head of Reach 2A

Month	Existing Level (2005)[1,2]						Future Level (2030)[1,2]					
	Existing Conditions	Change from Existing Condition (cfs)[3]					No Action Alt	Change from No Action (cfs)[4]				
	(cfs)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	(cfs)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	39 (23%)	64 (38%)	7 (4%)	30 (18%)	27 (16%)	158	23 (14%)	33 (21%)	4 (3%)	19 (12%)	24 (15%)	39 (23%)
November	37 (12%)	78 (26%)	2 (1%)	26 (8%)	21 (7%)	281	24 (8%)	41 (15%)	3 (1%)	18 (6%)	17 (6%)	37 (12%)
December	-33 (-46%)	-14 (-19%)	-62 (-87%)	-40 (-55%)	-36 (-50%)	254	-41 (-16%)	-32 (-13%)	-58 (-23%)	-44 (-17%)	-32 (-13%)	-33 (-46%)
January	-206 (-87%)	-202 (-85%)	-225 (-94%)	-206 (-86%)	-179 (-75%)	407	-180 (-44%)	-180 (-44%)	-190 (-47%)	-179 (-44%)	-145 (-36%)	-206 (-87%)
February	-345 (-55%)	-335 (-53%)	-329 (-52%)	-328 (-52%)	-334 (-53%)	597	-389 (-65%)	-385 (-64%)	-380 (-64%)	-336 (-56%)	-336 (-56%)	-345 (-55%)
March	0 (0%)	5 (1%)	8 (1%)	7 (1%)	44 (5%)	855	0 (0%)	5 (1%)	4 (1%)	4 (0%)	38 (4%)	0 (0%)
April	0 (0%)	9 (2%)	15 (3%)	12 (3%)	56 (13%)	585	0 (0%)	5 (1%)	9 (2%)	8 (1%)	50 (9%)	0 (0%)
May	0 (0%)	14 (10%)	24 (18%)	20 (15%)	90 (67%)	131	0 (0%)	7 (5%)	15 (11%)	13 (10%)	81 (62%)	0 (0%)
June	40 (30%)	50 (37%)	42 (31%)	61 (45%)	158 (117%)	131	24 (18%)	26 (20%)	26 (20%)	39 (30%)	142 (108%)	40 (30%)
July	39 (38%)	55 (54%)	51 (49%)	67 (65%)	189 (184%)	100	23 (23%)	28 (28%)	31 (31%)	43 (43%)	169 (169%)	39 (38%)
August	39 (38%)	39 (38%)	34 (33%)	53 (51%)	126 (123%)	100	23 (23%)	21 (20%)	21 (21%)	34 (34%)	113 (113%)	39 (38%)
September	40 (33%)	42 (35%)	7 (6%)	31 (26%)	28 (23%)	123	24 (19%)	22 (18%)	5 (4%)	19 (16%)	25 (20%)	40 (33%)
Average Annual	-27 (-10%)	-14 (-5%)	-34 (-12%)	-20 (-7%)	18 (7%)	308	-37 (-12%)	-32 (-10%)	-40 (-13%)	-28 (-9%)	15 (5%)	-27 (-10%)

Source: CalSim II 2005 and 2030 simulations (Node C603)

Notes:

[1] Values presented for dry and critical year types as defined by the San Joaquin River Water Year Hydrologic Classification Indices.

[2] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[3] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[4] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:
Alt = Alternatives
cfs = cubic feet per second

Table 14-31. Average Simulated Monthly Flow, San Joaquin River at Head of Reach 2B

Month	Existing Level (2005)[1]						Future Level (2030)[1]					
	Existing Conditions	Change from Existing Condition (cfs)[2]					No Action Alt	Change from No Action (cfs)[3]				
	(cfs)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	(cfs)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	11	116 (1045%)	171 (1537%)	9 (80%)	85 (768%)	23 (203%)	11	104 (928%)	131 (1173%)	3 (31%)	68 (610%)	21 (192%)
November	0	127 (n/a)	223 (n/a)	14 (n/a)	91 (n/a)	23 (n/a)	16	101 (617%)	158 (970%)	-4 (-27%)	62 (381%)	10 (63%)
December	44	73 (166%)	101 (231%)	-18 (-41%)	51 (117%)	-1 (-1%)	84	38 (46%)	58 (69%)	-47 (-56%)	30 (35%)	-25 (-30%)
January	80	19 (24%)	19 (24%)	-43 (-54%)	14 (17%)	-14 (-17%)	121	7 (6%)	-5 (-4%)	-55 (-45%)	-5 (-4%)	-20 (-17%)
February	130	-130 (-100%)	-104 (-80%)	-84 (-65%)	-91 (-70%)	-55 (-42%)	215	-191 (-89%)	-173 (-80%)	-159 (-74%)	-142 (-66%)	-119 (-56%)
March	60	-53 (-88%)	-31 (-52%)	-11 (-18%)	-22 (-37%)	16 (26%)	189	-145 (-76%)	-127 (-67%)	-120 (-63%)	-119 (-63%)	-99 (-52%)
April	1	-1 (-73%)	23 (2315%)	37 (3776%)	32 (3246%)	66 (6735%)	147	-119 (-80%)	-102 (-69%)	-91 (-62%)	-78 (-53%)	-46 (-31%)
May	83	-79 (-96%)	-49 (-59%)	-22 (-27%)	-25 (-31%)	25 (31%)	168	-117 (-70%)	-93 (-55%)	-72 (-43%)	-72 (-43%)	-17 (-10%)
June	23	97 (420%)	113 (492%)	95 (413%)	154 (669%)	178 (773%)	179	-20 (-11%)	-26 (-15%)	-42 (-24%)	18 (10%)	68 (38%)
July	94	83 (88%)	116 (123%)	100 (106%)	179 (190%)	199 (211%)	108	65 (60%)	73 (68%)	54 (50%)	135 (124%)	175 (162%)
August	0	131 (n/a)	117 (n/a)	94 (n/a)	163 (n/a)	160 (n/a)	0	118 (n/a)	91 (n/a)	69 (n/a)	136 (n/a)	155 (n/a)
September	0	135 (n/a)	127 (n/a)	21 (n/a)	103 (n/a)	35 (n/a)	0	122 (n/a)	99 (n/a)	15 (n/a)	84 (n/a)	34 (n/a)
Average Annual	44	44 (101%)	70 (160%)	17 (38%)	62 (142%)	55 (127%)	103	-2 (-2%)	8 (8%)	-37 (-36%)	11 (11%)	13 (12%)

Source: CalSim II 2005 and 2030 simulations (Node C605a)

Notes:

[1] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[2] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[3] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:
Alt = Alternatives
cfs = cubic feet per second
n/a = not applicable

Table 14-32. Average Simulated Monthly Flow in Dry and Critical Years, San Joaquin River at Head of Reach 2B

Month	Existing Level (2005)[1,2]						Future Level (2030)[1,2]					
	Existing Conditions (cfs)	Change from Existing Condition (cfs)[3]					No Action Alt (cfs)	Change from No Action (cfs)[4]				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	0	39 (n/a)	64 (n/a)	7 (n/a)	30 (n/a)	27 (n/a)	0	23 (n/a)	33 (n/a)	4 (n/a)	19 (n/a)	24 (n/a)
November	0	40 (n/a)	81 (n/a)	5 (n/a)	29 (n/a)	19 (n/a)	0	24 (n/a)	41 (n/a)	3 (n/a)	18 (n/a)	17 (n/a)
December	45	-6 (-13%)	13 (30%)	-35 (-78%)	-12 (-28%)	-9 (-20%)	48	-25 (-53%)	-16 (-34%)	-42 (-88%)	-28 (-58%)	-16 (-33%)
January	89	-57 (-64%)	-53 (-59%)	-75 (-84%)	-57 (-64%)	-30 (-34%)	103	-85 (-83%)	-85 (-83%)	-94 (-92%)	-84 (-82%)	-50 (-49%)
February	132	-132 (-100%)	-124 (-94%)	-117 (-89%)	-120 (-90%)	-72 (-54%)	195	-195 (-100%)	-192 (-98%)	-187 (-96%)	-148 (-76%)	-142 (-73%)
March	0	0 (0%)	5 (n/a)	8 (n/a)	7 (n/a)	44 (n/a)	0	0 (0%)	5 (n/a)	4 (n/a)	4 (n/a)	38 (n/a)
April	1	-1 (-100%)	9 (774%)	14 (1252%)	11 (1033%)	55 (4934%)	0	0 (0%)	5 (n/a)	9 (n/a)	8 (n/a)	50 (n/a)
May	0	0 (0%)	14 (n/a)	24 (n/a)	20 (n/a)	90 (n/a)	0	0 (0%)	7 (n/a)	15 (n/a)	13 (n/a)	81 (n/a)
June	0	40 (n/a)	50 (n/a)	42 (n/a)	61 (n/a)	158 (n/a)	0	24 (n/a)	26 (n/a)	26 (n/a)	39 (n/a)	142 (n/a)
July	0	39 (n/a)	55 (n/a)	51 (n/a)	67 (n/a)	189 (n/a)	0	23 (n/a)	28 (n/a)	31 (n/a)	43 (n/a)	169 (n/a)
August	0	39 (n/a)	39 (n/a)	34 (n/a)	53 (n/a)	126 (n/a)	0	23 (n/a)	21 (n/a)	21 (n/a)	34 (n/a)	113 (n/a)
September	0	40 (n/a)	42 (n/a)	7 (n/a)	31 (n/a)	28 (n/a)	0	24 (n/a)	22 (n/a)	5 (n/a)	19 (n/a)	25 (n/a)
Average Annual	22	4 (19%)	17 (80%)	-2 (-10%)	11 (51%)	53 (245%)	28	-13 (-46%)	-8 (-28%)	-16 (-58%)	-4 (-16%)	39 (140%)

Source: CalSim II 2005 and 2030 simulations (Node C605a)

Notes:

[1] Values presented for dry and critical year types as defined by the San Joaquin River Water Year Hydrologic Classification Indices.

[2] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[3] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[4] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:
Alt = Alternatives
cfs = cubic feet per second
n/a = not applicable

Flow changes in Reach 3 through Reach 4A would be less sensitive to changes in flood releases from Friant Dam because most flood flows bypass these reaches (Table 14-33 through Table 14-36). Decreases in flow during wetter winter and spring months, therefore, would be less than observed for upstream reaches. Similar to upper reaches, operational differences between the action alternatives would cause differences in timing of Temperance Flat RM 274 storage and releases, which would cause difference in flows between alternatives.

Reach 4B1 would not have differences in flow because all flow bypasses this reach (Table 4-37 and 4-38). Reach 4B2 and Reach 5 would be sensitive to flood release changes as flood flows can reenter the San Joaquin River from the bypass system at these points (Table 14-39 through Table 14-42). Flow changes would be caused by decreased flood releases from Friant Dam and by changes in water supply routing and timing, similar to that described for other reaches.

Table 14-33. Average Simulated Monthly Flow, San Joaquin River at Head of Reach 3

Month	Existing Level (2005)[1]						Future Level (2030)[1]					
	Existing Conditions (cfs)	Change from Existing Condition (cfs)[2]					No Action Alt (cfs)	Change from No Action (cfs)[3]				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	311	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	326	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
November	188	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	215	-14 (-6%)	-13 (-6%)	-15 (-7%)	-13 (-6%)	-12 (-6%)
December	185	-39 (-21%)	-39 (-21%)	-39 (-21%)	-39 (-21%)	-39 (-21%)	229	-61 (-27%)	-61 (-27%)	-58 (-25%)	-44 (-19%)	-61 (-27%)
January	283	-67 (-24%)	-67 (-24%)	-67 (-24%)	-67 (-24%)	-67 (-24%)	328	-69 (-21%)	-69 (-21%)	-69 (-21%)	-69 (-21%)	-70 (-21%)
February	333	-71 (-21%)	-68 (-20%)	-69 (-21%)	-70 (-21%)	-71 (-21%)	428	-138 (-32%)	-138 (-32%)	-138 (-32%)	-120 (-28%)	-139 (-32%)
March	374	-8 (-2%)	-8 (-2%)	-8 (-2%)	-8 (-2%)	-8 (-2%)	492	-87 (-18%)	-86 (-18%)	-87 (-18%)	-86 (-17%)	-99 (-20%)
April	368	4 (1%)	4 (1%)	4 (1%)	4 (1%)	4 (1%)	566	-84 (-15%)	-84 (-15%)	-84 (-15%)	-71 (-13%)	-86 (-15%)
May	526	-14 (-3%)	-14 (-3%)	-14 (-3%)	-14 (-3%)	-14 (-3%)	683	-91 (-13%)	-91 (-13%)	-91 (-13%)	-91 (-13%)	-94 (-14%)
June	448	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	605	-46 (-8%)	-46 (-8%)	-47 (-8%)	-47 (-8%)	-46 (-8%)
July	434	-3 (-1%)	-2 (-1%)	-1 (0%)	-2 (0%)	-1 (0%)	458	-13 (-3%)	-13 (-3%)	-17 (-4%)	-3 (-1%)	-12 (-3%)
August	404	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	408	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	355	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	366	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Annual	351	-16 (-5%)	-16 (-5%)	-16 (-5%)	-16 (-5%)	-16 (-5%)	425	-50 (-12%)	-49 (-12%)	-50 (-12%)	-45 (-11%)	-51 (-12%)

Source: CalSim II 2005 and 2030 simulations (Node C607)

Notes:

[1] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[2] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[3] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:
Alt = Alternatives
cfs = cubic feet per second

Table 14-34. Average Simulated Monthly Flow in Dry and Critical Years, San Joaquin River at Head of Reach 3

Month	Existing Level (2005)[1,2]						Future Level (2030)[1,2]					
	Existing Conditions (cfs)	Change from Existing Condition (cfs)[3]					No Action Alt (cfs)	Change from No Action (cfs)[4]				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	293	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	308	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
November	147	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	157	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
December	101	-36 (-36%)	-36 (-36%)	-36 (-36%)	-36 (-36%)	-36 (-36%)	109	-40 (-36%)	-40 (-36%)	-40 (-36%)	-40 (-36%)	-40 (-36%)
January	134	-71 (-53%)	-71 (-53%)	-71 (-53%)	-71 (-53%)	-71 (-53%)	154	-88 (-57%)	-88 (-57%)	-88 (-57%)	-88 (-57%)	-88 (-57%)
February	279	-59 (-21%)	-59 (-21%)	-59 (-21%)	-59 (-21%)	-59 (-21%)	355	-131 (-37%)	-131 (-37%)	-131 (-37%)	-92 (-26%)	-131 (-37%)
March	195	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	198	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
April	215	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	219	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
May	292	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	298	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
June	395	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	403	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
July	391	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	393	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
August	388	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	391	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	341	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	351	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Annual	264	-14 (-5%)	-14 (-5%)	-14 (-5%)	-14 (-5%)	-14 (-5%)	277	-21 (-8%)	-21 (-8%)	-21 (-8%)	-18 (-6%)	-21 (-8%)

Source: CalSim II 2005 and 2030 simulations (Node C607)

Notes:

[1] Values presented for dry and critical year types as defined by the San Joaquin River Water Year Hydrologic Classification Indices.

[2] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[3] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[4] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:
Alt = Alternatives
cfs = cubic feet per second

Table 14-35. Average Simulated Monthly Flow, San Joaquin River at Head of Reach 4A

Month	Existing Level (2005)[1]						Future Level (2030)[1]					
	Existing Conditions	Change from Existing Condition (cfs)[2]					No Action Alt	Change from No Action (cfs)[3]				
	(cfs)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	(cfs)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	86	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	86	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
November	246	-1 (0%)	-1 (0%)	-1 (0%)	-1 (0%)	1 (0%)	265	-14 (-5%)	-13 (-5%)	-15 (-5%)	-13 (-5%)	-12 (-5%)
December	117	-39 (-33%)	-39 (-33%)	-39 (-33%)	-39 (-33%)	-39 (-33%)	272	-61 (-22%)	-61 (-22%)	-58 (-21%)	-44 (-16%)	-61 (-22%)
January	228	-67 (-29%)	-67 (-29%)	-67 (-29%)	-67 (-29%)	-67 (-29%)	405	-69 (-17%)	-69 (-17%)	-69 (-17%)	-69 (-17%)	-70 (-17%)
February	365	-71 (-19%)	-68 (-19%)	-69 (-19%)	-70 (-19%)	-71 (-19%)	456	-138 (-30%)	-138 (-30%)	-138 (-30%)	-120 (-26%)	-139 (-30%)
March	867	-8 (-1%)	-8 (-1%)	-8 (-1%)	-8 (-1%)	-8 (-1%)	1,023	-87 (-8%)	-86 (-8%)	-87 (-9%)	-86 (-8%)	-99 (-10%)
April	927	-5 (-1%)	-4 (0%)	-4 (0%)	-5 (-1%)	-4 (0%)	2,056	-84 (-4%)	-84 (-4%)	-84 (-4%)	-71 (-3%)	-86 (-4%)
May	386	-14 (-4%)	-14 (-4%)	-14 (-4%)	-14 (-4%)	-14 (-4%)	759	-91 (-12%)	-91 (-12%)	-91 (-12%)	-91 (-12%)	-94 (-12%)
June	318	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	572	-46 (-8%)	-46 (-8%)	-47 (-8%)	-47 (-8%)	-46 (-8%)
July	45	-3 (-7%)	-2 (-5%)	-1 (-1%)	-2 (-5%)	-1 (-1%)	67	-13 (-20%)	-13 (-20%)	-17 (-25%)	-3 (-5%)	-12 (-18%)
August	18	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	18	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	35	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	36	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Annual	302	-17 (-6%)	-17 (-6%)	-17 (-6%)	-17 (-6%)	-17 (-6%)	499	-50 (-10%)	-49 (-10%)	-50 (-10%)	-45 (-9%)	-51 (-10%)

Source: CalSim II 2005 and 2030 simulations (Node C608)

Notes:

[1] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[2] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[3] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:
Alt = Alternatives
cfs = cubic feet per second

Table 14-36. Average Simulated Monthly Flow in Dry and Critical Years, San Joaquin River at Head of Reach 4A

Month	Existing Level (2005)[1,2]						Future Level (2030)[1,2]					
	Existing Conditions (cfs)	Change from Existing Condition (cfs)[3]					No Action Alt (cfs)	Change from No Action (cfs)[4]				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	77	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	71	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
November	204	-3 (-1%)	-3 (-1%)	-3 (-1%)	-3 (-2%)	3 (1%)	182	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
December	36	-36 (-100%)	-36 (-100%)	-36 (-100%)	-36 (-100%)	-36 (-100%)	142	-40 (-28%)	-40 (-28%)	-40 (-28%)	-40 (-28%)	-40 (-28%)
January	82	-71 (-87%)	-71 (-87%)	-71 (-87%)	-71 (-87%)	-71 (-87%)	218	-88 (-40%)	-88 (-40%)	-88 (-40%)	-88 (-40%)	-88 (-40%)
February	306	-59 (-19%)	-59 (-19%)	-59 (-19%)	-59 (-19%)	-59 (-19%)	372	-131 (-35%)	-131 (-35%)	-131 (-35%)	-92 (-25%)	-131 (-35%)
March	719	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	721	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
April	316	-1 (0%)	-1 (0%)	-1 (0%)	-1 (0%)	-1 (0%)	471	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
May	46	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	43	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
June	47	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	44	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
July	16	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	15	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
August	16	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	15	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	31	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	31	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Annual	157	-14 (-9%)	-14 (-9%)	-14 (-9%)	-14 (-9%)	-13 (-9%)	192	-21 (-11%)	-21 (-11%)	-21 (-11%)	-18 (-9%)	-21 (-11%)

Source: CalSim II 2005 and 2030 simulations (Node C608)

Notes:

1 Values presented for Dry years as defined by the Restoration year type.

2 Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

3 (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

4 (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:
Alt = Alternatives
cfs = cubic feet per second

Table 14-37. Average Simulated Monthly Flow, San Joaquin River at Head of Reach 4B1

Month	Existing Level (2005)[1]						Future Level (2030)[1]					
	Existing Conditions (cfs)	Change from Existing Condition (cfs)[2]					No Action Alt (cfs)	Change from No Action (cfs)[3]				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
November	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
December	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
January	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
February	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
March	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
April	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
May	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
June	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
July	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
August	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Annual	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Source: CalSim II 2005 and 2030 simulations (Node C609b)

Notes:

[1] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[2] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[3] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:
Alt = Alternatives
cfs = cubic feet per second

Table 14-38. Average Simulated Monthly Flow in Dry and Critical Years, San Joaquin River at Head of Reach 4B1

Month	Existing Level (2005)[1,2]						Future Level (2030)[1,2]					
	Existing Conditions (cfs)	Change from Existing Condition (cfs)[3]					No Action Alt (cfs)	Change from No Action (cfs)[4]				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
November	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
December	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
January	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
February	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
March	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
April	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
May	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
June	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
July	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
August	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Annual	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Source: CalSim II 2005 and 2030 simulations (Node C609b)

Notes:

[1] Values presented for dry and critical year types as defined by the San Joaquin River Water Year Hydrologic Classification Indices.

[2] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[3] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[4] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:
Alt = Alternatives
cfs = cubic feet per second

Table 14-39. Average Simulated Monthly Flow, San Joaquin River at Head of Reach 4B2

Month	Existing Level (2005)[1]						Future Level (2030)[1]					
	Existing Conditions (cfs)	Change from Existing Condition (cfs)[2]					No Action Alt (cfs)	Change from No Action (cfs)[3]				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	74	3 (4%)	3 (4%)	3 (4%)	3 (4%)	3 (4%)	75	3 (4%)	3 (4%)	3 (4%)	3 (4%)	2 (3%)
November	313	-16 (-5%)	-15 (-5%)	-19 (-6%)	-4 (-1%)	1 (0%)	311	-14 (-4%)	-13 (-4%)	-15 (-5%)	-13 (-4%)	-12 (-4%)
December	270	-101 (-37%)	-97 (-36%)	-102 (-38%)	-97 (-36%)	-97 (-36%)	361	-118 (-33%)	-118 (-33%)	-113 (-31%)	-90 (-25%)	-118 (-33%)
January	506	-175 (-34%)	-175 (-34%)	-174 (-34%)	-175 (-35%)	-174 (-34%)	583	-133 (-23%)	-131 (-23%)	-131 (-22%)	-131 (-22%)	-149 (-26%)
February	833	-283 (-34%)	-277 (-33%)	-277 (-33%)	-270 (-32%)	-296 (-36%)	791	-256 (-32%)	-254 (-32%)	-254 (-32%)	-231 (-29%)	-253 (-32%)
March	1,320	-240 (-18%)	-236 (-18%)	-232 (-18%)	-202 (-15%)	-231 (-17%)	1,261	-166 (-13%)	-165 (-13%)	-166 (-13%)	-164 (-13%)	-176 (-14%)
April	1,405	-227 (-16%)	-222 (-16%)	-224 (-16%)	-230 (-16%)	-247 (-18%)	2,179	-160 (-7%)	-159 (-7%)	-160 (-7%)	-128 (-6%)	-163 (-7%)
May	952	-338 (-36%)	-336 (-35%)	-336 (-35%)	-329 (-35%)	-345 (-36%)	887	-175 (-20%)	-175 (-20%)	-176 (-20%)	-172 (-19%)	-190 (-21%)
June	698	-201 (-29%)	-214 (-31%)	-219 (-31%)	-194 (-28%)	-230 (-33%)	676	-97 (-14%)	-96 (-14%)	-102 (-15%)	-109 (-16%)	-111 (-16%)
July	198	-44 (-22%)	-49 (-25%)	-61 (-31%)	-36 (-18%)	-75 (-38%)	199	-92 (-46%)	-92 (-46%)	-98 (-49%)	-66 (-33%)	-118 (-59%)
August	6	0 (1%)	0 (1%)	0 (1%)	0 (1%)	0 (1%)	6	0 (-1%)	0 (-1%)	0 (-1%)	0 (-1%)	0 (-1%)
September	23	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	23	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Annual	547	-134 (-25%)	-134 (-24%)	-136 (-25%)	-127 (-23%)	-140 (-26%)	609	-100 (-16%)	-99 (-16%)	-100 (-16%)	-91 (-15%)	-107 (-17%)

Source: CalSim II 2005 and 2030 simulations (Node C610)

Notes:

[1] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[2] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[3] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:
Alt = Alternatives
cfs = cubic feet per second

Table 14-40. Average Simulated Monthly Flow in Dry and Critical Years, San Joaquin River at Head of Reach 4B2

Month	Existing Level (2005)[1,2]						Future Level (2030)[1,2]					
	Existing Conditions	Change from Existing Condition (cfs)[3]					No Action Alt	Change from No Action (cfs)[4]				
	(cfs)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	(cfs)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	66	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	61	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
November	193	-3 (-1%)	-3 (-1%)	-3 (-1%)	-3 (-2%)	3 (1%)	171	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
December	76	-57 (-76%)	-57 (-76%)	-57 (-76%)	-57 (-76%)	-57 (-76%)	163	-53 (-33%)	-53 (-33%)	-53 (-33%)	-53 (-33%)	-53 (-33%)
January	295	-202 (-69%)	-202 (-69%)	-202 (-69%)	-203 (-69%)	-202 (-69%)	382	-181 (-47%)	-181 (-47%)	-181 (-47%)	-182 (-48%)	-181 (-47%)
February	735	-260 (-35%)	-258 (-35%)	-258 (-35%)	-253 (-34%)	-305 (-42%)	721	-299 (-42%)	-299 (-42%)	-299 (-42%)	-261 (-36%)	-300 (-42%)
March	707	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	708	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
April	305	-1 (0%)	-1 (0%)	-1 (0%)	-1 (0%)	-1 (0%)	460	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
May	36	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	33	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
June	36	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	34	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
July	5	0 (2%)	0 (4%)	0 (4%)	0 (4%)	0 (2%)	6	0 (-7%)	0 (-7%)	0 (-7%)	0 (-7%)	0 (-7%)
August	5	0 (4%)	0 (4%)	0 (4%)	0 (4%)	0 (4%)	5	0 (-5%)	0 (-5%)	0 (-5%)	0 (-5%)	0 (-5%)
September	20	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	21	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Annual	203	-42 (-21%)	-42 (-21%)	-42 (-21%)	-42 (-21%)	-45 (-22%)	227	-43 (-19%)	-43 (-19%)	-43 (-19%)	-40 (-18%)	-43 (-19%)

Source: CalSim II 2005 and 2030 simulations (Node C610)

Notes:

[1] Values presented for dry and critical year types as defined by the San Joaquin River Water Year Hydrologic Classification Indices.

[2] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[3] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[4] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:
Alt = Alternatives
cfs = cubic feet per second

Table 14-41. Average Simulated Monthly Flow, San Joaquin River at Head of Reach 5

Month	Existing Level (2005)[1]						Future Level (2030)[1]					
	Existing Conditions (cfs)	Change from Existing Condition (cfs)[2]					No Action Alt (cfs)	Change from No Action (cfs)[3]				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	85	3 (3%)	3 (3%)	3 (3%)	3 (3%)	3 (3%)	86	3 (4%)	3 (4%)	3 (4%)	3 (4%)	2 (3%)
November	379	-16 (-4%)	-15 (-4%)	-19 (-5%)	-4 (-1%)	1 (0%)	377	-14 (-4%)	-13 (-3%)	-15 (-4%)	-13 (-3%)	-12 (-3%)
December	510	-101 (-20%)	-97 (-19%)	-102 (-20%)	-97 (-19%)	-97 (-19%)	601	-118 (-20%)	-118 (-20%)	-113 (-19%)	-90 (-15%)	-118 (-20%)
January	1,071	-242 (-23%)	-246 (-23%)	-258 (-24%)	-231 (-22%)	-247 (-23%)	1,147	-212 (-18%)	-210 (-18%)	-215 (-19%)	-204 (-18%)	-223 (-19%)
February	1,604	-285 (-18%)	-280 (-17%)	-279 (-17%)	-273 (-17%)	-298 (-19%)	1,563	-256 (-16%)	-255 (-16%)	-254 (-16%)	-232 (-15%)	-254 (-16%)
March	2,073	-241 (-12%)	-238 (-11%)	-233 (-11%)	-204 (-10%)	-232 (-11%)	2,012	-175 (-9%)	-174 (-9%)	-175 (-9%)	-173 (-9%)	-177 (-9%)
April	1,985	-239 (-12%)	-234 (-12%)	-236 (-12%)	-242 (-12%)	-259 (-13%)	2,785	-184 (-7%)	-183 (-7%)	-184 (-7%)	-152 (-5%)	-190 (-7%)
May	1,247	-353 (-28%)	-350 (-28%)	-350 (-28%)	-343 (-27%)	-359 (-29%)	1,190	-193 (-16%)	-193 (-16%)	-194 (-16%)	-190 (-16%)	-207 (-17%)
June	861	-221 (-26%)	-234 (-27%)	-245 (-28%)	-214 (-25%)	-250 (-29%)	824	-101 (-12%)	-100 (-12%)	-113 (-14%)	-114 (-14%)	-129 (-16%)
July	236	-44 (-19%)	-49 (-21%)	-61 (-26%)	-36 (-15%)	-75 (-32%)	236	-92 (-39%)	-92 (-39%)	-98 (-41%)	-66 (-28%)	-118 (-50%)
August	14	0 (1%)	0 (1%)	0 (1%)	0 (1%)	0 (1%)	15	0 (-1%)	0 (-1%)	0 (-1%)	0 (-1%)	0 (-1%)
September	28	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	29	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Annual	835	-144 (-17%)	-144 (-17%)	-148 (-18%)	-136 (-16%)	-150 (-18%)	899	-111 (-12%)	-111 (-12%)	-113 (-13%)	-102 (-11%)	-118 (-13%)

Source: CalSim II 2005 and 2030 simulations (Node C611)

Notes:

1. Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.
2. (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.
3. (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:
Alt = Alternatives
cfs = cubic feet per second

Table 14-42. Average Simulated Monthly Flow in Dry and Critical Years, San Joaquin River at Head of Reach 5

Month	Existing Level (2005)[1,2]						Future Level (2030)[1,2]					
	Existing Conditions (cfs)	Change from Existing Condition (cfs)[3]					No Action Alt (cfs)	Change from No Action (cfs)[4]				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	68	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	64	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
November	227	-3 (-1%)	-3 (-1%)	-3 (-1%)	-3 (-1%)	3 (1%)	204	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
December	290	-57 (-20%)	-57 (-20%)	-57 (-20%)	-57 (-20%)	-57 (-20%)	377	-53 (-14%)	-53 (-14%)	-53 (-14%)	-53 (-14%)	-53 (-14%)
January	827	-202 (-24%)	-202 (-24%)	-202 (-24%)	-203 (-25%)	-202 (-24%)	914	-181 (-20%)	-181 (-20%)	-181 (-20%)	-182 (-20%)	-181 (-20%)
February	1,583	-260 (-16%)	-258 (-16%)	-258 (-16%)	-253 (-16%)	-305 (-19%)	1,569	-299 (-19%)	-299 (-19%)	-299 (-19%)	-261 (-17%)	-300 (-19%)
March	903	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	904	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
April	459	-1 (0%)	-1 (0%)	-1 (0%)	-1 (0%)	-1 (0%)	614	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
May	125	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	123	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
June	73	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	70	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
July	13	0 (1%)	0 (2%)	0 (2%)	0 (2%)	0 (1%)	14	0 (-3%)	0 (-3%)	0 (-3%)	0 (-3%)	0 (-3%)
August	7	0 (3%)	0 (3%)	0 (3%)	0 (3%)	0 (3%)	8	0 (-3%)	0 (-3%)	0 (-3%)	0 (-3%)	0 (-3%)
September	21	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	21	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Annual	375	-42 (-11%)	-42 (-11%)	-42 (-11%)	-42 (-11%)	-45 (-12%)	399	-43 (-11%)	-43 (-11%)	-43 (-11%)	-40 (-10%)	-43 (-11%)

Source: CalSim II 2005 and 2030 simulations (Node C611)

Notes:

[1] Values presented for dry and critical year types as defined by the San Joaquin River Water Year Hydrologic Classification Indices.

[2] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[3] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[4] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:
Alt = Alternatives
cfs = cubic feet per second

All alternatives would reduce the average streamflow in the flood bypass system in wetter winter and spring months (Table 14-43 through Table 14-46). Temperance Flat RM 274 Reservoir would store large runoff events in wetter months and years that otherwise would be released from Millerton Lake as flood flows and would then be diverted into the bypasses. Changes in flow leaving Reach 5 and the flood bypass system would continue to reflect this capture of flood flows in Temperance Flat RM 274 Reservoir, for later release in drier months and years for water supply deliveries in upper reaches.

Table 14-43. Average Simulated Monthly Flow in Chowchilla Bypass Below Bifurcation Structure

Month	Existing Level (2005)[1]						Future Level (2030)[1]					
	Existing Conditions (cfs)	Change from Existing Condition (cfs)[2]					No Action Alt (cfs)	Change from No Action (cfs)[3]				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
November	22	-15 (-67%)	-14 (-62%)	-17 (-77%)	-2 (-9%)	0 (2%)	3	-1 (-50%)	-1 (-50%)	-1 (-50%)	-1 (-50%)	-1 (-50%)
December	108	-47 (-43%)	-42 (-39%)	-48 (-44%)	-42 (-39%)	-42 (-39%)	56	-41 (-74%)	-41 (-73%)	-42 (-74%)	-32 (-56%)	-41 (-74%)
January	253	-147 (-58%)	-151 (-59%)	-162 (-64%)	-142 (-56%)	-152 (-60%)	168	-119 (-70%)	-117 (-69%)	-122 (-73%)	-114 (-68%)	-131 (-78%)
February	255	-185 (-72%)	-184 (-72%)	-183 (-72%)	-181 (-71%)	-202 (-79%)	122	-99 (-81%)	-99 (-81%)	-99 (-81%)	-97 (-79%)	-99 (-81%)
March	342	-229 (-67%)	-227 (-66%)	-222 (-65%)	-193 (-56%)	-221 (-65%)	116	-89 (-77%)	-89 (-77%)	-89 (-77%)	-89 (-77%)	-82 (-71%)
April	528	-235 (-45%)	-229 (-43%)	-232 (-44%)	-238 (-45%)	-253 (-48%)	166	-112 (-67%)	-111 (-67%)	-112 (-67%)	-93 (-56%)	-116 (-70%)
May	650	-351 (-54%)	-348 (-54%)	-349 (-54%)	-341 (-52%)	-359 (-55%)	205	-122 (-60%)	-122 (-59%)	-123 (-60%)	-119 (-58%)	-132 (-64%)
June	471	-243 (-52%)	-256 (-54%)	-274 (-58%)	-236 (-50%)	-272 (-58%)	164	-71 (-43%)	-70 (-43%)	-89 (-54%)	-82 (-50%)	-99 (-60%)
July	181	-47 (-26%)	-54 (-30%)	-67 (-37%)	-41 (-22%)	-81 (-45%)	159	-85 (-53%)	-85 (-53%)	-90 (-56%)	-69 (-43%)	-114 (-72%)
August	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Annual	234	-124 (-53%)	-125 (-53%)	-129 (-55%)	-117 (-50%)	-131 (-56%)	97	-61 (-64%)	-61 (-63%)	-64 (-66%)	-58 (-60%)	-68 (-70%)

Source: CalSim II 2005 and 2030 simulations (Node C605b)

Notes:

[1] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[2] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[3] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:

Alt = Alternatives

cfs = cubic feet per second

Table 14-44. Average Simulated Monthly Flow in Eastside Bypass Below Sand Slough

Month	Existing Level (2005)[1]						Future Level (2030)[1]					
	Existing Conditions (cfs)	Change from Existing Condition (cfs)[2]					No Action Alt (cfs)	Change from No Action (cfs)[3]				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	73	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	74	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
November	234	-1 (0%)	-1 (0%)	-1 (0%)	-1 (0%)	1 (0%)	253	-14 (-5%)	-13 (-5%)	-15 (-6%)	-13 (-5%)	-12 (-5%)
December	116	-38 (-33%)	-38 (-33%)	-38 (-33%)	-38 (-33%)	-38 (-33%)	260	-61 (-23%)	-61 (-23%)	-57 (-22%)	-44 (-17%)	-61 (-23%)
January	226	-66 (-29%)	-66 (-29%)	-66 (-29%)	-66 (-29%)	-66 (-29%)	393	-69 (-18%)	-69 (-18%)	-69 (-18%)	-69 (-18%)	-70 (-18%)
February	353	-71 (-20%)	-68 (-19%)	-69 (-19%)	-70 (-20%)	-71 (-20%)	444	-138 (-31%)	-138 (-31%)	-138 (-31%)	-120 (-27%)	-138 (-31%)
March	854	-8 (-1%)	-8 (-1%)	-8 (-1%)	-8 (-1%)	-8 (-1%)	1,010	-87 (-9%)	-86 (-9%)	-87 (-9%)	-86 (-9%)	-99 (-10%)
April	914	-5 (-1%)	-4 (0%)	-4 (0%)	-5 (-1%)	-4 (0%)	2,044	-84 (-4%)	-84 (-4%)	-84 (-4%)	-71 (-3%)	-86 (-4%)
May	374	-14 (-4%)	-14 (-4%)	-14 (-4%)	-14 (-4%)	-14 (-4%)	747	-91 (-12%)	-91 (-12%)	-91 (-12%)	-91 (-12%)	-94 (-13%)
June	305	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	560	-46 (-8%)	-46 (-8%)	-47 (-8%)	-47 (-8%)	-46 (-8%)
July	33	-3 (-9%)	-2 (-7%)	-1 (-2%)	-2 (-6%)	-1 (-2%)	55	-13 (-24%)	-13 (-24%)	-17 (-30%)	-3 (-6%)	-12 (-22%)
August	6	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	6	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	23	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	23	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Annual	291	-17 (-6%)	-17 (-6%)	-17 (-6%)	-17 (-6%)	-17 (-6%)	487	-50 (-10%)	-49 (-10%)	-50 (-10%)	-45 (-9%)	-51 (-10%)

Source: CalSim II 2005 and 2030 simulations (Node C609a)

Notes:

[1] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[2] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[3] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:

Alt = Alternatives

cfs = cubic feet per second

Table 14-45. Average Simulated Monthly Flow in Eastside Bypass Upstream from San Joaquin River Confluence

Month	Existing Level (2005)[1]						Future Level (2030)[1]					
	Existing Conditions	Change from Existing Condition (cfs)[2]					No Action Alt	Change from No Action (cfs)[3]				
	(cfs)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	(cfs)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	10	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	10	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
November	67	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	67	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
December	240	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	240	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
January	564	-67 (-12%)	-71 (-13%)	-84 (-15%)	-57 (-10%)	-72 (-13%)	564	-79 (-14%)	-78 (-14%)	-85 (-15%)	-73 (-13%)	-74 (-13%)
February	771	-2 (0%)	-2 (0%)	-2 (0%)	-2 (0%)	-2 (0%)	771	-1 (0%)	-1 (0%)	-1 (0%)	-1 (0%)	-1 (0%)
March	753	-2 (0%)	-2 (0%)	-2 (0%)	-2 (0%)	-2 (0%)	752	-9 (-1%)	-9 (-1%)	-9 (-1%)	-9 (-1%)	-1 (0%)
April	580	-12 (-2%)	-12 (-2%)	-12 (-2%)	-12 (-2%)	-12 (-2%)	606	-24 (-4%)	-24 (-4%)	-24 (-4%)	-24 (-4%)	-27 (-4%)
May	295	-14 (-5%)	-14 (-5%)	-14 (-5%)	-14 (-5%)	-14 (-5%)	303	-18 (-6%)	-18 (-6%)	-18 (-6%)	-18 (-6%)	-17 (-6%)
June	163	-20 (-12%)	-20 (-12%)	-27 (-16%)	-20 (-12%)	-20 (-12%)	149	-4 (-3%)	-4 (-3%)	-11 (-8%)	-4 (-3%)	-18 (-12%)
July	38	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	38	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
August	9	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	9	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	5	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	5	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Annual	288	-10 (-3%)	-10 (-4%)	-12 (-4%)	-9 (-3%)	-10 (-4%)	290	-11 (-4%)	-11 (-4%)	-12 (-4%)	-11 (-4%)	-12 (-4%)

Source: CalSim II 2005 and 2030 simulations (Node C589)

Notes:

[1] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[2] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[3] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:

Alt = Alternatives

cfs = cubic feet per second

Table 14-46. Average Simulated Monthly Flow in Mariposa Bypass

Month	Existing Level (2005)[1]						Future Level (2030)[1]					
	Existing Conditions (cfs)	Change from Existing Condition (cfs)[2]					No Action Alt (cfs)	Change from No Action (cfs)[3]				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	74	3 (4%)	3 (4%)	3 (4%)	3 (4%)	3 (4%)	75	3 (4%)	3 (4%)	3 (4%)	3 (4%)	2 (3%)
November	313	-16 (-5%)	-15 (-5%)	-19 (-6%)	-4 (-1%)	1 (0%)	311	-14 (-4%)	-13 (-4%)	-15 (-5%)	-13 (-4%)	-12 (-4%)
December	270	-101 (-37%)	-97 (-36%)	-102 (-38%)	-97 (-36%)	-97 (-36%)	361	-118 (-33%)	-118 (-33%)	-113 (-31%)	-90 (-25%)	-118 (-33%)
January	506	-175 (-34%)	-175 (-34%)	-174 (-34%)	-175 (-35%)	-174 (-34%)	583	-133 (-23%)	-131 (-23%)	-131 (-22%)	-131 (-22%)	-149 (-26%)
February	833	-283 (-34%)	-277 (-33%)	-277 (-33%)	-270 (-32%)	-296 (-36%)	791	-256 (-32%)	-254 (-32%)	-254 (-32%)	-231 (-29%)	-253 (-32%)
March	1,320	-240 (-18%)	-236 (-18%)	-232 (-18%)	-202 (-15%)	-231 (-17%)	1,261	-166 (-13%)	-165 (-13%)	-166 (-13%)	-164 (-13%)	-176 (-14%)
April	1,405	-227 (-16%)	-222 (-16%)	-224 (-16%)	-230 (-16%)	-247 (-18%)	2,179	-160 (-7%)	-159 (-7%)	-160 (-7%)	-128 (-6%)	-163 (-7%)
May	952	-338 (-36%)	-336 (-35%)	-336 (-35%)	-329 (-35%)	-345 (-36%)	887	-175 (-20%)	-175 (-20%)	-176 (-20%)	-172 (-19%)	-190 (-21%)
June	698	-201 (-29%)	-214 (-31%)	-219 (-31%)	-194 (-28%)	-230 (-33%)	676	-97 (-14%)	-96 (-14%)	-102 (-15%)	-109 (-16%)	-111 (-16%)
July	198	-44 (-22%)	-49 (-25%)	-61 (-31%)	-36 (-18%)	-75 (-38%)	199	-92 (-46%)	-92 (-46%)	-98 (-49%)	-66 (-33%)	-118 (-59%)
August	6	0 (1%)	0 (1%)	0 (1%)	0 (1%)	0 (1%)	6	0 (-1%)	0 (-1%)	0 (-1%)	0 (-1%)	0 (-1%)
September	23	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	23	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Annual	547	-134 (-25%)	-134 (-24%)	-136 (-25%)	-127 (-23%)	-140 (-26%)	609	-100 (-16%)	-99 (-16%)	-100 (-16%)	-91 (-15%)	-107 (-17%)

Source: CalSim II 2005 and 2030 simulations (Node C587a)

Notes:

[1] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[2] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[3] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:

Alt = Alternatives

cfs = cubic feet per second

San Joaquin River from the Merced River to the Delta

Flow changes in the San Joaquin River and in its associated tributaries below Reach 5 would be less than changes seen in upstream reaches (Table 14-47 through Table 14-56). None of the alternatives would change San Joaquin River tributary streamflows. Percent changes in San Joaquin River streamflow would be less than observed in upstream reaches because the basis-of-comparison or magnitude of flow in the San Joaquin River increases considerably as it nears the Delta. Similarly, effects caused by changes in flood releases from Friant Dam would diminish as the river nears the Delta. Most new water supply deliveries associated with the alternatives are made upstream from this reach and would, therefore, not increase flows below Reach 5 in drier months and years.

Table 14-47. Average Simulated Monthly Merced River Inflow to San Joaquin River

Month	Existing Level (2005)[1]						Future Level (2030)[1]					
	Existing Condition (cfs)	Change from Existing Condition (cfs)[2]					No Action Alt (cfs)	Change from No Action (cfs)[3]				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	449	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	461	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
November	437	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	437	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
December	592	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	601	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
January	908	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	907	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
February	1,153	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,178	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
March	849	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	846	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
April	668	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	650	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
May	974	2 (0%)	3 (0%)	3 (0%)	2 (0%)	3 (0%)	956	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
June	919	0 (0%)	0 (0%)	4 (0%)	0 (0%)	0 (0%)	943	0 (0%)	0 (0%)	11 (1%)	0 (0%)	0 (0%)
July	705	-1 (0%)	-1 (0%)	-1 (0%)	-1 (0%)	-1 (0%)	739	0 (0%)	0 (0%)	4 (1%)	0 (0%)	0 (0%)
August	461	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	497	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	270	-1 (0%)	-1 (-1%)	-1 (-1%)	-1 (0%)	-1 (-1%)	283	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Annual	696	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	706	0 (0%)	0 (0%)	1 (0%)	0 (0%)	0 (0%)

Source: Summarized from CalSim II 2005 and 2030 simulations (Node C566)

Notes:

[1] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[2] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[3] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:

Alt = Alternative

cfs = cubic feet per second

Table 14-48. Average Simulated Monthly Merced River Inflow in Dry and Critical Years to San Joaquin River

Month	Existing Level (2005)[1,2]						Future Level (2030)[1,2]					
	Existing Condition (cfs)	Change from Existing Condition (cfs)[3]					No Action Alt (cfs)	Change from No Action (cfs)[4]				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	292	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	293	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
November	356	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	356	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
December	370	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	370	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
January	608	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	596	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
February	789	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	797	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
March	317	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	319	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
April	466	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	475	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
May	308	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	258	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
June	160	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	166	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
July	109	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	118	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
August	96	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	100	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	58	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	58	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Annual	324	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	322	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Source: Summarized from CALSIM II 2005 and 2030 simulations (Node C566)

Notes:

[1] Values presented for Dry and Critical years as defined by the San Joaquin River Water Year Hydrologic Classification Indices.

[2] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[3] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[4] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:
Alt = Alternative
cfs = cubic feet per second

Table 14-49. Average Simulated Monthly Flow at San Joaquin River Below Merced River

Month	Existing Level (2005)[1]						Future Level (2030)[1]					
	Existing Condition (cfs)	Change from Existing Condition (cfs)[2]					No Action Alt (cfs)	Change from No Action (cfs)[3]				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	696	3 (0%)	3 (0%)	3 (0%)	3 (0%)	3 (0%)	685	3 (0%)	3 (0%)	3 (0%)	3 (0%)	2 (0%)
November	1,264	-16 (-1%)	-15 (-1%)	-19 (-1%)	-4 (0%)	1 (0%)	1,237	-14 (-1%)	-13 (-1%)	-15 (-1%)	-13 (-1%)	-12 (-1%)
December	1,490	-101 (-7%)	-97 (-6%)	-102 (-7%)	-97 (-6%)	-97 (-6%)	1,561	-118 (-8%)	-118 (-8%)	-113 (-7%)	-90 (-6%)	-118 (-8%)
January	2,285	-242 (-11%)	-246 (-11%)	-258 (-11%)	-231 (-10%)	-247 (-11%)	2,310	-212 (-9%)	-210 (-9%)	-215 (-9%)	-204 (-9%)	-223 (-10%)
February	3,292	-285 (-9%)	-280 (-8%)	-279 (-8%)	-273 (-8%)	-298 (-9%)	3,217	-256 (-8%)	-255 (-8%)	-254 (-8%)	-232 (-7%)	-254 (-8%)
March	3,203	-241 (-8%)	-238 (-7%)	-233 (-7%)	-204 (-6%)	-232 (-7%)	3,084	-175 (-6%)	-174 (-6%)	-175 (-6%)	-173 (-6%)	-177 (-6%)
April	2,660	-238 (-9%)	-233 (-9%)	-235 (-9%)	-241 (-9%)	-258 (-10%)	3,419	-184 (-5%)	-183 (-5%)	-184 (-5%)	-152 (-4%)	-190 (-6%)
May	2,289	-350 (-15%)	-347 (-15%)	-348 (-15%)	-341 (-15%)	-356 (-16%)	2,203	-193 (-9%)	-193 (-9%)	-194 (-9%)	-190 (-9%)	-207 (-9%)
June	1,803	-221 (-12%)	-234 (-13%)	-242 (-13%)	-214 (-12%)	-250 (-14%)	1,750	-101 (-6%)	-100 (-6%)	-102 (-6%)	-114 (-6%)	-129 (-7%)
July	933	-45 (-5%)	-51 (-5%)	-63 (-7%)	-38 (-4%)	-76 (-8%)	927	-92 (-10%)	-92 (-10%)	-94 (-10%)	-66 (-7%)	-118 (-13%)
August	513	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	510	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	745	-1 (0%)	-1 (0%)	-1 (0%)	-1 (0%)	-1 (0%)	734	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Annual	1,754	-144 (-8%)	-144 (-8%)	-147 (-8%)	-136 (-8%)	-150 (-9%)	1,792	-111 (-6%)	-110 (-6%)	-111 (-6%)	-102 (-6%)	-118 (-7%)

Source: Summarized from CalSim II 2005 and 2030 simulations (Node C620)

Notes:

[1] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[2] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[3] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:

Alt = Alternative

cfs = cubic feet per second

Table 14-50. Average Simulated Monthly Flow in Dry and Critical Years at San Joaquin River Below Merced River

Month	Existing Level (2005)[1,2]						Future Level (2030)[1,2]					
	Existing Condition (cfs)	Change from Existing Condition (cfs)[3]					No Action Alt (cfs)	Change from No Action (cfs)[4]				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	508	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	483	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
November	1,013	-3 (0%)	-3 (0%)	-3 (0%)	-3 (0%)	3 (0%)	967	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
December	1,033	-57 (-6%)	-57 (-6%)	-57 (-6%)	-57 (-6%)	-57 (-6%)	1,094	-53 (-5%)	-53 (-5%)	-53 (-5%)	-53 (-5%)	-53 (-5%)
January	1,728	-202 (-12%)	-202 (-12%)	-202 (-12%)	-203 (-12%)	-202 (-12%)	1,763	-181 (-10%)	-181 (-10%)	-181 (-10%)	-182 (-10%)	-181 (-10%)
February	2,888	-260 (-9%)	-258 (-9%)	-258 (-9%)	-253 (-9%)	-305 (-11%)	2,827	-299 (-11%)	-299 (-11%)	-299 (-11%)	-261 (-9%)	-300 (-11%)
March	1,404	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,365	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
April	874	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,018	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
May	462	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	395	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
June	221	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	193	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
July	78	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	57	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
August	103	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	82	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	491	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	473	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Annual	887	-42 (-5%)	-42 (-5%)	-42 (-5%)	-42 (-5%)	-45 (-5%)	880	-43 (-5%)	-43 (-5%)	-43 (-5%)	-40 (-5%)	-43 (-5%)

Source: Summarized from CALSIM II 2005 and 2030 simulations (Node C620)

Notes:

[1] Values presented for Dry and Critical years as defined by the San Joaquin River Water Year Hydrologic Classification Indices.

[2] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[3] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[4] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:

Alt = Alternative

cfs = cubic feet per second

Table 14-51. Average Simulated Monthly Tuolumne River Inflow to San Joaquin River

Month	Existing Level (2005)[1]						Future Level (2030)[1]					
	Existing Condition (cfs)	Change from Existing Condition (cfs)[2]					No Action Alt (cfs)	Change from No Action (cfs)[3]				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	597	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	594	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
November	574	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	569	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
December	839	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	809	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
January	1,286	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,246	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
February	1,704	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,651	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
March	2,136	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2,064	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
April	1,941	1 (0%)	1 (0%)	1 (0%)	1 (0%)	1 (0%)	1,947	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
May	1,754	-1 (0%)	-1 (0%)	0 (0%)	-1 (0%)	0 (0%)	1,797	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
June	1,451	0 (0%)	0 (0%)	6 (0%)	0 (0%)	0 (0%)	1,422	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
July	1,103	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,104	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
August	477	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	476	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	482	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	479	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Annual	1,192	0 (0%)	0 (0%)	1 (0%)	0 (0%)	0 (0%)	1,177	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Source: Summarized from CalSim II 2005 and 2030 simulations (Node C545)

Notes:

[1] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[2] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[3] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:

Alt = Alternative

cfs = cubic feet per second

Table 14-52. Average Simulated Monthly Tuolumne River Inflow in Dry and Critical Years to San Joaquin River

Month	Existing Level (2005)[1,2]						Future Level (2030)[1,2]					
	Existing Condition (cfs)	Change from Existing Condition (cfs)[3]					No Action Alt (cfs)	Change from No Action (cfs)[4]				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	347	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	347	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
November	345	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	345	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
December	350	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	350	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
January	794	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	723	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
February	1,135	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,101	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
March	570	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	552	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
April	662	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	686	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
May	649	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	683	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
June	298	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	299	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
July	284	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	284	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
August	298	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	298	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	299	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	299	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Annual	498	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	493	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Source: Summarized from CalSim II 2005 and 2030 simulations (Node 545)

Notes:

[1] Values presented for Dry And Critical years as defined by the San Joaquin River Water Year Hydrologic Classification Indices.

[2] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[3] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[4] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:

Alt = Alternative

cfs = cubic feet per second

Table 14-53. Average Simulated Monthly Flow at San Joaquin River Below Tuolumne River

Month	Existing Level (2005)[1]						Future Level (2030)[1]					
	Existing Condition	Change from Existing Condition (cfs)[2]					No Action	Change from No Action (cfs)[3]				
	(cfs)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt (cfs)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	1,389	3 (0%)	3 (0%)	3 (0%)	3 (0%)	3 (0%)	1,377	3 (0%)	3 (0%)	3 (0%)	3 (0%)	2 (0%)
November	1,850	-16 (-1%)	-15 (-1%)	-19 (-1%)	-4 (0%)	1 (0%)	1,818	-14 (-1%)	-13 (-1%)	-15 (-1%)	-13 (-1%)	-12 (-1%)
December	2,329	-101 (-4%)	-97 (-4%)	-102 (-4%)	-97 (-4%)	-97 (-4%)	2,371	-118 (-5%)	-118 (-5%)	-113 (-5%)	-90 (-4%)	-118 (-5%)
January	3,572	-242 (-7%)	-246 (-7%)	-258 (-7%)	-231 (-6%)	-247 (-7%)	3,557	-212 (-6%)	-210 (-6%)	-215 (-6%)	-204 (-6%)	-223 (-6%)
February	5,005	-285 (-6%)	-280 (-6%)	-279 (-6%)	-273 (-5%)	-298 (-6%)	4,876	-256 (-5%)	-255 (-5%)	-254 (-5%)	-232 (-5%)	-254 (-5%)
March	5,356	-241 (-5%)	-238 (-4%)	-233 (-4%)	-204 (-4%)	-232 (-4%)	5,165	-175 (-3%)	-174 (-3%)	-175 (-3%)	-173 (-3%)	-177 (-3%)
April	4,672	-236 (-5%)	-231 (-5%)	-233 (-5%)	-239 (-5%)	-257 (-5%)	5,440	-184 (-3%)	-183 (-3%)	-184 (-3%)	-152 (-3%)	-190 (-3%)
May	4,117	-351 (-9%)	-348 (-8%)	-348 (-8%)	-341 (-8%)	-357 (-9%)	4,076	-193 (-5%)	-193 (-5%)	-194 (-5%)	-190 (-5%)	-207 (-5%)
June	3,288	-221 (-7%)	-234 (-7%)	-236 (-7%)	-214 (-7%)	-250 (-8%)	3,210	-101 (-3%)	-101 (-3%)	-103 (-3%)	-114 (-4%)	-129 (-4%)
July	2,069	-46 (-2%)	-52 (-2%)	-63 (-3%)	-38 (-2%)	-77 (-4%)	2,067	-92 (-4%)	-92 (-4%)	-94 (-5%)	-66 (-3%)	-118 (-6%)
August	1,055	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,054	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	1,314	-1 (0%)	-1 (0%)	-1 (0%)	-1 (0%)	-1 (0%)	1,299	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Annual	2,987	-144 (-5%)	-144 (-5%)	-147 (-5%)	-136 (-5%)	-150 (-5%)	3,011	-111 (-4%)	-111 (-4%)	-111 (-4%)	-102 (-3%)	-118 (-4%)

Source: Summarized from CalSim II 2005 and 2030 simulations (Node C630)

Notes:

[1] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[2] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[3] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:

Alt = Alternative

cfs = cubic feet per second

Table 14-54. Average Simulated Monthly Flow in Dry and Critical Years at San Joaquin River Below Tuolumne River

Month	Existing Level (2005)[1,2]						Future Level (2030)[1,2]					
	Existing Condition	Change from Existing Condition (cfs)[3]					No Action	Change from No Action (cfs)[4]				
	(cfs)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt (cfs)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	919	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	895	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
November	1,369	-3 (0%)	-3 (0%)	-3 (0%)	-3 (0%)	3 (0%)	1,322	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
December	1,384	-57 (-4%)	-57 (-4%)	-57 (-4%)	-57 (-4%)	-57 (-4%)	1,444	-53 (-4%)	-53 (-4%)	-53 (-4%)	-53 (-4%)	-53 (-4%)
January	2,523	-202 (-8%)	-202 (-8%)	-202 (-8%)	-203 (-8%)	-202 (-8%)	2,486	-181 (-7%)	-181 (-7%)	-181 (-7%)	-182 (-7%)	-181 (-7%)
February	4,032	-260 (-6%)	-258 (-6%)	-258 (-6%)	-253 (-6%)	-305 (-8%)	3,937	-299 (-8%)	-299 (-8%)	-299 (-8%)	-261 (-7%)	-300 (-8%)
March	1,985	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,930	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
April	1,567	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,739	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
May	1,140	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,111	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
June	516	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	491	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
July	358	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	338	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
August	432	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	413	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	844	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	827	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Annual	1,405	-42 (-3%)	-42 (-3%)	-42 (-3%)	-42 (-3%)	-45 (-3%)	1,394	-43 (-3%)	-43 (-3%)	-43 (-3%)	-40 (-3%)	-43 (-3%)

Source: Summarized from CalSim II 2005 and 2030 simulations (Node C630)

Notes:

[1] Values presented for Dry and Critical years as defined by the San Joaquin River Water Year Hydrologic Classification Indices.

[2] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[3] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[4] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:

Alt = Alternative

cfs = cubic feet per second

Table 14-55. Average Simulated Monthly Stanislaus River Inflow to San Joaquin River

Month	Existing Level (2005)[1]						Future Level (2030)[1]					
	Existing Condition	Change from Existing Condition (cfs)[2]					No Action	Change from No Action (cfs)[3]				
	(cfs)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt (cfs)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	921	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	930	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
November	394	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	396	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
December	426	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	449	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
January	622	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	631	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
February	732	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	740	1 (0%)	1 (0%)	1 (0%)	1 (0%)	1 (0%)
March	965	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,028	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
April	1,414	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,462	-3 (0%)	-3 (0%)	-3 (0%)	-3 (0%)	-3 (0%)
May	1,225	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,300	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
June	878	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	892	1 (0%)	1 (0%)	1 (0%)	1 (0%)	1 (0%)
July	564	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	574	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
August	522	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	536	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	565	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	587	1 (0%)	1 (0%)	1 (0%)	1 (0%)	1 (0%)
Average Annual	769	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	794	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Source: Summarized from CalSim II 2005 and 2030 simulations (Node C528)

Notes:

[1] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[2] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[3] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:

Alt = Alternative

cfs = cubic feet per second

Table 14-56. Average Simulated Monthly Stanislaus River Inflow in Dry and Critical Years to San Joaquin River

Month	Existing Level (2005)[1,2]						Future Level (2030)[1,2]					
	Existing Condition	Change from Existing Condition (cfs)[3]					No Action	Change from No Action (cfs)[4]				
	(cfs)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt (cfs)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	785	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	786	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
November	294	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	294	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
December	273	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	275	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
January	342	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	340	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
February	495	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	474	2 (0%)	2 (0%)	2 (0%)	2 (0%)	2 (0%)
March	305	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	299	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
April	1,030	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,036	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
May	947	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	974	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
June	399	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	380	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
July	363	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	334	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
August	359	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	366	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	358	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	362	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Annual	495	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	493	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Source: Summarized from CalSim II 2005 and 2030 simulations (Node C528)

Notes:

[1] Values presented for Dry and Critical year types as defined by the San Joaquin River Water Year Hydrologic Classification Indices.

[2] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[3] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[4] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:

Alt = Alternative

cfs = cubic feet per second

San Francisco Bay/Sacramento-San Joaquin Delta Under the action alternatives, Delta inflows from the San Joaquin River would decrease slightly in wetter months because of reduced flood flows in the San Joaquin River (Table 14-57 and Table 14-58). Percent changes would be small because the basis-of-comparison or magnitude of flow in the San Joaquin River increases considerably as it reaches the Delta.

Changes in Delta inflows, though small, would result in a reoperation of CVP and SWP pumping, although changes would be small (Table 14-59 and Table 14-60). Table 14-61 and Table 14-62 show that outflow changes from the Delta would typically be less than 1 percent.

Table 14-57. Average Simulated Monthly Flow at San Joaquin River Upstream from Vernalis

Month	Existing Level (2005)[1]						Future Level (2030)[1]					
	Existing Condition (cfs)	Change from Existing Condition (cfs)[2]					No Action Alt (cfs)	Change from No Action (cfs)[3]				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	2,771	3 (0%)	3 (0%)	3 (0%)	3 (0%)	3 (0%)	2,768	3 (0%)	3 (0%)	3 (0%)	3 (0%)	2 (0%)
November	2,634	-16 (-1%)	-15 (-1%)	-19 (-1%)	-4 (0%)	1 (0%)	2,604	-14 (-1%)	-13 (0%)	-15 (-1%)	-13 (0%)	-12 (0%)
December	3,198	-101 (-3%)	-97 (-3%)	-102 (-3%)	-97 (-3%)	-97 (-3%)	3,263	-118 (-4%)	-118 (-4%)	-113 (-3%)	-90 (-3%)	-118 (-4%)
January	4,770	-242 (-5%)	-246 (-5%)	-258 (-5%)	-231 (-5%)	-247 (-5%)	4,763	-212 (-4%)	-210 (-4%)	-215 (-5%)	-204 (-4%)	-223 (-5%)
February	6,270	-285 (-5%)	-280 (-4%)	-279 (-4%)	-273 (-4%)	-298 (-5%)	6,149	-256 (-4%)	-255 (-4%)	-254 (-4%)	-232 (-4%)	-253 (-4%)
March	7,150	-241 (-3%)	-238 (-3%)	-233 (-3%)	-204 (-3%)	-232 (-3%)	7,023	-175 (-2%)	-174 (-2%)	-175 (-2%)	-173 (-2%)	-177 (-3%)
April	6,763	-236 (-3%)	-231 (-3%)	-232 (-3%)	-239 (-4%)	-256 (-4%)	7,580	-186 (-2%)	-186 (-2%)	-187 (-2%)	-155 (-2%)	-193 (-3%)
May	6,267	-351 (-6%)	-348 (-6%)	-348 (-6%)	-341 (-5%)	-357 (-6%)	6,301	-193 (-3%)	-193 (-3%)	-194 (-3%)	-190 (-3%)	-207 (-3%)
June	4,804	-221 (-5%)	-234 (-5%)	-235 (-5%)	-214 (-4%)	-250 (-5%)	4,739	-100 (-2%)	-99 (-2%)	-101 (-2%)	-112 (-2%)	-128 (-3%)
July	3,297	-46 (-1%)	-52 (-2%)	-63 (-2%)	-38 (-1%)	-77 (-2%)	3,303	-92 (-3%)	-92 (-3%)	-94 (-3%)	-66 (-2%)	-118 (-4%)
August	2,114	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2,126	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	2,377	-1 (0%)	-2 (0%)	-2 (0%)	-1 (0%)	-2 (0%)	2,386	1 (0%)	1 (0%)	1 (0%)	1 (0%)	1 (0%)
Average Annual	4,355	-144 (-3%)	-144 (-3%)	-147 (-3%)	-136 (-3%)	-150 (-3%)	4,404	-111 (-3%)	-111 (-3%)	-111 (-3%)	-102 (-2%)	-118 (-3%)

Source: Summarized from CalSim II 2005 and 2030 simulations (Node C637)

Notes:

[1] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[2] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[3] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:

Alt = Alternative

cfs = cubic feet per second

Table 14-58. Average Simulated Monthly Flow in Dry Years and Critical Years at San Joaquin River Upstream from Vernalis

Month	Existing Level (2005)[1,2]						Future Level (2030)[1,2]					
	Existing Condition (cfs)	Change from Existing Condition (cfs)[3]					No Action Alt (cfs)	Change from No Action (cfs)[4]				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	2,083	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2,060	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
November	1,955	-3 (0%)	-3 (0%)	-3 (0%)	-3 (0%)	3 (0%)	1,909	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
December	2,004	-57 (-3%)	-57 (-3%)	-57 (-3%)	-57 (-3%)	-57 (-3%)	2,067	-53 (-3%)	-53 (-3%)	-53 (-3%)	-53 (-3%)	-53 (-3%)
January	3,269	-202 (-6%)	-202 (-6%)	-202 (-6%)	-203 (-6%)	-202 (-6%)	3,231	-181 (-6%)	-181 (-6%)	-181 (-6%)	-182 (-6%)	-181 (-6%)
February	4,986	-260 (-5%)	-258 (-5%)	-258 (-5%)	-253 (-5%)	-305 (-6%)	4,870	-298 (-6%)	-298 (-6%)	-298 (-6%)	-260 (-5%)	-298 (-6%)
March	2,595	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2,534	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
April	2,962	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3,140	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
May	2,532	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2,529	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
June	1,376	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,331	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
July	1,181	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,132	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
August	1,265	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,253	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	1,650	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,638	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Average Annual	2,303	-42 (-2%)	-42 (-2%)	-42 (-2%)	-42 (-2%)	-45 (-2%)	2,290	-43 (-2%)	-43 (-2%)	-43 (-2%)	-40 (-2%)	-43 (-2%)

Source: Summarized from CalSim II 2005 and 2030 simulations (Node C637)

Notes:

[1] Values presented for dry and critical year types as defined by the San Joaquin River Water Year Hydrologic Classification Indices.

[2] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[3] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[4] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:

Alt = Alternative

cfs = cubic feet per second

Table 14-59. Average Simulated Monthly Exports through Jones and Banks Pumping Plants

Month	Existing Level (2005)[1]						Future Level (2030)[1]					
	Existing Condition	Change from Existing Condition (TAF)[2]					No Action	Change from No Action (TAF)[3]				
	(TAF)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt (cfs)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	426	0 (0%)	0 (0%)	2 (0%)	0 (0%)	-1 (0%)	414	-1 (0%)	-1 (0%)	-1 (0%)	-1 (0%)	0 (0%)
November	411	5 (1%)	4 (1%)	4 (1%)	2 (1%)	4 (1%)	409	9 (2%)	9 (2%)	8 (2%)	9 (2%)	9 (2%)
December	547	1 (0%)	1 (0%)	1 (0%)	1 (0%)	-1 (0%)	548	-1 (0%)	1 (0%)	1 (0%)	1 (0%)	1 (0%)
January	417	-4 (-1%)	-4 (-1%)	-4 (-1%)	-4 (-1%)	-4 (-1%)	417	-1 (0%)	-1 (0%)	0 (0%)	-1 (0%)	0 (0%)
February	402	0 (0%)	0 (0%)	1 (0%)	1 (0%)	0 (0%)	402	-1 (0%)	-1 (0%)	-1 (0%)	-1 (0%)	-1 (0%)
March	423	2 (0%)	2 (0%)	2 (0%)	2 (0%)	2 (1%)	426	3 (1%)	3 (1%)	3 (1%)	3 (1%)	3 (1%)
April	128	-3 (-2%)	-3 (-2%)	-3 (-2%)	-3 (-2%)	-3 (-2%)	144	-2 (-2%)	-2 (-2%)	-2 (-2%)	-2 (-1%)	-2 (-2%)
May	136	-12 (-9%)	-12 (-9%)	-12 (-9%)	-11 (-8%)	-12 (-8%)	137	-9 (-7%)	-9 (-7%)	-10 (-7%)	-10 (-7%)	-9 (-7%)
June	296	-3 (-1%)	-4 (-1%)	-4 (-1%)	-3 (-1%)	-4 (-1%)	298	-1 (0%)	-1 (0%)	-1 (0%)	-1 (0%)	-1 (0%)
July	644	-4 (-1%)	-4 (-1%)	-5 (-1%)	-4 (-1%)	0 (0%)	629	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
August	592	2 (0%)	2 (0%)	3 (0%)	2 (0%)	0 (0%)	583	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	551	6 (1%)	6 (1%)	6 (1%)	6 (1%)	5 (1%)	557	1 (0%)	1 (0%)	1 (0%)	1 (0%)	1 (0%)
Average Annual	4,972	-9 (0%)	-10 (0%)	-7 (0%)	-11 (0%)	-11 (0%)	4,963	-3 (0%)	-2 (0%)	-2 (0%)	-2 (0%)	-2 (0%)

Source: Summarized from CalSim II 2005 and 2030 simulations (Node D409)

Notes:

[1] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[2] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[3] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:

Alt = Alternative

TAF = thousand acre-feet

Table 14-60. Average Simulated Monthly Exports in Dry and Critical Years through Jones and Banks Pumping Plants

Month	Existing Level (2005)[1,2]						Future Level (2030)[1,2]					
	Existing Condition	Change from Existing Condition (TAF)[3]					No Action	Change from No Action (TAF)[4]				
	(TAF)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt (cfs)	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	329	0 (0%)	0 (0%)	1 (0%)	0 (0%)	0 (0%)	308	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
November	371	-1 (0%)	-1 (0%)	0 (0%)	-1 (0%)	0 (0%)	374	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
December	441	-2 (0%)	-2 (0%)	-1 (0%)	-2 (0%)	-2 (0%)	442	-2 (0%)	3 (1%)	3 (1%)	3 (1%)	3 (1%)
January	371	-2 (-1%)	-2 (-1%)	-2 (-1%)	-2 (-1%)	-2 (-1%)	371	-2 (-1%)	-2 (-1%)	-2 (-1%)	-2 (-1%)	-2 (-1%)
February	355	-2 (-1%)	-2 (-1%)	-2 (-1%)	-2 (-1%)	-2 (-1%)	363	-2 (-1%)	-2 (-1%)	-2 (-1%)	-2 (-1%)	-2 (-1%)
March	254	-2 (-1%)	-2 (-1%)	-2 (-1%)	-2 (-1%)	-2 (-1%)	251	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
April	106	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	112	1 (1%)	1 (1%)	1 (1%)	1 (1%)	1 (1%)
May	106	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	104	0 (0%)	-1 (-1%)	-1 (-1%)	-1 (-1%)	-1 (-1%)
June	126	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	125	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
July	563	-10 (-2%)	-9 (-2%)	-13 (-2%)	-9 (-2%)	0 (0%)	530	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
August	406	1 (0%)	0 (0%)	1 (0%)	0 (0%)	0 (0%)	382	-2 (-1%)	-3 (-1%)	-2 (-1%)	-3 (-1%)	-2 (-1%)
September	450	-1 (0%)	1 (0%)	-1 (0%)	-1 (0%)	0 (0%)	423	2 (0%)	2 (0%)	2 (0%)	1 (0%)	2 (0%)
Average Annual	3,878	-20 (-1%)	-17 (0%)	-20 (-1%)	-20 (-1%)	-9 (0%)	3,784	-6 (0%)	-1 (0%)	-1 (0%)	-1 (0%)	-1 (0%)

Source: Summarized from CalSim II 2005 and 2030 simulations (Node D409)

Notes:

[1] Values presented for Dry and Critical year types as defined by the Sacramento Valley Water Year Hydrologic Classification Indices.

[2] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[3] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[4] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:

Alt = Alternative

TAF = thousand acre-feet

Table 14-61. Average Simulated Monthly Delta Outflow

Month	Existing Level (2005)[1]						Future Level (2030)[1]					
	Existing Condition (cfs)	Change from Existing Condition (cfs)[2]					No Action Alt (cfs)	Change from No Action (cfs)[3]				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	6,036	6 (0%)	6 (0%)	11 (0%)	6 (0%)	5 (0%)	5,993	-1 (0%)	-1 (0%)	-1 (0%)	-2 (0%)	-1 (0%)
November	11,672	-13 (0%)	-11 (0%)	-18 (0%)	8 (0%)	-1 (0%)	11,648	-55 (0%)	-56 (0%)	-53 (0%)	-56 (0%)	-56 (0%)
December	21,576	-124 (-1%)	-114 (-1%)	-118 (-1%)	-115 (-1%)	-112 (-1%)	21,677	-137 (-1%)	-166 (-1%)	-159 (-1%)	-137 (-1%)	-165 (-1%)
January	42,060	-219 (-1%)	-224 (-1%)	-228 (-1%)	-198 (0%)	-210 (0%)	42,162	-203 (0%)	-202 (0%)	-209 (0%)	-196 (0%)	-218 (-1%)
February	51,671	-355 (-1%)	-345 (-1%)	-401 (-1%)	-322 (-1%)	-361 (-1%)	51,439	-287 (-1%)	-280 (-1%)	-279 (-1%)	-256 (0%)	-289 (-1%)
March	42,733	-279 (-1%)	-275 (-1%)	-272 (-1%)	-243 (-1%)	-272 (-1%)	42,586	-229 (-1%)	-229 (-1%)	-228 (-1%)	-228 (-1%)	-223 (-1%)
April	30,224	-195 (-1%)	-191 (-1%)	-193 (-1%)	-197 (-1%)	-210 (-1%)	30,745	-140 (0%)	-140 (0%)	-140 (0%)	-116 (0%)	-146 (0%)
May	22,637	-176 (-1%)	-174 (-1%)	-174 (-1%)	-169 (-1%)	-181 (-1%)	22,286	-46 (0%)	-46 (0%)	-47 (0%)	-41 (0%)	-61 (0%)
June	12,853	-166 (-1%)	-177 (-1%)	-177 (-1%)	-159 (-1%)	-192 (-1%)	12,670	-77 (-1%)	-77 (-1%)	-77 (-1%)	-89 (-1%)	-104 (-1%)
July	7,873	-42 (-1%)	-49 (-1%)	-62 (-1%)	-36 (0%)	-76 (-1%)	7,867	-93 (-1%)	-94 (-1%)	-98 (-1%)	-69 (-1%)	-122 (-2%)
August	4,353	-7 (0%)	-6 (0%)	-8 (0%)	-6 (0%)	-4 (0%)	4,330	4 (0%)	4 (0%)	4 (0%)	4 (0%)	4 (0%)
September	9,893	3 (0%)	1 (0%)	1 (0%)	2 (0%)	3 (0%)	9,853	4 (0%)	4 (0%)	4 (0%)	4 (0%)	4 (0%)
Average Annual	21,785	-129 (-1%)	-128 (-1%)	-135 (-1%)	-118 (-1%)	-133 (-1%)	21,758	-104 (0%)	-106 (0%)	-106 (0%)	-97 (0%)	-114 (-1%)

Source: Summarized from CalSim II 2005 and 2030 simulations (Node C406)

Notes:

[1] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[2] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[3] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:

Alt = Alternative

cfs = cubic feet per second

Table 14-62. Average Simulated Monthly Delta Outflow in Dry and Critical Years

Month	Existing Level (2005)[1,2]						Future Level (2030)[1,2]					
	Existing Condition (cfs)	Change from Existing Condition (cfs)[3]					No Action Alt (cfs)	Change from No Action (cfs)[4]				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
October	5,047	1 (0%)	1 (0%)	6 (0%)	-1 (0%)	-5 (0%)	5,014	2 (0%)	2 (0%)	2 (0%)	2 (0%)	2 (0%)
November	7,551	13 (0%)	11 (0%)	11 (0%)	17 (0%)	4 (0%)	7,520	-3 (0%)	-3 (0%)	-3 (0%)	-3 (0%)	-3 (0%)
December	7,323	-17 (0%)	-18 (0%)	-17 (0%)	-18 (0%)	-8 (0%)	7,567	1 (0%)	-79 (-1%)	-79 (-1%)	-80 (-1%)	-79 (-1%)
January	12,858	-7 (0%)	-8 (0%)	-8 (0%)	-7 (0%)	-5 (0%)	13,134	1 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
February	17,752	-28 (0%)	-29 (0%)	-29 (0%)	-29 (0%)	-27 (0%)	17,798	-3 (0%)	-3 (0%)	-3 (0%)	-3 (0%)	-3 (0%)
March	16,598	30 (0%)	31 (0%)	30 (0%)	30 (0%)	32 (0%)	16,508	15 (0%)	15 (0%)	15 (0%)	15 (0%)	15 (0%)
April	12,245	-2 (0%)	-2 (0%)	-2 (0%)	-2 (0%)	-2 (0%)	12,294	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
May	8,771	-8 (0%)	-9 (0%)	-8 (0%)	-9 (0%)	0 (0%)	8,505	1 (0%)	1 (0%)	1 (0%)	1 (0%)	1 (0%)
June	6,187	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	6,197	1 (0%)	1 (0%)	1 (0%)	1 (0%)	1 (0%)
July	4,622	-2 (0%)	-1 (0%)	-2 (0%)	-2 (0%)	-2 (0%)	4,663	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
August	3,815	-20 (-1%)	-17 (0%)	-22 (-1%)	-18 (0%)	-11 (0%)	3,951	9 (0%)	10 (0%)	10 (0%)	11 (0%)	10 (0%)
September	3,424	-6 (0%)	-6 (0%)	-6 (0%)	-6 (0%)	-7 (0%)	3,277	1 (0%)	1 (0%)	1 (0%)	1 (0%)	1 (0%)
Average Annual	8,793	-4 (0%)	-4 (0%)	-4 (0%)	-3 (0%)	-2 (0%)	8,812	2 (0%)	-5 (0%)	-5 (0%)	-5 (0%)	-5 (0%)

Source: Summarized from CalSim II 2005 and 2030 simulations (Node C406)

Notes:

[1] Values presented for Dry and Critical year types as defined by the Sacramento Valley Water Year Hydrologic Classification Indices.

[2] Alternatives are evaluated under existing and future conditions and compared to existing and future baselines. For the existing conditions evaluation, a 2005 level of development is used as the basis for comparison. Similarly, the future conditions evaluation uses a 2030 level of development as a basis of comparison. All evaluations use a simulation period of October 1921–September 2003.

[3] (%) indicates percent change from existing conditions. Negative value represents a decrease in flow, and positive value represents an increase in flow.

[4] (%) indicates percent change from No Action Alternative. Negative value represents a decrease in flow, and positive value represents an increase in flow.

Key:

Alt = Alternative

cfs = cubic feet per second

Central Valley Project/State Water Project Water Service Areas As the "central hub" of California's water supply delivery system, minor changes in Delta operations due to Temperance Flat RM 274 Dam operations could result in other minor changes to operations throughout the CVP and SWP system. Increased Friant Division water deliveries would be due to additional storage in Temperance Flat RM 274 Reservoir. Changes in water supply deliveries and Delta conditions could also result in changes in operations to other CVP and SWP facilities, including increased water deliveries due to additional storage in Temperance Flat RM 274 Reservoir. Recipients of exports through the Banks and Jones pumping plants include the Exchange Contractors, Federal wildlife refuges, and CVP and SWP water service contractors. Deliveries differ by action alternative, as described in Chapter 2, "Alternatives Description."

Changes in CVP and SWP deliveries, including changes in Friant Division deliveries from Millerton Lake, are shown in the Modeling Appendix. Detailed impact analyses of the economic effects of changes in water deliveries to CVP and SWP water service areas are found in Chapter 23, "Socioeconomics, Population, and Housing." A description of CVP and SWP operations can be found in the Affected Environment section of this chapter and in the Modeling Appendix.

Criteria for Determining Significance of Effects

The thresholds of significance for impacts to surface water supplies and facilities operations are based on the environmental checklist in Appendix G of the State CEQA Guidelines, as amended. These thresholds also encompass the factors taken into account under NEPA to determine the significance of an action in terms of its context and the intensity of its impacts. An alternative was determined to result in a significant impact related to surface water supply if it would adversely affect surface water supply facilities operations, as measured by the criteria in Table 14-63. The impact indicators are discussed in the following sections. Significance statements are relative to both existing conditions (2005) and future conditions (2030), unless stated otherwise.

Table 14-63. Impact Indicators and Significance Criteria for Surface Water Supply Facilities Operations

Impact Indicator	Significance Criterion
Friant Dam diversion capacities	Reduce Millerton Lake water-level elevations below the Friant-Kern Canal or Madera Canal intakes at Friant Dam.
San Joaquin River diversion capacities	Reduce the ability to satisfy downstream Holding Contract diversions in Reach 1, or reduce capacity of other existing operational diversion facilities in Reaches 2 through 5 in the San Joaquin River.
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.

Note:
[1] Changes in south Delta water levels are estimated using the Delta Simulation Model 2.
Key:
Delta = Sacramento-San Joaquin Delta

Friant Dam Diversion Capacities

Diversions are made at Friant Dam to the Friant-Kern and Madera canals for CVP Friant Division water supplies. Changes in Millerton Lake water surface elevations could adversely affect the operation of existing diversion facilities at the Friant Dam (see Table 14-2).

San Joaquin River Diversion Capacities

Releases are made at Friant Dam to comply with Holding Contract requirements along Reach 1. Several other diversion facilities exist in Reach 1 through Reach 5. Changes in streamflow within these reaches could adversely affect the operation of existing diversion facilities, including pumps, pipelines, and weirs.

Water Levels in the South Delta

Water levels in the south Delta are influenced to varying degrees by natural tidal fluctuations, San Joaquin River flows, barrier operations, Jones and Banks export pumping, local agricultural diversions and drainage return flows, channel capacities, siltation, and dredging. When the Jones and Banks pumping plants are exporting water, water levels in local channels can be drawn down, particularly during water years with low flow. The South Delta Water Agency (SDWA) and local farmers in the south and central Delta are interested in maintaining adequate water levels for their siphons and pumps, which are installed at fixed locations in the Delta, to continue to be used for irrigation diversions. The alternatives could affect the ability of the SDWA to divert water if changes in Delta flows reduce Delta channel water levels during the irrigation season (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, facilitate 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, but not in all years due to fisheries concerns. The existing seasonal barriers significantly affect water levels in the south Delta (see Chapter 27, "Cumulative Effects," for additional details).

To evaluate the potential water-level effects of the alternatives, modeling results were examined for sites near three monitoring locations near the three temporary barriers. South Delta agricultural irrigation users are primarily concerned with the water level at low-low tide because this is the minimum water surface elevation they experience. The impact analysis considers the maximum change in water elevation at the low-low tide for each day of each month. Channel tidal levels at the following three south Delta locations were evaluated:

- **Old River at Tracy Boulevard Bridge (Road Bridge)** – This station is a tidal level and EC monitoring location, and is upstream from the temporary barrier and proposed permanent barrier just east (upstream) from the DMC intake and fish facility.

- **Grant Line Canal above the Grant Line Canal Barrier –** This station is upstream from the temporary barrier on Grant Line Canal and upstream from the proposed permanent tidal gate.

- **Middle River near the Howard Road Bridge –** This station is located just upstream from the temporary barrier near the Victoria Canal and the proposed permanent tidal gate.

Water levels in the south Delta are considered to adversely affect water users, as defined by DWR's *Water Level Response Plan*, if they are below 0.0 foot msl at the Old River near the 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 (Reclamation and DWR 2004;

Reclamation et al. 2004). A change in water level is considered to be significant if the water level is below the identified limit, and the water-level change between the alternative and baseline is greater than a 0.1-foot decrease during the irrigation season (April through October).

Topics Eliminated from Further Discussion

Operating Temperance Flat RM 274 Reservoir could impact groundwater or socioeconomic conditions, as described in Chapters 13, "Hydrology – Groundwater," and 23, "Socioeconomics, Population, and Housing," respectively. Potential impacts to those resource areas are therefore not described in this chapter. Changes in surface water supplies are not considered an impact independent of the associated changes to groundwater and socioeconomics.

Additional water supply deliveries from operating Temperance Flat RM 274 Reservoir would not physically impact CVP and SWP conveyance and storage facilities downstream from Friant Dam. Additional deliveries would be made within existing capacity limits and operational constraints.

Direct and Indirect Effects

The following section describes the potential environmental consequences of the alternatives.

Impact SWS-1: Changes in Ability to Divert Water from Friant Dam

Primary Study Area

No Action Alternative Changes in Millerton Lake volumes and surface water elevations would be within operating ranges of the existing condition and would not constrain operations of existing diversion facilities at Friant Dam to meet existing authorized purposes.

There would be **no impact** under the No Action Alternatives.

Action Alternatives Changes in Millerton Lake volumes and surface water elevations would be within operating ranges of the existing conditions and would not constrain operations of existing diversion facilities at Friant Dam.

There would be **no impact** under the action alternatives. Mitigation is not required and thus not proposed.

Impact SWS-2: Changes in Ability to Divert Water from the San Joaquin River

Extended Study Area

No Action Alternative Changes in San Joaquin River flow volumes and timing would be within typical historical ranges and would not impede existing diversion facilities. Reclamation would continue to release sufficient flow to the San Joaquin River to satisfy Holding Contract diversions in Reach 1 and to meet Restoration Flow requirements (SJRRP 2012).

There would be **no impact** under the No Action Alternative.

Action Alternatives Changes in San Joaquin River flow volumes and timing would be within typical historical ranges and would not impede existing diversion facilities. Flows in Wet years would be reduced (see Attachment E in the Modeling Appendix) when Temperance Flat RM 274 Reservoir captures flood flows, but would not impede existing diversion facilities. Flows in other year types would generally increase and would not impede existing diversion facilities. Reclamation would continue to release sufficient flow to the San Joaquin River to satisfy Holding Contract diversions in Reach 1 and to meet Restoration Flow requirements.

There would be **no impact** under the action alternatives. Mitigation for this impact is not required and thus not proposed.

Impact SWS-3: Change in Water Levels in the Old River near the Tracy Road Bridge

Extended Study Area

No Action Alternative Water levels in the Delta could be lower under the No Action Alternative than existing conditions, but water-level changes of this magnitude and frequency would not adversely affect agricultural users' ability to divert irrigation water. As shown in Table 14-64, water-level decreases greater than 0.1 foot would not occur when water levels would be below the identified threshold in the simulated irrigation months during the late spring. The greatest decrease was 0.04 foot, compared to existing conditions.

This impact would be **less than significant** under the No Action Alternative.

Table 14-64. Change in Simulated Monthly Maximum 15-Minute Water Levels in Delta at Low-Low Tide Under the No Action Alternative Compared to Existing Conditions

Month[1]	Old River at Tracy Boulevard Bridge (feet)[2]	Grant Line Canal Above the Grant Line Canal Barrier (feet)[2]	Middle River near the Howard Road Bridge (feet)[2]
April	-0.02 (0%)	-0.02 (0%)	-0.02 (0%)
May	-0.02 (0%)	-0.03 (0%)	-0.04 (0%)
June	0 (0%)	0 (0%)	0 (0%)
July	0 (0%)	0 (0%)	0 (0%)
August	0 (0%)	0 (0%)	0 (0%)
September	0 (0%)	0 (0%)	0 (0%)
October	0 (0%)	0 (0%)	0 (0%)

Source: DSM2 simulations (Nodes 071_3116, 129_5691, and 206_5533)

Notes:

[1] Simulation period: October 1921–September 2003.

[2] (%) indicates percent of months with a maximum decrease in the water level exceeding 0.1 foot resulting in a water level below the identified limit.

Action Alternatives The action alternatives would not directly change Delta operations, but instead would change Delta conditions because of indirect effects of reducing infrequent spring flood flows from the San Joaquin River reaching the Delta. These changed conditions could alter the quantity and timing of Jones and Banks pumping in the south Delta, which could impact south Delta water levels.

As shown in Table 14-65, water-level decreases greater than 0.1 foot in the Old River near the Tracy Road Bridge that also result in water levels below the identified threshold would not occur in the simulated irrigation months during the late spring. The greatest decreases were 0.02 foot and 0.02 foot, compared to the existing conditions and No Action Alternative, respectively, yet these maximum decreases would not adversely affect agricultural users' ability to divert irrigation water.

This impact would be **less than significant** under the action alternatives. Mitigation for this impact is not required and thus not proposed.

Table 14-65. Simulated Monthly Maximum 15-Minute Change in Water Levels at Old River near Tracy Road Bridge at Low-Low Tide

Month1	Existing Level (2005)[2]					Future Level (2030)[2]				
	Alt 1 (ft msl)	Alt 2 (ft msl)	Alt 3 (ft msl)	Alt 4 (ft msl)	Alt 5 (ft msl)	Alt 1 (ft msl)	Alt 2 (ft msl)	Alt 3 (ft msl)	Alt 4 (ft msl)	Alt 5 (ft msl)
April	-0.01 (0%)	-0.01 (0%)	-0.01 (0%)	-0.02 (0%)	0 (0%)	-0.01 (0%)	-0.01 (0%)	-0.01 (0%)	-0.01 (0%)	-0.02 (0%)
May	0 (0%)	0 (0%)	0 (0%)	-0.02 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	-0.01 (0%)
June	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
July	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
August	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
October	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Source: DSM2 simulations (Node 071_3116)

Notes:
[1] Simulation period: October 1921–September 2003.
[2] (%) indicates percent of months with a maximum decrease in the water level exceeding 0.1 foot resulting in a water level below the identified limit.

Key:
Alt = Alternative
ft msl = feet mean sea level

Impact SWS-4: Change in Water Levels in the Grant Line Canal Above the Grant Line Canal Barrier

Extended Study Area

No Action Alternative Water levels in the Delta could be lower under the No Action Alternative than existing conditions, but changes in water level of this magnitude and frequency would not adversely affect agricultural users' ability to divert irrigation water. As shown in Table 14-64, water-level decreases greater than 0.1 foot would not occur and would not decrease water levels below the identified threshold in the simulated irrigation months during the late spring. The greatest decreases were 0.03 foot, compared to existing conditions.

This impact would be **less than significant** under the No Action Alternative.

Action Alternatives The action alternatives would not directly change Delta operations, but instead would change Delta conditions because of indirect effects of reducing infrequent spring flood flows from the San Joaquin River reaching the Delta. These changed conditions could alter the quantity and timing of Jones and Banks pumping in the south Delta, which could impact south Delta water levels.

As shown in Table 14-66, water-level decreases greater than 0.1 foot in the Grant Line Canal above the Grant Line Canal

Barrier that also result in water levels below the identified limit rarely occurred in the simulated irrigation months during the late spring. The greatest decreases were 0.03 foot and 0.02 foot compared to the existing conditions and No Action Alternative, respectively, yet these maximum decreases would not adversely affect agricultural users' ability to divert irrigation water.

This impact would be **less than significant** under the action alternatives. Mitigation for this impact is not required and thus not proposed.

Table 14-66. Simulated Monthly Maximum 15-Minute Change in Water Levels at Grant Line Canal above Grant Line Canal Barrier at Low-Low Tide

Month[1]	Existing Level (2005)[2]					Future Level (2030)[2]				
	Alt 1 (ft msl)	Alt 2 (ft msl)	Alt 3 (ft msl)	Alt 4 (ft msl)	Alt 5 (ft msl)	Alt 1 (ft msl)	Alt 2 (ft msl)	Alt 3 (ft msl)	Alt 4 (ft msl)	Alt 5 (ft msl)
April	-0.01 (0%)	-0.01 (0%)	-0.01 (0%)	-0.02 (0%)	0 (0%)	-0.02 (0%)	-0.02 (0%)	-0.02 (0%)	-0.02 (0%)	-0.02 (0%)
May	0 (0%)	0 (0%)	0 (0%)	-0.03 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	-0.02 (0%)
June	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
July	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
August	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
October	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Source: DSM2 simulations (Node 129_5691)

Notes:

[1] Simulation period: October 1921–September 2003.

[2] (%) indicates percent of months with a maximum decrease in the water level exceeding 0.1 foot resulting in a water level below the identified limit.

Key:

Alt = Alternative

ft msl = feet mean sea level

Impact SWS-5: Change in Water Levels in the Middle River near the Howard Road Bridge

Extended Study Area

No Action Alternative Water levels in the Delta could be lower under the No Action Alternative than existing conditions, but changes in water level of this magnitude and frequency would not adversely affect agricultural users' ability to divert irrigation water.

As shown in Table 14-64, water-level decreases greater than 0.1 foot would not occur and would not decrease water levels below the identified threshold in the simulated irrigation months during the late spring. The greatest decrease was 0.04 foot, compared to existing conditions.

This impact would be **less than significant** under the No Action Alternative.

Action Alternatives The action alternatives would not directly change Delta operations, but instead would change Delta conditions because of indirect effects of reducing infrequent spring flood flows from the San Joaquin River reaching the Delta. These changed conditions could alter the quantity and timing of Jones and Banks pumping in the south Delta, which could impact south Delta water levels.

As shown in Table 14-67, water level decreases greater than 0.1 foot in the Middle River near the Howard Road Bridge that also result in water levels below the identified limit would not occur in the simulated irrigation months during the late spring. The greatest decreases were 0.04 foot and 0.02 foot, compared to the existing conditions and No Action Alternative, respectively, yet these maximum decreases would not adversely affect agricultural users' ability to divert irrigation water.

This impact would be **less than significant** under the action alternatives. Mitigation for this impact is not required and thus not proposed.

Table 14-67. Simulated Monthly Maximum 15-Minute Change in Water Levels at Middle River near Howard Road Bridge at Low-Low Tide

Month[1]	Existing Level (2005)[2]					Future Level (2030)[2]				
	Alt 1 (ft msl)	Alt 2 (ft msl)	Alt 3 (ft msl)	Alt 4 (ft msl)	Alt 5 (ft msl)	Alt 1 (ft msl)	Alt 2 (ft msl)	Alt 3 (ft msl)	Alt 4 (ft msl)	Alt 5 (ft msl)
April	-0.01 (0%)	-0.01 (0%)	-0.01 (0%)	-0.02 (0%)	0 (0%)	-0.01 (0%)	-0.01 (0%)	-0.01 (0%)	-0.01 (0%)	-0.02 (0%)
May	-0.03 (0%)	-0.03 (0%)	-0.03 (0%)	-0.04 (0%)	-0.04 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	-0.01 (0%)
June	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
July	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
August	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
October	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Source: DSM2 simulations (Node 206_5533)

Notes:
[1] Simulation period: October 1921–September 2003.
[2] (%) indicates percent of months with a maximum decrease in the water level exceeding 0.1 foot resulting in a water level below the identified limit.

Key:
Alt = Alternative
ft msl = feet mean sea level

Mitigation Measures

This section discusses mitigation measures for each significant impact described in the environmental consequences section, as presented in Table 14-24.

No mitigation is required for Impact SWS-1 within the primary study area, or for Impacts SWS-2, SWS-3, SWS-4, and SWS-5 within the extended study area, as these impacts would be less than significant for all action alternatives.

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Chapter 15
Hydrology – Surface Water Quality

This chapter describes the environmental setting for surface water quality, as well as potential environmental consequences and associated mitigation measures, as they pertain to implementing the project alternatives. This chapter presents information on the primary study area (area of project features, the Temperance Flat Reservoir Area, and Millerton Lake below RM 274). It also discusses the extended study area (San Joaquin River from Friant Dam to the Merced River, the San Joaquin River from the Merced River to the Delta, the Delta, and the CVP and SWP water service areas).

Affected Environment

This section includes discussion of existing water quality conditions and related conditions that directly affect water quality, such as soils, climate, and current and historical land uses. The discussion encompasses the primary and extended study areas.

Primary Study Area

The following is a description of surface water quality in the primary study area, including within the area of project features, the Temperance Flat Reservoir Area, and in Millerton Lake, from the Temperance Flat Dam Site to Friant Dam.

Area of Project Features

Most of the area of project features is characterized by undeveloped land with steep slopes, granitic soils, rocky outcrops, and ephemeral streams. Rural residences are located along Sky Harbour Road on the south side of the San Joaquin River, and on Millerton Lake. Roads in this area include paved (Sky Harbor Road and associated turnoffs) and unpaved roads. While few data are available on the water quality of runoff or ephemeral streams within the area of project features, the water quality conditions can be inferred to some extent from the geologic, soils, and topographic conditions, as well as from the quality of water in the Temperance Flat Reservoir Area and Millerton Lake during runoff events.

Temperance Flat Reservoir Area

Water quality within the Temperance Flat Reservoir Area is generally of high quality, with low turbidity, high dissolved oxygen, and low concentrations of chlorophyll-a, arsenic, and other constituents. Water quality in this reach is generally suitable for most designated beneficial uses.

Historical water temperature data from the CDEC station located about 1 mile upstream from Kerckhoff Powerhouse, Station SJK, were acquired for the period from May 6, 2008, through December 19, 2012. This station is located within the Temperance Flat Reservoir Area. Average monthly water temperatures recorded at Station SJK peak in June through September, reaching 72°F to 73°F. Monthly average temperatures in July range from 72°F to 79°F. In November, the average monthly water temperature recorded at Station SJK is 57°F. Minimum average monthly water temperatures at Station SJK occur in January, reaching 44°F.

Measurements taken in 2004, 2005, 2010, and 2011 found that dissolved oxygen concentrations in the Temperance Flat Reservoir Area are generally higher than in Millerton Lake. Dissolved oxygen measured in 2010 and 2011 ranged from 10.19 mg/L to 12.64 mg/L (see the Physical Resources Appendix). Relatively low conductivity, TDS, and turbidity observed in 2010 and 2011 may be due in part to the influence of Kerckhoff Dam and other upstream dams. The construction and operation of dams and reservoirs, including Kerckhoff Dam and several projects located farther upstream, have altered sediment transport and storage processes in the upper San Joaquin River Basin. The reservoirs capture and permanently store nearly all of the bedload sediment that is transported to them, reducing the amount of sand and gravel that would have naturally been available for recruitment to downstream reaches. Dam operations also limit the release of flows to downstream reaches, reducing the frequency of sediment-transporting flows in most years (SCE 2007).

More than 90 percent of the precipitation in Fresno falls between October and April, with the heaviest rainfall occurring from December through March. Based on a comparison of water quality conditions in the Temperance Flat Reservoir Area and Millerton Lake between November 3, 2010, and July 26, 2011, as sampled by Reclamation, concentrations of mercury, arsenic, and other constituents in the San Joaquin River and Millerton Lake may increase during precipitation events after an extended dry period, but remain low (below drinking water standards established by the EPA, and in some cases below minimum detection levels) (see the Physical Resources Appendix).

As measured in 2010 and 2011, pH in the Temperance Flat Reservoir Area ranged from 4.92 to 5.53, relatively low (acidic) compared to most surface waters (see the Physical Resources Appendix). The pH values measured in the Temperance Flat Reservoir Area are within the range of measured pH values of precipitation in the region, and are related to the low alkalinity conditions observed in the watershed (ranging from 7 mg/L to 13 mg/L). Measured alkalinity was lower than the EPA-recommended minimum limit for the protection of aquatic wildlife (20 mg/L) (EPA 2012), with a maximum measured value of 13 mg/L in the Temperance Flat Reservoir Area. The EPA recommends that waters with alkalinity naturally below the 20 mg/L criteria not be further reduced (EPA 1986). Hardness is also relatively low in the Temperance Flat Reservoir Area, measuring 9.5 mg/L calcium carbonate ($CaCO_3$) on November 3, 2010, and ranging from 4.9 to 5.1 mg/L $CaCO_3$ on July 26, 2011. Alkalinity and hardness are largely controlled by the geology and soils of the region, and these low values are consistent with the insolubility of the granitic soils within the upper San Joaquin River watershed. Low pH rainfall, which ranges from 5 to 6 in California (NADP/NTN 2010), may be a strong influence on pH within the upper San Joaquin River watershed.

The Basin Plan specifies water quality objectives to protect beneficial uses within the river basins, as required by the CWC (Section 13240) and supported by the Federal CWA (Central Valley Water Board 2011). The Basin Plan provides regulatory guidance for TMDL standards at locations along the San Joaquin River. Additionally, under Section 303(d) of the Federal CWA, the State Water Board and Central Valley Water Board assess water quality data for the San Joaquin River every two years to determine if any portions do not meet the established water quality standards. The existing and potential beneficial uses of surface water bodies within the primary and extended study areas, as defined by the Central Valley Water Board in 2011, are shown in Table 15-1. Designated beneficial uses within the Temperance Flat Reservoir Area include municipal, agriculture, industry, recreation, freshwater habitat, and wildlife habitat.

Table 15-1. Existing and Potential Beneficial Uses of Surface Water Bodies in the Primary and Extended Study Areas

Surface Water Body	Municipal and Domestic Supply	Agriculture		Industry			Recreation			Freshwater Habitat		Migration		Spawning		Wildlife Habitat	Navigation
		Irrigation	Stock Watering	Process	Service Supply	Power	Contact	Canoeing and Rafting	Other Noncontact	Warm	Cold	Warm	Cold	Warm	Cold		
San Joaquin River Sources to Millerton Lake	E	E	E	--	--	E	E	E	E	E	E	--	--	--	--	E	--
Millerton Lake	E	E	E	--	--	--	E	--	E	E	P	--	--	--	--	E	--
Friant Dam to Mendota Pool (Reaches 1 and 2)	E	E	E	E	--	--	E	E	E	E	E	E	E	E	P	E	--
Mendota Dam to Sack Dam (Reach 3)	P	E	E	E	--	--	E	E	E	E	--	E	E	E	P	E	--
Sack Dam to Mouth of Merced River (Reaches 4 and 5)	P	E	E	E	--	--	E	E	E	E	--	E	E	E	P	E	--

Source: Central Valley Water Board 2011

Key:
-- = not applicable
E = Existing beneficial use
P = Potential beneficial use

Water quality conditions within the Temperance Flat Reservoir Area measured in 2010 and 2011 indicate mercury concentrations within the water column ranging from 0.0008 to 0.0090 µg/L. Mercury concentrations were higher in 2010 (0.009 µg/L), and likely reflect elevated concentrations of mercury in runoff occurring in the upper San Joaquin River watershed (see the Physical Resources Appendix). One possible source of mercury contamination within the watershed is resource extraction (State Water Board 2010b). Mercury itself is not mined within the watershed, but was historically used in the extraction of gold throughout California. Today, mercury is recovered as a byproduct from small-scale gold dredging operations. Mercury and gold are also recovered as byproducts from some gravel mining operations, especially in areas affected by historical gold mining (Alpers et al. 2005).

Within the Millerton Lake watershed, there are 57 historical gold mines and one active mine; and two historical sand and gravel mines. A survey conducted in 2003 by BLM in support of the Investigation identified three abandoned mine sites within the Temperance Flat Reservoir Area, including the Patterson Mine (formerly known as the Diana Mine), San Joaquin Mine, and the Sullivan Mine Group. These mines include multiple adits and millsites. Based on qualitative assessment of samples taken during this survey, as well as review of available historical literature and personal interviews, Springer concluded that the probability of substantial toxic contamination, both naturally occurring and imported, from mining and related activities at these sites, is very low (Springer 2005).

A second likely source of mercury within the watershed is atmospheric deposition. Atmospheric deposition of mercury in the high Sierra Nevada has been shown to be high, relative to other locations in the United States (Heyvaert et al., 2000). While mercury concentrations in surface water may remain low, mercury accumulates in biological tissues and tissue concentrations tend to increase higher in the food chain through biomagnification (Alpers et al. 2005). This is consistent with the observations noted above of low mercury concentrations within the water column and significantly higher concentrations in fish tissue.

Concentrations of primary plant nutrients analyzed in 2010 and 2011, including nitrogen and potassium, were below the minimum reporting limits (0.1 mg/L and 1 mg/L, respectively). Sulfur, a secondary nutrient, was detected at low levels in

2010, but was below the minimum reporting limit (0.5 mg/L) in 2011. The other secondary nutrients, calcium and magnesium, were detected in all samples at low levels. Low concentrations of calcium and magnesium are consistent with the relatively low hardness levels in these samples (as previously described). Chloride was detected in low levels in 2010, but not detected in 2011. Similarly, sodium decreased in concentration in July 2011 as compared to November 2010. This pattern likely reflects runoff occurring in the upper San Joaquin River watershed before the sampling event (California Department of a Transportation (Caltrans) applies deicing agents, including sodium and chloride, to roads in the upper San Joaquin River watershed) (see the Physical Resources Appendix).

Millerton Lake Below RM 274

As discussed for the Temperance Flat Reservoir Area, water quality within Millerton Lake is generally of high quality, with low temperatures, low turbidity, high dissolved oxygen, and low concentrations of chlorophyll-a, arsenic, and other constituents. Millerton Lake water quality is generally suitable for most designated beneficial uses.

Historical water temperatures at Station SJK during the month of July range from 72°F to 79°F, while the average monthly water temperature recorded at Station SJK in November is 57°F. These temperatures are lower than the temperature measured within Millerton Lake in July 2011 (81°F) or November 2010 (57°F to 59°F) (see the Physical Resources Appendix). Most of Millerton Lake becomes thermally stratified during spring and summer months. Complete mixing of the water column likely occurs during winter months (Reclamation 2008).

Measurements taken in 2004, 2005, 2010, and 2011 found that dissolved oxygen concentrations in Millerton Lake are generally high during most of the year, with lowest concentrations typically exhibited during November at depths greater than 175 feet (see the Physical Resources Appendix). Relatively low conductivity, TDS, and turbidity observed in 2010 and 2011 may be due in part to the influence of Kerckhoff Dam and other upstream dams, as previously described.

As described for the Temperance Flat Reservoir Area, concentrations of mercury, arsenic, and most constituents may increase within the primary study area during a major storm after an extended dry period, but overall remain low. Comparison of water quality conditions between sampling sites within the Temperance Flat Reservoir Area and Millerton Lake indicates that concentrations of most constituents decrease as water enters Millerton Lake. This is likely due to a high rate of mixing within the river as compared with Millerton Lake, where slower water movement allows these constituents to settle out of the water column more easily. This interpretation is supported by the relatively low turbidity observed within Millerton Lake as compared to within the San Joaquin River.

As measured in 2010 and 2011, pH in Millerton Lake ranged from 5.90 to 6.18, relatively low (acidic) compared to most surface waters (see the Physical Resources Appendix). The pH values measured in Millerton Lake are within the range of measured pH values of precipitation in the region, and are related to the low alkalinity conditions observed in the watershed (ranging from 7 mg/L to 13 mg/L). Measured alkalinity was lower than the EPA-recommended minimum limit for the protection of aquatic wildlife (20 mg/L) (EPA 2012). The EPA recommends that waters with alkalinity naturally below the 20 mg/L criteria not be further reduced (EPA 1986). Hardness is also relatively low in the watershed, ranging from 8.6 to 9.4 mg/L $CaCO_3$ on November 3, 2010, and from 7.8 to 8.3 mg/L $CaCO_3$ on July 26, 2011. Alkalinity and hardness are largely controlled by the geology and soils of the region, and these low values are consistent with the insolubility of the granitic soils within the upper San Joaquin River watershed, as previously described. Low pH rainfall, which ranges from 5 to 6 in California (NADP/NTN 2010), may be a strong influence on pH within the upper San Joaquin River watershed.

The existing and potential beneficial uses of Millerton Lake are shown in Table 15-1, and include municipal, agriculture, recreation, freshwater habitat, and wildlife habitat.

Millerton Lake is listed for mercury in the 2010 CWA Section 303(d) list of impaired waters requiring TMDLs, as shown in Table 15-2. This listing is based on a 2007 sampling of mercury accumulation in 33 tissue samples from largemouth bass. This study found that 18 out of 33 samples exceeded the Office of Environmental Health Hazard Assessment (OEHHA) Screening Value of 0.3 milligrams per kilogram to protect human health for frequent consumers of sport fish (Brodberg and Pollock 1999, Davis et al. 2009 and 2010, State Water Board 2010b). The same study found lower concentrations of mercury in largemouth bass at a location downstream from Friant Dam, suggesting that Millerton Lake may act as a mercury sink for the San Joaquin River (Davis et al. 2010). Water quality conditions detected in 2010 and 2011 indicate mercury concentrations within the water column of less than 0.0005 to 0.0006 μg/L.

As previously described for the Temperance Flat Reservoir Area, two possible sources of mercury contamination within the watershed are resource extraction and atmospheric deposition.

Table 15-2. 2010 Clean Water Act Section 303(d) List of Water Quality Limited Segments Within the Primary and Extended Study Areas

Segment	Pollutant/Stressor	Affected Area/ Reach Length
Millerton Lake	Mercury	4,366 acres
San Joaquin River, Friant Dam to Mendota Pool (Reaches 1 and 2[1])	Invasive Species	70 miles
Mendota Pool (Reach 2[1])	Mercury Selenium	3,045 acres
San Joaquin River, Mendota Pool to Bear Creek (Reaches 3 and 4[1])	Boron Chlorpyrifos DDT Diazinon Group A Pesticides Unknown Toxicity	13 miles
San Joaquin River, Bear Creek to Mud Slough (Reach 5[1])	Arsenic Boron Chlorpyrifos DDT Electrical Conductivity *Escherichia coli (E. coli)* Group A Pesticides Mercury Unknown Toxicity	14 miles
San Joaquin River, Mud Slough to Merced River (Reach 5[1])	Boron Chlorpyrifos DDT Diazinon Electrical Conductivity *Escherichia coli (E. coli)* Group A Pesticides Mercury Selenium Unknown Toxicity	3 miles

Table 15-2. 2010 Clean Water Act Section 303(d) List of Water Quality Limited Segments Within the Primary and Extended Study Areas (contd.)

Segment	Pollutant/Stressor	Affected Area/ Reach Length
Bear Creek, from Bear Valley to San Joaquin River	*Escherichia coli (E. coli)* Unknown Toxicity	43 miles
Mud Slough (downstream from San Luis Drain)	Boron Electrical Conductivity Pesticides Selenium Unknown Toxicity	13 miles
Mud Slough (upstream from San Luis Drain)	Boron Electrical Conductivity *Escherichia coli (E. coli)* Pesticides Unknown Toxicity	22 miles
Salt Slough	Boron Chlorpyrifos Electrical Conductivity Escherichia coli (E. coli) Mercury Prometryn Unknown Toxicity	10 miles

Source: State Water Board 2010a.

Note:

[1] See Chapter 5, "Biological Resources – Fisheries and Aquatic Resources" for a map of Reaches 1 through 5 of the San Joaquin River

Key:

DDT = dichloro-diphenyl-trichloroethane

As described for the Temperance Flat Reservoir Area, concentrations of primary plant nutrients analyzed in 2010 and 2011, including nitrogen and potassium, were below the minimum reporting limits (0.1 mg/L and 1 mg/L, respectively). Sulfur, a secondary nutrient, was detected at low levels in 2010, but was below the minimum reporting limit (0.5 mg/L) in 2011. The other secondary nutrients, calcium and magnesium, were detected in all samples at low levels. Low concentrations of calcium and magnesium are consistent with the relatively low hardness levels in these samples (as previously described). Chloride was detected in low levels in 2010, but not detected in 2011. Similarly, sodium decreased in concentration in July 2011 as compared to November 2010. This pattern likely reflects runoff occurring in the upper San Joaquin River watershed before this sampling event (Caltrans applies deicing agents, including sodium and chloride, to roads in the upper San Joaquin River watershed). Concentrations of the micronutrient chloride decreased in Millerton Lake as compared to the Temperance Flat Reservoir Area (see the Physical Resources Appendix).

Extended Study Area

Water quality in various segments of the San Joaquin River downstream from Friant Dam is degraded because of low flow and lower quality discharges from agricultural areas and wastewater treatment plants. The following sections describe water quality in the San Joaquin River from Friant Dam to the Merced River, in the San Joaquin River from the Merced River to the Delta, in the Delta, and in the CVP/SWP water service areas.

San Joaquin River from Friant Dam to Merced River

Water quality in Reach 1 is influenced by releases from Friant Dam, with minor contributions from agricultural return flows and storm-water runoff. Water quality data collected from the San Joaquin River downstream from Friant Dam demonstrate the generally high quality of water released at Friant Dam from Millerton Lake to Reach 1. Temperatures of San Joaquin River water releases to Reach 1 are dependent on the cold-water volume available at Millerton Lake (see Modeling Appendix). Since fall 2009, limited flows have reached Mendota Pool as part of the SJRRP. As part of the SJRRP, Reclamation collects and reports on water quality conditions from Friant Dam to the Merced River confluence. Project data collected to date indicate that there are few contaminants of concern in Reaches 1 and 2 (SJRRP 2012a, 2012b). Beneficial uses within Reaches 1 and 2 include municipal, agriculture, industry, recreation, freshwater habitat, and wildlife habitat, as shown in Table 15-1.

During the irrigation season, water released at Mendota Dam to Reach 3 generally has higher concentrations of TDS than in reaches 1 and 2. Increased EC and concentrations of total suspended solids demonstrate the effect of Delta contributions to San Joaquin River flow. Water quality criteria applicable to some beneficial uses are not currently met within Reaches 3 and 4. Beneficial uses within Reaches 3 and 4 include municipal, agriculture, industry, recreation, freshwater habitat, and wildlife habitat, as shown in Table 15-1.

During water quality monitoring as part of the Interim Flows Program, several trace elements (e.g., mercury, selenium) were measured in the San Joaquin River downstream from Mendota

Dam, likely due in part to inflow of water from the DMC and other tributaries.

Water temperatures downstream from Mendota Dam are dependent on water temperatures of inflow from the DMC and, occasionally, the Kings River system via James Bypass (Reclamation 2007). Because water temperature is a limiting factor for native fish, including Chinook salmon at different life stages, water temperature data collection studies are underway as part of the SJRRP. Water temperature data loggers are currently placed at various locations in a longitudinal array throughout the Restoration Area to record data in a variety of fish habitats (SJRRP 2011).

Reach 5 typically has the poorest water quality of any reach of the river from Friant Dam to the Merced River confluence. Beneficial uses within Reach 5 include municipal, agriculture, industry, recreation, freshwater habitat, and wildlife habitat, as shown in Table 15-1. Reach 5 and its tributaries (Bear Creek, Mud Slough, and Salt Slough) do not meet water quality standards applicable to some designated beneficial uses, as shown in Table 15-2. Water quality data collected at Salt Slough, Mud Slough, and San Joaquin River sites within Reach 5 demonstrate the effects of irrigation runoff contributions from west-side tributaries. San Joaquin River water temperatures within Reach 5 are influenced greatly by the water temperature of Salt Slough inflow, which contributes the majority of streamflow in the reach (see Modeling Appendix). As described for Reaches 3 and 4, preliminary data do not show a measureable improvement in water quality in Reach 5 because of the arrival of Interim Flows (SJRRP 2012a, 2012b).

CWA Section 303(d) listings for Reaches 1 and 2 include invasive species, as shown in Table 15-2. Mendota Pool is listed for mercury and selenium (State Water Board 2010a). The CWA Section 303(d) listings for these reaches include boron, chlorpyrifos, diazinon, dichloro-diphenyltrichloroethane (DDT), diazinon, Group A pesticides, and unknown toxicity, as shown in Table 15-2. TMDL and Basin Plan amendments are currently in place for diazinon and chlorpyrifos runoff into Reaches 3, 4, and 5; for selenium in Reach 5; salt and boron in Reach 3, 4, and 5; and oxygen-demanding substances in Reaches 1 through 5 (State Water Board 2013). TMDLs and Basin Plan amendments are currently being developed for additional pesticides (State Water Board 2010a). The CWA Section 303(d) listings for Reach 5 include arsenic, boron, chlorpyrifos, DDT, EC, *Escherichia coli* (*E. coli*), Group A pesticides, mercury, selenium, and unknown toxicity. TMDLs and Basin Plan amendments are currently being developed for arsenic, boron, DDT, EC, *E. coli*, Group A pesticides, and mercury (State Water Board 2010a).

Pesticides, fertilizers, and nitrate in this portion of the extended study area are further regulated under WDRs issued by the Central Valley Water Board for waste discharges from irrigated lands. Within this portion of the extended study area, the Central Valley Water Board has issued general WDRs for the Eastern San Joaquin River Watershed and Western San Joaquin River Watershed. WDRs are also in place for individuals not participating in the general WDRs.

San Joaquin River from Merced River to the Delta

Downstream from its confluence with the Merced River, San Joaquin River water quality generally improves at successive confluences with east-side rivers draining the Sierra Nevadas, particularly at confluences with the Merced, Tuolumne, and Stanislaus rivers. In the relatively long reach between the Merced and Tuolumne rivers, mineral concentrations tend to increase because of inflows of agricultural drainage water, other wastewaters, and effluent groundwater (DWR 1965). TDS in the San Joaquin River near Vernalis has historically (from 1951 to 1962) ranged from 52 mg/L (at high flows) to 1,220 mg/L (DWR 1965).

CWA Section 303(d) listings for the San Joaquin River from the Merced River to the Delta are provided in Table 15-3 (State Water Board 2010a). TMDL and Basin Plan amendments are currently in place for salinity, boron, selenium, diazinon, and chlorpyrifos in the lower San Joaquin River upstream from Vernalis. A Basin Plan amendment is also in place for dissolved oxygen; water quality objectives for the San Joaquin River upstream from the Stockton Deep Water Ship Channel to address this amendment are being developed by the stakeholder group CV-SALTS and its Lower San Joaquin River Committee (State Water Board 2013).

Table 15-3. Clean Water Act Section 303(d) List of Water Quality Limited Segments, San Joaquin River System from Merced River to Delta

Segment	Pollutant/ Stressor	Potential Source	Affected Area/Reach Length
San Joaquin River, Merced River to Tuolumne River	alpha-BHC	Source Unknown	29 miles
	Boron	Agriculture	
	Chlorpyrifos	Agriculture	
	DDE	Agriculture	
	DDT	Agriculture	
	Electrical Conductivity	Agriculture	
	Group A Pesticides	Agriculture	
	Mercury	Resource Extraction	
	Temperature, Water	Source Unknown	
	Unknown Toxicity	Agriculture	
San Joaquin River, Tuolumne River to Stanislaus River	Chlorpyrifos	Agriculture	8.4 miles
	DDT	Agriculture	
	Diazinon	Agriculture	
	Electrical Conductivity	Agriculture	
	Group A Pesticides	Agriculture	
	Mercury	Resource Extraction	
	Temperature, Water	Source Unknown	
	Unknown Toxicity	Agriculture	
San Joaquin River, Stanislaus River to Delta	Chlorpyrifos	Agriculture	3 miles
	DDE	Agriculture	
	DDT	Agriculture	
	Diuron	Agriculture	
	Electrical Conductivity	Agriculture	
	Escherichia coli (*E. coli*)	Source Unknown	
	Group A Pesticides	Agriculture	
	Mercury	Resource Extraction	
	Temperature, Water	Source Unknown	
	Toxaphene	Source Unknown	
	Unknown Toxicity	Agriculture	

Source: State Water Board 2010a.
Key:
alpha-BHC= alpha-benzene hexachloride
DDE = dichloro-diphenyl-dichloroethylene
DDT = dichloro-diphenyl-trichloroethane

Pesticides, fertilizers, and nitrate are further regulated under WDRs issued by the Central Valley Water Board for waste discharges from irrigated lands. Within the extended study area, the Central Valley Water Board has issued general WDRs for the Eastern San Joaquin River Watershed, Western San Joaquin River Watershed, and Tulare Lake Basin Area. WDRs are also in place for individuals not participating in the general WDRs.

Delta

Water quality in the Delta is highly variable, temporally and spatially. It is a function of complex circulation patterns that are affected by inflows, pumping for Delta agricultural operations and exports, operation of flow control structures, and tidal action. The existing water quality problems of the Delta system may be categorized as the presence of toxic materials, eutrophication and associated fluctuations in dissolved oxygen, presence of suspended sediments and turbidity, salinity, and presence of pathogenic bacteria (State Water Board 1999).

Delta waterways fall within the jurisdiction of both the Central Valley Water Board and the San Francisco Bay Water Board. Various Delta waterways in the areas under jurisdiction of the Central Valley Water Board are listed under CWA Section 303(d) as impaired for chlordane, chlorpyrifos, DDT, diazinon, dieldrin, EC, Group A pesticides, invasive species, mercury, polychlorinated biphenyls (PCB), and unknown toxicity (State Water Board 2010a). TMDLs are currently in place for diazinon, chlorpyrifos, and methylmercury in the Delta (State Water Board 2013). Delta waterways in the area under jurisdiction of the San Francisco Bay Water Board are listed under CWA Section 303(d) as impaired for chlordane, DDT, dieldrin, dioxin, furan compounds, invasive species, mercury, PCBs, and selenium (State Water Board 2010a).

The north Delta tends to have better water quality primarily because of inflow from the Sacramento River, though some water quality parameters, such as mercury, may be more impaired than in other portions. The quality of water in the west Delta is strongly influenced by tidal exchange with San Francisco Bay; during low-flow periods, seawater intrusion results in increased salinity. In the south Delta, water quality tends to be poorer because of the combination of inflows of poorer water quality from the San Joaquin River, discharges from Delta islands, and effects of diversions that can sometimes increase seawater intrusion from San Francisco Bay.

The Sacramento and San Joaquin rivers contribute approximately 61 percent and 33 percent, respectively, to tributary inflow TDS concentrations within the Delta. TDS concentrations are relatively low in the Sacramento River, but because of its large volumetric contribution, the river provides the majority of the TDS load supplied by tributary inflow to the Delta (DWR 2001). Although actual flow from the San Joaquin River is lower than from the Sacramento River, TDS concentrations in San Joaquin River water average approximately 7 times those in the Sacramento River. The influence of this relatively poor San Joaquin River water quality is greatest in the south Delta channels and in CVP and SWP exports. Water temperature in the Delta is only slightly influenced by water management activities (i.e., dam releases) (Reclamation and DWR 2005).

Delta exports contain elevated concentrations of disinfection byproduct precursors (e.g., dissolved organic carbon), and the presence of bromide increases the potential for formation of brominated compounds in treated drinking water. Organic carbon in the Delta originates from runoff from agricultural and urban land, drainage water pumped from Delta islands that have soils with high organic matter, runoff and drainage from wetlands, wastewater discharges, and primary organic carbon production in Delta waters. Delta agricultural drainage can also contain high levels of nutrients, suspended solids, organic carbon, minerals (salinity), and trace chemicals such as organophosphate, carbamate, and organochlorine pesticides.

CVP and SWP Water Service Areas

Water delivered to Friant Division contractors via the Friant-Kern and Madera canals from Millerton Lake is representative of water quality conditions at Millerton Lake and the upper San Joaquin River watershed—generally soft with low mineral and nutrient concentrations. As described in Chapter 14, "Hydrology – Surface Water Supplies and Facilities Operations," water from the Delta is delivered to the Arvin-Edison WSD via the California Aqueduct in exchange for water delivered from Millerton Lake, when conditions permit. Water delivered to Arvin-Edison WSD is representative of a mixture of Delta and Millerton Lake water quality conditions.

Surface water quality in the other CVP and SWP water service areas is affected by fluctuations of water quality in the Delta, which in turn are influenced by climate, water quality in the San Joaquin and Sacramento rivers, and local agricultural diversions and drainage water. Water quality concerns of particular importance are those related to salinity and drinking water quality. Salinity is an issue because excessive salinity may adversely affect crop yields and require more water for salt leaching, may require additional M&I treatment, may increase salinity levels in agricultural soils and groundwater, and is the primary water quality constraint to recycling wastewater (CALFED 2000). Constituents that affect drinking water quality are of more concern within the SWP water service areas because of high demand for M&I water supplies for SWP contractors, and include bromide, natural organic matter, microbial pathogens, nutrients, TDS, hardness, alkalinity, pH, organic carbon, disinfection byproducts, and turbidity.

Pesticides, fertilizers, and nitrate in this portion of the extended study area are further regulated under WDRs issued by the Central Valley Water Board for waste discharges from irrigated lands. Within this portion of the extended study area, the Central Valley Water Board has issued general WDRs for the Western San Joaquin River Watershed and Tulare Lake Basin Area. WDRs are also in place for individuals not participating in the general WDRs.

Environmental Consequences and Mitigation Measures

This section describes environmental consequences on surface water quality associated with implementation of the alternatives. The potential direct and indirect impacts to surface water quality and associated mitigation measures are summarized in Table 15-4.

Table 15-4. Summary of Impacts and Mitigation Measures for Surface Water Quality

Impact	Study Area	Alternative	Level of Significance Before Mitigation	Mitigation Measure	Level of Significance After Mitigation
Impact SWQ-1: Temporary Construction-Related Sediment Effects that would Violate Water Quality Standards or Adversely Affect Beneficial Uses	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	LTS		LTS
		Alternative Plan 2	LTS		LTS
		Alternative Plan 3	LTS		LTS
		Alternative Plan 4	LTS		LTS
		Alternative Plan 5	LTS		LTS
	Extended Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	LTS		LTS
		Alternative Plan 2	LTS		LTS
		Alternative Plan 3	LTS		LTS
		Alternative Plan 4	LTS		LTS
		Alternative Plan 5	LTS		LTS
Impact SWQ-2: Temporary Construction-Related Water Temperature Effects that would Violate Water Quality Standards or Adversely Affect Beneficial Uses	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	LTS		LTS
		Alternative Plan 2	LTS		LTS
		Alternative Plan 3	LTS		LTS
		Alternative Plan 4	LTS		LTS
		Alternative Plan 5	LTS		LTS
	Extended Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	LTS		LTS
		Alternative Plan 2	LTS		LTS
		Alternative Plan 3	LTS		LTS
		Alternative Plan 4	LTS		LTS
		Alternative Plan 5	LTS		LTS

Table 15-4. Summary of Impacts and Mitigation Measures for Surface Water Quality (contd.)

Impact	Study Area	Alternative	Level of Significance Before Mitigation	Mitigation Measure	Level of Significance After Mitigation
Impact SWQ-3: Temporary Construction-Related Water Quality Effects that would Violate Water Quality Standards or Adversely Affect Beneficial Uses	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	LTS		LTS
		Alternative Plan 2	LTS		LTS
		Alternative Plan 3	LTS		LTS
		Alternative Plan 4	LTS		LTS
		Alternative Plan 5	LTS		LTS
	Extended Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	LTS		LTS
		Alternative Plan 2	LTS		LTS
		Alternative Plan 3	LTS		LTS
		Alternative Plan 4	LTS		LTS
		Alternative Plan 5	LTS		LTS
Impact SWQ-4: Long-Term Water Quality Effects that would Violate Water Quality Standards or Adversely Affect Beneficial Uses within the Primary Study Area and San Joaquin River	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	PS	SWQ-4: Prepare and Implement a Site-Specific Remediation Plan for Historic Mine Features Subject to Inundation	LTS
		Alternative Plan 2	PS		LTS
		Alternative Plan 3	PS		LTS
		Alternative Plan 4	PS		LTS
		Alternative Plan 5	PS		LTS
	San Joaquin River from Friant Dam to the Merced River Confluence	No Action Alternative	LTS and Beneficial	None Required	LTS and Beneficial
		Alternative Plan 1	LTS		LTS
		Alternative Plan 2	LTS		LTS
		Alternative Plan 3	LTS		LTS
		Alternative Plan 4	LTS		LTS
		Alternative Plan 5	LTS		LTS
	San Joaquin River from the Merced River Confluence to the Delta	No Action Alternative	LTS	None Required	LTS
		Alternative Plan 1	LTS		LTS
		Alternative Plan 2	LTS		LTS
		Alternative Plan 3	LTS		LTS
		Alternative Plan 4	LTS		LTS
		Alternative Plan 5	LTS		LTS

Table 15-4. Summary of Impacts and Mitigation Measures for Surface Water Quality (contd.)

Impact	Study Area	Alternative	Level of Significance Before Mitigation	Mitigation Measure	Level of Significance After Mitigation
Impact SWQ-5: Long-Term Water Temperature Effects that would Violate Water Quality Standards or Adversely Affect Beneficial Uses	Primary Study Area	No Action Alternative	LTS	None Required	LTS
		Alternative Plan 1	LTS and Beneficial		LTS and Beneficial
		Alternative Plan 2	LTS and Beneficial		LTS and Beneficial
		Alternative Plan 3	LTS and Beneficial		LTS and Beneficial
		Alternative Plan 4	LTS and Beneficial		LTS and Beneficial
		Alternative Plan 5	LTS and Beneficial		LTS and Beneficial
	Extended Study Area	No Action Alternative	LTS	None Required	LTS
		Alternative Plan 1	LTS and Beneficial		LTS and Beneficial
		Alternative Plan 2	LTS and Beneficial		LTS and Beneficial
		Alternative Plan 3	LTS and Beneficial		LTS and Beneficial
		Alternative Plan 4	LTS and Beneficial		LTS and Beneficial
		Alternative Plan 5	LTS and Beneficial		LTS and Beneficial
Impact SWQ-6: Long-Term Effects on Delta Salinity that would Violate D-1641 Salinity Objectives	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI
	Extended Study Area	No Action Alternative	LTS	None Required	LTS
		Alternative Plan 1	LTS		LTS
		Alternative Plan 2	LTS		LTS
		Alternative Plan 3	LTS		LTS
		Alternative Plan 4	LTS		LTS
		Alternative Plan 5	LTS		LTS

Table 15-4. Summary of Impacts and Mitigation Measures for Surface Water Quality (contd.)

Impact	Study Area	Alternative	Level of Significance Before Mitigation	Mitigation Measure	Level of Significance After Mitigation
Impact SWQ-7: Long-Term Effects on Delta Salinity that would Violate the X2 Standard	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI
	Extended Study Area	No Action Alternative	LTS	None Required	LTS
		Alternative Plan 1	LTS		LTS
		Alternative Plan 2	LTS		LTS
		Alternative Plan 3	LTS		LTS
		Alternative Plan 4	LTS		LTS
		Alternative Plan 5	LTS		LTS
Impact SWQ-8: Long-Term Effects on Water Quality that would Violate Existing Water Quality Standards or Adversely Affect Beneficial Uses in the CVP/SWP Water Service Areas	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI
	Extended Study Area	No Action Alternative	LTS	None Required	LTS
		Alternative Plan 1	LTS		LTS
		Alternative Plan 2	LTS		LTS
		Alternative Plan 3	LTS		LTS
		Alternative Plan 4	LTS		LTS
		Alternative Plan 5	LTS		LTS

Key:
NI = no impact
LTS = less than significant

Methods and Assumptions

Water quality monitoring data and computer modeling were used to aid in evaluating potential impacts on surface water quality. Both temporary, construction-related effects and long-term operational effects were considered as part of this evaluation. Temporary construction impacts were evaluated qualitatively based on anticipated construction practices, materials, locations, and duration of project construction and related activities. Long-term effects were evaluated using computer modeling tools. Specifically, CalSim II was used to simulate CVP and SWP operations, determining surface water flows, storages, and deliveries associated with each alternative. These data were applied as inputs for computer models used for surface water quality impact assessments.

Computer models were used to evaluate impacts for each alternative on reservoir water temperature at Millerton Lake, San Joaquin River water temperature from Friant Dam to the Merced River, San Joaquin River salinity (EC) from the Mendota Pool to the Delta, and salinity and the X2 position in the Delta. The long-term effects analysis focuses on water temperature and salinity. Water temperature is an important water quality parameter for fisheries. Salinity is an important water quality parameter for multiple beneficial uses. The modeling tools used in this assessment are the best available modeling tools. They were selected because they are publicly available, have a knowledgeable user community, and are widely accepted for use in similar systemwide analyses of resources in the California Central Valley.

Reservoir Temperature

All the action alternatives increase the total volume of cold water in Millerton Lake and provide for cold-water storage (defined as water at or below 52°F for this analysis) at Temperance Flat RM 274 Reservoir, with larger available cold-water pools in action alternatives with planned operations for higher carryover storage. Additionally, the SLIS included in Alternative Plan 4 also allows for better management of the cold-water pool, resulting in improved water temperature conditions for anadromous fish in the San Joaquin River.

Daily water temperatures in the Temperance Flat Reservoir and Millerton Lake were modeled using a two-dimensional model based on the CE-QUAL-W2 (W2) modeling platform. The model uses daily water operations data from the daily disaggregation tool and historical meteorology to simulate water temperatures every 6 hours from January 1, 1980, to September 30, 2003. This time period is shorter than the CalSim model time period to reduce the volume of output, allow acceptable model execution times, and still cover the full range of water temperature operations expected over the longer CalSim time period.

Reservoir water temperature effects on fisheries habitat are described in Chapter 5.0, “Biological Resources – Fisheries and Aquatic Ecosystems.”

River Temperature

Daily Millerton Lake water operations data were used in a water temperature model to generate daily release temperatures into the Friant-Kern Canal, Madera Canal, and San Joaquin River. Daily water releases (flow and temperature) from Millerton Lake to the San Joaquin River were used in a temperature model of the San Joaquin River to route releases through the system from Friant Dam to the Merced River, and to compute the water temperature at various locations. The river temperature model is based on the HEC-5Q modeling platform. The model performs two separate functions. The first, based on the HEC-5 model embedded in the HEC-5Q modeling platform, routes water through the San Joaquin River and bypass system from Millerton Lake to the confluence with the Merced River. This portion of the model develops daily flows throughout the San Joaquin River system by modeling the physical diversion of water between the Chowchilla, Eastside, and Mariposa bypasses and the San Joaquin River, local accretions and depletions along the channels, and hydrologic routing of water. The second function uses flows and historical meteorology to simulate water temperatures every 6 hours from January 1, 1980, to September 30, 2003. Additional details on the river temperature model can be found in the Modeling Appendix.

River water temperature effects on fisheries habitat are described in Chapter 5.0, “Biological Resources – Fisheries and Aquatic Ecosystems.”

San Joaquin River Salinity

The CalSim II San Joaquin River water quality module was used to simulate salinity (EC) on the main stem San Joaquin River from the Mendota Pool to Vernalis. CalSim II includes the Link-Node approach algorithm, implemented in March 2004, to estimate San Joaquin River salinity at Vernalis by replacing the single regression equation with a series of salt balances from Friant Dam to Vernalis. The salt balances dynamically account for all inflows and outflows along a given reach, and assume perfect mixing of different waters. Westside inflows to the San Joaquin River are disaggregated into various flow components and each component is assigned an EC value. San Joaquin River salinity results simulated for alternatives with the CalSim II San Joaquin River water quality module were used only for comparative analysis of alternatives.

Delta Water Quality

DSM2 was used with CalSim II results to describe Delta water quality for each alternative, including EC values and chloride concentrations. DSM2 is a hydrodynamic model of the Delta developed by DWR that simulates flow and salinity changes throughout the Delta caused by changes in Delta inflow or CVP/SWP pumping. The model uses monthly CalSim II results and produces mean monthly flow and salinity values. The analysis of potential impacts on Delta water quality evaluates potential impacts on surface water quality for all in-Delta water users. Parameters used in the evaluation include simulated changes in X2 location, Delta outflow, I:E ratio, salinity, chloride ion concentrations, dissolved organic carbon concentrations, and flows in the Old and Middle rivers.

The water quality impact assessment focuses on salinity as EC, expressed in micromhos per centimeter (µmhos/cm), and chloride ion concentrations in mg/L, as indicators of Delta water quality because they are the primary water quality constituents most likely to be affected by temporal shifts in Delta pumping operations. Water year types used to present results related to Delta water quality are defined according to the Sacramento Valley Index Water Year Hydrologic Classification unless specified otherwise.

CalSim II uses a statistical model, known as an artificial neural network model (ANN), to estimate Delta salinity (measured as EC). The ANN is trained to mimic the physically based hydrodynamic model, DSM2. CalSim II uses the ANN to determine releases from upstream reservoirs to meet Delta salinity and X2 requirements. Simulated CalSim II mean monthly Delta inflows and Delta exports are subsequently used as inputs to DSM2 to generate Delta channel stage, velocity, flow, and salinity estimates. The ANN only approximates the Delta flow-salinity relationship as simulated by DSM2, so that there are small salinity differences between the ANN-determined values used in CalSim II to drive reservoir operations and the final DSM2 values used for impact studies/effects analysis. Differences in simulated Delta salinity between the two models may result in occasional violations of water quality standards in the DSM2 simulation, although none would occur under actual operations. The apparent violation of standards in DSM2 results are therefore referred to as "potential violations" because they occur in DSM2 but would not occur under actual operations. While there is some loss of accuracy in using the ANN to determine flow-salinity relationships in CalSim II, resulting DSM2 salinity values are useful for comparing relative changes between alternatives. This comparative analysis is an appropriate way of using model results.

Sediment

Potential temporary, construction-related sediment effects that would violate water quality standards or adversely affect beneficial uses are evaluated qualitatively in this chapter, based on the types and locations of potential construction activities. The potential impacts from sediment associated with erosion and geomorphology are analyzed in Chapter 11, "Geology and Soils."

Criteria for Determining Significance of Effects

An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental impacts that would be caused by, or result from, implementing the No Action Alternative and the range of action alternatives. Under NEPA, the severity and context of an impact must be characterized. An environmental document prepared to comply with CEQA must identify the potentially significant environmental impacts of a proposed project and a reasonable range of alternatives, if required. A "[s]ignificant 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 impacts (State CEQA Guidelines, Section 15126.4(a)).

Overall Impact Indicators for Water Quality

The following significance criteria were developed based on guidance provided by the State CEQA Guidelines, and consider the context and intensity of the environmental impacts as required under NEPA. These significance criteria were applied to the qualitative assessment and quantitative modeling results and used to determine impact significance. The analysis of water quality impacts and benefits focuses on water temperature, metals, and sediment because they are important water quality constituents in both the primary and extended study areas.

Reclamation developed the impact significance criteria for Delta water quality variables that have regulatory objectives or numerical standards, such as those contained in the 2006 WQCP, using the general considerations listed below (State Water Board 2006).

Impacts of an alternative on water quality would be significant if project implementation would do any of the following:

- Violate existing water quality standards or otherwise substantially degrade water quality
- Result in substantial water quality changes that would adversely affect beneficial uses
- Result in substantive undesirable impacts on public health or environmental receptors

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

Impact Indicators for Delta Salinity

If changes in salinity within the Delta during months of increased pumping, due to any of the action alternatives, would result in an increase in salinity, relative to the basis of comparison, of sufficient frequency and magnitude over the long term to adversely affect designated beneficial uses, to increase the frequency that existing regulatory standards are exceeded, or to substantially degrade water quality at the locations below, then the impact would be considered significant. Stations selected within the Delta are as follows:

- Contra Costa Canal Pumping Plant No. 1
- San Joaquin River at Antioch Water Works Intake
- West Canal at the mouth of the Clifton Court Forebay
- DMC at Jones Pumping Plant
- Barker Slough at North Bay Aqueduct Intake
- San Joaquin River at Jersey Point

- San Joaquin River near Vernalis
- San Joaquin River at Brandt Bridge
- Old River near the Middle River
- Old River Barrier at Tracy Road Bridge
- Sacramento River at Emmaton
- Sacramento River at Collinsville

These stations were selected to provide a thorough understanding of the changes in the San Joaquin River and Delta. Using the assumptions discussed in the Methods and Assumptions section, and detailed in the Modeling Appendix, the DSM2 model calculated changes in monthly mean EC values and chloride concentrations for the alternatives, relative to the bases of comparison. Monthly EC values and chloride concentrations were derived for an 82-year simulation period, extending from 1922 through 2003.

DSM2 model output was used to evaluate potential changes in salinity under the alternatives, relative to the bases of comparison. Changes in salinity were evaluated in the Delta during months of increased pumping under the alternatives, relative to the bases of comparison. The potential to violate D-1641 salinity objectives was considered for each alternative. D-1641 establishes maximum salinity objectives, including EC values and chloride concentrations, at several locations in the Delta, as shown in Table 15-5 and including the same locations listed above.

Figure 15-1 shows the major Delta islands, waterways, water quality control stations, and M&I intakes within the Delta with D-1641 salinity objectives. CVP and SWP facilities in the Delta and upstream watersheds are operated to meet the requirements of D-1641, and this would not change under the alternatives.

Table 15-5. D-1641 Salinity Objectives at Selected Compliance Locations

Compliance Location	Parameter	Description[1]	Water Year Type[2]	Time Period/ Date	Value[3]	Unit
• Contra Costa Canal Pumping Plant No. 1 • San Joaquin River at Antioch Water Works Intake	Chloride	Maximum mean daily 150 mg/L chloride for at least the number of days shown during the calendar year. Must be provided in intervals of not less than 2 weeks duration.	Wet Above Normal Below Normal Dry Critical	All year	240 190 175 165 155	days
• Contra Costa Canal Pumping Plant No. 1 • West Canal at Mouth of Clifton Court Forebay • Delta-Mendota Canal at Jones Pumping Plant • Barker Slough at North Bay Aqueduct Intake	Chloride	Maximum mean daily concentration.	All	Oct–Sept	250	mg/L
• West Canal at mouth of Clinton Court Forebay • Delta-Mendota Canal at Jones Pumping Plant	EC	Maximum monthly average of mean daily EC.	All	Oct–Sept	1.0	mmhos /cm
• San Joaquin River at Jersey Point	EC	Maximum 14-day running average of mean daily EC equal to 0.45 EC from April 1 to date shown, and EC from date shown to August 15.	Wet Above Normal Below Normal Dry Critical	Aug 15 Aug 15 June 20 June 15 --	-- -- 0.74 1.35 2.20	mmhos /cm
• San Joaquin River at Airport Way Bridge, Vernalis • San Joaquin River at Brandt Bridge • Old River near Middle River • Old River at Tracy Road Bridge	EC	Maximum 30-day running average of mean daily EC.	All	Apr–Aug Sept–Mar	0.7 1.0	mmhos /cm mmhos /cm
• Sacramento River at Emmaton	EC	Maximum 14-day running average of mean daily EC equal to 0.45 EC from April 1 to date shown, and EC from date shown to August 15.	Wet Above Normal Below Normal Dry Critical	Aug 15 July 1 June 20 June 15 --	-- 0.63 1.14 1.67 2.78	mmhos /cm
• Sacramento River at Collinsville	EC	Maximum monthly average of both daily high tide EC values, or demonstrate that equivalent or better protection will be provided at the location.	All	Oct–Sept Nov–Dec Jan Feb–Mar Apr–May	19.0 15.5 12.5 8.0 11.0	mmhos /cm

Source: State Water Resources Control Board 2000.

Notes:

[1] Determination of compliance with an objective expressed as a running average begins on the last day of the averaging period. The averaging period commences with the first day of the time period for the applicable objective. If the objective is not met on the last day of the averaging period, all days in the averaging period are considered out of compliance.

[2] Year types defined by Sacramento Valley Index.

[3] When no date is shown, EC limit continues from April 1.

Table 15-5. D-1641 Salinity Objectives at Selected Compliance Locations (contd.)

Key:
-- = not applicable
Apr = April
Aug = August
Dec = December
EC = electrical conductivity
Feb = February
Jan = January
Mar = March
mg/L = milligrams per liter
mmhos/cm = millimhos per centimeter
No. = number
Oct = October
Sept = September
Nov = November

Node ID	Description
1	Sacramento River at Rio Vista
2	Sacramento River at Emmaton
3	Sacramento River at Collinsville
4	Sacramento River at Chipps Island
5	Sacramento River at Port Chicago (Roe Island)
6	Old River near Middle River
7	Old River at Tracy Road Bridge
8	Delta Mendota Canal at Tracy Pumping Plant
9	West Canal at mouth of Clifton Court Forebay Intake
10	Old River at CCWD Los Vaqueros Intake
11	CCWD Proposed Alternative Intake
12	Middle River east of Victoria Island
13	Woodward Canal
14	Old River at Rock Slough
15	Contra Costa Canal at Pumping Plant #1
16	San Joaquin River near Vernalis
17	San Joaquin River at Brandt Bridge
18	San Joaquin River downstream of Calaveras River
19	Stockton Proposed Intake
20	San Joaquin River at Prisoners Point
21	San Joaquin River at San Andreas Landing
22	San Joaquin River at Jersey Point
23	San Joaquin River at Antioch Ship Channel
24	Mokelumne River at Terminous
25	Barker Slough at North Bay Aqueduct Intake
26	Head of Old River Barrier
27	Middle River Barrier
28	Grant Line Canal Barrier
29	Old River Barrier at Tracy Road Bridge

Figure 15-1. Major Delta Islands, Waterways, Water Quality Control Stations, and Municipal and Industrial Intakes

Impact Indicators for X2 Position

If a change in the mean monthly position of X2, relative to the bases of comparison, would be of sufficient frequency and magnitude to adversely affect water quality, then it would be considered a significant impact.

The X2 parameter represents the geographical location of the 2 ppt near-bottom salinity isohaline in the Delta, which is measured in distance upstream from the Golden Gate Bridge in Suisun Bay. The location of the estuarine salinity gradient is regulated from February through June by the location of the X2 objective, and is required to be maintained at not more than 75 km (approximately 47 miles) from February through June. If the alternatives would contribute to exceedence of this standard, the impact is considered significant.

Topics Eliminated from Further Consideration

No topics related to surface water quality were eliminated from further consideration.

Direct and Indirect Effects

The following section describes the potential environmental consequences of the alternatives. Where the action alternatives would have similar impacts regardless of which action alternative is implemented, the action alternatives are described together. Where impacts would differ, the action alternatives are described separately.

Impact SWQ-1: Temporary Construction-Related Sediment Effects that would Violate Water Quality Standards or Adversely Affect Beneficial Uses

Primary Study Area

No Action Alternative Under the No Action Alternative, no construction activities would occur in the primary study area that would have the potential to affect Millerton Lake or the San Joaquin River upstream from Millerton Lake water quality. Therefore, there would be no short-term increases in turbidity, suspended sediment, or nutrients in Millerton Lake or the San Joaquin River upstream from Millerton Lake that would violate water quality standards or adversely affect beneficial uses.

There would be **no impact** under the No Action Alternative.

Action Alternatives The construction-related activities described in Chapter 2, “Alternatives,” would result in short-term changes in the amount of exposed area that would be subject to erosion. Construction of Temperance Flat RM 274 Dam, powerhouse, batch plant, and transmission facilities would require the excavation, transport, stockpiling, grading, drilling, blasting, and use of bedrock, alluvium, and soil obtained from the aggregate quarry. Other activities would include the demolition and removal of existing facilities within the inundation zone, installation of support structures, construction of permanent access roads and temporary haul roads, and use of staging areas. Additionally, about 3,580 acres of vegetation in parts of the new inundation area would be partially or completely removed. Removal of vegetation would reduce the amount of effective ground cover (e.g., duff, large woody debris), thereby increasing the potential for short-term erosion and sedimentation along the shoreline. Soils disturbed by these activities as well as materials stockpiled for use during construction would be susceptible to erosion.

Temporary, construction-related erosion will be avoided and minimized via implementation of the erosion and sediment control plans and SWPPP (i.e., erosion and sediment control plans, including site revegetation) that are a part of the environmental commitments common to all action alternatives (see Chapter 2, “Alternatives”). These plans will address the necessary local jurisdiction requirements regarding erosion control and site revegetation, and would implement BMPs for erosion and sediment control. The plans would include site-specific structural and operational BMPs to prevent and control short-term and long-term erosion and sedimentation effects, stabilize soils and vegetation in areas affected by construction activities, and prevent and control impacts on runoff quality. Types of BMPs to be included in the plans may include, but would not be limited to, earth dikes and drainage swales, stream bank stabilization, silt fencing, sediment basins, fiber rolls, sandbag barriers, straw bale barriers, storm drain inlet protection, hydraulic mulch, and stabilized construction entrances.

This impact would be **less than significant** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

Extended Study Area

No Action Alternative Under the No Action Alternative, Temperance Flat RM 274 Dam and related physical features would not be constructed and water supplies from the proposed Temperance Flat RM 274 Reservoir would not be conveyed in the San Joaquin River.

There would be **no impact** under the No Action Alternative.

Action Alternatives Construction under the action alternatives is not anticipated to affect water quality conditions in the extended study area under any of the action alternatives. Construction effects are anticipated to be localized within the primary study area, and would be further minimized with appropriate BMPs. The residual effect to waters in the extended study area would be further minimized through mixing and dilution. Therefore, construction is anticipated to have little effect on water quality conditions downstream in the extended study area.

This impact would be **less than significant** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

Impact SWQ-2: Temporary Construction-Related Water Temperature Effects that would Violate Water Quality Standards or Adversely Affect Beneficial Uses

Primary Study Area
No Action Alternative Under the No Action Alternative, no construction activities would occur in the primary study area that would have the potential to affect water temperatures in Millerton Lake or the San Joaquin River upstream from Millerton Lake. Therefore, there would be no changes in water temperature conditions within Millerton Lake due to construction activities.

There would be **no impact** under the No Action Alternative.

Action Alternatives Under the action alternatives, construction activities associated with constructing Temperance Flat RM 274 Dam and other physical features would result in sizeable areas that would be subject to surface disturbance. Environmental commitments and BMPs for the various construction activities have been incorporated into all action alternatives. These activities could include removal of riparian vegetation, thereby exposing water bodies to increased solar radiation for various time periods. As described in Chapter 2, "Alternatives," a riparian revegetation program would be implemented at all streamside construction and relocation sites as applicable to ensure that shade is quickly reestablished after construction is completed.

Because of the large water surface area of Millerton Lake, coupled with the isolated and discrete nature of the construction activities, temporary construction-related effects are not expected to modify water temperature in a manner that would have a negative effect on beneficial uses or result in a water quality violation.

This impact would be **less than significant** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

Extended Study Area

No Action Alternative Under the No Action Alternative, Temperance Flat RM 274 Dam would not be constructed and water supplies from the proposed Temperance Flat RM274 Reservoir would not be conveyed in the San Joaquin River.

There would be **no impact** under the No Action Alternative.

Action Alternatives As previously described for the primary study area, due to the large water surface area of Millerton Lake, coupled with the isolated and discrete nature of the construction activities, temporary construction-related effects are not expected to modify water temperature in Millerton Lake in a manner that would have a negative effect on beneficial uses or result in a water quality violation. The action alternatives would not modify water temperature in a manner that would have a negative effect on beneficial uses or result in a water quality violation in the primary study area, and no additional construction would occur in the extended study area.

This impact would be **less than significant** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

Impact SWQ-3: Temporary Construction-Related Water Quality Effects that would Violate Water Quality Standards or Adversely Affect Beneficial Uses

Primary Study Area

No Action Alternative Under the No Action Alternative, no construction activities would occur in the primary study area that would have the potential to affect Millerton Lake or the San Joaquin River upstream from Millerton Lake water quality. Therefore, there would be no construction-related water quality effects in Millerton Lake or the San Joaquin River upstream from Millerton Lake that would violate water quality standards or adversely affect beneficial uses.

There would be **no impact** under the No Action Alternative.

Action Alternatives Construction activities in the primary study area could accidentally discharge waste petroleum products or other construction-related substances containing metals that could enter waterways in runoff. In addition, chemicals associated with operating heavy machinery would be used, transported, and stored on site during construction activities.

As described in Chapter 2, "Alternatives," Reclamation would prepare and implement a SWPPP before construction, identifying BMPs to prevent or minimize the discharge of sediments and other contaminants with the potential to affect beneficial uses or lead to violations of water quality objectives of surface waters. The SWPPP would include development of site-specific structural and operational BMPs to prevent and control impacts on runoff quality, and measures to be implemented before, during, and after each storm event. As part of the SWPPP, Reclamation would develop and implement a spill prevention and control plan to minimize effects from spills of hazardous, toxic, or petroleum substances for project-related construction activities occurring in or near waterways. The accidental release of chemicals, fuels, lubricants, and nonstorm drainage water into water bodies would be prevented to the greatest extent feasible. BMPs for the project could include, but would not be limited to, silt fencing, straw bale barriers, fiber rolls, storm drain inlet protection, hydraulic mulch, stabilized construction entrances, double containment of hazardous materials, and proper disposal of hazardous materials.

The action alternatives also include permanent disposal of waste rock from diversion tunnel and powerhouse excavation, in an area located approximately 3,200 feet southwest of the powerhouse within the existing inundation area of Millerton Lake. The disposal site would be approximately 21.5 acres in size, and would require permits under CWA, including a NPDES permit under CWA Section 402. The Central Valley Water Board controls the discharge of wastes to surface waters from industrial processes or construction activities through the NPDES permit process. WDRs are established in the permit to protect beneficial uses. Reclamation would comply with the terms of all permits to minimize the effects of waste rock disposal.

This impact would be **less than significant** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

Extended Study Area

No Action Alternative Under the No Action Alternative, Temperance Flat RM 274 Dam and related physical features would not be constructed and water supplies from the proposed Temperance Flat RM 274 Reservoir would not be conveyed in the San Joaquin River.

There would be **no impact** under the No Action Alternative.

Action Alternatives Construction is not anticipated to affect water quality conditions in the extended study area under any of the action alternatives. Construction effects are anticipated to be localized within the primary study area, and would be further minimized with appropriate BMPs. The residual effect to waters in the extended study area would be further minimized through mixing and dilution. Therefore, construction is anticipated to have little effect on water quality conditions downstream in the extended study area.

This impact would be **less than significant** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

Impact SWQ-4: Long-Term Water Quality Effects that would Violate Water Quality Standards or Adversely Affect Beneficial Uses within the Primary Study Area and San Joaquin River

The potential impacts of the alternatives on water quality conditions in the primary study area, within the extended study area from Friant Dam to the Merced River confluence, and from the Merced River confluence to the Delta are described as part of this impact. Water temperature impacts in the primary study area and in the San Joaquin River are described separately under Impact SWQ-5. Impacts within the Delta would be related to changes in salinity and are described under Impacts SWQ-6 and SWQ-7. Impacts within the CVP and SWP water service areas are described under Impact SWQ-8.

Primary Study Area

No Action Alternative Under the No Action Alternative, variation in reservoir levels of Millerton Lake due to reoperation of Friant Dam under the SJRRP would continue within the range of historical annual reservoir water surface elevations, as modified by climate change in the extended future (see Chapter 8, “Climate Change”). Therefore, there would be no long-term changes in constituent concentrations (including turbidity, suspended sediment, nutrients concentrations, and metals concentrations) in Millerton Lake or the San Joaquin River upstream from Millerton Lake that would violate water quality standards or adversely affect beneficial uses.

There would be **no impact** under the No Action Alternative.

Action Alternatives   Once Temperance Flat RM 274 Dam is constructed and the reservoir filled, shoreline erosion would occur along the zone of reservoir-elevation fluctuation between the top-of-active-storage capacity (elevation 985) and the top of minimum carryover storage capacity (elevation 674 under Alternative Plans 1, 2, and 3; elevation 734 under Alternative Plan 4; and elevation 603 under Alternative Plan 5). As described in Chapter 11, “Geology and Soils,” substantial soil erosion and loss of topsoil would occur in the shoreline area, subject to fluctuating water levels. Water surface elevations in Temperance Flat RM 274 Reservoir theoretically could fluctuate between the top-of-active-storage capacity and the top-of-minimum-carryover-storage capacity within a single year. This fluctuation comprises an area of about 4,300 acres under Alterative Plans 1, 2, and 3; about 3,700 acres under Alternative Plan 4; and about 5,000 acres under Alternative Plan 5.

The actual fluctuation in any single year is a function of the starting storage for that year, the inflow, and the operational diversions and releases, and is limited by, but not driven by, the maximum physical fluctuation potential. The maximum theoretical fluctuation of Temperance Flat RM 274 Reservoir in any action alternative occurs in Alternative Plan 5, and is 382 feet. From the CalSim II operation modeling, Temperance Flat RM 274 Reservoir elevation reached the maximum theoretical fluctuation in a single year of the 83 year simulation period once under each action alternative under existing conditions, and did not reach the maximum theoretical fluctuation under future conditions. The simulated fluctuation under Alternative Plan 5 is below 300 feet in about 96 percent of the simulated years, and below 245 feet in about 90 percent of the years, with an average annual fluctuation of about 150 feet. The amount of sediment that could be delivered under each action alternative is not quantifiable because of the number of variables that influence sediment transport and delivery.

Much of the topography in the general vicinity of the Temperance Flat RM 274 Reservoir is steep, increasing susceptibility to erosion, particularly the first several miles downstream from Kerckhoff Dam and the north side of Millerton Lake just upstream from RM 274. Although environmental commitments and BMPs are incorporated into the project description, the project would result in an incremental increase in the delivery of suspended sediment and turbidity to the receiving waters. The rate of shoreline erosion would be greatest during the first several years after construction and would reduce over time as the new shoreline stabilizes. Sediment would be largely retained within the reservoir and would not adversely affect beneficial uses in the primary study area.

Temperance Flat RM 274 Reservoir would increase the residence time of water in the primary study area, as compared with existing conditions. Increased residence time would promote primary productivity in these waters. While increased residence time can contribute to eutrophication in some environments, eutrophication is not anticipated in the proposed Temperance Flat RM 274 Reservoir, due to low concentrations of primary nutrients such as nitrogen and potassium (see the Affected Environment section of this chapter) in the San Joaquin River.

A survey conducted in 2003 by BLM in support of the Investigation identified three abandoned mine sites within the Temperance Flat Reservoir Area, including the Patterson Mine (formerly known as the Diana Mine), San Joaquin Mine, and the Sullivan Mine Group. These mines include multiple adits and millsites. Potential contamination from gold mines may occur from natural or imported elements. Natural contamination is generally from high concentrations of metallic sulfides and/or sulfosalts typically associated with gold deposits. Imported contaminates are primarily mineral processing chemicals such as mercury, commonly used as an amalgamation reagent. Based on qualitative assessment of samples taken during this survey, as well as review of available historical literature and personal interviews, Springer concluded that the probability of substantial toxic contamination after inundation, both naturally occurring and imported, from mining and related activities at these site, is very low (Springer 2005). However, further site investigation would be required to determine the level of toxic contamination that could occur from inundation of these sites.

This impact would be **potentially significant** under the action alternatives. Mitigation for this impact is proposed below in the Mitigation Measures section.

San Joaquin River from Friant Dam to the Merced River Confluence

No Action Alternative Under the No Action Alternative, Temperance Flat RM 274 Dam and related physical features would not be constructed and water supplies from the proposed Temperance Flat RM 274 Reservoir would not be conveyed in the San Joaquin River. Surface water quality conditions would be improved in some areas through the continued release of Restoration Flows under the SJRRP, through effects on constituent concentrations.

Changes in operation of Friant Dam under the SJRRP would not introduce new contaminants to the San Joaquin River system. However, by changing the timing and location of flows, changes in operation would change the relative concentrations of constituents in various segments of the river. The SJRRP PEIS/R describes the potential changes anticipated for the various river segments and bypasses. These findings are summarized below.

Surface water quality conditions within the San Joaquin River would be similar to or improved relative to existing conditions. Under the No Action Alternative, increased flows in many months would dilute concentrations of water quality constituents in those reaches that currently convey water. Under the existing conditions, water quality criteria applicable to some beneficial uses are not met within Reaches 3, 4, and 5 because of constituent loading to and within these reaches. Under the No Action Alternative, concentrations of these constituents may decrease, but it is not anticipated that water quality criteria would be met.

In other months, flows would be reduced due to a decrease in the release of flood flows. The reduction of flows in the bypass system would likely result in increased constituent concentrations, but would not result in any additional violations of existing water quality standards or substantial water quality changes that would adversely affect beneficial uses, or have substantive impacts on public health.

Reach 4B does not convey San Joaquin River flow under existing conditions. It is dry in some segments, and where it does flow, it conveys agricultural return flows and local runoff.

On a long-term basis, the SJRRP would improve San Joaquin River water quality conditions within Reach 4B compared to existing conditions. Increased flow through Reach 4B under the SJRRP would decrease concentrations of constituents in San Joaquin River flows.

Overall, this impact would be **less than significant and beneficial** under the No Action Alternative.

Action Alternatives Under the action alternatives, surface water quality conditions would be improved in some areas through the increased release of flows from Friant Dam, and adversely affected in other areas due to the reduction in flood flows. Surface water quality conditions within the San Joaquin River would be similar to the No Action Alternative. Under the action alternatives, increased flows in many months would dilute concentrations of water quality constituents in Reaches 1 and 2.

Sediment would be retained within Temperance Flat RM 274 Reservoir, as previously described. This sediment would not be transported further downstream or released from Friant Dam to the San Joaquin River, and could lead to reduced primary productivity in these waters. However, this would be somewhat offset by the effects of increased residence time in Temperance Flat RM 274 Reservoir as compared with existing conditions. Increased residence time would promote primary productivity in these waters, as previously described.

Under existing conditions, water quality criteria applicable to some beneficial uses are not met within Reaches 3, 4, and 5 because of constituent loading to and within these reaches. Under the action alternatives, flows would be reduced due to a decrease in the release of flood flows in some months. The reduction of flows in the bypass system would likely result in increased constituent concentrations, but would not result in any additional violations of existing water quality standards or substantial water quality changes that would adversely affect beneficial uses, or have substantive impacts on public health.

This impact would be **less than significant** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

San Joaquin River from the Merced River Confluence to the Delta

No Action Alternative Under the No Action Alternative, EC in the San Joaquin River downstream from the Merced River and downstream from the Tuolumne River would be less than under existing conditions due to increased flows from Restoration Flows, particularly during March and April. Although in some months of some years small increases in EC would occur, on a long-term average basis, simulated EC in the San Joaquin River at Vernalis was less than under existing conditions in all months, across all year types (see Modeling Appendix). Overall, San Joaquin River water quality conditions from the Merced River to the Delta would improve under the No Action Alternative.

This impact would be **less than significant** under the No Action Alternative.

Action Alternatives Under the action alternatives, EC in the San Joaquin River downstream from the Merced River and downstream from the Tuolumne River would be similar to the No Action Alternative. On a long-term average basis, all increases in simulated EC in the San Joaquin River at Vernalis were 1 percent, or less, in all months and across all year types, and less than 1 percent in Dry and Critical years.

This impact would be **less than significant** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

Impact SWQ-5: Long-Term Water Temperature Effects that would Violate Water Quality Standards or Adversely Affect Beneficial Uses

Primary Study Area

No Action Alternative Under the No Action Alternative, the operations of Millerton Lake would change from the existing condition, including changes in the volume and timing of releases to the San Joaquin River associated with Restoration Flows and flood management, and to the Friant-Kern and Madera canals associated with water supply deliveries. Accordingly, the reservoir levels and water temperatures in Millerton Lake would also change. Analysis of water temperature modeling results indicates that, on a long-term average basis, the volume of the cold-water pool would decrease by less than 10 percent in all months, across all year types, as compared to the existing conditions.

Under the No Action Alternative, Temperance Flat RM 274 Dam and Reservoir would not be constructed. No changes would be anticipated to occur to water temperatures in the San Joaquin River upstream from Millerton Lake.

Because the volume of cold water in Millerton Lake would remain similar to existing conditions, and no changes would occur to water temperatures in the San Joaquin River upstream from Millerton Lake, this impact would not cause violations of water quality standards or adversely affect beneficial uses.

This impact would be **less than significant** under the No Action Alternative.

Action Alternatives All action alternatives would increase the total combined volume of cold water in Millerton Lake and Temperance Flat RM 274 Reservoir, with larger available cold-water pools in action alternatives with higher carryover storage in most months. Analysis of water temperature modeling results indicates that, on a long-term average basis, the volume of the cold-water pool would increase in most months under all action alternatives. In all but Wet years, the volume of the cold-water pool would decrease by up to 60 percent in January under Alternative Plans 1 through 3 and 5 (as compared to the existing condition and No Action Alternative). Under Alternative Plan 5, the cold-water pool volume would also decrease in February, by up to 11 percent, in all but Wet years. The winter months, including January and February, have the largest volumes of cold-water pool under the existing condition and No Action Alternative, and this would not change under the action alternatives.

The SLIS included in Alternative Plan 4 would allow for better management of the cold-water pool. Accordingly, water temperature modeling results indicate that, on a long-term average basis, the volume of the cold-water pool would increase in all months (as compared to the existing condition and No Action Alternative).

Because the total combined volume of cold water in Millerton Lake and Temperance Flat RM 274 Reservoir would increase in most months, and decrease by less than 1 percent under some action alternatives in winter months only, this impact would not cause violations of water quality standards or adversely affect beneficial uses.

This impact would be **less than significant and beneficial** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

Extended Study Area Potential impacts of the alternatives on water temperatures within the extended study area would not extend beyond the Delta to the CVP and SWP water service areas, as discussed in Chapter 2, “Alternatives.” Therefore, the discussion below is limited to the San Joaquin River from Friant Dam to the Merced River confluence, the San Joaquin River from the Merced River confluence to the Delta, and the Delta.

No Action Alternative Under the No Action Alternative, Temperance Flat RM 274 Dam and related physical features would not be constructed and additional water supplies from the proposed Temperance Flat RM 274 Reservoir would not be conveyed in the San Joaquin River. Downstream from the Merced River confluence, monthly average San Joaquin River water temperatures under the No Action Alternative would be similar to existing conditions. Water temperature in the Delta is only slightly influenced by water management activities (i.e., dam releases) (Reclamation and DWR 2005), and would not change under the No Action Alternative.

This impact would be **less than significant** under the No Action Alternative. Mitigation is not required for the No Action Alternative.

Action Alternatives The action alternatives would improve San Joaquin River release temperatures from September through December, as shown in Chapter 2, “Alternatives.” Winter releases would be slightly warmer than under the No Action Alternative; however, in the winter months, release temperatures would still be cooler than needed for anadromous fish (see Modeling Appendix for further details on reservoir and river temperatures). Inclusion of an SLIS in Alternative Plan 4 would reduce release temperatures by up to 5°F more than without the SLIS during fall months, providing a greater benefit to salmonid spawning and rearing. The colder release temperatures anticipated under all action alternatives would also extend the distance downstream from Friant Dam where mean daily river temperatures would stay below 55°F, a water temperature suitable for salmonid spawning and rearing (see Chapter 2, “Alternatives,” and the Modeling Appendix).

The Basin Plan specifies that at no time or place will the temperature of intrastate waters be increased more than 5°F above the natural receiving-water temperature (Central Valley Water Board 2011). Analysis of water temperature modeling results indicates that this standard would be met under all action alternatives, as shown in the Modeling Appendix. Therefore, this impact would not cause violations of water quality standards or adversely affect beneficial uses.

The action alternatives would reduce the frequency, magnitude, and duration of Friant Dam releases greater than Restoration Flows. This in turn would reduce river continuity with some gravel pits, which may have a warming effect on water in the San Joaquin River (SJRRP 2012c).

This impact would be **less than significant and beneficial** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

Impact SWQ-6: Long-Term Effects on Delta Salinity that would Violate D-1641 Salinity Objectives

Extended Study Area

No Action Alternative The No Action Alternative would cause both increases and decreases in salinity as compared with existing conditions, as shown in the Modeling Appendix. On a long-term average basis, all increases in simulated EC were less than 5 percent across all year types, and less than 7 percent in Dry and Critical years. On a long-term average basis, all increases in simulated chloride concentrations were less than 18 percent across all year types, and less than 10 percent in Dry and Critical years. However, none of the changes would result in any additional violations of the Delta salinity standards.

D-1641 establishes maximum salinity objectives, including objectives for salinity (measured as EC) and chloride concentrations, at several locations in the Delta, as shown in Table 15-5. CVP and SWP facilities in the Delta and upstream watersheds are operated to meet the requirements of D-1641, and this would not change under the No Action Alternative. It is therefore anticipated that the No Action Alternative would not result in any additional violations of the D-1641 salinity objectives.

This impact would be **less than significant** under the No Action Alternative.

Action Alternatives The action alternatives would cause both increases and decreases in salinity as compared with existing conditions and No Action Alternative, as shown in the Modeling Appendix. Under the action alternatives, on a long-term average basis, all increases in simulated EC, as compared with existing conditions, were less than 2 percent across all year types, and less than or equal to 2 percent in Dry and Critical years. On a long-term average basis, all increases in simulated chloride concentrations, as compared with existing conditions, were less than 2 percent across all year types, and less than 1 percent in Dry and Critical years. As compared with the No Action Alternative, on a long-term average basis, all increases in simulated EC were less than 2 percent across all year types and in Dry and Critical years. On a long-term average basis, all increases in simulated chloride concentrations, as compared with the No Action Alternative, were less than 2 percent across all year types and in Dry and Critical years. However, none of these changes would result in any violations of the Delta salinity standards.

As previously described, D-1641 establishes maximum salinity objectives, including objectives for salinity (measured as EC) and chloride concentrations, at several locations in the Delta, as shown in Table 15-5. CVP and SWP facilities in the Delta and upstream watersheds are operated to meet the requirements of D-1641, and this would not change under the action alternatives. Therefore, the action alternatives are not anticipated to result in any additional violations of the D-1641 salinity objectives.

This impact would be **less than significant** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

Impact SWQ-7: Long-Term Effects on Delta Salinity that would Violate the X2 Standard

Extended Study Area

No Action Alternative The No Action Alternative would shift X2 upstream and downstream in comparison with existing conditions. On a long-term average basis, all upstream shifts in simulated X2 were less than 0.3 km across all year types, and less than 0.5 km in Dry and Critical years, as shown in the Modeling Appendix. None of the anticipated changes would result in any violations of the X2 standard.

As previously described, D-1641 establishes the X2 standard. The location of the estuarine salinity gradient is regulated from February through June by the location of the X2 objective, and is required to be maintained at not more than 75 km (approximately 47 miles) from February through June.

CVP and SWP facilities in the Delta and upstream watersheds are operated to meet the requirements of D-1641, and this would not change under the No Action Alternative. It is therefore anticipated that the No Action Alternative would not result in any violations of the D-1641 salinity objectives.

This impact would be **less than significant** under the No Action Alternative.

Action Alternatives The action alternatives would shift X2 upstream and downstream in comparison with existing conditions and the No Action Alternative. On a long-term average basis, all upstream shifts in the simulated X2 were less than 0.1 km across all year types. In Dry and Critical years, simulated X2 remained the same as under existing conditions and the No Action Alternative, or shifted downstream, depending on the month, as shown in the Modeling Appendix. None of the anticipated changes would result in any violations of the X2 standard, because the CVP and SWP would release more water upstream to meet standards.

As previously described, D-1641 establishes the X2 standard. The location of the estuarine salinity gradient is regulated from February through June by the location of the X2 objective, and is required to be maintained at not more than 75 km from February through June.

CVP and SWP facilities in the Delta and upstream watersheds are operated to meet the requirements of D-1641, and this would not change under the action alternatives. It is therefore anticipated that the action alternatives would not result in any violations of the D-1641 salinity objectives.

This impact would be **less than significant** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

Impact SWQ-8: Long-Term Effects on Water Quality that would Violate Existing Water Quality Standards or Adversely Affect Beneficial Uses in the CVP/SWP Water Service Areas

Extended Study Area

No Action Alternative Under the No Action Alternative, the recapture and recirculation of full Restoration Flows under the SJRRP would affect water quality in the Friant Division of the CVP. These changes would be associated with differences in constituent concentrations of water supplies diverted from the Delta and/or San Joaquin River and potentially delivered to Friant Division contractors compared to water delivered via the Friant-Kern and Madera canals. Water quality conditions within the CVP and/or SWP water service areas, where water pumped from the San Joaquin River may mix or be exchanged with water delivered from the Delta, would also be affected. Surface water quality impacts are not likely to result in additional violations of existing water quality standards, or substantial water quality changes that adversely affect beneficial uses, or have substantive impacts on public health.

This impact would be **less than significant** under the No Action Alternative.

Action Alternatives As described for Impact SWQ-4, the action alternatives would increase flows in many months in Reaches 1 and 2 and would dilute concentrations of water quality constituents in those reaches. The action alternatives include the delivery of new water supplies from Temperance Flat via the San Joaquin River through diversion at Mendota Pool. The contribution of relatively high-quality water from the San Joaquin River would dilute concentrations of water quality constituents in Mendota Pool, improving the quality of water supplies to entities receiving water from Mendota Pool, including CVP SOD (under Alternative Plans 2, 3, 4, and 5) and SWP M&I contractors (under Alternative Plans 1, 2, 3, and 4). The quality of water delivered to CVP and SWP water service areas would remain similar to the existing conditions and No Action Alternative, and would not result in violations of existing water quality standards, or substantial water quality changes that adversely affect beneficial uses, or have substantive impacts on public health.

This impact would be **less than significant** under the action alternatives. Mitigation is not required and is therefore not proposed.

Mitigation Measures

This section discusses mitigation measures for each significant impact described in the environmental consequences section, as presented in Table 15-4.

No mitigation is required for Impacts SWQ-1 through SWQ-3, or Impact SWQ-5 within the primary study area, or for Impacts SWQ-1 through SWQ-8 within the extended study area, as these impacts would be less than significant or less than significant and beneficial for all action alternatives. There would be no impact under the action alternatives under Impacts SWQ-6, SWQ-7, and SWQ-8 in the primary study area.

Impact SWQ-4 would be potentially significant within the primary study area. Mitigation Measure SWQ-4, below, is proposed to minimize the potential for Impact SWQ-4 to occur.

Mitigation Measure SWQ-4: Prepare and Implement a Site-Specific Remediation Plan for Historic Mine Features Subject to Inundation

Reclamation will prepare and implement a plan to remove or otherwise remediate the Patterson, San Joaquin, and Sullivan mine sites, which have the potential to introduce metals into the proposed Temperance Flat RM 274 Reservoir. This plan will include requirements to coordinate with Federal, State, and local agencies and landowners to ensure that measures taken will reduce the potential for a discharge of contaminants into the proposed Temperance Flat RM 274 Reservoir. Reclamation will obtain any required permits, approvals, and authorizations before any ground-disturbing remediation activity occurs.

Implementation of this mitigation measure would reduce Impact SWQ-4 to a **less-than-significant** level.

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Chapter 16
Indian Trust Assets

This section describes the affected environment related to ITAs for the proposed actions of the Investigation. ITAs are legal interests in property held in trust by the U.S. for Federally recognized Indian tribes or individual Indians.

The affected environment for ITAs is the primary study area, within which all construction activities will take place. No effects to ITA's outside the primary study area would occur, and are not discussed herein. A detailed description of both the primary and extended study areas was provided to BIA's Regional ITA Coordinator. The Regional ITA Coordinator examined both the project area descriptions and records held by BIA and Reclamation, and determined that the proposed action does not have potential to affect ITAs outside of the primary study area. Therefore, the extended study area is not discussed further in this chapter.

Affected Environment

There are no tribes possessing legal property interests held in trust by the United States in the Study Area for any of the action alternatives. Public Domain Allotments and Rancherias held privately in fee ownership with tribal affiliation are located near the primary study area. These fee properties are not ITAs, and any potential impacts to these properties will be addressed with all other non-ITA property interests in the primary and extended study areas (see Chapter 17, "Land Use Planning and Agricultural Resources"). Figure 16-1 identifies the Public Domain Allotments, Reservations, Rancherias, private and public land parcels within and adjacent to the primary study area. Table 16-1 lists the Federally Recognized Tribes with property interests in proximity to the primary study area.

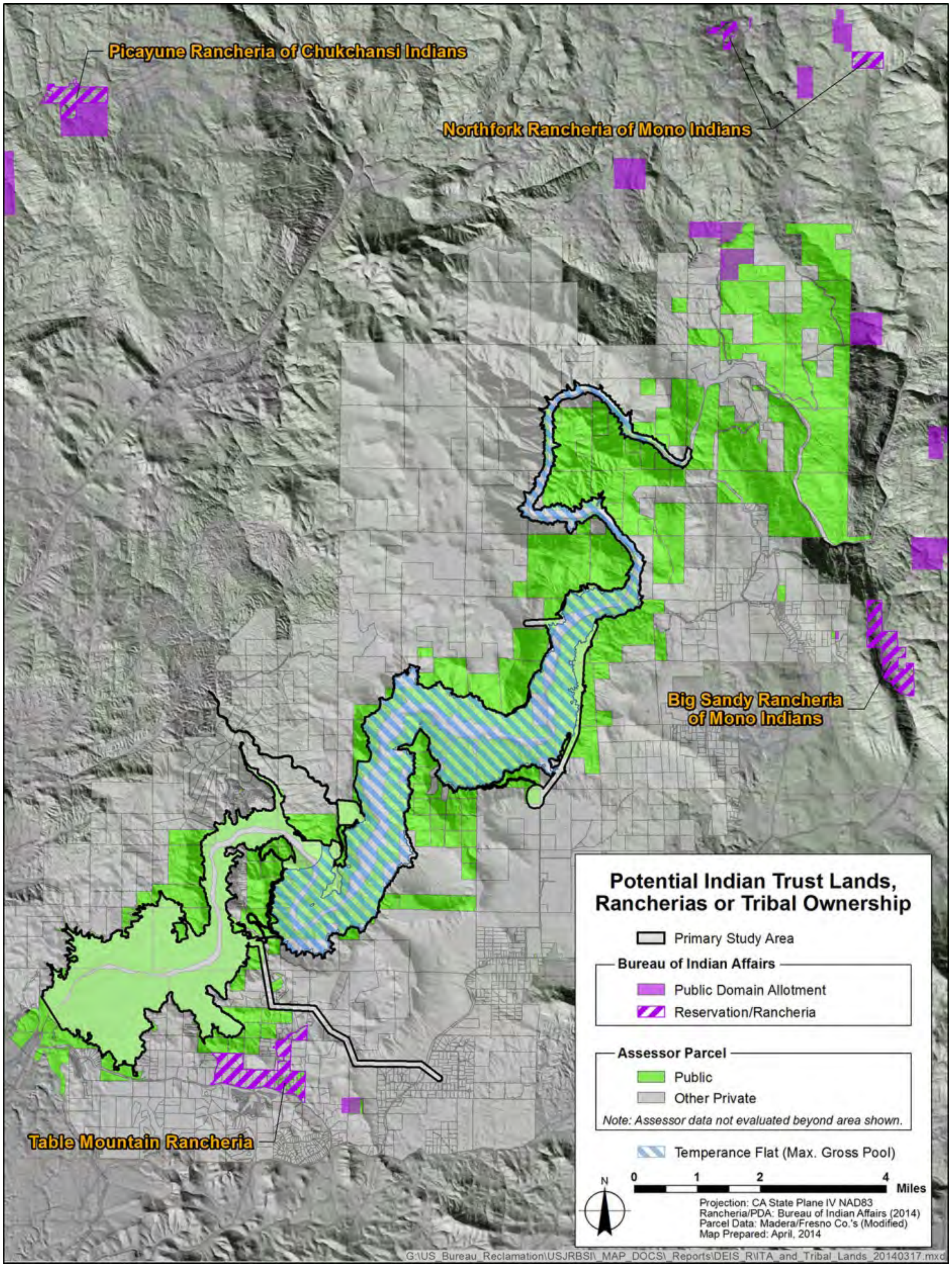

Figure 16-1. Reservations, Rancherias, Public Domain Allotments, Public and Private Property near the Primary Study Area

Table 16-1. Federally Recognized Tribes in Region with Property Interests in Proximity to Primary Study Area

Tribe	Location
Table Mountain Rancheria	Southwest of Primary Study Area
Picayune Rancheria of Chukchansi Indians	Northwest of Primary Study Area
North Fork Rancheria	North of Primary Study Area
Big Sandy Rancheria of Mono Indians	East of Primary Study Area

Environmental Consequences and Mitigation Measures

This section describes potential environmental consequences on ITAs that could result from implementing any of the alternatives. It also describes the methods of environmental evaluation, assumptions, and specific criteria that were used to determine the significance of impacts on ITAs. It then discusses the potential impacts and proposes mitigation where appropriate. The potential impacts on ITAs and associated mitigation measures are summarized in Table 16-2.

Table 16-2. Summary of Impacts and Mitigation Measures for Indian Trust Assets

Impact	Study Area	Alternative	Level of Significance Before Mitigation	Mitigation Measure	Level of Significance After Mitigation
ITA-1: Interfere with the Exercise of a Federally Reserved Water Right, or Degrade Water Quality Where There is a Federally Reserved Water Right	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI
	Extended Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI
ITA-2: Interfere with the Use, Value, Occupancy, Character or Enjoyment of an ITA	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI
	Extended Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI

Table 16-2. Summary of Impacts and Mitigation Measures for Indian Trust Assets (contd.)

Impact	Study Area	Alternative	Level of Significance Before Mitigation	Mitigation Measure	Level of Significance After Mitigation
ITA-3: Failure to Protect ITAs from Loss, Damage, Waste, Depletion, or Other Negative Effects	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI
	Extended Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI

Key:
NI = no impact

Methods and Assumptions

A qualitative assessment of the ITAs in the primary study area was performed. Records held by BIA and Reclamation were compared to the footprint of the alternatives, and the potential for each alternative to affect ITAs was determined.

As previously mentioned, a detailed description of both the primary and extended study areas was provided to BIA's Regional ITA Coordinator. The Regional ITA Coordinator examined both the project area descriptions and records held by BIA and Reclamation, and determined that the proposed action does not have potential to affect ITAs outside of the primary study area.

Criteria for Determining Significance of Effects

An impact to an existing ITA is considered potentially significant if implementation of a project alternative would adversely affect ITAs by resulting in the following:

- Interfere with the exercise of a Federally reserved water right, or degrade water quality where there is a Federally reserved water right
- Interfere with the use, value, occupancy, character or enjoyment of an ITA
- Failure to protect ITAs from loss, damage, waste, depletion, or other negative effects

Environmental measures have been incorporated into the project description, which are consistent with the CALFED ROD (2006) and the Department of Interior Departmental Manual Part 512, Chapter 2 (1995), to reduce any effects on ITAs potentially occurring near the primary study area. ITAs are not located within the primary study area.

1) If there is potential to affect an identified ITA, consultation will be initiated as defined therein before any actions are authorized and implemented. The purpose of the tribal consultation will be to further identify the nature of the effect and to identify appropriate mitigation measures.

2) The tribal consultation process will take place with the affected Federally-recognized Indian tribe(s). Appropriate avoidance and/or mitigation strategies will be discussed on a government-to-government basis.

Separate mitigation measures may be required for different types of trust assets.

Topics Eliminated from Further Consideration

As previously mentioned, the Regional ITA Coordinator examined both the project area descriptions and records held by BIA and Reclamation, and determined that the proposed action does not have potential to affect ITAs outside of the primary study area. Therefore, no impacts are anticipated in the extended study area, and this area is not discussed further.

Direct and Indirect Effects

The following section describes the potential environmental consequences of the project. Where the action alternatives would have identical or nearly identical impacts regardless of which action alternative is implemented, the action alternatives are described together. Where impacts would differ, the action alternatives are described separately.

Impact ITA-1: Interfere with the Exercise of a Federally Reserved Water Right, or Degrade Water Quality Where There is a Federally Reserved Water Right

Primary Study Area

No Action Alternative Under the No Action Alternative, there would be no impacts to ITAs because there are no ITAs in the primary study area. Additionally, no new facilities would be constructed and existing operations would continue to operate as they have historically occurred.

There would be **no impact** under the No Action Alternative.

Action Alternatives There are no ITAs in the primary study area. There are no tribes possessing legal property interests held in trust by the United States in the primary study area.

There would be **no impact** under the action alternatives. Mitigation for this impact is not needed, and thus not proposed.

Impact ITA-2: Interfere with the Use, Value, Occupancy, Character or Enjoyment of an ITA

Primary Study Area

No Action Alternative Under the No Action Alternative, there would be no impacts to ITAs because there are no ITAs in the primary study area. Additionally, no new facilities would be constructed and existing operations would continue to operate as they have historically occurred.

There would be **no impact** under the No Action Alternative.

Action Alternatives There are no ITAs in the primary study area. There are no tribes possessing legal property interests held in trust by the United States in the primary study area. Public Domain Allotments held privately in fee ownership with tribal affiliation are located near the primary study area, however these fee properties are not ITAs, and any potential impacts to these properties are addressed with all other non-ITA property interests in the primary and extended study areas (see Chapter 17, "Land Use Planning and Agricultural Resources").

There would be **no impact** under the action alternatives. Mitigation for this impact is not needed, and thus not proposed.

Impact ITA-3: Failure to Protect ITAs from Loss, Damage, Waste, Depletion, or Other Negative Effects

Primary Study Area

No Action Alternative Under the No Action Alternative, there would be no impacts to ITAs because there are no ITAs in the primary study area. Additionally, no new facilities would be constructed and existing operations would continue to operate as they have historically occurred.

There would be **no impact** under the No Action Alternative.

Action Alternatives There are no ITAs in the primary study area. There are no tribes possessing legal property interests held in trust by the United States in the primary study area. Public Domain Allotments held privately in fee ownership with tribal affiliation are located near the primary study area, however these fee properties are not ITAs, and any potential impacts to these properties are addressed with all other non-ITA property interests in the primary and extended study areas (see Chapter 17, "Land Use Planning and Agricultural Resources").

There would be **no impact** under the action alternatives. Mitigation for this impact is not needed, and thus not proposed.

Mitigation Measures

This section discusses mitigation measures for each significant impact described in the environmental consequences section, as presented in Table 11-7.

No mitigation is required for Impacts ITA-1 through ITA-3 within the primary or extended study areas, as there would be no impact under any of the action alternatives.

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Chapter 17
Land Use Planning and Agricultural Resources

This chapter describes the affected environment for land use planning and agricultural resources, as well as potential environmental consequences and associated mitigation measures, as they pertain to implementing the alternatives. It focuses primarily on the primary study area (area of project features, Temperance Flat Reservoir Area, and Millerton Lake below RM 274). It also discusses the extended study area (San Joaquin River from Friant Dam to the Merced River, the San Joaquin River from the Merced River to the Delta, the Delta, and the CVP and SWP water service areas).

Affected Environment

The affected environment for land use planning and agricultural resources includes discussion of existing land use conditions; private and public ownership of lands in the primary study area; agricultural resources, including Important Farmland, Williamson Act contract lands, and Farmland Security Zones (FSZ); and forestry resources.

Primary Study Area

Land Use

The primary study area encompasses the San Joaquin River upstream from Friant Dam to Kerckhoff Dam, including Millerton Lake (see Chapter 1, "Introduction"). Recreation, agriculture, open space, forestland, and rural residential development make up the majority of land uses in the primary study area (Figure 17-1).

Within the primary study area, the rural communities of Auberry and Prather are located in Fresno County. Outside of the primary study area, the town of Friant is located approximately 1 mile south of Friant Dam, and the City of Fresno is the nearest urban area of significant size, located approximately 10 miles southwest of the primary study area via Friant Road, while the City of Madera and SR 99 are about 22 miles to the west.

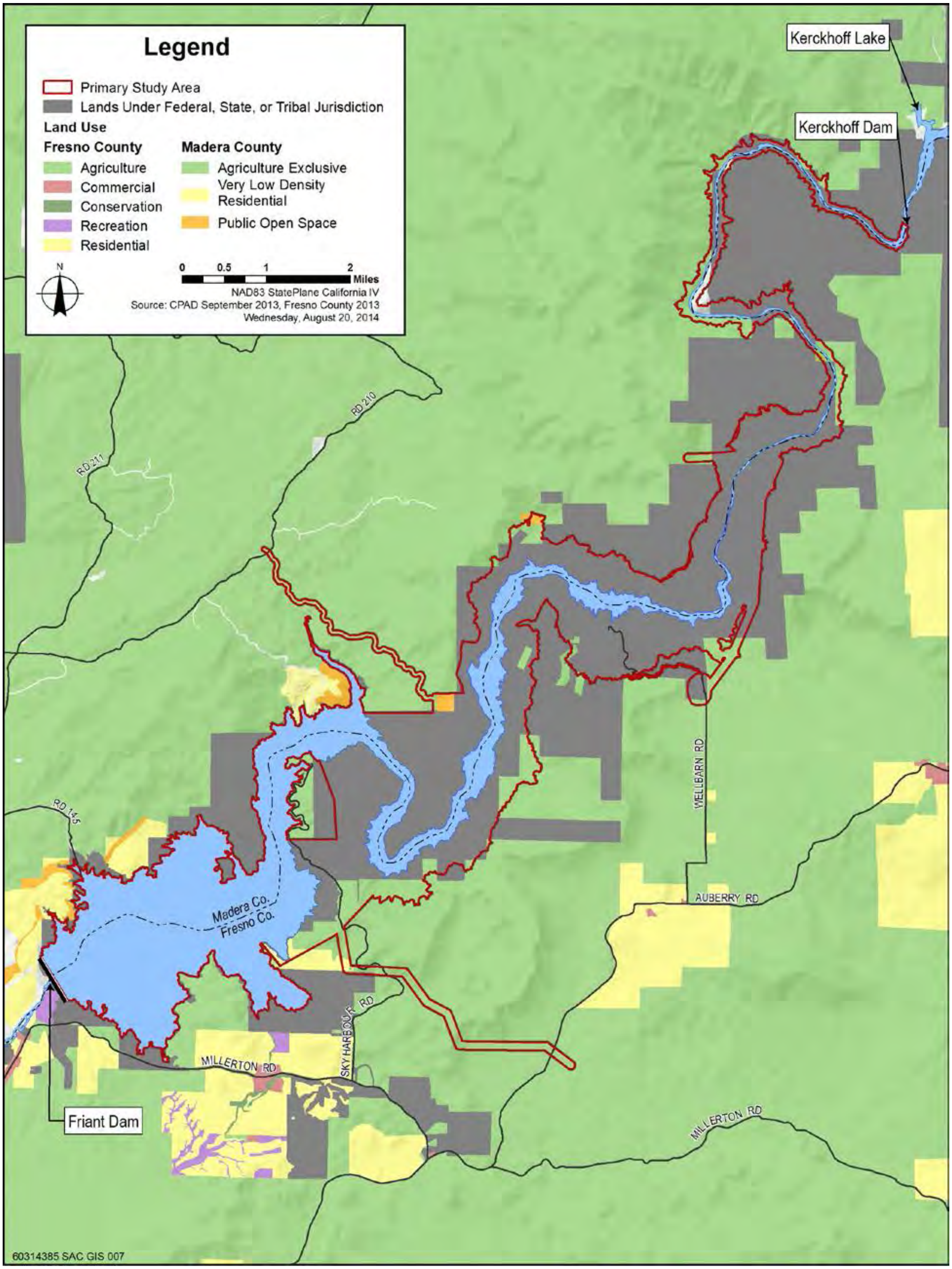


Figure 17-1. Planned Land Uses in the Primary Study Area and Vicinity

The following discussion characterizes the existing land uses within the primary study area, summarizes the Fresno County and Madera County general plan land use designations and county zoning, and identifies land ownership and management.

Existing Land Uses in and Adjacent to the Primary Study Area

Area of Project Features The majority of the area of project features is located in undeveloped open space and forestland within the Millerton Lake SRA.

The proposed new and relocated transmission line corridors are located in undeveloped open space and forestland. Approximately 1.6 miles of the southern portion of the new transmission line corridor is located on land owned and managed by the Sierra Foothill Conservancy. Rural residences are located at the southern terminus of the transmission line corridor along both sides of Cherokee Road and along both side of Caballero Road just east of Auberry Road. The relocated transmission line corridor is located on lands managed by the BLM and lands in private ownership. No residences are located within or immediately adjacent to the proposed relocated transmission line corridor.

Temperance Flat Reservoir Area Land uses within the Temperance Flat Reservoir Area include open space, forestland, grazing, and recreational areas.

There are a few isolated recreational facilities upstream from Millerton Lake within the Millerton Lake SRA. The North Finegold and Temperance Flat boat-in campgrounds are located approximately 4 miles and 9 miles, respectively, upstream from RM 274.

Located 5 miles northwest of Auberry, the SJRG SRMA, managed by BLM, covers approximately 6,700 acres of land on both the north and south sides of the San Joaquin River. The SJRG SRMA offers several educational and recreation facilities, concentrated in the Squaw Leap area on the south side of the river, accessible via Smalley Road from Auberry. Recreational activities in the SJRG SRMA include hiking, mountain biking, horseback riding, angling, whitewater rafting, and cave exploration (see Chapter 22, “Recreation,” for a detailed discussion of the lands and waters used for recreation and the recreational access and facilities that support those uses). The land in the SJRG SRMA is also leased to local property owners for cattle grazing. Four BLM grazing lessees use 4,000 acres in six grazing allotments and could use up to 1,200 animal-unit months of public land forage annually during various seasons of use (Doran 2013).

Cattle are grazed on lands in the Temperance Flat Reservoir Area. Approximately 4,000 acres in the northwestern portion of the Temperance Flat Reservoir Area are currently grazed at Kennedy Table during winter. In addition, Reclamation owns several grazing parcels in the general vicinity of Kennedy Table, two of which are currently leased to PG&E and the rest, although not currently leased, remain available for future grazing (see the Agricultural Resources and Grazing Lands section below for further discussion).

At the northern most boundary of the Temperance Flat Reservoir Area, Kerckhoff Dam impounds Kerckhoff Lake, which serves as the forebay for both Kerckhoff Powerhouse and Kerckhoff No. 2 Powerhouse. The Kerckhoff Dam and powerhouses are owned and operated by PG&E. Wishon Powerhouse, also owned and operated by PG&E, is located on the east shore of Kerckhoff Lake and releases water to the lake.

In 2010, the BLM Bakersfield Field Office determined that 5.4 miles of the San Joaquin River from the Kerckhoff Dam downstream to the Kerckhoff Powerhouse was eligible and suitable for designation as a Federal Wild and Scenic River based on its free-flowing character and outstandingly remarkable values (ORV). If this portion of the river is designated, the hydroelectric facilities along the segment would continue to operate according to existing plans and policies. However, without Congressional authorization or Secretarial designation, restrictions under the Wild and Scenic Rivers Act would not apply (see Chapter 28, “Other NEPA and CEQA Considerations”) for further discussion of the BLM RMP land use goals and policies related to wild and scenic rivers).

Eligibility for designation as a wild and scenic river is based on whether a river segment is “free-flowing” and whether it possesses at least one ORV, which could be a scenic, recreation, geologic, fish, wildlife, cultural, historic, or other value. In the case of this segment of the San Joaquin River, the scenic quality rating of “A” contributed to the finding that the segment is eligible to be included in the NWSRS. Other qualities contributing to the river segment’s eligibility included wildlife and cultural ORVs (BLM 2010).

Figure 17-2 shows the extent of the lands anticipated to be included in the Wild and Scenic River designation corridor, including a zone extending up to one-quarter mile from either river shoreline. This zone would establish restrictions on land management activities that would adversely affect the free-flowing character of the river or ORVs.

Millerton Lake Below RM 274 The majority of lands surrounding Millerton Lake below RM 274 are located in the 10,500-acre Millerton Lake SRA. Recreational uses in the Millerton Lake SRA include water-based activities, such as motor boating, sailing, water skiing, jet skiing, swimming, and fishing, and shoreline activities, such as picnicking, hiking, biking, camping, and nature watching. The developed areas around Millerton Lake consist of park and park-related facilities.

The park-related facilities on the south shore are the administrative buildings and maintenance facilities, Millerton Courthouse, Winchell Cove Marina, the South Finegold day-use area, boat ramps, and picnic and swimming areas. The north shore of Millerton Lake primarily consists of camping facilities, accessible via Road 145. Camping sites are located at Rocky Point, Mono, Fort Miller, Dumna Strand, Valley Oak, and Meadows Campgrounds (see Chapter 22, "Recreation," for a detailed discussion of the lands and waters used for recreation and the recreational access and facilities that support those uses).

Two residential subdivisions are located along the shoreline of Millerton Lake. Sky Harbor subdivision (also known as the Millerton Lake Park Estates) is located 6 miles north of the intersection of Sky Harbour Road and Millerton Road in Fresno County. The Sky Harbor subdivision includes 231 parcels, of which 59 parcels are developed with single-family residences (LAFCO 2011). Hidden Lake Estates subdivision is located on the northwestern shoreline of Millerton Lake in Madera County. The Hidden Lake Estates subdivision includes 208 parcels, with 46 developed with single-family residences (Madera County 2013).

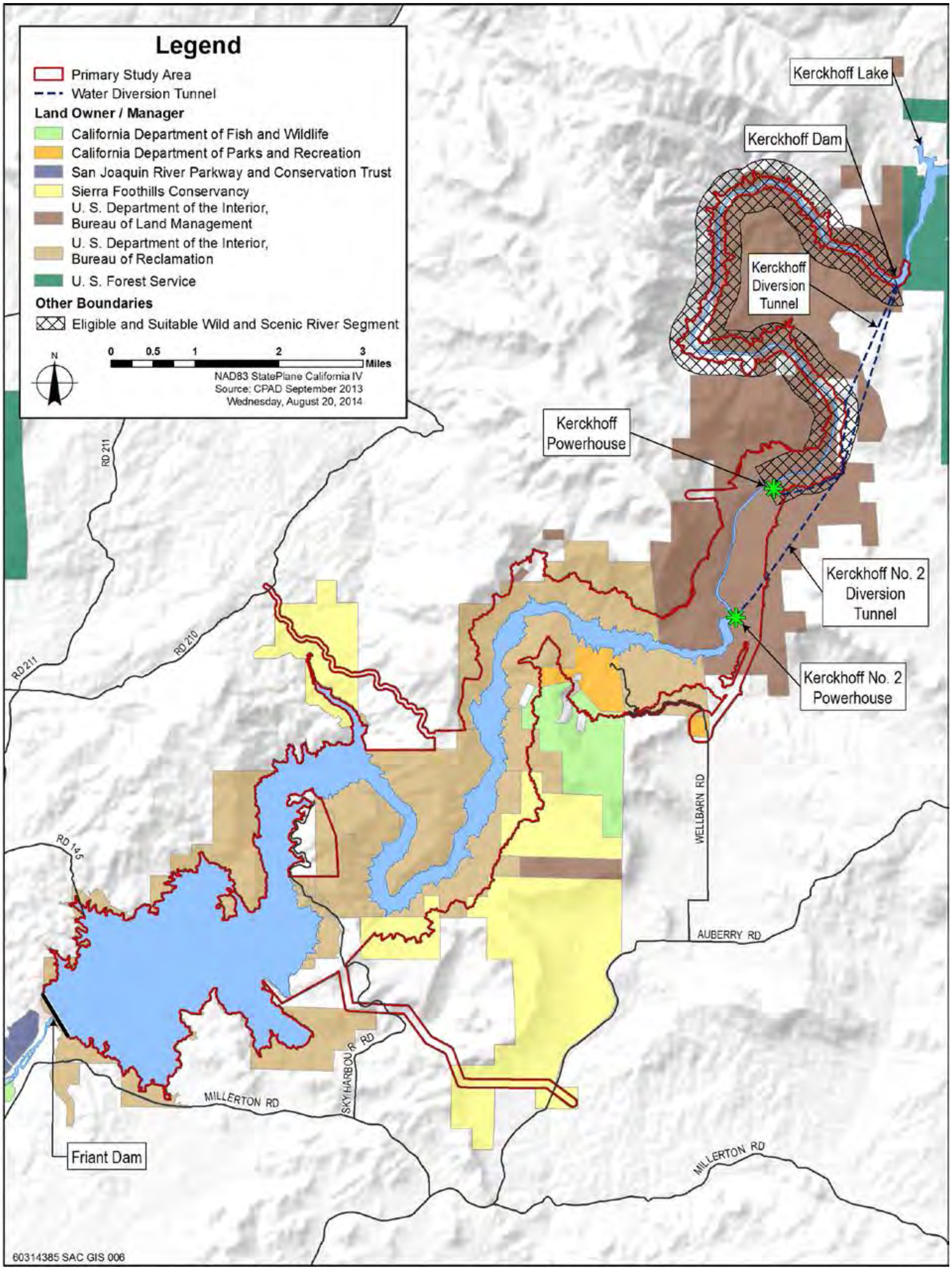


Figure 17-2. Land Ownership and Management in the Primary Study Area

Land Use Designations and Zoning Land use designations identify the proposed distribution, location, and extent of planned land uses. Figure 17-1 shows the *Madera County General Plan* (Madera County 1995) land use designations in the primary study area and vicinity. Figure 17-1 also presents planned land uses for Fresno County (Fresno County 2000a, 2000b), characterized by five categories of land use using combinations of similar zoning districts. Table 17-1 defines each land use designation and planned land uses in the primary study area and vicinity.

Zoning ordinances establish land use zoning districts that are then applied to land within the local jurisdiction. Typically, zoning ordinances will, for each land use designation, establish allowable land uses and requirements for development in each designation.

Land Ownership and Management Most land in the primary study area is publicly administered or owned by BLM, Reclamation, and the CDFW. To a lesser extent, privately owned lands, including lands owned by the Sierra Foothill Conservancy and PG&E, are located throughout the primary study area. Land ownership and management authority in the primary study area is shown in Figure 17-2 and described below.

U.S. Department of the Interior, U.S. Bureau of Land Management Located 5 miles northwest of Auberry, the BLM-managed SJRG SRMA covers approximately 6,700 acres of land on both the north and south sides of the San Joaquin River. As described above, the SJRG SRMA offers several educational and recreation facilities and Federal grazing leases.

U.S. Department of the Interior, Bureau of Reclamation Millerton Lake, Friant Dam and the majority of adjacent lands are owned by Reclamation. As described above, Millerton Lake provides a variety of water-based recreational activities as well as shoreline activities.

California Department of Fish and Wildlife Most of Big Table Mountain is owned by CDFW and managed by State Parks for protection of endangered species and interpretive opportunities. Relatively small parts of Big Table Mountain are owned by Reclamation and BLM.

Table 17-1. Fresno County and Madera County Planned Land Uses

Planned Land Use	Definition
Fresno County	
Agriculture	This category is a combination of the Agriculture, Exclusive Agriculture, Limited Agriculture, and Resource Conservation zoning districts.
Residential	This category is a combination of the Rural Residential, Single-Family Residential, Single-Family Residential Agriculture, Low Density Multiple Family Residential, and Trailer Park Residential zoning districts.
Recreation	This category is a combination of the Recreation and Commercial Recreation zoning districts.
Conservation	This category is the Open Conservation zoning district.
Commercial	This category is a combination of the Neighborhood Shopping Center, General Commercial, Central Trading, Residential and Professional Office, Rural Commercial Center, Agricultural Commercial Center, and Commercial and Light Manufacturing zoning districts.
Madera County	
Agriculture Exclusive	The Agriculture Exclusive provides for agricultural uses, limited agricultural support uses (i.e., barns, silos, stables, and fruit stands), timber production, mineral extraction, and one to two single-family dwelling units per parcel.
Public Open Space	The Open Space land use designation provides for low-intensity agricultural uses, grazing, forestry, recreational uses, major electrical trunk and communication transmission lines, habitat protection, reservoirs, refuse disposal, mining, and public and quasi-public uses.
Very Low Density Residential	The Very Low Density Residential land use designation provides for single-family detached and attached residential uses at densities of two dwelling units per acre, bed-and-breakfast establishments, limited agricultural uses, and public and quasi-public uses.

Sources: Fresno County 2000a, 2000b; Madera County 1995

Note:

The area of project features includes the proposed dam and appurtenant structures, power generation facilities, and other construction areas.

California State Parks State Parks manages the Millerton Lake SRA through agreements with Reclamation and CDFW, and most of Big Table Mountain is managed by State Parks through agreements with CDFW.

Sierra Foothill Conservancy The Sierra Foothill Conservancy owns and manages the Austin & Mary Ewell Memorial Preserve and McKenzie Table Mountain Preserve:

- The 718-acre Austin & Mary Ewell Memorial Preserve on Fine Gold Creek is located west of Millerton Lake in Madera County. The Sierra Foothill Conservancy holds a conservation easement for the preserve in favor of CDFW to protect Fine Gold Creek and Willow Creek, preserve sensitive plant and wildlife species of the Central Valley floor and Sierra Nevada foothills, and to maintain existing wildlife corridors (Sierra Foothill Conservancy 2013).

- The 2,960-acre McKenzie Table Mountain Preserve is located east of Millerton Lake between Friant and Prather, on the north side of Auberry Road. The preserve offers opportunities for hiking, wildlife viewing, and nature appreciation. In addition to the main body of the preserve on the north side of the road, the preserve also includes a 47-acre parcel along the creek on the south side. This smaller piece is being developed as a nature center which will host classes and school field trips (Sierra Foothill Conservancy 2013).

Pacific Gas and Electric Company PG&E owns approximately 200 acres in and around Kerckhoff Lake north of the SJRG SRMA. This area includes open space, grazing land, and recreational areas (Pacific Forest and Watershed Lands Stewardship Council 2007). Smalley Cove at Kerckhoff Lake, operated by PG&E, is located just east of the SJRG SRMA and offers day use and campsites with fire pits, potable water, and vault toilets.

Kerckhoff and Kerckhoff No. 2 powerhouses and Wishon Powerhouse are owned by PG&E and operated under FERC License No. 96 and No. 1354, respectively.

Agricultural Resources and Grazing Land

Agriculture is the prevalent land use in Fresno County and Madera County and contributes substantially to these counties' economy. Agriculture not only contributes to the local economy, but also helps to define the county's visual and social character, maintains productive land in open space, supports wildlife habitats and migration corridors, and provides access to a local food source.

Grazing is a traditional land use in public and private lands in the primary study area (Figure 17-3). Dairy and beef cattle represented Madera County's fifth highest individual commodity while cattle represent Fresno County's seventh highest individual commodity. Cattle accounted for $352 million and $4.5 million of the total gross valuation of agricultural commodities in Fresno and Madera counties, respectively (Fresno County 2011; Madera County 2011).

There are no active grazing lands within the area of project features or the Millerton Lake below RM 274. Approximately 4,000 acres in the northwestern portion of the Temperance Flat Reservoir Area are currently grazed at Kennedy Table during winter. In addition, Reclamation owns several parcels in the general vicinity of Kennedy Table, two of which are currently leased to PG&E; the rest, although not currently leased, remain available for future grazing. One of the currently leased grazed parcels is on rugged terrain on the north side of the San Joaquin River (Reclamation and State Parks 2010).

Grazing at Big Table Mountain was reestablished in 2000 on the experimental portion of the Big Table Mountain as part of an ongoing CDFW grazing study (Reclamation and State Parks 2010).

The grazing season in the primary study area is from October 15 to May 31. The carrying capacity of the grazing property is approximately 200 animal units or cow/calf pairs per grazing season, which is equivalent to 1,500 animal unit-months. If sufficient dry forage is available, grazing may also take place between June 1 and October 15, but at the much lower carrying capacity (Reclamation and State Parks 2010).

Important Farmland The California Department of Conservation (DOC) Important Farmland classifications—Prime Farmland, Farmland of Statewide Importance, Unique Farmland, and Farmland of Local Importance—recognize the land's suitability for agricultural production by considering physical and chemical characteristics of the soil, such as soil temperature range, depth of the groundwater table, flooding potential, rock fragment content, and rooting depth. The classifications also consider location, growing season, and moisture available to sustain high-yield crops. Together, Important Farmland and Grazing Land are defined by DOC as "Agricultural Land" (see the Regulatory Setting section for more information).

The following discussion identifies the 2008 and 2010 acreages of agricultural land, including Important Farmland and Grazing Land, in Fresno and Madera counties and describes the factors contributing to the conversion of irrigated agricultural land to nonirrigated uses in both counties.

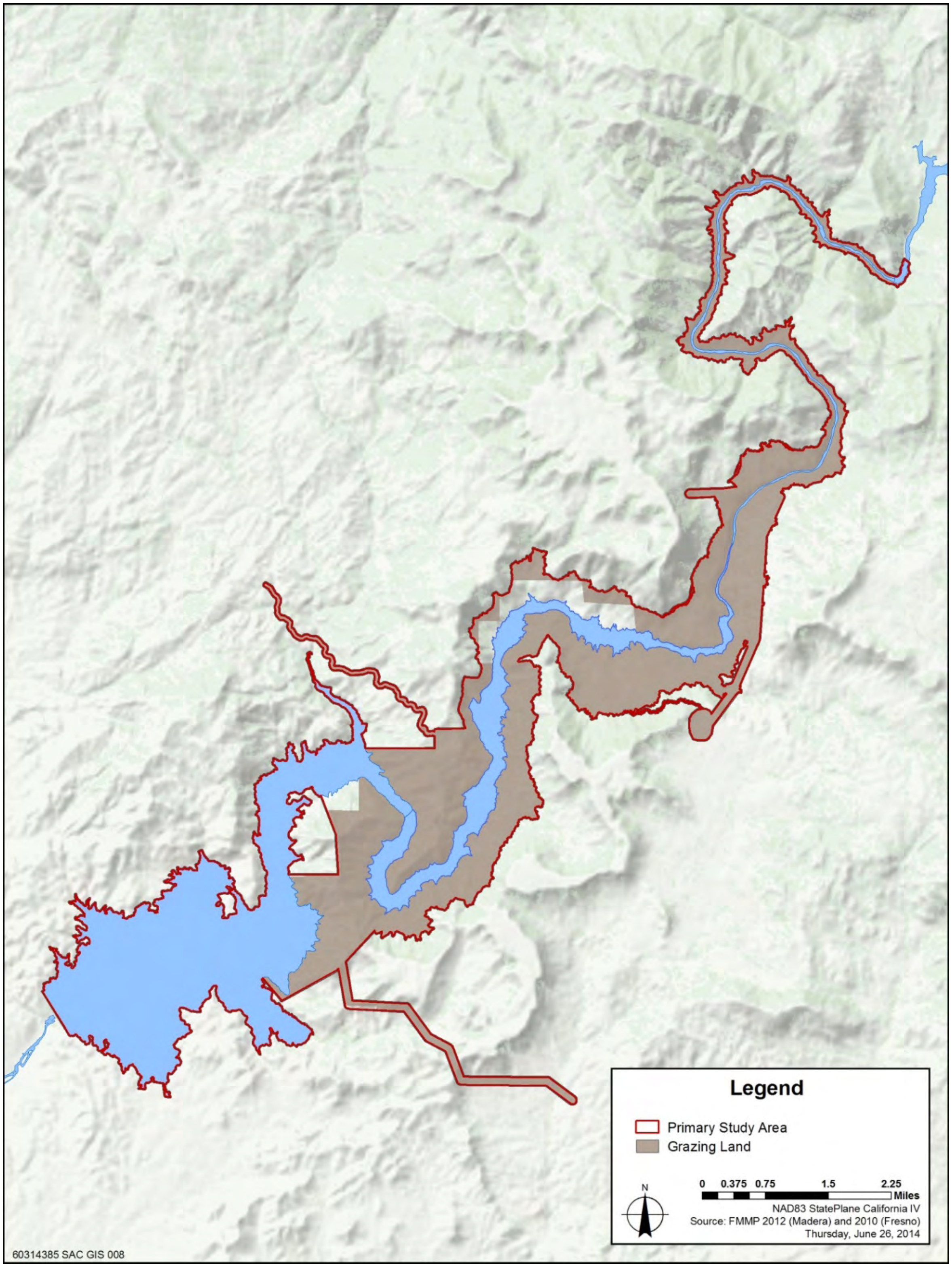


Figure 17-3. Grazing Land in the Primary Study Area

In 2008, DOC estimated that Fresno County had approximately 2,203,231 acres of agricultural land, of which approximately 1,376,278 acres were identified as Important Farmland and 826,953 acres were identified as Grazing Land. In 2010, Fresno County had approximately 2,016,095 acres of agricultural land, of which approximately 1,370,273 acres were identified as Important Farmland and 825,752 acres were identified as Grazing Land. Overall, the Important Farmland acreage decreased by approximately 0.4 percent between 2008 and 2010, and the overall decrease in agricultural land was 9.2 percent (Table 17-2).

Table 17-2. Summary of Agricultural Land Conversion in Fresno and Madera Counties, 2008–2010

Important Farmland Category	Acres		Net Change (2008–2010)	
	2008	2010	Acres	Percent
Fresno County				
Prime Farmland	693,174	685,411	-7,763	-1.1
Farmland of Statewide Importance	439,020	415,689	-23,331	-5.6
Unique Farmland	94,177	92,649	-1,528	-1.6
Farmland of Local Importance	149,907	176,524	26,617	17.8
Important Farmland Subtotal	1,376,278	1,370,273	-6,005	-0.4
Grazing Land	826,953	825,752	-1,201	-0.1
Agricultural Land Total	2,203,231	2,016,095	-7,206	-9.2
Madera County				
Prime Farmland	97,461	97,095	-396	-0.4
Farmland of Statewide Importance	85,136	84,755	-381	-0.4
Unique Farmland	163,973	165,931	1,958	1.2
Farmland of Local Importance	16,143	13,801	-2,342	17.0
Important Farmland Subtotal	362,743	361,582	-1,161	-0.3
Grazing Land	399,501	400,604	1,103	0.3
Agricultural Land Total	762,244	762,186	-58	0.001

Sources: DOC 2010a, 2010b

In 2008, DOC estimated that Madera County had approximately 762,244 acres of agricultural land, of which approximately 362,743 acres were identified as Important Farmland and 399,501 acres were identified as Grazing Land. In 2010, Madera County had approximately 762,186 acres of agricultural land, of which approximately 361,582 acres were identified as Important Farmland and 400,604 acres were identified as Grazing Land. Overall, the Important Farmland acreage decreased by approximately 0.3 percent between 2008 and 2010, and the overall decrease in agricultural land was 0.001 percent (Table 17-2).

Based on the California Division of Land Resource Protection Important Farmland Map for Fresno and Madera counties, no agricultural land designated as Important Farmland (i.e., Prime Farmland, Farmland of Statewide Importance, Unique Farmland, and Farmland of Local Importance) is located within the primary study area.

As shown in Figure 17-3, the majority of the primary study area is designated as Grazing Land, which is considered by DOC as "Agricultural Land." Approximately 1,630 acres, 5,170 acres, and 126 acres of Grazing Land are located within the area of project features, Temperance Flat Reservoir Area, and Millerton Lake below RM 274 area, respectively.

Williamson Act, Including Farmland Security Zones The State has developed processes to discourage conversion of agricultural land to nonagricultural uses. The use of Williamson Act contracts and FSZ (also known as Super Williamson Act lands) enables local governments to provide private landowners with tax incentives to continue agricultural or related open space uses (see the Regulatory Setting section for more information).

Figure 17-4 shows the locations of Williamson Act lands within the primary study area. Lands under Williamson Act contracts are located within the Temperance Flat Reservoir Area and Millerton Lake below RM 274 and FSZ lands are located within the Temperance Flat Reservoir Area. The following discussion summarizes the acreages of Williamson Act lands and FSZ lands and identifies the general location of these lands within each area.

Area of Project Features Approximately 161 acres of land under Williamson Act contracts and less than 1 acre of FSZ lands are located in the vicinity of Sky Harbour Road and Auberry Road. This total includes land under Williamson Act contracts that would be uses for permanent access roads, the intake structure, construction staging areas, and the relocated transmission line.

The corridor for the new transmission line includes approximately 79 acres of land under Williamson Act contracts and approximately 80 acres of land under FSZ lands. The majority of the Williamson Act contract lands are located along the northern and central portions of the corridor for the new transmission line while FSZ lands are located along the southern portion of that corridor. A portion of the relocated transmission line corridor is located on Williamson Act lands northeast of the transmission line terminus on Wellbarn Road.

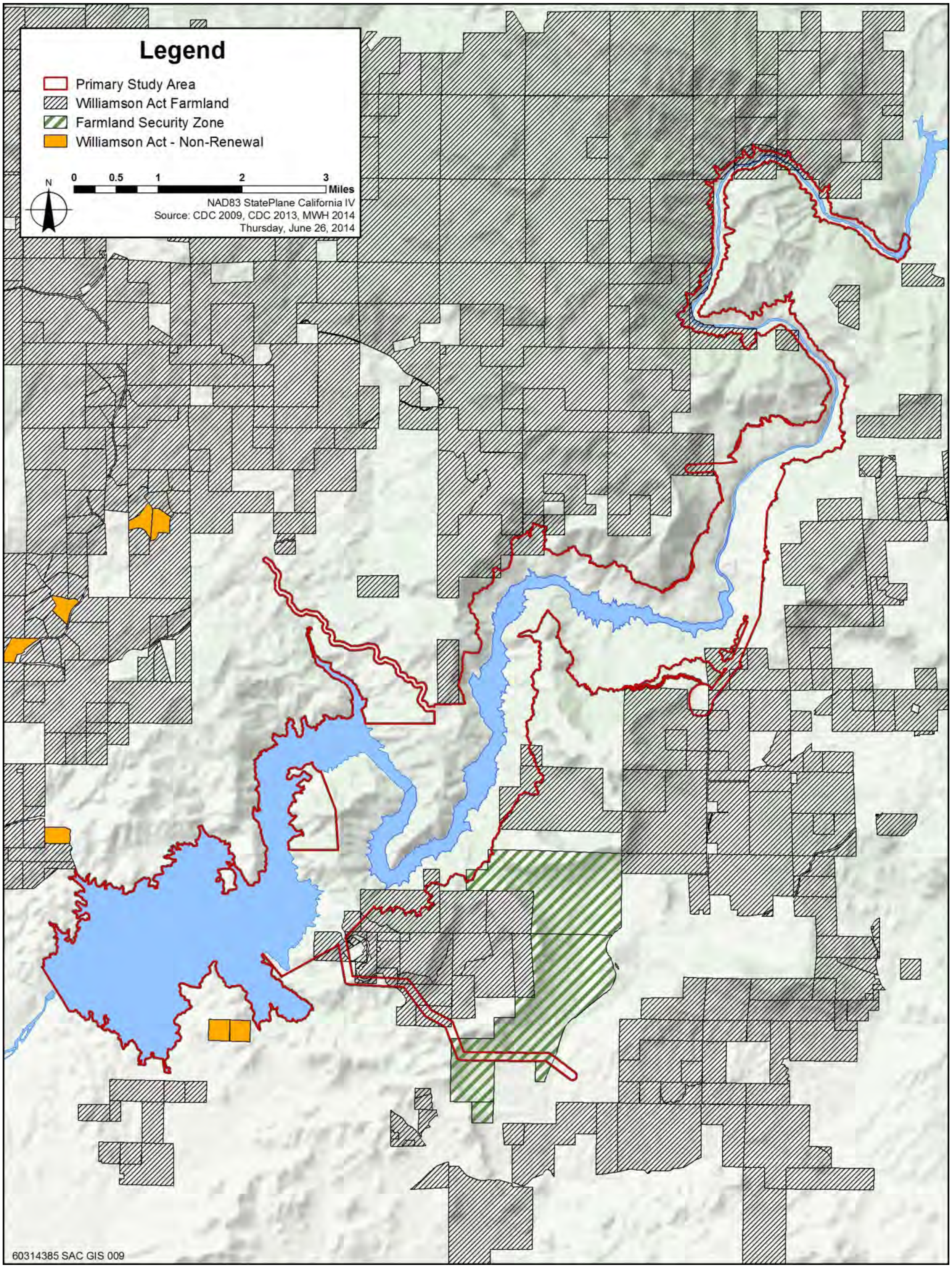


Figure 17-4. Williamson Act Contract Lands in the Primary Study Area

Temperance Flat Reservoir Area There are approximately 616 acres of land under Williamson Act contracts within the Temperance Flat Reservoir Area, with the majority of these lands located southwest of Kerckhoff Lake.

Approximately 10 acres of FSZ lands are located within the southeastern area of the Temperance Flat Reservoir Area.

Millerton Lake Below RM 274 There are no lands under Williamson Act or FSZ lands within Millerton Lake below RM 274.

Forestry Resources

Forests can serve as high-quality habitat for fish and wildlife species, sequester carbon to mitigate climate change impacts, capture vital runoff for agricultural and domestic water supply, and provide a variety of outdoor recreation and education opportunities. Many rural communities depend on income and employment opportunities resulting from working timber industries, or on amenity values that support a tourist industry and attract new residents seeking a better lifestyle. In metropolitan areas, urban forests contribute to improved air quality, cooling of heat islands for energy conservation, and local employment (CAL FIRE 2010).

Forestland is defined as native tree cover greater than 10 percent that allows for management of timber, aesthetics, fish and wildlife, recreation, and other public benefits (California PRC Section 12220[g]). Natural forest and woodland vegetation types in the primary study area typically have greater than 10 percent cover by native trees (Chapter 6, “Biological Resources – Botanical and Wetlands,” displays the distribution of natural forest and woodland vegetation in the primary study area).

Forestland in the primary study area is located within the area of project features and Temperance Flat Reservoir Area; it consists of upland woodland. A detailed description of upland woodland habitat and associated species is provided in Chapter 6, “Biological Resources – Botanical and Wetlands.”

Area of Project Features As shown in Table 17-3, upland woodland habitat occupies approximately 1,519 acres of the area of project features. The upland woodland habitat in this area is characterized by foothill pine oak woodland and blue oak woodland.

Table 17-3. Summary of Upland Woodland Habitat in the Area of Project Features

Dominant Species	Acres[1,2]
Foothill Pine Oak Woodland	1,215
Blue Oak Woodland	298
Live Oak	6
Total	**1,519**

Notes:
[1] Acreage of habitat identified for the area of project features does not include acreage overlapped by the Temperance Flat Reservoir Area.
[2] Acres have been rounded to the nearest whole number.

Temperance Flat Reservoir Area As shown in Table 17-4, upland woodland habitat occupies approximately 4,963 acres of the Temperance Flat Reservoir Area. The upland woodland habitat in this area is characterized by foothill pine oak woodland, blue oak woodland, live oak woodland, foothill pine woodland, and foothill pine chaparral woodland.

Table 17-4. Upland Woodland Habitat in the Temperance Flat Reservoir Area

Dominant Species	Acres[1,2]
Foothill Pine Oak Woodland	3,809
Blue Oak Woodland	1,089
Live Oak Woodland	51
Foothill Pine Woodland	9
Foothill Pine Chaparral Woodland	5
Total	**4,963**

Notes:
[1] Acreage of habitat identified includes the portion of the area of project features overlapped by the Temperance Flat Reservoir Area.
[2] Acres have been rounded to the nearest whole number.

Millerton Lake Below RM 274 There is no forestland mapped within Millerton Lake below RM 274.

Extended Study Area

The extended study area encompasses the San Joaquin River from Friant Dam to the Merced River, the San Joaquin River from the Merced River to the Delta, the Delta, and the CVP and SWP water service areas that would receive water supplies released from new storage capacity created by the alternatives. Each area could be affected during project operation as a result of enhanced water supply reliability, increased water supplies above those currently available, and changes to instream flows of the San Joaquin River.

San Joaquin River from Friant Dam to Merced River

This section describes land uses and agricultural and forestry resources in the vicinity of the San Joaquin River from Friant Dam to the Merced River. The San Joaquin River from Friant Dam to the Merced River is located in Fresno, Madera, and Merced counties.

The land uses and agricultural and forestry resources are not expected to substantially be directly or indirectly affected because the only changes that occur in this segment would be a change in flows that would be limited to the active stream channel. Therefore, this section briefly discusses land uses and agricultural and forestry resources in the vicinity of the San Joaquin River from Friant Dam to the Merced River.

Land Use The primary land uses along the San Joaquin River from Friant Dam to the Merced River are open space, recreational, and agricultural. Annual crops, vineyards, and orchards account for nearly all agricultural land uses in this area.

Urban land uses (e.g., residential, commercial, industrial) account for only a small percentage of land use along the San Joaquin River from Friant Dam to the Merced River. The river flows adjacent to the City of Fresno and the communities of Friant and Herndon, and passes near the unincorporated communities of Biola and Mendota in Fresno County and the City of Firebaugh in Madera County. Developed recreational areas are located from Friant Dam to SR 99. The San Joaquin River Parkway extends along both banks of the river, and the parkway includes multiple recreation sites and use areas, including Lost Lake Park, Fort Washington Beach, Sycamore Island Ranch, and Camp Pashayan, among others. Although these urban areas and developed recreational areas are located within the vicinity of the San Joaquin River, changes in operations would not increase flood flows that could affect urban or recreational land uses.

South of SR 99 to the Madera County line, land uses in Fresno County are agricultural and open space. Within Madera County, the majority of land uses consist of agricultural and open space. Most of the lands adjacent to the San Joaquin River in Merced County are agricultural and provide important open space and wildlife values to Merced County. Open space is protected by wildlife refuges, wildlife areas, ecological reserves, wildlife management areas, and California state parks.

Most of the land along the San Joaquin River from Friant Dam to the Merced River is privately owned. Publicly owned and managed lands include the U.S. Fish and Wildlife Service's San Luis National Wildlife Area and Grasslands Wildlife Management Area; the CDFW's North Grasslands Wildlife Area; and the California State Parks' San Joaquin River Ecological Reserve, Great Valley Grasslands State Park, and George J. Hatfield SRA. Other publicly owned State and county lands include State Lands Commission public trust and fee title lands and lands managed by the Lower San Joaquin River Levee District and Fresno County Parks.

The San Joaquin River portion of the extended study area from Friant Dam to the confluence with the Merced River is now subject to changed instream flows associated with implementing the Settlement. Restoration Flows could change the duration and seasonality of inundation, or soil saturation, which could potentially affect crop production (SJRRP 2012).

Agricultural Resources Agricultural resources in Fresno and Madera counties, which also include Friant Dam to the Merced River area, are described above the "Primary Study Area" section. Therefore, the following discussion summarizes agricultural resources, including Important Farmland and Williamson Act contract lands, in Merced County.

In 2008, DOC estimated that Merced County had approximately 1,160,833 acres of agricultural land, of which approximately 593,491 acres were identified as Important Farmland and 597,392 acres were identified as Grazing Land. In 2010, Merced County had approximately 1,158,988 acres of agricultural land, of which approximately 596,527 acres were identified as Important Farmland and 562,461 acres were identified as Grazing Land. Overall, the Important Farmland acreage increased by approximately 1 percent between 2008 and 2010 as a result of the addition of irrigated row crops and vineyards on lands previously designated as Grazing Land (DOC 2010c).

In Merced County, approximately 467,679 acres of land were under Williamson Act contracts in 2009 (DOC 2010d). As of 2009, approximately 6,081 acres were in the nonrenewal process. No land under Williamson Act contracts entered the nonrenewal process and no contracts were land terminated by nonrenewal expirations (DOC 2010d). Merced County does not participate in the FSZ program.

As described above, the San Joaquin River from Friant Dam to the Merced River is now subject to changed instream flows associated with implementing the Settlement. Restoration Flows could change the duration and seasonality of inundation, or soil saturation, which could potentially affect crop production (SJRRP 2012).

Forestry Resources Forestland along the San Joaquin River from Friant Dam to the Merced River generally consists of riparian forest that has been classified into four major types based on the dominant species: cottonwood riparian forest, willow riparian forest, mixed riparian forest, and valley oak riparian forest. There are no commercial forestry management uses present along this portion of the extended study area; therefore, forestry resources are not discussed further in this section.

San Joaquin River from Merced River to the Delta

This section describes land uses and agricultural and forestry resources in the vicinity of the San Joaquin River from the Merced River to the Delta. The San Joaquin River from the Merced River to the Delta is located in Merced, Stanislaus, San Joaquin, Contra Costa, and Sacramento counties.

The land uses and agricultural and forestry resources are not expected to substantially be directly or indirectly affected because the only changes that occur in this segment would be a change in flows that would be limited to the active stream channel. Therefore, this section briefly discusses land uses and agricultural and forestry resources in the vicinity of the San Joaquin River from the Merced River to the Delta.

Land Use The primary land uses along the San Joaquin River from the Merced River to the Delta are open space, recreational, and agricultural. Annual crops, vineyards, and orchards account for nearly all agricultural land uses in this area.

Urban land uses (e.g., residential, commercial, industrial) account for only a small percentage of land use along the San Joaquin River from the Merced River to the Delta. The river flows adjacent to the Cities of Lathrop and Stockton, and passes near the City of Tracy and the unincorporated community of Grayson.

North of the unincorporated community of Grayson in Stanislaus County is the San Joaquin River NWR. The NWR is

7,000 acres in size and managed with a focus on migratory birds and endangered species (USFWS 2012).

Beyond the City of Stockton, there are many islands located along the San Joaquin River. Land uses on these islands include agriculture, recreation, and open space.

Agricultural Resources Agricultural resources in Merced County are described above. Agricultural resources are also found along the San Joaquin River in Stanislaus, San Joaquin, Contra Costa, and Sacramento counties.

Forestry Resources Forestland along the San Joaquin River from the Merced River to the Delta generally consists of riparian forest that has been classified into four major types based on the dominant species: cottonwood riparian forest, willow riparian forest, mixed riparian forest, and valley oak riparian forest. There are no commercial forestry management uses present along this portion of the extended study area; therefore, forestry resources are not discussed further in this section.

Delta

The Delta falls within Alameda, Contra Costa, Sacramento, San Joaquin, Solano, and Yolo counties. Land use within the Delta includes recreation, agriculture, residential, commercial, wildlife habitat, and public facilities (Delta Protection Commission 2014). The history of the Delta is closely tied to its abundance of rich agricultural lands. Forestlands within the Delta are limited to small areas of riparian forest.

CVP and SWP Water Service Areas

Together, the water service areas of the CVP and SWP cover a large portion of California. Land uses within the CVP and SWP water service areas vary and include residential, commercial, industrial, agriculture, recreational, public facilities, open space, grazing, and timber production.

Environmental Consequences and Mitigation Measures

This section describes the methods of environmental evaluation, assumptions, and specific criteria that were used to determine the significance of impacts on land use planning and agricultural resources. It then discusses the potential impacts of the alternatives and proposes mitigation where appropriate. The potential impacts on land use planning and agricultural resources and associated mitigation measures are summarized in Table 17-5.

Methods and Assumptions

Evaluation of potential impacts on land use planning and agricultural resources was based in part on the following planning documents pertaining to the Study Area:

- *Fresno County General Plan* (Fresno County 2000a, 2000b)
- *Madera County General Plan Policy Document* (Madera County 1995)
- *BLM Bakersfield Proposed Resource Management Plan* (BLM 2012)
- *Millerton Lake Land Resource Management Plan and General Plan* (Reclamation and State Parks 2010).

Information for this analysis was supplemented through review of aerial imagery, field reconnaissance review, and consultation and coordination with appropriate agencies. The Important Farmland maps of DOC and California Land Conservation Act (Williamson Act) maps for Fresno and Madera counties were used to determine the agricultural significance of the lands in the primary and extended study areas. The area and distribution of riparian forests are based on review of aerial photographs, studies by DWR (2002), and GIS data.

Criteria for Determining Significance of Impacts

An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental impacts that would be caused by, or result from, the No Action Alternative or implementing any action alternative. Under NEPA, the severity and context of an impact must be characterized. An environmental document prepared to comply with CEQA must identify the potentially significant environmental impacts of a proposed project. A “[s]ignificant 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 impacts (State CEQA Guidelines, Section 15126.4[a]).

Table 17-5. Summary of Impacts and Mitigation Measures for Land Use Planning and Agricultural Resources

Impact	Study Area	Alternative	Level of Significance Before Mitigation	Mitigation Measure	Level of Significance After Mitigation
LUP-1: Disruption of Existing Land Uses	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	PS	LUP-1: Implement Mitigation Measure TRN-2, Implement a Traffic Management Plan	PSU
		Alternative Plan 2	PS		PSU
		Alternative Plan 3	PS		PSU
		Alternative Plan 4	PS		PSU
		Alternative Plan 5	PS		PSU
	Extended Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI
LUP-2: Conflict with Adopted Plans	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	PS	LUP-2: Conduct Conflict Resolution with Land Managers	PSU
		Alternative Plan 2	PS		PSU
		Alternative Plan 3	PS		PSU
		Alternative Plan 4	PS		PSU
		Alternative Plan 5	PS		PSU
	Extended Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI

Table 17-5. Summary of Impacts and Mitigation Measures for Land Use Planning and Agricultural Resources (contd.)

Impact	Study Area	Alternative	Level of Significance Before Mitigation	Mitigation Measure	Level of Significance After Mitigation
LUP-3: Conversion of Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	PS	LUP-3: Protect Agricultural Land Productivity	PSU
		Alternative Plan 2	PS		PSU
		Alternative Plan 3	PS		PSU
		Alternative Plan 4	PS		PSU
		Alternative Plan 5	PS		PSU
	Extended Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI
LUP-4: Conversion of Forest Land	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	PS	None Available	PSU
		Alternative Plan 2	PS		PSU
		Alternative Plan 3	PS		PSU
		Alternative Plan 4	PS		PSU
		Alternative Plan 5	PS		PSU
	Extended Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI

Key:
NI = no impact
PS = potentially significant
PSU = potentially significant and unavoidable

The thresholds of significance for impacts are based on the environmental checklist in Appendix G of the State CEQA Guidelines, as amended. These thresholds also encompass the factors taken into account under NEPA to determine the significance of an action in terms of its context and the intensity of its impacts. Based on these criteria, impacts on land use planning and agricultural resources would be significant if implementing an alternative under consideration would do any of the following:

- Physically divide an established community or disrupt existing land uses
- Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project adopted for the purpose of avoiding or mitigating an environmental impact
- Conflict with any applicable HCP or Natural Community Conservation Plan
- Convert Important Farmland (i.e., Prime Farmland, Unique Farmland, or Farmland of Statewide Importance), as shown on the maps prepared pursuant to the FMMP of the California Resources Agency, to nonagricultural use
- Conflict with existing zoning for agricultural use or a Williamson Act contract
- Conflict with existing zoning for, or cause rezoning of, forestland (as defined in PRC Section 12220[g]), timberland (as defined in PRC Section 4526), or timberland zoned Timberland Production (as defined in PRC Section 51104[g])
- Result in the loss of forestland or conversion of forestland to nonforest use
- Involve other changes in the existing environment that, because of their location or nature, could result in conversion of Important Farmland to nonagricultural use or the substantial diminishment of agricultural land resource quality or importance

Conflicts with applicable land use plans are not necessarily adverse alterations of the physical environment and thus not necessarily impacts. Therefore, with regard to applicable land use plans, conclusions are "consistent" or "inconsistent" not "less than significant," "potentially significant," or "significant." If the inconsistency relates to a plan, policy, or regulation adopted to avoid environmental impacts, then an inconsistency could result in a significant impact under CEQA.

Topics Eliminated from Further Consideration

The primary study area is not located within an HCP or Natural Community Conservation Plan area; therefore, no impacts related to this threshold would occur under any alternative and no further discussion of this issue is necessary.

Implementing any action alternative would increase the amount of water available for delivery from Millerton Lake. Portions of this water would be conveyed directly to Friant Division contractors or down the San Joaquin River and rediverted or exchanged for delivery to SOD CVP and SWP contractors. The conveyance of these water supplies would not exceed channel capacity of the San Joaquin River or Delta waterways. No change in existing use of adjacent lands would occur. Additional flows within the San Joaquin River and the Delta would not affect land use, agriculture, or forestry resources because increased reliability of existing water supplies would not necessitate changes in land use patterns, nor would the flows be sufficient to support increased production of agricultural or forestry resources. Therefore, none of the action alternatives would impact land use, agriculture, or forestry resources found in the San Joaquin River or Delta when compared to the No Action Alternative. The land use, agriculture, and forestry resources found in these areas are not discussed further in this analysis.

As described in Chapter 14, "Hydrology – Surface Water Supplies and Facilities Operations," of this Draft EIS, implementing any action alternative would increase water reliability for the Friant Division and/or SOD CVP and SWP contractors during most water-year types. The delivery of this additional water would not exceed historical maximum deliveries or existing contracted water volumes, result in placing new land into agricultural production, change cropping patterns, or result in other physical changes to the environment. Additional deliveries to the CVP and SWP water service areas would not affect land use, agriculture, or forestry resources because the potential increased supplies would not be sufficient to support a change in land use patterns, additional growth or additional agriculture or forestry operations. Therefore, no action alternative would impact land use, agriculture, and forestry resources found in the CVP or SWP water service areas when compared to the No Action Alternative. The land use, agriculture, and forestry resources found in these areas are not discussed further in this analysis.

Direct and Indirect Impacts

This section describes the environmental consequences of implementing any alternative. Where the action alternatives would have identical or nearly identical impacts regardless of which action alternative is implemented, the action alternatives are described together. Where impacts would differ, the action alternatives are described separately.

Impact LUP-1: Disruption of Existing Land Uses

Primary Study Area

No Action Alternative   Under the No Action Alternative, no new facilities would be constructed, and no existing facilities would be expanded, altered, or demolished. Future development of lands in Fresno and Madera counties would conform to the respective county general plans. Such development is not expected to physically divide communities established in the primary study area. No changes or only minor changes to land use or acreage of agricultural lands would occur. Federal lands being managed in accordance with adopted resource management plans would not be subject to any substantial change from their current use.

There would be **no impact** under the No Action Alternative.

Action Alternatives   Construction of the proposed Temperance Flat RM 274 Dam, relocation of transmission lines, and construction and operation of project access roads, recreational facilities, the aggregate quarry, and the batch plant would not physically divide an established community; however, the establishment of these facilities could result in short-term and long-term disruptions to existing land uses by interfering with the ability to access or use certain lands within the primary study area.

The proposed Temperance Flat RM 274 Reservoir would extend approximately 18.5 miles from RM 274 upstream to Kerckhoff Dam. Inundation of this 18.5-mile stretch would affect existing San Joaquin River crossings, trails, and roads that would be within the inundation area following reservoir filling.

As previously described and shown in Figure 17-1, land use in and surrounding the primary study area in Fresno County is predominantly designated agricultural and the primary study area in Madera County are predominantly designated as open space. The aggregate quarry, batch plant, and haul road proposed under Option A located within Madera county are on land currently identified by Madera County as public open space. The aggregate quarry, batch plant, and haul road proposed under Options B and C located within Fresno County are on land currently identified by Fresno County as agricultural.

The significance of disruptions to existing land uses was assessed based on the magnitude of the proposed disruption. For example, the change of an industrial use to commercial use within an area of predominantly commercial use would not be a significant impact. However, the change of a residential parcel to industrial use within an area of single-family homes would have a major impact. Implementing any action alternative would permanently change existing land uses, such as recreational land that would be inundated, and would not allow some lands to be used consistent with current planning designations.

This impact would be **potentially significant** under the action alternatives. Mitigation for this impact is proposed below in the Mitigation Measures section.

Impact LUP-2: Conflict with Adopted Plans

Primary Study Area

No Action Alternative Under the No Action Alternative, no new facilities would be constructed, and no existing facilities would be expanded, altered, or demolished. No changes or only minor changes to land use or acreage of agricultural lands would occur. Future development of private lands would be consistent with the applicable plans of Fresno and Madera counties. Federal lands being managed in accordance with adopted resource management plans would not be subject to any substantial change from their current use.

There would be **no impact** under the No Action Alternative.

Action Alternatives Implementing any action alternative would result in inundation of land along the San Joaquin River between RM 274 and Kerckhoff Dam, as well as relocation of transmission lines, construction and operation of roads, recreational facilities, the aggregate quarry, and the batch plant. These activities could conflict with adopted land use plans, policies, goals, or ordinances of affected jurisdictions.

As discussed in the Affected Environment section above, much of the land within the primary study area is owned by Federal, State, or tribal agencies. For this reason, land owned by these agencies is subject to the plans, policies, goals, and regulations of each agency/owner.

The action alternatives would affect resources covered by the following adopted land use plans, policies, goals, or ordinances:

- **BLM Bakersfield Proposed Resource Management Plan –** Much of the land at the northern end of the primary study area is administered by BLM. In 2010, BLM determined that 5.4 miles of the San Joaquin River from the Kerckhoff Dam downstream to the Kerckhoff Powerhouse was eligible and suitable for designation as a Federal Wild and Scenic River based on its free-flowing character and outstandingly remarkable values. The proposed RMP would establish a corridor along this portion of the river wherein future actions that would alter the free-flowing nature, diminish the stream's ORVs, or otherwise modify the level of watershed development to a degree that would change the classification would require congressional approval. Implementing any action alternative would result in inconsistency with the proposed RMP, particularly the determination that the San Joaquin River downstream from Kerckhoff Dam is suitable and eligible for wild and scenic river status. The inconsistency between the action alternatives and the BLM RMP involves a conflict of policies to protect the ORVs maintained by the free-flowing San Joaquin River.

- **Millerton Lake Resource Management Plan and General Plan –** Much of the primary study area between Friant Dam and BLM-administered land falls within the Millerton Lake SRA. The BLM's SJRG SRMA RMP/general plan prepared for Millerton Lake states that the agreement between Reclamation and State Parks allows for recreation that is consistent with the primary purpose of the project for water supply (Reclamation and State Parks 2010). Because use of

Reclamation land as part of the Millerton Lake SRA is based on the primary purpose of water supply, use of land within the Millerton Lake SRA for the proposed dam would not be inconsistent with the Millerton Lake RMP/general plan.

- **Big Table Mountain Ecological Reserve –** As shown in Figure 17-2, CDFW owns and manages an area of land in the primary study area known as the Big Table Mountain Reserve. Implementing any action alternative would include direct impacts on this land, including relocation of trails across reserve land. Additionally, trees and vegetation could be removed as part of project construction. Implementing any action alternative would be inconsistent with the ecological reserve.

This impact would be **potentially significant** under the action alternatives. Mitigation for this impact is proposed below in the Mitigation Measures section.

Impact LUP-3: Conversion of Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts

Primary Study Area
No Action Alternative Under the No Action Alternative, no new facilities would be constructed, and no existing facilities would be expanded, altered, or demolished. No changes or only minor changes to land use or acreage of agricultural lands would occur. Future development of private lands is not expected to conflict with established Williamson Act contracts unless the contracts are cancelled by the respective county. The conversion of existing farmlands would not take place unless authorized by the respective county general plan. Federal lands being managed in accordance with adopted resource management plans would not be subject to any substantial change from their current use.

There would be **no impact** under the No Action Alternative.

Action Alternatives As previously discussed in the Affected Environment section, implementing any action alternative would result in inundation of agricultural lands. None of the land within the primary study area is classified as Important Farmland. However, as shown in Figure 17-4, Williamson Act lands and FSZ (also known as Super Williamson Act lands) lands within the primary study area would be inundated or otherwise used for the project.

Approximately 856 acres of land under Williamson Act contracts and approximately 91 acres of FSZ lands are located within the primary study area. Of these amounts, 433 acres of land under Williamson Act contracts and 5 acres within an FSZ would be subject to inundation under any action alternative. The area of project features, excluding the new transmission line corridor, consists of 161 acres of land under Williamson Act contracts. This total includes land under Williamson Act contracts that would be used for permanent access roads, the intake structure, construction staging areas, and the relocated transmission line. Agricultural land within the primary study area would likely be precluded from future agricultural productivity because the land would be inundated or include project features, such as roads, trails, and/or other recreational features.

The new transmission line corridor includes 79 acres of land under Williamson Act contracts and 80 acres within the FSZ. Much of the agricultural lands within the transmission line corridors would be only temporarily affected, with most of the ground-disturbing impacts ending on completion of construction.

This impact would be **potentially significant**. Mitigation for this impact is proposed below in the Mitigation Measures section.

Impact LUP-4: Conversion of Forest Land

Primary Study Area

No Action Alternative Under the No Action Alternative, no new facilities would be constructed, and no existing facilities would be expanded, altered, or demolished. No changes or only minor changes to land use or acreage of forestlands would occur. Federal lands being managed in accordance with adopted resource management plans would not be subject to any substantial change from their current use.

There would be **no impact** under the No Action Alternative.

Action Alternatives As discussed above in the Affected Environment section, approximately 5,850 acres of upland woodland are located within the primary study area. PRC Section 12220 defines forestland as land that can support native tree cover under natural conditions and can be managed for one or more forest resources. The upland woodland meets the criteria in PRC Section 12220 and is therefore considered forestland for purposes of this Draft EIS.

Implementing any action alternative would involve clearing approximately 5,110 acres of forestland within the new reservoir inundation zone and areas to be used for project features, including roads, trails, the quarry, and the batch plant. The conversion of these forestlands would be permanent and constitute a loss in timber production.

This impact would be **potentially significant** under the action alternatives. No feasible avoidance or minimization measures are available to reduce this impact below the level of significance. Mitigation for this impact is not proposed because no feasible mitigation is available to reduce the impact to a less-than-significant level.

Mitigation Measures

This section discusses mitigation measures for each significant impact described in the Direct and Indirect Impacts section, as presented in Table 17-5.

No mitigation is required for Impacts LUP-1 through LUP-4 in the extended study area because there would be no impact under any action alternative in the extended study area.

Impact LUP-4 within the primary study area would be potentially significant. No feasible mitigation measures are available at the time of preparation of this Draft EIS to reduce this impact to a less-than-significant level. Therefore, Impact LUP-4 (within the primary study area) would be **potentially significant and unavoidable**.

Impacts LUP-1, LUP-2, and LUP-3 within the primary study area would be significant or potentially significant. The following Mitigation Measures LUP-1, LUP-2, and LUP-3 are required for Impacts LUP-1, LUP-2, and LUP-3, respectively, in the primary study area for all action alternatives. Implementing Mitigation Measures LUP-1, LUP-2, and LUP-3 would reduce these impacts, but not to a less-than-significant level. No additional feasible mitigation measures are available at the time of preparation of this Draft EIS to further reduce these impacts to a less-than-significant impact. Therefore, Impacts LUP-1, LUP-2, and LUP-3 (within the primary study area) would be **potentially significant and unavoidable**.

Mitigation Measure LUP-1: Implement Mitigation Measure TRN-2, Implement a Traffic Management Plan

Impacts on existing land uses would be minimized by preparing and implementing a traffic management plan to reduce construction-related traffic impacts on the roadways at or near the work site. The traffic management plan would help ensure connectivity within the Study Area, thereby minimizing impacts on the existing community. As described in Chapter 22, Recreational facilities that would be closed because of project construction would be relocated and reopened following the conclusion of construction activities.

Implementing Mitigation Measure LUP-1 would reduce Impact LUP-1, but not to a less-than-significant level. No additional feasible mitigation measures are available at the time of preparation of this Draft EIS to further reduce this impact to a less-than-significant level. Therefore, Impact LUP-1 (within the primary study area) would be **potentially significant and unavoidable**.

Mitigation Measure LUP-2: Conduct Conflict Resolution with Land Managers

To minimize or avoid conflict with adopted land use plans, goals, policies, and ordinances of affected jurisdictions, Reclamation will consult with BLM and CDFW, and enter into agreements, as appropriate, to resolve potential conflicts with the BLM Bakersfield Proposed Resource Management Plan and the Big Table Mountain Ecological Reserve, respectively.

Implementing Mitigation Measure LUP-2 would reduce Impact LUP-2, but not to a less-than-significant level. No additional feasible mitigation measures are available at the time of preparation of this Draft EIS to further reduce this impact to a less-than-significant level. Therefore, Impact LUP-2 (within the primary study area) would be **potentially significant and unavoidable**.

Mitigation Measure LUP-3: Protect Agricultural Land Productivity

To reduce impacts on land under a Williamson Act contract or within an FSZ, Reclamation will minimize development on such lands under a Williamson Act contract or within an FSZ. Reclamation will coordinate with landowners and agricultural operators to sustain existing agricultural operations, at the landowners’ discretion, until the individual agricultural parcels are needed for project purposes.

Implementing Mitigation Measure LUP-3 would reduce Impact LUP-3, but not to a less-than-significant level. No additional feasible mitigation measures are available at the time of preparation of this Draft EIS to further reduce this impact to a less-than-significant level. Therefore, Impact LUP-3 (within the primary study area) would be **potentially significant and unavoidable**.

Chapter 18
Noise and Vibration

This chapter describes the affected environment for noise and vibration, as well as potential environmental consequences and associated mitigation measures, as they pertain to implementing the alternatives. The discussion of noise focuses on the primary study area (area of project features, the Temperance Flat Reservoir Area, and Millerton Lake below RM 274). It also discusses the extended study area (San Joaquin River from Friant Dam to the Merced River, the San Joaquin River from the Merced River to the Delta, the Delta, and the CVP and SWP water service areas). Noise and vibration fundamentals are presented in the Physical Resources Appendix.

Affected Environment

This section describes the affected environment related to noise and vibration.

Noise Descriptors

The selection of a proper noise descriptor for a specific source depends on the spatial and temporal distribution, duration, and fluctuation of the noise. The noise descriptors most often encountered when dealing with traffic, community, and environmental noise are defined below (Caltrans 2009):

- **L_{max} (maximum noise level) –** The maximum noise level during a specific period of time. The L_{max} may also be referred to as the "highest (noise) level."

- **L_{min} (minimum noise level) –** The minimum noise level during a specific period of time.

- **L_X (statistical descriptor) –** The noise level exceeded X percent of a specific period of time.

- **L_{eq} (equivalent noise level) –** The energy mean (average) noise level. The instantaneous noise levels during a specific period of time in dBA are converted to relative energy values. From the sum of the relative energy values, an average energy value is calculated, which is then converted back to dBA to determine the L_{eq}.

- **L_{dn} (day-night noise level)** – The 24-hour L_{eq} with a 10-dBA "penalty" for the noise-sensitive hours between 10 p.m. and 7 a.m. The L_{dn} attempts to account for the fact that noise during this specific period of time is a potential source of disturbance with respect to normal sleeping hours.

- **CNEL (community noise equivalent level)** – A noise level similar to the L_{dn} described above, but with an additional 5-dBA "penalty" for the noise-sensitive hours between 7 p.m. and 10 p.m., which are typically reserved for relaxation, conversation, reading, and television. If the same 24-hour noise data are used, the CNEL is typically approximately 0.5 dBA higher than the L_{dn}.

- **SEL (single-event (impulsive) noise level)** – A receiver's cumulative noise exposure from a single impulsive-noise event, which is defined as an acoustical event of short duration and which involves a change in sound pressure above some reference value.

Existing Noise Sources and Levels

The primary study area largely consists of vacant property. The existing ambient noise environment in the immediate vicinity is consistent with that of typical rural areas and is defined primarily by human (e.g., people walking and talking, yard maintenance equipment, dogs barking) and natural sounds, (e.g., wind, birds), but is also affected by local roadway traffic and boats in Millerton Lake. To describe ambient noise levels in the primary study area, seven short-term and two long-term (24-hour) ambient noise measurements were conducted throughout the primary study area. Sound level measurement locations are shown on Figure 18-1. Table 18-1 summarizes the seven short-term measurements. Table 18-2 summarizes the two 24-hour, long-term measurements. Figure 18-2 and Figure 18-3 depict how noise levels change over the 24-hour period that the long-term measurements were collected.

Table 18-1. Summary of Short-Term Existing Ambient Noise Level Measurements

Location[1]	Date/Start Time	Duration (minutes)	Noise Source(s)	Noise Level, decibels, A-weighted (dBA)		
				L_{min}	L_{eq}	L_{max}
Site ST1	August 8, 2013/ 1:50 PM	15	Occasional car drive-by, boat noise from lake, natural sources such as birds, leaves in the wind, and yard maintenance noise.	36.0	47.7	78.4
Site ST2	August 8, 2013/ 12:45 PM	20	Occasional car drive-by, boat noise from lake, natural sources such as birds, leaves in the wind, and yard maintenance noise.	31.4	58.5	86.4
Site ST3	August 8, 2013/ 11:40 AM	20	Occasional car drive-by, boat noise from lake, natural sources such as birds, leaves in the wind, and yard maintenance noise.	30.2	41.3	57.4
Site ST4	August 9, 2013/ 10:15 AM	15	Humming/vibration from powerhouse was audible. Primary noise was natural noise such as river water movement, wind, birds	42.2	45	56
Site ST5	August 9, 2013/ 10:45 AM	10	20 feet from switching station. Powerhouse was running. Noise was similar to HVAC units.	73.5	74.3	75.7
Site ST6	August 9, 2013/ 11:05 PM	15	Close to river bank. Powerhouse was not audible. Primary noise sources included flowing river water, wind, birds.	50.2	51.4	56
Site ST7	August 9, 2013/ 12:10 PM	15	Occasional car drive-by, boat noise from lake, natural sources such as birds, leaves in the wind, and yard maintenance noise.	34.7	49	74.7

Notes:
[1] Site numbers correspond to locations shown in Figure 18-1.

Key:
dBA = A-weighted decibels
L_{eq} = energy-equivalent noise level
L_{max} = maximum noise level
L_{min} = minimum noise level

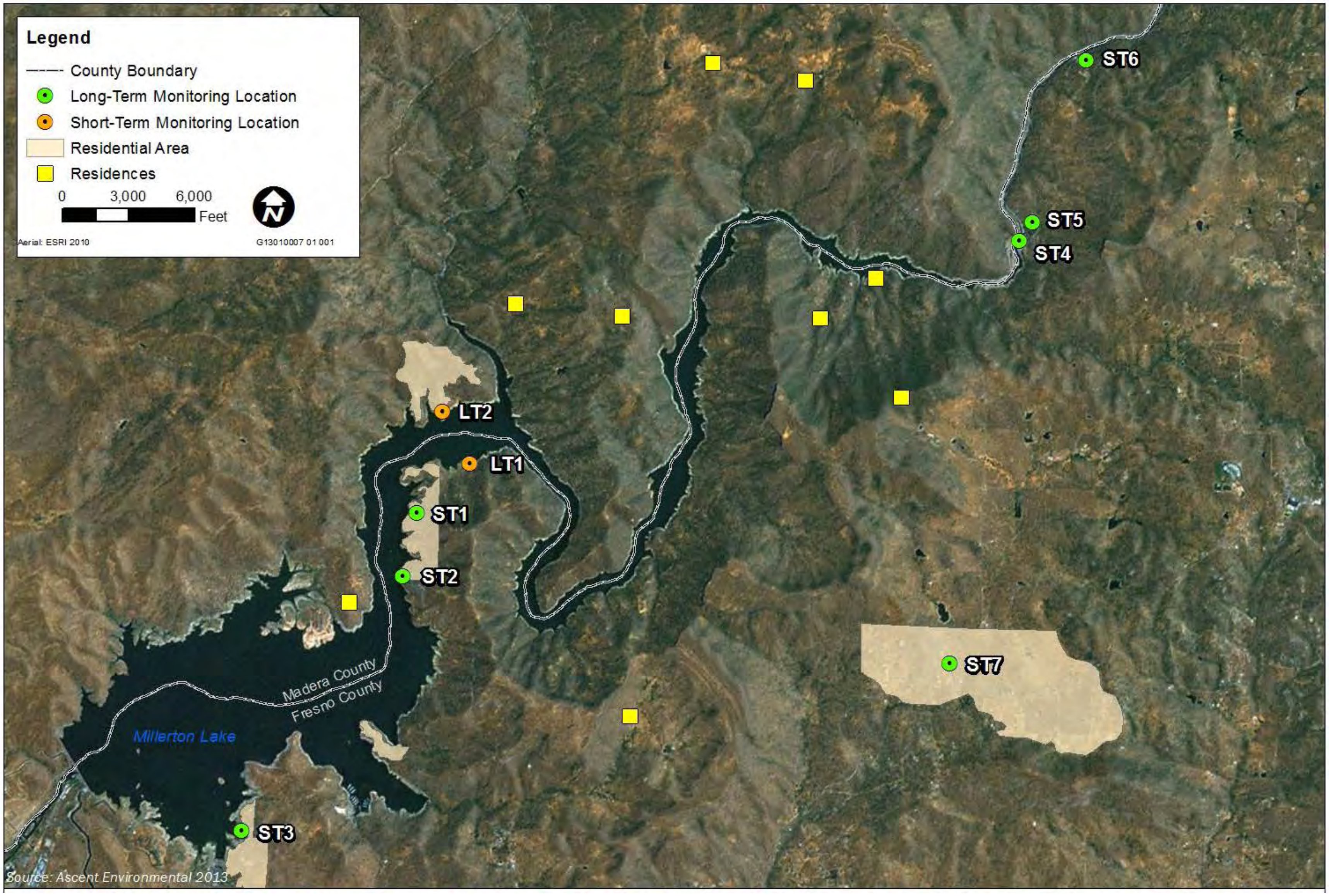


Figure 18-1. Noise Measurement Locations and Noise-Sensitive Receptor Locations

Table 18-2. Summary of Long-Term Existing Ambient Noise Level Measurements

Location[1]	Start Time (date/time)	Notes/Noise Source(s)	Noise Level (dBA) CNEL/ L_{dn}	Daytime L_{min}	Daytime L_{max}	Nighttime L_{min}	Nighttime L_{max}
Site LT1[2]	August 8, 2013/5:00 PM	Located in the Hidden Lake Estate residential neighborhood in Madera County. Noise sources included birds, leaves in the wind, yard maintenance equipment, the occasional car on residential streets, and boat noise during the day.	47.4/ 46.0	33.3	78.9	34.3	48.2
Site LT2[2]	August 9, 2013/ 6:00 PM	Located on the Fresno County side of Millerton Lake near the proposed dam construction site. Noise sources included birds, leaves in the wind, and people walking, swimming and talking. Boat noise was audible during the day.	46.0/ 45.9	17.9	70.3	30.1	53.0

Notes:

[1] Site numbers correspond to locations shown in Figure 18-1.

[2] Figures 18-3 and 18-4 depict how noise levels changed over the 24-hour period Long-Term Measurements 1 and 2, respectively.

Key:
CNEL = community noise equivalent level
dBA = A-weighted decibels
L_{dn} = day-night noise level
L_{max} = maximum noise level
L_{min} = minimum noise level

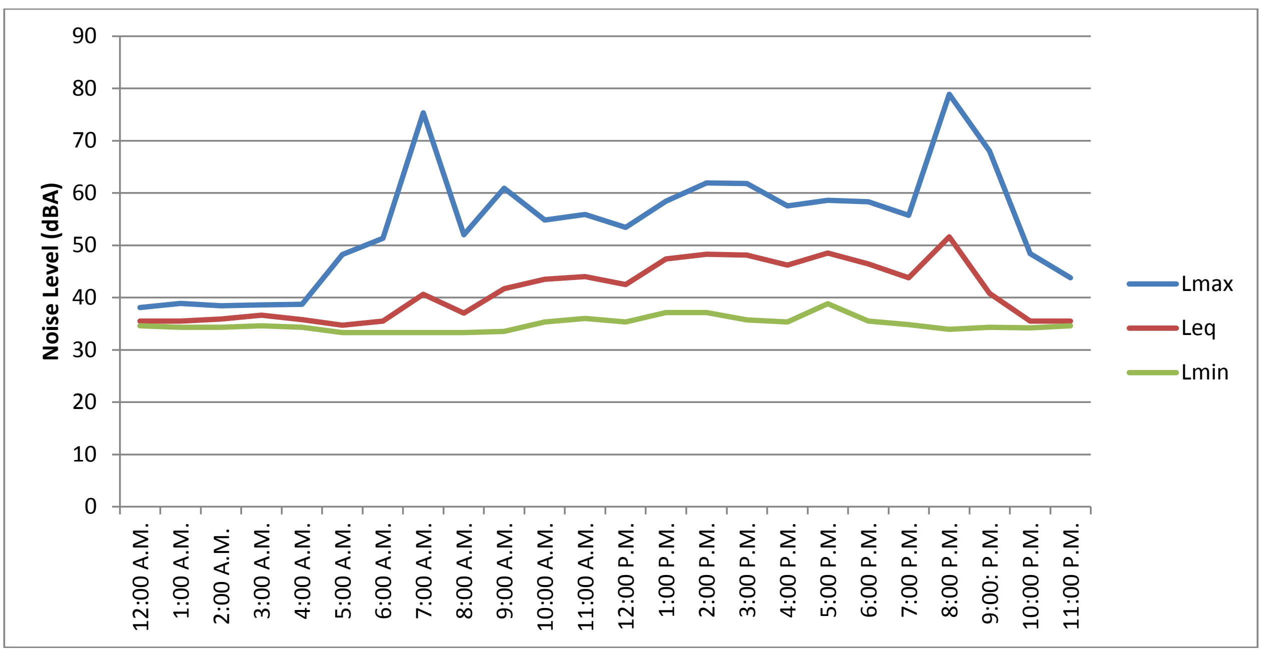


Figure 18-2. Hourly Summary of Long-Term Measurement 1

Figure 18-3. Hourly Summary of Long-Term Measurement 2

Existing Noise-Sensitive Land Uses

Noise-sensitive land uses generally include those uses where noise exposure could result in health-related risks to individuals, as well as places where quiet is an essential element of their intended purpose. Residential dwellings are of primary concern because of the potential for increased and prolonged exposure of individuals to both interior and exterior noise levels. Schools, historic sites, cemeteries, and recreation areas are also generally considered sensitive to increases in exterior noise levels. Places of worship, and other similar places where low interior noise levels are of great importance, are also considered noise sensitive. Noise-sensitive land uses are also considered to be sensitive to ground vibration, which can result in human annoyance. Commercial and industrial buildings where ground vibration (including vibration levels that may be well below those associated with human annoyance) could interfere with operations within the building would be most sensitive to ground vibration.

Land uses in the vicinity of the primary study area are shown and described in Chapter 17, “Land Use Planning and Agricultural Resources.” These include residences scattered around Millerton Lake and the community of Friant, to the southwest. Residences in Fresno County closest to the area of project features include homes on portions of Sky Harbour Road (and adjacent streets) north of Table Mountain

Rancheria, houses along Sky Harbour Drive (a separate street from Sky Harbour Road), and rural residences near the northern portion of Wellbarn Road.

Residences in Madera County include a house on Dumna Island, homes at Hidden Lake Estates, a house on Ralston Way, and a house located north of the proposed aggregate quarry.

Schools in the area include Auberry School on Wellbarn Road, New Life Christian Academy on Auberry Road, and Foothill Elementary School on Auberry Road – all in Fresno County; and Minarets High School on North Fork Road and Spring Valley Elementary School, located near the junction of Highway 41 and North Fork Road (County Road 200) – both in Madera County.

Extended Study Area

Noise sources within the extended study area range from those typically discussed above for the primary study area, to state and interstate highways, aircrafts, and construction activity. Sensitive receptors in the extended study area would not be affected by noise generated by the action alternatives. Due to the local nature of noise impacts, no noise-related effects are anticipated in the extended study area under the action alternatives. Therefore, the extended study area is not discussed further in this chapter.

Environmental Consequences and Mitigation Measures

This section describes potential environmental consequences to the noise environment that could result from implementing any alternative. It also describes the methods of environmental evaluation, assumptions, and specific criteria that were used to determine the significance of impacts on noise-sensitive receptors. It then discusses the potential impacts and proposes mitigation where appropriate. The potential noise impacts and associated mitigation measures are summarized in Table 18-3.

Table 18-3. Summary of Impacts and Mitigation Measures for Noise and Vibration

Impact	Study Area	Alternative	Level of Significance Before Mitigation	Mitigation Measure	Level of Significance After Mitigation
NOI-1: Exposure of Sensitive Receptors to Noise Generated by Facility Construction	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	S	NOI-1: Implement Measures to Prevent Exposure of Sensitive Receptors to Temporary Construction Noise at Project Construction Sites	SU
		Alternative Plan 2	S		SU
		Alternative Plan 3	S		SU
		Alternative Plan 4	S		SU
		Alternative Plan 5	S		SU
	Extended Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI
NOI-2: Construction-Generated Ground Vibration	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	LTS		LTS
		Alternative Plan 2	LTS		LTS
		Alternative Plan 3	LTS		LTS
		Alternative Plan 4	LTS		LTS
		Alternative Plan 5	LTS		LTS
	Extended Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI
NOI-3: Exposure of Sensitive Receptors in the Primary Study Area to Construction-Related Traffic Noise	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	S	NOI-3: Install Sound Barriers along County Road 211 and County Road 210, and Restrict Truck Hauling on Public Roads to the Less-Sensitive Daytime Hours	SU
		Alternative Plan 2	S		SU
		Alternative Plan 3	S		SU
		Alternative Plan 4	S		SU
		Alternative Plan 5	S		SU
	Extended Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI

Table 18-3. Summary of Impacts and Mitigation Measures for Noise and Vibration (contd.)

Impact	Study Area	Alternative	Level of Significance Before Mitigation	Mitigation Measure	Level of Significance After Mitigation
NOI-4: Long-Term Operational Stationary- and Area-Source Noise	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	LTS		LTS
		Alternative Plan 2	LTS		LTS
		Alternative Plan 3	LTS		LTS
		Alternative Plan 4	LTS		LTS
		Alternative Plan 5	LTS		LTS
	Extended Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI
NOI-5: Long-Term Increases in Traffic Noise	Primary Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	S	NOI-5: Implement Measures to Reduce Exposure to Operational Traffic Noise along Wellbarn Road and Smalley Road	SU
		Alternative Plan 2	S		SU
		Alternative Plan 3	S		SU
		Alternative Plan 4	S		SU
		Alternative Plan 5	S		SU
	Extended Study Area	No Action Alternative	NI	None Required	NI
		Alternative Plan 1	NI		NI
		Alternative Plan 2	NI		NI
		Alternative Plan 3	NI		NI
		Alternative Plan 4	NI		NI
		Alternative Plan 5	NI		NI

Key:
NI = no impact
LTS = less than significant
S = significant
SU = significant and unavoidable

Methods and Assumptions

Construction Noise

To assess potential short-term construction noise impacts, sensitive receptors and their relative exposure were identified. Noise levels of specific construction activities were determined and resultant noise levels at those receptors were calculated based on their distance from the noise source, the type of land surface between the noise source and receptor (e.g., vegetated land, water), and the presences of any intervening topography that would effectively act as a noise barrier by blocking the line of sight between the noise source and receptor.

Ground Vibration

Ground vibration impacts were assessed based on existing documentation (e.g., vibration levels produced by specific construction equipment or activities) and the distance to buildings or structures from the given vibration source. Attenuated ground vibration levels at receptors were calculated using formulas and methodologies established by the Federal Transit Administration (FTA) (2006).

Potential long-term operational area-source and stationary-source noise impacts were assessed quantitatively using reference noise levels and attenuation calculations to compare levels of noise exposure at sensitive receptors to applicable noise standards established by Fresno and Madera counties. In addition, the potential for new or relocated transmission lines to produce corona noise that would adversely affect nearby receptors was assessed qualitatively.

Traffic Noise

The Federal Highway Association Traffic Noise Model (FHWA 2006) was used to model traffic noise levels along roadways that would be affected by construction-related worker and truck trips and/or increased operational traffic volumes. Long-term operational increases in visitation would increase because of both improved conditions at Millerton Lake and new recreational opportunities at the new Temperance Flat RM 274 Reservoir. Trip distribution estimates were based on data presented in Chapter 24, “Transportation, Circulation, and Infrastructure.” The project’s contribution to baseline traffic noise levels along area roadways was determined by comparing predicted noise levels at 50 feet from the roadway edge with and without project-generated traffic. Predicted traffic noise levels at particular sensitive receptors were calculated assuming a noise reduction of 3.0 dBA per doubling of distance (dBA/DD) from the roadway. As with the traffic analysis presented in Chapter 24, because the number of truck trips under each action alternative is approximate, for a conservative analysis, construction trips associated with Alternative Plan 4 were used in this analysis to represent all five action alternatives.

Additional analysis is provided to address SELs from truck passbys on public roads during project construction. This analysis identifies an applicable threshold based on relevant court rulings and measured reference SELs from truck passbys.

Criteria for Determining Significance of Impacts

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 environmental impact statement must be prepared. An environmental document prepared to comply with CEQA must identify the potentially significant environmental effects of a proposed project. A "[s]ignificant 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 following significance criteria were developed based on guidance provided by the State CEQA Guidelines, other Federal, State, and local guidance, and consider the context and intensity of the environmental effects as required under NEPA. Impacts of an alternative on noise would be significant if project implementation would do any of the following:

- Expose persons to or generate noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies.
- Expose persons to or generate excessive groundborne vibration or groundborne noise levels.
- Permanently increase ambient noise levels in the project vicinity substantially above levels existing without the project.

- Temporarily or periodically increase ambient noise levels in the project vicinity substantially above levels existing without the project.

- Expose people residing or working in the project area to excessive aircraft-generated noise levels.

For noise-sensitive receptors located in Fresno County, attenuated noise levels were compared to Fresno County's exterior noise level standards of 50 dBA L_{50} (the noise level exceeded 50 percent of a specific period of time) during daytime hours (7 a.m. – 10 p.m.) and 45 dBA L_{50} during nighttime hours (10 p.m. – 7 a.m.), as shown in Table 18-3. However, construction noise generated between the hours of 6:00 AM to 9:00 PM on weekdays or 7:00 AM to 5:00 PM on Saturdays and Sundays is exempt from these standards.

For noise-sensitive receptors located in Madera County, attenuated noise levels were compared to Madera County's maximum allowable hourly L_{eq} standards for non-transportation noise sources of 50 dBA during daytime hours (7 a.m. – 10 p.m.) and 45 dBA during nighttime hours (10 p.m. – 7 a.m.), as shown in Table 18-7. However, based on the general noise regulations in the Section 9.58.020 of the Madera County Noise Ordinance, as described in the regulatory setting above, it is understood that construction noise generated between the hours of 7:00 AM to 7:00 PM on weekdays or 9:00 AM to 5:00 PM on Saturdays is exempt from these standards.

Ground vibration generated by construction activities would be significant if it would expose residential structures or other buildings used by people to ground vibration levels that exceed FTA's maximum acceptable vibration standard of 80 VdB for residential uses (e.g., annoyance, sleep disturbance) (FTA 2006) and/or the perception threshold of 0.1 inches/second peak particle velocity (PPV) established by Madera County General Plan Policy 7.A.9 (Madera County 1995). Because Fresno County does not specify a ground vibration threshold for evaluating the potential of human disturbance, the perception threshold of 0.1 inches/second PPV is used to evaluate the potential for human disturbance at locations in both Madera County and Fresno County. Ground vibration generated by construction activities would also be significant if it would exceed the Caltrans-recommended standard of 0.2 inches/second PPV with respect to the prevention of damage to older residential structures (Caltrans 2004).

For the analysis of both short-term construction-related traffic noise and long-term operational traffic noise resulting from increased recreational use, separate thresholds of significance were applied based on whether the nearest affected noise-sensitive receptor is located in Fresno County or Madera County. Based on the criteria outlined in Policy HS-G.7 of the Fresno General Plan, project-related traffic noise in Fresno County would be significant if it would result in a 5 dBA L_{dn} increase where existing noise levels are less than 60 dBA L_{dn}, a 3 dBA L_{dn} increase where existing noise levels are between 60 and 65 dBA L_{dn}, or a 1.5 dBA L_{dn} increase where existing noise levels are greater than 65 dBA L_{dn} at outdoor activity areas of noise-sensitive uses. Based on Policy 7.A.2 of the Madera County General Plan, traffic noise at noise-sensitive receptors in Madera County would be significant if levels exceed 60 dBA L_{dn} within the outdoor activity areas of existing or planned noise-sensitive-receptors. Because Madera County does not have a stated policy about traffic noise increases, the incremental increase standards of Fresno County are also used to determine the significance of traffic noise increases at noise-sensitive receptors located in Madera County.

In addition, a threshold of 65 dBA SEL is applied to determine whether truck passbys associated with material and equipment hauling on public roadways could result in sleep disturbance at residential dwellings.

The Federal, State, regional, and local policies that support the criteria discussed above are described below.

Federal

To address the human response to groundborne vibration, the FTA of the U.S. Department of Transportation has set forth guidelines for maximum-acceptable vibration criteria for different types of land uses. These criteria include a velocity standard of 65 vibration decibels (VdB) root mean squared (RMS) for land uses where low ambient vibration is essential for interior operations (e.g., hospitals, high-tech manufacturing, and laboratory facilities), 80 VdB for residential uses and buildings where people normally sleep, and 83 VdB for institutional land uses with primarily daytime operations (e.g., schools, churches, clinics, and offices) (FTA 2006).

Standards have also been established to address the potential for groundborne vibration to cause structural damage to buildings. These standards were developed by the Committee of Hearing, Bio Acoustics, and Bio Mechanics at the request of the EPA (FTA 2006). For fragile structures, the Committee of Hearing, Bio Acoustics, and Bio Mechanics recommends a maximum limit of 0.25 in/sec PPV(0.05 meters per second) (National Academy of Sciences 1977).

State

Governor's Office of Planning and Research The Governor's Office of Planning and Research published the *State of California General Plan Guidelines* (OPR 2003), which provides guidance for the acceptability of projects within specific L_{dn} contours. Table 18-4 summarizes acceptable and unacceptable community noise exposure limits for various land use categories.

Table 18-4. State Noise-Compatibility Guidelines by Land-Use Category

Land-Use Category	Community Noise Exposure (CNEL/L_{dn}, dBA)			
	Normally Acceptable[1]	Conditionally Acceptable[2]	Normally Unacceptable[3]	Clearly Unacceptable[4]
Residential – Low-Density Single-Family, Duplexes, Mobile Homes	< 60	55–70	70–75	75+
Residential – Multifamily	< 65	60–70	70–75	75+
Transient Lodging – Motels, Hotels	< 65	60–70	70–80	80+
Schools, Libraries, Churches, Hospitals, Nursing Homes	< 70	60–70	70–80	80+
Auditoriums, Concert Halls, Amphitheaters	NA	< 70	65+	NA
Sports Arenas, Outdoor Spectator Sports	NA	< 75	70+	NA
Playgrounds, Neighborhood Parks	< 70	NA	68–75	72.5+

Table 18-4. State Noise-Compatibility Guidelines by Land-Use Category (contd.)

Land-Use Category	Community Noise Exposure ($CNEL/L_{dn}$, dBA)			
	Normally Acceptable[1]	Conditionally Acceptable[2]	Normally Unacceptable[3]	Clearly Unacceptable[4]
Golf Courses, Riding Stables, Water Recreation, Cemeteries	< 75	NA	70–80	80+
Office Buildings, Businesses, Commercial and Professional	< 70	68–78	75+	NA
Industrial, Manufacturing, Utilities, Agriculture	< 75	70–80	75+	NA

Source: OPR 2003

Notes:
[1] Specified land use is satisfactory, based on the assumption that any buildings involved are of normal conventional construction, without any special noise-insulation requirements.
[2] New construction or development should be undertaken only after a detailed analysis of the noise-reduction requirements is made and needed noise-insulation features are included in the design. Conventional construction, but with closed windows and fresh-air supply systems or air conditioning, will normally suffice.
[3] New construction or development should generally be discouraged. If new construction or development does proceed, a detailed analysis of the noise-reduction requirements must be made and needed noise-insulation features included in the design. Outdoor areas must be shielded.
[4] New construction or development should generally not be undertaken.

Key:
CNEL = community noise equivalent level
dBA = A-weighted decibels
L_{dn} = day-night noise level
NA = not applicable

Generally, residential uses (e.g., mobile homes) are considered to be acceptable in areas where exterior noise levels do not exceed 60 A-weighted decibels (dBA) L_{dn}, (where, as described in the Physical Resources Appendix, the dBA scale discriminates against frequencies in a manner approximating the sensitivity of the human ear when a source is at 50 dBA). Residential uses are normally unacceptable in areas exceeding 70 dBA L_{dn} and conditionally acceptable within 55–70 dBA L_{dn}. Schools are normally acceptable in areas up to 70 dBA L_{dn} and normally unacceptable in areas exceeding 70 dBA L_{dn}. Commercial uses are normally acceptable in areas up to 70 dBA CNEL. Between 67.5 and 77.5 dBA L_{dn}, commercial uses are conditionally acceptable, depending on the noise insulation features and the noise reduction requirements. With respect to water recreation uses, exterior noise levels that do not exceed

75 dBA CNEL/L_{dn} are considered normally acceptable, levels between 70 and 80 dBA CNEL/L_{dn} are normally unacceptable, and levels that exceed 80 dBA CNEL/L_{dn} are clearly unacceptable. The guidelines also present adjustment factors that may be used to arrive at noise-acceptability standards that reflect the noise-control goals of the community, the particular community's sensitivity to noise, and the community's assessment of the relative importance of noise issues.

California Department of Transportation For the protection of fragile, historic, and residential structures, Caltrans recommends a threshold of 0.2 in/sec PPV for normal residential buildings and 0.08 in/sec PPV for old or historically significant structures (Caltrans 2002). These standards are more stringent than the Federal standard established by Committee of Hearing, Bio Acoustics, and Bio Mechanics, presented above.

California Department of Boating and Waterways– Engine Noise Standards Section 654.06 of the Harbors and Navigation Code, which is part of California Boating Law, requires that all motorized recreational vessels sold in California shall not have noise levels at a distance of 50 feet that exceed 86 dBA if manufactured before 1974, 84 dBA if manufactured before 1976, or 82 dBA if manufactured before 1978 (California Department of Boating and Waterways 2012).

Regional and Local

Fresno County General Plan The Fresno County General Plan Health and Safety Element established acceptable noise level limits for both transportation and non-transportation noise sources (Fresno County 2014). The following noise-related policies are applicable to the proposed action:

- **Policy HS-G.2. Acceptable Roadway Noise Levels –** The County shall require new roadway improvement projects to achieve and maintain the normally acceptable noise levels shown in Chart HS-1 [shown in Figure 18-4 of this document].

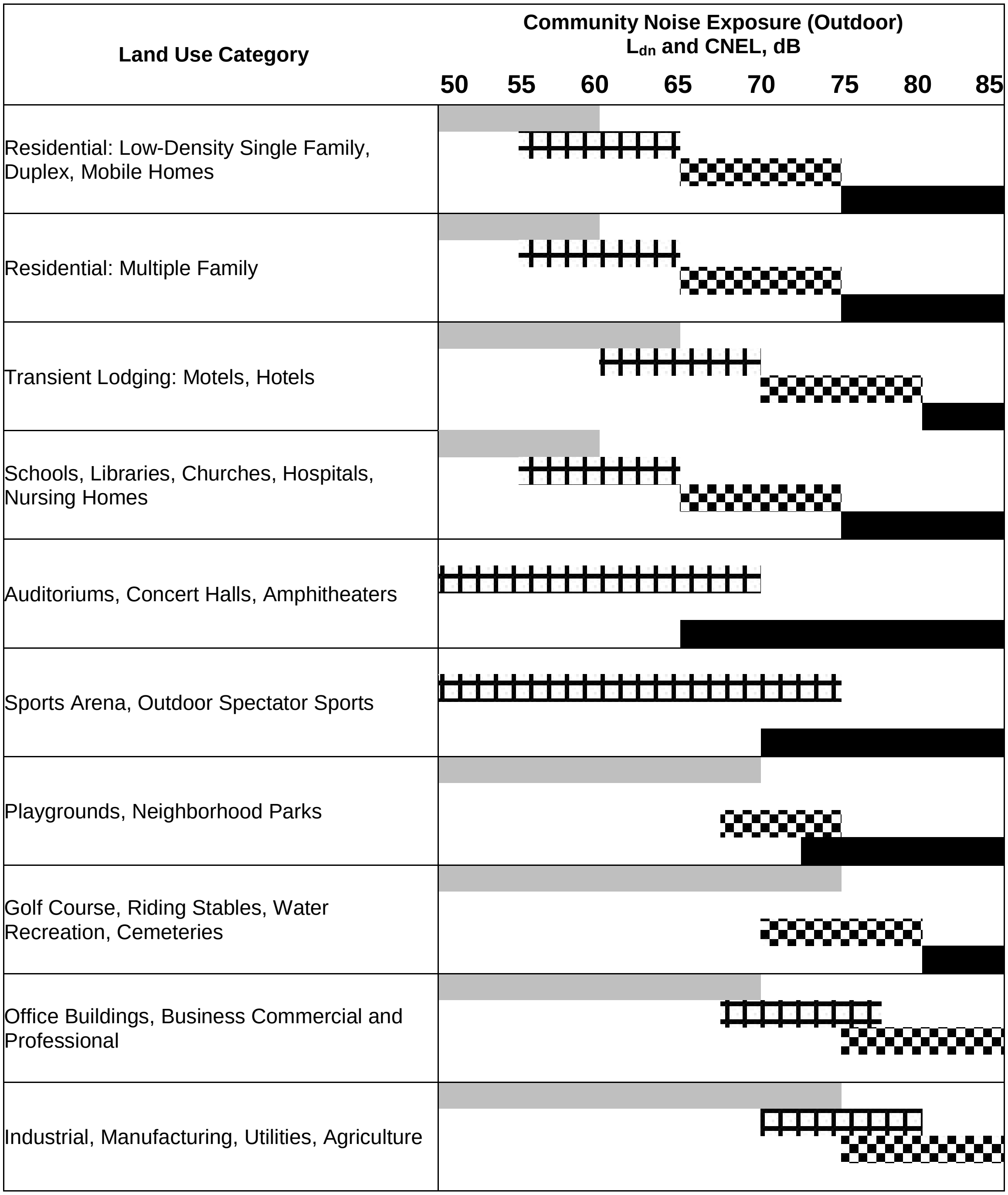
- **Policy HS-G.4. Noise Mitigation Design and Acoustical Analysis –** So that noise mitigation may be considered in the design of new projects, the County shall require an acoustical analysis as part of the environmental review process where:

a. Noise-sensitive land uses are proposed in areas exposed to existing or projected noise levels that are "generally unacceptable" or higher according to the Chart HS-1 [shown in Figure 18-4 of this document];

b. Proposed projects are likely to produce noise levels exceeding the levels shown in the County's Noise Control Ordinance at existing or planned noise-sensitive uses.

- **Policy HS-G.5. Noise Mitigation Measures –** Where noise mitigation measures are required to achieve acceptable levels according to land use compatibility or the Noise Control Ordinance, the County shall place emphasis of such measures upon site planning and project design. These measures may include, but are not limited to, building orientation, setbacks, earthen berms, and building construction practices. The County shall consider the use of noise barriers, such as sound walls, as a means of achieving the noise standards after other design-related noise mitigation measures have been evaluated or integrated into the project.

- **Policy HS-G.6. Construction-Related Noise –** The County shall regulate construction-related noise to reduce impacts on adjacent uses in accordance with the County's Noise Control Ordinance.



	NORMALLY ACCEPTABLE	Specified land use is satisfactory based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements.
	CONDITIONALLY ACCEPTABLE	New construction or development should be undertaken only after a detailed analysis of the noise reduction requirement is made and needed noise insulation features included in the design. Conventional construction, but with closed windows and fresh air supply systems or air conditioning will normally suffice.
	GENERALLY UNACCEPTABLE	New construction or development should generally be discouraged. If new construction or development does proceed, a detailed analysis of the noise reduction requirements must be made and needed noised insulation features included in the design.
	LAND USE DISCOURAGED	New construction or development should generally not be undertaken.

Figure 18-4. Land Use Compatibility for Community Noise Environments, Fresno County

- **Policy HS-G.7. Noise Impacts to Sensitive Land Uses** – Where existing noise-sensitive uses may be exposed to increased noise levels due to roadway improvement projects, the County shall apply the following criteria to determine the significance of the impact:

  - Where existing noise levels are less than 60 dBA L_{dn} at outdoor activity areas of noise-sensitive uses, a 5 dBA L_{dn} increase in noise levels will be considered significant.

  - Where existing noise levels are between 60 and 65 dBA L_{dn} at outdoor activity areas of noise-sensitive uses, a 3 dBA L_{dn} increase in noise levels will be considered significant; and

  - Where existing noise levels are greater than 65 dBA L_{dn} at outdoor activity areas of noise-sensitive uses, a 1.5 dBA L_{dn} increase in noise levels will be considered significant.

- **Policy HS-G.8. Noise Level Compatibility –** The County shall evaluate the compatibility of proposed projects with existing and future noise levels through a comparison to Chart HS-1 [shown in Figure 18-4 of this document].

Fresno County Noise Ordinance The Fresno County Noise Ordinance (Chapter 8.40 of the Fresno County Ordinance Code) is applied to noise sources that can be regulated by local government, such as equipment related to commercial and industrial land uses. The Noise Ordinance does not apply to transportation noise sources such as traffic on public roads, rail operations, and aircraft in flight. Table 18-5 summarizes the Noise Ordinance Standards.

The Fresno County Noise Ordinance also states that it is unlawful for any person, at any location within the unincorporated area of the county to operate or cause to be operated within a dwelling unit, any source of sound or to allow the creation of any noise which causes the noise level when measured inside a receiving dwelling unit situated in either the incorporated or unincorporated are to exceed the noise level standards as set forth in Table 18-6.

Table 18-5. Exterior Noise Level Standards for Non-Transportation Noise Sources, dBA, Fresno County Noise Ordinance

Category	Cumulative Number of Minutes in Any One-Hour Time Period (L_X)	Daytime (7AM – 10PM)	Nighttime (10PM – 7AM)
1	30 (L_{50})	50	45
2	15 (L_{25})	55	50
3	5 ($L_{8.3}$)	60	55
4	1 ($L_{1.7}$)	65	60
5	0 (L_{max})	70	65

Source: Fresno County Ordinance Code 8.40.040

Notes:

In the event the measured ambient noise level exceeds the applicable noise level standard in any category above, the applicable standard shall be adjusted so as to equal the ambient noise level.

Each of the noise level standards specified above shall be reduced by five dBA for simple tone noises, noises consisting primarily of speech or music, or for recurring impulsive noises.

If the intruding noise source is continuous and cannot reasonably be discontinued or stopped for a time period whereby the ambient noise level can be measured, the noise level measured while the source is in operation shall be compared directly to the noise level standards.

Key:
dBA = A-weighted decibel
L_{max} = maximum noise level
L_X = the noise level exceeded X percent of a specific period of time

Table 18-6. Interior Noise Level Standards for Non-Transportation Noise Sources, dBA, Fresno County Noise Ordinance

Category	Cumulative Number of Minutes in Any One-Hour Time Period (L_X)	Daytime (7AM – 10PM)	Nighttime (10PM – 7AM)
1	5 ($L_{8.3}$)	45	35
2	1 ($L_{1.7}$)	50	40
3	0 (L_{max})	55	45

Source: Fresno County Ordinance Code 8.40.050

Notes:

In the event the measured ambient noise level exceeds the applicable noise level standard in any category above, the applicable standard shall be adjusted so as to equal the ambient noise level.

Each of the noise level standards specified above shall be reduced by five dBA for simple tone noises, noises consisting primarily of speech or music, or for recurring impulsive noises.

If the intruding noise source is continuous and cannot reasonably be discontinued or stopped for a time period whereby the ambient noise level can be measured, the noise level measured while the source is in operation shall be compared directly to the noise level standards.

Key:
dBA = A-weighted decibel
L_{max} = maximum noise level
L_X = the noise level exceeded X percent of a specific period of time

Section 8.40.060 of the Fresno County Ordinance Code exempts certain noise-generating activities from the standards listed in Table 18-5 and Table 18-6, including construction activity that takes place during the daytime hours from 6:00 AM to 9:00 PM on weekdays or between the hours of 7:00 AM and 5:00 PM on Saturday and Sunday.

Madera County General Plan Noise Element The Madera County General Plan Noise Element establishes acceptable noise level limits for both transportation and non-transportation noise sources (Madera County 1995). The following policies are relevant to the proposed action:

- **Policy 7.A.2 –** Noise created by new transportation noise sources, including roadway improvement projects, shall be mitigated so as not to exceed 60 dBA L_{dn} within the outdoor activity areas of existing or planned noise-sensitive land uses and 45 dBA L_{dn} in interior spaces of existing or planned noise-sensitive land uses.

- **Policy 7.A.5 –** Noise which will be created by new non-transportation noise sources, or existing non-transportation noise sources which undergo modifications that may increase noise levels, shall be mitigated so as not to exceed the noise level standards of Table 7.A.4 [reproduced as Table 18-7 below] on lands designated for noise-sensitive uses. This policy does not apply to noise levels associated with agricultural operations.

Table 18-7. Maximum Allowable Noise Exposure for Non-Transportation Noise Sources in Madera County

Noise Level[1]	Daytime 7AM – 10PM	Nighttime 10PM – 7AM
Hourly L_{eq}, dB	50	45
Maximum level (L_{max}), dB	70	65

Source: Madera County General Plan 1995.

Note:
[1] As determined at the property line of the receiving land use. When determining the effectiveness of noise mitigation measures, the standards may be applied on the receptor side of noise barriers at the property line. Each of the noise levels specified above shall be lowered by 5 dBA for pure tone noises, noises consisting primarily of speech or music, or for recurring impulsive noises. These noise level standards do not apply to residential units established in conjunction with industrial or commercial uses (e.g., caretaker dwellings).

Key:
dBA= A-weighted decibel
L_{eq} = the average noise level during a specified time period

Madera County General Plan Noise Element - Vibration Standards The Madera County General Plan also contains the following policies regarding exposure to ground vibration (Madera County 1995):

- **Policy 7.A.9 –** Vibration perception threshold: The minimum ground or structure-borne vibrational motion necessary to cause a normal person to be aware of the vibration by such direction means as, but not limited to, sensation by touch or visual observation of moving objects. The perception threshold shall be presumed to be a motion velocity of one-tenth (0.1) inches per second over the range of one to one hundred Hz. (Resolution No. 2010-043)

- **Policy 7.A.10 –** Projects should not be permitted if they result in the] operation or permitting the operation of any device that creates a vibration which is above the vibration perception threshold of an individual at the location where the sensitivity exists such as the property line of a residential development or from the location of residence constructed on agricultural property. (Resolution No. 2010-043)

Madera County Noise Ordinance Section 9.58.020 of the Madera County Code contains general noise regulations for noise sources located within Madera County. This section contains general regulations geared towards residences, schools, generation of motor vehicles, and car horns, but does not contain numeric noise level standards for use in evaluating the compatibility of new projects with its surroundings. Section 9.58.020.G in the general noise regulations states that construction activities are limited to the hours between 7:00 AM and 7:00 PM Monday through Friday and between 9:00 AM to 5:00 PM on Saturdays and construction activities are prohibited on Sundays.

California State Parks Superintendent's Posted Order No. 378-001-12 for the Millerton Lake State Recreation Area The Millerton Lake SRA is managed by State Parks. Day use activities, including the operation of motorized watercraft, is limited to the hours between 6:00 AM and 10:00 PM April 1^{st} through September 30^{th}, 6:00 AM and 7:00 PM October 1^{st} through October 31^{st}, 6:00 AM and 6:00 PM November 1^{st} through February 29^{th}, 6:00 AM and 7:00 PM March 1^{st} through March 31^{st} (State Parks 2012).

Park rangers also enforce boating rules on the lake including those required by California Boating Law, discussed above.

Topics Eliminated from Further Consideration

None of the action alternatives would expose people residing or working in the primary study area to excessive aircraft-generated noise levels because of the distance of existing airports to the primary study area. In addition, none of the action alternatives would place new sensitive receptors near any aircraft-related facilities. There would also be no change in railway traffic as a result of any action alternative. Therefore, potential effects on the primary study area related to these issues are not discussed further in this Draft EIS.

While many materials used during project construction under the action alternatives may be hauled to the city of Fresno by rail, these rail trips would occur on existing rail lines and would not be expected to result in substantial changes to rail noise levels. Therefore, potential effects on the primary and extended study areas related to these issues are not discussed further in this Draft EIS.

Due to the local nature of noise impacts, no noise-related effects are anticipated in the extended study area under the action alternatives, other than in the area from Fresno to the primary study area. Therefore, the effects of noise-related effects between Fresno and the primary study area are described together with the primary study area impacts, and the extended study area is not discussed further in this chapter.

Direct and Indirect Effects

Impact NOI-1: Exposure of Sensitive Receptors to Noise Generated by Facility Construction

Primary Study Area

No Action Alternative No project-related construction activities would occur under the No Action Alternative. Therefore, sensitive receptors would not be exposed to noise generated by facility construction.

There would be **no impact** under the No Action Alternative.

Action Alternatives Construction noise levels in the primary study area would fluctuate depending on the particular type, number, and duration of usage for the varying equipment. The effects of construction noise largely depend on the type of construction activities occurring on any given day; noise levels generated by those activities; distances to noise-sensitive receptors; potential noise-attenuating features such as topography, vegetation, and existing structures; and the existing ambient noise environment in the receptor's vicinity. Construction activities would occur in several discrete stages, each phase requiring a specific complement of equipment with varying equipment type, quantity, and intensity. These variations in operational characteristics of equipment change the effect they have on the noise environment of the area of project features and in the surrounding area for the duration of the construction process.

Construction activities would be concentrated at particular locations, depending on the phase, including the dam site and associated staging area, temporary coffer dams, the aggregate quarry, the batch plant between the dam site and aggregate quarry, the existing powerhouses, the powerhouse, the intake structure, the batch plant between the powerhouse and intake structure, the tunnels, the corridors of new or relocated transmission lines, as well as the construction of temporary haul roads and permanent access roads (see Chapter 2, "Alternatives"). Reference noise levels associated with the construction of these facilities are provided in Table 18-8.

Table 18-8. Construction Activity Noise Levels, dBA

Building Activity	L_{eq} dBA[1]	Reference Distance (feet)
Aggregate Quarry	85	100
Batch Plant	90	50
Building of Haul Road or Access Road	88	50
Coffer Dams	89	50
Dam Site and Staging Area	89	50
Powerhouse	89	50
Reservoir Clearing	83	50
Helicopter Use	72	50

Notes:
[1] Refer to the Physical Resources Appendix for assumptions and sources used to develop these reference noise levels.

Key:
dBA = A-weighted decibel
L_{eq} = the average noise level during a specified time period

Noise-sensitive receptors in Fresno County that could be adversely affected by construction activity at these facility locations include the residences near the intersection of Perkins Avenue and Sky Harbour Road, the residences on streets near the intersection of El Lado Road and Sky Harbour Road, houses near Winchell Bay, and two houses on Sky Harbour Drive (not to be confused with Sky Harbour Road).

Noise-sensitive receptors in Madera County that could be adversely affected by construction activity include the residences in Hidden Lake Estates, a house located on Ralston Way, a house located approximately 3,000 feet north of the northernmost aggregate quarry site (Option A1) proposed under quarry, batch plan, and haul road Option A, and a house on Dumna Island.

Noise exposure levels at each receptor location were estimated for the closest construction activities and are summarized in Table 18-9. The calculations account for the distances between the receptors and nearest construction-related activities, whether the intervening landscape is vegetated land or water, and whether any intervening hills block the line of sight between the receptor and noise source. Detailed calculations and modeling parameters are provided in the Physical Resources Appendix.

Table 18-9. Summary of Modeled Construction Noise Levels at Noise-Sensitive Receptors (dBA L_{eq}/L_{50})

	Noise-Sensitive Receptors in Fresno County					Noise-Sensitive Receptors in Madera County			
Location of Construction-Related Activity[1]	**Houses Near Perkins Avenue**	**Two Houses On Sky Harbour Drive**	**Houses Near El Lado Road**	**Five Houses on North End of Sky Harbour Road**	**Houses on North East Side of Winchell Bay**	**House North of Aggregate Quarry Site under Quarry, Batch Plant, and Haul Road Option A**	**House on Dumna Island**	**Hidden Lake Estates**	**House on Ralston Way**
Building of Access Road #1	32	--[2]	50	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]
Building of Access Road #3	--[2]	--[2]	47	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]
Building of Aggregate Quarry Haul Road north of the proposed dam site	--[2]	--[2]	--[2]	--[2]	--[2]	42	--[2]	41	72
Building of Haul Road from the Staging Area to the Left Abutments of the Dam and Cofferdams	42	--[2]	--[2]	64	--[2]	--[2]	49	54	--[2]

Table 18-9. Summary of Modeled Construction Noise Levels at Noise-Sensitive Receptors (dBA L_{eq}/L_{50}) (contd.)

Location of Construction-Related Activity[1]	Noise-Sensitive Receptors in Fresno County					Noise-Sensitive Receptors in Madera County			
	Houses Near Perkins Avenue	Two Houses On Sky Harbour Drive	Houses Near El Lado Road	Five Houses on North End of Sky Harbour Road	Houses on North East Side of Winchell Bay	House North of Aggregate Quarry Site under Quarry, Batch Plant, and Haul Road Option A	House on Dumna Island	Hidden Lake Estates	House on Ralston Way
Aggregate Quarry (Quarry, Batch Plant, and Haul Road Option A only)	--[2]	--[2]	--[2]	--[2]	--[2]	36	--[2]	38	34
Aggregate Quarry (Quarry, Batch Plant, and Haul Road Option C only)	--[2]	--[2]	--[2]	--[2]	--[2]	43	--[2]	--[2]	--[2]
Batch Plant on Madera County Side (Quarry, Batch Plant, and Haul Road Option A only)	--[2]	--[2]	--[2]	--[2]	--[2]	28	--[2]	42	25
Batch Plant near Dam Staging Area (Quarry, Batch Plant, and Haul Road Options B & C only)	32	--[2]	--[2]	42	--[2]	--[2]	--[2]	--[2]	--[2]
Batch Plant near Diversion Tunnel (Quarry, Batch Plant, and Haul Road Options B & C only)	--[2]	--[2]	33	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]
Coffer Dam, downstream	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]	48	26
Dam Site and Staging Area	38	--[2]	--[2]	37	--[2]	--[2]	--[2]	50	31
Waste Area	--[2]	--[2]	--[2]	--[2]	76	--[2]	--[2]	--[2]	--[2]
Intake Structure	--[2]	25	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]
Powerhouse Area	33	20	41	--	51	--[2]	50	--[2]	--[2]
Transmission Line	--[2]	--[2]	--[2]	--[2]	38	--[2]	--[2]	--[2]	--[2]
Ventilation Shaft	--[2]	27	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]
Reservoir Clearing	--[2]	--[2]	--[2]	--[2]	--[2]	48	--[2]	42	28

Source: Data modeled by Ascent Environmental in 2014.

Table 18-9. Summary of Modeled Construction Noise Levels at Noise-Sensitive Receptors (dBA L_{eq}/L_{50}) (contd.)

Notes:

[1] Locations of construction activity are shown in Chapter 2, “Alternatives.”

[2] Many cells are blank because noise attenuation calculations were only performed for the closest areas of construction activity to each receptor or receptor group. Refer to the Physical Resources Appendix for detailed calculations, modeling parameters, reference noise levels, and related sources.

Key:

-- = Not applicable

dBA = A-weighted decibel

L_{50} = the noise level exceeded 50 percent of a specific period of time

L_{eq} = the average noise level during a specified time period

As shown in Table 18-9, construction noise levels would not exceed Fresno County’s exterior daytime and nighttime noise standards at the houses located on and near Perkins Avenue, including the houses on Pahmit Road and nearby segments of Sky Harbour Road, or at the houses located on Sky Harbour Drive.

Some of the houses located on and near El Lado Road could be exposed to noise levels of 50 dBA during the construction of Access Road #1 and noise levels of 47 dBA during the construction of Access Road #3. While these exceedances would occur only while the closest portions of these access roads are being constructed, these noise levels would exceed Fresno County’s nighttime noise standard of 45 dBA L_{50}, which applies to the hours of 7:00 AM to 10:00 PM daily.

The five houses located on the north end of Sky Harbour Road could be exposed to noise levels as high as 64 dBA during the construction of the haul road between the staging area to the left abutments of the dam and cofferdams, particularly the segment of the haul road between the existing South Finegold Day Use Area and the proposed dam staging area. This noise level would exceed Fresno County’s exterior daytime noise standard of 50 dBA L_{50} and nighttime standard of 45 dBA L_{50}. Assuming the average exterior-to-interior noise level reduction of 20 dBA provided by wood frame buildings with the windows closed (Caltrans 2011), the interior noise level at these houses would be approximately 44 dBA, which would exceed Fresno County’s nighttime interior noise standard of 35 dBA $L_{8.3}$.

The houses located on the northeast side of Winchell Bay could be exposed to noise levels from the proposed waste area as high as 76 dBA and noise from construction activity at the powerhouse area as high as 51 dBA. These noise levels would also exceed Fresno County's exterior daytime and nighttime noise standards. Assuming the average exterior-to-interior noise level reduction of 20 dBA provided by wood frame buildings with the windows closed (Caltrans 2011), the interior noise level at these houses would be approximately 56 dBA, which would exceed Fresno County's daytime interior noise standard of 45 dBA $L_{8.3}$ and nighttime interior noise standard of 35 dBA $L_{8.3}$.

Among noise-sensitive receptors located in Madera County, the house on Dumna Island would be exposed to a noise level of 49 dBA and 50 dBA from the building of Access Road #3 and construction activity at the proposed powerhouse location, respectively. It is not anticipated that these noise-generating activities would occur at the same time because the access road would need to be completed before construction at the powerhouse site could begin. These noise levels would exceed Madera County's exterior nighttime noise standard of 45 dBA L_{eq}, which applies to the hours of 10:00 PM to 7:00 AM daily.

Some residences located in Hidden Lake Estates could be exposed to noise levels of 54 dBA during the construction portions of the haul road between the staging area to the left abutments of the dam and cofferdams. There would be a direct line of site between this residential area and portions of the haul road and the rate of attenuation would be lower given the "hard" acoustical surface of the intervening portion of Millerton Lake. This noise level would exceed Madera County's noise standard of 50 dBA L_{eq} for daytime hours and standard of 45 dBA L_{eq} for nighttime hours. Homes located in Hidden Lake Estates could also be exposed to noise levels of 48 dBA and 50 dBA from construction activity at the downstream coffer dam and the dam staging area, respectively. Noise levels generated from these activity areas would also exceed Madera County's nighttime noise standard of 45 dBA L_{eq}.

A house located approximately 200 feet north of Ralston Way (County Road 210) in Madera County would be adversely affected by noise associated with construction along nearby segments of the roadway, which would be improved to serve as a haul road providing access between Highway 41 and the Madera County side of the dam site as well as the proposed sites of the aggregate quarry and batch plant under Quarry, Batch Plant, and Haul Road Option A. The level of construction noise exposure could reach 72 dBA at the house, which would be in exceedance of Madera County's outdoor noise standards (i.e., daytime L_{eq} of 50 dBA and nighttime L_{eq} of 45 dBA). Assuming the average exterior-to-interior noise level reduction of 20 dBA provided by wood frame buildings with the windows closed (Caltrans 2011), interior noise levels at the house could be as high as 52 dBA, which exceeds the interior noise standard of 45 dBA L_{dn} for residences established by Policy 7.A.1 of the Madera County General Plan.

Other noise-generating construction activities that could adversely affect noise-sensitive receptors include helicopter use, vegetation clearing that would occur in areas that would be inundated with water after project completion (this process is referred to as reservoir clearing), relocation of approximately 4-miles of inundated portions of the Kerckhoff-Le Grand and Kerckhoff-Sanger transmission lines, and construction of a new, approximately 5-mile transmission line from the powerhouse to the existing Kerckhoff-Sanger line near the intersection of Auberry and Millerton Roads.

A helicopter would be used for a total of approximately 19 hours during the construction of some new recreation facilities in more remote locations during daytime hours. The noise level generated from operation of a Kaman K-Max K-1200 helicopter is approximately 83 dBA SEL below the helicopter and at a hover distance of 492 feet above the ground (Kaman Aerospace Corporation 1993). If the helicopter were to hover as low as 50 feet from the ground it would result in approximately 100 dBA SEL at 50 feet from the construction site at ground level (i.e., someone standing 50 feet from the construction site would be exposed to this noise level). However, helicopters do not operate in one place for extended periods of time and therefore a more likely noise level of 72 dBA L_{eq} would occur at 50 feet from the construction site where a helicopter is hovering for 10 minutes. Because a helicopter would be used to access some recreational facilities in more remote locations during daylight hours it is not anticipated that helicopter noise would exceed applicable noise standards at any noise-sensitive receptors or result in sleep disturbance at any residential land uses.

Reservoir clearing would occur in areas of both counties in the inundation area along the San Joaquin River between the site of the new dam and the downstream end of Kerckhoff Lake. Reservoir clearing activity typically involves the clearing of vegetation and therefore would not occur in any single location for an extended period. The typical noise level associated with reservoir clearing activities is 83 dBA L_{eq} at distance of 50 feet

(EPA 1971). Through distance alone, this noise level would attenuate over land to the daytime noise standard of 50 dBA L_{eq}/L_{50} of both counties at a distance of approximately 900 feet (see the Physical Resources Appendix for detailed calculations). Noise-sensitive receptors located within 900 feet of areas that would be cleared include the houses located along the north end of Wellbarn Road in Fresno County.

Transmission line construction would produce noise levels of approximately 88 dBA L_{eq} at a distance of 50 feet, which would attenuate to Fresno County's daytime noise standard of 50 dBA L_{eq} at a distance of approximately 1,400 feet (see the Physical Resources Appendix for detailed calculations). No noise-sensitive receptors are located within this distance of the areas where the relocated portions of the Kerckhoff-Le Grand and Kerckhoff-Sanger transmission lines would be relocated. Some noise-sensitive receptors; however, are located within 1,400 feet of the proposed transmission line corridor connecting to the powerhouse and the existing Kerckhoff-Sanger line, including three houses on south side of Sky Harbour Drive near the intersection of Sky Harbour Road and multiple houses located in the residential area along Auberry Road.

In summary, various noise-sensitive receptors would be exposed to construction-related noise levels that exceed the daytime and/or nighttime noise standards established by the respective county jurisdictions. While both counties exempt construction from noise standards during specific times of the week, these noise-sensitive receptors may be exposed to construction noise levels that exceed applicable daytime and nighttime standards outside of these exempt periods. Fresno County exempts construction from its noise standards from 6:00 AM to 9:00 PM on weekdays and 7:00 AM to 5:00 PM on Saturdays and Sundays, but its daytime noise standards apply during other times of the week. Similarly, Madera County effectively exempts construction noise from its noise standards from 7:00 AM to 7:00 PM Monday through Friday and 9:00 AM to 5:00 PM on Saturdays but its daytime noise standards also apply during other times of the week. In addition, interior noise levels at the houses on the northeast side of Winchell Bay in Fresno County and the house on Ralston Way in Madera County could exceed applicable indoor noise standards of 45 dBA L_{eq}.

This impact would be **significant** under the action alternatives. Mitigation for this impact is proposed below in the Mitigation Measures section.

Impact NOI-2: Construction-Generated Ground Vibration

Primary Study Area
No Action Alternative No project-related construction or operation activities would occur under the No Action Alternative. Therefore, no ground vibration would be generated through construction.

There would be **no impact** under the No Action Alternative.

Action Alternatives Construction-related activities under the action alternatives would generate ground vibration due to the use of heavy-duty construction equipment. Ground vibration generated by construction equipment spreads through the ground and diminishes in magnitude with increased distance. Construction activities generate varying degrees of ground vibration, depending on the specific construction equipment used and activities involved. Construction-related ground vibration is normally associated with impact equipment such as pile drivers, jackhammers, and the operation of some heavy-duty construction equipment, such as dozers and trucks. Blasting activities also generate relatively high levels of ground vibration. The effects of ground vibration may be imperceptible at the lowest levels, result in low rumbling sounds and detectable vibrations at moderate levels, can cause sleep disturbance or annoyance at high levels, and, at even higher levels, can result in damage to nearby structures.

The action alternatives could result in ground vibration during construction of the various proposed facilities, such as the dam structure, intake structure, and diversion tunnels. Based on equipment use information for the action alternatives, equipment that would generate the most ground vibration include the use of hydraulic drills (e.g., for tunnel construction) and large dozers. In addition to the use of heavy-duty construction equipment it is assumed that blasting could potentially be used during the tunnel construction or at the quarry site for aggregate processing. The levels of ground vibration associated with these types of construction equipment and activities are summarized in Table 18-10, below.

Table 18-10. Representative Ground Vibration and Noise Levels for Construction Equipment

Equipment	PPV at 25 feet (in/sec)[1]	PPV at 15 feet (in/sec)[2]	Approximate L_v (VdB) at 25 feet
Blasting	1.130	2.431	109
Hydraulic Drill[1]	0.089	0.191	87
Large Dozer	0.089	0.191	87
Loaded Trucks	0.076	0.164	86

Source: FTA 2006

Notes:
[1] PPV = peak particle velocity; LV = the root mean square velocity expressed in vibration decibels (VdB), assuming a crest factor of 4 FTA reference noise level is for a Caisson Drill which is representative of typical drilling activities at construction sites and therefore was used to represent a hydraulic drill.
[2] PPV at 25 feet are based on FTA 2006. To calculate PPV at 15 feet, the following equation (FTA 2006) was used:
PPV at 15 feet = PPV (at 25 feet) * ([25/15]^1.5)

Key:
in/sec = inches per second

The ground vibration levels listed in Table 18-10 were evaluated against applicable vibration thresholds as described in the Methods and Assumptions section above. This analysis focused on the human disturbance threshold of 0.1 inch/second PPV because it is more stringent than the Caltrans-recommended threshold of 0.2 inch/second PPV for evaluating the potential for structural damage. It is also more stringent than FTA's maximum acceptable vibration standard of 80 VdB because ground vibration levels need more distance to diminish to less than 0.1 inch/second PPV than to less than 80 VdB.

Based on FTA's recommended procedure for applying a propagation adjustment to reference ground vibration levels shown above, predicted worst-case ground vibration levels would exceed the threshold for human disturbance of 0.1 inch/second PPV for blasting at distances within 130 feet, for the use of heavy-duty equipment within 25 feet, and for vibration from trucks on haul roads within 21 feet.

With regards to structural damage, the Caltrans-recommended threshold of 0.2 inch/second PPV would be exceeded for blasting at distances within 80 feet, drilling within 15 feet, and heavy-duty equipment 15 feet. These distances would not be exceeded during construction of any action alternative.

Sensitive receptors are located throughout the primary study area (Figure 18-4). However, there are no sensitive receptors or structures located within any distance described above for which structural damage or human disturbance could occur.

This impact would be **less than significant** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

Impact NOI-3: Exposure of Sensitive Receptors in the Primary Study Area to Construction-Related Traffic Noise

Primary Study Area

No Action Alternative No new construction-related vehicle trips and associated transportation noise would be introduced under the No Action Alternative. Therefore, sensitive receptors would not be exposed to construction-related traffic noise.

There would be **no impact** under the No Action Alternative.

Action Alternatives The action alternatives would result in increases in daily traffic volumes and associated traffic noise levels along area roadway segments during project construction. The Federal Highway Administration's (FHWA) Traffic Noise Model (FHWA 2006) was used to predict traffic noise levels along affected roadways for existing conditions, with and without trips associated with project construction under the action alternatives. Trip estimates were based on the number of daily trips related to the construction workers' commute, movement of equipment, and material delivery that would be added to area roadways during the peak of construction, as discussed in Chapter 24, "Transportation, Circulation, and Infrastructure." Because Alternative Plan 4 would generate more truck trips than the other action alternatives, for a conservative analysis, construction trips associated with Alternative Plan 4 were used in this analysis to represent all five action alternatives.

Table 18-11 displays the L_{dn} approximately 50 feet from the roadway edge (100 feet for SR 99 and SR 41) of each modeled road segment for existing conditions with and without the construction-related traffic. Note that most of the noise levels presented in Table 18-11 would be lower at the nearest sensitive receptors because the receptors are located further than the modeled distance. Table 18-11 also shows the net change in roadside noise levels due to construction-related vehicle trips by workers and trucks. The roadway noise levels presented in the table represent worst-case potential traffic noise exposures, which assume no natural or human-made shielding (e.g., trees, intervening topography, or sound walls) between the roadway and nearby receptors. Detailed modeling parameters are provided in the Physical Resources Appendix.

Table 18-11. Summary of Traffic Noise Increases During Construction

Name	From	Quarry, Batch Plant, and Haul Road Option(s) Adding Construction Traffic[1]	Existing, dBA L_{dn} (short-term)[2]	Existing + Construction Trips, dBA L_{dn} (short-term)[2]	Increase, dBA L_{dn} (short-term)	County
SR 99	Jensen Avenue to SR 41	A, B, C	81.9	81.9	0.0	Fresno
SR 41	SR 99 to North Friant Road	A, B, C	78.4	78.4	0.1	Fresno
SR 41	North Friant Road to SR 145	A only	77.6	77.7	0.1	Madera
North Fork Road (County Road 200)	SR 41 to County Road 211	A only	60.8	62.6	1.8	Madera
County Road 211 (O'Neals Road)	North Fork Road (County Road 200) to County Road 210 (Hildreth Road)	A only	51.8	57.3	5.5	Madera
County Road 210	County Road 211 (O'Neals Road) to Aggregate Quarry Haul Road	A only	48.2	56.6	8.4	Madera
SR 145	West of SR 41	None	67.2	67.2	0.0	Madera
Millerton Road	North Fork Road to Brighton Crest Road	A, B, C	67.4	68.0	0.6	Fresno
Millerton Road	Brighton Crest Road to Sky Harbour Road	A, B, C	67.4	68.0	0.6	Fresno
Millerton Road	Sky Harbour Road to Table Mountain Road	None	66.7	66.7	0.0	Fresno
Millerton Road	Table Mountain Road to Auberry Road	None	64.4	64.4	0.0	Fresno
Sky Harbour Road	North of Millerton Road	A, B, C	55.1	59.8	4.7	Fresno
Friant Road	Lost Lake Road to North Fork Road	A, B, C	66.5	67.1	0.6	Fresno
Friant Road	Willow Avenue to Lost Lake Road	A, B, C	71.2	71.7	0.05	Fresno
Friant Road	Copper Avenue to Willow Avenue	A, B, C	69.1	69.6	0.5	Fresno
Friant Road	Rice Road to Copper Avenue	A, B, C	69.1	69.6	0.5	Fresno
Friant Road	SR 41 and Rice Road	A, B, C	66.5	67.1	0.6	Fresno

Table 18-11. Summary of Traffic Noise Increases During Construction (contd.)

Name	From	Quarry, Batch Plant, and Haul Road Option(s) Adding Construction Traffic[1]	Existing, dBA L_{dn} (short-term)[2]	Existing + Construction Trips, dBA L_{dn} (short-term)[2]	Increase, dBA L_{dn} (short-term)	County
Road 206	Road 145 to North Friant Road	None	62.1	62.1	0.0	Madera
Smalley Road	Powerhouse Road to San Joaquin River	A, B, C	48.5	49.4	0.9	Fresno
Powerhouse Road	Auberry Road to Smalley Road	A, B, C	52.1	52.5	0.4	Fresno
Powerhouse Road	Smalley Road to San Joaquin River	A, B, C	49.6	50.3	0.7	Fresno
Auberry Road	Powerhouse Road to SJ&E Road	A, B, C	67.8	67.8	0.0	Fresno
Auberry Road	SJ&E Road and Powerhouse Road	A, B, C	67.8	67.8	0.0	Fresno
Auberry Road	Morgan Canyon Road (SR 168) to SJ&E Road	A, B, C	67.8	67.8	0.0	Fresno
Auberry Road	Morgan Canyon Road (SR 168) to Wellbarn Road	A, B, C	64.0	64.1	0.1	Fresno
Auberry Road	Wellbarn Road to Millerton Road E.	A, B, C	63.8	64.0	0.2	Fresno
Auberry Road	Millerton Road E. to Millerton Road W.	A, B, C	64.5	64.7	0.2	Fresno
Auberry Road	Millerton Road W. to E. Copper Avenue	A, B, C	65.3	65.5	0.2	Fresno
Copper Avenue	Friant Road and Auberry Road	A, B, C	65.5	65.5	0.0	Fresno
Wellbarn Road	Auberry Road to Temperance Flat	A, B, C	47.4	51.5	4.1	Fresno

Source: Data modeled by Ascent Environmental in 2014.

Notes:

[1] The following four road segments would only experience construction traffic under quarry, batch plant, and haul road Option A: SR 41 from North Friant Road to County Road 200; N Fork Rd (County Rd 200) from SR 41 to County Rd 211; County Rd 211 (O'Neals Rd) from N Fork Rd to County Rd 210 (Hildreth Rd); and County Rd 210 from County Rd 211 (O'Neals Rd) to aggregate quarry haul road on the north side of the proposed dam. Therefore, there would be no increased traffic noise levels on these road segments under quarry, batch plant, and haul road Options B and C.

[2] Traffic noise levels were estimated using FHWA's Traffic Noise Model (FHWA 2006) based on trip information provided in Chapter 24, "Transportation, Circulation, and Infrastructure." Where construction traffic levels would vary among quarry, batch plant, and haul road Options A, B, and C, the highest trip levels from these three options were evaluated. Modeled traffic noise levels assume no natural or human-made shielding (e.g., vegetation, berms, walls, buildings). Refer to the Physical Resources Appendix for modeling input assumptions and output results.

Key:

CNEL = community noise equivalent level;

dBA = A-weighted decibel

SR = State Route

As shown in Table 18-11, on most of the modeled roadway segments the traffic noise increases would not be greater than 1.5 dBA L_{dn} during the construction period.

Those roadway segments that would experience traffic noise level increases great than 1.5 dBA L_{dn} are discussed further here. Traffic noise levels on the segment of Sky Harbour Road north of Millerton Road would increase from 55.1 dBA L_{dn} to 59.8 dBA L_{dn}, and traffic noise levels along the segment of Wellbarn Road from Auberry Road to Temperance Flat would increase from 47.4 dBA L_{dn} to 51.5 dBA L_{dn}. The existing traffic noise levels along these two roadway segments are less than 60 dBA L_{dn} and would not increase by more than 5 dBA.

Traffic noise levels along North Fork Road (Madera County Road 200) between SR 41 and County Road 211would experience an increase of 1.6 dBA L_{dn} from 61.4 to 63.0 dBA L_{dn} under Quarry, Batch Plant, and Haul Road Option A only. This noise level increase would not exceed applicable standards because the existing traffic noise level is less than 65 dBA L_{dn}.

The segment of County Road 211 between North Fork Road and Hildreth Road, and the segment of County Road 210 between County Road 211 and the aggregate quarry haul road in Madera County would experience traffic noise levels exceeding the 5 dBA-increase standard under Quarry, Batch Plant, and Haul Road Option A only.

In addition to increases in average daily traffic noise, intermittent SELs and increases in the frequency of occurrence of such levels is also of concern, particularly during the more noise-sensitive nighttime hours. Although the average daily noise descriptors (i.e., L_{dn} and CNEL) incorporate a nighttime weighting or “penalty” that is intended to reflect the expected increased sensitivity to noise at night, L_{dn} and CNEL standards do not fully protect residents from sleep disturbance. The SEL describes a receiver’s cumulative noise exposure from a single impulsive noise event (e.g., an automobile passing by or an air craft flying overhead), which is a rating of a discrete noise event that compresses the total sound energy of the event into a 1-second time period, measured in decibels (Caltrans 2011).

Fresno County, Madera County, Caltrans, the Governor’s Office of Research and Planning, and most cities and counties have not established noise level standards for the effects of single-event noise. However, following the court decision in *Berkeley Keep Jets Over the Bay Committee v. Board of Port Commissioners of the City of Oakland, 2001* (*Berkeley* case) there has been increased attention to the evaluation of single-event noise levels and their effects on sleep. Because the

Berkeley case involved aircraft, and the action alternatives would involve construction-related haul truck trips, the situations are not entirely the same. Nonetheless, the SELs from truck passbys associated with construction under the action alternatives are evaluated here.

Many studies have been conducted regarding the effects of single-event noise on sleep disturbance, but because of the wide variation in the reaction of test subjects to SELs of various levels no definitive consensus has been reached with respect to a universal criterion to apply. Upon a review of studies about sleep disturbance and aircraft-generated SELs, the Federal Interagency Committee on Aviation Noise (FICAN) provided estimates of the percentage of people expected to be awakened when exposed to specific SELs inside a home (FICAN 1997). According to the FICAN's review, 10 percent of the population is estimated to be awakened when the SEL interior noise level is 81 dBA. An estimated 5 to 10 percent of the population is affected when the SEL interior noise level is between 65 and 81 dBA, and few sleep awakenings (less than 5 percent) are predicted if the interior SEL is less than 65 dBA. However, FICAN did not recommend a threshold of significance based on the percent of people awakened.

The threshold for sleep disturbance is not absolute because there is a high degree of variability from one person to another. Thus, the means of applying such research to land use decisions is not completely clear. As a result, no government agency has suggested what frequencies of awakenings are acceptable (Caltrans 2011). For these reasons, the Federal Interagency Committee on Noise , the Governor's Office of Research and Planning, and most cities and counties (including Fresno and Madera counties), continue to use L_{dn} or CNEL as the primary tool for the purpose of land use compatibility planning (Caltrans 2011). In fact, the L_{dn} and CNEL represents the cumulative exposure to all single events, that is, the exposure of all SELs taken together, weighed to add penalties for nighttime occurrences, and averaged over a 24-hour period. Thus, it can be argued that the L_{dn} standards established by Fresno County (shown in Chapter 18, "Noise and Vibration") and Madera County (i.e., General Plan Policy 7.A.2), already account for the individual impacts associated with the SELs. (Note that CNEL and L_{dn} are often used interchangeably, as there is only a subtle difference in noise level penalties during evening hours used to formulate the two metrics.)

Fresno and Madera counties have also established L_{max} standards, as shown in Table 18-5 and Table 18-6 for Fresno County and Table 18-7 for Madera County. The L_{max} metric is used to evaluate a maximum instantaneous sound level; however, the limitation of an instantaneous sound level is that it provides no information regarding the duration of a sound. Two different aircraft overflights or truck passbys, for instance, can produce vastly different total amounts of sound energy at a given receptor depending on how quickly the aircraft or trucks pass by. Thus, the relationship between L_{max} and SEL is not constant because some noise events last longer than others. The closer the noise event, the closer the L_{max} and SEL measurements will be to each other (Caltrans 2011).

Because the *Berkeley* case drew concerns due to interior SEL values in excess of 65 dBA, this analysis uses a threshold of 65 dBA SEL within residences. Exposure to 65 dBA SEL would result in a chance of sleep disturbance of less than 5 percent.

Reference SELs for heavy truck passbys were measured by Bollard Acoustical Consultants and reported in an EIR for a proposed commercial center (City of Ceres 2010). The results of the measurements indicated that heavy truck passby levels ranged from 77 to 85 dBA SEL, with a mean of 83 dBA SEL at a reference distance of 50 feet.

Assuming the average exterior-to-interior noise level reduction of 20 dBA provided by wood frame buildings with the windows closed (Caltrans 2011), the maximum SEL in the interior of rooms located closer than 50 feet from a passing truck would exceed 65 dBA SEL. Because some houses along the haul routes have inhabitable rooms located closer than 50 feet to the roadway, these rooms would experience SELs that exceed the threshold of 65 dBA and, therefore, the percentage of people expected to be awakened when inside the affected homes would exceed 5 percent. Roadways within 50 feet of nearby residences where this impact could potentially occur include North Friant Road between Lost Lake Road and North Fork Road, Millerton Road just east of Winchell Cove Road, Sky Harbour Road north of Millerton Road, Sky Harbour Drive east of Sky Harbour Road, the intersection of Auberry Road and Wellbarn Road, Auberry Road just west of Little Sandy Road, Auberry Road South of Blue Heron Lane, Auberry Road south of SJ and E Road, and Powerhouse Road north of Auberry Road. There are also some residences located within 50 feet of (Madera) County Road 210 between County Road 211 and the proposed site of the aggregate quarry haul road north of the proposed dam site, which would experience construction-related truck trips under Quarry, Batch Plant, and Haul Road Option A only.

This impact would be **significant** under the action alternatives. Mitigation for this impact is proposed below in the Mitigation Measures section.

Impact NOI-4: Long-Term Operational Stationary- and Area-Source Noise

Primary Study Area

No Action Alternative No new operational noise sources would be introduced under the No Action Alternative. Therefore, no long-term operational stationary- or area-source noise would be generated.

There would be **no impact** under the No Action Alternative.

Action Alternatives The action alternatives would introduce new noise sources to the primary study area, including the new powerhouse, recreational watercraft operating in the new Temperance Flat RM 274 Reservoir, and potentially corona noise from the new transmission line connected to the powerhouse as well as the relocated portions of the existing Kerckhoff-Le Grand and Kerckhoff-Sanger transmission lines. Noise levels typically associated with these sources and the potential of exposing noise-sensitive receptors to excessive noise levels are discussed separately below.

Powerhouse Operations It is assumed that the noise level generated by the proposed 160 MW powerhouse would be similar to that of the existing Kerckhoff Powerhouse. The short-term noise measurement of the Kerckhoff Powerhouse, collected at Site ST5, as shown in Figure 18-1 and summarized in Table 18-1., indicates a steady noise level of approximately 74 dBA L_{eq} at a distance of 20 feet. Through distance alone this noise level would attenuate to less than 45 dBA L_{eq} at 600 feet, even without any additional attenuation provided by ground absorption and there are no residences or other noise-sensitive receptors located within this distance. (Detailed calculations are provided in the Physical Resources Appendix.) Thus, noise generated by the new powerhouse would not exceed Fresno County’s respective daytime and nighttime noise standards of 50 dBA L_{50} and 45 dBA L_{50}, or Madera County’s respective daytime and nighttime noise standards of 50 dBA L_{eq} and 45 dBA L_{eq}.

Recreational Boating Activity Upon completion of the action alternatives, a new reservoir would be created with new boat ramps. Thus, residences located near the new reservoir could be exposed to varying levels of boat noise. Operation of motorized watercraft would be limited to the daytime hours posted by the Park Rangers of the Millerton Lake State Recreation Area, which limit boating to particular daytime hours, depending on the time of year. Because recreational boating is largely considered an area source of noise, this evaluation compares noise generated by recreational boating to the standards established by Fresno County and Madera County for non-transportation noise sources.

As stated in the regulatory setting above, Section 654.06 of the Harbors and Navigation Code requires noise levels from recreational watercraft to be no greater than 86 dBA at a distance of 50 feet (California Department of Boating and Waterways 2012). In Fresno County the closest noise-sensitive receptors to the new reservoir would be houses along Sky Harbour Road and an existing house located south of the proposed new Wellbarn Road Boat Ramp. Noise levels from boating on the new reservoir would be generated no closer than 2,800 feet from the homes on Sky Harbour Road. Through distance alone boat noise levels would attenuate to approximately 41 dBA at these homes and additional attenuation would be provided by the intervening topography, including Pincushion Mountain. The existing house located closest to the proposed site of the Wellbarn Road Boat Ramp is located approximately 2,300 feet from the edge of the new reservoir (when at full capacity). At this distance boating noise levels would attenuate to approximately 43 dBA at this house. (Detailed calculations are provided in the Physical Resources Appendix.) At both this residence and the residences along Sky Harbour Road, levels of noise exposure from boating on the new reservoir would not exceed Fresno County's exterior daytime noise standards of 50 dBA L_{50} or 70 dBA L_{max}.

In Madera County the closest noise-sensitive receptors to the new reservoir would be some existing houses located in the Hildreth area approximately 4,100 feet from the edge of the new reservoir (when at full capacity). At this distance, boat noise would attenuate to approximately 36 dBA. A receptor that would be closer to the new reservoir is the house located north of the location where the aggregate plant would be operated. At a distance of approximately 1,400 feet from the edge of the new reservoir, the level of noise exposure at this house would be approximately 45 dBA. (Detailed calculations are provided in the Physical Resources Appendix.) Thus, the levels of noise exposure from boating activity on Temperance Flat RM 274 Reservoir would not exceed Madera County's exterior daytime noise standards of 50 dBA L_{eq} or 70 dBA L_{max} at any of the noise-sensitive receptors located in Madera County.

Corona Noise from Transmission Lines   Audible noise from transmission lines is primarily due to the point source corona effect—a crackling and hissing, hum-like sound with potential for small amounts of light—resulting from small variability in the conductor materials. Such noise is common and not harmful, and routinely occurs when air is ionized around a gap, a burr (raised area), a small irregularity, or some non-insulated component during the conductance of electricity through transmission lines. Corona is also produced when transmission lines break down over time and their fastener components loosen resulting in an air gap. Corona noise is most prominent during periods of rain, fog, or high humidity.

Corona noise is a source of electricity transmission inefficiencies (i.e., power is lost); and, therefore, transmission lines are designed to minimize coronal effect. Such design features include using homogenous insulators and implementing good high voltage design practices (i.e., maximizing the distance between conductors that have large voltage differentials, using conductors with large radii, and avoiding parts that have sharp points or sharp edges).

Under the action alternatives, a new, approximately 5-mile transmission line would be constructed from the powerhouse to the existing Kerckhoff-Sanger line near Auberry and Millerton Roads, and approximately 4-miles of the Kerckhoff-Le Grand and Kerckhoff-Sanger transmission lines would be relocated outside of the area that would be inundated by the new reservoir. Because the types of wear and tear to transmission lines that could result in atypically loud coronal noise also result in energy loss (e.g., damaged insulators or other transmission line materials, scratches to the conductor surface), transmission lines are typically inspected on a scheduled basis and repairs are made as needed. Also, coronal noise is typically most audible in high voltage lines (i.e., 345 kV and above) and during weather conditions with precipitation and high humidity (CPUC 2009). Because all transmission lines that would be added or relocated as part of the action alternatives would have a capacity of 115 kV, it is not anticipated that corona noise generated by these lines, if any, would expose any nearby sensitive receptors to substantial increases in ambient noise levels or to levels that exceed any applicable standards.

Summary The levels of noise exposure at the nearest noise-sensitive receptors from operation of the new proposed powerhouse, boating activity on Temperance Flat RM 274 Reservoir, and any corona noise produced by the new and relocated transmission lines would not exceed the applicable noise standards of Fresno and Madera counties. Moreover, no noise-sensitive receptors would be exposed to substantial levels of noise from more than one of these sources, resulting in an additive affect, simply because the sources would not be located near each other.

This impact would be **less than significant** under the action alternatives. Mitigation for this impact is not needed and thus not proposed.

Impact NOI-5: Long-Term Increases in Traffic Noise

Primary Study Area
No Action Alternative No new vehicle trips and associated transportation noise would be introduced under the No Action Alternative. Therefore, there would be no long-term increases in traffic noise.

There would be **no impact** under the No Action Alternative.

Action Alternatives The action alternatives would result in long-term increase in daily traffic volumes and associated traffic noise level increases along area roadway segments due to increased recreation. FHWA's Traffic Noise Model (FHWA 2006) was used to predict traffic noise levels along affected roadways for existing conditions, with and without implementation of the action alternatives, based on the trip distribution estimates obtained from Chapter 24, "Transportation, Circulation, and Infrastructure." As explained in Chapter 24, it is estimated that during the eight weekend days in July an additional approximately 476 vehicle trips per day would be added to area roadways because of improved conditions at Millerton Lake and an additional 1,344 vehicle trips per day would be added to area roadways because of new recreational opportunities at the Temperance Flat RM 274 Reservoir. The traffic noise modeling is based on these worst-case days.

To be conservative, it was assumed that the increase in traffic associated with improved conditions at Millerton Lake (i.e., 476 trips per day) could potentially occur along routes that provide access between the city of Fresno, which is the largest nearby population center, and recreational areas around Millerton Lake. Regarding the 1,344 trips that would be added due to new recreational opportunities at the Temperance Flat RM 274 Reservoir, it was assumed that these trips could be added to any route between the city of Fresno and the Fresno County side of the new reservoir.

Table 18-12 displays the L_{dn} approximately 50 feet from the roadway edge (100 feet for SR 99 and SR 41) of each modeled road segment for existing conditions with and without the traffic associated with expanded operations. Note that most of the noise levels presented in Table 18-12 would be lower at the nearest sensitive receptors because the receptors are located further than the modeled distance. Table 18-12 also shows the net change in roadside noise levels due to operational trips. The roadway noise levels presented in the table represent worst-case potential traffic noise exposures, which assume no natural or human-made shielding (e.g., trees, intervening topography, or sound walls) between the roadway and nearby receptors. Detailed modeling parameters are provided in the Physical Resources Appendix.

Table 18-12. Summary of Traffic Noise Increases During Long-Term Operations

Name	From	Existing, dBa L_{dn} (long-term)[1]	County	Existing+ New Recreational Users, dBa L_{dn} (long-term)[1]	Increase, dba L_{dn} (long-term)[1]
SR 99	Jensen Avenue to SR 41	81.9	Fresno	81.9	0.0
SR 41	SR 99 to North Friant Road	78.4	Fresno	78.5	0.1
SR 145	West of SR 41	67.2	Madera	67.2	0.0
Millerton Road	North Fork Road to Brighton Crest Road	67.4	Fresno	68.0	0.7
Millerton Road	Brighton Crest Road to Sky Harbour Road	67.4	Fresno	68.0	0.7
Millerton Road	Sky Harbour Road to Table Mountain Road	66.7	Fresno	67.3	0.6
Millerton Road	Table Mountain Road to Auberry Road	64.4	Fresno	65.3	1.0

Table 18-12. Summary of Traffic Noise Increases During Long-Term Operations (contd.)

Name	From	Existing, dBa L_{dn} (long-term)[1]	County	Existing+ New Recreational Users, dBa L_{dn} (long-term)[1]	Increase, dba L_{dn} (long-term)[1]
Sky Harbour Road	North of Millerton Road	55.1	Fresno	57.0	1.9
Friant Road	Lost Lake Road to North Fork Road	66.5	Fresno	67.1	0.6
Friant Road	Willow Avenue to Lost Lake Road	71.2	Fresno	71.9	0.6
Friant Road	Copper Avenue to Willow Avenue	69.1	Fresno	69.7	0.6
Friant Road	Rice Road to Copper Avenue	69.1	Fresno	69.7	0.6
Friant Road	SR 41 and Rice Road	66.5	Fresno	67.1	0.6
Road 206	Road 145 to North Friant Road	62.1	Madera	63.6	1.5
North Fork Road (Road 200)	SR 41 to Aggregate Quarry	61.4	Fresno	61.4	0.0
Smalley Road	Powerhouse Road to San Joaquin River	48.5	Fresno	53.8	5.3
Powerhouse Road	Auberry Road to Smalley Road	52.1	Fresno	55.2	3.1
Powerhouse Road	Smalley Road to San Joaquin River	49.6	Fresno	49.6	0.0
Auberry Road	Powerhouse Road to SJ&E Road	67.8	Fresno	68.0	0.2
Auberry Road	SJ&E Road and Powerhouse Road	67.8	Fresno	68.0	0.2
Auberry Road	Morgan Canyon Road (SR 168) to SJ&E Road	67.8	Fresno	68.0	0.2
Auberry Road	Morgan Canyon Road (SR 168) to Wellbarn Road	64.0	Fresno	64.6	0.6
Auberry Road	Wellbarn Road to Millerton Road E.	63.8	Fresno	64.9	1.1
Auberry Road	Millerton Road E. to Millerton Road W.	64.5	Fresno	65.4	1.0
Auberry Road	Millerton Road W. to E. Copper Avenue	65.3	Fresno	66.1	0.8
Copper Avenue	Friant Road and Auberry Road	65.5	Fresno	66.3	0.8
Wellbarn Road	Auberry Road to Temperance Flat	47.4	Fresno	53.5	6.1

Note:
[1] Traffic noise levels were estimated using FHWA's Traffic Noise Model (FHWA 2006) based on trip information provided in Chapter 24, "Transportation, Circulation, and Infrastructure." Modeled traffic noise levels assume no natural or human-made shielding (e.g., vegetation, berms, walls, buildings). Refer to the Physical Resources Appendix for modeling input assumptions and output results.

Key:
CNEL = community noise equivalent level
dBA = A-weighted decibel
SR = State Route

As shown in Table 18-11, all but five of the modeled roadway segments would experience a traffic noise level increase of less than 1.5 dBA L_{dn}. The segment of Sky Harbour Road north of Millerton Road and the segment of Road 206 in Madera County between Road 145 and North Friant Road could experience respective increases of 1.9 dBA L_{dn} and 1.5 dBA L_{dn}; however, the resultant noise levels along these two segments would be less than 65 dBA L_{dn}. Thus, these segments would not exceed applicable standards.

The segment of Powerhouse Road between Auberry Road and Smalley Road would experience an increase of 3.1 dBA, as shown in Table 18-11. Because this increase is less than 5 dBA and the resultant noise level (of 55.2 dBA L_{dn}) would not exceed 60 dBA L_{dn}, the noise level increase along this segment would not exceed applicable standards.

Applicable standards would be exceeded, however, along the segment of Wellbarn Road that approaches the proposed boat ramp and the segment of Smalley Road that approaches the second new boat ramp. Houses located along Wellbarn Road, which is the only road that would provide access (from Auberry Road) to the proposed new boat ramp at Temperance Flat RM 274 Reservoir, as well as the Auberry School, could experience a substantial traffic noise increase . The modeling results shown in Table 18-12 indicate that the traffic noise level would increase by approximately 6.1 dBA L_{dn}. This would exceed Fresno County’s incremental increase standard of 5 dBA L_{dn}.

Similarly, houses along the segment of Smalley Road west of Power House Road would experience a traffic noise increase of 5.3 dBA L_{dn}. This would also exceed Fresno County’s incremental increase standard of 5 dBA L_{dn}.

This impact would be **significant** under the action alternatives. Mitigation for this impact is proposed below in the Mitigation Measures section.

Mitigation Measures

This section discusses mitigation measures for each significant impact described in the Direct and Indirect Impacts section, as presented in Table 18-7.

No mitigation is required for Impact NOI-2 or NOI-4 within the primary study area because these impacts would be less than significant for all action alternatives. The following mitigation is required for Impacts NOI-1 NOI-3, and NOI-5 in the primary study area for all action alternatives.

Mitigation Measure NOI-1: Implement Measures to Prevent Exposure of Sensitive Receptors to Temporary Construction Noise at Project Construction Sites

Reclamation and its primary construction contractors will implement the measures listed below during construction:

- To the extent feasible, construction activities shall be limited to the less noise-sensitive daytime hours of 7:00 AM to 7:00 PM Monday through Friday and 9:00 AM to 5:00 PM on Saturdays. No construction work shall be performed on Sundays or Federal or State holidays.

- All construction equipment and staging areas shall be located at the farthest distance feasible from nearby noise-sensitive land uses that have a direct line of sight to the location of construction activity.

- All construction equipment shall be properly maintained and equipped with noise-reduction intake and exhaust mufflers and engine shrouds, in accordance with manufacturers' recommendations. Equipment engine shrouds shall be closed during equipment operation.

- All motorized construction equipment shall be shut down when not in use to prevent idling.

- Where feasible and necessary, a temporary barrier will be placed as close to the noise source or receptor as possible and will break the line of sight between the source and receptor.

- A disturbance coordinator will be designated and the person's telephone number conspicuously posted around the project sites and supplied to nearby residences. The disturbance coordinator will receive all public complaints and be responsible for determining the cause of the complaint and implementing any feasible measures to alleviate the problem.

- If feasible, to protect the houses on the northeast side of Winchell Bay, Reclamation shall install temporary noise curtains or some other type of temporary sound barrier along the south end of the waste area where waste rock from the diversion tunnel and powerhouse area would be placed. The noise barrier layer shall consist of rugged, impervious, material with a surface weight of at least one pound per square foot. The sound barrier shall block the line of site between the houses located on the northeast side of Winchell Bay and the waste area.

- Reclamation shall require its contractors to implement any feasible site-specific noise control measures to protect the house located approximately 200 feet north of Ralston Way (County Road 210) from road improvement-related construction to nearby portions of the roadway, which would serve as Access Road #1. Measures may include the installation of a temporary noise curtain or other type of barrier between the house and construction activity along the roadway, rerouting the roadway so that no portions pass within 250 feet of the house, and/or coordinating with the occupants of the residence to ensure that nearby noise-generating construction activity is performed during the least noise-sensitive times of day (e.g., when occupants aren't home).

- If any construction activity results in interior noise levels at residential receptors that would exceed the interior noise standard of 45 dBA L_{dn} during non-exempt times of day, the Reclamation shall offer alternative overnight accommodation to the inhabitants of the affected residence.

Implementation of Mitigation Measure NOI-1 would reduce temporary project generated construction source noise levels and, when feasible, limit them to the less sensitive daytime hours, thus limiting exposure of noise-sensitive receptors to temporary construction noise (Impact NOI-1). However, some construction activities would need to occur during the non-exempt times of day, and possibly on Sundays to adhere to the construction schedule, which is governed, in part, by the rainy season. If performed during the more noise-sensitive evening or nighttime hours some construction activities could generate noise levels that exceed either Fresno County's nighttime noise standard of 45 dBA L_{50} or Madera County's nighttime noise standard of 45 dBA L_{eq}. For instance, as shown in Table 18-9, the construction of the aggregate quarry haul road north of the proposed dam site under Quarry, Batch Plant, and Haul Road Option A would generate noise levels as high as 72 dBA at the house on Ralston Way; the construction of the haul road from the staging area to the left abutments of the dam and cofferdams would result in a noise level of 64 dBA at the five houses on the north end of Sky Harbour Road; construction activity at the downstream cofferdam and the dam site staging area could generate 48 dBA and 50 dBA, respectively, at some residences in Hidden Lake Estates; activity at the waste area and powerhouse would generate 76 dBA and 50 dBA, respectively, at the houses on the north side of Winchell Bay; activity at the powerhouse area would also result in 50 dBA at the house on Dumna Island; and reservoir clearing could produce 45 dBA at the house north of where the aggregate quarry would be located under Quarry, Batch Plant, and Haul Road Option A. While implementation of temporary sound barriers could help reduce the level of noise exposure from some construction activities to levels less than the nighttime standards, the feasibility of installing such barriers is not certain at this time. For these reasons, this impact would be **significant and unavoidable**.

Mitigation Measure NOI-3: Install Sound Barriers along County Road 211 and County Road 210, and Restrict Truck Hauling on Public Roads to the Less-Sensitive Daytime Hours

If Quarry, Batch Plant, And Haul Road Option A is implemented, Reclamation will implement the following measures to reduce exposure of existing noise-sensitive receptors along County Road 211 (between North Fork Road and County Road 210) and County Road 210 (between County Road 211 and the proposed aggregate quarry haul route north of the proposed dam site) to an incremental increase of less than 5 dBA L_{dn}.

Reclamation shall offer the owners of all the residences with addresses along these two roadway segments the installation of a sound barrier along the property line of their affected residential properties. The sound barriers must be constructed of solid material (e.g., wood, brick, adobe, an earthen berm, or combination thereof). All barriers shall blend into the overall landscape and have an aesthetically pleasing appearance that agrees with the color and rural character of the houses and the general area, and not become the dominant visual element of the community. Relocation of the driveway at each residence may be necessary to preclude having gaps in the sound barrier. Relocation of landscaping may also be necessary to achieve an aesthetically pleasing appearance. The owners of the affected properties may choose to refuse this offer; however, the offer shall be made available to subsequent owners of the property if change of ownership occurs before project construction is complete. If an existing owner refuses these measures, a deed notice must be included with any future sale of the property to comply with California state real estate law, which requires that sellers of real property disclose “any fact materially affecting the value and desirability of the property” (California Civil Code, Section 1102.1[a]) and shall indicate that Reclamation agrees to install a sound barrier, as described above.

To ensure compliance with applicable noise standards, a site-specific noise study shall be conducted by Reclamation or one of its approved consultants to determine specific noise barrier design. Reclamation shall also be responsible for removal of these sound barriers at the end of project construction.

The construction of sound barriers along County Road 211 between North Fork Road and County Road 210 would achieve the minimum 0.5 dBA L_{dn} reduction to ensure that the resultant traffic noise increase would not exceed the applicable incremental increase standard of 5 dBA L_{dn}. The construction sound barriers along the segment of County Road 210 between County Road 211 and proposed aggregate quarry haul road north of the dam site would achieve the minimum 3.4 dBA L_{dn} reduction to ensure that the resultant traffic noise increase would not exceed the applicable standard of 5 dBA L_{dn}.

Additionally, to minimize the impact of nighttime SELs associated with truck passbys under Quarry, Batch Plant, and Haul Road Options A, B, and C, Reclamation and its primary construction contractors shall prohibit both (1) the arrival of haul trucks that travel along the roadway segments listed below (i.e., on routes that pass within in 50 feet of an inhabitable room of a residential dwelling) before 7:30 AM or after 9:00 PM and (2) the departure of trucks from construction sites before 7:00 AM or after 9:30 PM that would use the roadway segments listed below:

- North Friant Road between Lost Lake Road and North Fork Road,
- Millerton Road just east of Winchell Cove Road,
- Sky Harbour Road north of the turnoff to the proposed site of the surge chamber,

- Sky Harbour Drive east of Sky Harbour Road,
- Intersection of Auberry Road and Wellbarn Road,
- Auberry Road just west of Little Sandy Road,
- Auberry Road South of Blue Heron Lane,
- Auberry Road south of SJ and E Road,
- Powerhouse Road north of Auberry Road,
- County Road 210 between County Road 211 and proposed aggregate quarry haul road north of the proposed dam site (under Quarry, Batch Plant, and Haul Road Option A only), or
- Any other route that passes within 50 feet of an inhabitable room of a residential dwelling unit.

By including a half-hour increment to the period when construction is exempt from local noise standards, this measure ensures that haul trucks would not be traveling on local public roads during non-exempt times of day. This time-of-day restriction applies to any vehicle with three or more axles, including trucks hauling equipment, construction materials, earthen material, and/or workers. Reclamation shall require its primary contractor, all subcontractors, and all vendors to acknowledge and commit to adhering to this restriction in their contracts and purchase orders.

Implementation of the nighttime restriction for construction-related truck traffic, as required by Mitigation Measure NOI-3, would reduce exposure of residential dwelling units to interior single noise events that exceed 45 dBA SEL generated by the passbys of trucks associated with construction under the action alternatives during the more noise-sensitive nighttime hours of 10:00 PM to 7:00 PM, as established by Fresno County.

Implementation of sound barriers along County Road 211 between North Fork Road and County Road 210, and the segment of County Road 210 between County Road 211 and proposed aggregate quarry haul road north of the proposed dam site, also required by Mitigation Measure NOI-3 if Quarry, Batch Plant, and Haul Road Option A is implemented, would reduce construction-related traffic noise level increases to less than 5 dBA L_{dn}. However, because the affected residents cannot be required to have a sound barrier installed, Impact NOI-3 would be **significant and unavoidable** under Quarry, Batch Plant, and Haul Road Option A. Under Quarry, Batch Plant, and Haul Road Options B and C, however, no sound barriers would be necessary to reduce traffic noise increases that exceed applicable traffic noise increase criteria. Therefore, Impact NOI-3 would be **less than significant** with implementation of Mitigation Measure NOI-3 under Quarry, Batch Plant, and Haul Road Options B and C.

Mitigation Measure NOI-5: Implement Measures to Reduce Exposure to Operational Traffic Noise along Wellbarn Road and Smalley Road

Reclamation will implement the following measures to reduce exposure of existing noise-sensitive receptors along Wellbarn Road, including Auberry School, and along Smalley Road to an incremental increase of less than 5 dBA L_{dn}.

Reclamation shall provide notification to potential recreation users when either the Wellbarn Road or Smalley Road boat ramps are at full capacity. Notification shall include posting signs on Auberry Road before the turnoff to Wellbarn Road, and on Powerhouse Road or Auberry Road before the turnoff to Smalley Road, notifying users that the respective Wellbarn Road or Smalley Road boat ramps, respectively, are at full capacity. These sign locations would help prevent any unnecessary trips on the Wellbarn Road and Smalley Road.

Reclamation shall offer the owners of all the residences with addresses on Wellbarn Road and the house located near its intersection with Ranch Road and the Auberry School the installation of a sound barrier along the property line of their affected residential properties. The sound barriers must be constructed of solid material (e.g., wood, brick, adobe, an earthen berm, or combination thereof). All barriers shall blend into the overall landscape and have an aesthetically pleasing appearance that agrees with the color and rural character of the houses and the general area, and not become the dominant visual element of the community. Relocation of the driveway at each residence may be necessary to preclude having gaps in the sound barrier. Relocation of landscaping may also be necessary to achieve an aesthetically pleasing appearance. The owners of the affected properties may choose to refuse this offer; however, the offer shall be made available to subsequent owners of the property. If an existing owner refuses these measures a deed notice must be included with any future sale of the property to comply with California state real estate law, which requires that sellers of real property disclose "any fact materially affecting the value and desirability of the property" (California Civil Code, Section 1102.1[a]) and shall indicate that Reclamation agrees to install a sound barrier, as described above.

To ensure compliance with applicable noise standards, a site-specific noise study shall be conducted by Reclamation or one of its approved consultants to determine specific noise barrier design.

The construction of sound barriers along Wellbarn Road would achieve the minimum 1.1 dBA L_{dn} reduction to ensure that the resultant traffic noise increase would not exceed the applicable Fresno County incremental increase standard of 5 dBA L_{dn}. The construction sound barriers along Smalley Road would achieve the minimum 0.3 dBA L_{dn} reduction to ensure that the resultant traffic noise increase would not exceed the applicable Fresno County standard of 5 dBA L_{dn}.

Implementation of Mitigation Measure NOI-5 would reduce traffic on Wellbarn Road and Smalley Road, and give affected residents along Wellbarn Road and the Auberry School the opportunity to reduce increases in traffic noise. However, because users would not be restricted from accessing Wellbarn Road or Smalley Road when traffic would exceed 5 dBA L_{dn}, and the school and residents cannot be required to have a sound barrier installed, Impact NOI-5 would be **significant and unavoidable**.