Chapter 5
Water Supply, Surface Hydrology, and Water Quality

5.1 Introduction

This chapter describes the environmental setting for water supply, surface hydrology, and water quality and the regulatory setting associated with these resource areas. It also evaluates the environmental impacts on water supply, surface hydrology, and water quality that could result from the Lower San Joaquin River (LSJR) alternatives and southern Delta water quality (SDWQ) alternatives, and, if applicable, offers mitigation measures that would reduce significant impacts.

The discussion and analysis of water supply, surface hydrology, and water quality is for the plan area, which includes: the LSJR, the three eastside tributaries of the LSJR (the Merced, Tuolumne, and Stanislaus Rivers), and the southern Delta. The LSJR and three eastside tributaries drain rainfall runoff and snowmelt from the western slopes of the Sierra Nevada. The operation of the three rim dams and associated major reservoirs on the eastside tributaries influences the flow and water quality in the rivers. These rim dams and reservoirs are New Exchequer Dam and Lake McClure Reservoir on the Merced River, New Don Pedro Dam and Reservoir on the Tuolumne River, and New Melones Dam and Reservoir on the Stanislaus River. This chapter also describes the surface hydrology and water quality of the Upper San Joaquin River (Upper SJR) (upstream of the Merced River confluence), since it flows into the LSJR, influencing flows at Vernalis. However, the Upper SJR is not considered part of the plan area for the purposes of evaluating the LSJR alternatives. Figure 1-1 depicts the San Joaquin River (SJR) Basin and Figure 1-2 depicts the plan area.

This chapter describes the baseline physical conditions and evaluates the expected changes in the baseline related to flows, salinity, temperature, and pollutant concentrations of the LSJR and the three eastside tributaries for the LSJR and SDWQ alternatives. Methodology descriptions and detailed results are presented in Appendix F.1, *Hydrologic and Water Quality Modeling*, and Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*.[1] The hydrologic modeling calculated the likely changes in river flows, surface water supply diversions, and flood-control releases that would result from the LSJR alternatives. As presented below, the LSJR alternatives would change the three eastside tributary river flows and the LSJR flows February–June, and have the potential to affect temperatures and pollutant concentrations in the three eastside tributaries and the LSJR, surface water diversions and reservoir operations in these tributaries, and salinity in the LSJR and southern Delta. In addition, because inflow from the LSJR to the Delta would change under the LSJR alternatives, the LSJR alternatives have the potential to alter the Central Valley Project (CVP) and State Water Project (SWP) water exports. The SDWQ alternatives have the potential to result in changes to the number of times the salinity objectives would be violated (as measured at the interior south Delta water quality monitoring stations), and would potentially affect agricultural beneficial uses in the southern Delta

[1] The analyses in Appendix F.1, *Hydrologic and Water Quality Modeling*, and Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*, measure salinity (EC) using microSiemens per centimeter (μS/cm). The text in this chapter primarily measures salinity using deciSiemens per meter (dS/m). However, tables may summarize results in μS/cm. The conversion is 1 dS/m = 1000 μS/cm.

(further discussion and analysis of agricultural resources is presented in Chapter 11, *Agricultural Resources*).

Impacts on water supply, surface hydrology, and water quality are summarized in Table 5-1. The impact analysis includes significance thresholds for determining significant impacts on water supply, surface hydrology, or water quality (salinity, temperature, or 303(d) pollutants). Significant impacts would result if the LSJR or SDWQ alternatives would substantially reduce river flows relative to baseline such that existing flow values (e.g., benefits) are reduced, substantially reduce (i.e., greater than 5 percent of the maximum demand) annual surface water supply diversions relative to baseline, violate salinity or temperature water quality objectives, or substantially degrade water quality such that it does not protect agricultural beneficial uses or results in an increased concentration of 303(d) pollutants. The impacts on other resources that are affected by changes in water supply, surface hydrology or water quality impacts are discussed in the following chapters: Chapter 6, *Flooding, Sediment, and Erosion;* Chapter 7, *Aquatic Resources;* Chapter 8, *Terrestrial Biological Resources;* Chapter 9, *Groundwater Resources*; Chapter 10, *Recreational Resources and Visual Quality*; Chapter 11, *Agricultural Resources*; and Chapter 13, *Service Providers*.

Impacts related to LSJR Alternative 1 and SDWQ Alternative 1 (No Project) are presented in Chapter 15, *LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, and the supporting technical analysis is presented in Appendix D, *Evaluation of LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*. Impacts related to methods of compliance are discussed in Appendix H, *Evaluation of Methods of Compliance*.

Table 5-1. Summary of Water Supply, Surface Hydrology, and Water Quality Impacts

Alternative	Summary of Impact(s)	Significance Determination
HYD-1: Substantially reduce monthly river flow values caused by the percent unimpaired flow objective		
LSJR Alternative 1	See note.[1]	
LSJR Alternative 2	Flows are reduced substantially on the Stanislaus River such that the average February–June flows value are reduced by 5% of the maximum flow when compared to the baseline flows; adaptive management cannot modify flows on this river as there would not be enough water to reallocate between months. Therefore, monthly river flow values would be substantially reduced on the Stanislaus. The average monthly flow values on the Merced and Tuolumne Rivers and LSJR would not be reduced by 5% of the maximum flow values.	Significant and unavoidable
LSJR Alternatives 3 and 4	The average monthly flow value would increase on the Stanislaus, Merced, and Tuolumne Rivers and LSJR; therefore, monthly river flow values would not be substantially reduced on these rivers when compared to baseline.	Less than significant
SDWQ Alternative 1	See note.[1]	
SDWQ Alternatives 2 and 3	The Vernalis objective would continue to be maintained and would not represent a change from baseline with respect to flow. Furthermore, these alternatives would not be related to percent of unimpaired flow.	No impact

Alternative	Summary of Impact(s)	Significance Determination
HYD-2: Substantially alter hydrology such that regulating reservoir operations are limited		
LSJR Alternative 1	See note.[1]	
LSJR Alternatives 2–4	The monthly average hydropower release flow variations are within the baseline. No substantial change in the flows or water elevations in the regulating reservoirs or in the river segments that connect the rim dams to the downstream regulating reservoirs would occur.	Less than significant
SDWQ Alternative 1	See note.[1]	
SDWQ Alternatives 2 and 3	The Vernalis objective would continue to be maintained and would not represent a change from baseline with respect to flow; therefore, substantial alterations to hydrology are not expected that would affect regulating reservoirs.	No impact
WS-1: Substantially reduce surface water supply diversions caused by a change in river flows or reduce exports to CVP and SWP export service areas caused by a change in river flows		
LSJR Alternative 1	See note.[1]	
LSJR Alternative 2	Surface water diversions would not be reduced greater than 5% of the maximum demand from the Stanislaus, Tuolumne, or Merced Rivers. A reduction in annual average exports to the CVP and SWP export service areas is not expected as a result of reduced inflow in some months from the LSJR. Therefore, a substantial reduction in surface water supply diversions or reduced exports would not occur.	Less than significant
LSJR Alternatives 3 and 4	Surface water diversions are expected to be reduced greater than 5% of the maximum demand and would be unable to be replaced by additional surface water diversions on the Stanislaus, Tuolumne, or Merced Rivers. However, a reduction in the annual average exports to the CVP and SWP export service areas is not expected as inflow would increase from the LSJR. Therefore, a substantial reduction in surface water supply diversions would occur, but a reduction in exports would not occur.	Significant and unavoidable
SDWQ Alternative 1	See note.[1]	
SDWQ Alternatives 2 and 3	See HYD-1.	No impact

Alternative	Summary of Impact(s)	Significance Determination
WQ-1: Violate water quality objectives by increasing in the number of months with EC[2] above the water quality objectives for salinity at Vernalis or southern Delta compliance stations		
LSJR Alternative 1	See note.[1]	
LSJR Alternative 2	There would be an increased incidence of EC values above the existing EC objectives for the interior southern Delta compliance stations; but they would not increase greater than 5%. Therefore, a violation of water quality objectives above the water quality objectives for salinity at Vernalis or southern Delta compliance stations would not occur because it is expected the slight increase would continue to protect beneficial uses.	Less than significant
LSJR Alternatives 3 and 4	There would be an overall reduction in monthly exceedences for the interior southern Delta compliance stations. Therefore, a violation of water quality objectives above the water quality objectives for salinity at Vernalis or southern Delta compliance stations would not occur.	Less than significant
SDWQ Alternative 1	See note.[1]	
SDWQ Alternative 2	There would be an overall reduction of EC values above the 1.0 dS/m EC objective when compared to existing EC objectives. Therefore, a violation of water quality objectives above the water quality objectives for salinity at Vernalis or southern Delta compliance stations would not occur.	Less than significant
SDWQ Alternative 3	There would be a reduction of monthly exceedances when compared to existing EC objectives. Therefore, a violation of water quality objectives above the water quality objectives for salinity at Vernalis or southern Delta compliance stations would not occur.	Less than significant
WQ-2: Substantially degrade water quality by increasing Vernalis and/or southern Delta salinity (EC) such that agricultural beneficial uses are impaired		
LSJR Alternative 1	See note.[1]	
LSJR Alternative 2	The range of average EC values during the irrigation season of April–September in the SJR at Vernalis and in the southern Delta channels under LSJR Alternative 2 would remain very similar to baseline salinity conditions, and would not experience an increase of more than 5% of the EC objective (0.035 dS/m); accordingly, it is not anticipated that agricultural beneficial uses would be impaired.	Less than significant

[2] EC is electrical conductivity, which is generally expressed in deciSiemens per meter (dS/m) in this chapter and document. Measuring EC assesses salinity, which is the concentration of dissolved salts (often expressed in parts per thousand or parts per million). Because salinity refers to salt concentration in the water, whereas EC values are the result of one measurement technique to assess salinity, both "EC" and the more general term "salinity" are used in this chapter.

Alternative	Summary of Impact(s)	Significance Determination
LSJR Alternatives 3 and 4	The range of average EC values during the irrigation season of April–September in the SJR at Vernalis in the southern Delta channels is expected to be reduced; accordingly, it is not anticipated that agricultural beneficial uses would be impaired.	Less than significant
SDWQ Alternative 1	See note. [1]	
SDWQ Alternatives 2 and 3	There would be no change in water quality relative to baseline; accordingly, it is not anticipated agricultural beneficial uses would be impaired.	Less than significant
WQ-3: Substantially degrade water quality by increasing water temperature caused by reduced river flows		
LSJR Alternative 1	See note.[1]	
LSJR Alternative 2	The average monthly water temperatures would not increase more than 2°F in the Merced and Tuolumne Rivers and LSJR; but are expected to increase by more than the 2°F in April, May, and June in the Stanislaus River as a result of lower river flows in low runoff months in some years. Therefore, it is expected that the increase in water temperatures would substantially degrade water quality.	Significant and unavoidable
LSJR Alternatives 3 and 4	The average monthly water temperatures would not increase more than 2°F in the Merced, Tuolumne, and Stanislaus Rivers and the LSJR. Therefore, it is expected that the change in water temperatures would not substantially degrade water quality.	Less than significant
SDWQ Alternative 1	See note.[1]	
SDWQ Alternatives 2 and 3	These alternatives do not have the ability to change temperature in a river because it sets a water quality objective for salinity (not temperature).	No impact
WQ-4: Substantially degrade water quality by increasing contaminant concentrations caused by reduced river flows		
LSJR Alternative 1	See note.[1]	
LSJR Alternative 2	Flows are reduced on the Stanislaus and Tuolumne Rivers in some months such that contaminant concentrations would increase by more than 50% of the baseline concentrations. Therefore, it is expected that this increase in concentration would substantially degrade water quality. Flows are not reduced substantially on the Merced River or the LSJR.	Significant and unavoidable
LSJR Alternatives 3 and 4	Flows are not reduced substantially and baseline contaminant concentrations would not increase by more than 50% of the baseline concentrations on the Stanislaus, Tuolumne or Merced Rivers or the LSJR. Therefore, it is expected that the change in concentrations would not substantially degrade water quality.	Less than significant
SDWQ Alternative 1	See note.[1]	

Alternative	Summary of Impact(s)	Significance Determination
SDWQ Alternatives 2 and 3	These alternatives do not have the ability to result in an increase in contaminant concentrations because the Vernalis objective would continue to be maintained and does not represent a change from baseline with respect to flow.	No impact

Note:

[1] The No Project Alternative would result in implementation of flow objectives and salinity objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project impact discussion and Appendix D, *Evaluation of LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project Alternative technical analysis.

5.2 Environmental Setting

This section describes the water supply conditions (reservoir operations and surface water diversions), surface hydrology conditions (stream flows) and water quality conditions (salinity and temperature) for the Upper SJR, the LSJR, and the three eastside tributaries, including the following topics, which are important to the subsequent impact analysis.

- Rainfall runoff and snowmelt components of the unimpaired flows for each of the rivers related to the percent of unimpaired flow requirements under each LSJR alternative.
- Beneficial uses, water quality objectives, criteria, and impairments, which are related to potential water quality impacts, for each of the rivers and southern Delta.
- Existing reservoir operations, related to potential water supply impacts, for water supply, hydropower generation, and flood control.
- Existing surface water diversions on the three eastside tributaries related to beneficial uses and potential water supply impacts.
- Existing minimum flow requirements on the three eastside tributaries below the rim dams related to potential effects of the LSJR alternatives on flows.
- Existing salinity, temperature, and other important water quality parameters (e.g., boron) related to potential water quality impacts and subsequent temperature impacts of the Upper SJR, LSJR, eastside tributaries, and the southern Delta.
- Existing relationships, related to water quality and the SDWQ alternatives, between SJR flow, reservoir releases, local runoff, treated wastewater discharges, and agricultural drainage flows on salinity (e.g., dissolution and dilution) in the LSJR and the southern Delta.

The unimpaired and historical flows are summarized using monthly average flows for the tributaries and Upper SJR and LSJR in Sections 5.2.2–5.2.6. Additional information about unimpaired and historical flows is in Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*. The hydrology and water quality of the southern Delta is strongly influenced by the SJR inflow at Vernalis and the CVP and SWP export pumping near Tracy. The monthly range of CVP and SWP southern Delta export pumping is detailed in Section 5.2.7.

5.2.1 San Joaquin River Basin and Southern Delta Hydrology and Water Quality

Following is a summary of unimpaired flow and the measured (historical) flows of the SJR Basin and southern Delta, as well as a general discussion of water quality criteria (beneficial uses, objectives, and impairments) within the SJR Basin and southern Delta. Existing flow data and water quality data, specifically salinity and temperature data, is described for the Upper SJR, LSJR, three eastside tributaries, and the southern Delta to establish the baseline physical conditions for comparison with the changes that are expected for the LSJR and SDWQ alternatives in Section 5.4. Specific details of flow and water quality associated with the Upper SJR, the three eastside tributaries, the LSJR, and the southern Delta are presented in Sections 5.2.2–5.2.7.

Unimpaired and Historical Flow

In the Sierra Nevada, with the combination of rainfall runoff, winter snowpack accumulation, and spring snowmelt, there is a typical monthly progression of fall storm flows, winter storm flows and snowpack accumulation, spring snowmelt, and summer groundwater discharge (i.e., baseflow) (McBain and Trush 2000; Kondolf et al. 2001; Stillwater Sciences 2002; Cain et al. 2003). These seasonal flow characteristics are observed in all three eastside tributaries to the SJR in nearly all years, with wide variations in runoff volume from year to year.

The hydrology of the SJR as measured at Vernalis is greatly altered from the unimpaired runoff conditions. Unimpaired flow is the river flow at a specified location that would occur if all runoff from the watershed remained in the river, without storage or diversion. Construction of many dams and agricultural diversions have altered the natural hydrology of the SJR and its major tributaries (McBain and Trush 2000; Kondolf et al. 2001; Cain et. al 2003; Brown and Bauer 2009). The unimpaired monthly hydrology is used to describe the LSJR alternatives, which reflect the year-to-year variations in monthly runoff that are observed in Central Valley hydrology and approximate flows of a more natural pattern. Therefore, it is important to describe and understand the unimpaired flows of the SJR Basin and three eastside tributary watersheds. Runoff from the SJR Basin and three eastside tributary watersheds shows wide annual, monthly (i.e., seasonal changes), and daily (i.e., storm events) variations and is modified by reservoir storage, diversions, and agricultural return flows from irrigated lands.

The SJR Basin is subject to two types of floods; prolonged rainstorms during the winter and rapid snowpack melting in the late spring and early summer of heavy snowfall years. Floods along foothill streams (without storage dams), and the LSJR, where flood flows often exceed channel capacities and damage urban and agricultural levees or flood portions of these areas. Floods are generally controlled below dams because the reservoir operations include sufficient flood storage space to reduce the reservoir releases to the specified maximum flood-control flows, except for rare events when the spillways must be used (e.g., January 1997). Table 5-2 shows the watershed areas, median unimpaired runoff, and storage reservoirs for the SJR at Friant Dam and the three eastside tributaries.

Table 5-2. Watershed Characteristics for the SJR at Friant Dam and the LSJR Eastside Tributaries

	Stanislaus River	Tuolumne River	Merced River	SJR at Friant Dam
Characteristic				
Drainage Area of Tributary at Confluence with the SJR	1,195 square miles (980 square miles [82%] upstream of Goodwin Dam)	1,870 square miles (1,533 square miles [82%] upstream of La Grange Dam)	1,270 square miles (1,067 square miles [84%] upstream of Merced Falls)	1,660 square miles
Miles Downstream to Mouth	59 miles below Goodwin Dam	52 miles below La Grange Dam	52 miles below Crocker-Huffman Dam	NA
Average and Median Annual Unimpaired Flow (1922-2003)	1,120/1,080 TAF	1,853/1,720 TAF	960/894 TAF	1,732/1,453 TAF
Major Storage Reservoir	New Melones Dam and Reservoir (2,400 TAF)	New Don Pedro Dam and Reservoir (2,030 TAF)	New Exchequer Dam, Lake McClure (1,020 TAF)	Friant Dam, Millerton Lake (520 TAF)
Total Watershed Storage	2. 85 MAF	2. 94 MAF	1. 04 MAF	1. 15 MAF

Source: Adjusted from Cain et al. 2003
NA = Not applicable
TAF = thousand acre-feet
MAF = million acre-feet

Beneficial Uses

Beneficial uses are designated for specific water bodies, either as existing or potential, by each regional water board in their respective water quality control plans (WQCPs), or basin plans. For water bodies where beneficial uses have not been identified specifically in a basin plan, the *tributary rule* allows a regional water board to apply the designated beneficial uses that exist in the nearest downstream tributary. The 2006 *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary* (2006 Bay-Delta Plan) identifies beneficial uses within the Delta (See Section 5.3 for a discussion of the 2006 Bay-Delta Plan). Additionally, the *Fourth Edition Water Quality Control Plan for the Sacramento River and San Joaquin River Basins* (Basin Plan) (Central Valley Water Board) identifies beneficial uses of the Delta and SJR areas within its jurisdiction. Water bodies in the plan area are used for many purposes, as evidenced by the number of beneficial uses shown in Table 5-3.

Table 5-3. Designated Beneficial Uses for Water Bodies in the SJR Basin and Southern Delta

Name[a]	Abbreviation[a]	Beneficial Uses[a]
Designated Beneficial Uses Common to Inland Waters in All Basin Plans and the Delta		
Municipal and Domestic Supply	MUN	Uses of water for community, military, or individual water supply systems including drinking water supply
Agricultural Supply	AGR	Uses of water for farming, horticulture, or ranching including irrigation (including leaching of salts), stock watering, or support of vegetation for range grazing
Industrial Service Supply	IND	Uses of water for industrial activities that do not depend primarily on water quality, including mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, and oil well pressurization
Industrial Process Supply	PRO	Uses of water for industrial activities that depend primarily on water quality
Groundwater Recharge	GWR	Uses of water for natural or artificial recharge of groundwater for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers
Navigation	NAV	Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels
Water Contact Recreation	REC-1	Uses of water for recreational activities involving body contact with water where ingestion of water is reasonably possible, including swimming, wading, water-skiing, skin and scuba diving, surfing, white-water activities, fishing, and use of natural hot springs
Non-Contact Water Recreation	REC-2	Uses of water for recreational activities involving proximity to water but where there is generally no body contact with water or any likelihood of ingestion of water, including picnicking, sunbathing, hiking, beachcombing, camping, boating, tide pool and marine life study, hunting, sightseeing, and aesthetic enjoyment in conjunction with the above activities
Commercial and Sport Fishing	COMM	Uses of water for commercial or recreational collection of fish, shellfish, or other organisms, including uses involving organisms intended for human consumption or bait purposes
Warm Freshwater Habitat	WARM	Uses of water that support warm water ecosystems, including preservation or enhancement of aquatic habitats, vegetation, fish, and wildlife, including invertebrates
Cold Freshwater Habitat	COLD	Uses of water that support cold water ecosystems, including preservation or enhancement of aquatic habitats, vegetation, fish, and wildlife, including invertebrates
Wildlife Habitat	WILD	Uses of water that support terrestrial or wetland ecosystems, including preservation and enhancement of terrestrial habitats or wetlands, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), and wildlife water and food sources
Preservation of Biological Habitats of Special Significance	BIOL	Uses of water that support designated areas or habitats, such as established refuges, parks, sanctuaries, ecological reserves, or Areas of Special Biological Significance, where the preservation or enhancement of natural resources requires special protection

Name[a]	Abbreviation[a]	Beneficial Uses[a]
Rare, Threatened, or Endangered Species	RARE	Uses of water that support aquatic habitats necessary, at least in part, for the survival and successful maintenance of plant and animal species established under state or federal law as rare, threatened, or endangered
Migration of Aquatic Organisms	MIGR	Uses of water that support habitats necessary for migration and other temporary activities by aquatic organisms, such as anadromous fish
Spawning, Reproduction, and/or Early Development	SPWN	Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish
Shellfish Harvesting	SHELL	Uses of water that support habitats suitable for the collection of filter feeding shellfish (e.g., clams, oysters, mussels) for human consumption, commercial, or sport purposes
Additional Beneficial Uses of the Delta		
Estuarine Habitat	EST	Uses of water that support estuarine ecosystems, including preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, and wildlife (e.g., estuarine mammals, waterfowl, shorebirds)
Freshwater Replenishment[b]	FRSH	Uses of water for natural or artificial maintenance of surface water quantity or quality
Hydropower Generation[b]	POW	Uses of water for hydropower generation
Aquaculture[b]	AQUA	Uses of water for aquaculture or mariculture operations, including propagation, cultivation, maintenance, and harvesting of aquatic plants and animals for human consumption or bait purposes

Source: Central Valley Regional Water Quality Control Board 2009a; San Francisco Bay Regional Water Quality Control Board 2007; State Water Resources Control Board 2006.

[a] The names, abbreviations, and beneficial use descriptions are not identical in each basin plan.

[b] Potential beneficial use identified in Sacramento–San Joaquin Basin Plan.

Water Quality Objectives and Criteria

The following terms are used to describe water quality standards in the State Water Board's environmental analysis: *numerical and narrative basin plan water quality objectives*, *California Toxics Rule (CTR) criteria*, and *U.S. Environmental Protection Agency (USEPA) recommended criteria*.

Numerical and Narrative Basin Plan Water Quality Objectives. The State Water Board's 2006 Bay-Delta Plan and each regional water board's basin plan identifies numeric and narrative water quality objectives, together with the beneficial uses assigned to water bodies and the state antidegradation policy. By definition, basin plan objectives have gone through the standard-setting process, which includes public participation, consideration of economics, environmental review, and state and federal agency review and approval. Consequently, basin plan objectives are legally applicable and enforceable. Objectives applicable to the Delta, regulated through water rights conditioned by the State Water Board, are found in the 2006 Bay-Delta Plan. Objectives applicable to the Delta and other surface waters, regulated through point and nonpoint source controls, are found in the Central Valley Water Board's Basin Plan.

California Toxics Rule Criteria. The CTR criteria were established through the USEPA-led water quality standard–setting process. Hence, the CTR criteria, together with the beneficial uses assigned to water bodies and the state antidegradation policy, constitute additional water quality criteria for surface waters (beyond those specified in the basin plans). These are applicable to all surface waters in California.

USEPA Recommended Criteria. USEPA periodically recommends ambient water quality criteria to states for their consideration in adopting state standards. As stated by USEPA, the USEPA recommended criteria (also referred to as 304[a][1] criteria) "…are not regulations, and do not impose legally binding requirements on EPA, States, tribes or the public. " Therefore, USEPA recommended criteria and other nonenforceable guidance values are referred to as *advisory* when discussed in this chapter in order to distinguish them from adopted objectives and criteria.

Numerical water quality objectives typically specify the concentration value of a particular constituent as well as an averaging period to which the concentration value applies to protect a particular beneficial use. Averaging periods typically depend on the sensitivity of the use, such as a 1-hour averaging period for objectives designed to prevent acute toxicity in aquatic life, to longer averaging periods (e.g., 30-day or annual average) for less sensitive effects (e.g., human health effects, industrial uses, agricultural crop production). The value of some numerical water quality objectives depends on the prevailing ambient freshwater and saltwater salinity conditions. The salinity conditions across the large majority of the Delta are sufficiently low that the Delta channels are subject to the freshwater regulatory water quality criteria/objectives. However, tidal influence and associated saltwater intrusion can result in salinity that requires regulation with saltwater criteria/objectives. Tables 2 and 3 of the 2006 Bay-Delta Plan include objectives for the southern Delta to protect the beneficial uses of fish and wildlife and agriculture, respectively. Generally, these objectives include the following.

- Under all water year types, the three interior southern Delta compliance stations and the SJR at Airport Way Bridge, Vernalis station have a maximum 30-day running average of mean daily EC (dS/m) of 0.7 April–August and 1.0 September–March.
- Under different water year types, the SJR at Airport Way Bridge, Vernalis, the minimum monthly flow requirements (cfs) are set at various times of the year. Particularly they are set February–April 14 and May 16–June, April 15–May 15, and October.

State objectives can be numeric or narrative. A numeric objective defines a concentration that must not be exceeded for a parameter (e.g., 10 milligrams per liter [mg/L]). A narrative objective establishes a *desired level of protection* or describes a *favorable condition to be achieved* rather than defining a specific numerical concentration. An example of a narrative objective is "Waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses. "

Water Quality and Impairments

Under CWA Section 303(d), states, territories, and authorized tribes are required to develop a ranked list of water-quality limited segments of rivers and other water bodies under their jurisdictions. Listed waters are those that do not meet water quality standards even after point sources of pollution have installed the minimum required levels of pollution-control technology. The law requires that action plans, or total maximum daily loads (TMDLs), be developed to monitor and improve water quality. TMDL is defined as the sum of the individual waste load allocations from point sources, load allocations from nonpoint sources and background loading, plus an appropriate margin of safety. A TMDL defines the maximum amount of a pollutant that a water body can receive and still meet water quality standards. TMDLs can lead to more stringent National Pollutant Discharge Elimination System (NPDES) permits (CWA § 402) as discussed in in Section 5.3.1, of this chapter.

Impaired waters in the plan area have been identified through the following: ongoing environmental planning, regulatory, and monitoring processes. Important programs are CALFED, the basin plan functions of the Central Valley Water Board, Bay-Delta Plan functions of the State Water Board, and the Clean Water Act (CWA) Section 303(d) listing process for state water bodies that do not meet applicable water quality objectives. In October 2011, USEPA gave final approval to the Section 303(d) list of impaired waters based on recommendations from regional boards and information solicited from the public and other interested parties. Table 5-4 shows the constituents identified in the Section 303(d) list for impaired waters in the plan area.

Table 5-4. Clean Water Act Section 303(d) Listed Pollutants and Sources for SJR Basin and the Southern Delta

Pollutant/Stressor	Listed Source	Location of Listing
Arsenic	Source unknown	Upper SJR (Bear Creek to Mud Slough)
Boron	Agriculture	LSJR (Merced to Tuolumne), Upper SJR (Mendota Pool to Bear Creek), Upper SJR (Bear Creek to Mud Slough), Upper SJR (Mud Slough to Merced River)
Chlorpyrifos	Agriculture, urban runoff/ storm sewers	Merced River (Lower), Tuolumne River (Lower), Stanislaus River (Lower), LSJR (Merced to Tuolumne), LSJR (Tuolumne to Stanislaus), LSJR (Stanislaus to Delta boundary), southern Delta, Upper SJR (Mendota Pool to Bear Creek), Upper SJR (Bear Creek to Mud Slough), Upper SJR (Mud Slough to Merced River)
Dacthal	Agriculture	LSJR (Stanislaus to Delta boundary), Upper SJR (Bear Creek to Mud Slough)
Dichlorodiphenyldichloroethylene (DDE)	Agriculture	LSJR (Merced to Tuolumne)
Dichlorodiphenyltrichloroethane (DDT)	Agriculture, nonpoint source	Southern Delta, LSJR (Merced to Tuolumne), LSJR (Tuolumne to Stanislaus), LSJR (Stanislaus to Delta boundary), Upper SJR (Mendota Pool to Bear Creek). Upper SJR (Bear Creek to Mud Slough), Upper SJR (Mud Slough to Merced River)
Diazinon	Agriculture, urban runoff/ storm sewers	Merced River (Lower), Tuolumne River (Lower), Stanislaus (Lower), LSJR (Tuolumne to Stanislaus), southern Delta, Upper SJR (Mendota Pool to Bear Creek). Upper SJR (Mud Slough to Merced River)
Diuron	Agriculture	LSJR (Stanislaus to Delta boundary)
Escherichia coli (E. coli)	Source unknown	Merced River (Lower), LSJR (Stanislaus to Delta boundary), Upper SJR (Mud Slough to Merced River)
Invasive species	Source unknown, ballast water	Southern Delta

Pollutant/Stressor	Listed Source	Location of Listing
Group A pesticides	Agriculture	Merced River (Lower), Tuolumne River (Lower), Stanislaus (Lower), LSJR (Tuolumne to Stanislaus), LSJR (Stanislaus to Delta boundary), southern Delta, Upper SJR (Mendota Pool to Bear Creek), Upper SJR (Bear Creek to Mud Slough), Upper SJR (Mud Slough to Merced River)
Mercury	Resource extraction, industrial-domestic wastewater, atmospheric deposition, nonpoint source	Merced River (Lower), Tuolumne River (Lower), Stanislaus (Lower), LSJR (Tuolumne to Stanislaus), LSJR (Stanislaus to Delta boundary), southern Delta, Upper SJR (Bear Creek to Mud Slough), Upper SJR (Mud Slough to Merced River)
Salinity (EC)	Agriculture	Southern Delta, LSJR (Merced to Tuolumne), LSJR (Tuolumne to Stanislaus), Upper SJR (Mendota Pool to Bear Creek), Upper SJR (Bear Creek to Mud Slough), Upper SJR (Mud Slough to Merced River)
Selenium	Agriculture	Upper SJR (Mud Slough to Merced River)
Toxaphene	Source unknown	LSJR (Stanislaus to Delta boundary)
Temperature, water	Source unknown	Merced River (Lower), Tuolumne River (Lower), Stanislaus River (Lower), LSJR (Merced to Tuolumne), LSJR (Tuolumne to Stanislaus), LSJR (Stanislaus to Delta boundary)
Total dissolved solids (TDS)	Source Unknown	Southern Delta
Unknown toxicity	Source unknown	Merced River (Lower), Tuolumne River (Lower), Stanislaus River (Lower), LSJR (Merced to Tuolumne), LSJR (Stanislaus to Delta boundary), southern Delta, Upper SJR (Mendota Pool to Bear Creek), Upper SJR (Bear Creek to Mud Slough)
Source: Central Valley Water Board 2009b		

There are several ongoing watershed-monitoring programs in the plan area. These monitoring programs are associated with Section 303(d) TMDL programs, the State Water Board Surface Water Ambient Monitoring Program, and numerous other efforts of local governments and public/private entities.

Section 303(d) requires that states evaluate and rank water quality impairments that cannot be resolved through point source controls and, in accordance with the priority ranking, evaluate the TMDL for those pollutants USEPA identifies under Section 304(a)(2) as suitable for such calculation. The TMDL must be established at a level necessary to implement the applicable water quality standards with seasonal variations and a margin of safety that takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality. As mentioned above, the TMDL is the amount of loading that the water body can receive and still meet water quality standards. The TMDL must include an allocation of allowable loadings to point and nonpoint sources, with consideration of background loadings. Table 5-5 summarizes the TMDLs that have been completed or are being developed for Section 303(d) listed constituents within the plan area (Central Valley Water Board 2009b).

Table 5-5. Summary of Completed and Ongoing Total Maximum Daily Loads in the Southern Delta and SJR

Pollutant/Stressor	Water Bodies Addressed	TMDL Status
Chlorpyrifos and diazinon	LSJR	TMDL report completed—October 2005 State-Federal approval—December 2006
Chlorpyrifos and diazinon	SJR and Delta	TMDL report completed—June 2006 State-Federal approval—October 2007
Mercury/methylmercury	Delta	TMDL report completed—April 2010
Mercury/methylmercury	Reservoirs	Ongoing
Pesticides	Basin-wide	Ongoing
Organochlorine pesticides	SJR tributaries; Delta	Ongoing
Salt and boron	SJR at Vernalis	TMDL report completed—October 2005 State-Federal approval—February 2007
Selenium	SJR at Vernalis	TMDL report completed—August 2001 State-Federal approval—March 2002

Source: Central Valley Water Board 2009b.
SJR = San Joaquin River
TMDL = total maximum daily load

Constituents of concern that impair water quality in the plan area are those that, at elevated concentrations, have the potential to significantly impact one or more beneficial uses (Table 5-3), such as the constituents identified from the Section 303(d) listing process described above (Tables 5-4 and 5-5). For example, salinity is an important parameter of concern for the southern Delta and Bay-Delta that reflects the total ionic content of the water, ranging from very low levels deemed fresh water to the high salinity content of seawater. Chloride, bromide, sulfate, and boron are specific ions that contribute to overall salinity and are constituents of concern. Salinity can affect multiple beneficial uses, including defining the types and distribution of aquatic organisms that are adapted to fresh water versus brackish, or saline, water conditions in the Delta. Agricultural users are also concerned with boron and salinity. Many crops are sensitive to these constituents, which can affect their yield.

In addition to salinity-causing ions, there are numerous other constituents that impair water quality, including temperature, turbidity and suspended sediment, dissolved oxygen (DO), pesticides, herbicides, nutrients, and trace metals and can result in significant impacts on aquatic life. Trace metals, pesticides, and herbicides can be toxic to aquatic life at relatively low concentrations. Temperature and DO are of concern because the eastside tributaries, LSJR, and southern Delta serve as a migration and rearing corridor for anadromous salmonids, which are sensitive to these parameters. Excess nutrients can cause blooms of nuisance algae and aquatic vegetation, and their decay can result in depleted DO.

As noted in Table 5-4, the entire Delta is identified on the Section 303(d) list as impaired by unknown toxicity. Aquatic toxicity refers to the mortality of aquatic organisms or sublethal effects (e.g., significant impacts on growth, reproductive success). Aquatic toxicity can be caused by any number of individual constituents of concern, or through additive and synergistic effects attributable to the presence of multiple toxicants.

Salinity and Water Temperature

As indicated above in Table 5-4, the SJR between the Merced and Stanislaus Rivers is considered impaired by high salinity, and the lower portions of the Merced, Tuolumne, Stanislaus, and SJR to the Delta are considered to be impaired by elevated water temperatures. Temperature and salinity are the two main water quality parameters that may be affected by the alternatives.

The SJR is unusual because salinity tends to be lower downstream (e.g., at Vernalis) than upstream of the Merced River confluence. High salinity upstream of the Merced River confluence is due to heavy contributions of salts from Salt and Mud Sloughs, as well as water re-circulated from the Delta via the Delta-Mendota Canal and agricultural return flows. As water moves downstream, the Merced, Tuolumne, and Stanislaus Rivers dilute the salinity in the SJR because they have relatively high flows, but contribute little salt to the system. Current water quality objectives specify that SJR water entering the southern Delta at Vernalis should remain below 1.000 dS/m during September through March and below 0.700 dS/m during April through August. Because of the relatively low salinity in the three eastside tributaries, it has been possible to attain this objective by increasing releases from New Melones Reservoir on the Stanislaus River when necessary. Salinity conditions in the LSJR, Merced, Tuolumne, and Stanislaus Rivers are described in more detail below and in Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*.

During the warmer months, water released from the three large reservoirs on the Stanislaus, Tuolumne, and Merced Rivers is relatively cool. Cool water accumulates in the reservoirs during the rainy season and during spring runoff. The cool water at the bottom of the reservoirs is minimally affected by seasonal warming that occurs at the surface during the warmer months. However, when cool water is released from the bottom of the reservoirs through the late spring, summer, and fall, the cool water supply can become depleted, potentially causing the temperature of the water that is released to the river to become warmer. While large releases may deplete cool water in reservoirs, they can also help to reduce warming along the length of a river during the warmer months. Higher flows result in faster travel times, which allow water to move farther downstream before warming to reach equilibrium with environmental conditions. Baseline water temperature conditions are described in detail in Appendix F.1, *Hydrologic and Water Quality Modeling*.

5.2.2 Upper San Joaquin River

Unimpaired and Historical Flow

The SJR watershed upstream of Friant Dam covers an area of about 1,660 square miles. The SJR watershed upstream of the Merced River confluence is approximately 5,800 square miles, but most of the natural runoff originates upstream of Friant Dam. Several reservoirs in the upper portion of the SJR Basin, including Edison, Florence, Huntington, Mammoth Pool, and Shaver Lake, are primarily used for seasonal storage for hydroelectric power generation. These upstream reservoir operations affect inflows to Millerton Lake, the reservoir behind Friant Dam. The average annual unimpaired runoff estimated at Friant Dam is about 1,732 thousand acre-feet (TAF) and the median runoff is about 1,453 TAF. The reservoir provides a maximum storage of 520 TAF, provides flood control for the SJR, provides downstream releases to supply senior water rights diversions, and provides diversions into the Madera and Friant-Kern Canals. Flood-control storage space in Millerton Lake is limited, and additional flood control is provided by the upstream reservoirs.

There are two existing requirements for flow below Friant Dam. A minimum of 5 cubic feet per second (cfs) is required below the last water right diversion located about 40 miles downstream near Gravelly Ford. A maximum river release of about 125 cfs in the summer months supplies these downstream riparian and water right users. The maximum flood-control release from Friant Dam (established by USACE) is 8,000 cfs. The U. S. Bureau of Reclamation (USBR) is undertaking the SJR Restoration Program[3] which will provide water throughout the year to reconnect the upstream river below Friant to the SJR at the mouth of the Merced River. In 2006, parties to *NRDC v. Rodgers* executed a stipulation of settlement that calls for, among other things, restoration of flows on the Upper SJR from Friant Dam to the confluence of the Merced River. Required release flows from Friant Dam for each water year type have been identified, but the amount of this Upper SJR water that would be observed at the mouth of the Merced River is unresolved.

Table 5-6a shows the monthly cumulative distribution[4] of SJR unimpaired runoff (cfs) at Friant Dam for 1922–2003. The range of monthly runoff is summarized with a cumulative distribution at each 10th percentile from the minimum to the maximum. The median (50 percent cumulative) monthly values provide a good summary of the seasonal pattern. The maximum runoff was in April, May, and June. The minimum runoff was in September, October, and November. The estimated median unimpaired flow pattern in the February–June period was 1,340 cfs in February, 1,925 cfs in March, 3,966 cfs in April, 6,916 cfs in May, and 5,430 cfs in June. The range of flows in these months is quite large from year to year.

Table 5-6b shows the monthly cumulative distribution of historical (observed) flow below Friant Dam (cfs) for 1985–2009 (most recent 25-year period). The highest median flows of 200 cfs are in June, July, and August. The highest historical flows (90 percent cumulative) were greater than 2,000 cfs in February–June, indicating that flood-control releases were made in a few years for each of these months. The historical average annual flow volume released from Friant Dam was about 400 TAF, which was 25 percent of unimpaired flow. The median annual flow volume was about 130 TAF, indicating that the flood releases in a few years raised the average flow volume below Friant Dam to about three times the median flow.

[3] Implementation of the settlement and the Friant Dam release flows required by the San Joaquin River Restoration Program are not part of the alternatives described in Chapter 3, *Alternatives Description*; however, it is expected they would increase the existing SJR flows at Stevinson in the near future.

[4] The cumulative distribution of a particular variable (e.g., flow, salinity, temperature) is determined by sorting the values from minimum to maximum and graphing them as the percentage of the total number of values. The lowest value is at the left of the graph (e.g., 0 percent) and the highest value is at the right of the graph (100 percent). The cumulative distribution indicates the probability of occurrence for the variable. This term is not referring to, and should not be confused with, the term cumulative impacts, which is a specific CEQA term. A discussion of cumulative impacts for CEQA purposes is provided at the end of resource chapters (Chapters 5–14), Chapter 4, *Introduction to Analysis*, Chapter 15, *LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, and Chapter 16, *Cumulative Impact Summary, Growth-Inducting Effects, and Irreversible Commitment of Resources*.

Table 5-6a. Monthly Cumulative Distribution of SJR Unimpaired Flow (cfs) at Friant Dam for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Annual (TAF)
Minimum	81	95	121	161	204	305	957	1,216	587	260	150	75	362
10%	115	171	237	296	541	1,079	2,134	3,400	2,029	667	233	127	803
20%	157	223	267	384	760	1,353	2,583	3,907	2,487	754	282	169	936
30%	171	257	345	535	956	1,545	2,889	5,063	3,552	920	363	194	1,128
40%	206	290	508	632	1,111	1,731	3,399	6,084	4,675	1,462	440	226	1,250
50%	266	354	584	768	1,340	1,925	3,966	6,916	5,430	1,868	556	259	1,453
60%	301	436	723	1,105	1,800	2,146	4,194	7,560	6,209	2,365	701	312	1,856
70%	338	546	894	1,332	2,050	2,614	4,693	8,283	8,052	2,968	840	382	2,048
80%	389	706	1,187	1,833	2,889	3,334	5,194	9,677	9,793	4,319	1,191	551	2,410
90%	544	1,101	1,892	2,743	3,741	3,773	5,879	11,456	10,789	5,982	2,056	699	3,044
Maximum	2,048	4,151	7,489	11,953	8,506	7,895	10,300	17,826	19,597	12,225	4,558	2,853	4,642
Average	315	563	969	1,351	1,837	2,342	3,978	7,043	6,275	2,736	850	404	1,732

cfs = cubic feet per second
TAF = thousand acre-feet

Table 5-6b. Monthly Cumulative Distribution of SJR Historical Flow (cfs) below Friant Dam for 1985–2009

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Annual (TAF)
Minimum	61	56	36	32	39	36	97	121	136	150	124	114	64
10%	107	73	58	39	67	88	107	126	153	172	152	132	81
20%	124	96	78	58	78	92	119	144	182	198	191	157	103
30%	146	107	93	85	87	109	139	158	194	209	199	173	114
40%	155	118	97	94	95	119	144	165	244	219	208	183	121
50%	158	120	103	96	100	137	156	181	281	232	232	189	132
60%	160	125	104	100	110	174	192	218	301	260	245	219	161
70%	174	133	110	111	127	422	253	262	345	281	261	237	302
80%	190	147	117	118	457	1,004	1,258	1,016	637	573	278	251	766
90%	215	173	164	203	2,260	2,076	4,652	4,672	2,946	739	318	292	1,305
Maximum	357	378	1,147	9,144	6,514	6,548	7,367	7,637	6,535	5,322	464	383	1,657
Average	165	129	156	468	674	802	1,172	1,172	973	659	239	209	411

cfs = cubic feet per second
TAF = thousand acre-feet

Figure 2-4 shows the monthly unimpaired and historical SJR flows below Friant Dam for the most recent 10-year period of 2000–2009. The average unimpaired flow for this 10-year period was 1,687 TAF (97 percent of the 1922–2003 average). The historical flows were much less than the unimpaired flows except in wet years when flood releases were more than half of the unimpaired runoff (e.g., 2005 and 2006). Most of the runoff was seasonally stored in upstream reservoirs and in Millerton Lake and diverted to the Friant-Kern and Madera canals for irrigation. During high-flow years, however, there are considerable flood-control releases from Friant Dam.

Additional flow enters the SJR from the Chowchilla and the Fresno Rivers and smaller creeks. These two rivers have smaller watersheds that do not extend to the crest of the Sierra Nevada and, consequently, have much less runoff, most of which is stored for irrigation uses. In wet years, some flood flows from the Tulare Lake Basin (i.e., Kings River) enter the SJR through Fresno Slough to the Mendota Pool. Local runoff from the Bear Creek watershed in the vicinity of Merced and runoff with agricultural drainage and managed wetlands and wildlife refuges in the Grasslands watershed provides additional SJR flow upstream of the Merced River. Flow and water quality in the SJR upstream of the Merced River is measured at Stevinson, upstream of Salt Slough, and at Fremont Ford, upstream of Mud Slough. Mud Slough is a combination of runoff, irrigation drainage, and discharge from the San Luis Drain that bypasses tile drainage around the Grasslands wildlife refuges and waterfowl clubs.

Water Quality

Water upstream from Friant Dam has low mineral and nutrient concentrations due to the insolubility of granitic soils in the watershed and the river's granite substrate (SCE 2007). As the SJR and tributary streams flow from the Sierra Nevada foothills across the eastern valley floor, their mineral concentration increases. Sediment is likely captured behind the many dams. Water quality in various segments of the SJR below Friant Dam is degraded because of low flow and discharges from agricultural areas and wastewater treatment plants. Water quality downstream is generally influenced by releases from Friant Dam, with contributions from agricultural and urban return flows as the river approaches the Merced River confluence. It generally degrades the farther downstream it gets from the dam. Downstream of the dam, as previously described the river is identified on the 303(d) list for constituents associated with agricultural uses, such as pesticides (chlorpyrifos, diazinon, Dichlorodiphenyltrichloroethane [DDT]), salinity (EC), and unknown toxicity (Central Valley Water Board 2009b) (Table 5-4).

Water temperatures below Friant Dam and Mendota Dam are dependent on water temperatures of inflow from the Delta Mendota Canal and, occasionally, the Kings River system via James Bypass. Water temperature conditions downstream are also dependent on inflow water temperatures during flood flows from upstream. SJR water temperatures south of the confluence of the Merced River are influenced greatly by the water temperature of Salt Slough inflow, which contributes the majority of streamflow in this area (USBR 2007).

5.2.3 Merced River

Unimpaired and Historical Flow

The Merced River flows into the SJR at river mile (RM) 118 and is the most upstream of the three eastside tributaries with existing fish populations. The Merced River is 135 miles long and drains a 1,270- square-mile watershed. Approximately 52 miles of the Merced River are downstream of the Crocker-Huffman Dam, the most downstream barrier to fish migration. The four dams on the Merced River, known collectively as the Merced River Development Project, are owned by Merced Irrigation District (Merced ID) and are licensed by the Federal Energy Regulatory Commission (FERC). New Exchequer Dam (Lake McClure), with a capacity of 1. 02 MAF, regulates releases to the Merced River. The Merced River unimpaired flow is essentially the same as the Lake McClure inflow because there are no major storage reservoir or diversions upstream. The runoff from the Yosemite Valley flows unimpaired downstream to Lake McClure.

Merced ID provides surface water and electric service to approximately 164,000 acres in Merced County (Merced ID 2008a). Merced ID diverts approximately 100 cfs from the Merced Falls reservoir via the Northside Canal and another 2,000 cfs from the Merced River via the Main Canal at the Crocker-Huffman Diversion Dam. These diversions (assuming 4 AF per acre) would total about 600 TAF, with a historical average of about 525 TAF annually (Stillwater Sciences 2002).

Flows released from the Crocker-Huffman Dam to the Merced River must satisfy FERC requirements, which include the Davis-Grunsky Contract and the Cowell Agreement. The Davis-Grunsky Contract (with the Department of Fish and Game [DFG]) provides minimum flow standards of 180–220 cfs November–March from Crocker-Huffman Dam to Shaffer Bridge. The Cowell Agreement (pursuant to a Merced Superior Court order) calls for the Merced ID to maintain monthly flows downstream of the Crocker-Huffman Dam to satisfy water right adjudications. The flows are 50 cfs October–February and are 100 cfs to 250 cfs during the March–September irrigation season. This water is diverted from the river at a number of private ditches between Crocker-Huffman Dam and Shaffer Bridge. The Shaffer Bridge flows therefore generally control the Merced River flows. A flood-control release limit of 6,000 cfs was established by USACE for the combination of Dry Creek and the Merced River flows at Stevinson. Merced ID holds the initial FERC license (Project Number 2179) for the Merced River Hydroelectric Project, which was issued on April 18, 1964. FERC Project Number 2179 required the licensee to provide minimum stream flows (Table 5-7) in the Merced River downstream from the project reservoirs.

Table 5-7. FERC Project Number 2179 Stream Flow Requirements for the Merced River (cfs)

Period	Normal Year	Dry Year
June 1 to October 15	25	15
October 16 to October 31	75	60
November 1 to December 31	100–200	75–150
January 1 to May 31	75	60

cfs = cubic feet per second
FERC = Federal Energy Regulatory Commission

Table 5-8a shows the monthly cumulative distribution of Merced River unimpaired runoff (cfs) at New Exchequer Dam for 1922–2003. The range of monthly runoff is summarized with 10 percent cumulative distribution values from the minimum to the maximum. The maximum runoff was in April, May, and June. The minimum runoff was in August, September, October, and November. The estimated median unimpaired flow pattern in the February–June period was 969 cfs in February, 1,303 cfs in March, 2,391 cfs in April, 3,955 cfs in May, and 2,451 cfs in June. The range of flows in these months is quite large from year to year.

Table 5-8b shows the monthly cumulative distribution of historical (observed) Merced River flow (cfs) at Stevinson (downstream of Dry Creek) for 1985–2009 (most recent 25-year period). The average unimpaired flow for this 25-year period was 937 TAF (98 percent of the 1922-2003 average). The highest median flows were in April and May, which are the months with highest unimpaired runoff. The highest historical Merced River flows (90 percent cumulative) were greater than 1,500 in February–June, indicating that flood-control releases were made in a few years in each of these months. The monthly ranges of historical Merced River flows were large only in the months with flood-control releases. The median flows in the summer months of July–September were less than 150 cfs. The historical average annual flow volume for the Merced River at Stevinson was 438 TAF, about 47 percent of the average unimpaired flow for this period. The median annual flow volume was 267 TAF, indicating that flood releases in a few years raised the average flow volume in the Merced River to about 1. 5 times the median flow.

Table 5-8a. Monthly Cumulative Distributions of Merced River Unimpaired Flow (cfs) for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Annual (TAF)
Minimum	8	20	17	54	55	131	519	637	212	62	-	-	150
10%	23	59	89	162	337	601	1,352	1,650	741	129	27	-	412
20%	33	86	129	214	461	851	1,562	2,179	870	191	42	4	498
30%	46	102	167	326	579	970	1,927	2,832	1,400	292	63	22	566
40%	63	126	256	377	801	1,102	2,155	3,295	1,923	416	83	34	669
50%	81	152	354	571	969	1,303	2,391	3,955	2,451	529	121	58	894
60%	96	222	448	763	1,235	1,518	2,667	4,332	2,868	721	183	79	1,070
70%	116	302	560	1,069	1,821	1,875	2,880	4,730	3,462	842	221	102	1,158
80%	159	372	862	1,500	2,578	2,489	3,246	5,223	4,403	1,344	273	133	1,412
90%	255	699	1,647	2,579	3,514	2,718	3,643	6,400	5,633	1,991	514	203	1,718
Maximum	835	4,346	6,058	10,306	6,295	6,013	7,206	9,194	11,025	5,719	1,578	798	2,787
Average	115	335	703	1,073	1,496	1,643	2,473	3,932	2,875	909	208	93	960

cfs = cubic feet per second
TAF = thousand acre-feet

Table 5-8b. Monthly Cumulative Distribution of Historical Merced River Flow (cfs) at Stevinson for 1985–2009

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Annual (TAF)
Minimum	32	131	171	129	69	166	136	91	25	6	18	25	73
10%	75	183	199	205	218	236	167	139	104	34	30	45	102
20%	159	231	218	226	243	250	183	191	126	59	65	78	140
30%	263	246	227	242	269	272	307	313	156	97	88	95	193
40%	298	248	236	259	312	285	357	647	180	125	100	114	220
50%	325	254	255	318	323	313	449	669	192	136	125	127	267
60%	374	271	293	421	351	363	622	734	257	178	145	186	324
70%	440	329	385	563	453	1,047	985	857	377	210	163	211	476
80%	526	423	473	697	933	2,360	1,425	1,409	609	321	313	371	703
90%	914	568	631	826	1,605	2,733	2,868	2,628	2,200	840	645	720	1,185
Maximum	1,861	635	2,019	7,347	6,990	2,964	4,616	4,113	3,185	2,456	722	1,127	1,275
Average	435	316	410	754	912	969	1,019	1,013	599	361	215	259	438

cfs = cubic feet per second
TAF = thousand acre-feet

Figure 2-6 shows the monthly unimpaired and historical Merced River flow at Stevinson for the recent 10-year period of 2000–2009. The unimpaired flow at New Exchequer Dam averaged 884 TAF per year (TAF/y) and the historical releases (including flood flows in 2000, 2005 and 2006) averaged 403 TAF/y. The peak historical flows were in April and May of 2006 because Lake McClure was nearly full, and this relatively high flow of 4,500 cfs was for flood-control purposes. The majority of the historical flow volume was observed in the wet years with flood-control releases. Lake McClure is the smallest of the tributary reservoirs and is generally filled and drawn down each year.

Dams and Reservoirs

The New Exchequer powerhouse has a capacity of approximately 95 megawatts (MW) with a maximum head of 400 feet and a maximum flow of about 3,200 cfs (MID 2008b). The hydropower facilities at the rim dams operate each day to maximize energy generation efficiency and revenue, thereby giving preference to full generation during peak energy demand periods (generally 9AM–9PM). This is done by operating the turbine-generators at a constant high flow for a portion of the day and shutting them off for the remainder of the day. Water released for peaking power is regulated at the approximately 10 TAF McSwain Reservoir, with a normal fluctuation of several feet. The McSwain Dam powerhouse has a capacity of 9 MW, with a maximum head of about 55 feet, and a maximum flow of about 2,700 cfs (MID 2008c). Merced Falls Dam is a small diversion dam (for Northside Canal) with a small hydroelectric generator owned by Pacific Gas & Electric with a capacity of about 3.4 MW, a maximum head of about 50 feet, and a maximum flow of about 1,750 cfs (MID 2008b). The Crocker-Huffman Dam diverts water to the Merced ID main canal and Merced River Hatchery and releases water to the Merced River. Because the capacity of the New Exchequer turbine is generally greater than that of the canal diversions and the river, it is operated for only part of each day (peaking energy) to release daily diversions and river flow from McSwain Dam and Merced Falls Dam. Therefore, daily fluctuations in flow and water elevation in McSwain Reservoir are normal.

Water Quality

Some water quality characteristics in the Merced River are affected by reservoir operations and by changes in river flow attributable to water supply and hydropower generation activities. Appendix F.1, *Hydrologic and Water Quality Modeling*, contains a description of baseline water temperatures on the Merced River, and Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*, includes a presentation of existing salinity conditions.

EC generally increases as water moves downstream in the Merced River because of the relatively high EC in agricultural drainage and groundwater discharge to the river. The increase in EC is generally greater when the river flow is low. However, near the confluence with the SJR, the measured monthly EC in the Merced River (at Stevinson) is still generally low, usually ranging from about 0.050 to 0.400 dS/m.

5.2.4 Tuolumne River

Unimpaired and Historical Flow

The Tuolumne River flows into the SJR at RM 83, approximately 8 miles upstream of the Stanislaus River confluence and 35 miles downstream of the Merced River. The Tuolumne River is 155 miles long and drains a 1,870 square mile watershed from its headwaters in the Sierra Nevada mountains to its confluence with the SJR, approximately 10 miles west of Modesto. Approximately 52 miles of the river are downstream of La Grange Dam, the furthest downstream impediment to fish passage. Existing dams, water diversions, and downstream minimum flow agreements influence the hydrology of the Tuolumne River. Hetch Hetchy (360 TAF), Cherry Lake (270 TAF) and Lake Eleanor (27 TAF) in the upper Tuolumne River watershed provide hydropower and water supply for San Francisco and other Bay Area cities.

New Don Pedro is the major storage reservoir on the Tuolumne River. The 2.0 MAF reservoir stores water for irrigation, hydroelectric generation, fish and wildlife enhancement, recreation, and flood control (340 TAF for flood control). Water released from the New Don Pedro Dam is impounded and re-regulated by the LaGrange Dam and Reservoir. LaGrange Dam, located 2.5 miles downstream of New Don Pedro, is the diversion point for the Turlock Irrigation District (TID) and Modesto Irrigation District (MID) canals. The Fourth Agreement specifies the storage in New Don Pedro is shared between MID, TID, and CCSF (see Section 5.3.3 of this chapter). CCSF does not divert water directly from Don Pedro but owns the right to store up to 740 TAF in the reservoir, using part of Don Pedro as a water "bank." In the event CCSF needs water has and there is a balance in the water bank, CCSF is permitted by the districts to bypass a lesser flow than that entitled to the districts under the Raker Act (see Section 5.3.1 of this chapter).

The water rights on the Tuolumne River are shared. TID and MID have senior water rights and control more of the river flow in most years. The water right allocation is determined from the daily estimate of the unimpaired flow at La Grange Dam. All of the river flow less than 2,416 cfs belongs to the districts. During the 60-day period April 15–June 14 (peak snowmelt) the flow threshold for the districts is raised to 4,066 cfs (Environmental Defense 2004). In some dry years, very little of the Tuolumne's unimpaired flow belongs to CCSF, and CCSF would have to withdraw from its water bank to meet the Raker Act entitlements.

Figure 5-1 shows two examples of how water rights are divided (on a daily basis) between TID and MID and CCSF. During 1992, only 68 TAF (mostly in April) accrued for CCSF that year (68 TAF is equivalent to 1,143 cfs for 30 days). CCSF asked customers to conserve water and bought additional supplies from the Department of Water Resources' (DWR's) emergency drought water bank. Fortunately, rain and snow returned to the Sierra Nevada in 1993, allowing full water deliveries and replenishing surface storage in the Tuolumne River watershed (including water banked in New Don Pedro) and the Bay Area. The average calculated water rights for CCSF were about 750 TAF/y, about 40 percent of the Tuolumne River unimpaired flow of 1,853 TAF/y for the 1922–2003 period (Environmental Defense 2004). This is higher than the average aqueduct diversion of about 290 TAF/y, so much of this water is stored in New Don Pedro and eventually transferred or spilled during flood-control releases. The current CCSF demand for water is about 290 TAF. (Environmental Defense 2004). This CCSF diversion is therefore about 15 percent of the average unimpaired flow.

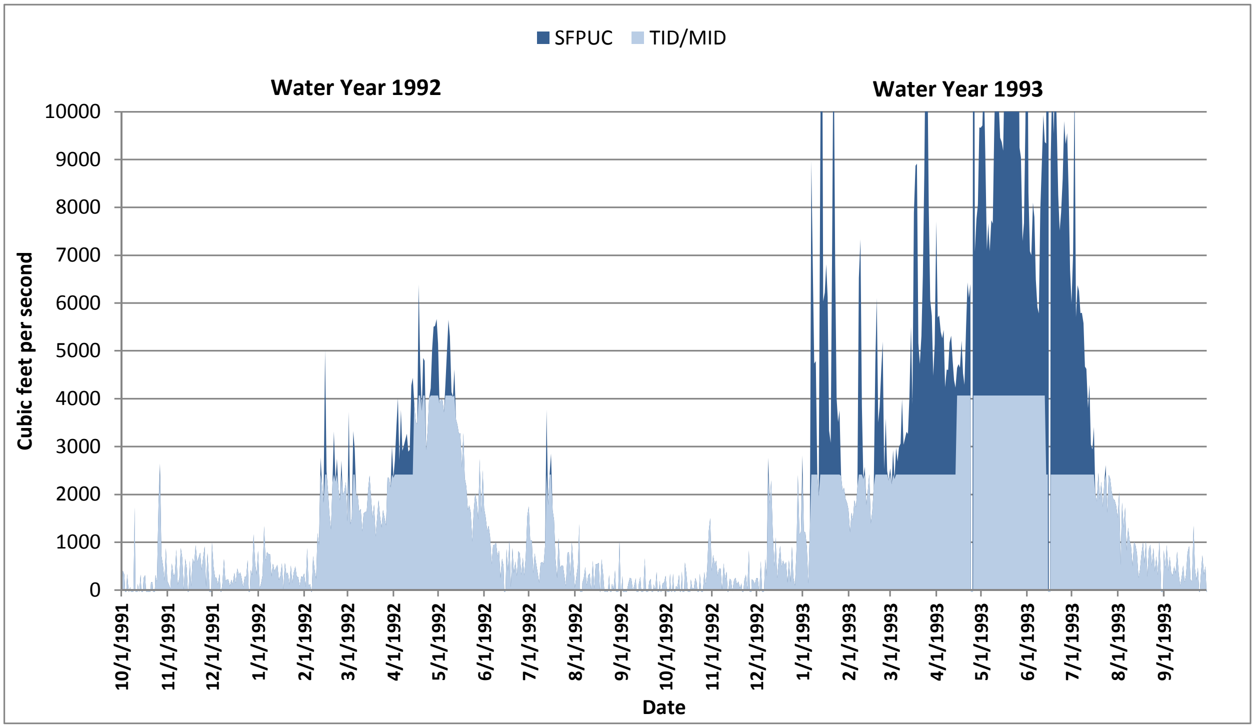

Figure 5-1. Division of Water Rights between Turlock and Modesto Irrigation Districts (TID/MID) and the City and County of San Francisco (CCSF) for 1992 and 1993 (Source: DWR).

The average diversion into TID's canal into Turlock Lake is 575 TAF/y and another 310 TAF/y are diverted to MID's canal into the Modesto Reservoir. These diversions (885 TAF/y) represent about 50 percent of the median unimpaired flow of 1,776 TAF. A total of 1,175 TAF/y are diverted from the Tuolumne River, representing about 65 percent of the average unimpaired runoff. The FERC license (Project Number 2299) for the New Don Pedro Project was amended in 1995 to establish higher release flows on the Tuolumne River below La Grange Dam. Higher flows are required when the runoff is greater. About 95 TAF are allocated on a monthly pattern in the driest years, with a maximum of about 300 TAF allocated in years with higher runoff. Pulse flows were specified for fish attraction to their spawning grounds in October and outmigration in April and May.

Table 5-9a gives the monthly cumulative distribution of Tuolumne River unimpaired flows for 1922–2003. Each month has a range of runoff depending on the rainfall and accumulated snowpack. The peak runoff for the Tuolumne River is observed in May and June, and relatively high runoff (median monthly runoff greater than 2,000 cfs) is observed February–June. The minimum flows are observed in August, September, and October. The median runoff for the February–June period was 2,085 cfs in February, 2,566 cfs in March, 4,498 cfs in April, 7,343 cfs in May, and 5,648 cfs in June. The average Tuolumne River runoff represents about 30 percent of the unimpaired flow at Vernalis. Because 290 TAF/y is diverted upstream of New Don Pedro Reservoir, the average inflow to New Don Pedro is about 1,563 TAF/y (85 percent of the Tuolumne River unimpaired flow).

Table 5-9b gives the monthly cumulative distribution of the historical flows for the Tuolumne River observed at Modesto for the recent period of 1985–2009. The average unimpaired flow for this 25-year period was 1,823 TAF (98 percent of the 1922–2003 average). The release flow requirements changed in 1995, as described above. The average monthly historical flows were about 500 cfs in the summer and fall (July–December), and were 1,000 cfs–2,000 cfs in the winter and spring (January–June). The median historical annual river flow was 361 TAF. The average annual historical flow was 811 TAF, more than 2.25 times the median, suggesting that the majority of the historical flow was the result of flood-control releases in wet years. The average historical flow was about 45 percent of the average unimpaired flow, but the majority of this historical flow was observed in the wet years with flood-control releases. New Don Pedro Reservoir allows considerable carryover storage from one year to the next.

Figure 2-7 shows the monthly unimpaired and the historical Tuolumne River flow at Modesto for the recent 10-year period of water years 2000–2009. The historical monthly flows at Modesto were generally lower than the unimpaired flows in the winter and spring months and were often slightly higher than the unimpaired flows in the late summer and fall months. The peak historical flow was in April and May of 2006 because New Don Pedro Reservoir was nearly full, and the high release flow of 8,000 cfs was for flood-control purposes. The unimpaired flow at New Don Pedro Dam averaged 1,738 TAF/y and the historical releases (including flood flows in 2000, 2005, and 2006) averaged 695 TAF/y for the 10-year period. On an annual basis, the historical La Grange Dam releases averaged about 40 percent of the unimpaired flow, but on a daily basis the releases were usually much less than 40 percent of the unimpaired flow, with flood-control releases providing the majority of the flow below LaGrange Dam.

Table 5-9a. Monthly Cumulative Distributions of Tuolumne River Unimpaired Flow (cfs) for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Annual (TAF)
Minimum	-	21	55	81	142	379	1,326	1,724	283	166	-	-	383
10%	64	134	219	359	752	1,354	2,719	3,467	1,509	283	52	19	842
20%	87	150	332	529	1,046	1,881	3,136	4,730	2,280	364	104	42	1,055
30%	116	239	423	685	1,216	2,093	3,706	5,620	3,708	559	153	63	1,189
40%	149	284	550	887	1,514	2,358	4,144	6,162	4,850	919	212	85	1,414
50%	178	382	783	1,213	2,085	2,566	4,498	7,343	5,648	1,119	289	125	1,776
60%	193	564	920	1,715	2,496	2,870	4,927	8,071	6,722	1,781	359	165	2,024
70%	254	804	1,322	2,130	2,924	3,449	5,366	8,744	7,468	2,329	447	221	2,176
80%	329	1,153	1,774	2,818	4,034	4,163	5,809	9,355	8,923	3,114	563	294	2,516
90%	609	1,636	3,562	4,224	5,360	5,511	6,473	10,710	10,040	4,942	901	374	3,109
Maximum	2,486	8,765	10,565	16,806	10,718	9,411	11,097	15,617	17,077	10,598	3,337	1,745	4,631
Average	265	807	1,441	2,020	2,586	3,088	4,601	7,258	5,913	2,012	432	205	1,853

cfs = cubic feet per second
TAF = thousand acre-feet

Table 5-9b. Monthly Cumulative Distribution of Historical Tuolumne River Flow (cfs) at Modesto for 1985–2009

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Annual (TAF)
Minimum	135	162	176	154	166	239	271	144	104	97	97	111	134
10%	166	204	193	205	243	260	362	274	115	109	120	121	155
20%	233	227	237	287	266	288	389	412	143	134	142	167	202
30%	251	254	253	369	418	301	538	465	210	198	190	185	264
40%	337	294	314	462	458	353	683	604	248	241	241	222	303
50%	408	317	408	543	474	742	752	734	255	253	264	256	361
60%	579	445	429	643	1,373	1,113	1,006	871	386	330	357	422	550
70%	629	472	457	834	2,467	3,589	1,788	1,359	479	353	444	514	1,112
80%	728	494	745	1,396	3,163	4,746	3,402	2,943	981	503	556	689	1,440
90%	1,098	544	1,765	2,262	5,371	5,524	5,512	4,556	4,262	1,769	996	974	2,273
Maximum	1,794	1,212	4,996	15,498	8,782	6,182	8,264	7,964	5,481	3,291	1,437	2,365	2,399
Average	542	414	735	1,453	1,964	2,041	1,971	1,752	1,047	602	422	498	811

cfs = cubic feet per second
TAF = thousand acre-feet

Dams and Reservoirs

The hydroelectric power plant of New Don Pedro Dam has four units with a combined capacity of 203 MW and a maximum flow of 5,500 cfs (TID and MID 2011). Water released from the New Don Pedro Dam is regulated at La Grange Dam and Reservoir, also the diversion point for the MID and TID canals. A small hydroelectric power plant with a capacity of 4 MW and a maximum flow of 750 cfs is used to release water from the TID canal to the Tuolumne River. Because New Don Pedro turbine capacity is generally greater than the canal diversions and river releases, it is operated for only part of each day (peaking energy); daily fluctuations in flow and water elevation in La Grange Reservoir are normal.

Water Quality

Water quality is generally considered somewhat degraded below Don Pedro Reservoir as a result of agricultural irrigation return flow and some urban and agricultural runoff (CCSF 2008). Total dissolved solids content and turbidity generally increase in a downstream direction (CCSF 2008). The Tuolumne is identified on the 303(d) list for constituents associated with agricultural uses, such as pesticides (chlorpyrifos, diazinon, DDT), EC, and temperature (Table 5-4) (Central Valley Water Board 2009b).

Reservoir operations and changes in river flow attributable to water supply and hydropower generation activities affect some water quality characteristics in the Tuolumne River. Primary among them is water temperature, which may in turn affect DO content. Water temperature in flowing streams depends on the water source, air temperature, flow, surface area, and exposure to solar radiation. Reductions in stream flow when air temperature is high usually result in increases in water temperature. Storage of water in reservoirs may increase or decrease water temperatures. In the warmer months, water temperature increases in a downstream direction as the river leaves the foothills of the Sierra Nevada and flows to the floor of the San Joaquin Valley (CCSF 2008).

EC generally increases as water moves downstream in the Tuolumne River because of the relatively high EC in agricultural drainage and groundwater discharge to the river. The increase in EC is generally greater when the river flow is low. However, near the confluence with the SJR, the measured monthly EC in the Tuolumne River (at Modesto) is still generally low. The Tuolumne River EC values generally have been 0.050–0.300 dS/m (Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*).

5.2.5 Stanislaus River

Unimpaired and Historical Flow

Stanislaus River joins the SJR about 3 miles upstream of Vernalis at RM 75 and 8 miles downstream of the Tuolumne River mouth. The Stanislaus River is 161 miles long and drains approximately 1,195 square miles of mountainous and valley terrain. New Melones Reservoir, which is located just downstream of the confluence of the three forks of the Stanislaus River, is the major storage reservoir on this river. It has a storage capacity of about 2.4 MAF. Tulloch Dam and power plant, located 6 miles downstream of New Melones Dam, is part of the Tri-Dam Project, which is a power generation project that includes Donnells and Beardsley Dams, located upstream of New Melones Reservoir. The water released from New Melones Dam (for peaking power) is re-regulated in Tulloch Reservoir. Goodwin Dam is located approximately 2 miles from Tulloch Reservoir, and approximately 59 miles of the Stanislaus River are downstream of Goodwin Dam to the confluence with the LSJR.

South San Joaquin Irrigation District (SSJID), Oakdale Irrigation District (OID), Stockton East Water District (SEWD), and Central San Joaquin Water Conservation District (CSJWCD) divert water from the Stanislaus River at Goodwin Dam. SSJID and OID jointly hold contract rights with USBR to divert 600 TAF when the projected unimpaired flow is greater than 600 TAF. OID and SSJID have an internal agreement to equally divide the available water, each receiving 300 TAF. USBR contracted with SEWD and CSJWCD for delivery of 155 TAF/y. The maximum diversion from the Stanislaus River is therefore 755 TAF/y. This represents about 67 percent of the average unimpaired Stanislaus River runoff of 1,120 TAF/y. The inflow to New Melones is seasonally shifted from the unimpaired flow by the upstream hydropower operations. The annual inflow to New Melones is about the same as the unimpaired runoff because there are no major upstream diversions.

Table 5-10a gives the monthly cumulative distribution of Stanislaus River unimpaired flows for 1922–2003. Each month has a range of runoff depending on the rainfall and accumulated snowpack. The peak runoff for the Stanislaus River is observed in May and June and relatively high runoff (median monthly runoff greater than 1,000 cfs) is observed February–June. The lowest median flows of about 150 cfs are observed in August, September, and October. The median runoff for the February–June period was 1,251 cfs in February, 1,704 cfs in March, 3,247 cfs in April, 4,657 cfs in May, and 2,757 cfs in June. The average Stanislaus River runoff represents about 18 percent of the average unimpaired flow at Vernalis.

Table 5-10b gives the monthly cumulative distribution (range) of the historical flows for the Stanislaus River observed at Ripon for the recent period of 1985–2009. The average unimpaired flow for this 25-year period was 1,081 TAF (97 percent of the 1922–2003 average). The Stanislaus release flow requirements have generally increased during this period. The average monthly historical flows were about 500–600 cfs in the summer and fall (July–December) and were about 850–1,250 cfs January–June. The average annual historical flow was 584 TAF, about 1. 5 times the median flow, suggesting that a few years had substantial flood-control releases. The average historical flow was about 52 percent of the average unimpaired flow, but the majority of this historical flow was observed in a few wet years with flood-control releases. New Melones Reservoir allows considerable carryover storage from one year to the next.

Table 5-10a. Monthly Cumulative Distributions of Stanislaus River Unimpaired Flow (cfs) for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Annual (TAF)
Minimum	-	35	56	47	25	218	586	723	190	-	-	-	155
10%	48	95	146	218	398	827	1,683	1,634	681	107	33	16	467
20%	70	125	189	301	576	1,142	2,108	2,637	978	213	60	37	593
30%	90	155	217	400	781	1,326	2,509	3,020	1,629	308	92	57	680
40%	107	170	310	512	954	1,569	2,900	3,807	2,105	426	111	68	892
50%	128	229	399	664	1,251	1,704	3,247	4,657	2,757	556	152	80	1,088
60%	155	288	515	923	1,759	2,023	3,485	5,236	3,215	814	180	89	1,250
70%	175	381	726	1,402	1,884	2,304	3,868	5,781	3,664	1,029	222	115	1,356
80%	195	520	951	1,895	2,339	2,622	4,274	6,361	4,184	1,368	302	162	1,570
90%	253	804	2,028	2,940	3,417	3,802	4,631	7,153	5,572	1,810	425	216	1,921
Maximum	1,438	6,155	6,704	10,724	9,250	6,742	7,271	9,675	10,627	4,659	1,246	643	2,952
Average	157	463	858	1,322	1,685	2,076	3,226	4,585	2,953	867	203	112	1,120

cfs = cubic feet per second
TAF = thousand acre-feet

Table 5-10b. Monthly Cumulative Distribution of Historical Stanislaus River Flow (cfs) at Ripon for 1985–2009

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Annual (TAF)
Minimum	251	218	179	168	183	260	251	349	218	262	215	207	191
10%	323	290	222	194	220	308	507	532	464	339	305	273	309
20%	339	312	262	240	297	381	595	742	578	408	327	304	330
30%	391	317	304	313	312	501	742	841	591	434	356	316	344
40%	434	322	316	378	349	643	813	877	609	480	368	325	384
50%	479	373	341	404	435	854	902	1,091	712	502	404	369	421
60%	505	392	402	458	623	1,013	976	1,302	848	560	417	416	480
70%	556	414	442	614	850	1,138	1,112	1,424	1,016	654	522	458	607
80%	613	428	817	1,064	1,510	2,250	1,299	1,506	1,176	743	657	490	798
90%	819	627	943	1,508	2,824	2,980	1,850	1,592	1,312	1,099	1,197	978	1,172
Maximum	1,951	962	3,194	6,273	6,499	4,887	4,537	4,130	1,867	1,876	1,792	1,702	1,537
Average	579	409	559	898	1,111	1,291	1,102	1,205	843	631	559	497	584

cfs = cubic feet per second
TAF = thousand acre-feet

Figure 2-8 shows the monthly unimpaired and historical Stanislaus River flow at Ripon for the recent 10-year period of water years 2000–2009. The historical (observed) monthly flows at Ripon are generally lower than the unimpaired flows in the winter and spring months and are often slightly higher than the natural flows in the summer and fall months. The peak historical flows during this period were in 2006 because New Melones Reservoir was nearly full, and relatively high flows of 2,000 cfs–4,500 cfs were released for flood-control purposes. The average unimpaired flow was 1,100 TAF/y and the average historical flow was 611 TAF/y for this 10-year period. The historical flow therefore averaged about 55 percent of the unimpaired flow on an annual basis, but the daily releases were usually less than 55 percent of the unimpaired flow, with flood-control releases providing the majority of the flow below Goodwin Dam.

Dams and Reservoirs

New Melones reservoir has two hydroelectric generators with a combined capacity of approximately 300 MW (USBR 2012) and a maximum flow of 8,300 cfs. Tulloch Dam and power plant are located approximately 6 miles downstream of New Melones Dam. The water released from New Melones Dam (for peaking power) is regulated in Tulloch Reservoir, which has a capacity of 67 TAF(CALFED 2009). Tulloch reservoir operates with a seasonal variation and a 3-foot daily fluctuation (from peaking hydropower releases)(Lake Tulloch Alliance 2007). The Tulloch hydroelectric plant has a capacity of 17 MW, with a maximum flow of about 2,000 cfs (CALFED 2009). Goodwin Dam is approximately two miles downstream of Tulloch Dam and is the diversion dam for the OID and SSJID canals. Water may also be pumped into the Goodwin Tunnel for deliveries to the CSJWCD and SEWD. The water supply diversions and river releases pass through Tulloch powerhouse. Because New Melones hydroelectric units are operated for only part of each day to release the daily diversions and river flow, daily fluctuations in flow and water elevations in Tulloch Reservoir are normal.

Water Quality

Some water quality characteristics in the Stanislaus River are affected by reservoir operations and by changes in river flow attributable to water supply and hydropower generation activities. Salinity and water temperature are the two main water quality constituents of concern that might be affected by the alternatives. Appendix F, *Hydrologic and Water Quality Modeling*, contains a description of baseline water temperatures on the Merced River, and Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*, includes a presentation of baseline salinity conditions.

EC generally increases as water moves downstream in the Stanislaus River because of the relatively high EC in agricultural drainage and groundwater discharge to the river. The increase in EC is generally greater when the river flow is low. However, near the confluence with the SJR, the measured monthly EC in the Stanislaus River (at Ripon) is still generally low, usually ranging from about 0.075 to 0.150 dS/m.

5.2.6 Lower San Joaquin River

Unimpaired and Historical Flow

The drainage area of the SJR above Vernalis includes approximately 12,250 square miles. Vernalis is the measurement location for SJR inflow to the southern Delta. The flow from upstream of the Merced River together with the tributary flows from the Merced, Tuolumne, and Stanislaus Rivers, intermittent flows from the westside creeks, and agricultural drainage and groundwater seepage flows, contribute to the SJR flow at Vernalis.

The State Water Board established SJR at Vernalis flow objectives in the 1995 (and subsequent 2006) Bay-Delta Plan. These flow objectives include minimum flows February 1–June 30 that depend on the SJR water year type and the Delta outflow (i.e., X2[5] requirements), which depend on the combined eight River (Sacramento River and SJR) runoff[6]. The 30-day April–May pulse flow requirements increase when the X2 requirement is at Chipps Island (75 kilometers [km], requiring an outflow of about 11,400 cfs). These SJR flow objectives (included in D-1641[7]) are given in Table 5-11. These D-1641 Vernalis flow objectives have not been fully implemented; similar pulse flows were provided under the Vernalis Adaptive Management Program (VAMP) (2000–2011), but this implementation program has ended. The Vernalis flow objective in October is 1,000 cfs with an additional pulse flow requirement (for attraction of adult Chinook salmon) that increases the monthly average objective to 2,000 cfs in most years.

Table 5-11. 1995 and 2006 Bay-Delta Plan Flow Requirements at Vernalis

Water Year Type	Feb–June Flows (cfs)	April–May, 30-day Pulse Flows (cfs)
Critical	710–1,140	3,110–3,540
Dry	1,420–2,280	4,020–4,880
Below Normal	1,420–2,280	4,620–5,480
Above Normal	2,130–3,420	5,730–7,020
Wet	2,130–3,420	7,330–8,620
cfs = cubic feet per second		

The 1995 Bay-Delta Plan introduced the E/I ratio, which limits the combined export to a specified monthly fraction of the combined Delta inflow. The E/I ratio is 35 percent February–June and 65 percent June–January. The February E/I can be increased to 45 percent under low-flow conditions. This E/I objective allows a maximum pumping amount that is often similar to the allowable exports under the Delta outflow objectives, but sometimes the E/I ratio is more limiting than the required

[5] The X2 standard, introduced in the 1995 Bay-Delta Plan, refers to the position at which 2 parts per thousand (ppt) salinity occurs in the Delta estuary and is designed to improve shallow-water fish habitat in the spring of each year and can limit export pumping (see Section 5.3.2, for additional information regarding X2).

[6] The 8-river index is the sum of the unimpaired runoff for the Sacramento River at Bend Bridge, Feather River inflow to Oroville, Yuba River at Smartville, American River inflow to Folsom Reservoir, Stanislaus River inflow to New Melones Reservoir, Tuolumne River inflow to Don Pedro Reservoir, Merced River inflow to Lake McClure, and SJR inflow to Millerton Lake.

[7] Water Rights Decision-1641 (D-1641) is the decision which implements the water quality objectives of the 1995 Bay-Delta Plan.

outflow. Sometimes the exports must be further reduced to increase the Delta outflow to satisfy the salinity requirements at Emmaton and Jersey Point or at the CCWD Rock Slough diversion. The SJR/export ratio is the inverse of the established E/I ratio, which is calculated from the total Delta inflow. The SJR/export ratios are more restrictive and allow the exports to be 100 percent of the SJR inflow in critical years, 50 percent of the SJR inflow in dry years, 33 percent of the SJR inflow in below normal years, and 25 percent of the SJR inflow in above normal or wet years. These ratios effectively limit exports to 1,500 cfs for April and May unless the SJR is higher than the minimum flow required in these months (also discussed in Chapter 2, *Water Resources*).

Table 5-12a gives the monthly cumulative distribution of the SJR at Vernalis unimpaired flows for 1922–2003. Each month has a range of runoff depending on the seasonal rainfall and accumulated snowpack. The median (50 percent) monthly flows generally characterize the seasonal runoff pattern and are largely the sum of the unimpaired runoff from the rivers draining the Sierra Nevada described above. The peak runoff for the SJR at Vernalis is observed in May, with relatively high median monthly runoff (> 15,000 cfs) observed in April, May, and June. The lowest median flows of about 500 cfs are observed in September and October. The median flows for the February–June period were 6,294 cfs in February, 8,227 cfs in March, 15,205 cfs in April, 23,054 cfs in May, and 16,240 cfs in June. The majority of the average SJR at Vernalis runoff originated above Friant Dam and the three eastside tributary river dams. About 500 TAF (8 percent) of the Vernalis flow was from the westside creeks and the valley floor watersheds located below the four major storage dams (Friant, New Melones, New Don Pedro, and Exchequer Dams).

Table 5-12b gives the monthly cumulative distribution of the historical SJR flows observed at Vernalis for the recent period of 1984–2009. The average unimpaired flow for this 25-year period was 5,964 TAF (97 percent of the 1922–2003 average). The release flow requirements on the three eastside tributaries have generally increased during this period. The average monthly historical flows were about 2,000–2,500 cfs in the summer and fall (Jul–December) and were about 4,000–6,000 cfs January–June. The median historical annual SJR flow volume at Vernalis was 1,707 TAF. The average annual historical SJR at Vernalis flow volume was 2,777 TAF, about 1. 5 times the median flow, suggesting that a few years had substantial flood-control releases. The average historical SJR flow at Vernalis was about 46 percent of the average unimpaired flow for this 25-year period, but the majority of this historical flow was observed in a few wet years with flood-control releases.

Table 5-12a. Monthly Cumulative Distributions of SJR Unimpaired Flow (cfs) at Vernalis for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Annual (TAF)
Minimum	135	226	270	370	469	1,065	3,421	4,332	1,271	596	179	119	1,060
10%	266	482	756	1,090	2,203	4,328	8,453	10,196	5,050	1,248	390	228	2,565
20%	402	679	961	1,631	3,242	5,925	9,345	13,532	6,683	1,558	556	298	3,294
30%	472	799	1,191	2,174	4,063	6,502	11,451	16,697	10,444	2,167	705	349	3,626
40%	573	875	1,687	2,771	4,846	7,239	13,180	19,843	13,957	3,397	821	449	4,372
50%	611	1,141	2,264	3,544	6,294	8,227	15,205	23,054	16,240	4,044	1,095	528	5,804
60%	771	1,607	3,037	5,522	8,656	9,940	16,063	26,775	19,258	5,671	1,475	631	6,471
70%	919	2,118	4,004	6,582	10,908	11,608	18,291	28,163	23,256	7,338	1,746	767	7,370
80%	1,093	3,163	5,635	10,125	15,598	15,808	19,438	31,439	27,828	10,359	2,165	1,102	8,745
90%	1,433	4,567	10,127	16,209	22,086	18,631	24,588	39,962	34,832	15,453	3,969	1,409	11,035
Maximum	6,937	25,787	35,970	61,733	41,703	42,337	43,320	57,955	63,738	34,979	11,891	5,812	18,978
Average	889	2,346	4,557	6,880	9,459	10,839	15,639	23,881	18,722	6,728	1,720	832	6,176

cfs = cubic feet per second
TAF = thousand acre-feet

Table 5-12b. Monthly Cumulative Distribution of Historical SJR Flow (cfs) at Vernalis for 1985–2009

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Annual (TAF)
Minimum	788	956	895	816	758	1,422	1,168	892	481	447	483	574	656
10%	1,047	1,125	1,040	1,160	1,375	1,768	1,457	1,480	1,059	709	712	872	886
20%	1,343	1,285	1,292	1,437	1,789	2,097	1,905	1,968	1,115	1,110	980	939	1,144
30%	1,435	1,565	1,405	1,816	2,008	2,196	2,262	2,141	1,435	1,163	1,118	1,132	1,259
40%	1,734	1,685	1,548	2,106	2,175	2,429	2,545	2,638	1,660	1,306	1,236	1,335	1,385
50%	2,003	1,759	1,688	2,319	2,534	2,736	2,751	2,755	1,748	1,400	1,557	1,452	1,707
60%	2,567	2,004	2,085	2,500	3,152	3,421	3,173	3,560	2,157	1,682	1,913	1,970	1,928
70%	2,703	2,146	2,231	3,784	6,227	8,279	4,956	4,808	2,747	2,055	2,027	2,145	3,448
80%	3,181	2,528	2,587	4,625	7,796	12,285	8,012	8,490	4,238	2,624	2,604	2,484	4,206
90%	3,836	2,771	4,081	5,582	11,607	14,887	19,796	14,933	12,398	4,990	3,491	3,835	6,644
Maximum	6,153	3,290	12,192	30,377	35,057	25,035	27,937	26,055	17,760	13,193	5,442	5,758	8,588
Average	2,396	1,904	2,435	4,131	6,144	6,594	6,355	5,804	3,951	2,514	1,845	1,956	2,777

cfs = cubic feet per second
TAF = thousand acre-feet

Figure 2-9 shows the monthly unimpaired historical flow at Vernalis for the recent 10-year period of water years 2000–2009. The unimpaired flows at Vernalis averaged 6,056 TAF/y and the historical releases (including flood flows in 2000, 2005, and 2006) average 2,915 TAF/y. The historical Vernalis flows average about 48 percent of the unimpaired flow, but the releases were usually much less than 48 percent of the unimpaired, with flood-control releases providing the majority of the flow. The historical monthly flows at Vernalis were generally lower than the unimpaired flows in the winter and spring months and were often slightly higher than the unimpaired flows in the fall months.

Water Quality

Salinity and water temperature are the two main water quality constituents of concern that might be affected by the alternatives. Appendix F.1, *Hydrologic and Water Quality Modeling*, contains a description of baseline water temperatures on the LSJR, and Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*, includes a presentation of baseline salinity conditions. Both water temperature and salinity are constituents included on the 303(d) list as impairments for the LSJR (Table 5-4) (Central Valley Water Board 2009b).

The EC measurements at three stations located on the LSJR between the Merced River and the Tuolumne River (Newman, Crows Landing, and Patterson) were generally similar, usually ranging from 1.000 to 1.500 dS/m but with higher values of 1.500–2.000 dS/m in the dry years of 1988–1994 and EC values of less than 0.500 dS/m during high flows of more than 5,000 cfs (Appendix F.2).

In the SJR between the Tuolumne River and the Stanislaus Rivers, EC values were measured at Maze by DWR prior to 1992 and since 2007. Values were estimated from the Vernalis flow and EC subtracting the Stanislaus flow and EC for the intermediate years. During wet years, the Maze EC measurements ranged from less than 0.250 dS/m to about 1.000 dS/m. In contrast, the Maze EC ranged 1.000 dS/m–2.000 dS/m in the 1988–1994 dry period, but the EC has been less than 1.250 dS/m since 2000. This EC data suggests that the SJR at Maze has a moderate salinity with EC values generally less than 1.000 dS/m, except when the flow is less than 1,000 cfs.

5.2.7 Southern Delta

This section describes the environmental setting with regards to southern Delta flows and exports. There are four major channels in the southern Delta: the SJR from Vernalis past Stockton; Old River from the head of Old River to Clifton Court Forebay, Grant Line Canal from Old River to Clifton Court Forebay, and Middle River from Old River to Victoria Canal. Old River, between Clifton Court Forebay and Franks Tract, and Middle River downstream of Victoria Canal are also important southern Delta channels (see Figure 2-10). While it mostly falls within the boundaries of the South Delta Water Agency (SDWA), the southern Delta generally includes all channels south or west of the SJR channel, some of which may be outside of SDWA boundaries.

Flows and CVP and SWP Exports

As mentioned earlier, the SJR enters the Delta at Vernalis. The Old River channel diverges from the SJR downstream of Mossdale and connects with Middle River and Grant Line Canal. The CVP and SWP intakes are located on Old River at the western end of the southern Delta. About half of the SJR flow is diverted west into Old River and about half of the SJR flow continues north toward Stockton.

Water flows in the southern Delta are influenced by SJR inflow at Vernalis (described above), channel flow splits, tidal flows, temporary barriers, water export facilities, local agricultural diversions, agricultural drainage, and municipal treated wastewater discharges.

Downstream of Vernalis, flow from the SJR splits at the head of Old River and either continues downstream in the SJR toward Stockton or enters Old River and flows toward the CVP and SWP pumps. When Vernalis flow is greater than about 15,000 cfs, a portion of the flow entering the southern Delta enters through Paradise Cut, about 5 miles upstream of the head of Old River. The amount of flow entering Old River (including flow through Paradise Cut) is affected by the agricultural barriers and the combined pumping rates of CVP and SWP relative to SJR inflows at Vernalis. When the combined CVP and SWP pumping rates are low, the flow split to Old River is roughly 50/50. The flow into Old River increases by about 5 percent of the combined CVP and SWP pumping. When the rock barrier at the head of Old River is installed, the flow into Old River is reduced to about 250 cfs of leakage through the rock barrier (Jones and Stokes 2001).

The South Delta Temporary Barriers Project was initiated by DWR in 1991 and consists of four rock barriers placed at various locations across southern Delta channels. Three of the barriers are installed to increase the channel water elevations for agricultural diversions. The head of Old River barrier has been installed in April and May of many years since 1992 (not in years with flows above 7,000 cfs) to improve juvenile Chinook salmon fish migration from the SJR. As discussed further Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives,* this barrier has been installed during the fall of most years since 1963 to improve flow and DO conditions in the downstream SJR near Stockton for the benefit of adult fall-run Chinook salmon migrating to upstream spawning locations.

The two major water diversions in the southern Delta are the SWP (Banks Pumping Plant) and the CVP (Jones Pumping Plant). The Contra Costa Water District (CCWD) also diverts water from the southern Delta. Many small agricultural diversions (siphons and pumps) divert water from throughout the Delta during the spring and summer irrigation season. The CVP Jones Pumping Plant, formerly known as Tracy Pumping Plant, is located about 5 miles northwest of Tracy. The Jones Pumping Plant consists of six pumps with a permitted diversion capacity of 4,600 cfs. The total CVP water supply contracts total about 3,500 TAF/y for the Jones Pumping Plant.

The Harvey O. Banks Pumping Plant has a physical pumping capacity of 10,300 cfs. However, flow diverted from the Delta into Clifton Court Forebay is limited by a USACE permit to a maximum of 6,680 cfs during much of the year. SWP water is either pumped into the South Bay aqueduct, pumped into San Luis Reservoir for seasonal storage, pumped further south in the California Aqueduct to Kern County Water agency, pumped over the Coastal Range in the Coastal Aqueduct, or pumped over the Tehachapi Pass to southern California contractors. Based on SWP contracts, the total water supply demand for the Banks Pumping plant is about 4,000 TAF/y.

The CVP and SWP export pumping are controlled under the 2006 Bay-Delta Plan objectives (D-1641). Both the CVP and the SWP have maximum permitted pumping (or diversion) rates. Delta outflow requirements may limit pumping if the combined Delta inflow is not enough to satisfy the in-Delta agricultural diversions and the full capacity CVP and SWP pumping. When pumping is limited by hydrology, the Cooperative Operating Agreement (COA) governs the CVP and SWP share in reservoir releases and Delta pumping. When pumping is limited for fish protection (e.g., OMR limits) the CVP and SWP generally share the allowable pumping.

Tables 5-13a through 5-13c show the monthly historical CVP and SWP export pumping for 1985–2009. The CVP pumping is relatively constant through the year, with median monthly pumping of 3,500–4,200 cfs October–March. This water was used to fill the CVP portion of San Luis Reservoir to allow peak CVP water deliveries April–September. CVP pumping has been reduced April–June of most years for fish protection, with a median pumping of 2,133 cfs in April, 1,270 cfs in May, and 2,991 cfs in June. CVP pumping has been highest July–September, with median pumping of more than 4,000 cfs. The median CVP annual pumping was about 2,500 TAF, which is considerably less than the total CVP demands (contracts) of 3,500 TAF. The SWP median monthly pumping was similar to the CVP pumping; the median SWP pumping was 3,000 cfs to 3,800 cfs October–March. The majority of this water was used to fill the SWP portion of San Luis Reservoir to allow peak SWP water deliveries April–September, although some water is pumped over the Tehachapi Mountains to southern California through the fall and winter months. SWP pumping has been reduced April–June of most years for fish protection, with a median pumping of 2,101 cfs in April, 1,031 cfs in May, and 1,911 cfs in June. SWP pumping has been highest July–September with median pumping of 5,586 cfs in July, 5,539 in August, and 4,746 cfs in September. The median SWP annual pumping was about 2,600 TAF which is considerably less than the total SWP south-of-Delta demands (contracts) of 4,100 TAF.

The combined pumping is almost always greater than the SJR flow at Vernalis, so a considerable volume of Sacramento River water flows toward the pumps through Old and Middle River (OMR) channels in almost all months. The median monthly pumping was 6,800 cfs–7,500 cfs October–March. The combined pumping was reduced for fish protection April–June, with a median pumping of 4,227 cfs in April, 2,810 cfs in May, and 4,630 cfs in June. The highest combined pumping was in the summer, with a median pumping of 9,000 cfs–10,000 cfs July–September.

Table 5-13a. Monthly Cumulative Distributions of Historical CVP Export Pumping (cfs) for 1985–2009

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (TAF)
Minimum	967	954	33	1,373	557	739	816	843	790	897	989	1,594	1,338
10%	2,030	2,060	1,565	2,169	2,520	1,955	1,433	857	1,096	2,914	2,677	3,333	1,932
20%	3,594	2,775	2,437	2,882	3,183	2,331	1,651	936	1,725	3,838	3,911	4,001	2,079
30%	3,924	3,573	3,325	3,137	3,561	2,690	1,827	1,064	2,512	4,105	4,250	4,207	2,308
40%	4,117	3,705	3,591	3,490	3,710	3,378	2,022	1,179	2,912	4,241	4,347	4,272	2,475
50%	4,202	3,895	3,735	3,935	3,879	3,551	2,133	1,270	2,991	4,311	4,366	4,279	2,489
60%	4,236	4,098	3,864	3,985	3,936	3,903	2,164	1,390	3,025	4,340	4,375	4,289	2,501
70%	4,297	4,173	4,025	4,100	4,008	4,064	2,198	1,506	3,355	4,374	4,386	4,331	2,561
80%	4,310	4,218	4,129	4,202	4,196	4,105	2,357	1,736	3,980	4,395	4,399	4,361	2,627
90%	4,332	4,282	4,149	4,271	4,312	4,178	2,728	2,047	4,388	4,424	4,427	4,379	2,681
Maximum	4,350	4,324	4,275	4,358	4,368	4,355	3,326	2,985	4,439	4,463	4,430	4,393	2,714
Average	3,637	3,437	3,298	3,483	3,617	3,325	2,558	1,822	2,845	4,007	3,998	3,969	2,413

cfs = cubic feet per second
TAF = thousand acre-feet

Table 5-13b. Monthly Cumulative Distributions of Historical SWP Export Pumping (cfs) for 1985–2009

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (TAF)
Minimum	344	732	113	302	234	-	17	500	269	533	1,580	999	1,524
10%	1,292	1,292	1,650	1,989	1,741	1,053	700	628	474	1,952	2,649	2,509	1,700
20%	1,857	2,094	2,765	2,918	1,951	1,898	1,326	735	745	2,995	3,855	2,850	2,071
30%	2,586	2,279	3,010	3,146	2,614	2,706	1,770	849	1,058	3,643	4,118	3,517	2,381
40%	2,850	2,714	3,657	3,470	3,445	2,868	1,921	939	1,353	4,437	4,445	3,897	2,535
50%	3,027	3,192	3,841	3,712	3,749	2,985	2,101	1,031	1,911	5,586	5,539	4,746	2,605
60%	3,973	3,730	4,201	4,996	4,670	3,379	2,131	1,199	2,163	6,042	6,274	5,211	2,629
70%	4,674	3,827	4,262	5,752	4,851	3,812	2,448	1,365	2,561	6,235	6,549	5,848	2,819
80%	5,037	5,131	5,854	6,464	4,969	5,223	2,686	1,698	3,616	6,329	6,749	6,493	3,179
90%	5,973	5,312	6,532	7,440	6,267	5,848	3,018	1,901	5,045	6,694	6,988	6,939	3,520
Maximum	6,455	5,834	6,838	7,801	7,391	6,888	3,868	2,617	5,965	7,162	7,147	7,149	3,688
Average	3,342	3,297	3,940	4,328	3,718	3,633	2,546	1,607	2,382	4,648	5,121	4,624	2,606

cfs = cubic feet per second
TAF = thousand acre-feet

Table 5-13c. Monthly Cumulative Distributions of Historical CVP and SWP Combined Export Pumping (cfs) for 1985–2009

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (TAF)
Minimum	1,732	1,687	2,088	1,674	2,263	2,062	1,464	1,377	1,760	1,431	2,569	4,140	2,945
10%	4,455	3,956	3,411	4,589	4,108	3,234	2,529	1,585	1,886	4,866	5,634	5,300	3,519
20%	5,226	5,192	4,789	5,901	5,571	3,903	3,269	1,748	2,545	7,018	7,538	6,984	4,364
30%	5,640	5,748	6,476	6,223	6,336	5,839	3,752	2,011	3,330	7,839	8,502	7,521	4,698
40%	6,371	6,213	7,197	7,120	6,771	6,950	4,137	2,527	4,252	8,914	8,839	8,177	4,976
50%	7,237	6,823	7,468	7,477	7,454	7,019	4,227	2,810	4,630	9,943	9,921	9,120	5,035
60%	8,127	7,671	7,875	8,918	8,450	7,052	4,390	2,982	4,951	10,335	10,657	9,568	5,179
70%	8,871	8,141	8,305	9,883	8,728	7,551	4,513	3,067	6,517	10,577	10,956	10,152	5,354
80%	9,254	9,325	9,577	10,495	9,143	8,015	4,758	3,287	7,367	10,713	11,161	10,816	5,887
90%	10,276	9,413	10,696	11,532	10,261	8,849	5,211	3,812	9,330	10,972	11,300	11,217	6,155
Maximum	10,767	9,958	10,913	12,018	11,499	11,029	5,989	4,692	10,378	11,536	11,555	11,511	6,305
Average	6,978	6,734	7,238	7,811	7,334	6,958	5,105	3,429	5,227	8,655	9,119	8,593	5,019

cfs = cubic feet per second
TAF = thousand acre-feet

Southern Delta Water Levels and Flows

This section summarizes the baseline water level and flow conditions in the southern Delta channels as currently managed with the DWR Temporary Barrier Program (TBP). The temporary barriers are installed during the irrigation season in Old River near the Delta-Mendota Canal (DMC), in Grant Line Canal at Tracy Boulevard Bridge, and into Middle River at Victoria Canal. The temporary barriers (weirs) block the tidal flows during ebb tide (falling water elevations, water moving downstream towards the estuary) and thereby maintain higher elevations during ebb tides. This section also summarizes modeling results that show how tidal elevations and flows in the southern Delta channels are affected by CVP and SWP pumping and by the TBP (DWR and USBR 2005).

Because water levels in the southern Delta channels are tidally influenced, they are always changing (fluctuating). Because agricultural diversions (siphons and pumps) may be limited at lower water levels (elevations) a general goal in the southern Delta channels has been to maintain suitable water elevations for the beneficial use of water for agriculture (water supplies). Water level and flow conditions in a tidal channel are more difficult to determine than for a river. Where water elevation in a river will always increase with higher flow, tidal elevations do not necessarily increase with higher net flow. Tidal elevations can be averaged over a monthly lunar cycle, with the average high tide (mean high water [MHW]) or the average low tide (mean low water [MLW]) calculated. Because low water levels in the southern Delta channels have the greatest effect on agricultural diversions, the MLW provides a good measure of water level conditions.

In a river, the direction of flow is downstream and dilutes any salt discharge and transports the salt downstream. However, the direction and magnitude of flow for a network of tidal channels is more difficult to calculate. The tidal flow during each ebb tide moves water one direction (towards the estuary) and the tidal flow during each flood tide moves water in the opposite direction (away from the estuary). Salinity (EC) will increase in a tidal channel having a high salinity discharge both upstream and downstream; the increase in salinity will be less if the tidal flows are large (from a greater tidal mixing volume) or if the net flow is large (from greater dilution).

Effects of Pumping and Barriers on Water Levels and Flows

The natural tidal elevations and tidal flows that would occur in the southern Delta channels with a specific SJR inflow at Vernalis but without the CVP Jones and SWP Banks pumping diversions would be the highest possible water elevations, the greatest possible tidal flows, and the highest net flows in the southern Delta channels. This maximum possible combination of water levels, tidal flows, and net flows can be used to compare the changes (reductions) in water levels and flows in the southern Delta channels caused by exports or TBP conditions. This summary of the southern Delta channel tidal elevations and tidal flows is based on Section 5.2, *Delta Tidal Hydraulics*, of the *Draft South Delta Improvement Program Environmental Impact Statement/Environmental Impact Report* (SDIP EIS/EIR) (DWR and USBR 2005).

The major effect on southern Delta tidal elevations and tidal flows results from CVP and SWP pumping. The CVP Jones plant maximum pumping capacity is 4,600 cfs, and these pumps operate throughout the tidal cycle. The SWP Banks plant is operated to use off-peak energy, and the Clifton Court Forebay (CCF) gates are typically closed during the flood tide prior to the high tide each day to allow the maximum possible high tide elevations in the southern Delta channels (with CVP pumping). The CCF gates are also closed during low tide elevations if the water level in Old River is less than the CCF water elevation. CVP and SWP pumping will reduce the tidal elevations, with current maximum pumping of about 12,000 cfs lowering the high tide elevations by 1.5 feet and lowering the low tide elevations by about 0.75 feet. The tidal flows in the channels are reduced substantially (50 percent less with full pumping). The net flows in Old River and Grant Line Canal (from the SJR diversion to Old River) are not changed substantially by pumping. Slightly more SJR water is diverted into Old River by CVP and SWP pumping (about 5 percent of the pumping flow). Most of the water needed to supply higher CVP and SWP pumping moves south in OMR channels from the central Delta; the net flows are increased, while the tidal flows are only reduced slightly in

OMR channels downstream (i.e., north) of the pumping plants. The tidal elevations and tidal flows are more substantially affected by the temporary barriers, which block tidal flow.

Figure 5-2 shows the actual (measured) effects of the temporary barriers on tidal elevations at the Old River barrier, located just upstream of the DMC intake in 2003. The measured daily minimum and maximum tidal elevations in Old River upstream and downstream of the temporary barrier near the DMC intake demonstrate the effect of the barrier (weir), which was installed with an elevation of about +2 feet MSL (mean sea level). All of the tidal elevations show the typical lunar-cycle fluctuations (i.e., 14-day period). The minimum tidal elevations were -1.0 feet downstream of the barrier, and were increased to +1 feet MSL when the barrier was installed (with culverts open) in early April. The minimum elevations were slightly increased to about 1.5 feet MSL when the culverts were closed in early June (after the VAMP period). The minimum and maximum tidal elevations at Martinez for 2003 are shown for reference as the full tidal elevation range. The effect of the temporary barrier on minimum tidal elevations (MLW) was an increase of about 2–2.5 feet. Pumping does not appear to have any large effect on tidal elevations near the DMC. However, the temporary barrier greatly reduces the tidal flow and the net flow in Old River upstream of the barrier, as discussed below.

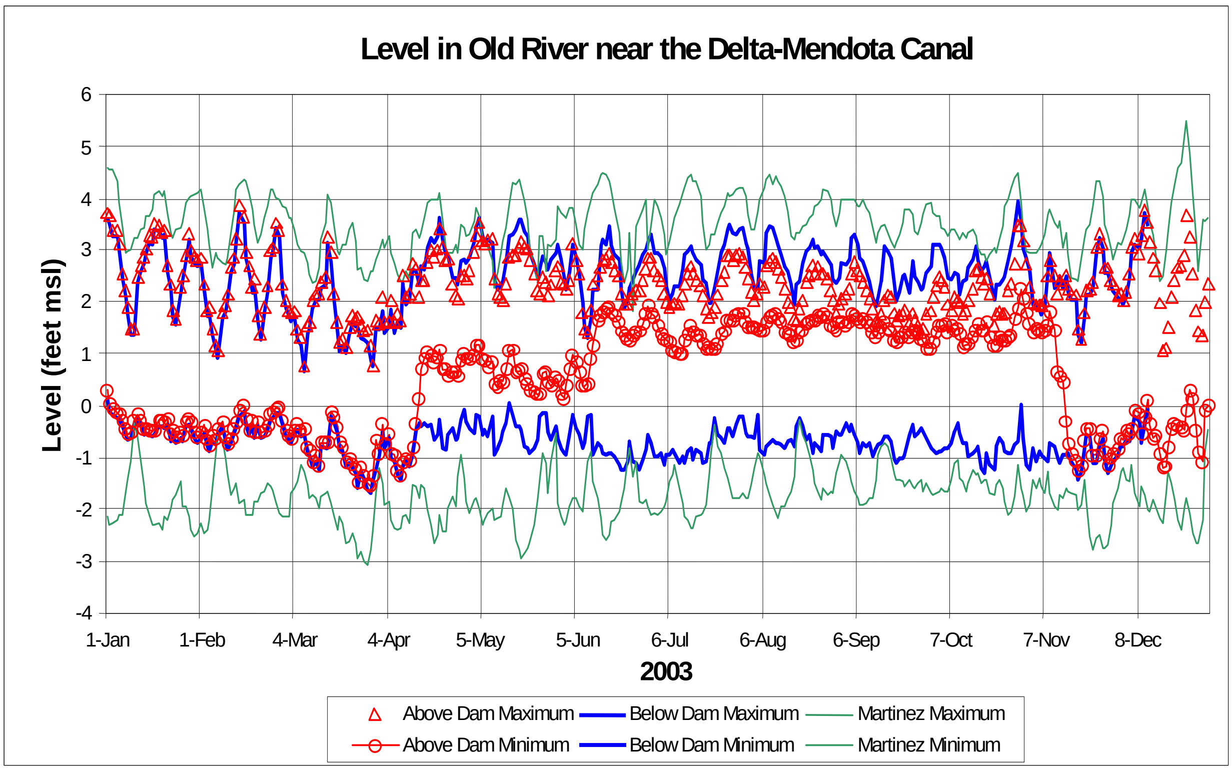

Figure 5-2. Measured Daily Minimum and Maximum Tidal Elevations in Old River Upstream and Downstream of the Temporary Barrier (near the DMC Intake) Compared to the Tidal Elevations at Martinez for 2003 (Source: DWR and USBR 2005 Figure 5.2-46) (msl = mean sea level)

A series of one-month Delta Simulation Model II (DSM2) simulations for representative historical tidal variations of July 1985 were used in the SDIP to show the effects of CVP and SWP pumping and the effects of the temporary barriers. The simulated SJR at Vernalis flow was 1,640 cfs, the CVP pumping was 4,530 cfs, and the SWP pumping was 7,150 cfs for July 1985. The natural tidal level and flow variations in the southern Delta channels without any CVP or SWP pumping or tidal gates were simulated as a reference. Figure 5-3a and 5-3b shows the DSM2-simulated tidal level and tidal flow volumes at the Old River barrier upstream of the DMC entrance, with no CVP and no SWP pumping. The tidal flow volume was calculated from the tidal flow during each ebb or flood tide period. The tidal flow volume (acre-feet [AF]) is equivalent to the average tidal flow (cfs) for the 12-hour period of flood tide (positive) or ebb tide (negative) during each day. The water level ranged from about –0.8 feet to about 4.0 feet MSL, with a median of 1.4 feet MSL. The corresponding average downstream tidal flow was 1,340 cfs (during 12 hours each day), the average upstream tidal flow was –1,480 cfs, and the net upstream tidal flow was –70 cfs. The simulated SJR diversion to Old River was 975 cfs, and the net flow in Grant Line Canal was 395 cfs; therefore, this upstream flow in Old River at the DMC resulted from agricultural diversions along Old River upstream of the barrier.

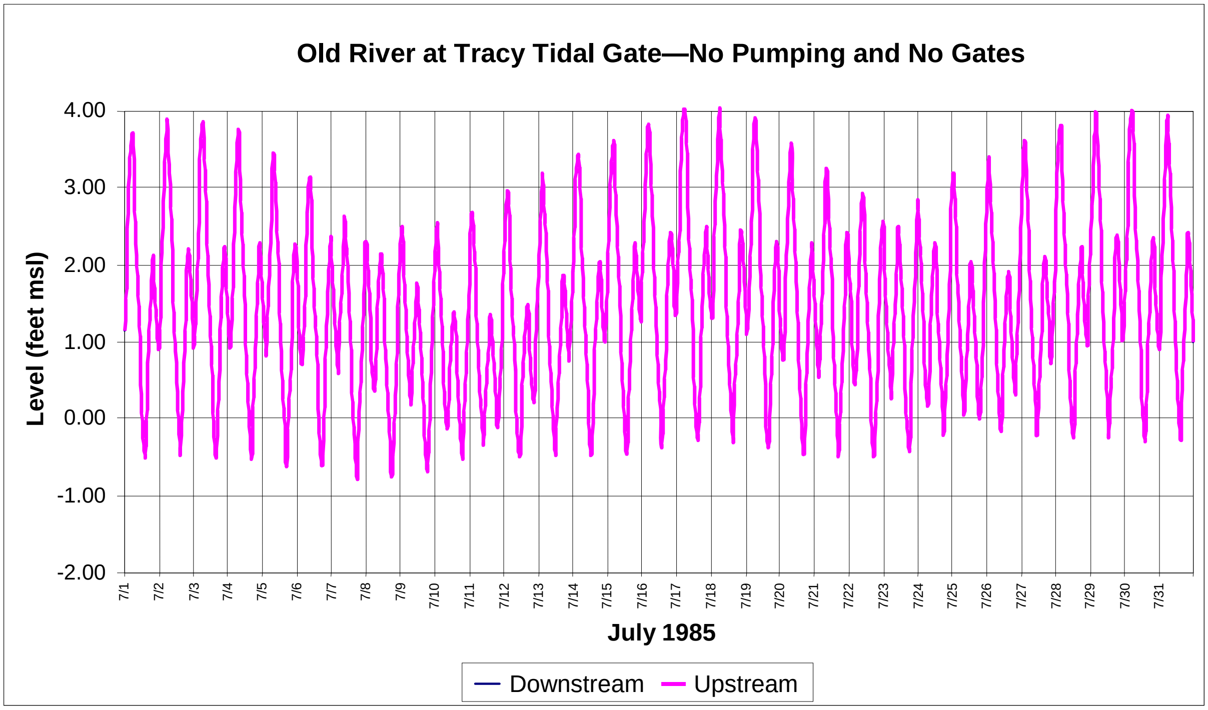

Figure 5-3a. DSM2-Simulated Tidal Elevations for Old River at the DMC Temporary Barrier with No CVP or SWP Pumping and No Barrier for July 1985 (Source: DWR and USBR 2005 Figure 5.2-29) (msl = mean sea level)

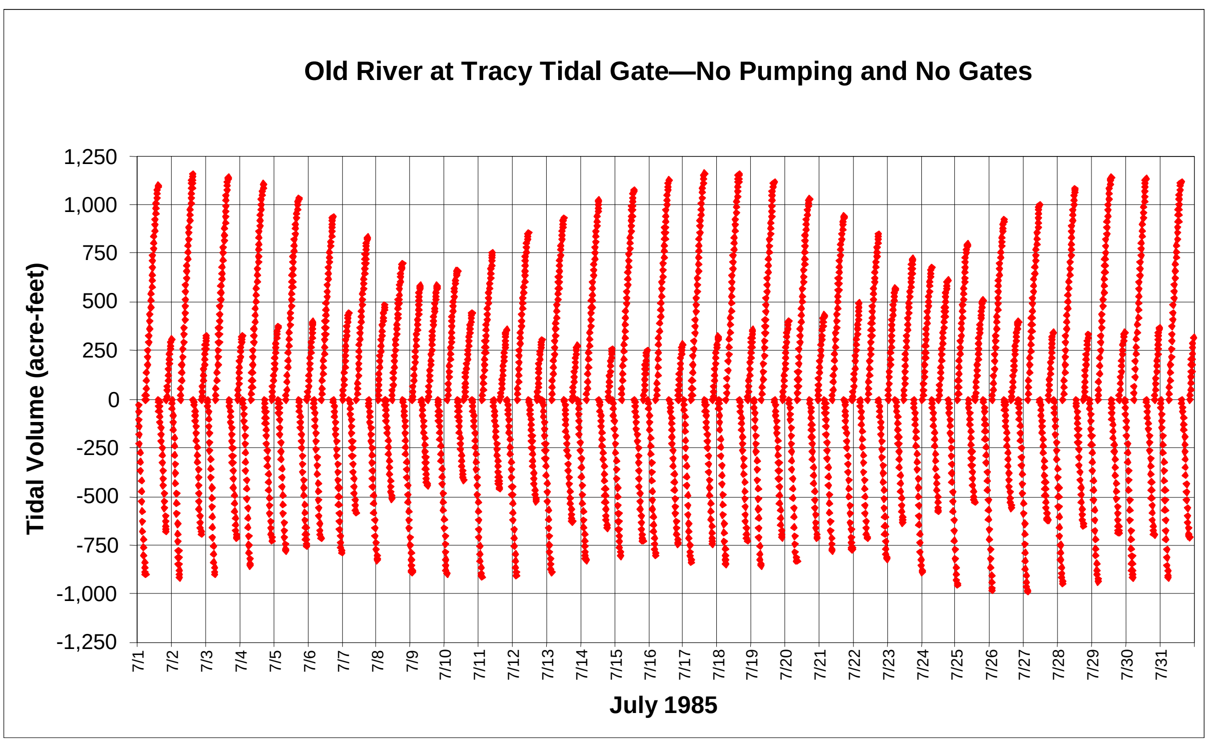

Figure 5-3b. DSM2-Simulated Tidal Flow Volumes (acre-feet) for Old River at the DMC Temporary Barrier with No CVP or SWP Pumping and No Barrier for July 1985 (Source: DWR and USBR 2005 Figure 5.2-29) (msl = mean sea level)

Figures 5-4a and 5-4b show the DSM2-simulated tidal level and tidal flow volumes at the Old River tidal gate location with CVP and SWP pumping (but no temporary barrier). The average downstream tidal flow was 680 cfs, and the average upstream tidal flow was –712 cfs, with a net upstream flow of –17 cfs. The tidal flows at the Old River at DMC barrier location were about half of the tidal flows without any CVP or SWP pumping, but the net flow was slightly increased. The simulated SJR diversion to Old River was 1,470 cfs (increased to 90 percent of the SJR flow) and the Grant Line Canal net flow was 1,017 cfs (increased because of higher SJR diversion to Old River). The CVP and SWP pumping reduced the tidal flows but increased the SJR diversion to Old River and the net flows in these south Delta channels.

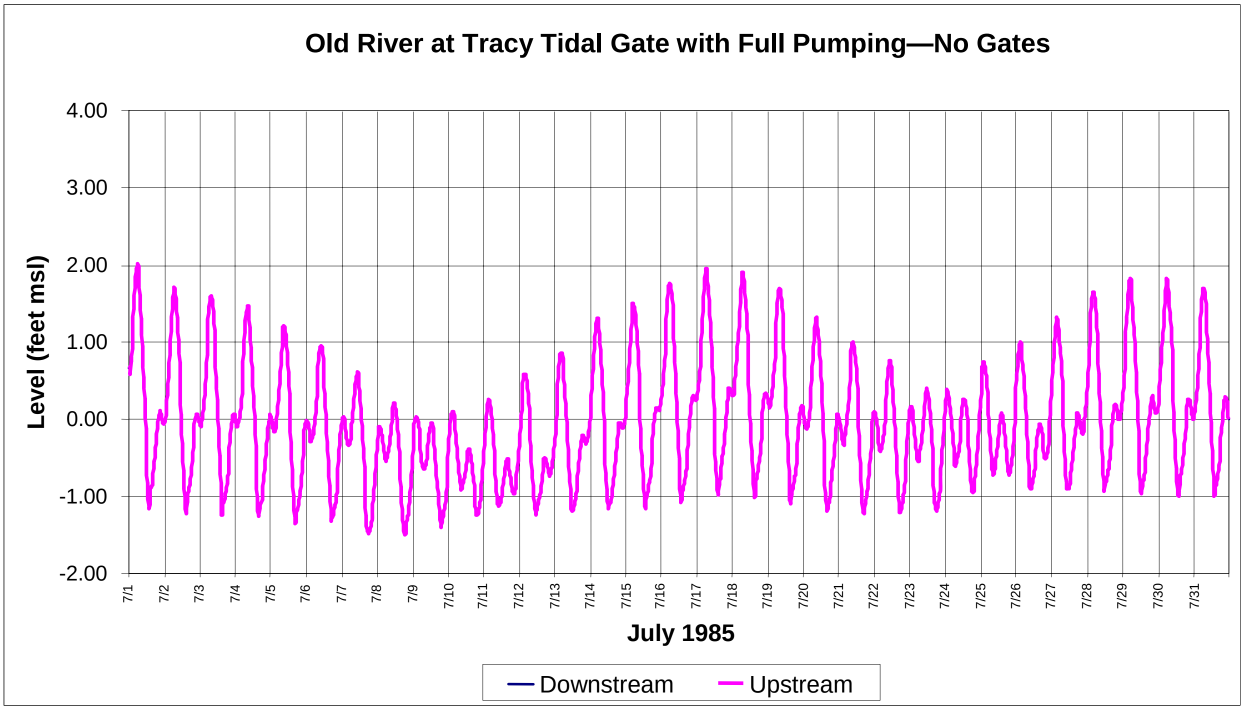

Figure 5-4a. DSM2-Simulated Tidal Elevations for Old River at the DMC Temporary Barrier with CVP Pumping (4,533 cfs) and SWP Pumping (7,180 cfs) with No Barriers for July 1985 (Source: DWR and USBR 2005 Figure 5.2-33) (msl = mean sea level)

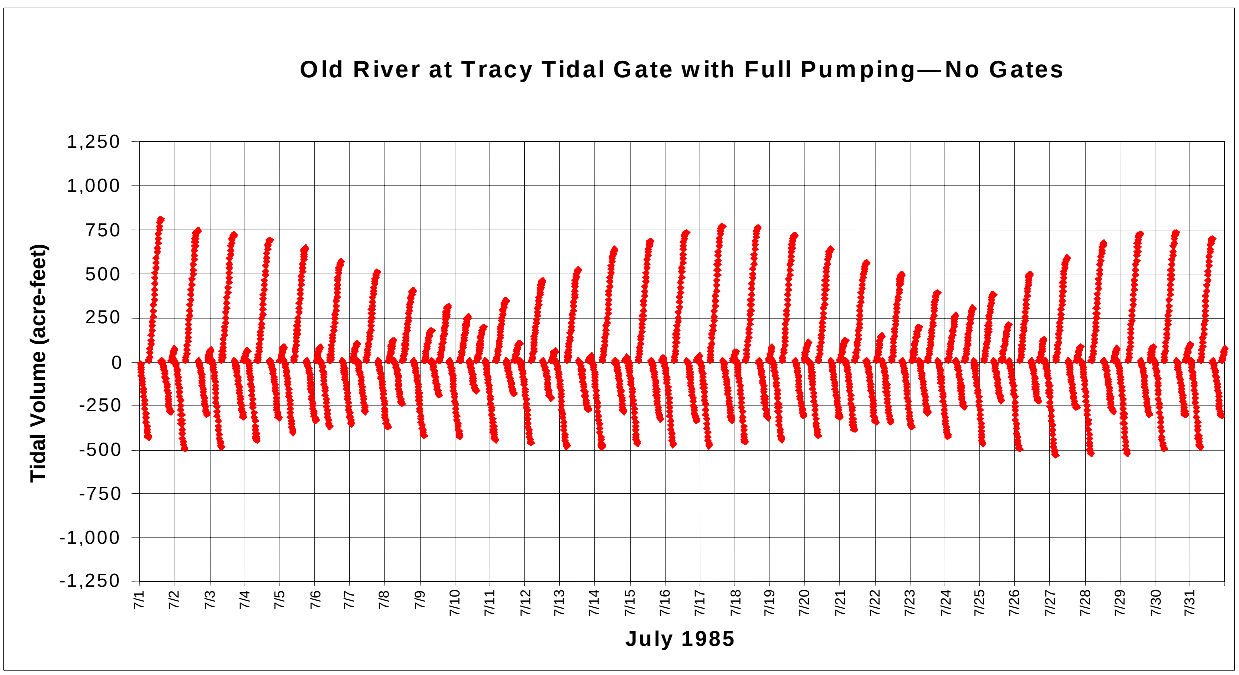

Figure 5-4b. DSM2-Simulated Tidal Flow Volumes (acre-feet) for Old River at the DMC Temporary Barrier with CVP and SWP Pumping with No Barriers for July 1985 (Source: DWR and USBR 2005 Figure 5.2-33) (msl = mean sea level)

Figures 5-5a and 5-5b show the DSM2-simulated tidal level and tidal flow volumes at the Old River temporary barrier location near the DMC with CVP and SWP pumping and with the TBP barriers. The downstream tidal level ranged from -1.8 feet MSL to about 3.6 feet MSL, with a median of 0.0 feet MSL. The upstream water level during low tide was maintained by the temporary barrier weir, which had a simulated crest elevation of about 2.0 feet. The upstream tidal level varied from about 0.8 feet to about 2.7 feet, with a median of 1.3 feet MSL. The downstream tide reached a maximum of 3.5 feet MSL on many days, but the flow over the weir (of about 1,000 cfs) was not sustained for long and was not sufficient to raise the upstream level to more than 2.5 feet MSL. Upstream flow over the barrier did not begin until the downstream level reached the weir crest at 2.0 feet MSL. This did not occur during the neap-tide periods July 7–July 11 and again July 23–July 25. Downstream flow was blocked once the upstream level dropped to 2.0 feet MSL. The tidal flow at the Old River at DMC barrier was very restricted compared to conditions without the temporary barrier. The simulated SJR diversion to Old River was 930 cfs (reduced compared to without the barriers) and the Grant Line Canal net flow was 460 cfs (reduced because of less SJR diversion to Old River). The TBP barriers greatly reduced the tidal flows and also reduced the SJR diversion and net flows in these southern Delta channels. The TBP does increase the low tidal levels (MLW) but the TBP may also cause increased salinity in channels upstream of the barriers.

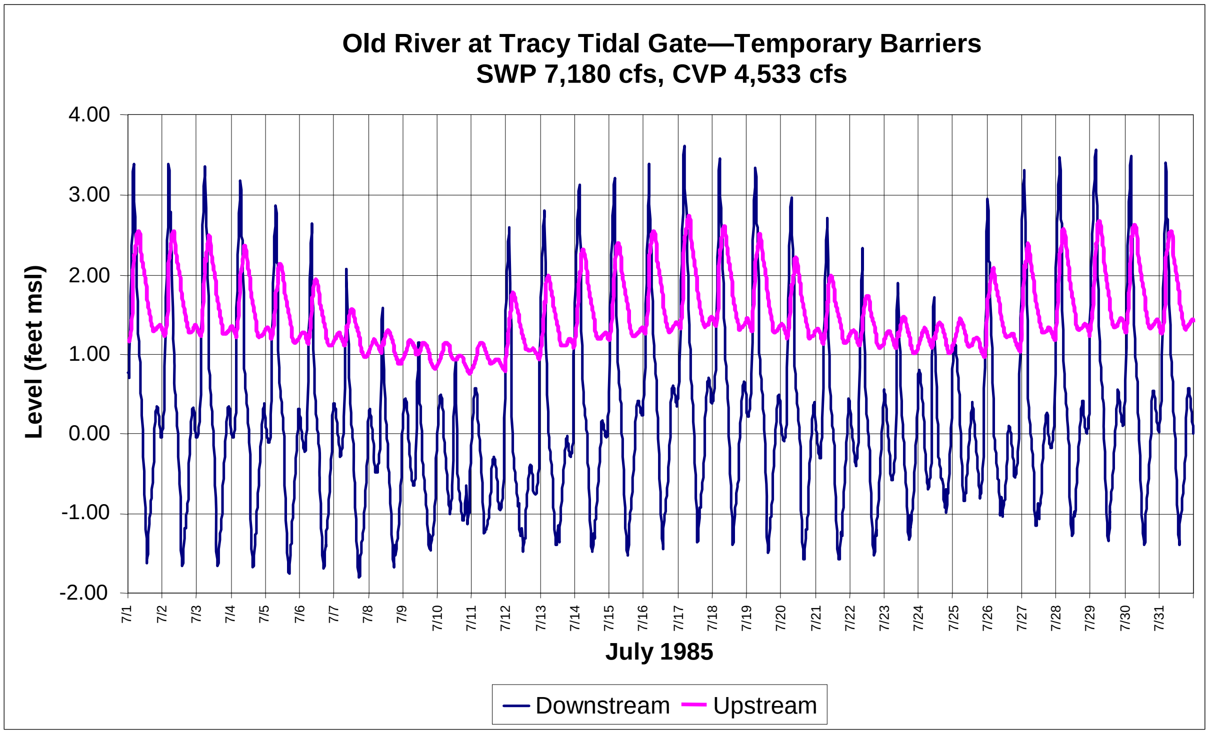

Figure 5-5a. DSM2-Simulated Tidal Elevations for Old River at the DMC Temporary Barrier with Full CVP and SWP Pumping with the Barrier Installed for July 1985 (Source: DWR and USBR 2005 Figure 5.2-37) (cfs = cubic feet per second; msl = mean sea level)

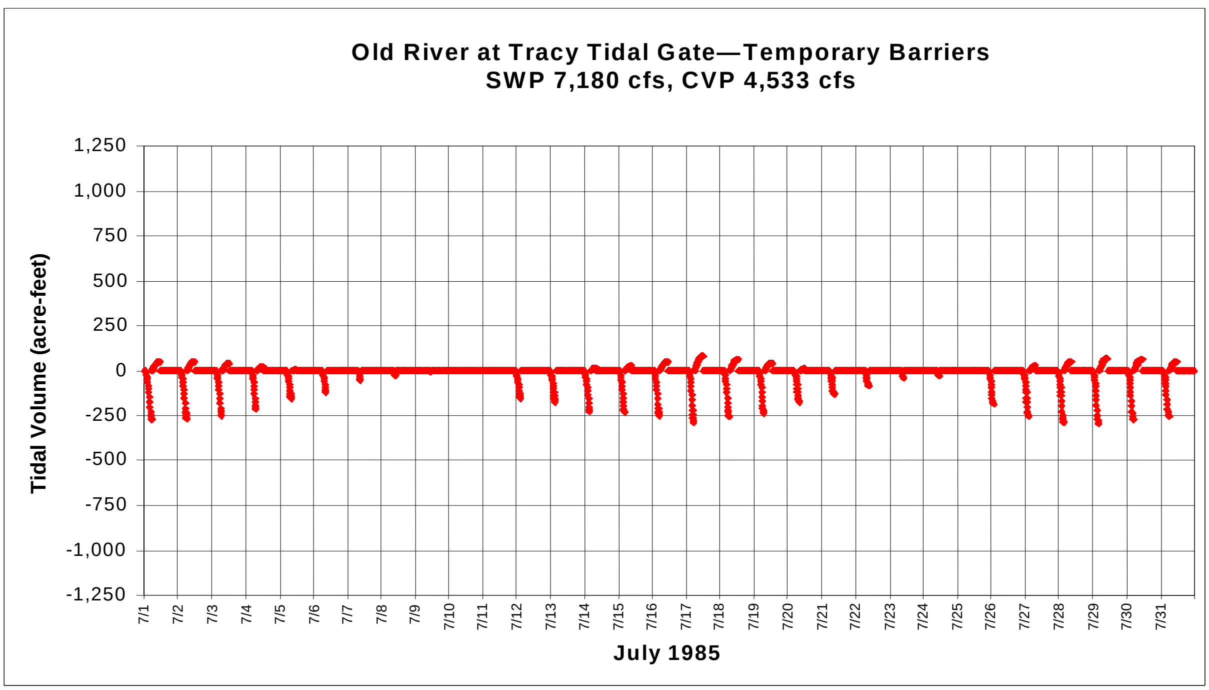

Figure 5-5b. DSM2-Simulated Tidal Flow Volumes (acre-feet) for Old River at the DMC Temporary Barrier with Full CVP and SWP Pumping with the Barrier Installed for July 1985 (Source: DWR and USBR 2005 Figure 5.2-37) (cfs = cubic feet per second)

Water Quality and Salinity

EC values in the southern Delta are affected primarily by the salinity of water flowing into the southern Delta from the SJR at Vernalis, salt discharged back into southern Delta channels that was previously diverted for irrigation, the combined CVP and SWP pumping influencing salinity in the southern Delta, and tidal mixing of inflow from the Pacific Ocean. Municipal treated wastewater discharges have some effect on the southern Delta salinity. The SJR flow at Vernalis has a large effect on the SJR salinity at Vernalis. Higher flows will generally reduce the salinity, following a dilution relationship in which salinity is inversely proportional to the flow. Higher CVP and SWP pumping also has an effect on southern Delta salinity by bringing more low-salinity Sacramento River water across the Delta to the export pumps. However, periods of low Delta outflow (in the fall months) causes increased seawater intrusion and higher EC at the southern Delta export and CCWD intakes.

EC at the three southern Delta compliance stations downstream of Vernalis (SJR at Brandt Bridge, Old River at Middle River [Union Island], and Old River at Tracy Boulevard) are generally higher than the Vernalis EC because of agricultural drainage and municipal discharges. All of the agricultural land in the southern Delta diverts irrigation and salt leaching water (during winter months) from the southern Delta channels. The total amount of diverted water can generally be estimated from the irrigated acreage, with about 3–4 feet per acre applied. The withdrawal of water from channels for use on agricultural fields (i.e., agricultural diversions) does not change the salinity of the channel water. But because agricultural drainage (i.e., runoff from agricultural fields) eventually returns the diverted salt that is applied to the soils back to the channels (often during rainfall runoff and salt leaching periods in the winter), there is an indirect and/or delayed increase in southern Delta salinity. In some channel locations (e.g., Old River at Tracy Boulevard) there can be an increase in the channel salinity during the irrigation season as a result of the agricultural drainage returning to the channels (Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*).

There are several treated wastewater discharges in the southern Delta. Figure 2-10 identifies their locations. The effects of the wastewater discharges depend on the difference between the discharge EC and the river EC. All of the salt from agricultural drainage and wastewater discharges, as well as from the SJR at Vernalis, is generally exported at the CVP and SWP export pumping plants. Because CVP and SWP export pumping draws a majority of the exported water from the Sacramento River, thereby reducing the salinity in the channels near the pumping plants, it is difficult to detect the effects of agricultural drainage or treated municipal wastewater discharged in the southern Delta. Table 5-14 below lists the major wastewater dischargers (greater than 1 million gallons per day) and their effect on existing EC concentrations in the southern Delta.

Table 5-14. Effect of Wastewater Dischargers on Existing Salinity Concentrations in the Southern Delta

Wastewater Discharger	Capacity (cfs)	EC (dS/m)	Daily Salt Load (Tons)	Annual Salt Load (Tons)	Effects on SJR
Manteca	15	1,400	36	13,500	The effects of the Manteca discharge on EC of the SJR can be estimated for any river flow and EC values. For example, with a river flow of 1,500 cfs and an EC of .700 dS/m (irrigation season), the Manteca discharge would increase the river EC by about 0.007 dS/m (i.e., [1400-700] x 15 / 1515)
Stockton	50	1,200	105	38,000	For flow past Stockton of 750 cfs with an EC of .700 dS/m (irrigation season), the increase in EC would be about .031 dS/m (i. e. , [1,200 -500] x 50 / 800)
Tracy	15	1,800	47	17,000	If the Old River flow was 750 cfs with an EC of 0.700 dS/m, the City of Tracy discharge would increase the Old River EC by about 0.022 dS/m (i. e. , [1800-700] x 15 / 765)
Mountain House	8. 5	1,400	20	7,500	The effects of the Mountain House treated wastewater discharge on EC are more difficult to estimate because the flows in this section of Old River are tidal, so water may enter and leave this Old River channel section from both ends. The net summer flows at the upstream end (near Tracy Boulevard Bridge) are positive (i. e. , downstream) but less than 100 cfs, because the agricultural diversions in Old River of about 100-250 cfs are drawing water from both ends of the Old River channel
Discovery Bay wastewater facility	3	2,100	Unknown	Unknown	Because the pumping at the CVP and SWP pumps is generally greater than the Old River flow from the SJR, net flows are generally upstream and the wastewater discharge is mixed with the southern Delta exports, just like the other southern Delta discharges

Source: Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*

Note: Only discharges of greater than 1 million gallons per day (1.5 cfs) are included in this table.

cfs = cubic feet per second

EC = salinity (electrical conductivity)

dS/m = deciSiemens per meter

Historical Salinity (EC) Measurements

The measured EC values throughout the southern Delta indicate that the monthly patterns of EC are generally below the existing Bay-Delta Plan EC objectives. There have been periodic violations in recent dry years at one or more of these stations, but high salinity is not the general pattern. High salinity that exceeds the existing EC objectives in about half of the years in the irrigation months of April–August has been routinely measured only at Tracy Boulevard Bridge. The monthly salinity is controlled by the Vernalis EC and is then slightly increased by agricultural drainage and treated municipal wastewater. Appendix F.2, *Evaluation of Historical Flow and Salinity Measurements of the Lower San Joaquin River and Southern Delta*, describes the salinity conditions in the lower SJR and southern Delta, the available flow, EC and salt load data, and DWR's and USBR's CALSIM Water Resources Simulation Model (CALSIM)[8] assumptions about the SJR salinity above the Merced River and at Vernalis.

Baseline salinity conditions in the SJR and southern Delta channels can be summarized with the USGS and DWR monitoring data from the recent period 1985–2011. Tables 5-15a through 5-15d show the distribution of monthly average EC values that have been measured at Vernalis, the SJR at Brandt Bridge, Old River at Middle River (Union Island), and Old River at Tracy Boulevard, respectively. The lowest values have only occasionally been below 0.200 dS/m. The highest 90th percentile value was 1.174 dS/m (in Old River at Tracy Boulevard in February). Maximum monthly values have rarely been greater than 1.200 dS/m, with the highest monthly value of 1.326 dS/m again occurring in Old River at Tracy Boulevard during February. These data show that the EC values in the southern Delta rarely fall outside of a range of 0.200–1.200 dS/m.

Table 5-15a shows the historical EC data from Vernalis for 1985–2011 (27 years), presented in the monthly cumulative distribution format. The monthly median values provide the general seasonal pattern. The highest monthly median values were in December–March, when the salinity objective in the 2006 Bay-Delta Plan is 1.000 dS/m. The lowest monthly median EC values were measured in the irrigation season of April–August, when the salinity objective in the Bay-Delta Plan is 0.700 dS/m. The average Vernalis EC was lower in months with higher flows and higher in months with lower flows. The lowest EC (10 percent cumulative values) were 0.200–0.400 dS/m during the April–August irrigation season and were 0.250–0.500 dS/m September–March.

The January and February EC values were greater than 1.000 dS/m, the current 2006 Bay-Delta Plan salinity objective, in about 10 percent of the years. The March and April EC values were higher than 1.000 dS/m in just a few years. The measured EC values were greater than 0.700 dS/m April–August, the current 2006 Bay-Delta Plan salinity objective, in about 10 percent to 30 percent of the years depending on the month (e.g., less than 10 percent for May and almost 30 percent for July).[9] The Vernalis EC approached the 1.000 dS/m objective in January–March 2003 and January–March 2009. The Vernalis EC has been about 0.650 dS/m in only about 6 months during the April–August period since 1996 because New Melones releases water to meet the EC objective at Vernalis.

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[8] CALSIM is a generalized water resources simulation model for evaluating operational alternatives of the State Water Project/Central Valley Project system. CALSIM II is the latest application of the generic CALSIM model to simulate SWP/CVP operations. CALSIM and CALSIM II are products of joint development between DWR and USBR. This document uses CALSIM and CALSIM II interchangeably.

[9] The 0.700 dS/m salinity objective was only implemented beginning in 1996.

Table 5-15a. Monthly Average Measured SJR at Vernalis EC (µS/cm) for 1985–2011

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Minimum	262	452	210	128	144	163	128	95	110	152	214	239
10%	310	504	336	338	250	230	200	166	184	320	432	332
20%	398	579	587	490	338	314	276	230	264	473	498	410
30%	414	616	728	534	553	412	351	296	452	541	525	475
40%	476	657	752	639	630	672	470	352	500	586	570	550
50%	507	673	771	752	750	747	535	380	575	611	608	591
60%	524	692	782	778	784	800	570	438	627	633	629	626
70%	584	705	836	815	873	835	643	501	686	693	651	687
80%	696	755	853	945	940	904	695	644	731	758	758	762
90%	768	807	880	1,047	1,104	962	743	692	827	766	797	798
Maximum	866	819	926	1,137	1,299	1,095	1,144	718	871	846	873	898
Average	520	661	699	694	695	647	506	413	534	583	600	578

µS/cm = microSiemens per centimeter

Table 5-15b shows the historical EC data from Brandt Bridge for 1985–2009 (25 years), presented in the monthly cumulative distribution format. The monthly median EC values at Brandt Bridge show the same seasonal pattern as Mossdale and Vernalis. There is some agricultural drainage between Vernalis and Brandt Bridge, but the monthly EC at Brandt Bridge was similar to the EC at Vernalis and at Mossdale. The median monthly EC values were about 0.025–0.050 dS/m higher than the median monthly Vernalis EC values during the non-irrigation season of September–March and were 0.050–0.100 dS/m higher than the median Vernalis EC values during the irrigation season of April–August. The monthly EC values were greater than the 0.700 dS/m objective in about 30 percent of the years during April; in about percent of the years during May, in about 30 percent of the years during June, in about 40 percent of the years during July, and in about 30 percent of the years during August. Most of the EC values higher than 0.700 dS/m were in years prior to 1995, when the salinity objective was higher.

Table 5-15b. Monthly Average Measured SJR at Brandt Bridge EC (μS/cm) for 1985–2009

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Minimum	240	436	252	150	168	215	154	115	156	243	314	291
10%	337	560	392	424	299	253	228	199	228	356	488	399
20%	401	596	611	526	433	345	335	304	413	548	524	477
30%	467	621	742	574	617	428	397	333	508	609	580	528
40%	504	668	755	672	696	620	562	404	590	676	620	605
50%	530	699	777	772	778	719	636	427	613	695	653	652
60%	601	708	823	800	803	801	659	497	680	709	681	701
70%	659	747	837	863	875	868	686	517	773	739	694	751
80%	722	775	881	968	936	932	733	684	787	777	764	780
90%	808	845	929	1,011	1,047	969	787	734	823	851	801	833
Maximum	941	961	955	1,063	1,213	1,108	827	840	961	888	872	959
Average	560	694	734	719	715	662	548	459	593	648	639	631

μS/cm = microSiemens per centimeter

Table 5-15c shows the monthly cumulative distribution of historical EC data from Old River at Middle River (Union Island), located just upstream of the city of Tracy discharge. The monthly median EC values were similar to Vernalis, Mossdale, and Brandt Bridge. The median EC values for 1993–2009 (17 years) were 0.588 dS/m in September, 0.510 dS/m in October, 0.711 dS/m in November, 0.818 dS/m) in December, 0.761 dS/m in January, 0.695 dS/m in February, and 0.682 dS/m in March. The monthly median EC values were 0.543 dS/m in April, 0.402 dS/m in May, 0.565 dS/m in June, 0.634 dS/m in July, and 0.630 dS/m in August. The median EC values at Union Island were sometimes higher and sometimes lower than the Vernalis EC values, and were generally lower than the median EC values at Mossdale. Because the SJR water at Mossdale flows past either Brandt Bridge or Union Island, the EC at these two stations should be similar.

Table 5-15c. Monthly Average Measured Old River at Middle River (Union Island) EC (μS/cm) for 1993–2009

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Minimum	245	567	271	191	184	225	150	111	123	183	365	282
10%	300	588	536	391	280	278	257	179	195	360	457	396
20%	451	617	661	546	317	324	305	253	367	457	516	432
30%	472	653	759	591	439	402	354	338	514	617	566	503
40%	494	679	795	623	610	455	472	375	537	629	609	555
50%	510	711	818	761	695	682	543	402	565	634	630	588
60%	530	721	839	778	780	802	586	425	570	684	639	606
70%	541	731	864	808	918	873	616	439	639	713	704	650
80%	595	768	876	819	958	947	665	476	675	721	726	693
90%	616	787	890	948	971	1,016	711	517	750	779	732	722
Maximum	660	853	907	1,008	979	1,043	855	649	899	853	918	913
Average	491	696	754	679	651	639	501	376	530	610	619	574

μS/cm = microSiemens per centimeter

Table 5-15d shows the historical EC data from Old River at Tracy Boulevard Bridge, located downstream of the City of Tracy discharge and downstream of Doughty Cut, which diverts most of the Old River flow to Grant Line Canal. This section of Old River has less tidal movement and less net flow but is influenced by several agricultural drainage pumps that discharge into Old River. The monthly median EC values for 1985–2009 (25 years) were 0.761 dS/m (170 higher than Vernalis) in September, 0.730 dS/m (223 higher than Vernalis) in October, 0.801 dS/m (128 higher) in November, 0.870 dS/m (99 higher) in December, 0.872 dS/m (120 higher) in January, 0.877 dS/m (127 higher) in February, and 0.906 dS/m (159 higher) in March. The monthly median EC values were 0.721 dS/m (186 higher) in April, 0.591 dS/m (211 higher) in May, 0.697 dS/m (122 higher) in June, 0.815 dS/m (204 higher) in July and 0.776 dS/m (168 higher) in August. These EC values are much higher than the Old River at Middle River (Union Island) EC values measured just a few miles upstream. The Tracy Boulevard Bridge location may not accurately indicate the salinity of the water being supplied to this portion of Old River for irrigation use.

Compliance with the 1995 Bay-Delta salinity objectives at Vernalis has been consistently achieved over the past 15 years. However, compliance with the interior southern Delta salinity objectives has not always been achieved. There is a strong relationship between salinity concentrations at Vernalis and salinity concentrations at Brandt Bridge and Old River at Middle River under most conditions. Salinity increases between Vernalis and Brandt Bridge averaged about 0.050 dS/m (Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives)*. The historical salinity increase for Old River at Tracy Boulevard has been greater, averaging about 0.150 dS/m, with several monthly increases of more than 0.200 dS/m. The monthly increases in downstream EC are greatest when the SJR flow is low because the dilution of the drainage EC or municipal discharge EC is less when the SJR flow is low.

Table 5-15d. Monthly Average Measured Old River at Tracy Boulevard Bridge EC (µS/cm) for 1985–2009

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Minimum	294	408	355	265	286	245	194	135	240	246	325	295
10%	437	630	646	399	407	339	282	266	245	461	534	512
20%	554	681	714	617	493	376	411	407	463	645	644	597
30%	667	716	756	727	677	467	482	433	569	703	694	626
40%	674	748	831	765	782	685	672	524	625	744	737	692
50%	730	801	870	872	877	906	721	591	697	815	776	761
60%	779	842	901	907	904	950	825	617	786	841	812	816
70%	828	858	928	1,016	1,044	968	858	709	839	904	872	871
80%	875	895	994	1,096	1,094	1,059	954	748	956	931	909	934
90%	1,048	978	1,054	1,167	1,174	1,114	976	778	1,034	985	980	945
Maximum	1,094	1,136	1,246	1,233	1,326	1,174	1,206	1,008	1,210	1,186	1,194	1,541
Average	726	798	848	834	827	757	684	562	692	769	771	770

µS/cm = microSiemens per centimeter

5.3 Regulatory Setting

5.3.1 Federal

Relevant federal programs, policies, plans, or regulations related to water supply, surface hydrology, and water quality are described below.

Clean Water Act

The federal CWA (33 U.S.C., § 1251 et seq.) places primary reliance for developing water quality standards on the states (e. g., water quality objectives). The CWA established the basic structure for regulating point and nonpoint discharges of pollutants into the waters of the United States and gave USEPA the authority to implement pollution control programs, such as setting wastewater standards for industry. The statute employs a variety of regulatory and nonregulatory tools to reduce pollutant discharges into waters of the United States, finance municipal wastewater treatment facilities, and manage polluted runoff. The CWA authorizes USEPA to authorize state governments to implement many permitting, administrative, and enforcement aspects of the law, although USEPA still retains oversight responsibilities in many instances. In California, USEPA has authorized the State Water Board to administer the CWA, which is done in conjunction with implementation of the Porter-Cologne Water Quality Control Act (Porter-Cologne Act) (Wat. Code, § 13000 et seq.). The State Water Board is updating the 2006 Bay-Delta Plan in accordance with the CWA.

Clean Water Act Section 303(d)

If the CWA's permit program fails to clean up a river or river segment, states, territories, and authorized tribes are required under CWA Section 303(d) to identify such "impaired waters" under their jurisdiction and list them in order of priority (see Table 5-4). The law requires that states determine TMDLs to monitor and improve water quality for these waters. TMDLs can affect the water quality standards in basin plans by leading to more stringent NPDES permits (CWA, § 402, discussed below). Relevant to the plan area (see Section 5.2.1), the State Water Board and USEPA have approved TMDLs for organic enrichment/low DO and methylmercury in the Delta and for salt and boron in the SJR at Vernalis. The 303(d) pollutant concentrations could be affected by the LSJR alternatives.

Clean Water Act Section 402

Under CWA Section 402, point-source discharges to surface waters are regulated through the NPDES program. In California, the State Water Board oversees the NPDES program, which is administered by the regional water boards. The NPDES program provides both general permits (those that cover a number of similar or related activities and/or for a specific geographic region) and individual permits. As the 2006 Bay Delta Plan is amended, future NPDES permits, established and enforced by the Central Valley Water Board, may be required to incorporate the latest Bay-Delta Plan standards.

Federal Antidegradation Policy

The federal antidegradation policy is designed to provide the level of water quality necessary to protect existing uses and provide protection for higher quality and national water resources. The federal policy directs states to adopt a statewide policy, which California did (see Chapter 19, *Antidegradation Analysis*).

Raker Act

Congress passed the Raker Act in 1913 to protected the water rights of TID and MID on the Tuolumne River. The act apportioned flows on the Tuolumne River and allowed CCSF to construct the O'Shaughnessy Dam. The act requires CCSF to bypass the district entitlements of the lesser of unimpaired flow as measured at La Grange Dam, or 2,416 cfs June 15–April 14 and 4,066 cfs April15–June 14. CCSF is therefore entitled to any remaining portion of the unimpaired flow greater than the district entitlements. The LSJR alternatives would establish flow requirements on the Tuolumne River.

5.3.2 State

Relevant state programs, policies, and regulations related to water supply, surface hydrology, and water quality are described below.

Porter-Cologne Water Quality Control Act of 1969

Under the Porter-Cologne Act, water quality objectives are limits or levels of water quality constituents or characteristics established for the purpose of protecting beneficial uses (e.g., agricultural beneficial uses or wildlife and fish beneficial uses). The act requires the State Water Board and regional water boards to formulate and adopt WQCPs that designate the beneficial uses of the water to be protected and establish water quality objectives and a program to meet the objectives. Water quality objectives under the act are defined as the limits or levels of water quality constituents or characteristics that are established for the reasonable protection of beneficial uses of water or the prevention of nuisance in a specific area. Therefore, the water quality objectives form the regulatory references for meeting state and federal requirements for water quality control.

A change in water quality is allowed only if the change is consistent with the maximum beneficial use of the waters of the state, would not unreasonably affect the present or anticipated beneficial uses, and would not result in water quality lower than that specified in applicable WQCPs (Central Valley Water Board 2009a).

The State Water Board is updating the 2006 Bay-Delta Plan in accordance with the Porter-Cologne Act.

San Francisco Bay/Sacramento–San Joaquin Delta Estuary WQCP (Bay-Delta Plan)

The current WQCP in effect in the Delta is the *2006 Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary* (2006 Bay-Delta Plan). The 2006 Bay-Delta Plan identifies beneficial uses of water in the Delta to be protected, water quality objectives for the reasonable protection of beneficial uses, and an implementation program to achieve the water quality objectives. For additional information on the 2006 Bay-Delta Plan, see Chapter 1, *Introduction*.

Sacramento River and SJR Basins WQCP (Basin Plan)

The Central Valley Water Board's *Water Quality Plan for the Sacramento and San Joaquin River Basins* (Basin Plan) covers the entire Sacramento and SJR Basins, including an area bound by the crests of the Sierra Nevada on the east and the Coast Range and Klamath Mountains on the west, and extending some 400 miles, from the California-Oregon border southward to the headwaters of the SJR.

The Basin Plan defines the beneficial uses, water quality objectives, implementation programs, and surveillance and monitoring programs. The Basin Plan contains specific numeric water quality objectives that are applicable to certain water bodies or portions of water bodies. Numerical objectives have been established for bacteria, DO, pH, pesticides, EC, total dissolved solids, temperature, turbidity, and trace metals. The Basin Plan also contains narrative water quality objectives for certain parameters that must be attained through pollutant control measures and watershed management. Narrative water quality objectives also serve as the basis for the development of detailed numerical objectives. The Central Valley Water Board would evaluate the update to the 2006 Bay-Delta Plan and incorporate any appropriate changes into the Basin Plan.

State Antidegradation Policy

The goal of State Water Board Resolution No. 68-16 (Statement of Policy with Respect to Maintaining High Quality Waters in California) is to maintain high quality waters where they exist in the state. The State Water Board has interpreted Resolution No. 68-16 to incorporate the federal antidegradation policy, which is applicable if a discharge that began after November 28, 1975, will lower existing surface water quality. (See Chapter 19, *Antidegradation Analysis*, for further discussion.)

Nonpoint Source Pollution Control Program (Water Code Section 13369[a][2][B])

In May 2004, the State Water Board adopted a new policy regulating nonpoint source pollution. The Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program fulfills the requirements of Water Code Section 13369(a)(2)(B). This policy affects landowners and operators throughout the state engaged in agricultural production, timber harvest operations, and other potential sources of nonpoint source pollution.

The policy generally expects nonpoint source dischargers to use management practices that do not impair surface water quality and charges each landowner a fee to cover increased regulatory oversight. Consequently, implementation programs for nonpoint source pollution control have expanded beyond waivers and now may be developed by a regional water board, the State Water Board, individual dischargers, or by a coalition of dischargers in cooperation with a third-party representative, organization, or government agency. The latter programs are collectively known as *third-party programs*, and the third-party role is restricted to entities that are not actual dischargers under regional water board/State Water Board nonpoint source discharge permitting and enforcement jurisdiction.

State Water Board Decision 1641

The Bay-Delta Plan (discussed previously) outlines current water quality objectives for the Delta. State Water Board D-1641 contains the current water right requirements, applicable to DWR and USBR's operations of the CVP and SWP facilities, respectively, to implement the Bay-Delta water quality objectives. D-1641 specifies that, February–June, the location of X2 must be west of Collinsville and must be west of Chipps Island or Port Chicago for a certain number of days each month, depending on the previous month's Eight River Index. D-1641 specifies that compliance with the X2 standard may occur in one of three ways: (1) the daily average EC at the compliance point is less than or equal to 2. 64 dS/m; (2) the 14-day average EC is less than or equal to 2. 64 dS/m; or (3) the 3-day average Delta outflow is greater than or equal to the corresponding minimum outflow. The State Water Board approved the conduct of VAMP for a period of 12 years in lieu of meeting the SJR pulse flow objectives identified in the Bay-Delta Plan and assigned responsibility to USBR for meeting the SJR flow objectives. The State Water Board also approved petitions for water right changes and established the condition for the water rights of various San Joaquin River Group Authority members to provide water for VAMP and the October pulse flow objective. Accordingly, the VAMP flows are considered baseline and are appropriately modeled.

CVP and SWP Coordinated Operations Agreement

CVP and SWP are relatively independent projects that use a common water supply. However, the CVP and SWP operations are linked by the requirement that they meet Delta flow and water quality standards and are linked by joint operations south of the Delta at the San Luis complex and the joint-use San Luis Canal. In 1986, Public Law 99-546 authorized the coordinated operations agreement (COA) between USBR and DWR, intended to define the rights and responsibilities of CVP and SWP with respect to use of that common water supply and provide an infrastructure to monitor those rights and responsibilities. Specifically, the COA defines the project facilities and their water supplies, sets forth procedures for coordination of operations, identifies formulas for sharing joint responsibilities for meeting Delta flow and water quality standards and other legal uses of water, identifies how unstored flow will be shared, sets up a framework for exchange of water and services between the projects, and provides for periodic review every 5 years.

Although implementation of the COA has changed since 1986 as modifications have occurred to the CVP and SWP systems and the operations of those systems have been altered, revisions to the 1986 COA have not been implemented to reflect changes in regulatory standards, operating conditions, and new project features, such as the Environmental Water Account (EWA).

The COA is considered as part of the baseline and is incorporated into the modeling appropriately.

5.3.3 Regional or Local

Relevant regional or local programs, policies, regulations, or agreements related to water supply, surface hydrology, and water quality are described below. Although local policies, plans, or regulations are not binding on the State of California, below is a description of relevant ones.

Fourth Agreement

The Fourth Agreement, between CCSF, TID, and MID (1966), sets forth conditions for CSSF to partially fund the construction of the New Don Pedro Reservoir. Under this agreement, if CCSF is able to bypass flows in excess of TID's and MID's Raker Act entitlements, and then the CCSF "banks" this amount of water, up to a seasonal high of 740 TAF, for later use. If CCSF bypasses less than the two districts Raker Act entitlements, then the CCSF would withdraw water from the water bank; a negative balance (CCSF bank depleted) would require prior agreement with the two irrigation districts. The Fourth Agreement also states that in the event any future changes to the New Don

Pedro FERC water release conditions negatively impact the two irrigation districts, CCSF, MID, and TID would apportion the burden prorated at 51.7121 percent to CCSF and 48.2879 percent to MID and TID. (CCSF/TID/MID 1966.)

5.4 Impact Analysis

This section lists the thresholds used to define impacts on water supply, surface hydrology, and water quality. It describes the methods of analysis and the approach to determine the significance of impacts on water supply, surface hydrology, and water quality. It also identifies impacts that are not evaluated further in the impact discussion. The impact discussion describes the changes to baseline resulting from the alternatives and incorporates the thresholds for determining whether those changes are significant. Measures to mitigate (i.e., avoid, minimize, rectify, reduce, eliminate, or compensate for) significant impacts accompany the impact discussion, where appropriate.

5.4.1 Thresholds of Significance

The thresholds for determining the significance of impacts for this analysis are based on the State Water Board's Environmental Checklist in Appendix A of the Board's CEQA regulations (Cal. Code Regs, tit. 23, §§ 3720–3781) and the Environmental Checklist in Appendix G of the State CEQA Guidelines. The thresholds derived from the checklist(s) have been modified, as appropriate, to meet the circumstances of the alternatives. (Cal. Code Regs., tit. 23, § 3777, subd. (a)(2).) Hydrology and water quality impacts were determined to be potentially significant (see Appendix B, *State Water Boards Environmental Checklist* in this SED) and therefore are discussed in the analysis. Impacts would be significant if the LSJR or SDWQ alternatives result in the following conditions.

- Substantially reduce monthly river flow values relative to baseline.
- Substantially alter hydrology such that regulating reservoir operations would be limited.
- Substantially reduce surface water supply diversions caused by a change in river flows or reduce exports to CVP and SWP export service areas caused by a change in river flows.
- Violate water quality objectives for salinity by increasing in the number of months with EC above the water quality objectives for salinity at Vernalis or southern Delta compliance stations.
- Substantially degrade water quality by increasing Vernalis and/or southern Delta salinity (EC) such that agricultural beneficial uses are impaired Substantially increase temperature.
- Substantially degrade water quality by increasing water temperature caused by reduced river flows.
- Substantially degrade water quality by increasing contaminant concentrations caused by reduced river flows.

As described in Appendix B, *State Water Board's Environmental Checklist,* the LSJR and SDWQ alternatives would result in either no impact or less-than-significant impacts on the following related to water supply, surface hydrology, and water quality and, therefore, are not discussed within this chapter.

- Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff.

Other water supply, surface hydrology or water quality-related thresholds and impacts identified in Appendix B, that were determined to be potentially significant, are discussed in the following chapters: Chapter 6, *Flooding, Sediment, and Erosion;* Chapter 7, *Aquatic Resources;* Chapter 9, *Groundwater Resources*; Chapter 11, *Agricultural Resources*; and Chapter 13, *Service Providers*.

5.4.2 Methods and Approach

Changes to the magnitude and frequency of monthly flow requirements under the LSJR alternatives could result in changes to resulting flows in the rivers, the amount of water available for surface diversions, and the salinity, 303(d) pollutant concentration and temperature of the rivers. Changes to the salinity objective under the SDWQ alternatives could result in a change to the frequency of exceedances of the existing or alternative salinity objective at Vernalis and in the southern Delta and a change to the beneficial uses (i.e., agriculture) in the southern Delta. Flow, water supply, salinity, temperature and 303(d) pollutant concentration are evaluated in Section 5.4.3.

The CALSIM model of monthly reservoir operations and flows calculated baseline conditions that were used to assess hydrology and water supply impacts in this SED. The water supply effects of the LSJR alternatives were analyzed using the State Water Board's Water Supply Effects (WSE) model. The scientific basis for the WSE is described in Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*, and the detailed methods and results for the LSJR alternatives are presented in Appendix F.1, *Hydrologic and Water Quality Modeling*. Because changes in the required tributary flows would lead to changes in the reservoir operations, flood control releases, and diversions for existing water supply beneficial uses, the WSE model was used to estimate these likely changes.

The three eastside tributary flow changes would also cause salinity changes in the SJR at Vernalis and in the southern Delta, so the WSE model was also used to simulate these changes. The results of the WSE model were used to quantitatively evaluate the changes in hydrology and water quality in the three eastside tributaries, the LSJR, and the southern Delta using a flow value (i.e., general flow benefits) rating. Temperature changes were quantitatively evaluated using the SJR Basin Water Temperature Model (temperature model)(see Section 5.4.2); salinity was evaluated with calculations based on the CALSIM and WSE results, and changes in contaminant concentration were evaluated based on flow changes simulated with the WSE model. Below is a description of these methodologies.

The LSJR alternatives are not expected to have upstream physical environmental effects and/or effects on upstream reservoir or hydropower operations because of the following reasons and therefore upstream reaches were not included in the modeling or analysis.

- The Merced River unimpaired flow is essentially the same as the Lake McClure inflow because there are no major storage reservoirs or diversions upstream in the Merced River watershed.

- Some upstream hydroelectric generating facilities operate as run-of-the-river generating plants, diverting water into penstocks and discharging water at a downstream location without changing the total flow. These facilities are operated with appropriate minimum flow requirements for the stream reach between the forebay (diversion) and afterbay (discharge). The LSJR alternatives, which would be implemented further downstream, would have no effect on these upstream hydropower facilities.
- Some upstream reservoirs provide seasonal storage of winter runoff and snowmelt to provide a more constant flow through downstream hydroelectric generating facilities and to allow irrigation diversions to remain higher through the summer irrigation season. These upstream reservoirs are operated with declining storage in the summer and fall and increasing storage in the winter and spring. The fraction of the unimpaired runoff that is retained in these upstream reservoirs depends on the upstream watershed area and is a small fraction of the watershed runoff. For example, the total upstream storage in the Stanislaus River watershed is about 450 TAF. New Spicer Meadows is the largest reservoir (180 TAF capacity), with a watershed area of 45 square miles; the runoff to New Spicer Meadows would be about 5 percent of the unimpaired runoff at New Melones Dam (watershed of 980 square miles). Therefore, operations of these upstream storage facilities can continue without regard to the downstream flow objectives. The seasonal inflow to the major downstream reservoirs (i.e., New Melones, New Don Pedro) will be reduced by the upstream seasonal storage, but this may allow a greater total seasonal storage for water supply and hydroelectric energy generation.
- The Tuolumne River has major upstream reservoirs and hydroelectric facilities and a significant upstream diversion (e.g., CCSF, Hetch Hetchy aqueduct), but the water rights and operating agreement for New Don Pedro Reservoir includes seasonal storage in the CCSF upstream reservoirs and water banking between TID, MID and CCSF as described above in Section 5.2.4. The water accounting for New Don Pedro Reservoir would likely be modified by the LSJR alternatives, but the upstream CCSF operations (storage, hydropower, and water diversion) are expected to be unchanged.

Therefore, physical environmental effects upstream of the three rim dams and respective reservoirs are not expected under the LSJR alternatives and are not discussed further in this SED.

Water Supply Effects Modeling

This section describes the CALSIM model baseline and the WSE model used for the LSJR alternatives, along with the approach used to quantify the effects that implementation of the LSJR alternatives and SDWQ alternatives could have on reservoir operations, river flows, and water supplies in the plan area. The monthly hydrology (input) for the WSE model comes from the San Joaquin River Water Quality Module (SJR module) of the CALSIM model. A brief description of the CALSIM model is presented below, followed by an explanation of the calculations made in the WSE model.

CALSIM Model

The monthly hydrology results from the SJR module of the CALSIM operations model were used for describing baseline and several inputs to the WSE model. The CALSIM SJR module was developed by USBR to simulate monthly flows, reservoir storages, and water supply deliveries in the SJR Basin. It is used as part of the CALSIM planning model for the CVP and SWP that calculates reservoir operations and Delta operations for a specified set of water resources, level of development (i.e., demands), and regulatory requirements using the historical sequence of hydrologic conditions

1922–2003. The CALSIM SJR module estimates the diversions on each of the three eastside tributaries based on runoff and reservoir storages. The CALSIM calculates annual Stanislaus River diversions using the end-of-February storage plus actual March to September reservoir inflow. The diversions and releases from the Tuolumne and Merced Rivers are estimated from the annual runoff. The CALSIM SJR module uses a series of monthly flows to calculate flows and salinity at the mouth of each of the three eastside tributaries and along the SJR.

Baseline monthly flows, reservoir storage levels, and diversions were obtained directly from the current (2009) conditions CALSIM II model run from DWR's *State Water Project Reliability Report 2009* (DWR 2010). This CALSIM case included a representation of the December 2008 U.S. Fish and Wildlife Service (USFWS) and the 2009 National Marine and Fisheries Service biological opinion reasonable and prudent alternative, including Action 3.1.3 (NMFS BO). The NFMS BO required Stanislaus River flows and some (but not all) of the D-1641 Vernalis objective flows to be released from New Melones Reservoir. The D-1641 April 15–May 15 Vernalis pulse flows were previously released from a combination of New Melones, New Don Pedro, and Lake McClure.

The first notice of preparation (NOP) was issued in February 2009, at which time the NMFS BO was not in place. The NMFS BO was in place during the second NOP, issued in April 2011. However, because the DWR 2009 *State Water Project Reliability Report* version of the CALSIM model was used to estimate baseline conditions in this SED, the change that occurred to flows with respect to the NMFS BO between the first and second NOPs are included in the baseline. Shortly after the revised NOP was issued in April 2011, the final (2011) VAMP spring pulse flow (April 15–May 15) was implemented. VAMP was part of baseline at the time both NOPs were issued and VAMP is included in the 2009 *State Water Project Reliability Report* version of the CALSIM model used to represent baseline conditions in this SED.

Appendix F.2, *Evaluation of Historical Flow and Salinity (EC) Measurements in the Lower San Joaquin River and Southern Delta,* describes the comparison of the measured monthly average SJR flows at Vernalis and the CALSIM results for current conditions for water years 1984–2003. This covers a period during which actual operations in the watershed were relatively similar to those modeled in the CALSIM representation of current conditions. All major eastside dams were completed and filled, and their combined effect on flows at Vernalis should be present in the actual data. CALSIM model output ends with water year 2003. Appendix F.2 includes more discussion of the CALSIM flows and EC results in comparison to recent historical flow and EC data. This comparison supports the assumption that the CALSIM results provide a reasonable representation of the baseline SJR flow and EC conditions.

Water Supply Effects Model

The WSE model results are the basis for evaluating the effects of flow in the rivers, water supply, and reservoir storage due to the LSJR flow objective alternatives and the salinity effects due to the SDWQ alternatives. The WSE model was developed by the State Water Board and is described in detail in Appendix F.1, *Hydrologic and Water Quality Modeling*. The WSE model is a monthly water balance spreadsheet model run over 82 years of hydrology in each of the three eastside tributaries based upon user-defined inputs, output from CALSIM, and flood-storage rules. The model maximizes diversions and reservoir storage to minimize effects on both cold water pool and diversions. The WSE model allows the tributary flow targets for each tributary to be changed and become a specified fraction of the monthly unimpaired flows. The model estimates the annual water diversion targets for each tributary by setting annual diversions in February based on the end-of-January reservoir storage level, without assuming the remaining runoff. Lower January storage will reduce the annual diversions simulated by the model.

To quantify the effects of each LSJR alternative relative to the baseline, the monthly tributary flows, reservoir storage levels, and annual diversions output from the CALSIM baseline are subtracted from the WSE model outputs on a tributary basis and the SJR at Vernalis. The modeled baseline (from CALSIM) is the basis for comparison and determination of water supply, surface hydrology and water quality impacts (HYD-1, HYD-2, WS-1, WQ-1 through WQ-4). The WSE modeling assumptions regarding reservoir drawdowns were based on historical drawdown patterns. For modeling purposes, it was assumed that recent historical conditions are the best representation of future management decisions given the various uses of water from the reservoirs. The modeling assumes that diversions would be reduced to maintain the historical reservoir drawdown patterns to achieve the same end-of-October storage levels. However, actual reservoir operations would likely include runoff forecasts, which are not reflected in the WSE modeling, that could increase the annual diversion allocations if the forecast runoff was high.

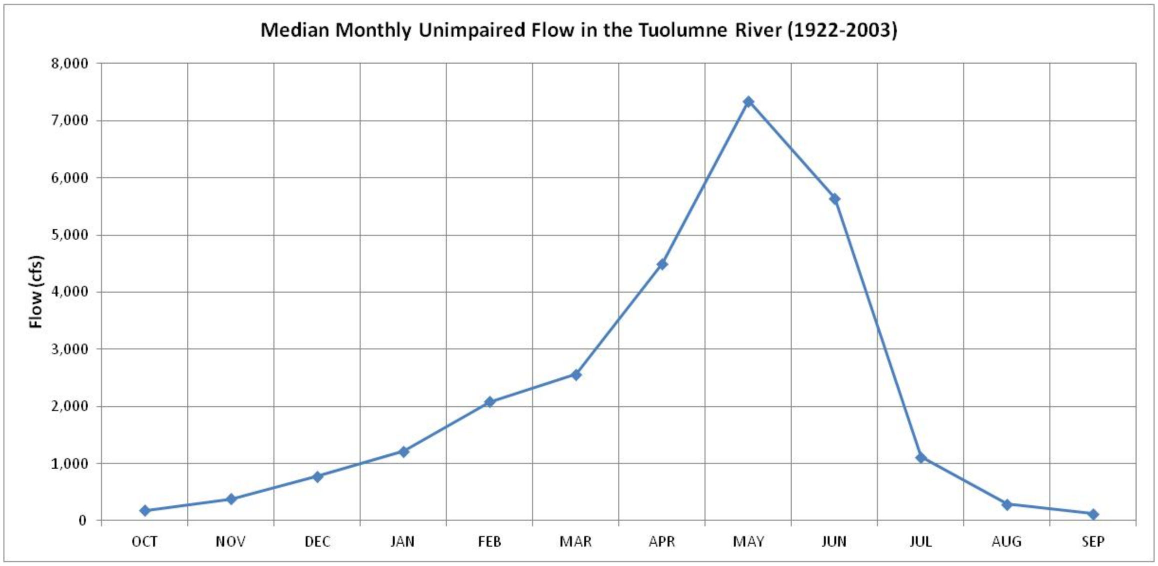
The NMFS BO flows on the Stanislaus River are included in the baseline. However, these flows are not included in the WSE modeling of the LSJR alternatives. Instead, the WSE modeling of the LSJR alternatives assumes that a certain percent (20, 40 or 60) of unimpaired flow will be met, which may be lower or higher than the NMFS BO flows. As a result, when the WSE model results are compared to baseline, the modeling shows some reductions in flows on the Stanislaus River under some of the LSJR alternative conditions. However, because the State Water Board's plan amendment would not directly result in any changes to the NMFS BO flow requirements on the Stanislaus River, actual reductions in flows below the NMFS BO flows would be unlikely as a result of the alternatives. At the same time, the NMFS BO flow requirements may change in the future as a result of coordination between the State Water Board, NMFS, and others. Accordingly, a conservative assessment of potential impacts on the Stanislaus River that captures a range of flow-related impacts was performed. Flows under the NMFS BO fall within this range. In addition, a sensitivity analysis showing the effects of the alternatives on flows with the NMFS BO in effect is presented in Appendix L, *Sensitivity Analyses.*

The modeling results of flows for 1922–2003, reservoir storage and surface water elevation, annual surface water supply diversions, and Vernalis salinity for the modeled LSJR alternatives baseline are presented in Appendix F.1. Tables of monthly flows under LSJR Alternatives 2, 3, and 4 for each year in the three eastside tributaries and on the SJR at Vernalis are the basic model results and are included in Appendix F.1. Appendix F.1 also summarizes the monthly flows and reservoir storages in monthly and annual cumulative distribution tables and presents annual diversions and carryover storage (end-of-September).

Monthly Flow Value

Because the WSE model only provides expected flow results under each LSJR alternative, a method for evaluating the relative values of different monthly flows is needed to determine the magnitude of impacts (or benefits) of monthly flow changes. The flow value is introduced as the "scale" for measuring and evaluating the impacts of the overall changes in the distribution of flows in each month. This allows the possibility that benefits of flow in a specified month may not be just a linear function of flow. Minimum flows are already protected by the existing flow requirements on each river, but increasing these low flows by some increment may provide greater benefits. Because a monthly flow value is the combination of all of the physical and biological effects resulting from a river's flow in a specified month, the actual relationships between flow (cfs) and flow value are unknown. Generally, some maximum monthly flow value is assumed to result from higher monthly flows, which would be proportional to the unimpaired monthly flows for the river. For the purposes of the analysis, it is assumed flows provide increasing benefits up to a maximum designated monthly flow, which is set equal to the median monthly unimpaired flow. The benefits of flows greater than this selected monthly value are assumed to have the same maximum monthly benefit. Flood control releases and extremely high river flows could cause flood damage, river erosion, and risks to public safety. These impacts are assessed in Chapter 6, *Flooding, Sediment, and Erosion*.

Figures 5-6a and b show an example of how the flow value was calculated for the Tuolumne River. Figure 5-6a shows the median monthly unimpaired flows for the Tuolumne River. The median unimpaired flows were about 1,000 cfs in January, about 2,000 cfs in February, about 2,500 cfs in March, about 4,500 cfs in April, about 7,250 cfs in May, and about 5,750 in June. Figure 5-6b shows that the flow value in May increases linearly between 0 cfs and the median unimpaired flow of 7,343 cfs. This flow-value curve follows the common assumption that more flow is generally beneficial, up to a relatively high flow that would achieve full benefits. For this example, the flow-value curve would increase from 0 percent at 0 cfs to 100 percent at 7,343 cfs, and remain constant at 100 percent at higher flows. A low flow of 250 cfs in May would have a flow value of about 3.5 percent of the maximum possible flow value (100 percent). With this example flow-value curve, any decrease in flows less than 7,343 cfs would have a reduced value, and any increase in flows less than 7,343 cfs would have an increased value. The flow-value curves are different for each month and each river. Based on this method, each simulated monthly value of flow was assigned a flow value from the curve. The change in the flow values associated with each LSJR alternative was used to assess general flow-related impacts.



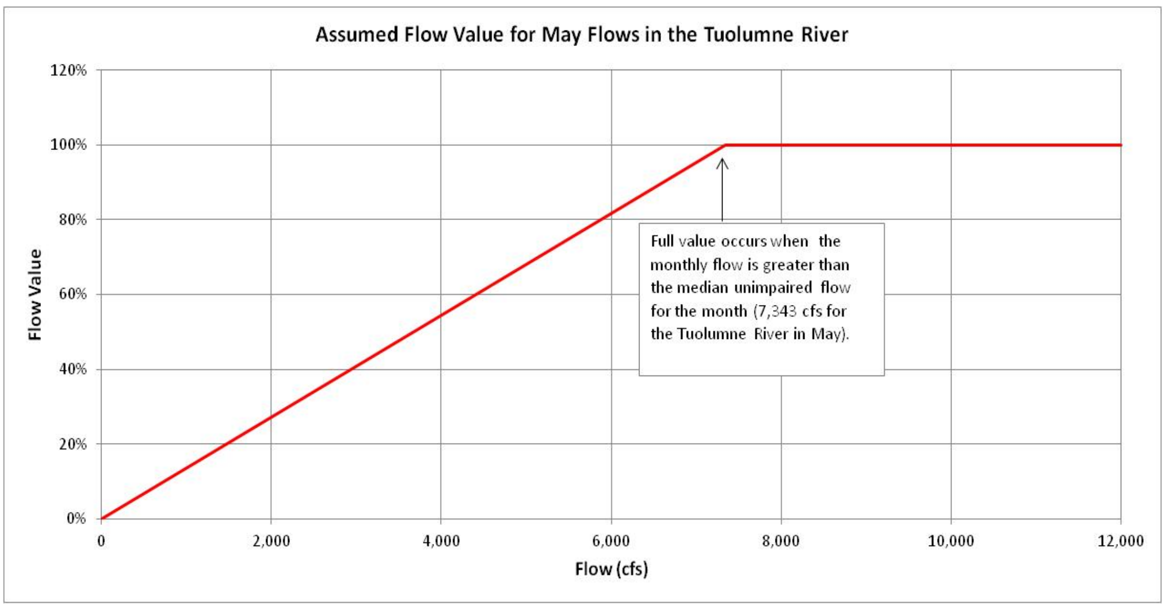


Figure 5-6a and b. Example of Monthly Flow-Value Curves Used to Evaluate General Flow Conditions and Overall Flow Impacts (or Benefits) (cfs = cubic feet per second)

The monthly cumulative distributions of calculated flow values for the LSJR alternatives are compared to the monthly cumulative distributions for the baseline flow values to determine a shift in the monthly flow values. Although some monthly flows are expected to increase and some are expected to decrease, the flow effects are evaluated from the shifts in the monthly cumulative distributions of flow value rather than the individual monthly changes in flow values. A reduction in the average flow value of February–June of more than 5 percent (of the maximum flow value) is considered a significant impact (HYD-1).

Surface Water Diversions

The LSJR alternatives have the potential to reduce surface water diversions as a result of releasing more water to the three eastside tributaries for the protection of the beneficial uses of fish and wildlife. For this analysis, the WSE model was used to estimate the reductions of the surface water diversions (i.e., water supply deficits) under each LSJR alternative. The WSE model estimates the annual diversion as a fraction of the full water supply based on the end-of-January storage. The model was adjusted for each tributary to closely match the CALSIM baseline reservoir storage patterns for 1922–2003. The results from the WSE model for each tributary are provided in Appendix F.1, *Hydrologic and Water Quality Modeling*. The annual diversions are compared to the CALSIM baseline values for each year and for the entire 82-year period to determine water supply impacts (WS-1). The impact of a water supply reduction would be proportional to the maximum water supply diversion (i.e., demand). An average reduction of more than 5 percent of the maximum water supply demand was selected as a reasonable threshold to determine whether there was a significant impact on water supply.

Exports and Outflow

The LSJR alternatives have the potential to change the CVP and SWP exports. Appendix F.1, *Hydrologic and Water Quality Modeling*, details the methodology used to estimate the change in exports. SJR at Vernalis flow changes were expected in the months of February–June, when the LSJR alternatives were simulated for each of the three eastside tributaries. Some increased reservoir flood-control releases were simulated in some years (because of slightly higher reservoir storages). Changes in SJR flow at Vernalis would either change exports or change outflow. Based on the existing Delta objectives and NMFS BO rules, the most likely changes each month were estimated from the CALSIM baseline Delta conditions (i.e., inflows, exports, Delta outflow, and required Delta outflow). The analysis related to exports and outflow reflects a scenario assuming the State Water Board does not make any changes to the export constraints to protect any increased flows downstream of Vernalis to estimate the possible effects on exports. The State Water Board is currently in the process of reviewing and updating the export restrictions included in the Bay-Delta Plan as part of its periodic review of the Bay-Delta Plan. Through that process, the State Water Board will determine what changes should be made to the export restrictions in light of the new flow objectives and other changes to the Bay-Delta Plan. The State Water Board will then determine what actions are needed to implement changes to the flow and export objectives.

Salinity Analysis

Numeric Objectives

The salinity calculations in the WSE model are based on the baseline salinity results from the CALSIM SJR module. These methods are summarized here and further discussed in Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*, and Appendix F.1, *Hydrologic and Water Quality Modeling*. The WSE spreadsheet estimates how the SJR at Vernalis salinity (EC) would be changed with the LSJR alternatives. Generally, the EC would be reduced by higher flows and would be increased with reduced flows, which might occur in months with relatively low runoff (i.e., lower monthly flow objective) or in months when flood-control releases are reduced. The salinity model calculates the Vernalis EC effects by changing the tributary flows and assumes that all other sources of salinity remain the same as depicted in the baseline CALSIM results.

Appendix F.2, *Evaluation of Historical Flow and Salinity (EC) Measurements in the Lower San Joaquin River and Southern Delta,* describes the comparison of measured monthly average SJR at Vernalis EC values and the CALSIM EC results for baseline for water years 1984–2003. This covers a period during which actual operations in the watershed(s) were relatively similar to those modeled in the CALSIM representation of baseline. The Bay-Delta Plan Vernalis EC objective was implemented in 1995, so the historical EC data should be closest in the last 10 years of this comparison graph. The CALSIM model assumes constant flow-EC relationships for the SJR above the Merced, Tuolumne, and Stanislaus Rivers. The CALSIM model also assumes predetermined monthly diversions along the SJR and monthly salt loads and inflows from agricultural runoff, tile drainage, and shallow groundwater discharge to the SJR between the Merced River and Vernalis. The linkage between the DMC water deliveries (moderately high salinity) and these drainage and groundwater inflows to the SJR are not further quantified in the CALSIM SJR documentation (USBR 2004).

For evaluation of the LSJR alternatives, the following conditions were assumed to remain the same as baseline: (1) The salt balance terms included in the monthly CALSIM SJR model; (2) The monthly flows, EC values, and salt loads upstream of the Merced River; and (3) The diversions, inflows, and salt loads along the SJR from the Merced River to Vernalis, except the tributary inflows. The Vernalis flows and EC values were adjusted in the WSE model for each of the LSJR alternatives according to changes in the three eastside tributary flows.

Simple calculations of the southern Delta EC values were made based on the historical EC increases between Vernalis and the southern Delta stations for 1985–2009 (see Appendix F.2). A review of the historical EC data indicated that the EC increment from Vernalis to Brandt Bridge or Old River at Middle River (Union Island) can be estimated with a flow dilution relationship:

EC increase from Vernalis (dS/m) = 100/ SJR flow at Vernalis (cfs) *(Eqn. 5-1)*

Accordingly, for a flow of 1,000 cfs the EC increase would be 1.000 dS/m. For a flow of 2,000 cfs the EC increase would be 0.050 dS/m and for a flow of 5,000 cfs the EC increase would be 0.020 dS/m. The EC increase at Old River at Tracy Boulevard was assumed to be 3 times the EC increase at Brandt Bridge:

EC increase from Vernalis (dS/m) = 300/ SJR flow at Vernalis (cfs) *(Eqn. 5-2)*

The alternatives could affect salinity by changing the flow at Vernalis and thereby changing the dilution of the upstream salt loads reaching Vernalis; the salinity at Vernalis will increase as the flow decreases. This analysis assessed potential southern Delta salinity impacts associated with LSJR Alternatives 2, 3, and 4 and SDWQ Alternatives 2 and 3 in two ways. One method assessed the effect of the alternatives based on whether regulatory water quality objectives are met. The other method assessed the potential overall change in salinity in the southern Delta. The potential for changes in salinity to affect the beneficial use of water for aquatic resources, agricultural supply, and drinking water supply are discussed in Chapter 7, *Aquatic Resources*, Chapter 11, *Agricultural Resources*, and Chapter 13, *Service Providers*, respectively.

The number of months during the 82-year period when the EC values were greater than the monthly EC objectives at Vernalis or at the southern Delta monitoring (compliance) stations was used to assess whether there would be significant water quality impacts associated with exceeding water quality objectives for salinity in the southern Delta under the LSJR and SDWQ alternatives (WQ-1). There are some EC values that exceed the EC objectives in the baseline; therefore, substantial increases in the number of months (frequency) with EC above the EC objective would be judged as an indicator of the magnitude of water quality impacts. An increase in the number of months with EC values above the EC objective of more than 5 percent of the months simulated (i.e., 49) was selected as a reasonable threshold to determine whether there was a significant impact on salinity (WQ-1).

The salinity objectives are established to protect beneficial use for agricultural water supply. Although the monthly EC values might increase or decrease slightly, depending on the changes in the monthly flows, the cumulative distribution of the EC values can be used as a general comparison for the improvement or reduction of irrigation season EC values (beneficial use period [April–September]). Therefore, the approach for determining the impacts of increased salinity from the LSJR alternatives considers the long term average of cumulative distribution for EC during the irrigation season. An overall increase of more than 5 percent of the salinity objective (0.035 dS/m [35 μS/cm]) during the 6-month irrigation season of April–September (the 0.700 dS/m [700 μS/cm] EC objective was selected as a reasonable threshold to determine whether there was a significant impact on salinity (WQ-2).

Circulation and Water Levels and Tidal Flows

Salinity conditions in the southern Delta water bodies are affected by their capacity to assimilate upstream and local salt loading. This assimilative capacity is potentially affected by hydrodynamic conditions, such as water levels and the direction and magnitude of flow in the various channels of the southern Delta. CVP and SWP pumping operations in the southern Delta have the potential to impact water level and flow conditions there, and the temporary barriers are currently installed during the irrigation season in Old River near the DMC, in Grant Line Canal at Tracy Boulevard Bridge, and into Middle River at Victoria Canal to address these impacts. The temporary barriers block the tidal flows during ebb tide (falling water elevations, water moving downstream towards the estuary) and thereby maintain higher elevations during ebb tides. The Grant Line barrier is placed each year at a lower elevation than the other two weirs. This allows net flows during a tidal cycle to circulate with net upstream flows in Old River and Middle Rivers and net downstream flow in Grant Line Canal and out of the southern Delta towards the CVP and SWP intakes.

The SDWQ alternatives call for continuation of the temporary barriers, followed by special studies and development of a coordinated operations plan. The existing water levels in the southern Delta channels, therefore, are not expected to change with the LSJR alternatives or SDWQ alternatives that are being evaluated in this SED. The LSJR alternatives would generally increase flows at Vernalis and would thereby provide some increase in the net flows in the southern Delta channels. Therefore, these aspects of the LSJR alternatives and SDWQ alternatives are expected to have either no impact or provide a slight improvement to salinity conditions in the southern Delta and are not discussed further in the impact analysis.

Water Temperature Analysis

The LSJR alternatives could affect water temperature by altering both river flows and reservoir storage, which influences the monthly release temperature. To model effects on temperature in the LSJR and three eastside tributaries, the State Water Board modified the temperature model, a model using the Hydrologic Water Quality Modeling System (HWMS-HEC5Q), a graphical user interface that employs the USACE Hydrologic Engineering Center (HEC) flow and water quality simulation model, HEC-5Q. The temperature model was developed by a group of consultants between 2003 and 2008 through a series of CALFED contracts that included peer review and refinement (CALFED 2009). Calibration data was used to accurately simulate temperatures for a range of reservoir operations, river flows, and meteorology. To determine effects of the LSJR alternatives, the model was run with CALSIM baseline results and WSE model results, and the resulting temperatures were compared at key locations along each of the three eastside tributaries.

The temperature model was designed to provide a SJR basin-wide evaluation of temperature response at 6-hour intervals for alternative conditions, such as operational changes, physical changes, and combinations of the two. The extent of the model includes the Merced, Tuolumne, and Stanislaus River systems from their SJR confluences to the upstream end of their major reservoirs (i.e., McClure, Don Pedro, and New Melones, respectively). The upstream extent of the model is the Merced River confluence. The downstream extent of the model is Mossdale. The model simulates the reservoir stratification, release temperatures, and downstream river temperatures as a function of the inflow temperatures, reservoir geometry and outlets, meteorology, and river geometry. More details of the model development are described in Appendix F.1, *Hydrologic and Water Quality Modeling.*

To assess the effects of the LSJR alternatives, the historical inflows to the reservoirs and the historical releases for water supply diversions and downstream flows were adjusted to match the monthly CALSIM inflows, water supply diversions, and downstream river flows. The simulated temperatures for the CALSIM baseline were very similar to the simulated temperatures for the historical operations (i.e., calibration results). The temperature model results for the CALSIM baseline flows were compared to the simulated river temperatures for each LSJR alternative (with different reservoir operations and downstream river flows). The temperature model was used to simulate the baseline water temperatures in each tributary reservoir and in the rivers below the diversion dams (i.e., Goodwin, La Grange, and Crocker-Huffman Dams). Detailed temperature modeling results are presented in Appendix F.1.

The water temperature impacts were evaluated for the months of February–June when the monthly tributary river flows are modified under the LSJR alternatives. A reduction in the monthly flows would cause the temperatures to increase. The water temperatures at the halfway point for each tributary river are described and compared in the impact analysis because most Chinook salmon spawning and rearing generally occurs in the upstream portion of the rivers. Furthermore, the upstream temperatures (between the diversion dams and the halfway points) are most responsive to changes in flow. A temperature increase of greater than 2°F compared to baseline was determined to be a reasonable threshold to determine (evaluate) whether there was a significant impact on temperature (WQ-3).

303(d) Pollutant Analysis

Pollutants identified by the 303(d) list for the various receiving waters in the plan area (Table 5-4) are more likely to approach criteria levels when river flows are relatively low because concentrations of pollutants generally increase when flows are low. An increase in flows would not likely cause concentrations to exceed criteria levels. The concentrations, or loads, for the 303(d) pollutants are unknown within the plan area. There are not sufficient water quality measurements for each month over the range of baseline flows that could be used to calculate concentrations or loads; therefore, a generalized evaluation of changes in pollutant concentrations, based on changes in flows expected for the LSJR alternatives, is used to evaluate whether the LSJR alternatives would result in an increase in 303(d) contaminant concentrations. The impact assessment for general pollutant concentrations is based on the changes in the monthly cumulative distributions of flows, rather than the individual monthly changes, to represent the probability of future monthly flows and dilutions. The likely pollutant concentration changes (ratios) were estimated with the ratio of the baseline flow and the alternative flow using the median baseline flows experienced during the summer months (WQ-4). The conservative evaluation assumes that baseline concentrations of 303(d) pollutants would approach or exceed water quality criteria limits during low flows.

5.4.3 Impacts and Mitigation Measures

HYD-1: Substantially reduce monthly river flow values caused by the percent unimpaired flow objective

The evaluation of reduced flows was based on the monthly cumulative distribution of flows rather than individual changes in monthly flows because flows in many years might increase, whereas they might decrease in others. It is the overall distribution of monthly flows (or flow values) that determines a significant impact from reduced flows (or flow values) for the LSJR alternatives. Increased LSJR and tributary flows below the major reservoirs are generally assumed to be beneficial for fish habitat, temperature, salinity, recreation, and other environmental and public trust resources. As described in Section 5.4.2, changes in flow were assessed using the flow-value curves. Flow value was assumed to increase linearly between zero percent at a flow of zero and a maximum of 100 percent at the median monthly unimpaired flow for each river. Since the flow values use the modeled results of baseline conditions and the LSJR alternatives, the impact analysis first presents a brief discussion of the expected changes between baseline and LJSR alternatives for storage, flows, and diversions; then provides an example of the cumulative distributions of flow and the flow values using the Tuolumne River; and, finally presents the baseline flow values for the three eastside tributaries and LSJR.

The CALSIM and WSE models were used to simulate monthly reservoir storage, flow, and diversions for baseline and each LSJR alternative. Monthly model results for the entire 82-year simulation period are shown for New Melones storage, flow at Ripon, and diversions for the Stanislaus River in Figure 5-7, Figure 5-8, and Figure 5-9. Differences between simulated flow values can be discerned more clearly when shorter time increments are evaluated (Figure 5-10). Similar results for the Tuolumne and Merced Rivers and for the SJR at Vernalis are shown in Appendix F.1, *Hydrologic and Water Quality Modeling*.

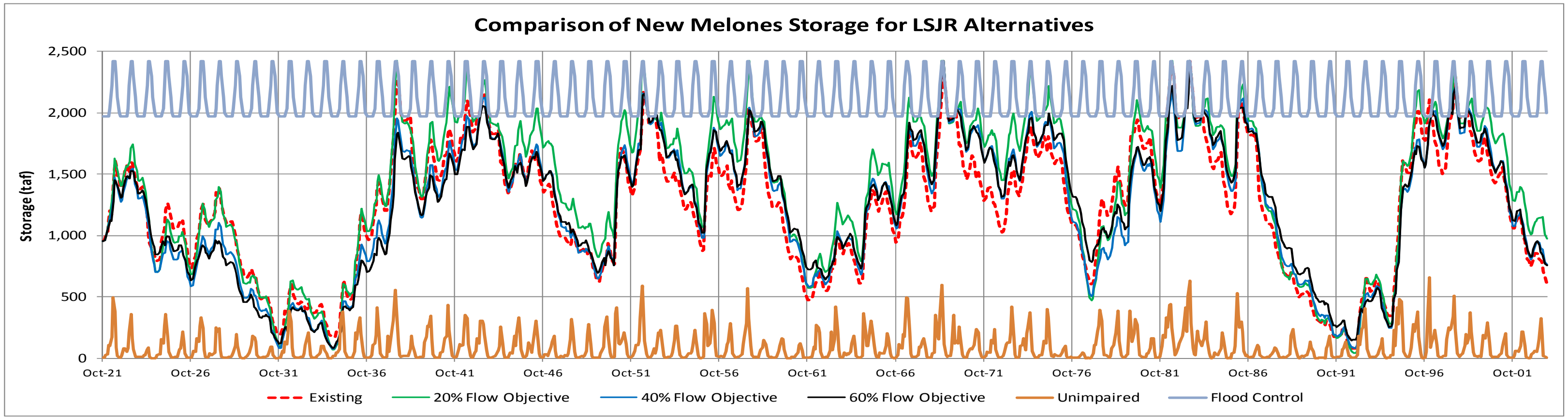


Figure 5-7. Comparison of CALSIM Baseline and WSE Model Results for LSJR Alternatives: New Melones Reservoir Storage for 1922–2003 (taf = thousand acre-feet)

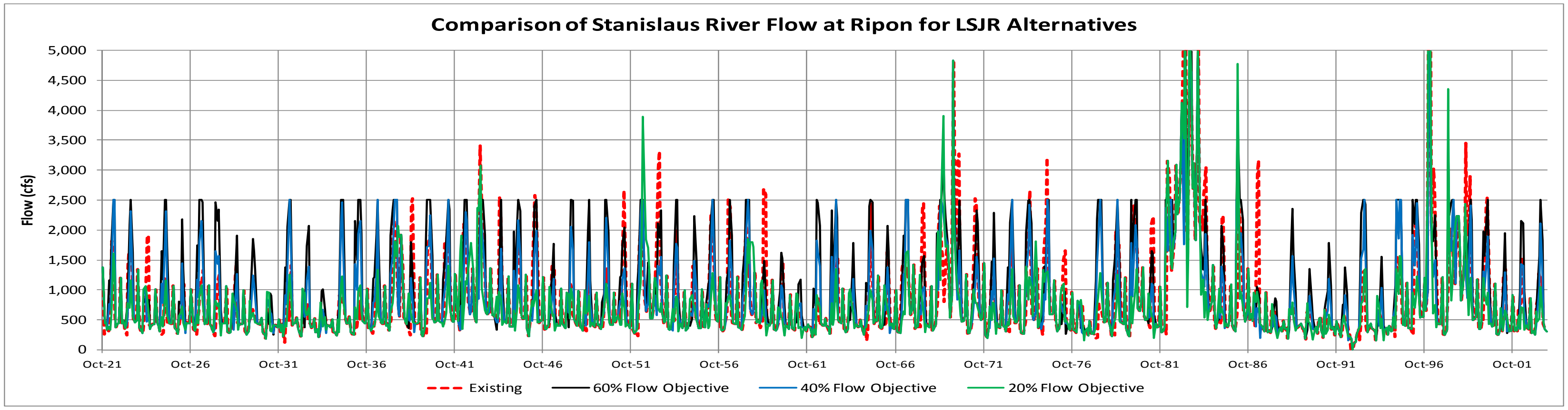


Figure 5-8. Comparison of CALSIM Baseline and WSE Model Results for LSJR Alternatives: Stanislaus River Flows for 1922–2003 (cfs = cubic feet per second)

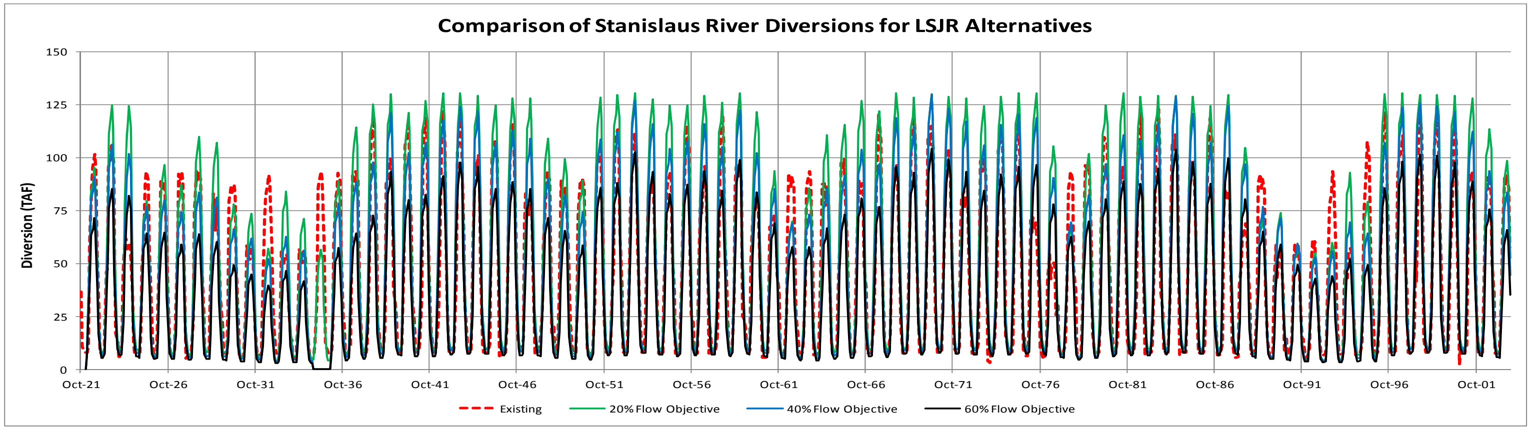


Figure 5-9. Comparison of CALSIM Baseline and WSE Model Results for LSJR Alternatives: Stanislaus River Diversions for 1922–2003 (TAF = thousand acre-feet)

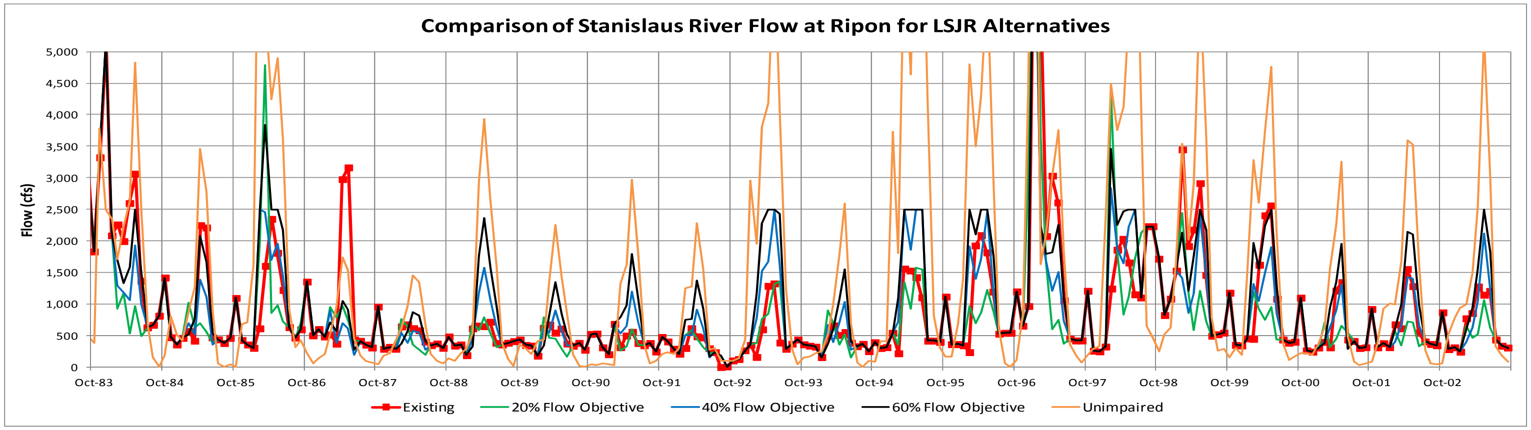


Figure 5-10. Comparison of Monthly Stanislaus River Flows for Baseline and LSJR Flow Objective Alternatives for Water Years 1984–2003 (cfs = cubic feet per second)

As a general comparison of the LSJR alternatives, the baseline February–June flow volumes (TAF) and average changes to the February–June flow volumes are presented in Table 5-16 for the three eastside tributaries and LSJR. Average simulated flows in each of the rivers were reduced under LSJR Alternative 2, but increased under LSJR Alternatives 3 and 4. The monthly flow results for the baseline and each of the LSJR alternatives can be found in Appendix F.1, *Hydrologic and Water Quality Modeling*.

Table 5-16. Average February–June Baseline Flow and Differences from Baseline in the Eastside Tributaries and the SJR at Vernalis for the LSJR Alternatives for the 82-year Modeling Period

	Stanislaus River near Ripon TAF/ (%)	Tuolumne River near Modesto TAF / (%)	Merced River near Stevinson TAF / (%)	SJR near Vernalis TAF/ (%)
Baseline	352 / (100%)	538/ (100%)	270/ (100%)	1800/ (100%)
LSJR Alternative 2 Difference from Baseline	-93 / (-26%)	-21 / (-4%)	-7 / (-2%)	-121 / (-7%)
LSJR Alternative 3 Difference from Baseline	4 / (1%)	148 / (27%)	72 / (27%)	225 / (12%)
LSJR Alternative 4 Difference from Baseline	115 / (33%)	289 / (54%)	147 / (54%)	551 / (31%)

Note: Resulting flow effects on the tributaries are as calculated near the confluence with the SJR, specifically at Ripon, Modesto, and Stevinson.
TAF = thousand acre-feet

The Tuolumne River is used to demonstrate that monthly cumulative distributions provide a good summary of the modeling results for the 82-year simulation period and that monthly flow values provide a good scale for evaluating flow benefits and impacts. Table 5-17a gives an example of the monthly cumulative distributions for the CALSIM baseline Tuolumne River flows at Modesto for the 1922–2003 period. The values for each month are sorted, and the distributions of flows from minimum to maximum are reported (in 10 percent increments). Similar tables of monthly cumulative distributions of flows for each tributary and for the SJR at Vernalis are given for the CALSIM baseline and for each of the LSJR alternatives in Appendix F.1 (Tables F.1-9a–m for baseline, Tables F.1-10a–m for LSJR Alternative 2 (Tables F.1-11a–m for LSJR Alternative 3, and Tables F.1-12a–m for LSJR Alternative 4). Table 5-17b gives the monthly cumulative distributions of the Tuolumne River at Modesto baseline flow values as they correspond to the baseline monthly cumulative flow distributions. The median unimpaired Tuolumne River flows for each month are used to calculate the flow values. For example, the median unimpaired flow for February is 2,084 cfs, so any flow greater than this would have a flow value of 100 percent. These higher February flows occurred about 30 percent of the time (i.e., 70 percent cumulative). Changes in flows above this level would not increase the flow value. This emphasizes the importance of increasing flows that are less than the median monthly unimpaired flow.

Table 5-17a. Monthly Cumulative Distributions of Tuolumne River Flows at Modesto for Baseline for 1922–2003 (CALSIM Results)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Annual (TAF)
Minimum	194	206	217	208	152	245	381	398	170	169	167	153	194
10%	285	246	257	316	307	344	530	532	247	237	257	243	281
20%	390	324	327	427	454	444	742	796	300	299	326	323	354
30%	457	382	412	436	484	490	877	898	351	339	349	353	401
40%	480	447	434	518	519	595	1,080	1,082	377	378	379	369	454
50%	537	460	457	552	606	760	1,505	1,311	454	418	402	409	521
60%	602	479	520	599	801	1,324	1,822	1,426	582	523	485	507	756
70%	691	525	595	691	2,016	3,109	2,317	1,576	733	576	553	567	1,115
80%	733	614	626	1,115	3,429	3,709	3,105	1,790	2,805	1,067	568	585	1,404
90%	808	760	1,119	3,050	4,916	4,849	4,467	4,826	4,410	3,479	618	661	1,803
Maximum	3,175	5,485	7,476	17,735	7,111	16,125	9,183	9,501	8,518	8,341	2,862	2,367	4,119
Average	597	574	831	1,262	1,684	2,117	1,982	1,819	1,435	1,103	476	482	866

cfs = cubic feet per second
TAF = thousand acre-feet

Table 5-17b. Monthly Cumulative Distributions of Calculated Tuolumne River at Modesto Flow Values (percent) for Baseline for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Median Unimpaired (cfs)	178	382	783	1,213	2,084	2,566	4,498	7,343	5,648	1,119	289	125
Minimum	1.00	0.54	0.28	0.17	0.07	0.10	0.08	0.05	0.03	0.15	0.58	1.00
10%	1.00	0.64	0.33	0.26	0.15	0.13	0.12	0.07	0.04	0.21	0.89	1.00
20%	1.00	0.85	0.42	0.35	0.22	0.17	0.16	0.11	0.05	0.27	1.00	1.00
30%	1.00	1.00	0.53	0.36	0.23	0.19	0.20	0.12	0.06	0.30	1.00	1.00
40%	1.00	1.00	0.55	0.43	0.25	0.23	0.24	0.15	0.07	0.34	1.00	1.00
50%	1.00	1.00	0.58	0.45	0.29	0.30	0.33	0.18	0.08	0.37	1.00	1.00
60%	1.00	1.00	0.66	0.49	0.38	0.52	0.41	0.19	0.10	0.47	1.00	1.00
70%	1.00	1.00	0.76	0.57	0.97	1.00	0.52	0.21	0.13	0.51	1.00	1.00
80%	1.00	1.00	0.80	0.92	1.00	1.00	0.69	0.24	0.50	0.95	1.00	1.00
90%	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.66	0.78	1.00	1.00	1.00
Maximum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Average	1.00	0.93	0.63	0.54	0.49	0.52	0.42	0.24	0.24	0.49	0.97	1.00

February–June Average = 0.38
cfs = cubic feet per second

The average baseline flow values for the three eastside tributaries and LSJR are presented in Tables 5-17c through 5-17e and a summary is presented here. Table 5-17c indicates that the average baseline flow values for the Merced River at Stevinson were 55 percent in February, 40 percent in March, 23 percent in April, 26 percent in May, and 33 percent in June. The grand average Merced River baseline flow value for these five months was 38 percent. Table 5-17b indicates that for the Tuolumne River at Modesto, the baseline flows provide average flow value of 49 percent in February, 52 percent in March, 42 percent in April, 24 percent in May and 24 percent in June. The grand average Tuolumne River baseline flow value for these five months was 38 percent. The monthly flow values reflect the relatively low existing flows on the Tuolumne River during these months compared to the median monthly unimpaired flows. Table 5-17d indicates that for the Stanislaus River at Ripon, the baseline flows provide average flow values of 43 percent in February, 55 percent in March, 50 percent in April, 34 percent in May, and 32 percent in June. The grand average Stanislaus River baseline flow value for these five months was 43 percent. The monthly values reflect the somewhat reduced baseline flows on the Stanislaus River during these months compared to the median monthly unimpaired flows. Table 5-17e indicates that the average baseline flow values for the SJR at Vernalis were 63 percent in February, 56 percent in March, 40 percent in April, 28 percent in May, and 26 percent in June. The grand average SJR at Vernalis baseline flow value for these five months was 43 percent. The monthly average flow values reflect the relatively low flows during these months compared to the median monthly unimpaired flows.

Table 5-17c. Monthly Cumulative Distributions of Calculated Merced River at Stevinson Flow Values (percent) for Baseline for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Median Unimpaired (cfs)	81	152	354	571	946	1,303	2,391	3,955	2,451	529	121	58
Minimum	1.00	1.00	0.38	0.47	0.22	0.14	0.00	0.01	0.01	0.07	0.29	0.03
10%	1.00	1.00	0.91	0.58	0.34	0.21	0.08	0.04	0.05	0.13	0.45	0.53
20%	1.00	1.00	1.00	0.66	0.40	0.23	0.15	0.06	0.06	0.17	0.61	0.93
30%	1.00	1.00	1.00	0.69	0.43	0.26	0.21	0.07	0.07	0.22	0.82	1.00
40%	1.00	1.00	1.00	0.72	0.47	0.27	0.26	0.09	0.10	0.30	1.00	1.00
50%	1.00	1.00	1.00	0.76	0.53	0.29	0.28	0.13	0.11	0.33	1.00	1.00
60%	1.00	1.00	1.00	0.84	0.77	0.36	0.31	0.16	0.13	0.42	1.00	1.00
70%	1.00	1.00	1.00	1.00	0.98	0.51	0.34	0.20	0.18	0.57	1.00	1.00
80%	1.00	1.00	1.00	1.00	1.00	0.87	0.38	0.29	0.67	1.00	1.00	1.00
90%	1.00	1.00	1.00	1.00	1.00	1.00	0.43	0.66	1.00	1.00	1.00	1.00
Maximum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Average	1.00	1.00	0.98	0.80	0.66	0.46	0.29	0.22	0.28	0.48	0.85	0.90

February–June Average = 0.38
cfs = cubic feet per second

Table 5-17d. Monthly Cumulative Distributions of Calculated Stanislaus River at Ripon Flow Values (percent) for Baseline for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Median Unimpaired (cfs)	128	229	399	664	1,277	1,704	3,247	4,657	2,757	556	152	80
Minimum	0.81	0.55	0.50	0.24	0.10	0.12	0.14	0.10	0.11	0.42	0.00	0.11
10%	1.00	1.00	0.63	0.32	0.18	0.18	0.19	0.13	0.15	0.65	1.00	1.00
20%	1.00	1.00	0.72	0.39	0.21	0.24	0.24	0.17	0.16	0.75	1.00	1.00
30%	1.00	1.00	0.78	0.45	0.31	0.33	0.35	0.24	0.16	0.78	1.00	1.00
40%	1.00	1.00	0.81	0.47	0.36	0.37	0.43	0.29	0.18	0.79	1.00	1.00
50%	1.00	1.00	0.88	0.51	0.38	0.39	0.50	0.33	0.26	0.81	1.00	1.00
60%	1.00	1.00	0.89	0.53	0.43	0.52	0.57	0.39	0.40	0.82	1.00	1.00
70%	1.00	1.00	0.96	0.57	0.47	0.88	0.64	0.42	0.44	0.92	1.00	1.00
80%	1.00	1.00	1.00	0.68	0.52	0.95	0.72	0.51	0.49	1.00	1.00	1.00
90%	1.00	1.00	1.00	0.86	0.89	1.00	0.79	0.56	0.55	1.00	1.00	1.00
Maximum	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.71	1.00	1.00	1.00	1.00
Average	1.00	0.99	0.85	0.55	0.43	0.55	0.50	0.34	0.32	0.83	0.99	0.99

February–June Average = 0.43
cfs = cubic feet per second

Table 5-17e. Monthly Cumulative Distributions of Calculated SJR at Vernalis Flow Values (percent) for Baseline for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Median Unimpaired (cfs)	611	1,141	2,264	3,544	6,294	8,227	15,205	23,054	16,240	4,044	1,095	528
Minimum	1.00	1.00	0.60	0.34	0.30	0.16	0.08	0.05	0.04	0.14	0.34	1.00
10%	1.00	1.00	0.75	0.45	0.35	0.23	0.12	0.08	0.07	0.25	0.99	1.00
20%	1.00	1.00	0.80	0.50	0.36	0.26	0.20	0.13	0.09	0.31	1.00	1.00
30%	1.00	1.00	0.85	0.55	0.38	0.28	0.23	0.15	0.10	0.33	1.00	1.00
40%	1.00	1.00	0.88	0.61	0.40	0.32	0.30	0.20	0.12	0.37	1.00	1.00
50%	1.00	1.00	0.91	0.66	0.54	0.42	0.34	0.21	0.15	0.41	1.00	1.00
60%	1.00	1.00	0.96	0.69	0.70	0.60	0.41	0.25	0.19	0.46	1.00	1.00
70%	1.00	1.00	1.00	0.94	0.97	0.92	0.43	0.28	0.21	0.53	1.00	1.00
80%	1.00	1.00	1.00	1.00	1.00	1.00	0.51	0.32	0.44	0.88	1.00	1.00
90%	1.00	1.00	1.00	1.00	1.00	1.00	0.84	0.57	0.73	1.00	1.00	1.00
Maximum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Average	1.00	1.00	0.90	0.71	0.63	0.56	0.40	0.28	0.26	0.51	0.98	1.00

February–June Average = 0.43
cfs = cubic feet per second

LSJR Alternative 1: No Project

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project impact discussion and Appendix D, *Evaluation of LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project Alternative technical analysis.

LSJR Alternative 2: 20% Unimpaired Flow (Significant and unavoidable)

LSJR Alternative 2 has target flows that are sometimes higher though generally similar to the baseline flows on the Merced and Tuolumne Rivers but are somewhat less than the baseline flows on the Stanislaus River. The monthly cumulative distributions of the tributary river flows and SJR at Vernalis flows are given in Appendix F.1 (Table F.1-9a–m for the baseline and in Tables F.1-10a–m for LSJR Alternative 2). The flow values calculated from these monthly flows are evaluated here.

Table 5-18a and Table 5-18b show the monthly cumulative distributions of calculated flow values for LSJR Alternative 2 and the changes in the cumulative distributions of the flow values from baseline for the Merced River. The average flow values for LSJR Alternative 2 were 55 percent in February, 40 percent in March, 23 percent in April, 26 percent in May, and 33 percent in June. The average of the February–June flow values for LSJR Alternative 2 was 35 percent, and the average of the February–June flow values for the baseline flows was 38 percent. The Merced River flow values calculated for each year with the specified monthly flow-value curves could be higher or lower than the existing flow values, but the overall average flow benefits decreased slightly (by 3 percent) on the Merced River. Table 5-18b indicates that LSJR Alternative 2 would result in many years with reduced flow values in February, March, or April (indicated with negative changes in flow values from baseline to LSJR Alternative 2). Since the average Merced River flow value for February–June decreased less than 5 percent, impacts would be less than significant.

Table 5-18a. Monthly Cumulative Distributions of Calculated Merced River at Stevinson Flow Values (percent) for LSJR Alternative 2 for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Minimum	1.00	1.00	0.77	0.47	0.16	0.12	0.06	0.04	0.06	0.07	0.29	0.03
10%	1.00	1.00	0.92	0.58	0.16	0.12	0.11	0.08	0.06	0.13	0.45	0.53
20%	1.00	1.00	1.00	0.67	0.16	0.13	0.13	0.11	0.07	0.17	0.61	0.93
30%	1.00	1.00	1.00	0.69	0.18	0.15	0.16	0.14	0.11	0.22	0.82	1.00
40%	1.00	1.00	1.00	0.73	0.25	0.17	0.18	0.17	0.16	0.30	1.00	1.00
50%	1.00	1.00	1.00	0.80	0.53	0.20	0.20	0.20	0.20	0.33	1.00	1.00
60%	1.00	1.00	1.00	0.85	0.75	0.26	0.22	0.22	0.23	0.42	1.00	1.00
70%	1.00	1.00	1.00	1.00	0.98	0.45	0.24	0.24	0.29	0.57	1.00	1.00
80%	1.00	1.00	1.00	1.00	1.00	0.79	0.28	0.32	0.75	1.00	1.00	1.00
90%	1.00	1.00	1.00	1.00	1.00	1.00	0.31	0.61	1.00	1.00	1.00	1.00
Maximum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Average	1.00	1.00	0.98	0.81	0.55	0.40	0.23	0.26	0.33	0.48	0.85	0.90

Table 5-18b. Changes in the Monthly Cumulative Distributions of Merced River at Stevinson Flow Values (percent) from Baseline to LSJR Alternative 2 for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Minimum	0.00	0.00	0.40	0.00	-0.06	-0.03	0.06	0.03	0.05	0.00	0.00	0.00
10%	0.00	0.00	0.01	0.00	-0.18	-0.09	0.03	0.04	0.01	0.00	0.00	0.00
20%	0.00	0.00	0.00	0.01	-0.24	-0.10	-0.02	0.05	0.01	0.00	0.00	0.00
30%	0.00	0.00	0.00	0.00	-0.24	-0.11	-0.05	0.07	0.04	0.00	0.00	0.00
40%	0.00	0.00	0.00	0.01	-0.22	-0.10	-0.08	0.08	0.06	0.00	0.00	0.00
50%	0.00	0.00	0.00	0.04	-0.01	-0.09	-0.08	0.07	0.09	0.00	0.00	0.00
60%	0.00	0.00	0.00	0.01	-0.02	-0.10	-0.08	0.06	0.10	0.00	0.00	0.00
70%	0.00	0.00	0.00	0.00	0.00	-0.06	-0.09	0.04	0.11	0.00	0.00	0.00
80%	0.00	0.00	0.00	0.00	0.00	-0.08	-0.10	0.02	0.08	0.00	0.00	0.00
90%	0.00	0.00	0.00	0.00	0.00	0.00	-0.12	-0.05	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Average	0.00	0.00	0.01	0.01	-0.11	-0.07	-0.07	0.04	0.05	0.00	0.00	0.00

Table 5-18c and Table 5-18d show the monthly cumulative distributions of calculated flow values for LSJR Alternative 2 and the changes in the cumulative distributions of the flow values from baseline for the Tuolumne River. The average flow benefits for LSJR Alternative 2 were 46 percent in February, 54 percent in March, 32 percent in April, 21 percent in May and 32 percent in June. The average of the February–June flow values for LSJR Alternative 2 was 37 percent and the average of the February–June flow values for the existing flows was 38 percent. The Tuolumne River flow values calculated for each year with the specified monthly flow-value curves could be higher or lower than the existing flow value, but the overall average Tuolumne River flow value February–June decreased slightly (by 1 percent). Since the average Tuolumne River flow value February–June decreased less than 5 percent, impacts would be less than significant.

Table 5-18c. Monthly Cumulative Distributions of Tuolumne River at Modesto Flow Values (percent) for LSJR Alternative 2 for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Minimum	1.00	0.55	0.28	0.17	0.10	0.08	0.06	0.05	0.04	0.15	0.58	1.00
10%	1.00	0.65	0.33	0.26	0.10	0.13	0.12	0.09	0.05	0.21	0.89	1.00
20%	1.00	0.87	0.42	0.35	0.11	0.16	0.14	0.13	0.08	0.27	1.00	1.00
30%	1.00	1.00	0.53	0.36	0.13	0.18	0.17	0.15	0.13	0.30	1.00	1.00
40%	1.00	1.00	0.56	0.43	0.19	0.23	0.20	0.17	0.17	0.34	1.00	1.00
50%	1.00	1.00	0.61	0.48	0.32	0.42	0.23	0.20	0.20	0.38	1.00	1.00
60%	1.00	1.00	0.68	0.51	0.43	0.67	0.28	0.22	0.25	0.48	1.00	1.00
70%	1.00	1.00	0.77	0.62	0.74	1.00	0.37	0.24	0.30	0.54	1.00	1.00
80%	1.00	1.00	0.95	1.00	1.00	1.00	0.55	0.25	0.48	0.95	1.00	1.00
90%	1.00	1.00	1.00	1.00	1.00	1.00	0.63	0.29	1.00	1.00	1.00	1.00
Maximum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.82	1.00	1.00	1.00	1.00
Average	1.00	0.93	0.65	0.57	0.46	0.54	0.32	0.21	0.32	0.50	0.97	1.00

Table 5-18d. Changes in the Monthly Cumulative Distributions of Tuolumne River at Modesto Flow Values (percent) from Baseline to LSJR Alternative 2 for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Minimum	0.00	0.01	0.00	0.00	0.02	-0.02	-0.03	-0.01	0.01	0.00	0.00	0.00
10%	0.00	0.01	0.00	0.00	-0.05	-0.01	0.00	0.02	0.01	0.00	0.00	0.00
20%	0.00	0.02	0.00	0.00	-0.11	-0.01	-0.02	0.02	0.03	0.00	0.00	0.00
30%	0.00	0.00	0.00	0.00	-0.10	-0.01	-0.03	0.03	0.07	0.00	0.00	0.00
40%	0.00	0.00	0.01	0.00	-0.06	0.00	-0.04	0.02	0.10	0.00	0.00	0.00
50%	0.00	0.00	0.02	0.02	0.03	0.12	-0.10	0.02	0.12	0.01	0.00	0.00
60%	0.00	0.00	0.01	0.02	0.04	0.15	-0.13	0.03	0.14	0.01	0.00	0.00
70%	0.00	0.00	0.01	0.05	-0.22	0.00	-0.14	0.02	0.17	0.02	0.00	0.00
80%	0.00	0.00	0.15	0.08	0.00	0.00	-0.14	0.01	-0.01	0.00	0.00	0.00
90%	0.00	0.00	0.00	0.00	0.00	0.00	-0.36	-0.36	0.22	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.18	0.00	0.00	0.00	0.00
Average	0.00	0.01	0.02	0.02	-0.03	0.01	-0.09	-0.03	0.08	0.00	0.00	0.00

Table 5-18e and Table 5-18f show the monthly cumulative distributions of calculated flow values for LSJR Alternative 2 and the changes in the cumulative distributions of the flow values from baseline for the Stanislaus River. The average flow values for LSJR Alternative 2 were 63 percent in February, 46 percent in March, 23 percent in April, 20 percent in May, and 26 percent in June. The average of the February–June flow values for LSJR Alternative 2 was 36 percent, and the average of the February–June flow values for the baseline flows was 43 percent. The Stanislaus River flow values calculated for each year with the specified monthly flow-value curves could be higher or lower than the existing flow values, but the overall average flow values February–June decreased somewhat (by 7 percent) on the Stanislaus River. Because the average decrease was more than 5 percent of the maximum possible flow value, impacts would be significant.

Table 5-18e. Monthly Cumulative Distributions of Stanislaus River at Ripon Flow Values (percent) for LSJR Alternative 2 for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Minimum	0.81	0.55	0.50	0.24	0.27	0.15	0.10	0.06	0.05	0.42	1.00	0.11
10%	1.00	1.00	0.63	0.32	0.30	0.22	0.14	0.11	0.08	0.65	1.00	1.00
20%	1.00	1.00	0.72	0.39	0.37	0.26	0.17	0.12	0.12	0.75	1.00	1.00
30%	1.00	1.00	0.78	0.45	0.48	0.31	0.19	0.14	0.14	0.78	1.00	1.00
40%	1.00	1.00	0.82	0.47	0.55	0.37	0.21	0.17	0.16	0.79	1.00	1.00
50%	1.00	1.00	0.88	0.51	0.62	0.43	0.22	0.20	0.20	0.81	1.00	1.00
60%	1.00	1.00	0.90	0.53	0.70	0.46	0.25	0.23	0.24	0.82	1.00	1.00
70%	1.00	1.00	0.97	0.59	0.75	0.54	0.26	0.25	0.28	0.92	1.00	1.00
80%	1.00	1.00	1.00	0.71	0.82	0.61	0.28	0.27	0.37	1.00	1.00	1.00
90%	1.00	1.00	1.00	0.99	1.00	0.79	0.31	0.31	0.49	1.00	1.00	1.00
Maximum	1.00	1.00	1.00	1.00	1.00	1.00	0.71	0.56	1.00	1.00	1.00	1.00
Average	1.00	0.99	0.85	0.56	0.63	0.46	0.23	0.20	0.26	0.83	1.00	0.99

Table 5-18f. Changes in the Monthly Cumulative Distributions of Stanislaus River at Ripon Flow Values (percent) from Baseline to LSJR Alternative 2 for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Minimum	0.00	0.00	0.00	0.00	0.17	0.03	-0.04	-0.04	-0.05	0.00	1.00	0.00
10%	0.00	0.00	0.00	0.00	0.12	0.04	-0.05	-0.02	-0.06	0.00	0.00	0.00
20%	0.00	0.00	0.00	0.00	0.16	0.02	-0.07	-0.05	-0.04	0.00	0.00	0.00
30%	0.00	0.00	0.00	0.00	0.17	-0.02	-0.15	-0.10	-0.02	0.00	0.00	0.00
40%	0.00	0.00	0.01	0.00	0.19	-0.01	-0.21	-0.12	-0.01	0.00	0.00	0.00
50%	0.00	0.00	0.01	0.00	0.23	0.03	-0.28	-0.13	-0.06	0.00	0.00	0.00
60%	0.00	0.00	0.00	0.01	0.27	-0.06	-0.33	-0.16	-0.16	0.00	0.00	0.00
70%	0.00	0.00	0.00	0.01	0.28	-0.34	-0.38	-0.17	-0.16	0.00	0.00	0.00
80%	0.00	0.00	0.00	0.03	0.30	-0.34	-0.44	-0.24	-0.12	0.00	0.00	0.00
90%	0.00	0.00	0.00	0.13	0.11	-0.21	-0.47	-0.25	-0.06	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	-0.27	-0.15	0.00	0.00	0.00	0.00
Average	0.00	0.00	0.00	0.01	0.20	-0.09	-0.27	-0.14	-0.07	0.00	0.01	0.00

The monthly flow changes on the Stanislaus River with LSJR Alternative 2 February–June are relatively high (Table 5-16 indicates an average reduction of 93 TAF) such that the flows cannot be adaptively managed within these months to maintain the baseline flow values. There is not likely enough water February–June under LSJR Alternative 2 to reallocate water from higher runoff months and make up the reductions in monthly flow values. Impacts would be significant.

Table 5-18g and Table 5-18h show the monthly cumulative distributions of calculated flow values for LSJR Alternative 2 and the changes in the cumulative distributions of the flow values from baseline for the SJR at Vernalis. The average flow values for LSJR Alternative 2 were 63 percent in February, 56 percent in March, 40 percent in April, 28 percent in May, and 26 percent in June. The SJR at Vernalis flow values declined in February–June as more of the unimpaired runoff was stored or diverted for water supply uses. The average of the February–June flow values for LSJR Alternative 2 was 40 percent, and the average of the February–June flow values for the baseline flows was 43 percent. The overall average flow values for February–June decreased somewhat (by 3 percent) on the SJR at Vernalis. Because the average decrease was not more than 5 percent of the maximum possible flow value, impacts would be less than significant.

Table 5-18g. Monthly Cumulative Distribution of SJR at Vernalis Flow Values (percent) for LSJR Alternative 2 for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Median Unimpaired (cfs)	611	1,141	2,264	3,544	6,294	8,227	15,205	23,054	16,240	4,044	1,095	528
Minimum	1.00	1.00	0.60	0.34	0.28	0.16	0.09	0.06	0.04	0.14	0.51	1.00
10%	1.00	1.00	0.75	0.45	0.33	0.22	0.12	0.09	0.07	0.25	0.99	1.00
20%	1.00	1.00	0.80	0.50	0.34	0.24	0.14	0.11	0.09	0.31	1.00	1.00
30%	1.00	1.00	0.85	0.56	0.36	0.28	0.16	0.13	0.11	0.33	1.00	1.00
40%	1.00	1.00	0.88	0.62	0.42	0.32	0.18	0.15	0.15	0.37	1.00	1.00
50%	1.00	1.00	0.92	0.67	0.61	0.39	0.22	0.19	0.18	0.41	1.00	1.00
60%	1.00	1.00	0.98	0.73	0.76	0.61	0.26	0.22	0.21	0.46	1.00	1.00
70%	1.00	1.00	1.00	0.98	0.95	0.80	0.30	0.25	0.25	0.53	1.00	1.00
80%	1.00	1.00	1.00	1.00	1.00	0.99	0.42	0.28	0.42	0.88	1.00	1.00
90%	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.53	0.83	1.00	1.00	1.00
Maximum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Average	1.00	1.00	0.90	0.71	0.64	0.54	0.31	0.24	0.29	0.51	0.98	1.00

cfs = cubic feet per second

Table 5-18h. Changes in the Monthly Cumulative Distributions of SJR at Vernalis Flow Values (percent) from Baseline to LSJR Alternative 2 for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Median Unimpaired (cfs)	611	1,141	2,264	3,544	6,294	8,227	15,205	23,054	16,240	4,044	1,095	528
Minimum	0.00	0.00	0.00	0.00	-0.01	-0.01	0.01	0.01	0.00	0.00	0.17	0.00
10%	0.00	0.00	0.00	0.00	-0.03	-0.01	0.00	0.01	0.00	0.00	0.00	0.00
20%	0.00	0.00	0.00	0.00	-0.02	-0.02	-0.07	-0.02	0.00	0.00	0.00	0.00
30%	0.00	0.00	0.00	0.00	-0.02	0.01	-0.06	-0.02	0.02	0.00	0.00	0.00
40%	0.00	0.00	0.00	0.01	0.02	-0.01	-0.11	-0.04	0.04	0.00	0.00	0.00
50%	0.00	0.00	0.01	0.01	0.07	-0.03	-0.12	-0.02	0.04	0.00	0.00	0.00
60%	0.00	0.00	0.02	0.04	0.06	0.01	-0.15	-0.03	0.02	0.00	0.00	0.00
70%	0.00	0.00	0.00	0.05	-0.02	-0.12	-0.13	-0.03	0.04	0.00	0.00	0.00
80%	0.00	0.00	0.00	0.00	0.00	-0.01	-0.09	-0.04	-0.02	0.00	0.00	0.00
90%	0.00	0.00	0.00	0.00	0.00	0.00	-0.09	-0.05	0.10	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Average	0.00	0.00	0.00	0.01	0.01	-0.02	-0.09	-0.03	0.02	0.00	0.00	0.00

cfs = cubic feet per second

As discussed previously, the monthly flow value on the Stainslaus River would be reduced such that significant impacts would occur. An SED must identify feasible mitigation measures for each significant environmental impact identified in the SED. (Cal. Code Regs., tit. 23, § 3777(b)(3)). In order to reduce significant impacts identified above on the Stanislaus River, additional flow, beyond that which is currently required by LSJR Alternative 2, would be needed. Additional flow could be provided by reducing existing surface water diversions. Evaluating the effects of more flow and fewer surface water diversions is part of other alternatives (i.e., LSJR Alternatives 3 and 4) and is separately considered in this document. Requiring additional flow to reduce impacts cannot be independently applied under LSJR Alternative 2 as a mitigation measure because requiring more flow would be inconsistent with the terms of LSJR Alternative 2 (i.e., requiring 20 percent of unimpaired flow on the Stanislaus River). Furthermore, as noted above, the flows required on the Stanislaus River under LSJR Alternative 2 would sometimes be much less than baseline and could not be adaptively managed to provide additional flows. Therefore, there are no feasible mitigation measures to avoid, minimize, rectify, reduce, or eliminate the impact, and this impact would remain significant and unavoidable. Impacts of reduced Stanislaus River flows under LSJR Alternative 2 on aquatic resources, terrestrial biological resource, recreational resources, and energy produced by hydropower resources are discussed in Chapter 7, *Aquatic Resources*; Chapter 8, *Terrestrial Biological Resources*; Chapter 10, *Recreational Resources and Visual Quality*; and Chapter 14, *Energy and Climate Change*, respectively.

LSJR Alternative 3: 40% Unimpaired Flow (Less than significant)

LSJR Alternative 3 has target flows that are generally greater than the existing flows; therefore, there were many months with increased flows during the February–June period. Table 5-19a shows the monthly cumulative distributions of calculated flow values for the Merced River under LSJR Alternative 3. The average flow values for LSJR Alternative 3 were 60 percent in February, 50 percent in March, 41 percent in April, 39 percent in May and 45 percent in June. The average of the February–June flow values for LSJR Alternative 3 was 47 percent and the average of the February–June flow values for the existing flows was 38 percent. The Merced River flow values calculated for each year with the specified monthly flow-value curves could be higher or lower than the existing flow benefits, but the overall average flow values increased (by 9 percent) on the Merced River. Since the average flow value February–June increased on the Merced River, impacts would be less than significant.

Table 5-19a. Monthly Cumulative Distribution of Merced River Flow Values (percent) for LSJR Alternative 3 for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Minimum	1.00	1.00	0.77	0.47	0.16	0.12	0.09	0.06	0.06	0.07	0.29	0.03
10%	1.00	1.00	0.93	0.58	0.16	0.18	0.23	0.17	0.12	0.13	0.45	0.53
20%	1.00	1.00	1.00	0.66	0.21	0.26	0.26	0.22	0.14	0.17	0.61	0.93
30%	1.00	1.00	1.00	0.69	0.28	0.30	0.32	0.29	0.23	0.22	0.82	1.00
40%	1.00	1.00	1.00	0.72	0.38	0.34	0.36	0.33	0.31	0.30	1.00	1.00
50%	1.00	1.00	1.00	0.77	0.58	0.41	0.40	0.40	0.40	0.33	1.00	1.00
60%	1.00	1.00	1.00	0.85	0.82	0.47	0.45	0.44	0.46	0.42	1.00	1.00
70%	1.00	1.00	1.00	1.00	1.00	0.63	0.48	0.48	0.56	0.57	1.00	1.00
80%	1.00	1.00	1.00	1.00	1.00	0.82	0.54	0.51	0.76	1.00	1.00	1.00
90%	1.00	1.00	1.00	1.00	1.00	1.00	0.61	0.56	0.99	1.00	1.00	1.00
Maximum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Average	1.00	1.00	0.99	0.80	0.60	0.50	0.41	0.39	0.45	0.48	0.85	0.90

Table 5-19b shows the monthly cumulative distributions of calculated flow values for LSJR Alternative 3 for the Tuolumne River. The average flow values for LSJR Alternative 3 were 56 percent in February, 62 percent in March, 46 percent in April, 38 percent in May and 43 percent in June. The average of the February–June flow values for the LSJR Alternative 3 was 49 percent and the average of the February–June flow values for the existing flows was 38 percent. The Tuolumne River flow values calculated for each year with the specified monthly flow-value curves could be higher or lower than the existing flow values, but the overall average flow benefits were increased (by 11 percent) on the Tuolumne River. Since the average flow value February–June increased on the Tuolumne River, impacts would be less than significant.

Table 5-19b. Monthly Cumulative Distribution of Tuolumne River Flow Values (percent) for LSJR Alternative 3 for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Minimum	1.00	0.54	0.28	0.17	0.10	0.08	0.12	0.09	0.04	0.15	0.58	1.00
10%	1.00	0.64	0.33	0.26	0.14	0.21	0.24	0.19	0.11	0.21	0.89	1.00
20%	1.00	0.85	0.42	0.35	0.21	0.32	0.28	0.26	0.16	0.27	1.00	1.00
30%	1.00	1.00	0.53	0.36	0.27	0.36	0.33	0.31	0.26	0.30	1.00	1.00
40%	1.00	1.00	0.56	0.43	0.36	0.41	0.37	0.34	0.34	0.34	1.00	1.00
50%	1.00	1.00	0.60	0.47	0.52	0.52	0.43	0.40	0.40	0.37	1.00	1.00
60%	1.00	1.00	0.68	0.50	0.67	0.76	0.47	0.44	0.48	0.47	1.00	1.00
70%	1.00	1.00	0.77	0.58	0.90	1.00	0.52	0.48	0.53	0.51	1.00	1.00
80%	1.00	1.00	0.94	1.00	1.00	1.00	0.59	0.48	0.62	0.95	1.00	1.00
90%	1.00	1.00	1.00	1.00	1.00	1.00	0.71	0.48	1.00	1.00	1.00	1.00
Maximum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.88	1.00	1.00	1.00	1.00
Average	1.00	0.93	0.65	0.56	0.56	0.62	0.46	0.38	0.43	0.49	0.97	1.00

Table 5-19c shows the monthly cumulative distributions of calculated flow values for LSJR Alternative 3 for the Stanislaus River. The average flow values for LSJR Alternative 3 were 62 percent in February, 51 percent in March, 40 percent in April, 37 percent in May and 41 percent in June. The average of the February–June flow values for LSJR Alternative 3 was 46 percent and the average of the February–June flow value for the existing flows was 43 percent. The Stanislaus River flow values calculated for each year with the specified monthly flow-value curves could be higher or lower than the existing flow benefits, but the overall average flow values February–June were increased slightly (by 3 percent) on the Stanislaus River. Since the average flow value during this time increased on the Stanislaus River, impacts would be less than significant.

Table 5-19c. Monthly Cumulative Distribution of Stanislaus River Flow Values (percent) for LSJR Alternative 3 for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Minimum	0.81	0.55	0.50	0.24	0.25	0.19	0.14	0.06	0.05	0.42	1.00	0.11
10%	1.00	1.00	0.63	0.32	0.32	0.28	0.21	0.14	0.10	0.65	1.00	1.00
20%	1.00	1.00	0.72	0.39	0.40	0.32	0.26	0.23	0.15	0.75	1.00	1.00
30%	1.00	1.00	0.78	0.45	0.48	0.36	0.31	0.26	0.23	0.78	1.00	1.00
40%	1.00	1.00	0.82	0.47	0.54	0.39	0.36	0.33	0.30	0.79	1.00	1.00
50%	1.00	1.00	0.88	0.51	0.61	0.44	0.40	0.39	0.40	0.81	1.00	1.00
60%	1.00	1.00	0.90	0.53	0.64	0.48	0.43	0.45	0.47	0.82	1.00	1.00
70%	1.00	1.00	0.97	0.57	0.71	0.58	0.48	0.50	0.53	0.92	1.00	1.00
80%	1.00	1.00	1.00	0.68	0.94	0.69	0.53	0.54	0.61	1.00	1.00	1.00
90%	1.00	1.00	1.00	0.86	1.00	0.96	0.57	0.54	0.81	1.00	1.00	1.00
Maximum	1.00	1.00	1.00	1.00	1.00	1.00	0.77	0.54	1.00	1.00	1.00	1.00
Average	1.00	0.99	0.85	0.55	0.62	0.51	0.40	0.37	0.41	0.83	1.00	0.99

Table 5-19d shows the monthly cumulative distributions of calculated flow values for LSJR Alternative 3 for the SJR at Vernalis. The average flow values for LSJR Alternative 3 were 66 percent in February, 58 percent in March, 41 percent in April, 35 percent in May and 37 percent in June. The average of the February–June flow values for LSJR Alternative 3 was 47 percent and the average of the February–June flow values for the baseline flows was 43 percent. The SJR at Vernalis flow values calculated for each year with the specified monthly flow-value curves could be higher or lower than the baseline flow values, but the overall average flow value February–June increased somewhat (by 4 percent) on the SJR at Vernalis. Since the average flow values increased during this time, impacts would be less than significant.

Table 5-19d. Monthly Cumulative Distribution of SJR at Vernalis Flow Values for LSJR Alternative 3 for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Median Unimpaired (cfs)	611	1,141	2,264	3,544	6,294	8,227	15,205	23,054	16,240	4,044	1,095	528
Minimum	1.00	1.00	0.60	0.34	0.28	0.16	0.09	0.07	0.04	0.14	0.51	1.00
10%	1.00	1.00	0.75	0.45	0.33	0.23	0.18	0.14	0.10	0.25	0.99	1.00
20%	1.00	1.00	0.80	0.50	0.34	0.31	0.21	0.19	0.13	0.31	1.00	1.00
30%	1.00	1.00	0.85	0.55	0.39	0.35	0.26	0.23	0.19	0.33	1.00	1.00
40%	1.00	1.00	0.88	0.61	0.43	0.39	0.32	0.27	0.26	0.37	1.00	1.00
50%	1.00	1.00	0.91	0.66	0.60	0.46	0.34	0.33	0.32	0.41	1.00	1.00
60%	1.00	1.00	0.96	0.70	0.81	0.67	0.39	0.37	0.37	0.46	1.00	1.00
70%	1.00	1.00	1.00	0.98	1.00	0.83	0.44	0.40	0.41	0.53	1.00	1.00
80%	1.00	1.00	1.00	1.00	1.00	1.00	0.52	0.43	0.51	0.88	1.00	1.00
90%	1.00	1.00	1.00	1.00	1.00	1.00	0.78	0.63	0.83	1.00	1.00	1.00
Maximum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Average	1.00	1.00	0.90	0.71	0.66	0.58	0.41	0.35	0.37	0.51	0.98	1.00

cfs = cubic feet per second

LSJR Alternative 4: 60% Unimpaired Flow (Less than significant)

LSJR Alternative 4 has target flows that are generally greater than the baseline flows; therefore, there were many months with increased flows during the February–June period. Table 5-20a shows the monthly cumulative distributions of calculated flow values for LSJR Alternative 4 for the Merced River. The average flow values for LSJR Alternative 4 were 67 percent in February, 64 percent in March, 59 percent in April, 45 percent in May and 56 percent in June. The average of the February–June flow values for LSJR Alternative 4 was 58 percent, and the average of the February–June flow values for the existing flows was 38 percent. The Merced River flow values calculated for each year with the specified monthly flow-value curves could be higher or lower than the existing flow values, but the overall average flow values February–June increased (by 20 percent) on the Merced River. Because the average flow value increased during this time, impacts would be less than significant.

Table 5-20a. Monthly Cumulative Distribution of Merced River Flow Values (percent) for LSJR Alternative 4 for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Minimum	1.00	1.00	0.67	0.47	0.16	0.12	0.13	0.10	0.06	0.07	0.29	0.03
10%	1.00	1.00	0.92	0.58	0.23	0.27	0.34	0.25	0.18	0.13	0.45	0.53
20%	1.00	1.00	1.00	0.66	0.30	0.39	0.39	0.33	0.21	0.17	0.61	0.93
30%	1.00	1.00	1.00	0.69	0.39	0.45	0.47	0.43	0.34	0.22	0.82	1.00
40%	1.00	1.00	1.00	0.72	0.54	0.51	0.54	0.50	0.47	0.30	1.00	1.00
50%	1.00	1.00	1.00	0.76	0.72	0.61	0.60	0.51	0.60	0.33	1.00	1.00
60%	1.00	1.00	1.00	0.84	1.00	0.70	0.67	0.51	0.69	0.42	1.00	1.00
70%	1.00	1.00	1.00	1.00	1.00	0.87	0.72	0.51	0.82	0.57	1.00	1.00
80%	1.00	1.00	1.00	1.00	1.00	1.00	0.81	0.51	0.82	1.00	1.00	1.00
90%	1.00	1.00	1.00	1.00	1.00	1.00	0.84	0.51	1.00	1.00	1.00	1.00
Maximum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Average	1.00	1.00	0.98	0.80	0.67	0.64	0.59	0.45	0.56	0.48	0.85	0.90

Table 5-20b shows the monthly cumulative distributions of calculated flow values for LSJR Alternative 4 for the Tuolumne River. The average flow values for LSJR Alternative 4 were 67 percent in February, 72 percent in March, 60 percent in April, 45 percent in May, and 52 percent in June. The average of the February–June flow values for LSJR Alternative 4 was 59 percent, and the average of the February–June flow values for the baseline flows was 38 percent. The Tuolumne River flow benefits calculated for each year with the specified monthly flow-value curves could be higher or lower than the existing flow values, but the overall average flow values February–June were increased (by 21 percent) on the Tuolumne River. Since the average flow value increased during this time, impacts would be less than significant.

Table 5-20b. Monthly Cumulative Distribution of Tuolumne River Flow Values (percent) for LSJR Alternative 4 for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Minimum	1.00	0.54	0.28	0.17	0.10	0.09	0.18	0.14	0.04	0.15	0.58	1.00
10%	1.00	0.64	0.33	0.26	0.21	0.32	0.36	0.28	0.16	0.21	0.89	1.00
20%	1.00	0.85	0.42	0.35	0.32	0.47	0.42	0.39	0.24	0.27	1.00	1.00
30%	1.00	1.00	0.53	0.36	0.40	0.54	0.50	0.46	0.39	0.30	1.00	1.00
40%	1.00	1.00	0.56	0.43	0.53	0.61	0.56	0.48	0.51	0.34	1.00	1.00
50%	1.00	1.00	0.60	0.47	0.73	0.68	0.60	0.48	0.60	0.37	1.00	1.00
60%	1.00	1.00	0.68	0.50	0.99	0.99	0.67	0.48	0.62	0.47	1.00	1.00
70%	1.00	1.00	0.78	0.61	1.00	1.00	0.72	0.48	0.62	0.51	1.00	1.00
80%	1.00	1.00	0.98	1.00	1.00	1.00	0.78	0.48	0.62	0.95	1.00	1.00
90%	1.00	1.00	1.00	1.00	1.00	1.00	0.78	0.48	1.00	1.00	1.00	1.00
Maximum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.93	1.00	1.00	1.00	1.00
Average	1.00	0.93	0.65	0.56	0.67	0.72	0.60	0.45	0.52	0.49	0.97	1.00

Table 5-20c shows the monthly cumulative distributions of calculated flow values for LSJR Alternative 4 for the Stanislaus River. The average flow values for LSJR Alternative 4 were 69 percent in February, 65 percent in March, 57 percent in April, 45 percent in May, and 56 percent in June. The average of the February–June flow values for LSJR Alternative 4 was 58 percent, and the average of the February–June flow values for the baseline flows was 43 percent. The Stanislaus River flow values calculated for each year with the specified monthly flow-value curves could be higher or lower than the existing flow values, but the overall average flow values February–June were increased (by 15 percent) on the Stanislaus River. Since the average flow value increased during this time, impacts would be less than significant.

Table 5-20c. Monthly Cumulative Distribution of Stanislaus River Flow Values (percent) for LSJR Alternative 4 for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Minimum	0.81	0.55	0.50	0.24	0.25	0.22	0.11	0.09	0.06	0.42	1.00	0.11
10%	1.00	1.00	0.63	0.32	0.33	0.34	0.31	0.21	0.15	0.65	1.00	1.00
20%	1.00	1.00	0.72	0.39	0.41	0.43	0.38	0.34	0.21	0.75	1.00	1.00
30%	1.00	1.00	0.78	0.45	0.49	0.47	0.47	0.39	0.35	0.78	1.00	1.00
40%	1.00	1.00	0.82	0.47	0.56	0.55	0.54	0.50	0.46	0.79	1.00	1.00
50%	1.00	1.00	0.88	0.51	0.66	0.60	0.60	0.54	0.60	0.81	1.00	1.00
60%	1.00	1.00	0.90	0.53	0.87	0.71	0.64	0.54	0.70	0.82	1.00	1.00
70%	1.00	1.00	0.97	0.57	0.93	0.82	0.72	0.54	0.80	0.92	1.00	1.00
80%	1.00	1.00	1.00	0.68	1.00	0.97	0.77	0.54	0.91	1.00	1.00	1.00
90%	1.00	1.00	1.00	0.86	1.00	1.00	0.77	0.54	0.91	1.00	1.00	1.00
Maximum	1.00	1.00	1.00	1.00	1.00	1.00	0.77	0.54	1.00	1.00	1.00	1.00
Average	1.00	0.99	0.85	0.55	0.69	0.65	0.57	0.45	0.56	0.83	1.00	0.99

Table 5-20d shows the monthly cumulative distributions of calculated flow values for LSJR Alternative 4 for the SJR at Vernalis. The average flow benefits for LSJR Alternative 4 were 70 percent in February, 66 percent in March, 51 percent in April, 40 percent in May, and 44 percent in June. The average of the February–June flow values for LSJR Alternative 4 was 54 percent, and the average of the February–June flow values for the baseline flows was 43 percent. The SJR at Vernalis flow values calculated for each year with the specified monthly flow-value curves could be higher or lower than the baseline flow values February–June, but the overall average flow values were increased (by 11 percent) on the SJR at Vernalis. Because the average flow value increased during this time, impacts would be less than significant.

Table 5-20d. Monthly Cumulative Distribution of SJR at Vernalis Flow Value (percent) for LSJR Alternative 4 for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Median Unimpaired (cfs)	611	1,141	2,264	3,544	6,294	8,227	15,205	23,054	16,240	4,044	1,095	528
Minimum	1.00	1.00	0.60	0.34	0.28	0.16	0.10	0.10	0.06	0.14	0.51	1.00
10%	1.00	1.00	0.75	0.45	0.34	0.29	0.26	0.19	0.13	0.25	0.99	1.00
20%	1.00	1.00	0.80	0.50	0.37	0.41	0.30	0.27	0.18	0.31	1.00	1.00
30%	1.00	1.00	0.85	0.55	0.45	0.45	0.36	0.33	0.28	0.33	1.00	1.00
40%	1.00	1.00	0.88	0.61	0.54	0.50	0.43	0.37	0.37	0.37	1.00	1.00
50%	1.00	1.00	0.92	0.66	0.69	0.60	0.48	0.38	0.45	0.41	1.00	1.00
60%	1.00	1.00	0.98	0.70	1.00	0.81	0.54	0.40	0.49	0.46	1.00	1.00
70%	1.00	1.00	1.00	0.98	1.00	0.95	0.59	0.43	0.53	0.53	1.00	1.00
80%	1.00	1.00	1.00	1.00	1.00	1.00	0.63	0.44	0.55	0.88	1.00	1.00
90%	1.00	1.00	1.00	1.00	1.00	1.00	0.92	0.62	0.90	1.00	1.00	1.00
Maximum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Average	1.00	1.00	0.90	0.71	0.70	0.66	0.51	0.40	0.44	0.51	0.98	1.00

cfs = cubic feet per second

SDWQ Alternative 1: No Project

The No Project Alternative would result in implementation of salinity objectives identified in the 2006 Bay–Delta Plan. See Chapter 15, *LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project impact discussion and Appendix D, *Evaluation of LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project technical analysis.

SDWQ Alternative 2: 1.0 dS/m Salinity and SDWQ 3: 1.4 dS/m Salinity (No Impact)

The SJR at Vernalis salinity objective (EC) would continue to be maintained and does not represent a change from baseline with respect to flow. Furthermore, this alternative is not related to percent of unimpaired flow. Therefore, impacts would not occur.

HYD-2 Substantially alter hydrology such that regulating reservoir operations are limited

The rim dams release water through the hydroelectric turbines at their maximum efficiency capacity in order to generate energy. Releases are made typically for several hours each day, and no releases are made for the remainder of the day. The number of hours of releases is a function of daily average release flow and the turbine capacity flow.

LSJR Alternative 1: No Project

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project impact discussion and Appendix D, *Evaluation of LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project Alternative technical analysis.

LSJR Alternative 2: 20% Unimpaired Flow, LSJR Alternative 3: 40% Unimpaired Flow, and LSJR Alternative 4: 60% Unimpaired Flow (Less than significant)

The normal "peaking-energy" operation of the rim dams and regulating dams would continue under LSJR Alternatives 2, 3, and 4. The only changes to the peaking-energy operation would be slightly different hours with peaking-energy releases each day during the month according to the monthly changes in the simulated WSE river flows and diversion flows under LSJR Alternatives 2, 3, and 4.

The downstream "regulating reservoirs" on each of the three eastside tributaries (i.e., McSwain Dam and Merced Falls Dam on the Merced River; hydroelectric power plant at TID canal on the Tuolumne River; and Tulloch and Goodwin Dam on the Stanislaus River) operate with a seasonal storage elevation and a daily fluctuating elevation (that depends on the number of peaking hours). The WSE model calculated the monthly changes in river flows for the February–June period but maintained the baseline monthly river flows for the July–January period (no river flow changes). But the WSE-simulated changes in the annual water supply diversions from the downstream regulating reservoirs or diversion dams would cause a proportionate change in each of the monthly diversion flows and would reduce the rim dam hydropower releases.

The highest diversions are made in July under baseline operations and LSJR alternative conditions. The maximum diversion from the Stanislaus River was about 2,125 cfs, the maximum diversion from the Tuolumne River was about 3,250 cfs, and the maximum diversion from the Merced River was about 2,150 cfs. If the annual water supply diversion was reduced by 25 percent, each of the monthly diversion flows would be reduced by 25 percent. The reservoir release flow would be reduced by this same amount, and the number of peaking-energy generation hours (releases) would be reduced. The dam operators have the flexibility with hydroelectric production to choose to generate with reduced capacity for more hours each day or with increased capacity for less hours. Therefore, because the monthly average hydropower release flow variations are within the normal baseline operations, LSJR Alternatives 2, 3, and 4 would not cause substantial changes in the flows or water elevations in the regulating reservoirs or in the river segments that connect the rim dams to the downstream regulating reservoirs. Impacts would be less than significant for LSJR Alternatives 2, 3, and 4.

SDWQ Alternative 1: No Project

The No Project Alternative would result in implementation of salinity objectives identified in the 2006 Bay–Delta Plan. See Chapter 15, *LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project impact discussion and Appendix D, *Evaluation of LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project technical analysis.

SDWQ Alternative 2: 1.0 dS/m Salinity and SDWQ 3: 1.4 dS/m Salinity (No Impact)

The SJR at Vernalis flow objective would continue to be maintained and does not represent a change from baseline with respect to flow; therefore, substantial alterations to hydrology are not expected that would affect regulating reservoirs. Impacts would not occur.

WS-1: Substantially reduce surface water supply diversions caused by a change in river flows or reduce exports to CVP and SWP export service areas caused by a change in river flows

The LSJR alternatives could require higher river flows in the three eastside tributaries and would likely result in a change in surface water diversions. The WSE model was used to predict the change in annual surface water diversions expected under each LSJR alternative. If the LSJR alternative results in an increase in average surface water supply deficit from the baseline greater than 5 percent of the maximum water supply diversions, the alternative would result in a significant impact. Additionally, as discussed above in Section 5.4.2, the CVP and SWP exports could be modified based on the inflow from the LSJR. If the LSJR alternatives result in a substantial reduction in average export deficits from the baseline, the alternatives would result in a significant impact. Baseline annual surface water diversions are presented first for the three eastside tributaries, the change to annual surface water diversions between baseline and the LJSR alternatives are then summarized, and then a summary of the baseline CVP and SWP exports and the change to the exports is presented.

The baseline Merced River annual diversions ranged from 134 to 624 TAF. The 10 percent cumulative diversion was 421 TAF, the median diversion was 552 TAF, and the 90 percent cumulative diversion was 593 TAF. The average annual diversion was 527 TAF. The existing Merced River water supply deficits ranged from 7 (10 percent) to 179 TAF (90 percent), with an average deficit of 73 TAF, about 12 percent of the assumed maximum water supply.

The baseline Tuolumne River annual diversions ranged from 542 to 1,132 TAF. The 10 percent cumulative diversion was 762 TAF, the median diversion was 906 TAF, and the 90 percent cumulative diversion was 1,042 TAF. The average annual diversion was 885 TAF. The existing Tuolumne River water supply deficits ranged from 58 (10 percent) to 338 TAF (90 percent), with an average deficit of 215 TAF, about 20 percent of the assumed maximum water supply.

The baseline Stanislaus River annual diversions ranged from 368 to 678 TAF. The 10 percent cumulative diversion was 455 TAF, the median diversion was 593 TAF, and the 90 percent cumulative diversion was 656 TAF. The average annual diversion was 577 TAF. The existing Stanislaus River water supply deficits ranged from 94 (10 percent) to 295 TAF (90 percent), with an average deficit of 173 TAF, about 23 percent of the assumed maximum water supply.

Table 5-21 shows the simulated average differences in water supply diversions between baseline and the LSJR alternatives. The results indicate that there would be small reductions and some increases in water supply under LSJR Alternative 2, depending on the river. However, there would be reduced water supply under LSJR Alternatives 3 and 4. Table 5-22a and b shows the annual cumulative distribution (range) for the CALSIM simulated water supply diversions and water supply deficits (maximum demand minus delivery) for the Merced River, the Tuolumne River, and the Stanislaus River. Baseline has delivery deficits corresponding to the historical sequence of runoff and reservoir storage. Deliveries are reduced in dry years when the reservoir storage is not sufficient to supply the total demands. The modeled baseline is described below.

Table 5-21. Average Annual Baseline Water Supply and Differences from Baseline (Changes in Deliveries) in the Eastside Tributaries and LSJR Plan Area for the LSJR Alternatives for 1922–2003

	Stanislaus (TAF)/ (%)	Tuolumne (TAF) / (%)	Merced (TAF) / (%)	LSJR Plan Area (TAF)/ (%)
Baseline	577 / 100%	885 / 100%	527 / 100%	1989 / 100%
LSJR Alternative 2	73 / 13%	-6 / -1%	-10 / -2%	57 / 3%
LSJR Alternative 3	-8 / -1%	-173 / -20%	-87 / -17%	-268 / -13%
LSJR Alternative 4	-120 / -21%	-329 / -37%	-164 / -31%	-613 / -31%

Note: The maximum water supply demands for the Merced, Tuolumne, and Stanislaus Rivers were assumed to be 600 TAF, 1,100 TAF, and 750 TAF/y respectively.
TAF = thousand acre-feet
TAF/y = thousand acre-feet per year

Table 5-22a. Annual Cumulative Distributions of Unimpaired Runoff and Water Supply Diversions for Baseline and LSJR Alternatives 2, 3, and 4 (20%, 40%, and 60%) for 1922-2003 (TAF)

	Stanislaus					Tuolumne					Merced				
	Unimpaired Flow	Baseline	20%	40%	60%	Unimpaired Flow	Baseline	20%	40%	60%	Unimpaired Flow	Baseline	20%	40%	60%
Minimum	155	368	383	309	234	384	542	451	350	208	151	134	260	203	130
10%	456	455	483	390	302	835	762	613	491	316	408	421	368	292	209
20%	591	537	536	445	358	1,052	814	719	564	400	489	499	446	359	274
30%	679	568	606	488	393	1,165	858	839	645	483	561	525	489	408	325
40%	891	589	655	546	443	1,413	877	884	703	545	668	545	539	442	354
50%	1,092	593	705	608	481	1,776	906	938	761	596	895	552	567	477	385
60%	1,260	603	721	630	506	2,031	920	976	794	648	1,080	561	573	491	413
70%	1,362	615	738	662	525	2,197	935	1,005	834	686	1,165	578	582	504	439
80%	1,560	634	743	685	560	2,486	978	1,023	859	701	1,399	588	589	523	458
90%	1,916	656	746	716	571	3,099	1,042	1,034	874	712	1,712	593	592	529	465
Maximum	2,950	678	750	740	594	4,632	1,132	1,045	880	715	2,786	624	594	531	469
Average	1,118	577	649	569	456	1,849	885	879	712	556	956	527	517	440	364

Table 5-22b. Annual Cumulative Distributions of Surface Water Supply Deficits (Reduced Deliveries) for Baseline and LSJR Alternatives 2, 3, and 4 (20%, 40%, and 60%) for 1922-2003 (TAF)

	Stanislaus				Tuolumne				Merced Diversions			
	Baseline	20%	40%	60%	Baseline	20%	40%	60%	Baseline	20%	40%	60%
Maximum	382	367	441	516	558	649	750	892	466	340	397	470
90%	295	267	360	448	338	487	609	784	179	232	308	391
80%	213	214	305	392	286	381	536	700	101	154	241	326
70%	182	144	262	357	242	261	455	617	75	111	192	275
60%	161	95	204	307	223	216	397	555	55	61	158	246
50%	157	45	142	269	194	162	339	504	48	33	123	215
40%	147	29	120	244	180	124	306	452	39	27	109	187
30%	135	12	88	225	165	95	266	414	22	18	96	161
20%	116	7	65	190	122	77	241	399	12	11	77	142
10%	94	4	34	179	58	66	226	388	7	8	71	135
Minimum	72	-	10	156	(32)	55	220	385	(24)	6	69	131
Average	173	101	181	294	215	221	388	544	73	83	160	236

Table 5-23 gives a summary of the CVP and SWP export calculations from Appendix F.1. This table shows the expected changes in exports that would likely be caused by monthly SJR flow changes as a result of the LSJR alternatives.

Table 5-23. Cumulative Distribution of Baseline and Changes in CVP and SWP Exports Caused by Changes in SJR Flow at Vernalis for the LSJR Alternatives (TAF)

	Baseline		LSJR Alternative 2		LSJR Alternative 3		LSJR Alternative 4	
	Annual Exports	Feb–June Exports	Annual Exports Change	Feb–June Exports Change	Annual Exports Change	Feb–June Exports Change	Annual Exports Change	Feb–June Exports Change
Minimum	2,150	415	-272	-265	76	40	89	52
50%	4,939	1,214	5	-4	24	133	129	231
Maximum	6,802	2,652	174	137	-89	-90	34	7
Average	4,820	1,347	-8	-27	66	48	161	135
	Percentage Change		0%	-2%	1%	4%	3%	10%

TAF = thousand acre-feet

LSJR Alternative 1: No Project

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project impact discussion and Appendix D, *Evaluation of LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project Alternative technical analysis.

LSJR Alternative 2: 20% Unimpaired Flow (Less than significant)

The WSE calculated Merced River diversions for LSJR Alternative 2 ranged from 260 to 594 TAF, with an average annual diversion of 517 TAF. The average Merced River deficit would increase from 73 to 83 TAF/y with LSJR Alternative 2. This increase of 10 TAF/y would not be greater than 5 percent of the maximum water supply demand for the Merced River (30 TAF), and this impact would be less than significant.

The WSE calculated Tuolumne River diversions for LSJR Alternative 2 ranged from 451 to 1,045 TAF, with an average annual diversion of 879 TAF. The average Tuolumne River deficit would increase from 215 to 221 TAF/y with LSJR Alternative 2. This increase of 6 TAF/y would not be greater than 5 percent of the maximum water supply demand for the Tuolumne River (55 TAF), and this impact would be less than significant. The implementation of LSJR Alternative 2 would consider and accommodate the prior allocation of Tuolumne River water rights and upstream diversion. Some portion of the increased release flows from New Don Pedro Reservoir could be shared by CCSF. This may require changing the water bank account but would not likely interfere with the CCSF diversions because its share of water rights is usually greater than the aqueduct diversions.

The WSE calculated Stanislaus River diversions for LSJR Alternative 2 ranged from 383 to 750 TAF, with an average annual diversion of 649 TAF. The average Stanislaus River deficit would decrease from173 to 101 TAF/y with LSJR Alternative 2. The impact of this increase in water supply on the Stanislaus River would be less than significant.

The calculated annual reduction in CVP and SWP southern Delta exports for LSJR Alternative 2 averaged -8 TAF/y, which represents no change when compared to baseline. The overall change in exports would be within the annual variability; accordingly, it is expected that water supply in the export service areas would not be reduced. Impacts would be less than significant.

LSJR Alternative 3: 40% Unimpaired Flow (Significant and unavoidable)

The WSE calculated Merced River diversions for LSJR Alternative 3 ranged from 203 to 531 TAF, with an average annual diversion of 440 TAF. The average Merced River deficit would increase from 73 to 160 TAF/y with LSJR Alternative 3. This increase of 87 TAF/y (water supply deficit) would be much greater than 5 percent of the maximum water supply demand for the Merced River (30 TAF) and would be a significant impact. There is no mitigation possible for the reduced river diversions on the Merced River. This is because the purpose of LSJR Alternative 3 is to increase river flows during the months of February–June to improve fish habitat conditions and improve survival of rearing and migrating fish. The runoff to the eastside tributary reservoirs is determined by rainfall and snowmelt conditions and the reservoir storage capacity is fixed. Accordingly, there is no possibility of increasing the total surface water supply to provide more water for surface water diversions. More water released to the Merced River would leave less water available for water supply diversions. Impacts would be significant.

The WSE calculated Tuolumne River diversions for LSJR Alternative 3 ranged from 350 to 880 TAF, with an average annual diversion of 712 TAF. The average Tuolumne River deficit therefore would increase from 215 to 388 TAF/y with LSJR Alternative 3. The implementation of LSJR Alternative 3 would consider and accommodate the prior allocation of Tuolumne River water rights and upstream diversion. Some portion of the increased release flows from New Don Pedro Reservoir could be shared by CCSF. This may require changing the water bank account but would not likely interfere with the CCSF diversions because its share of water rights is usually greater than the aqueduct diversions. However, this increase of 173 TAF/y (water supply deficit) would be much greater than 5 percent of the maximum water supply demand for the Tuolumne River (55 TAF); impacts would be significant.

As described in Chapter 11, *Agricultural Resources* and Chapter 18, *Economic Analyses*, the agricultural analysis and agricultural economic analysis conservatively calculated the maximum possible agricultural and economic impacts if there is no additional water supply to augment reduced surface water supplies, such as groundwater, under LSJR Alternative 3 for the Merced and Tuolumne Rivers. In all likelihood, some of the potential surface water supply reductions predicted by the WSE model and identified in Table 5-21 would be made up through increased groundwater pumping, thus potentially reducing some of the possible agriculture and economic impacts. As described in Chapter 9, *Groundwater Resources*, the groundwater analysis conservatively calculates the maximum possible groundwater impact if all modeled shortfalls in surface water supplies are replaced by pumped groundwater.

The WSE calculated Stanislaus River diversions for LSJR Alternative 3 ranged from 309 to 740 TAF, with an average annual diversion of 569 TAF. The average Stanislaus River deficit would decrease from173 to 181 TAF/y with LSJR Alternative 3. This increase in water supply deficit of 8 TAF/y would be less than 5 percent of the maximum water supply demand for the Stanislaus River (37.5 TAF); impacts would be less than significant.

The calculated annual changes in CVP and SWP southern Delta exports for LSJR Alternative 3 averaged 66 TAF/y. This is an increase of about 1.5 percent of the baseline average exports of 4,820

TAF/y. Because exports are expected to increase under LSJR Alternative 3, impacts would be less than significant.

As previously discussed, impacts on the Merced and Tuolumne River would be significant with respect to surface water diversion reductions. An SED must identify feasible mitigation measures for each significant environmental impact identified in the SED. (Cal. Code Regs., tit. 23, § 3777(b)(3)). As discussed above for the Merced River, the New Don Pedro Reservoir storage capacity is fixed. Accordingly, there is no possibility of increasing the total water supply to provide more water for surface water diversions as mitigation. More water released to the Tuolumne River would leave less water for surface water diversions. The State Water Board would need to require lower flows then are currently required by LSJR Alternative 3 on the Merced and Tuolumne Rivers in order to reduce significant impacts identified above to existing water diverters. Evaluating the effects of lower flows on the different rivers is part of other alternatives (i.e., LSJR Alternatives 1 and 2) and is separately considered in this document. Requiring lower flows to reduce water supply impacts cannot be independently applied under LSJR Alternative 3 as a mitigation measure because requiring lower flows would be inconsistent with the terms of LSJR Alternative 3 (i.e., requiring 40 percent of unimpaired flow on the Merced and Tuolumne Rivers).

CEQA does not grant agencies new, discretionary powers independent of the powers granted to the agencies by other laws. (Pub. Resources Code, § 21004; Cal. Code Regs., tit. 14, § 15040.) Accordingly, a mitigation measure may be legally infeasible if the lead agency does not have the discretionary authority to implement it. (Pub. Resources Code, § 21004; Cal. Code Regs., tit. 14, § 15040; 15041; 150126.4; 15364.) While it may be possible for water diverters (e.g., irrigation districts or municipalities) to reduce their reliance on surface water diversions, thereby reducing the significant impact of LSJR Alternative 3 (See Chapter 11, *Agricultural Resources*, Chapter 13, *Service Providers*, and Appendix H, *Evaluation of Methods of Compliance*), the State Water Board does not have the authority to mandate the actions of others that would offset reduced surface water diversions. Impacts would remain significant and unavoidable.

LSJR Alternative 4: 60% Unimpaired Flow (Significant and unavoidable)

The WSE calculated Merced River diversions for LSJR Alternative 4 ranged from 130 to 469 TAF, with an average annual diversion of 364 TAF. The average Merced River deficit would increase from 73 to 236 TAF/y with LSJR Alternative 4. This increased water supply deficit of 163 TAF/y would be much greater than 5 percent of the maximum water supply demand for the Merced River (30 TAF) and would be a significant impact. As discussed above for the Merced and Tuolumne Rivers in LSJR Alternative 3, the reservoir storage capacity on these rivers is fixed. Accordingly, there is no possibility of increasing the total water supply to provide more water for surface water diversions. More water released to the Merced River would leave less water for surface water diversions; impacts would be significant.

The WSE calculated Tuolumne River diversions for LSJR Alternative 4 ranged from 208 to 715 TAF, with an average annual diversion of 556 TAF. The average Tuolumne River deficit therefore would increase from 215 to 544 TAF/y with LSJR Alternative 4. The implementation of LSJR Alternative 4 would consider and accommodate the prior allocation of Tuolumne River water rights and upstream diversion. Some portion of the increased release flows from New Don Pedro Reservoir could be shared by CCSF. This may require changing the water bank account but would not likely interfere with the CCSF diversions because its share of water rights is usually greater than the aqueduct diversions. . However, the increased water supply deficit of 329 TAF/y would be much greater than

5 percent of the maximum water supply demand for the Tuolumne River (55 TAF); impacts would be significant.

The WSE calculated Stanislaus River diversions for LSJR Alternative 4 ranged from 234 to 594 TAF, with an average annual diversion of 456 TAF. The average Stanislaus River deficit would decrease from173 to 294 TAF/y with LSJR Alternative 4. This increased water supply deficit of 121TAF/y would be much more than 5 percent of the maximum water supply demand for the Stanislaus River (37.5 TAF) and would be a significant impact. As discussed above for the Merced and Tuolumne Rivers in LSJR Alternatives 3 and 4, the New Melones Reservoir storage capacity on the Stanislaus River is fixed. Accordingly, there is no possibility of increasing the total water supply to provide more water for surface water diversions. More water released to the Stanislaus River would leave less water for surface water diversions; impacts would be significant.

As discussed previously, the agricultural analysis and agricultural economic analysis conservatively calculated the maximum possible agricultural and economic impacts if there is no additional water supply to augment reduced surface water supplies, such as groundwater, under LSJR Alternative 4 (Chapter 11, *Agricultural Resources* and Chapter 18, *Economic Analyses*). In all likelihood, some of the potential surface water supply reductions predicted by the WSE model and identified in Table 5-21 would be made up through increased groundwater pumping, thus potentially reducing some of the possible agriculture and economic impacts. As described in Chapter 9, *Groundwater Resources*, the groundwater analysis conservatively calculates the maximum possible groundwater impact if all modeled shortfalls in surface water supplies are replaced by pumped groundwater.

As discussed previously, significant impacts would occur as a result of the surface water diversion reductions on the Merced, Tuolumne, and Stanislaus Rivers. The State Water Board must identify feasible mitigation measures for each significant environmental impact identified in the SED. (Cal. Code Regs., tit. 23, § 3777(b)(3)). As discussed above under LSJR Alternative 3, the reservoir storage capacity on the three eastside rivers are fixed. Accordingly, there is no possibility of increasing the total water supply to provide more water for surface water diversions as mitigation. More water released to the rivers would leave less water for surface water diversions. Similar to LSJR Alternative 3, in order to reduce significant impacts identified above to existing water diverters, the State Water Board would need to require lower flows on all three tributaries then what is required by LSJR Alternative 4. Evaluating the effects of lower flows on the different rivers is part of other alternatives (i.e., LSJR Alternative 1 and 2) and is separately considered in this document. Requiring lower flows cannot be independently applied under LSJR Alternative 4 as a mitigation measure because requiring less flow would be inconsistent with the terms of LSJR Alternative 4 (i.e., requiring 60 percent of unimpaired flow on the Merced and Tuolumne Rivers). Also as described above under LSJR Alternative 3, it may be possible for water diverters (e.g., irrigation districts or municipalities) to reduce their reliance on surface water diversions thereby reducing the significant impact of LSJR Alternative 4 (See Chapter 13, *Service Providers* and Appendix H, *Evaluation of Methods of Compliance*). However, the State Water Board does not have the authority to mandate the actions of entities that would offset reduced surface water diversions. Impacts would remain significant and unavoidable.

The calculated annual changes in CVP and SWP southern Delta exports for LSJR Alternative 4 averaged 161 TAF/y. This is a slight increase of about 3 percent of the baseline average exports of 4,820 TAF/y. Because exports are expected to increase under LSJR Alternative 4, impacts would be less than significant.

SDWQ Alternative 1: No Project

The No Project Alternative would result in implementation of salinity objectives identified in the 2006 Bay–Delta Plan. See Chapter 15, *LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project impact discussion and Appendix D, *Evaluation of LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project technical analysis.

SDWQ Alternative 2: 1.0 dS/m Salinity and SDWQ 3: 1.4 dS/m Salinity (No Impact)

See HYD-1. Because the SJR at Vernalis salinity objective would be maintained, impacts would not occur.

WQ-1: Violate water quality objectives by increasing in the number of months with electrical conductivity (EC) above the water quality objectives for salinity at Vernalis or southern Delta compliance stations

The impact associated with each LSJR alternative was assessed using the existing water quality objectives. The number of months when the estimated EC at the southern Delta compliance stations would exceed the existing water quality objectives for each LSJR alternative was compared to the number of months that the estimated EC would exceed the existing water quality objectives under baseline flow and EC conditions. The impact associated with each SDWQ alternative was assessed by evaluating how the number of months with EC greater than the SDWQ alternatives would change in response to the change in objectives. The number of months the EC exceeded the existing EC objective was compared to the number of months the EC exceeded the SDWQ alternative. The SDWQ alternatives are compared to the baseline of existing flows and existing objectives. Described below are baseline conditions at the Vernalis and the southern Delta compliance stations.

The baseline monthly EC values at Vernalis, corresponding to the monthly flows and assumed LSJR salt loads, were calculated for the 1922–2003 period with the CALSIM model. Additional releases from New Melones Reservoir in some months were assumed in the CALSIM modeling to satisfy the Vernalis EC objectives; the Vernalis EC was maintained at 0.950dS/m (950 µS/cm) in months, with an EC objective of 1.000 dS/m (1,000 µS/cm) (October–March), and the Vernalis EC was maintained at 0.650dS/m (650 µS/cm) in months with an EC objective of 0.700 dS/m (700 µS/cm) (April–September). The calculated monthly EC values for the SJR at Vernalis, SJR at Brandt Bridge, and Old River at Tracy Boulevard for baseline are given in Appendix F.1 (Tables F.1-14b, e, and g).

Table 5-24a shows a summary of monthly Vernalis EC values for baseline as simulated with the CALSIM model for 1922–2003, sorted by the number of years with values greater than 0.400 dS/m–1.200 dS/m (400 µS/cm–1,200 µS/cm (in 0.100 dS/m (100 µS/cm) increments). The monthly EC objective September–March is 1.000 dS/m (1,000 µS/cm), and the EC objective April–August is 0.700 dS/m (700 µS/cm)[10]. The table indicates the number of years with a calculated monthly EC value greater than the EC values given in the first column. For example, the Vernalis EC values in October for baseline were above 0.400 dS/m (400 µS/cm) in 75 years (out of 82 years), above 0.500 dS/m (500 µS/cm) in 43 years, above 0.600 dS/m (600 µS/cm) in 15 years, above 0.700 dS/m (700 µS/cm) in 6 years, and above 0.800 dS/m (800 µS/cm) in 0 years. Other months with an EC objective of 1.000 dS/m (1,000 µS/cm) show no violations at Vernalis. There were 32 years with an EC of greater than 0.900 dS/m (900 µS/cm) in February and 29 years with a March EC of greater

[10] These EC objective values have a line under them in the table; the number of months with calculated EC above the EC objective is in this row.

than 0.900 dS/m (900 μS/cm), suggesting that the EC values for baseline were often approaching the EC objective in these months. The Vernalis EC for baseline in April–August were also less than the EC objective in all years except for one year in August[11]. Many of the simulated Vernalis EC values in April–August were above 0.600 dS/m (600 μS/cm), suggesting that EC was approaching the EC objectives in many years during this period.

Table 5-24a. Monthly Distribution of SJR at Vernalis EC Values (100 μS/cm increments) for Baseline for 1922–2003

EC Value	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Average	April–Sep
400	75	80	78	74	62	56	34	34	71	78	77	77	77	73
500	43	76	78	72	57	51	14	14	47	69	61	62	58	46
600	15	55	76	65	55	48	7	9	38	62	41	21	45	13
700	6	9	68	58	48	43	0	0	0	0	1	4	12	1
800	0	0	50	37	40	36	0	0	0	0	1	1	1	0
900	0	0	0	7	32	29	0	0	0	0	1	1	0	0
1,000	0	0	0	0	0	0	0	0	0	0	1	0	0	0
1,100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,200	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 5-24b shows the baseline monthly distribution of calculated EC values at Brandt Bridge. There were 6 years in January, 2 years in February, 13 years in March, 1 year in September, 0 years in October, 0 years in November, and 0 years in December that exceeded the 1.000 dS/m (1,000 μS/cm) objective (a total of 22 months out of 574). There were 5 years in April, 4 years in May, 31 years in June, 46 years in July, and 24 years in August that exceeded the 0.700 dS/m (700 μS/cm) objective (a total of 110 months out of 410). The baseline EC values at Brandt Bridge exceeded the EC objectives in a total of 132 months out of the 984 months 1922–2003.

Table 5-24b. Monthly Distribution of SJR at Brandt Bridge EC Values (100 μS/cm increments) for Baseline for 1922–2003

EC Value	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Average	April–Sep
400	79	80	78	74	63	56	39	38	71	78	78	77	80	73
500	58	78	78	72	58	52	18	16	61	72	70	72	66	58
600	19	63	76	65	55	48	10	12	39	66	52	46	47	29
700	13	34	69	58	49	45	5	4	31	46	24	9	29	9
800	2	2	62	54	40	38	0	0	0	1	1	3	7	1
900	0	0	18	25	36	33	0	0	0	0	1	1	1	1
1,000	0	0	0	6	2	13	0	0	0	0	1	1	0	0
1,100	0	0	0	0	0	0	0	0	0	0	1	0	0	0
1,200	0	0	0	0	0	0	0	0	0	0	1	0	0	0

[11] This was a CALSIM error where New Melones Reservoir storage was 0 TAF and Stanislaus River flow was 0 cfs.

Table 5-24c shows the baseline monthly distribution of calculated EC in Old River at Tracy Boulevard. There was a total of 119 months with EC values higher than the EC objective of 1.000dS/m (1,000 µS/cm) (September–March) and a total of 173 months with EC values higher than the EC objective of 0.700 dS/m (700 µS/cm) (April–August). The baseline EC values at Tracy Boulevard exceeded the existing EC objectives in a total of 292 months (out of 984). This represents about 30 percent of the months in the 82-year modeled simulation, which is much more than the number of months with measured Old River at Tracy Boulevard EC values that were greater than the EC objectives in the past 25 years. The values predicted by the modeled simulation are much more than the actual measured data because of the method used to calculate the EC increment between Vernalis and Old River at Tracy Boulevard provides somewhat greater EC values than the measured EC values to incorporate the expected effect of higher Vernalis flow to reduce the EC increment (Appendix F.1, Section F.1.4.1).

Table 5-24c. Monthly Distribution of Old River at Tracy Boulevard EC Values (100 µS/cm increments) for Baseline from CALSIM for 1922–2003

EC Value	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Average	April–Sep
400	81	80	78	74	64	60	49	49	73	78	79	79	81	74
500	74	80	78	73	59	54	29	29	65	73	77	77	73	66
600	45	76	76	68	57	49	13	13	49	68	64	64	56	49
700	18	61	74	64	53	47	10	10	39	62	52	45	46	27
800	13	33	68	56	46	43	6	6	34	49	38	15	27	10
900	6	4	56	46	40	37	2	1	11	13	12	5	10	5
1,000	1	1	23	25	34	32	0	0	2	6	2	3	1	1
1,100	1	0	2	6	2	12	0	0	1	1	1	1	1	1
1,200	0	0	0	1	0	0	0	0	0	1	1	1	0	1

Table 5-25 summarizes the number of months with EC higher than the objectives at the two representative compliance stations (Brandt Bridge and Union Island stations, which are assumed to have the same EC) for baseline and for each LSJR alternative. The number of months with EC higher than the objectives would be reduced for SDWQ Alternatives 2 and 3. All of the monthly Vernalis flows for the LSJR alternatives included releases from New Melones Reservoir to meet the existing Vernalis EC objectives. Because CALSIM included a buffer of 50 µS/cm in its calculations, the Vernalis EC was lower than for the LSJR alternatives in some months. Therefore, the number of months with EC higher than the EC objectives between baseline and LSJR Alternative 2 is somewhat higher than expected.

Table 5-25. Number of Months when Estimated EC Values would be Greater than EC Objectives at Southern Delta Compliance Stations 1922–2003 (984 months)

Compliance Station	Baseline	LSJR Alternative 2	LSJR Alternative 3	LSJR Alternative 4
Baseline EC Objectives (700 µS/cm April–August and 1,000 µS/cm September–March)				
Brandt Bridge	132	176	123	100
Tracy Boulevard	292	303	225	203
SDWQ Alternative 2 (1,000 µS/cm January–December)				
Brandt Bridge	23	66	44	28
Tracy Boulevard	119	120	97	82
SDWQ Alternative 3 (1,400 µS/cm January–December)				
Brandt Bridge	0	0	0	0
Tracy Boulevard	0	0	0	0

Note: WSE modeling assumed that New Melones Reservoir would continue to release additional water required to meet the existing Vernalis EC objectives of 0.700 dS/m (700 µS/cm) for April–August and 1.000 dS/m (1000 µS/cm) for September–March.
µS/cm = microSiemens per centimeter

LSJR Alternative 1: No Project

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project impact discussion and Appendix D, *Evaluation of LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project Alternative technical analysis.

LSJR Alternative 2: 20% Unimpaired Flow (Less than significant)

The calculated monthly EC values for the SJR at Vernalis, SJR at Brandt Bridge, and Old River at Tracy Boulevard for LSJR Alternative 2 are given in Appendix F.1 (Tables F.1-15a–c). Table 5-26a shows the monthly Vernalis EC values for LSJR Alternative 2, with adjusted Stanislaus River flows to meet the Vernalis EC objectives. There were no months with EC violations at Vernalis. Table 5-26b shows that Brandt Bridge EC values for LSJR Alternative 2 were higher than the 1.000 dS/m (1,000 µS/cm) objective in the months of September–March in a total of 66 months (out of 574 months). The EC was higher than the EC objective for LSJR Alternative 2 in 44 months more than for baseline) because some of the estimated Vernalis flows were lower, and the corresponding Vernalis EC values were slightly higher (but without violating the EC objectives). Some of these EC increases at Brandt Bridge were caused by reductions in the Vernalis flows resulting from LSJR Alternative 2, but some were caused by the increased EC values at Vernalis calculated in the WSE model. As described above, the CALSIM baseline used a maximum EC of 0.650 dS/m (650 µS/cm) rather than the 0.700 dS/m (700 µS/cm) objective for April–August, and the CALSIM baseline used a maximum EC of 0.950 dS/m (950 µS/cm) rather than the 1.000 dS/m (1,000 µS/cm) objective for September–March period. Under LSJR Alternative 2, the Brandt Bridge EC values were higher than the EC objective of 0.700 dS/m (700 µS/cm) in a total of 110 months (out of 410 months) during the April–August period, which was the same number of times as baseline. The calculated EC values in Old River at Middle River (Union Island) are assumed to be the same as at Brandt Bridge. Because the increased incidence of EC values that would be above the EC objective (176 vs. 132 for baseline) would not exceed an increase of 5 percent of the months (49 out of 984 months). Impacts would be less than significant.

Table 5-26a. Monthly Distribution of SJR at Vernalis EC Values (100 µS/cm increments) for LSJR Alternative 2 for 1922–2003

EC Value	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Average	April–Sep
400	68	79	78	73	63	60	64	45	55	75	73	70	78	71
500	39	73	78	69	57	52	45	23	36	69	61	60	61	52
600	14	53	74	60	50	46	29	10	24	62	41	21	43	20
700	6	9	66	56	42	43	0	0	0	0	1	4	13	0
800	0	0	49	35	37	37	0	0	0	0	0	1	0	0
900	0	0	0	7	34	31	0	0	0	0	0	1	0	0
1,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,200	0	0	0	0	0	0	0	0	0	0	0	0	0	0

µS/cm = microSiemens per centimeter

Table 5-26b. Monthly Distribution of SJR at Brandt Bridge EC Values (100 µS/cm increments) for LSJR Alternative 2 for 1922–2003

EC Value	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Average	April–Sep
400	74	79	78	74	63	61	66	51	62	75	73	71	80	72
500	50	74	78	70	57	53	50	26	45	71	69	67	66	62
600	17	61	74	60	53	47	32	15	27	66	52	45	48	35
700	13	34	68	57	42	45	13	6	21	46	24	9	33	11
800	2	2	60	50	39	40	0	0	1	1	1	3	7	1
900	0	0	18	25	35	33	0	0	0	0	0	1	0	0
1,000	0	0	0	6	32	27	0	0	0	0	0	1	0	0
1,100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,200	0	0	0	0	0	0	0	0	0	0	0	0	0	0

µS/cm = microSiemens per centimeter

Table 5-26c shows that the Old River at Tracy Boulevard EC values for LSJR Alternative 2 were higher than the 1.000 dS/m (1,000 µS/cm) objective in the months of September–March in a total of 120 months. As described above, the calculated EC values in Old River at Tracy Boulevard are generally higher than the measured EC during the past 25 years. This was nearly the same number of violation months as for the baseline (119 months). The Tracy Boulevard calculated EC values were higher than the EC objective of 0.700 dS/m (700 µS/cm) in a total of 183 months during the April–August period, 10 more months than baseline (173 months). The impact of the increased incidence of EC values that were above the EC objective at Tracy Boulevard (303 months vs. 292 months for baseline) would be less than significant.

Table 5-26c. Monthly Distribution of Old River at Tracy Boulevard EC Values (100 μS/cm increments) for LSJR Alternative 2 for 1922–2003

EC Value	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Average	April–Sep
400	82	82	82	82	82	82	82	82	82	82	82	82	82	82
500	67	79	78	72	58	55	62	39	52	71	73	69	75	69
600	41	73	74	66	55	48	43	22	39	67	64	61	57	52
700	17	57	73	60	48	46	30	13	26	62	52	45	45	35
800	13	33	66	55	40	43	14	7	22	49	38	15	28	16
900	6	4	53	43	37	36	2	0	16	13	12	5	10	5
1,000	1	1	23	25	34	33	0	0	3	6	2	3	2	1
1,100	1	0	2	6	31	26	0	0	1	1	1	1	0	0
1,200	0	0	0	1	0	2	0	0	0	1	1	1	0	0

μS/cm = microSiemens per centimeter

LSJR Alternative 3: 40% Unimpaired Flow (Less than significant)

The calculated monthly EC values for the SJR at Vernalis, SJR at Brandt Bridge, and Old River at Tracy Boulevard for LSJR Alternative 3 are given in Appendix F.1 (Tables F.1-16a–c). Table 5-27a shows the monthly Vernalis EC values for LSJR Alternative 3, with adjusted Stanislaus River flows to meet the Vernalis EC objectives. There were no months with EC violations at Vernalis. Table 5-27b shows that Brandt Bridge EC values for LSJR Alternative 3 were higher than the 1.000 dS/m (1,000 μS/cm) objective in the months of September–March in a total of 44 months (22 months more than baseline). The EC was sometimes higher because the estimated Vernalis monthly flows were sometimes lower, and the corresponding Vernalis EC values were higher (without violating the Vernalis EC objectives) in several months. The Brandt Bridge EC values were higher than the EC objective of 0.700 dS/m (700 μS/cm) in a total of 79 months during the April–August period (31 months less than baseline). In total, there were slightly fewer months with EC values greater than the objective under LSJR Alternative 3 (123 vs. 132 months for baseline).

Table 5-27a. Monthly Distribution of SJR at Vernalis EC Values (100 μS/cm increments) for LSJR Alternative 3 for 1922–2003

EC Value	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Average	April–Sep
400	67	80	78	73	62	58	27	8	28	77	77	72	77	67
500	41	75	77	69	53	46	8	2	11	69	61	60	55	21
600	15	53	71	61	45	42	3	1	7	62	41	21	30	3
700	6	9	66	57	40	34	0	0	0	0	1	4	4	0
800	0	0	50	36	37	21	0	0	0	0	0	1	0	0
900	0	0	0	7	28	12	0	0	0	0	0	1	0	0
1,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,200	0	0	0	0	0	0	0	0	0	0	0	0	0	0

μS/cm = microSiemens per centimeter

Table 5-27b. Monthly Distribution of SJR at Brandt Bridge EC Values (100 µS/cm increments) for LSJR Alternative 3 for 1922–2003

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Average	April–Sep
400	71	80	78	73	64	60	35	9	32	77	77	73	79	71
500	54	76	78	70	56	50	12	3	15	72	70	67	62	35
600	19	61	73	61	45	44	3	1	10	66	52	45	42	8
700	13	34	67	57	41	39	2	1	6	46	24	9	13	1
800	2	2	60	52	38	23	0	0	0	1	1	3	1	0
900	0	0	18	25	33	13	0	0	0	0	0	1	0	0
1,000	0	0	0	6	26	11	0	0	0	0	0	1	0	0
1,100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,200	0	0	0	0	0	0	0	0	0	0	0	0	0	0

µS/cm = microSiemens per centimeter

Table 5-27c shows that the Old River at Tracy Boulevard EC values for LSJR Alternative 3 were higher than the 1.000 dS/m (1,000 µS/cm) objective in the months of September–March in a total of 97 months. As described above, the calculated EC values in Old River at Tracy Boulevard are generally higher than the measured EC during the past 25 years. This was less than the violations for baseline (119 months). The Tracy Boulevard calculated EC values were higher than the EC objective of 0.700 dS/m (700 µS/cm) in a total of 128 months during the April–August period, which was less than baseline (183 months). The number of months with EC values above the EC objective (225 vs. 292 for baseline) would be reduced. Because LSJR Alternative 3 would likely reduce the number of months with EC above the existing EC objectives, impacts would be less than significant.

Table 5-27c. Monthly Distribution of Old River at Tracy Boulevard EC Values (100 µS/cm increments) for LSJR Alternative 3 for 1922–2003

EC Value	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Average	April–Sep
400	75	80	78	74	66	64	44	17	39	78	79	76	81	73
500	66	80	78	73	59	52	20	8	23	73	77	72	73	62
600	43	75	75	65	47	45	8	2	16	68	64	62	52	32
700	18	58	70	61	44	41	3	1	10	62	52	44	39	11
800	13	33	67	55	40	34	2	1	7	49	38	15	13	4
900	6	4	55	46	36	21	1	0	6	13	12	5	2	2
1,000	1	1	23	25	31	13	0	0	1	6	2	3	0	0
1,100	1	0	2	6	24	11	0	0	0	1	1	1	0	0
1,200	0	0	0	1	0	1	0	0	0	1	1	1	0	0

µS/cm = microSiemens per centimeter

LSJR Alternative 4: 60% Unimpaired Flow (Less than significant)

Table 5-28a shows the monthly Vernalis EC values for LSJR Alternative 4, with adjusted Stanislaus River flows to meet the Vernalis EC objectives. There were no months with EC violations at Vernalis. Table 5-28b shows that Brandt Bridge EC values for LSJR Alternative 4 were higher than the 1.000 dS/m (1,000 µS/cm) objective in the months of September–March in a total of 28 months. The EC was higher than the EC objective more often for LSJR Alternative 4 than for baseline (22 months under baseline) because the estimated Vernalis flows were lower, and the corresponding Vernalis EC values were higher (without violating the Vernalis EC objectives) in a few months. The Brandt Bridge EC values were higher than the EC objective of 0.700 dS/cm (700 µS/cm) in a total of 72 months during the April–August period, which was less than baseline. The overall reduced incidence of EC values that were higher than the EC objective is considered beneficial. In total, there were fewer months with Brandt Bridge EC values greater than the EC objective under LSJR Alternative 4 (100 vs. 132 months for baseline).

Table 5-28a. Monthly Distribution of SJR at Vernalis EC Values (100 µS/cm increments) for LSJR Alternative 4 for 1922–2003

EC Value	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Average	April–Sep
400	66	79	78	73	55	52	4	1	11	77	77	69	75	64
500	42	75	78	69	45	41	2	0	5	69	61	61	47	7
600	15	55	72	61	40	27	0	0	2	62	41	21	17	0
700	6	9	66	57	33	11	0	0	0	0	1	4	1	0
800	0	0	49	37	26	9	0	0	0	0	0	1	0	0
900	0	0	0	7	19	8	0	0	0	0	0	1	0	0
1,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,200	0	0	0	0	0	0	0	0	0	0	0	0	0	0

µS/cm = microSiemens per centimeter

Table 5-28b. Monthly Distribution of SJR at Brandt Bridge EC Values (100 µS/cm increments) for LSJR Alternative 4 for 1922–2003

EC Value	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Average	April–Sep
400	70	80	78	73	58	54	8	2	14	77	77	69	78	69
500	55	76	78	69	46	42	2	1	7	72	70	67	55	21
600	19	63	73	61	41	31	1	0	5	66	52	46	28	4
700	13	34	67	57	35	12	0	0	2	46	24	9	6	0
800	2	2	58	52	29	11	0	0	0	1	1	3	0	0
900	0	0	18	25	23	8	0	0	0	0	0	1	0	0
1,000	0	0	0	6	16	5	0	0	0	0	0	1	0	0
1,100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,200	0	0	0	0	0	0	0	0	0	0	0	0	0	0

µS/cm = microSiemens per centimeter

Table 5-28c shows that the Old River at Tracy Boulevard EC values for LSJR Alternative 4 were higher than the 1.000 dS/m (1,000 µS/cm) objective in the months of September–March in a total of 82 months. As described above, the calculated EC values in Old River at Tracy Boulevard are generally higher than the measured EC during the past 25 years. This was less than the violations for baseline (119 months). The Tracy Boulevard calculated EC values were higher than the EC objective of 0.700 dS/m (700 µS/cm) in a total of 121 months during the April–August period, which was less than baseline. The incidence of monthly EC values that were above the EC objective would be reduced. Because LSJR Alternative 4 would likely reduce the number of months with EC values above the EC objectives, impacts would be less than significant.

Table 5-28c. Monthly Distribution of Old River at Tracy Boulevard EC Values (100 µS/cm increments) for LSJR Alternative 4 for 1922–2003

EC Value	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Average	April–Sep
400	71	80	78	74	61	57	15	4	25	77	78	71	80	73
500	64	79	78	72	48	43	3	1	10	73	77	69	68	51
600	44	75	75	64	43	37	2	1	7	68	64	63	47	19
700	18	60	70	61	38	25	1	0	6	62	52	45	25	5
800	13	33	67	55	32	11	0	0	3	49	38	15	7	2
900	6	4	54	45	26	10	0	0	2	13	12	5	1	0
1,000	1	1	23	25	21	8	0	0	0	6	2	3	0	0
1,100	1	0	2	6	14	6	0	0	0	1	1	1	0	0
1,200	0	0	0	1	0	1	0	0	0	1	1	1	0	0

µS/cm = microSiemens per centimeter

SDWQ Alternative 1: No Project

The No Project Alternative would result in implementation of salinity objectives identified in the 2006 Bay–Delta Plan. See Chapter 15, *LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project impact discussion and Appendix D, *Evaluation of LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project technical analysis.

SDWQ Alternative 2: 1.0 dS/m Salinity (Less than significant)

Each of the LSJR alternatives were evaluated using the existing southern Delta EC objectives and the results for each LSJR alternative are described above. SDWQ Alternative 2 would not change the Vernalis flow or EC values. The number of months with calculated EC values above the SDWQ Alternative 2 EC objective (1.0 dS/m in all months) would be different for the same assumed EC increases from Vernalis to Brandt Bridge and to Tracy Boulevard. This is because most EC violations in the months of April–August at Brandt Bridge and Tracy Boulevard would be eliminated with the higher EC objective, but the calculated number of months with EC violations in the months of September–March would remain the same (because the EC objective would be the same). SDWQ Alternative 2 would generally reduce the number of months with EC values above the existing EC objectives (baseline) for the baseline flows and all LSJR alternatives (flows) in the following manner as shown in Table 5-25.

- If SDWQ Alternative 2 is adopted, the number of calculated EC violations at Brandt Bridge would decrease from 132 months (out of 984) to 23 months if the flow and EC at Vernalis remained at baseline levels. The number of calculated EC violations at Tracy Boulevard would decrease from 292 months to 119 months. This reduces the incidence of EC values that were above the EC objective when compared to baseline.
- If LSJR Alternative 2 is implemented and SDWQ Alternative 2 is adopted, the number of EC violations at Brandt Bridge would decrease from 132 months at existing EC objectives and existing flow to 66 months. The Tracy Boulevard EC exceedance would decrease from 292 at existing EC objectives and existing flow to 120.
- If LSJR Alternative 3 is implemented and SDWQ Alternative 2 is adopted, the number of EC violations at Brandt Bridge would decrease from 132 months at existing EC objectives and existing flow to 44 months. The number of EC violations at Tracy Boulevard would decrease from 292 months for existing EC objectives to 97 months with SDWQ Alternative 2.
- If LSJR Alternative 4 is implemented and SDWQ Alternative 2 is adopted, the number of EC violations at Brandt Bridge would decrease from 132 months at existing EC objectives and existing flow to 28 months. The number of EC violations at Tracy Boulevard would decrease from 292 months to 82 months.

Because SDWQ Alternative 2 would allow more months to meet the water quality objectives, the impacts of this alternative would be less than significant.

SDWQ Alternative 3: 1.4 dS/m Salinity (Less than significant)

Each of the LSJR alternatives were evaluated using the existing southern Delta EC objectives and the results for each LSJR alternative are described above. SDWQ Alternative 3 would not change the Vernalis flow or EC values, regardless of whether the baseline flows or one of the LSJR alternatives were selected and implemented. The number of months with calculated EC values above the SDWQ Alternative 3 EC objectives (1.4 dS/m in all months) would be reduced to 0 months, because there are no calculated EC values of greater than 1.4 dS/m for baseline or for any of the LSJR alternatives. The reduced incidence of EC values that were above the EC objective is considered beneficial, and because there has never been a calculated EC value greater than 1.4 dS/m for the southern Delta, impacts would be less than significant.

WQ-2: Substantially degrade water quality by increasing Vernalis and/or southern Delta salinity (EC) such that agricultural beneficial uses are impaired

The EC objectives are established to protect beneficial use for agricultural water supply. The calculated monthly EC values were used to evaluate possible degradation of water quality through an increase in salinity for agricultural beneficial uses at Vernalis or in the southern Delta channels. The baseline monthly cumulative distributions of EC values at SJR at Vernalis, SJR at Brandt Bridge, and Old River at Tracy Boulevard are given in Appendix F.1 (Tables F.1-14b,e, and g). The monthly cumulative distributions of EC values at SJR at Vernalis, SJR at Brandt Bridge, and Old River at Tracy Boulevard for the LSJR alternatives are also given in Appendix F.1 (Tables F.1-15a–c) for LSJR Alternative 2, Tables F.1-16a–c for LSJR Alternative 3, and Tables F.1-17a–c for LSJR Alternative 4). The approach for determining the overall impacts of increased salinity from the LSJR alternatives considers the long term average of cumulative distribution for EC during the irrigation season. An overall increase of more than 5 percent of the salinity objective (0.035 dS/m [35 µS/cm]) during the

6-month irrigation season of April–September (the 0.700 dS/m [700 µS/cm] EC objective is April–August) would be significant.

The average April–September EC values for baseline at Vernalis ranged from 0.206 dS/m (206 µS/cm) to 0.768 dS/m (768 µS/cm), with an average of 0.505 dS/m (505 µS/cm). The calculated April–September average EC values for baseline at Brandt Bridge ranged from 0.213 dS/m (213 µS/cm) to 0.920 dS/m (920 µS/cm), with an average of 0.550 dS/m (550 µS/cm) (0.045 dS/m [45 µS/cm] higher Vernalis EC). The calculated April–September average EC values for baseline at Tracy Boulevard ranged from 0.226 dS/m (226 µS/cm) to 1.223 dS/m (1,223 µS/cm), with an average of 0.640 dS/m (640 µS/cm) (0.135 dS/m [135 µS/cm] higher than Vernalis EC).

Table 29a, b, and c show the average April-September EC values expected under LSJR Alternatives 2, 3, and 4.

Table 5-29a, b, and c. Cumulative Distributions of April–September Average EC values at Vernalis, Brandt Bridge, and Old River at Tracy Boulevard for Baseline and LSJR Alternatives for 1922–2003

		LSJR Alternative 2		LSJR Alternative 3		LSJR Alternative 4	
	Baseline	Results	Change	Results	Change	Results	Change
A. April–September Average EC (µS/cm) at Vernalis for Baseline and LSJR Alternatives							
Minimum	206	210	4	205	-1	199	-7
10%	367	333	-34	351	-16	332	-35
20%	443	458	16	415	-27	391	-51
30%	469	482	13	426	-43	406	-64
40%	490	513	22	440	-50	414	-76
50%	516	540	24	452	-64	423	-93
60%	538	558	20	467	-72	429	-109
70%	561	577	16	494	-67	450	-111
80%	578	611	33	509	-69	464	-115
90%	634	644	10	540	-94	484	-149
Maximum	768	678	-90	629	-139	574	-194
Average	505	518	14	452	-53	419	-86
B. April–September Average EC (µS/cm) at Brandt Bridge for Baseline and LSJR Alternatives							
Minimum	213	217	4	212	-1	205	-8
10%	385	348	-37	368	-17	347	-37
20%	468	488	20	441	-28	416	-52
30%	503	515	11	457	-46	435	-68
40%	526	549	23	470	-55	448	-78
50%	554	585	31	491	-63	459	-95
60%	585	604	19	511	-74	468	-117
70%	615	638	23	541	-74	494	-121
80%	635	673	38	565	-70	510	-125
90%	720	721	1	593	-127	546	-174
Maximum	920	802	-118	726	-193	656	-263
Average	550	564	14	492	-58	456	-94

		LSJR Alternative 2		LSJR Alternative 3		LSJR Alternative 4	
	Baseline	Results	Change	Results	Change	Results	Change
C. April–September Average EC (µS/cm) at Tracy Boulevard for Baseline and LSJR Alternatives							
Minimum	226	230	4	225	-1	218	-8
10%	420	378	-42	402	-18	378	-42
20%	519	547	28	488	-31	462	-57
30%	568	584	16	513	-55	488	-80
40%	599	621	22	536	-63	513	-87
50%	635	673	37	565	-71	529	-107
60%	685	712	26	602	-83	554	-131
70%	724	749	25	636	-88	583	-141
80%	746	787	41	670	-76	604	-142
90%	877	881	4	732	-145	668	-208
Maximum	1,223	1,065	-158	933	-290	851	-372
Average	640	654	15	572	-68	530	-110

µS/cm = microSiemens per centimeter

LSJR Alternative 1: No Project

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project impact discussion and Appendix D, *Evaluation of LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project Alternative technical analysis.

LSJR Alternative 2: 20% Unimpaired Flow (Less than significant)

Table 5-29a indicates that the average April–September EC values at Vernalis ranged from 0.210 dS/m (210 µS/cm) to 0.678 dS/m (678 µS/cm), with an average of 0.518 dS/m (518 µS/cm) under LSJR Alternative 2. The change in the distribution of EC at Vernalis was fairly uniform, with an average increase of 0.014 dS/m (14 µS/cm). This slight increase in Vernalis EC was caused by the general reduction in the monthly flows compared to the baseline flows at Vernalis. Because the existing EC objectives at Vernalis were maintained for each of the LSJR alternatives, the maximum EC values at Vernalis did not increase above the objectives. Table 5-29b indicates that the average April–September EC values at Brandt Bridge ranged from 0.217 dS/m (217 µS/cm) to 0.802 dS/m (802 µS/cm), with an average EC of 0.564 dS/m (564 µS/cm) under LSJR Alternative 2. The change in the distribution of EC at Brandt Bridge was fairly uniform, with an average increase of 0.014 dS/m (14 µS/cm). Table 5-29c indicates that the average April–September EC values at Tracy Boulevard ranged from 0.230 dS/m (230 µS/cm) to 1.065 dS/m (1,065 µS/cm), with an average of 0.654 dS/m (654 µS/cm). The change in the distribution of EC at Tracy Boulevard for LSJR Alternative 2 was fairly uniform, with an average increase of 0.015 dS/m (15 µS/cm).

Although the monthly EC values might increase or decrease slightly, depending on the changes in the monthly flows, the range of salinity during the irrigation season of April–September in the SJR at Vernalis and in the southern Delta channels under LSJR Alternative 2 would remain very similar to baseline. It is anticipated that agricultural beneficial uses would not be impaired; therefore, impacts would be less than significant.

LSJR Alternative 3: 40% Unimpaired Flow (Less than significant)

Table 5-29a indicates that the average April–September EC values at Vernalis ranged from 0.205 dS/m (205 µS/cm) to 0.629 dS/m (629 µS/cm), with an average of 0.452 dS/m (452 µS/cm) under LSJR Alternative 3. The change in the distribution of EC at Vernalis for LSJR Alternative 3 was fairly uniform, with an average reduction of -0.053 dS/m (-53 µS/cm). This reduction in Vernalis EC was caused by the general increase in the monthly flows compared to the baseline flows at Vernalis. Table 5-29b indicates the average April–September EC values at Brandt Bridge ranged from 0.212 dS/m (212 µS/cm) to 0.726 dS/m (726 µS/cm), with an average EC of 0.492 dS/m (492 µS/cm) under LSJR Alternative 3. The change in the distribution of EC at Brandt Bridge was fairly uniform, with an average reduction of -0.058 dS/m (-58 µS/cm). Table 5-29c indicates that the average April–September EC values at Tracy Boulevard ranged from 0.225 dS/m (225 µS/cm) to 0.933 dS/m (933 µS/cm), with an average of 0.572 dS/m (572 µS/cm). The change in the distribution of EC at Tracy Boulevard for LSJR Alternative 3 was greatest for the higher EC values, with an average reduction of -0.068 dS/m (-68 µS/cm).

Because the range of salinity during the irrigation season of April–September in the SJR at Vernalis and in the southern Delta channels under LSJR Alternative 3 would be reduced by about 0.050 dS/m (50 µS/cm) compared to baseline, agricultural beneficial uses would not be impaired. Impacts would be less than significant.

LSJR Alternative 4: 60% Unimpaired Flow (Less than significant)

Table 5-29a indicates that the average April–September EC values at Vernalis ranged from 0.199 dS/m (199 µS/cm) to 0.574 dS/m (574 µS/cm), with an average of 0.419 dS/m (419 µS/cm) under LSJR Alternative 4. The reductions in EC at Vernalis for LSJR Alternative 4 was greatest for the higher EC values, with an average reduction of -0.086 dS/m (-86 µS/cm). This reduction in Vernalis EC was caused by the general increase in the monthly flows compared to the baseline flows at Vernalis. Table 5-29b indicates that the average April–September EC values at Brandt Bridge ranged from 0.205 dS/m (205 µS/cm) to 0.656 dS/m (656 µS/cm), with an average EC of 0.456 dS/m (456 µS/cm) under LSJR Alternative 4. The change in the EC at Brandt Bridge was greatest for the higher EC values, with an average reduction of -0.094 dS/m (-94 µS/cm). Table 5-29c indicates that the average April–September EC values at Tracy Boulevard ranged from 0.218 dS/m (218 µS/cm) to 0.851 dS/m (851 µS/cm), with an average of 0.530 dS/m (530 µS/cm). The change in the distribution of EC at Tracy Boulevard for LSJR 4 was greatest for the higher EC values, with an average reduction of – 0.110 dS/m (-110 µS/cm).

Because the range of salinity during the irrigation season of April–September in the SJR at Vernalis and in the southern Delta channels under LSJR Alternative 4 would be reduced by about 0.100 dS/m (100 µS/cm) compared to baseline, agricultural beneficial uses would not be impaired. Impacts would be less than significant.

SDWQ Alternative 1: No Project

The No Project Alternative would result in full implementation of salinity objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project impact discussion and Appendix D, *Evaluation of LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for a No Project Alternative technical analysis.

SDWQ Alternatives 2 and 3: 1.0 and 1.4 dS/m Salinity (Less than significant)

If necessary, reservoir releases are currently increased in order to meet the objective of maintaining EC below 1.000 dS/m (1,000 µS/cm) for September–March and below 0.700 dS/m (700 µS/cm) for April–August in the SJR at Vernalis. The Vernalis EC objective would not change from the existing EC objective and is the same for all SDWQ alternatives. Changes in EC that may occur downstream of Vernalis are dependent on conditions at Vernalis and within the Delta. As modeled for baseline and the LSJR alternatives, additional water is not released from upstream reservoirs to meet EC objectives farther downstream in the Delta for the SJR at Brandt Bridge and Old River at Tracy Boulevard.

Under SDWQ Alternatives 2 and 3, there would be no change in operations affecting Delta salinity relative to baseline, and merely changing the water quality objectives at these two locations is not expected to affect water quality in the Delta relative to baseline. Therefore, the historical range of salinity (between 0.2 and 1.2 dS/m [200 and 1,200 µS/cm]) is expected to remain unchanged under SDWQ Alternatives 2 and 3. Because the historical range of salinity would remain similar to baseline, it is not anticipated that agricultural beneficial uses would be impaired with SDWQ Alternatives 2 or 3. Impacts would be less than significant.

WQ-3: Substantially degrade water quality by increasing water temperature caused by reduced river flows

The simulated river temperatures as a function of river flow in each month provide the basis for the temperature impact assessment. These temperature results are fully described in Appendix F.1. Modeled water temperature results for baseline are presented below for each tributary. The simulated temperatures for each month would generally increase if river flow is reduced and would decrease if river flow is increased. A general shift in monthly flows is expected to cause a corresponding change in the water temperatures. However, if the existing flows are relatively high, a general shift in monthly flows would likely cause a smaller change in temperatures than would the same flow shift if the existing flows were lower.

Only changes in relatively low flows are likely to have a substantial effect on water temperatures. Flow changes that would affect water temperatures are expected in the months of February–June; other months may have changes in flood-control releases, but these would have relatively high flows and would not greatly affect temperatures. Although the flow objectives are changed only in the months of February–June, some changes to flood-control releases were simulated with the WSE model, and release temperatures from July–January could be changed by reduced carryover storage. But since the WSE carryover storage did not change appreciably from the baseline, temperatures were not affected during these months. Chapter 7, *Aquatic Resources*, includes an evaluation of these months with respect to USEPA temperature criteria.

The average monthly temperatures were compared between baseline and the LSJR alternatives for determining water temperature impacts. In this chapter, an increase in the overall average temperature for a month of more than 2°F (1.1°C) was used as the threshold for determining a significant water quality impact on temperature. This temperature evaluation was performed at a single location for each tributary: at the Highway 59 Bridge on the Merced River, at Waterford on the Tuolumne River, and at Riverbank on the Stanislaus River (Appendix F.1, *Hydrologic and Water Quality Modeling*). The temperature changes relative to established water temperature criteria will be more fully evaluated in Chapter 7, *Aquatic Resources*.

Table 5-30 gives the monthly cumulative distribution of average simulated water temperatures in the Merced River at Highway 59 Bridge for baseline 1980–2003 and for the LSJR alternatives. The baseline average water temperatures at Highway 59 Bridge indicate the normal seasonal warming January–July is about 20 F. The monthly increase in the average temperatures February–July was 3–5°F.

Table 5-30. Monthly Cumulative Distributions of Simulated Merced River Water Temperatures (Fahrenheit) at Highway 59 Bridge for Baseline and LSJR Alternatives for 1980–2003

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Merced River at Highway 59 Bridge (RM 42) Temperatures for Baseline												
Minimum	42.1	45.1	45.9	45.8	52.6	54.5	58.6	61.6	60.4	49.3	50.7	46.5
10%	44.9	48.5	49.6	53.7	53.9	55.2	58.8	62.0	62.4	56.7	53.0	48.8
20%	46.6	49.1	50.8	55.2	57.0	56.3	59.8	63.1	64.3	59.8	54.3	49.1
30%	47.8	49.6	51.8	56.0	58.9	63.1	66.0	64.3	66.3	61.5	55.4	49.8
40%	48.2	50.1	53.2	57.9	59.7	66.0	68.7	68.2	69.1	62.0	56.3	50.5
50%	48.7	50.6	55.0	58.8	61.1	66.7	70.1	71.1	71.4	62.6	56.5	50.9
60%	48.9	51.3	56.3	59.4	63.9	68.2	71.4	71.8	72.4	63.9	56.9	51.3
70%	50.0	52.0	56.7	59.9	64.5	68.9	74.1	75.5	76.8	65.6	58.3	52.0
80%	52.0	52.6	58.0	60.8	65.3	69.3	75.5	75.8	80.4	67.2	60.6	53.0
90%	52.6	54.4	58.7	62.6	67.8	70.2	76.7	76.8	81.6	69.6	61.5	53.9
Maximum	52.8	55.8	59.7	69.0	71.9	71.9	82.0	78.7	83.6	70.1	63.8	55.6
Average	48.7	50.9	54.2	58.1	61.4	64.5	69.0	70.0	71.6	62.7	57.1	51.0
Merced River at Highway 59 Bridge (RM 42) Temperatures for LSJR Alternative 2												
Minimum	42.9	44.9	46.4	50.6	53.3	54.5	58.5	61.6	60.3	50.8	50.6	46.5
10%	45.0	47.8	49.9	53.6	53.9	55.3	58.9	62.1	62.4	57.7	53.2	48.7
20%	46.5	48.7	51.5	55.5	56.0	56.4	60.1	63.1	64.3	60.1	54.0	49.0
30%	47.8	49.0	53.7	56.4	57.3	61.2	65.6	64.3	66.1	60.6	55.4	49.8
40%	48.2	50.1	55.2	58.5	59.3	63.2	68.3	67.7	68.6	61.4	56.4	50.2
50%	48.6	50.2	56.1	59.4	59.7	64.5	69.7	70.5	70.8	62.2	56.4	50.8
60%	49.7	51.7	57.2	59.6	60.8	66.3	71.1	71.8	72.2	63.9	56.6	51.1
70%	50.4	52.2	58.4	59.8	61.6	67.8	74.3	75.0	75.6	64.3	57.8	51.6
80%	52.2	53.2	59.0	60.6	62.2	68.3	75.1	75.7	79.2	65.8	59.0	52.7
90%	52.6	54.9	59.7	61.0	62.7	69.0	76.4	76.4	81.4	67.3	59.4	53.9
Maximum	53.5	56.7	62.4	62.5	64.4	70.0	81.7	78.4	84.1	68.2	62.3	55.5
Average	48.9	50.9	55.5	58.0	59.2	63.3	68.8	69.7	71.3	62.1	56.5	50.9
Merced River at Highway 59 Bridge (RM 42) Temperatures for LSJR Alternative 3												
Minimum	42.7	45.1	46.4	49.7	53.2	54.4	58.8	61.6	60.3	48.6	50.6	46.4
10%	44.9	48.1	49.6	52.4	54.1	56.0	59.0	62.3	62.4	57.2	53.3	48.6
20%	46.5	48.4	51.3	54.2	54.6	56.8	60.2	63.3	64.4	59.5	54.0	49.0
30%	47.8	48.7	53.3	54.8	55.9	59.1	66.4	64.2	65.9	60.6	55.3	49.7
40%	48.2	49.7	53.8	57.3	58.0	61.5	69.1	68.8	69.5	61.1	56.0	50.1
50%	48.5	50.4	55.4	57.6	58.3	62.9	70.8	71.1	71.3	62.5	56.7	50.7
60%	49.6	51.2	56.1	58.0	59.3	64.0	71.5	73.3	73.4	63.9	56.9	51.0
70%	50.4	51.7	56.9	58.2	59.8	65.6	75.4	76.2	76.4	64.8	57.7	51.6

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80%	52.0	53.2	57.7	58.7	60.5	65.8	77.0	77.0	80.1	66.2	59.1	52.6
90%	52.7	54.4	58.5	59.2	61.2	67.5	77.8	78.0	81.9	68.0	59.7	54.4
Maximum	53.4	56.6	60.3	60.5	62.6	70.2	81.7	79.8	84.5	68.7	62.4	55.5
Average	48.8	50.7	54.6	56.5	57.9	62.1	69.6	70.5	71.8	62.1	56.6	50.9
Merced River at Highway 59 Bridge (RM 42) Temperatures for LSJR Alternative 4												
Minimum	42.6	45.1	46.3	49.3	53.1	54.4	58.8	61.6	60.2	48.2	50.6	46.4
10%	44.9	48.5	49.5	51.5	54.4	56.1	59.0	62.5	62.5	56.9	53.2	48.4
20%	46.4	48.8	51.1	53.3	54.6	56.5	60.6	63.3	64.4	59.1	53.9	49.0
30%	47.7	49.3	52.3	53.8	55.4	58.8	67.3	64.1	65.8	60.5	55.2	49.6
40%	48.0	49.6	53.6	56.5	57.5	60.7	70.1	69.9	70.4	61.5	55.9	49.9
50%	48.4	50.3	54.8	56.8	58.2	62.4	72.0	71.8	71.9	62.4	56.9	50.7
60%	49.5	51.5	55.2	57.2	58.7	63.7	72.3	74.6	74.6	63.9	57.0	50.9
70%	50.4	51.8	55.9	57.3	59.3	64.5	76.9	77.7	76.2	65.2	57.7	51.6
80%	51.9	53.0	56.4	57.8	59.8	65.0	79.1	78.6	81.1	66.7	59.3	52.6
90%	52.7	53.8	57.4	58.2	60.7	66.8	79.4	79.7	82.8	68.8	60.2	54.4
Maximum	53.2	56.5	59.0	59.4	62.8	70.2	82.0	81.1	84.8	69.8	62.6	55.5
Average	48.7	50.8	53.9	55.6	57.6	61.6	70.5	71.5	72.3	62.3	56.6	50.8
Effects on Average Merced River Temperatures at Highway 59 Bridge												
Baseline	48.7	50.9	54.2	58.1	61.4	64.5	69.0	70.0	71.6	62.7	57.1	51.0
LSJR Alternative 2	0.2	0.0	1.2	-0.2	-2.2	-1.3	-0.2	-0.3	-0.3	-0.6	-0.5	-0.1
LSJR Alternative 3	0.1	-0.1	0.4	-1.7	-3.4	-2.5	0.6	0.5	0.2	-0.6	-0.5	-0.2
LSJR Alternative 4	0.0	-0.1	-0.3	-2.5	-3.7	-2.9	1.5	1.5	0.7	-0.4	-0.4	-0.2
RM = river mile												

Table 5-31 gives the monthly cumulative distribution of average simulated water temperatures in the Tuolumne River at Waterford for baseline 1980–2003 and for the LSJR alternatives. The baseline average water temperatures at Waterford indicate the normal seasonal warming January–July is about 25°F. This maximum seasonal warming was about 5°F greater than for the Merced River and may reflect the lower Tuolumne River flows. The monthly increase in the average temperatures February–May was about 3°F per month, the monthly increase from May–June was almost 10°F, and the increase from June–July was about 5°F.

Table 5-31. Monthly Cumulative Distributions of Simulated Tuolumne River Water Temperatures (Fahrenheit) at Waterford for Baseline and LSJR Alternatives for 1980–2003

	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Tuolumne River at Waterford (RM 32) Temperatures for Baseline												
Minimum	47.6	49.5	50.5	51.2	53.2	55.8	57.3	60.8	58.1	56.0	53.2	47.1
10%	48.4	50.0	50.7	52.6	54.1	56.0	58.1	70.0	65.6	59.4	53.4	47.8
20%	48.9	50.5	51.7	53.3	55.2	56.3	59.0	71.3	67.0	60.1	53.9	48.8
30%	49.1	51.6	52.2	54.6	57.6	58.3	68.6	72.1	68.3	60.4	54.7	49.1
40%	49.5	52.6	53.2	55.1	58.3	70.0	73.6	72.3	68.9	60.5	55.2	49.4
50%	49.7	52.9	56.4	56.7	59.5	73.6	77.3	75.7	71.2	62.3	55.4	49.7
60%	50.0	53.3	57.3	59.1	61.5	77.4	81.7	79.6	75.9	63.7	55.5	50.0
70%	50.6	54.1	59.3	60.8	64.3	77.6	82.9	80.5	76.3	65.2	55.6	50.8
80%	50.8	54.6	60.0	61.3	64.6	77.9	83.2	80.9	77.0	66.3	56.7	51.0
90%	51.6	55.3	60.6	62.6	66.1	78.9	84.0	81.8	77.5	67.4	57.0	52.1
Maximum	52.2	56.4	62.6	64.5	69.4	79.8	84.8	83.5	79.2	69.7	58.0	52.5
Average	49.9	52.8	55.8	57.4	60.2	69.2	74.0	75.4	71.5	62.8	55.3	49.9
Tuolumne River at Waterford (RM 32) Temperatures for LSJR Alternative 2												
Minimum	47.7	49.6	50.0	51.5	53.9	54.5	57.2	60.2	58.2	56.3	53.3	47.0
10%	48.4	50.1	50.8	52.7	54.8	55.5	57.6	69.9	60.4	57.0	53.5	48.0
20%	48.8	50.5	51.8	53.9	56.5	56.6	58.8	71.5	65.1	59.4	53.8	48.8
30%	49.1	51.6	52.3	55.0	56.8	58.5	68.5	72.1	68.1	60.0	54.5	49.2
40%	49.4	52.6	53.3	57.2	58.0	61.2	72.7	72.2	68.8	60.2	55.1	49.6
50%	49.7	52.8	54.4	58.1	58.6	63.0	76.9	75.8	71.2	61.1	55.4	49.6
60%	50.0	53.1	56.6	59.1	60.2	65.3	81.3	79.5	75.9	63.6	55.6	50.0
70%	50.7	54.2	58.2	59.5	60.5	70.9	81.5	80.6	76.3	65.1	56.1	50.9
80%	50.9	55.2	60.3	60.0	61.2	73.0	81.8	81.0	76.8	66.9	57.0	51.0
90%	51.6	56.2	61.6	60.6	63.8	77.2	82.5	81.6	77.5	67.5	57.5	52.2
Maximum	53.1	56.7	62.3	63.3	66.1	78.5	83.6	83.5	79.3	69.6	58.0	52.8
Average	49.9	52.9	55.6	57.3	59.1	64.8	73.2	75.3	70.8	62.4	55.4	49.9
Tuolumne River at Waterford (RM 32) Temperatures for LSJR Alternative 3												
Minimum	47.7	49.5	50.0	51.4	53.8	54.3	57.1	60.1	57.5	55.7	53.3	47.0
10%	48.4	50.0	50.7	52.7	54.2	55.6	57.5	70.0	59.3	57.7	53.6	48.0
20%	48.8	50.5	51.8	53.0	54.5	56.3	59.1	71.8	62.5	58.9	53.8	49.0
30%	49.1	50.9	52.1	54.2	54.9	57.4	68.8	72.2	68.1	59.8	54.6	49.3
40%	49.4	51.8	52.7	55.2	55.4	58.1	72.4	72.6	69.1	60.1	55.1	49.7

	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
50%	49.6	52.7	53.6	55.6	56.6	59.9	76.2	75.9	71.4	61.3	55.4	49.8
60%	50.0	53.0	54.8	56.0	57.4	61.1	80.4	79.6	76.1	63.8	55.7	50.0
70%	50.7	53.4	55.4	56.4	57.8	64.5	80.7	80.8	76.5	65.4	56.3	50.9
80%	50.9	53.8	56.5	57.0	58.2	65.6	81.2	81.2	77.0	66.9	57.2	51.1
90%	51.6	54.5	57.0	57.1	59.5	70.3	82.1	81.9	77.8	68.0	57.7	52.1
Maximum	53.1	56.7	58.3	58.4	61.3	74.9	82.6	83.7	79.5	70.1	58.1	52.9
Average	49.9	52.4	53.9	55.2	56.6	61.4	72.8	75.5	70.6	62.4	55.5	50.0
Tuolumne River at Waterford (RM 32) Temperatures for LSJR Alternative 4												
Minimum	47.7	49.5	50.0	51.4	53.5	54.2	57.0	60.1	56.3	55.4	53.4	47.0
10%	48.3	50.0	50.7	52.4	54.3	55.6	57.4	70.1	58.5	57.3	53.5	48.0
20%	48.8	50.2	51.6	52.7	54.4	56.2	59.2	71.9	59.6	58.7	53.8	48.9
30%	49.1	50.8	51.8	53.2	54.8	56.6	68.8	72.3	68.2	59.8	54.3	49.3
40%	49.3	51.8	52.6	54.0	55.3	57.2	72.4	72.8	69.2	60.1	55.0	49.6
50%	49.6	52.4	53.3	54.8	56.3	58.9	76.0	76.1	71.5	61.1	55.4	49.8
60%	50.0	52.7	54.0	55.2	56.8	60.1	80.1	79.7	76.2	63.9	55.7	49.9
70%	50.7	52.8	54.3	55.5	56.9	61.8	80.5	81.0	76.7	65.5	56.0	50.9
80%	50.9	53.3	55.2	55.9	57.4	62.6	80.9	81.4	77.1	66.8	57.2	51.1
90%	51.6	53.6	55.6	56.1	58.1	66.3	81.8	82.0	77.9	68.1	57.8	52.1
Maximum	53.1	56.7	55.9	56.9	59.9	71.0	82.3	83.9	79.7	70.4	58.1	53.0
Average	49.9	52.1	53.2	54.4	56.1	59.9	72.7	75.6	70.3	62.4	55.5	50.0
Effects on Average Tuolumne River Temperatures at Waterford (RM 32)												
Baseline	49.9	52.8	55.8	57.4	60.2	69.2	74.0	75.4	71.5	62.8	55.3	49.9
LSJR Alternative 2	0.0	0.2	-0.2	-0.1	-1.1	-4.4	-0.8	-0.1	-0.7	-0.4	0.1	0.1
LSJR Alternative 3	0.0	-0.4	-1.9	-2.2	-3.6	-7.8	-1.2	0.1	-0.9	-0.4	0.2	0.2
LSJR Alternative 4	0.0	-0.7	-2.5	-3.0	-4.1	-9.3	-1.3	0.3	-1.2	-0.4	0.1	0.1
RM = river mile												

Table 5-32 gives the monthly cumulative distribution of average simulated water temperatures in the Stanislaus River at Riverbank for baseline 1980–2003 and for the LSJR alternatives. The baseline average water temperatures at Riverbank indicate the normal seasonal warming January–July is about 22°F. The monthly increase in the average temperatures February–May was about 2°F per month, and the monthly increase May–July was about 5°F per month.

Table 5-32. Monthly Cumulative Distributions of Simulated Stanislaus River Water Temperatures (Fahrenheit) at Riverbank for Baseline and LSJR Alternatives for 1980-2003

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Stanislaus River at Riverbank (RM 33) Temperatures for Baseline												
Minimum	45.2	48.4	49.5	52.1	55.1	55.0	55.6	57.2	54.4	52.7	49.7	46.7
10%	46.7	50.0	51.3	53.6	56.0	59.1	64.5	61.5	59.3	55.4	52.2	48.1
20%	48.0	50.3	52.8	54.2	56.4	60.7	68.2	66.1	63.7	56.0	52.4	48.8
30%	48.4	50.7	53.3	55.1	56.8	61.3	69.7	68.5	66.4	57.0	53.9	49.7
40%	48.5	50.9	54.0	55.6	57.4	62.5	70.4	69.4	67.4	57.3	54.5	49.9
50%	48.9	51.5	55.0	56.0	57.9	65.9	71.8	69.6	68.3	58.7	55.0	50.0
60%	49.4	51.9	55.2	56.5	58.4	68.4	72.0	70.3	68.9	58.8	55.4	50.4
70%	49.8	52.3	55.4	56.9	59.4	69.7	73.3	71.2	69.6	60.1	56.3	50.7
80%	50.4	53.3	56.5	59.0	62.1	70.7	74.1	71.4	70.6	64.2	57.0	51.2
90%	51.2	54.8	57.1	60.4	63.1	71.3	76.2	72.1	73.4	65.7	57.7	51.4
Maximum	52.1	55.8	58.3	63.7	67.9	74.3	78.0	82.7	76.4	72.0	58.9	52.7
Average	49.0	51.8	54.5	56.5	58.9	65.5	70.6	68.9	67.2	59.6	54.9	50.0
Stanislaus River at Riverbank Temperatures for LSJR Alternative 2												
Minimum	45.2	48.2	49.6	53.0	56.1	54.7	55.6	57.5	55.0	53.2	49.8	46.4
10%	46.8	48.8	51.3	55.2	57.2	59.5	62.7	61.6	59.6	55.1	51.8	48.0
20%	47.9	49.9	53.9	57.1	58.4	63.8	68.1	66.2	63.6	55.7	52.4	48.5
30%	48.3	50.4	54.6	58.3	59.5	64.2	69.1	68.0	65.9	56.5	53.5	49.4
40%	48.5	50.7	54.9	58.5	59.9	66.6	69.9	68.6	67.6	56.9	54.2	49.8
50%	48.8	51.0	55.4	59.1	61.2	68.1	70.4	69.3	68.0	58.0	54.7	50.0
60%	49.3	51.6	55.7	59.5	61.8	70.9	70.9	70.2	68.6	58.2	55.5	50.2
70%	49.8	52.2	56.5	59.9	62.9	71.4	72.1	70.4	69.3	60.0	56.1	50.8
80%	50.4	52.5	57.2	60.5	63.1	72.0	73.2	71.0	70.4	63.9	56.7	51.1
90%	51.1	52.7	57.4	61.4	64.7	74.2	74.0	72.3	72.9	65.6	57.4	51.4
Maximum	52.0	53.6	58.7	63.4	68.7	78.0	77.3	74.3	75.4	72.0	58.8	52.4
Average	48.9	51.1	55.1	58.7	61.1	67.6	69.6	68.2	67.0	59.4	54.7	49.8
Stanislaus River at Riverbank Temperatures for LSJR Alternative 3												
Minimum	45.2	47.9	49.5	52.6	54.7	55.6	55.5	57.3	55.0	53.2	49.9	46.5
10%	46.2	48.5	51.5	53.3	55.0	57.4	63.9	61.9	59.7	55.4	52.0	48.0
20%	48.0	49.6	52.5	54.8	56.0	58.8	67.6	66.3	64.2	55.9	52.5	48.8
30%	48.4	50.1	54.0	55.9	57.6	61.4	69.1	68.2	66.1	56.5	53.6	49.5
40%	48.5	50.3	54.6	56.7	57.9	62.3	69.7	68.7	67.7	57.6	54.7	49.6
50%	48.9	50.8	54.8	56.8	58.6	64.6	70.4	69.8	68.4	58.4	54.8	49.9
60%	49.3	51.2	55.2	56.9	59.1	65.7	71.0	70.5	69.0	58.6	55.8	50.4
70%	49.9	52.2	55.4	57.4	59.8	69.8	71.7	71.1	69.4	60.1	56.2	50.6
80%	50.4	52.6	56.3	58.4	60.0	70.2	73.5	71.3	71.2	64.4	57.2	51.2
90%	51.1	53.0	57.2	59.3	62.5	71.9	74.3	72.8	73.5	66.7	57.6	51.4
Maximum	52.1	53.5	58.6	61.7	64.9	76.7	77.8	77.3	75.8	72.0	58.9	53.3
Average	48.9	50.9	54.5	56.7	58.6	64.8	69.6	68.7	67.3	59.7	54.9	49.9

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Stanislaus River at Riverbank Temperatures for LSJR Alternative 4												
Minimum	45.2	47.9	49.5	52.1	54.6	55.6	55.4	57.1	55.0	53.1	49.8	46.5
10%	46.2	48.5	51.2	52.9	54.9	56.7	64.0	62.1	59.8	55.4	52.0	48.1
20%	48.0	49.3	51.8	54.2	55.6	58.0	67.6	66.6	64.5	56.0	52.6	48.9
30%	48.4	50.3	53.6	55.2	57.4	60.3	69.0	68.7	66.4	56.6	53.7	49.4
40%	48.6	50.5	53.8	55.8	57.4	60.9	69.8	69.3	68.1	57.7	54.4	49.7
50%	48.8	50.6	54.0	56.0	57.6	62.0	70.7	70.3	68.5	58.4	54.8	50.1
60%	49.3	51.8	54.1	56.1	58.0	62.8	71.3	71.0	69.3	58.7	55.9	50.3
70%	49.8	52.1	54.3	56.8	58.5	67.1	71.9	71.5	69.6	60.1	56.2	50.6
80%	50.4	52.4	55.2	57.0	59.0	67.7	73.5	71.9	71.5	63.8	56.7	51.3
90%	51.1	52.6	55.7	58.0	60.5	70.0	74.3	73.8	73.5	66.7	57.7	51.6
Maximum	52.1	53.5	57.4	59.2	64.4	75.5	76.4	77.1	77.9	72.0	60.6	53.2
Average	48.9	50.8	53.7	55.7	57.8	63.1	69.6	69.1	67.6	59.8	54.9	50.0
Effects on Average Stanislaus River Temperatures at Riverbank												
Baseline	49.0	51.8	54.5	56.5	58.9	65.5	70.6	68.9	67.2	59.6	54.9	50.0
LSJR Alternative 2	-0.1	-0.7	0.6	2.2	2.3	2.2	-0.9	-0.6	-0.2	-0.2	-0.2	-0.1
LSJR Alternative 3	-0.1	-0.8	0.0	0.1	-0.3	-0.7	-1.0	-0.2	0.1	0.1	0.0	0.0
LSJR Alternative 4	-0.1	-0.9	-0.8	-0.8	-1.0	-2.4	-0.9	0.2	0.4	0.2	0.0	0.0
RM = river mile												

LSJR Alternative 1: No Project

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. Chapter 15, *LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project impact discussion and See Appendix D, *Evaluation of LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project Alternative technical analysis.

LSJR Alternative 2: 20% Unimpaired Flow (Significant and unavoidable)

Table 5-30 (bottom) gives the changes in the monthly cumulative distributions of temperatures and the average monthly water temperatures at Highway 59 Bridge for the LSJR alternatives. There were no monthly increases of more than 2°F for the LSJR alternatives on the Merced River at the Highway 59 Bridge. LSJR Alternative 2 increased flows enough to reduce the average May temperature by 2.2°F. There were no increases in monthly average temperatures of more than 2°F and, therefore, water temperature impacts on the Merced River would be less than significant.

Table 5-31 (bottom) gives the changes in the monthly cumulative distributions of temperatures and the average monthly water temperatures at Waterford for the LSJR alternatives. The water temperature changes on the Tuolumne River were mostly reductions. There were no increases in monthly average temperatures of more than 2°F and, therefore, water temperature impacts on the Tuolumne River would be less than significant.

Table 5-32 (bottom) gives the changes in the monthly cumulative distributions of temperatures and the average monthly water temperatures simulated for 1980–2003 in the Stanislaus River at Riverbank for the LSJR alternatives. LSJR Alternative 2 reduced flows enough to increase the average April temperature by 2.2°F, increase the average May temperature by 2.3°F, and increase the average June temperature by 2.2°F. Temperature increases of more than 2°F in the months of April, May, and June are most likely in years when river flows are low (less than 500 cfs). The simulated LSJR Alternative 2 flows are relatively low (less than 250 cfs) in low runoff months (less than 1,250 cfs) of some years. However, using the selected threshold of 2°F for a significant temperature impact, these monthly changes for LSJR Alternative 2 on the Stanislaus River at Riverbank are considered significant. Because the average monthly temperatures in April, May, and June are expected to increase by more than the 2°F threshold, the impacts would be significant.

The State Water Board must identify feasible mitigation measures for each significant environmental impact identified in the SED. (Cal. Code Regs., tit. 23, § 3777(b)(3)). In order to reduce significant impacts on the Stanislaus River, additional flow would be needed because of the inverse relationship between flow and temperature (see Chapter 7, *Aquatic Resources*). Evaluating the effects of more flow in the different rivers or fewer surface water diversions is part of other alternatives (i.e., LSJR Alternatives 3 and 4) and is separately considered in this document. Requiring additional flow to reduce temperature effects on the Stanislaus River cannot be independently applied under LSJR Alternative 2 as a mitigation measure because requiring more flow would be inconsistent with the terms of LSJR Alternative 2 (i.e., requiring 20 percent of unimpaired flow on the Stanislaus River). Furthermore, as noted above, the flows required on the Stanislaus River under LSJR Alternative 2 would be much less than baseline and could not be adaptively managed to provide additional flows in the late spring when beneficial uses (fish and wildlife) are susceptible to changes in temperature. Impacts would remain significant and unavoidable.

LSJR Alternative 3: 40% Unimpaired Flow (Less than significant)

On the Merced River at Highway 59 Bridge, LSJR Alternative 3 reduced the average April temperature by 1.7°F, reduced the average May temperature by 3.4°F, and reduced the average June temperature by 2.5°F. Using the assumed threshold of 2°F for a significant temperature change, these are all less than the threshold and may represent substantial temperature benefits. Impacts would be less than significant.

On the Tuolumne River at Waterford, LSJR Alternative 3 reduced the average March temperature by 1.9°F, reduced the average April temperature by 2.2°F , reduced the average May temperature by 3.6°F, and reduced the average June temperature by 7.8°F. Using the assumed threshold of 2°F for a significant temperature change, these are all less than the threshold and may represent substantial temperature benefits. Impacts would be less than significant.

There were no significant temperature effects on the Stanislaus River at Riverbank for LSJR Alternative 3. The average monthly water temperatures for LSJR Alternative 3 were very similar to the baseline average temperatures February–June. Impacts would be less than significant.

LSJR Alternative 4: 60% Unimpaired Flow (Less than significant)

On the Merced River at the Highway 59 Bridge, LSJR Alternative 4 reduced the average April temperate by 2.5°F, reduced the average May temperature by 3.7°F, and reduced the average June temperature by 2.9°F. Using the assumed threshold of 2°F for a significant temperature change, these impacts would be below the threshold and may represent substantial temperature benefits. Impacts would be less than significant.

On the Tuolumne River at Waterford, LSJR Alternative 4 reduced the average March temperature by 2.5°F, reduced the average April temperature by 3.0°F , reduced the average May temperature by 4.1°F, and reduced the average June temperature by 9.3°F. Using the assumed threshold of 2°F for a significant temperature impact, these impacts would be below the threshold and may represent substantial temperate benefits. Therefore, impacts would be less than significant.

There were no significant temperate effects on the Stanislaus River at Riverbank for LSJR Alternative 4. LSJR Alternative 4 average month water temperatures were very similar to baseline average temperatures February–June. Impacts would be less than significant.

SDWQ Alternative 1: No Project

The No Project Alternative would result in implementation of salinity objectives identified in the 2006 Bay–Delta Plan. See Chapter 15, *LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project impact discussion and Appendix D, *Evaluation of LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project technical analysis.

SDWQ Alternative 2: 1.0 dS/m Salinity and SDWQ 3: 1.4 dS/m Salinity (No Impact)

SDWQ Alternatives 2 and 3 do not have the ability to change temperature in a river because they propose changes to water quality objectives for salinity (not temperature). Therefore, impacts would not occur.

WQ-4: Substantially degrade water quality by increasing contaminant concentrations caused by reduced river flows

Changing the baseline monthly flows would change the dilution of any contaminants (i.e., 303(d) pollutants) that enter a river as a point source or non-point source. The source loading of 303(d) pollutants is expected to be either constant or caused by runoff or agricultural drainage and would be independent of the reservoir releases occurring under baseline conditions and the LSJR alternatives. Therefore, the change in concentration (concentration ratio) would be the inverse of the change in flow (flow ratio). In other words, the concentration of a 303(d) pollutant is expected to increase with a decrease in flow.

There would be no changes in the Upper SJR flow or pollutant concentrations upstream of the confluence of the LSJR with the Merced River. Changes in the Merced River would change the dilution in the Merced River and would change flows and dilution in the LSJR downstream of the Merced River. The changes downstream would be smaller than in the tributary river, because the LSJR baseline flows are greater than the flows in the tributary river. Changes in the Tuolumne River flow would change the dilution and concentrations of pollutants in the Tuolumne River, with smaller changes in the LSJR downstream of the Tuolumne. Changes in the Stanislaus River flows would change the dilution of pollutants in the Stanislaus River and in the LSJR downstream of the Stanislaus (e.g., at Vernalis).

LSJR Alternative 1: No Project

The No Project Alternative would result in implementation of flow objectives identified in the 2006 Bay-Delta Plan. See Chapter 15, *LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project impact discussion and Appendix D, Evaluation of LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative), for the No Project Alternative technical analysis.

LSJR Alternative 2: 20% Unimpaired Flow (Significant and unavoidable)

The impact assessment is based on the comparison of the baseline flows to the LSJR Alternative 2 flows. As described below, the Merced River and SJR at Vernalis would not experience reduced flows such that 303(d) pollutant concentrations would be increased. It is expected flows would be reduced in the Stanislaus River in June and in the Tuolumne River in February. As a result, 303(d) pollutant contaminant concentrations caused by reduced river flows would be increased on the Stanislaus River in June and in the Tuolumne River in February, thus substantially degrading water quality. Impacts would be significant.

The minimum flow that would be adequate for dilution of pollutant concentrations are assumed to be 150 cfs for the Merced River, based on the median July–September baseline flows. Because this was also the minimum target flow used in the WSE model, no Merced River flows of less than 150 cfs were simulated in the February–June period. Therefore, there would be no change in baseline conditions, and none of the flows would be reduced such that 303(d) pollutant concentrations might increase and exceed established criteria. Impacts would be less than significant.

The minimum flow that would be adequate for dilution of pollutant concentrations was estimated to be 400 cfs for the Tuolumne River, based on the median July–September baseline flows. The flows during the summer months are used as a reference because flows are generally lower during these months and, therefore, higher pollutant concentrations are expected. A concentration ratio of more than 1.5 would represent an increase of 50 percent of the baseline concentration and would be expected to cause a significant increase for pollutants with a baseline concentration approaching the water quality criteria. Therefore, baseline flows of less than 400 cfs that were reduced less than 265 cfs (i.e., 400/265 = 1.5) would result in an increase in 303(d) pollutant concentrations. February baseline flows were less than 400 cfs in about 20 percent of the years. February flows were less than 265 cfs in about 20 percent of the years under the LSJR Alternative 2. None of the other months (March–June) on the Tuolumne River would result in flows less than 265 cfs. The February flow reductions in some years would be a significant impact because 303(d) pollutant concentrations might increase and exceed established criteria. Therefore, impacts would be significant.

The baseline flows for the Stanislaus River are summarized in Table F.1-9l and the Stanislaus River flows for the LSJR Alternative 2 are given in Table F.1-10l. The Stanislaus River flows would be reduced in the months of February–June in many of the years. For evaluation purposes, an adequate dilution flow for the Stanislaus River was assumed to be 400 cfs, based on the median (50 percent cumulative distribution) baseline flows during the summer months (July–September). Table F.1-9l indicates that February baseline flows were less than 400 cfs in about 30 percent of the years; but none of these relatively low flows were reduced substantially with LSJR Alternative 2 (i.e., concentration ratio of more than 1.5). Therefore, no significant increases in contaminant concentrations are expected in February. March baseline flows were less than 400 cfs in about 20 percent of the years; but none of these flows were reduced substantially with LSJR Alternative 2. There were no baseline flows of less than 400 cfs in April or May, and none of these flows were reduced to less than 265 cfs with LSJR Alternative 2; no significant impacts on contaminant concentration are identified for April or May. June baseline flows were less than 400 cfs in about 10 percent of the years, and June flows were reduced to less than 265 cfs in about 10 percent of the years with LSJR alternative 2. The June flow reductions in some years would be a significant impact because 303(d) pollutant concentrations might increase and exceed established criteria. Therefore, impacts would be significant.

Because the SJR flow at Vernalis is the sum of all tributary flows and upstream SJR flows, it is unlikely that a pollutant concentration would approach water quality criteria downstream of Vernalis. Pollutants associated with agricultural practices (pesticides) or agricultural drainage (i.e., boron, selenium, salt, nutrients) would more likely be higher upstream of the Stanislaus, Tuolumne, or Merced Rivers. Because there is a large amount of agricultural drainage in the SJR from Mud and Salt Sloughs and in groundwater seepage to the SJR between the Merced River and Vernalis, the three eastside tributaries are expected to generally dilute and reduce the LSJR pollutant concentrations. Table F.1-9m shows the monthly cumulative distributions of SJR at Vernalis flows for baseline. Table F.1-10m shows the monthly cumulative distributions of SJR at Vernalis flows for LSJR Alternative 2. For evaluation purposes, an adequate dilution flow for the SJR at Vernalis was assumed to be 1,600 cfs, based on the median (50 percent cumulative distribution) baseline flows during the summer months (July–September). A concentration ratio of more than 1.5 would represent an increase of 50 percent of the baseline concentration and would increase pollutants with a baseline concentration that approach the water quality criteria potentially resulting in a water quality concern. The impact evaluation for contaminants was focused on baseline Vernalis flows of less than 1,600 cfs that were reduced to less than 1,060 cfs (i.e., 1,600/1,060 = 1.5) for LSJR Alternative 2. None of the February–June baseline flows was less than 1,600 cfs and none of the February–June flows were reduced substantially with LSJR Alternative 2. Therefore, there were no significant increases in contaminant concentrations at Vernalis with LSJR Alternative 2.

An SED must identify feasible mitigation measures for each significant environmental impact identified in the SED. (Cal. Code Regs., tit. 23, § 3777(b)(3)). In order to reduce significant impacts on the Stanislaus River additional flow would be needed because of the inverse relationship between flow and pollutant concentrations. Impacts could be avoided with a higher minimum flow applied during adaptive management of the required flows. However, evaluating the effects of more flow in the different rivers is part of other alternatives (i.e., LSJR Alternatives 3 and 4) and is separately considered in this document. Requiring additional flow to reduce 303(d) pollutant effects cannot be independently applied under LSJR Alternative 2 as a mitigation measure because requiring more flow would be inconsistent with the terms of LSJR Alternative 2 (i.e., requiring 20 percent of unimpaired flow). Impacts would remain significant and unavoidable.

LSJR Alternative 3: 40% Unimpaired Flow (Less than significant)

All tributary flows during the February–June period would be about twice as high for LSJR Alternative 3 compared to LSJR Alternative 2, similar to or higher than baseline flows. Because these flows would be closer to the Stanislaus baseline flows, there would not be any significant increases in pollutant concentrations caused by reduced Stanislaus River flows. Very few reductions in baseline flows that were less than the assumed minimum flows required for pollutant dilution were simulated at Vernalis or on the Tuolumne or Merced Rivers for LSJR Alternative 3 (See Table F.1-9 for baseline flows and Table F.1-11 for LSJR Alternative 3 flows). Impacts would be less than significant.

LSJR Alternative 4: 60% Unimpaired Flow (Less than significant)

Flows would be closer to the Stanislaus River baseline flows or higher, there would not be any significant increases in pollutant concentrations caused by reduced Stanislaus River flows. Very few reductions in baseline flows that were less than the assumed minimum flow required for pollutant dilution were simulated at Vernalis or on the Tuolumne or Merced Rivers for LSJR Alternative 4 (See Table F.1-9 for baseline flows and Table F.1-12 for LSJR Alternative 3 flows). Impacts would be less than significant.

SDWQ Alternative 1: No Project

The No Project Alternative would result in implementation of salinity objectives identified in the 2006 Bay–Delta Plan. See Chapter 15, *LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project impact discussion and Appendix D, *Evaluation of LSJR Alternative 1 and SDWQ Alternative 1 (No Project Alternative)*, for the No Project technical analysis.

SDWQ Alternative 2: 1.0 dS/m Salinity and SDWQ Alternative 3: 1.4 dS/m Salinity (No Impact)

SDWQ Alternatives 2 and 3 do not have the ability to result in an increase in contaminant concentrations because the SJR at Vernalis salinity objective (EC) would continue to be maintained and does not represent a change from baseline with respect to flow. Therefore, impacts would not occur.

5.5 Cumulative Impacts

5.5.1 Definition

Cumulative impacts are defined in the State CEQA Guidelines (14 Cal. Code Regs., § 15355) as "two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts." A cumulative impact occurs from "the change in the environment which results from the incremental impact of the project when added to other closely related past, present, and reasonably foreseeable future projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time" (14 Cal. Code Regs., § 15355(b)).

Consistent with the State CEQA Guidelines (14 Cal. Code Regs., § 15130(a)), the discussion of cumulative impacts in this chapter focuses on significant and potentially significant cumulative impacts. The State CEQA Guidelines (14 Cal. Code Regs., § 15130(b)) state the following:

> The discussion of cumulative impacts shall reflect the severity of the impacts and their likelihood of occurrence, but the discussion need not provide as great detail as is provided for the effects attributable to the project alone. The discussion should be guided by the standards of practicality and reasonableness, and should focus on the cumulative impact to which the identified other projects contribute rather than the attributes of other projects which do not contribute to the cumulative impact.

5.5.2 Past, Present, and Reasonably Foreseeable Future Projects

Chapter 16, *Cumulative Impact Summary, Growth-Inducting Effects, and Irreversible Commitment of Resources*, includes a list of past, present, and reasonably foreseeable future projects considered for the cumulative analysis.

Present and reasonably foreseeable future projects are projects that are currently under construction, approved for construction, or in final stages of formal planning. These projects were identified by reviewing available information regarding planned projects and are summarized in Chapter 16. Past, present and reasonably foreseeable future projects related to water supply, surface hydrology, and water quality are all the projects listed in Chapter 16.

5.5.3 Significance Criteria

Two significance criteria must be met for an environmental consequence to have a significant cumulative impact: (1) the effect must make a cumulatively considerable incremental contribution to an overall cumulative impact, and (2) the overall cumulative impact (considering past, present, and reasonably foreseeable future projects) must be significant. (See Cal. Code Regs., tit. 14, §§ 15064, 15065, 15130.) The cumulative analysis uses the impact threshold topics discussed in the impact analysis (i.e., flow value, water supply, water quality exceedances, temperature, 303(d) pollutant concentrations).

5.5.4 Mitigation Measures for Significant Cumulative Impacts

As specified by Section 15130 of the State CEQA Guidelines (2012) the analysis of cumulative impacts will examine feasible options for mitigating or avoiding a project's contribution to any significant cumulative effects. With some projects, the only feasible mitigation for cumulative impacts may be the adoption of ordinances or regulations rather than the imposition of conditions on a project-by-project basis. Mitigation measures to reduce an alternative's contribution to significant cumulative effects are presented below where feasible and appropriate.

5.5.5 Cumulative Impact Analysis

Past and present projects by humans have substantially changed the water supply, surface hydrology and water quality in the LSJR and the three eastside tributaries compared to historical conditions, resulting in cumulative impacts on reduced flows in many months and much higher salinity and temperatures in many locations. The past, present and future development of water resources has allowed, however, greatly expanded irrigated acreage and agricultural productivity. There are few additional water resources development projects that could be constructed to provide any greater water supply diversions. Several cumulative impacts may arise as climate changes are taken into account. Conditions in the LSJR could gradually worsen and in the future would potentially have a negative impact on runoff conditions. Rainfall runoff may increase, and snowmelt runoff may decrease, increasing the flood-control releases and reducing the available water supply conditions. Summer water temperatures in the three eastside tributaries may increase in the future. Increased river flows in the spring and summer months would have a beneficial effect on temperatures, especially if warming from climate change does occur. Given the current condition of the hydrology and water quality in the tributaries and LSJR, the cumulative impacts of past, present, and reasonably foreseeable future projects combined have been cumulatively considerable and significant.

LSJR Alternative 2 is expected to reduce some flows during some low flow years on the Stanislaus River; accordingly, LSJR Alternative 2 is expected to result in hydrology (e.g., flow value) and water quality conditions (e.g., temperature and 303(d) pollutants) that may be less favorable in the Stanislaus River. Therefore, because the expected conditions on the Stanislaus River under LSJR

Alternative 2, in combination with past, present, and foreseeable projects, are expected to result in cumulatively considerable impacts. Cumulative impacts would be considered significant. As discussed in HYD-1 and the rest of the impacts, the significant cumulative impacts on the Stanislaus River associated with the flow value, water supply, temperature, and 303(d) pollutants could be reduced or lessened with additional flow. Additional flow beyond that which is currently required by LSJR Alternative 2 would be needed. Additional flow could be provided by reducing existing surface water diversions. Evaluating the effects of more flow and fewer surface water diversions is part of other alternatives (i.e., LSJR Alternatives 3 and 4) and is separately considered in this document. Therefore, more flow and fewer surface water diversions cannot be independently applied as mitigation measures. Furthermore, as noted above in the impact analysis (Section 5.4.3), the flows required on the Stanislaus River under LSJR Alternative 2 would sometimes be much less than baseline and could not be adaptively managed to provide additional flows. Therefore, there are no feasible mitigation measures to avoid, minimize, rectify, reduce, or eliminate the impact, and this impact would remain significant and unavoidable. Conditions on the Tuolumne and Merced Rivers and the LJSR under LSJR Alternative 2 are expected to be similar to baseline and would not represent a significant impact on flow values or temperature. This is because flow and temperature are expected to improve with LSJR Alternative 2. LSJR Alternative 2 could result in an increase in salinity exceedances in the southern Delta as a result of certain lower flow periods, but this is not expected to affect the agricultural beneficial uses. While the Tuolumne River is expected to experience some increase in 303(d) pollutant concentrations, it would only be during the month of February. When considered with the other less-than-significant impacts on the Tuolumne River, these water quality exceedances would not be considered to be cumulatively considerable. Because the expected conditions on the Merced, Tuolumne, and LSJR, under LSJR Alternative 2 would improve hydrology and water quality conditions, the impacts, in combination with past, present, and foreseeable projects, are not expected to result in cumulatively considerable impacts. Cumulative impacts would be considered less than significant.

The overall effect of LSJR Alternatives 3 or 4 on river flows is generally expected to be beneficial. Improvements in salinity and water temperatures are also expected in most locations on the tributaries, based on present and reasonably foreseeable future projects. Overall, these LSJR alternatives, when considered separately or in combination with other past, present, and reasonably foreseeable future projects, would not result in a cumulatively considerable incremental contribution to a significant cumulative impact on the water supply, surface hydrology, or water quality of the LSJR and the three eastside tributaries. Instead, they would generally result in beneficial effects on river flows, salinity, and water temperatures and 303(d) pollutants. However, LSJR Alternatives 3 or 4 would reduce surface water supply diversions. These reductions under the alternatives would be considered cumulatively considerable impacts and are significant and unavoidable. This is because all of the runoff from the entire SJR watershed is generally used for water supply or specified river flow releases. Only in a few very high runoff years is much of the SJR runoff released for flood-control purposes. These cumulative water supply impacts are unavoidable because the purpose of the LSJR alternatives is to allocate more of the total runoff to river flows for improved fish habitat, improved fish survival and migration to the estuary, and increased fish populations.

The overall effect of SDWQ Alternatives 2 or 3 would be reduced exceedances at the three interior compliance stations. It is expected that actual water quality in the southern Delta would remain within the historical range of conditions (between 0.2 dS/m and 1.2 dS/m [200 and 1,200 μS/cm). SDWQ Alternative 2 or 3 are expected to result in conditions that would result in fewer exceedances than have occurred in the past. These effects are not expected to contribute to a cumulatively considerable incremental contribution because water quality would remain within historical conditions and because the number of exceedances would ultimately be reduced. Accordingly, SDWQ Alternatives 2 or 3 in combination with past, present, and foreseeable projects would not result in a cumulatively considerable impact relative to water supply, surface hydrology, and water quality. Cumulative impacts would be considered less than significant.

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