Chapter 6

Surface Water Quality

6.1 Introduction

This chapter describes Surface Water Quality in the Study Area; and potential changes that could occur as a result of implementing the alternatives evaluated in this Environmental Impact Statement (EIS). Implementation of the alternatives could affect these resources through potential changes in operation of the Central Valley Project (CVP) and State Water Project (SWP) and ecosystem restoration.

6.2 Regulatory Environment and Compliance Requirements

Potential actions that could be implemented under the alternatives evaluated in this EIS could affect surface water resources impacted by changes in the operations of CVP or SWP reservoirs and in the vicinity of and lands served by CVP and SWP water supplies. Actions located on public agency lands; or implemented, funded, or approved by Federal and state agencies would need to be compliant with appropriate Federal and state agency policies and regulations, as summarized in Chapter 4, Approach to Environmental Analyses.

Several of the Federal and state laws and regulations that provide quantitative criteria to determine compliance also are summarized in this subsection of this chapter to provide context for information provided in the remaining sections of this chapter.

6.2.1 Federal Water Pollution Control Act Amendments of 1972 (Clean Water Act)

The Federal Water Pollution Control Act Amendments of 1972, also known as the Clean Water Act (CWA), established the institutional structure for the U.S. Environmental Protection Agency (USEPA) to regulate discharges of pollutants into the waters of the United States, establish water quality standards, conduct planning studies, and provide funding for specific grant projects. The CWA was further amended through the CWA of 1977 and the Water Quality Act of 1987. The California State Water Resources Control Board (SWRCB) has been designated by the USEPA to develop and enforce water quality objectives and implementation plans in California, as described below under State Policies and Regulations.

The California RWQCBs have adopted, and the SWRCB has approved, water quality control plans (basin plans) for each watershed basin in the State. The basin plans designate the beneficial uses of waters within each watershed basin, and water quality objectives designed to protect those uses pursuant to

Section 303 of the CWA. The beneficial uses together with the water quality objectives that are contained in the basin plans constitute State water quality standards.

Under the CWA section 303(d), the USEPA identifies and ranks water bodies for which existing pollution controls are insufficient to attain or maintain water quality standards based upon information prepared by all states, territories, and authorized Indian tribes (referred to collectively as “states” in the CWA). This list of impaired waters for each state comprises the state’s 303(d) list. Each state must establish priority rankings and develop TMDLs for all impaired waters. TMDLs calculate the greatest pollutant load that a water body can receive and still meet water quality standards and designated beneficial uses.

Section 305(b) of the CWA requires every state to submit a biennial water quality assessment of all state waters. These state-wide reports serve as the basis for USEPA’s national Water Quality Inventory Report to Congress. Each water body is assessed regarding its ability to support the most common beneficial uses: aquatic life, drinking water supply, fish consumption, non-contact recreation, shell fishing, and swimming; also known as core beneficial uses (SWRCB 2010a).The USEPA requires states to integrate the 303(d) and 305(b) reports. For California, this report is called the California 303(d)/305(b) Integrated Report, and is prepared by the SWRCB using Integrated Reports submitted by each RWQCB (SWRCB 2010a). The 303(d) and 305(b) processes are further explained below under State Policies and Regulations.

The California Environmental Protection Agency, SWRCB, and RWQCBs have identified numerous water bodies within the project area that do not comply with applicable water quality standards and either adopted or are developing TMDLs, shown below in Table 6.1.

Table 6.1 Constituents of Concern per the 303(d) list within the Study Area

Region	Waterbody	Constituent of Concern	TMDL Status[1]
Trinity and Lower Klamath Rivers	Trinity Lake (was Claire Engle Lake)	Mercury	Expected: 2019
	Trinity River HU, Lower Trinity HA; Trinity River HU, Middle HA; Trinity River HU, South Fork HA; Trinity River, Upper HA; Trinity River HU, Upper HA, Trinity River, East Fork	Sedimentation/Siltation, Temperature[2], Mercury[3]	Approved: 2001
	Klamath River HU, Lower HA, Klamath Glen HAS	Nutrients, Organic, Enrichment/Low Dissolved Oxygen, Water Temperature	Approved: 2010
		Sedimentation/Siltation	Expected: 2025
Sacramento River Basin	Shasta Lake (where West Squaw Creek Enters); Keswick Reservoir (portion downstream from Spring Creek); Spring Creek, Lower (Iron Mountain Mine to Keswick Reservoir)	Acid Mine Drainage[4], Cadmium, Copper, Zinc	Expected: 2020

Region	Waterbody	Constituent of Concern	TMDL Status[1]
	Shasta Lake; Whiskeytown Lake (areas near Oak Bottom, Brandy Creek Campgrounds and Whiskeytown); Clear Creek (below Whiskeytown Lake, Shasta County)	Mercury	Expected: 2021
	Sacramento River (Keswick Dam to the Delta)[5]	Unknown Toxicity	Expected: 2019
		Chlordane[6], DDT, Mercury[7], PCBs, Dieldrin[8]	Expected: 2021
	Colusa Basin Drain	Diazinon	Expected: 2008
		Malathion	Expected: 2010
		Azinphos-methyl (Guthion), Group A Pesticides , Unknown Toxicity	Expected: 2019
		DDT, Dieldrin, E. coli, Low Dissolved Oxygen, Mercury, Carbofuran	Expected: 2021
	Oroville Lake; Feather River, Lower (Lake Oroville Dam to Confluence with Sacramento River), Yuba River, Lower[9]	Group A Pesticides	Expected: 2011
		Chlorpyrifos, Unknown Toxicity	Expected: 2019
		Mercury, PCBs	Expected: 2021
	Folsom Lake; Natoma, Lake; American River, Lower (Nimbus Dam to confluence with Sacramento River)[10]	Mercury	Expected: 2019
		Unknown Toxicity, PCBs	Expected: 2021
	Cache Creek, Lower (Clear Lake Dam to Cache Creek Settling Basin near Yolo Bypass)	Mercury	Approved: 2007
		Unknown Toxicity	Expected: 2019
		Boron	Expected: 2021
San Joaquin River and Tulare Basins	Mendota Pool; Panoche Creek (Silver Creek to Belmont Avenue)	Mercury[11]	Expected: 2021
		Selenium	Expected: 2019
		Sediment Toxicity[12]	Expected: 2021
		Sedimentation/Siltation[12]	Expected: 2007
	Agatha Canal (Merced County); Grasslands Marshes; Mud Slough, North (downstream of San Luis Drain); Salt Slough (upstream from confluence with San Joaquin River)[13]	Selenium[14]	Approved: 2002
		Chlorpyrifos	Approved: 2008
		Boron, Electrical Conductivity, Pesticides, Unknown Toxicity[15]	Expected: 2019
		Escherichia coli, Mercury, pH, Prometryn	Expected: 2021
	San Luis Reservoir	Mercury	Expected: 2021
	O'Neil Forebay		Expected: 2012
		Selenium[17, 18]	Approved: 2002

Region	Waterbody	Constituent of Concern	TMDL Status[1]
	Millerton Lake; San Joaquin River (Friant Dam to Stanislaus River)[16]	Chlorpyrifos, Diazinon[19]	Approved: 2007
		DDE20, DDT, Group A Pesticides	Expected: 2011
			Expected: 2012
		Boron[21], Invasive Species[23], Unknown Toxicity	Expected: 2019
		Arsenic[24], Electrical Conductivity[18, 22], Mercury[18], Water Temperature[26]	Expected: 2021
		alpha.-BHC[20], Escherichia coli[18, 25],	Expected: 2022
	San Joaquin River (Stanislaus River to Delta Boundary)	Chlorpyrifos, Electrical Conductivity	Approved: 2007
		DDE, DDT, Group A Pesticides	Expected: 2011
		Mercury	Expected: 2012
		Toxaphene, Unknown Toxicity	Expected: 2019
		Diuron, Escherichia coli, Water Temperature	Expected: 2021
	Merced River, Lower; Tuolumne River, Lower; New Melones Reservoir; Tulloch Reservoir; Stanislaus River, Lower[27]	Diazinon	Expected: 2010
		Group A Pesticides	Expected: 2011
		Chlorpyrifos, Mercury, Water Temperature	Expected: 2021
		Unknown Toxicity	Expected: 2022
	Cosumnes River, Lower (below Michigan Bar; partly in Delta Waterways, eastern portion)	Invasive Species	Expected: 2019
		Escherichia coli, Sediment Toxicity	Expected: 2021
	Mokelumne River, Lower (in Delta Waterways, eastern portion)	Copper, Zinc	Expected: 2020
		Chlorpyrifos, Mercury, Dissolved Oxygen, Unknown Toxicity	Expected: 2021
	Calaveras River, Lower (from Stockton Diverting Canal to the San Joaquin River; partly in Delta waterways, eastern portion)	Chlorpyrifos, Diazinon	Approved: 2007
		Pathogens	Approved: 2008
		Organic Enrichment/Low Dissolved Oxygen	Expected: 2012
		Mercury	Expected: 2021
	Kings River, Lower (Island Weir to Stinson and Empire	Electrical Conductivity, Molybdenum, Toxaphene	Expected: 2015

Region	Waterbody	Constituent of Concern	TMDL Status[1]
	Weirs); Kings River, Lower (Pine Flat Reservoir to Island Weir); Kaweah River (below Terminus Dam, Tulare County); Kaweah River, Lower (includes St Johns River)[28]	Chlorpyrifos[29], pH[30], Unknown Toxicity	Expected: 2021
Sacramento-San Joaquin River Delta	Sacramento San Joaquin Delta	Mercury	Approved: 2008
		PCBs	Expected: 2008
		Selenium	Expected: 2010
		Chlordane, DDT, Dieldrin	Expected: 2013
		Dioxin compounds, Furan Compounds, Invasive Species	Expected: 2019
	Delta waterways (central, eastern, northern, northwestern, western portion, southern portions, export area, and Stockton Ship Channel)	Chlorpyrifos[31], Diazinon, Organic Enrichment/Low Dissolved Oxygen[32]	Approved: 2007
		Pathogens[32]	Expected: 2008
		Mercury	Expected: 2009
		Chlordane[33], DDT, Dieldrin[33], Group A Pesticides	Expected: 2011
		Dioxin[32], Electrical Conductivity[34], Furan Compounds[32], Invasive Species, PCBs[35], Unknown Toxicity	Expected: 2019
Suisun Bay and Suisun Marsh	Suisun Bay	Mercury	Approved: 2008
		PCBs	Expected: 2008
		Selenium	Expected: 2010
		Chlordane, DDT, Dieldrin	Expected: 2013
		Dioxin compounds, Furan Compounds, Invasive Species	Expected: 2019
	Suisun Marsh Wetlands	Mercury, Nutrients, Organic Enrichment/Low Dissolved Oxygen, Salinity/TDS/Chlorides	Expected: 2013
San Francisco Bay Region	Carquinez Strait and San Pablo Bay	Mercury	Approved: 2008
		PCBs	Expected: 2008
		Selenium	Expected: 2010
		Chlordane, DDT, Dieldrin	Expected: 2013
		Dioxin compounds, Furan Compounds, Invasive Species	Expected: 2019

Source: SWRCB 2011A

Notes:

1 TMDL status is either expected to be completed or approved by USEPA in the year specified

2 Water temperature is only a constituent of concern for the South Fork Trinity River and a TMDL is expected to be completed in 2019.

3 Mercury is only a constituent of concern for the East Fork Trinity River in the upper hydrologic area and a TMDL is expected to be completed in 2019.

4 Acid Mine Drainage is a constituent of concern at Spring Creek only

5 Chlordane, DDT, PCBs, Dieldrin not constituents of concern for Sacramento River (Keswick Dam to Red Bluff)

6 Chlordane not a constituent of concern for Sacramento River (Red Bluff to Knights Landing)

7 Mercury not a constituent of concern for Sacramento River (Keswick Dam to Cottonwood Creek). Mercury TMDL is expected to be complete in 2012 for Sacramento River (Knights Landing to the Delta)

8 Dieldrin TMDL for Sacramento from Knights Landing to the Delta is expected to be completed in 2022.

9 Mercury is the only constituent of concern for Yuba River and a TMDL is expected to be complete in 2021. Mercury TMDL expected to be complete in 2021 for Feather River, Lower (Lake Oroville Dam to Confluence with Sacramento River). Mercury and PCBs are the only constituents of concern for Lake Oroville and TMDLs are expected to be complete in 2021 for both constituents.

10 Mercury is the only constituent of concern for Folsom Lake and Lake Natoma. Mercury TMDL is expected to be completed in 2010 for American River, Lower (Nimbus Dam to confluence with Sacramento River)

11 Mercury TMDL for Panoche Creek (Silver Creek to Belmont Avenue) expected to be complete in 2020.

12 Not a constituent of concern for Mendota Pool

13 pH and selenium are the only constituents of concern for Agatha Canal (Merced County). Electrical conductivity and Selenium are the only constituents of concern for Grasslands Marshes. Boron, Electrical Conductivity, Pesticides, Selenium, and Unknown Toxicity are the only constituents of concern for Mud Slough, North (downstream of San Luis Drain). pH, selenium, and pesticides are not constituents of concern for Salt Slough (upstream from confluence with San Joaquin River)

14 The CVRWQCB completed a TMDL for selenium in the lower San Joaquin River (downstream of the Merced River) in 2001 and Salt Slough in 1997/1999, and USEPA approved this in 2002.

15 The unknown toxicity TMDL for Mud Slough (downstream of San Luis Drain) is expected to be written and complete in 2021.

16 Mercury is the only constituent of concern for Millerton Lake and a TMDL is expected to be complete in 2019.

17 Selenium is only a constituent of concern in San Joaquin River (Mud Slough to Merced River)

18 Electrical conductivity, Escherichia coli, mercury and selenium are not constituents of concern for San Joaquin River (Mendota Pool to Bear Creek). The Electrical Conductivity TMDL for San Joaquin River (Bear Creek to Merced River) is expected to be written and complete in 2019. The Mercury TMDL for San Joaquin River (Bear Creek to Stanislaus River) is expected to be written and complete in 2012.

19 Diazinon not a constituent of concern for San Joaquin River (Bear Creek to Mud Slough and Merced River to Tuolumne River)

20 DDE and alpha.-BHC is only a constituent of concern in San Joaquin River (Merced River to Tuolumne River)

21 The Boron TMDL for San Joaquin River (Merced to Tuolumne River) was approved by the USEPA in 2007. Boron is not a constituent of concern for the San Joaquin River (Tuolumne River to Stanislaus River).

22 The Electrical Conductivity TMDL for San Joaquin River (Tuolumne River to Stanislaus River) is expected to be written and complete in 2021.

23 Invasive species only a constituent of concern for the San Joaquin River (Friant Dam to Mendota Pool).

24 Arsenic not a constituent of concern in San Joaquin River except Bear Creek to Mud Slough.

25 Escherichia coli is not a constituent of concern for San Joaquin River (Mendota Pool to Bear Creek and Merced River to Stanislaus River). The Escherichia coli TMDL for San Joaquin River (Bear Creek to Mud Slough) is expected to be written and complete in 2021.

26 Water temperature is only a constituent of concern for San Joaquin River (Merced River to Stanislaus River)

27 Mercury is the only constituent of concern for New Melones Reservoir and Tulloch Reservoir. The diazinon TMDL for lower Merced River and lower Stanislaus River is expected to be complete in 2008. The Chlorpyrifos TMDL for the lower Merced River is expected to be complete in 2008. The Mercury TMDL for lower Merced River is expected to be complete in 2019 and lower Stanislaus River TMDL is expected to be complete in 2020. The Unknown Toxicity TMDL for lower Stanislaus River is expected to be complete in 2019 and lower Merced River is expected in 2021.

28 The only constituents of concern for Kings River, Lower (Island Weir to Stinson and Empire Weirs) are electrical conductivity, toxaphene, molybdenum.

29 Chlorpyrifos is only a constituent of concern for Kings River, Lower (Pine Flat Reservoir to Island Weir).

30 pH is only a constituent of concern for Kaweah River (below Terminus Dam, Tulare County).

31 Chlorpyrifos TMDL for Delta waterways (central portion) expected to be complete in 2019. Chlorpyrifos TMDL for Delta waterways (western portion) expected to be complete in 2006.

32 Not a constituent of concern for Delta waterways except for Stockton Ship Channel.

33 Not a constituent of concern for Delta waterways except for northern portion.

34 Not a constituent of concern for Delta waterways (central, northern, eastern portions, and Stockton Ship Channel)

35 Not a constituent of concern for Delta waterways except for the northern portion and the Stockton Ship Channel.

National Toxics Rule (NTR) was established by USEPA in accordance with CWA section 303 to provide ambient water quality criteria for priority toxic pollutants to protect aquatic life and human health.

The Secretary of the Interior established the first antidegradation policy in 1968. In 1975, USEPA included the antidegradation requirements in the Water Quality Standards Regulation (40 Code of Federal Regulations [CFR] 130.17, 40 CFR 55340-41). The requirements were included in the 1987 CWA amendment in section 303(d)(4(B)). The Federal antidegradation policy requires states to develop regulations to allow increases in pollutant loadings or changes in surface water quality only if: 1) existing surface water uses are maintained and protected, and established water quality requirements are met; 2) if water quality requirements cannot be maintained by a project, water quality must be maintained to fully protect "fishable/swimmable" uses and other existing uses; and 3) for Outstanding National Resource Waters water quality criteria where "States may allow some limited activities which result in temporary and short-term changes in water quality" (Water Quality Standards Regulations) but would not impact existing uses or special use of these waters.

6.2.2 Major California Water Quality Regulations

The Porter Cologne Water Quality Control Act (Porter-Cologne Act) established the SWRCB and divided the state into nine regions, each overseen by a RWQCB. The nine RWQCBs have the primary responsibility for the coordination and control of water quality within their respective jurisdictional boundaries. The SWRCB and the RWQCBs have been delegated Federal authority to implement the requirements of the Federal CWA in California. The RWQCBs that have jurisdiction over the water bodies in the project area are the NCRWQCB, the CVRWQCB, the SFB RWQCB, the Los Angeles RWQCB, the Santa Ana RWQCB, the San Diego RWQCB, the Lahontan RWQCB, and the Colorado River RWQCB. The Porter-Cologne Act requires the RWQCBs to prepare and periodically update basin plans. Basin plans establish beneficial uses of water, water quality objectives, and implementation programs for achieving the objectives.

The State of California has adopted several water quality policies that are similar to federal water quality policies, including the California Toxics Rule (CTR) and the Policy for Implementing Toxic Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (State Implementation Policy).

The CTR is applicable to all State waters, as are the USEPA advisory National Recommended Water Quality Criteria. Fresh water criteria apply to waters of salinity less than 1 parts per thousand 95 percent or more of the time, seawater criteria are for water greater than 10 parts per thousand 95 percent or more of the time, and estuarine waters use the more stringent of the two possible criteria, in absence of estuary-specific criteria.

The State Implementation Policy for water quality control, adopted in 2000, applies to discharges of toxic pollutants into the inland surface waters, enclosed bays, and estuaries of California subject to regulation under the Porter-Cologne Act and the Federal CWA. This policy establishes:

- Implementation provisions for priority pollutant criteria promulgated by the USEPA through the NTR and the CTR, and for priority pollutant objectives established by RWQCBs in their basin plans;
- Monitoring requirements for 2,3,7,8-tetrachlorodibenzodioxin (TCDD) equivalents; and
- Chronic toxicity control provisions.

6.2.2.1 Basin Plans

The RWQCBs are required to formulate and adopt basin plans for all areas under their jurisdiction under the Porter-Cologne Act. Each basin plan must contain water quality objectives to ensure the reasonable protection of beneficial uses, as well as a program of implementation for achieving water quality objectives with the basin plans.

Section 13050(f) of the Porter-Cologne Act lists the beneficial uses of the waters of the state that may be protected against water quality degradation, which include but are not limited to: domestic, municipal, agricultural, and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, and wildlife and other aquatic resources or preserves. Basin plans must designate and protect beneficial uses in the region. A uniform list of beneficial uses is defined by the SWRCB, however each RWQCB may identify additional beneficial uses specific to local water bodies.

Basin plans must adopt water quality standards to protect public health or welfare, enhance the quality of water, and serve the purposes of the CWA. These water quality standards include: designated beneficial uses; water quality objectives to protect the beneficial uses; implementation of the Federal and State policies for antidegradation; and general policies for application and implementation.

The basin plans are subject to modification, considering applicable laws, policies, technologies, water quality conditions and priorities. Basin plans must be assessed every three years for the appropriateness of existing standards and evaluation and prioritization of basin planning issues. In California however, water bodies are assessed every two years for CWA 303(d) and 305(b) requirements. Revisions are accomplished through Basin Plan amendments. Once a Basin Plan amendment is adopted in noticed public hearings, it must be approved by the SWRCB, Office of Administrative Law and in some cases, the USEPA.

6.2.2.1.1 California 303(d)/305(b) Integrated Reports

The California 303(d)/305(b) Integrated Report is updated biennially for inclusion in the USEPA's national Water Quality Inventory Report to Congress. The report is composed of the current California 303(d) list, and all current listing decisions for contaminants in impaired water bodies. The statewide report is the compilation of 303(d)/305(b) Integrated Reports submitted by each RWQCB. The final California 303(d) list must be submitted to and approved by the USEPA before it becomes effective.

The most recent statewide report is the 2010 California 305(b)/303(d) Integrated Report, accompanied by the 2010 Staff Report, which outlines the process by which water bodies were assessed for impairment and by which listing decisions were made. Each successive 303(d) list updates the previous approved 303(d) list, in this case the 2006 Section 303(d) list. The updates are made by each RWQCB in accordance with the Water Quality Control Policy for Developing California's CWA Section 303(d) list ("Listing Policy").

For the 2010 Integrated Report, the data assessed included the 2006 California CWA Section 303(d) list and its supporting data and information, applicable Surface Water Ambient Monitoring Program (SWAMP) data from 2000 to 2007, data from several local monitoring programs, and data provided during public solicitation. Data incorporated into the assessment were existing and readily available to RWQCB staff.

Data were assessed to identify the beneficial uses for each water body, and whether water quality criteria were being met. The core beneficial uses most commonly evaluated were aquatic life, drinking water supply, fish consumption, non-contact recreation, shell fishing, and swimming. The water quality criteria considered included water quality objectives set forth by RWQCB Basin Plans, criteria included in Statewide Basin Plans, the CTR, and MCLs. Narrative "Evaluation Guidelines" were designated for pollutants without numeric Basin Plan Objectives, MCLs or CTR criteria, as described in the Listing Policy.

The data and assessment results were summarized in LOEs for water body segment-contaminant combinations. The LOEs include specific information used to determine whether water quality standards are being met for the water body segment, including: affected beneficial uses; relevant pollutant; relevant water quality criteria; and detailed information regarding data samples and quality assurance information. Fact sheets were prepared that summarize the LOEs and the reasoning for inclusion or exclusion of the water body-pollutant combination from the 303(d) list. The fact sheets are stored in the Water Boards' California Water Quality Assessment (CalWQA) database.

Water body segment-contaminant combinations were categorized into one of three Beneficial Use Support Ratings: fully supporting (supporting), not supporting, and insufficient information. These Beneficial Use Support Ratings were used as the basis for categorizing the water bodies into Integrated Report categories.

For water bodies that are in need of a TMDL, the Listing Policy provides instruction for scheduling TMDL development, based on, among other factors, the significance of the water segment, the degree that water quality objectives are not met or that beneficial uses are threatened, and the potential threat to human health and the environment.

The 2010 California 305(b)/303(d) Integrated Report results in a significant increase in proposed 303(d) listings in comparison to previous years. This is likely the result of a large volume of water quality data available for the 2010 assessment, which was not available for the 2006 assessment. There are also more protective water quality standards for some water bodies, requiring their addition to the 303(d) list.

6.2.2.2 Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS)

In 2006, the CVRWQCB, the SWRCB, and stakeholders began a joint effort to address salinity and nitrate problems in California's Central Valley and adopt long-term solutions that will lead to enhanced water quality and economic sustainability. This effort is referred to as the CV-SALTS Initiative. The goal of CV-SALTS is to develop a comprehensive region-wide Salt and Nitrate Management Plan (SNMP) describing a water quality protection strategy that will be implemented through a mix of voluntary and regulatory efforts. The SNMP may include recommendations for numeric water quality objectives, beneficial use designation refinements, and/or other refinements, enhancements, or basin plan revisions. The SNMP will serve as the basis for amendments to the three basin plans that cover the Central Valley Region (Sacramento River and San Joaquin River Basin Plan, the Tulare Lake Basin Plan and the Sacramento/San Joaquin Rivers Bay-Delta Plan). The Basin Plan Amendments (BPAs) will likely establish a comprehensive implementation plan to achieve water quality objectives for salinity (including nitrate) in the Region's surface waters and groundwater; and the SNMP may include recommendations for numeric water quality objectives, beneficial use designation refinements, and/or other refinements, enhancements, or Basin Plan revisions.

6.3 Affected Environment

This section describes surface water quality that could be potentially affected by the implementation of the alternatives considered in this EIS. Changes in water quality due to changes in CVP and SWP operations may occur in the Trinity River, Central Valley, San Francisco Bay Area, and Central Coast and Southern California regions. Changes to surface water bodies and water supplies are described in Chapter 5, Surface Water Resources and Water Supplies.

This chapter focuses on constituents of concerns that could be affected by changes in CVP and SWP water operations. The constituents of concern have been identified in the Final California 2010 Integrated Report (303(d) List/305(b) Report) as well as other water quality reports. This section provides descriptions of sources of constituents, water quality effects, water quality objectives and/or guidelines, and plans to improve water quality.

6.3.1 Beneficial Uses of Surface Waters in the Study Area

Water quality conditions throughout the study area are assessed and described by the RWQCB Basin Plans and Integrated Reports. Each region has specific beneficial uses, as summarized in Table 6.2 and water quality constituents of concern; however, several pollutants are prevalent throughout the study area. The origins and prevalence of these pollutants are discussed below.

Table 6.2 Designated Beneficial Uses within Project Study Area

Surface Water Body	Municipal and Domestic Supply (MUN)	Agricultural Supply (AGR)	Industrial Service Supply (IND)	Industrial Process Supply (PRO)	Groundwater Recharge (GWR)	Fresh water Replenishment (FRSH)	Navigation (NAV)	Hydropower Generation (POW)	Water Contact Recreation (REC-1)	Non-Contact Water Recreation (REC-2)	Commercial and Sport Fishing (COMM)	Warm Fresh water Habitat (WARM)	Cold Fresh water Habitat (COLD)	Wildlife Habitat (WILD)	Rare, Threatened, or Endangered Species (RARE)	Marine Habitat (MAR)	Migration of Aquatic Organisms (MIGR)	Spawning, Reproduction, and/or Early Development (SPWN)	Shellfish Harvesting (SHELL)	Estuarine Habitat (EST)	Aquaculture (AQUA)	Native American Culture (CUL)	Flood Peak Attenuation/ Flood Water Storage (FLD)	Wetland Habitat (WET)	Water Quality Enhancement (WQE)
Trinity and Lower Klamath Rivers																									
Lower Klamath River and Klamath Glen Hydrologic Subarea	E	E	P	P	E	E	E	P	E	E	E	E	E	E	E	E	E	E	E	E	P	E	–	–	–
Trinity Lake	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	–	P	E	–	–	P	–	–	–	–
Lewiston Reservoir	E	E	P	P	E	E	E	E	E	E	E	P	E	E	E	–	P	E	–	–	E	–	–	–	–
Middle Trinity River and Surrounding Hydrologic Area	E	E	E	P	E	E	E	P	E	E	E	–	E	E	E	–	E	E	–	–	E&P	–	–	–	–
Lower Trinity River and Surrounding Hydrologic Area[1]	E&P	E&P	E	E&P	E	E	E	E&P	E	E	E	–	E	E	E	–	E	E	P	–	E&P	E[2]	–	–	–
Sacramento River Basin																									
Shasta Lake	E	E	–	–	–	–	–	E	E	E	–	E[4]	E[4]	E	–	–	–	E[5,6]	–	–	–	–	–	–	–

Surface Water Body	Municipal and Domestic Supply (MUN)	Agricultural Supply (AGR)	Industrial Service Supply (IND)	Industrial Process Supply (PRO)	Groundwater Recharge (GWR)	Fresh water Replenishment (FRSH)	Navigation (NAV)	Hydropower Generation (POW)	Water Contact Recreation (REC-1)	Non-Contact Water Recreation	Commercial and Sport Fishing	Warm Fresh water Habitat (WARM)	Cold Fresh water Habitat (COLD)	Wildlife Habitat (WILD)	Rare, Threatened, or Endangered Species (RARE)	Marine Habitat (MAR)	Migration of Aquatic Organisms (MIGR)	Spawning, Reproduction, and/or Early Development (SPWN)	Shellfish Harvesting (SHELL)	Estuarine Habitat (EST)	Aquaculture (AQUA)	Native American Culture (CUL)	Flood Peak Attenuation/ Flood Water Storage (FLD)	Wetland Habitat (WET)	Water Quality Enhancement (WQE)
Sacramento River: Shasta Dam to Colusa Basin Drain	E	E	E	–	–	–	E	E	E^{3}	E	–	E^{4}	E^{4}	E	–	–	$E^{5,6}$	$E^{5,6}$	–	–	–	–	–	–	–
Colusa Basin Drain	–	E	–	–	–	–	–	–	E^{3}	–	–	E^{4}	P^{4}	E	–	–	E^{6}	E^{6}	–	–	–	–	–	–	–
Sacramento River: Colusa Basin Drain to Eye (“I”) Street Bridge	E	E	–	–	–	–	E	–	E^{3}	E	–	E^{4}	E^{4}	E	–	–	$E^{5,6}$	$E^{5,6}$	–	–	–	–	–	–	–
Whiskeytown Lake	E	E	–	–	–	–	–	E	E	E	–	E^{4}	E^{4}	E	–	–	–	E^{6}	–	–	–	–	–	–	–
Clear Creek below Whiskeytown Lake	E	E	–	–	–	–	–		E^{3}	E	–	E^{4}	E^{4}	E	–	–	E^{5}	$E^{5,6}$	–	–	–	–	–	–	–
Feather River below Lake Oroville (Fish Barrier Dam to Sacramento River)	E	E	–	–	–	–	–	–	E^{3}	E	–	E^{4}	E^{4}	E	–	–	$E^{5,6}$	$E^{5,6}$	–	–	–	–	–	–	–

Surface Water Body	Municipal and Domestic Supply (MUN)	Agricultural Supply (AGR)	Industrial Service Supply (IND)	Industrial Process Supply (PRO)	Groundwater Recharge (GWR)	Fresh water Replenishment (FRSH)	Navigation (NAV)	Hydropower Generation (POW)	Water Contact Recreation (REC-1)	Non-Contact Water Recreation (REC-2)	Commercial and Sport Fishing (COMM)	Warm Fresh water Habitat (WARM)	Cold Fresh water Habitat (COLD)	Wildlife Habitat (WILD)	Rare, Threatened, or Endangered Species (RARE)	Marine Habitat (MAR)	Migration of Aquatic Organisms (MIGR)	Spawning, Reproduction, and/or Early Development (SPWN)	Shellfish Harvesting (SHELL)	Estuarine Habitat (EST)	Aquaculture (AQUA)	Native American Culture (CUL)	Flood Peak Attenuation/ Flood Water Storage (FLD)	Wetland Habitat (WET)	Water Quality Enhancement (WQE)
American River below Lake Natoma (Folsom Dam to Sacramento River)	E	E	E	–	–	–	–	E	E^{3}	E	–	E^{4}	E^{4}	E	–	–	$E^{5,6}$	$E^{5,6}$	–	–	–	–	–	–	–
Yolo Bypass[7]	–	E	–	–	–	–	–	–	E	E	–	E^{4}	P^{4}	E	–	–	$E^{5,6}$	E^{6}	–	–	–	–	–	–	–
Sacramento-San Joaquin River Delta																									
Sacramento-San Joaquin River Delta[7,8,9]	E	E	E	E	E	–	E	–	E	E	E	E^{4}	E^{4}	E	E	–	$E^{5,6}$	E^{6}	E	E	–	–	–	–	–
San Joaquin River and Tulare Basin																									
San Joaquin River: Friant Dam to Mendota Pool	E	E	–	E	–	–			E^{3}	E	–	E^{4}	E^{4}	E	–	–	$E^{5,6}$	E^{6}, P^{5}	–						
San Joaquin River: Mendota Dam to the Mouth of Merced River	P	E	–	E	–	–			E^{3}	E	–	E^{4}	–	E	–		$E^{5,6}$	E^{6}, P^{5}	–						

Surface Water Body	Municipal and Domestic Supply (MUN)	Agricultural Supply (AGR)	Industrial Service Supply (IND)	Industrial Process Supply (PRO)	Groundwater Recharge (GWR)	Fresh water Replenishment (FRSH)	Navigation (NAV)	Hydropower Generation (POW)	Water Contact Recreation (REC-1)	Non-Contact Water Recreation (REC-2)	Commercial and Sport Fishing (COMM)	Warm Fresh water Habitat (WARM)	Cold Fresh water Habitat (COLD)	Wildlife Habitat (WILD)	Rare, Threatened, or Endangered Species (RARE)	Marine Habitat (MAR)	Migration of Aquatic Organisms (MIGR)	Spawning, Reproduction, and/or Early Development (SPWN)	Shellfish Harvesting (SHELL)	Estuarine Habitat (EST)	Aquaculture (AQUA)	Native American Culture (CUL)	Flood Peak Attenuation/ Flood Water Storage (FLD)	Wetland Habitat (WET)	Water Quality Enhancement (WQE)
San Joaquin River: Mouth of Merced River to Vernalis	P	E	–	E	–				E[3]	E	–	E[4]	–	E	–		E[5,6]	E[6]	–	–	–	–	–	–	–
New Melones Reservoir	E	E	–	–	–	–	–	E	E	E	–	–	E[4]	E	–	–	–	–	–	–	–	–	–	–	–
Tulloch Reservoir	P	E	–	–	–	–	–	E	E	E	–	E[4]	–	E	–	–	–	–	–	–	–	–	–	–	–
Stanislaus River: Goodwin Dam to San Joaquin River	P	E	E	E	–	–	–	E	E[3]	E	–	E[4]	E[4]	E	–	–	E[5]	E[5,6]	–	–	–	–	–	–	–
San Luis Reservoir	E	E	E	–	–	–	–	E	E	E	–	E[4]	–	E	–	–	–	–	–	–	–	–	–	–	–
O'Neill Reservoir	E	E	–	–	–	–	–	–	E	E	–	E[4]	–	–	–	–	–	–	–	–	–	–	–	–	–
California Aqueduct	E	E	E	E	–	–	–	E	E	E	–	–	–	E	–	–	–	–	–	–	–	–	–	–	–
Delta-Mendota Canal	E	E	–	–	–	–	–	–	E	E	–	E[4]	–	E	–	–	–	–	–	–	–	–	–	–	–

6.3.1.1 Water Temperature

Water temperature is a concern in regions throughout California including the lower Klamath River, Trinity Lake, Sacramento River, and the San Joaquin River. These regions support warm and cold fresh water habitat and other aquatic beneficial uses. Water bodies in these areas must maintain water temperatures supportive of resident and seasonal fish species habitats, particularly for endangered species. Common narrative and numeric water quality objectives for water temperature in water bodies within the study area are specified in each of the basin plans for the North Coast, Central Valley, Tulare Lake and the San Francisco Bay regions (NCRWQCB 2011; CVRWQCB 2004, and 2011; SFB RWQCB 2013):

- The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses.
- At no time or place shall the temperature of cold or warm-intrastate waters be increased by more than 5° F above natural receiving water temperature.

Water quality objectives for water temperature within the project study area are also specified in the SWRCB *Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California (Statewide Temperature Plan)*.

Further information on the measurement and enforcement of water quality objectives for temperature is included in the Statewide Temperature Plan (SWRCB 1998).

6.3.1.2 Salinity

Salinity, a measure of dissolved salts in water, is a concern in the tidally-influenced Delta as it can cause impacts on domestic supply, agriculture, industry, and wildlife (CALFED 2007). The impacts of salinity on the domestic supply of water in the Delta include aesthetic (skin or tooth discoloration), or cosmetic (taste, odor, or color) effects, and increasing other quality concerns by blending which can lead to a reduction in the quantity of usable water. Salts, such as bromide, in drinking water can indicate the formation of harmful byproducts (see the Bromide, Organics, and Pathogens section). Agriculture is impacted by salinity in the Delta by reducing crop yields and salinity in the soil can cause plant stress. Another salt ion, chloride, in high concentrations in municipal and industrial supply has been known to cause corrosion in canned goods because of residual salts in paper boxes or linerboard.

Some fish and wildlife are also affected by salinity concentrations in the Delta because certain levels of salinity are required during different life stages to survive. On measure of salinity in the western Delta is “X2.” X2 refers to the horizontal distance from the Golden Gate Bridge up the axis of the Delta estuary to where tidally averaged near-bottom salinity concentration of 2 parts of salt in 1,000 parts of water occurs. The X2 standard was established to improve shallow water estuarine habitat in the months of February through June and relates to the extent of salinity movement into the Delta (DWR, Reclamation, USFWS and NMFS 2013). The location of X2 is important to both aquatic life and water supply beneficial uses.

The SWRCB D-1641 includes "spring X2" criteria that require operations of the CVP and SWP upstream reservoir releases from February through June to maintain freshwater and estuarine conditions in the western Delta to protect aquatic life. In addition, the 2008 U.S. Fish and Wildlife Service (USFWS) Biological Opinion (BO) also includes an additional Delta salinity requirement in September and October in wet and above normal water years (Fall X2), as described in Chapter 5, Surface Water Resources and Water Supplies.

6.3.1.3 Mercury

Mercury is a constituent of concern throughout California, both as total mercury and as biologically-formed methylmercury, which is more available for food chain exposure and toxicity. Mercury present in the Delta, its tributaries, Suisun Marsh, and San Francisco Bay is derived both from current processes and as a result of historical deposition. Most of the mercury present in these locations is the result of historical mining of mercury ore in the Coast Ranges (via Putah and Cache creeks to the Yolo Bypass) and the extensive use of elemental mercury to aid gold extraction processes in the Sierra Nevada (via Sacramento, San Joaquin, Cosumnes, and Mokelumne rivers) (Alpers et al. 2008; Wiener et al. 2003). Elemental mercury from historical gold mining processes appears to be more bioavailable than that from mercury ore tailings because mercury used in gold mining processes was purified before use (CVRWQCB 2010a). Additional sources of mercury include atmospheric deposition from both local and distant sources, and discharges from wastewater treatment plants (SWRCB 2014a).

Methylation of mercury is an important step in the entrance of mercury into food chain (USEPA 2001a). This transformation can occur in both sediment and the water column. Methylmercury is absorbed more quickly by aquatic organisms than inorganic mercury, and it biomagnifies (i.e., increases the concentration of methylmercury in predatory fish from eating smaller contaminated fish and invertebrates). The pH of water, the length of the aquatic food chain, water temperature, and dissolved organic material and sulfate are all factors that can contribute to the bioaccumulation of methylmercury in aquatic organisms. The proportion of an area that is wetlands, the soil type, and erosion can also contribute to the amount of mercury that is transported from soils to water bodies. These effects can be seen in the variability in bioaccumulated mercury in the Sacramento-San Joaquin River Delta.

Consumption of contaminated fish is the major pathway for human exposure to methylmercury (USEPA 2001a). Once consumed, methylmercury is almost completely absorbed into the blood and transported to all tissues, and is also transmitted to the fetus through the placenta. Neurotoxicity from methylmercury can result in mental retardation, cerebral palsy, deafness, blindness, and dysarthia in utero, and in sensory and motor impairments in adults. Cardiovascular and immunological effects from low-dose methylmercury exposure have also been reported.

In an effort to protect aquatic and human health, USEPA recommended maximum concentrations “without yielding unacceptable effects” in 2001 for acute exposure, identified as the criteria maximum concentration (CMC), and for chronic exposure, identified as the criterion continuous concentration (CCC) (USEPA 2001a and USEPA 2014a). Current state-wide water quality criteria for mercury were established in the CTR in 2000 (USEPA 2000a). Under these requirements, total recoverable mercury for the protection of human health was set as limits for consumption of water and organisms as well as consumption of organisms only, as summarized in Table 6.3. Mercury objectives are also included in some California RWQCB basin plans, as discussed in subsequent sections of this chapter. Where both a CTR criterion and a Basin Plan objective exist, the more stringent value applies (SWRCB 2006a).

Table 6.3 Water Quality Criteria for Mercury and Methylmercury (as Total Mercury)

NRWQC	For the protection of freshwater species		CMC = 1.4 µg/l
			CCC = 0.77 µg/l
	For the protection of saltwater species		CMC = 1.8 µg/l
			CCC = 0.94 µg/l
	For the protection of human health[1]		0.3 mg/kg [2]
CTR	For the protection of human health	Consumption of water + organism	0.050 µg/l
		Consumption of organism only	0.051 µg/l

Source: NRWQC (National Recommended Water Quality Criteria) - USEPA 2014a; CTR (California Toxic Rule) - USEPA 2000a, USEPA 2001b

Notes:

1. For the consumption of organisms only and based on a total consumption 0.0175 kg fish and shellfish per day.

2. Methylmercury in fish tissue (wet weight)

A review of the mercury human health criteria by USEPA in 2001 concluded that a fish tissue (including shellfish) residue water quality criterion for methylmercury is more appropriate than a water-column-based water quality criterion (USEPA 2001a). A fish tissue criterion directly addresses the dominant human exposure route for methylmercury, and thus is more closely tied to the CWA goal of protecting public health. The USEPA also strongly encourages States and authorized Tribes to develop local or regional water quality criteria if they will be more appropriate for the target population.

The SWRCB is considering adopting statewide objectives for methylmercury based on the USEPA criteria, which would apply to inland waters, enclosed bays, and estuaries (SWRCB 2006a). These objectives would be applicable to waters that are not listed as impaired or that do not require a TMDL. Potential elements include a methylmercury fish tissue objective, a total mercury water quality objective, a methylmercury water quality objective, or some combination of these. Implementation procedures related to the NPDES permitting process also may be included.

The CTR criterion may be implemented as a fish tissue-based objective (FTO), or it may be converted into an ambient methylmercury water quality objective (AWQO), the latter reflecting the USEPA's fish consumption rate of 0.0175 kg fish/day, or site-specific consumption rates that more accurately reflect local consumption patterns (SWRCB 2006a). A USFWS evaluation of the USEPA criterion for methylmercury concluded that the FTO of 0.3 mg methylmercury/kg fish would be insufficient to protect three species that may occur in the study area including California Least Tern, California Clapper Rail, and Bald Eagle evaluated in the study.

6.3.1.4 Selenium

Selenium is a constituent of concern in the project area because of its potential effects on water quality and on aquatic and terrestrial resources primarily in the San Joaquin Valley and the San Francisco Bay, as well as some locations in Southern California (SWRCB 2011a). Elevated concentrations of selenium in soil and waterways within the San Joaquin Valley, and to some extent in the San Francisco Bay, are due primarily to erosion of uplifted selenium-enriched Cretaceous and Tertiary marine sedimentary rock located at the base of the east-facing side of the Coastal Range (Presser and Piper 1998; Presser 1994). The selenium-enriched soil derived from the eroded rock has been transported to the western San Joaquin Valley through natural processes; selenium is mobilized from the soil by irrigation practices and transported to waterways receiving agricultural drainage (Presser and Ohlendorf 1987). Other sources of selenium to the western Delta and San Francisco Bay include several oil refineries located in the vicinity of Carquinez Strait and San Pablo Bay (Presser and Luoma 2013; SWRCB 2011a). The specific water bodies within these areas that may be affected by the project and are impaired by selenium, as specified on the California CWA Section 303(d) list, include the Panoche Creek (from Silver Creek to Belmont Avenue), Mendota Pool, Grasslands Marshes, San Joaquin River (from Mud Slough to Merced River), Sacramento-San Joaquin Delta, and Suisun Bay (SWRCB 2011a).

Adverse effects of selenium may occur as a result of either a selenium deficiency or excess in the diet (ATSDR 2003; Ohlendorf 2003); the latter is the primary concern in the case of the impaired water bodies on the 303(d) list. Because of the known effects of selenium bioaccumulation from water to aquatic organisms and to higher trophic levels in the food chain, the fresh water, estuarine and wildlife habitat; spawning, reproduction, and/or early development; and rare, threatened, or endangered species beneficial uses of the water bodies are the most sensitive receptors to selenium exposure. Thus, excessive exposure can lead to selenium toxicity or selenosis and result in death or deformities of fish embryos, fry, or larvae (Ohlendorf 2003, Janz et al. 2010). Consequently, regulatory agencies have established exposure criteria to protect the beneficial uses of the water bodies.

Agencies such as the Agency for Toxic Substances and Disease Registry (ATSDR), California Office of Environmental Health Hazard Assessment (OEHHA), USEPA, SWRCB, and RWQCBs have determined acceptable selenium exposure levels for humans and water bodies in California. The ATSDR has stated the minimum risk levels (MRLs) for selenium to be ingested over a one-year period is 0.005 mg/kg/day, with an uncertainty factor of 3 (ATSDR 2013a). The 0.005 mg/kg/day value is also used by OEHHA to develop guidelines for consuming fish (OEHHA 2008). USEPA has set 50 µg/l as the maximum MCL for selenium in drinking water and OEHHA has set a more stringent draft public health goal (PHG) of 30 µg/l for selenium in drinking water (USEPA 2009a; OEHHA 2010). USEPA has also specified through the California Toxics Rule that the water quality criteria for aquatic life in all of California's fresh water bodies except for the San Joaquin River from Merced River to Vernalis are 20 µg/l for short-term (1-hour average) and 5 µg/l for long-term (4-day average) exposure (USEPA 2000a). For the San Joaquin River from Merced River to Vernalis, the short-term exposure is 12 µg/l and long-term limit is 5 µg/l, as stated in the Sacramento-San Joaquin River Basin Plan (CVRWQCB 2011). The water quality criteria for aquatic life in all of California's water bodies is 5 µg/l (4-day average exposure) and 20 µg/l (1-hour exposure) (USEPA 2014a).

The USEPA, Reclamation, the SWRCB, and the RWQCBs have created plans to reduce the toxic levels of selenium in California's impaired water bodies. The USEPA's Action Plan consists of recommendations to restore water quality and to protect aquatic species in the San Francisco Bay and Sacramento-San Joaquin Delta, which include strengthening selenium water quality criteria to reduce long-term exposure of sensitive aquatic and terrestrial species to selenium (USEPA 2012a). Grasslands Marshes, located in the San Joaquin Valley, include an area contaminated with selenium from agricultural irrigation and drainage practices when the marshes were irrigated with a blend of subsurface agricultural drainage water and higher-quality water. Reclamation's Grasslands Bypass Project reroutes the discharge of selenium-laden subsurface agriculture water from upstream agricultural dischargers that formerly passed through the Grassland Water District and nearby wildlife refuges and wetlands to Mud Slough by conveying it through a portion of the San Luis Drain. The project began in 1996 and has since reduced the selenium load discharged from the Grassland Drainage Area from 9,600 lbs to 2,200 lbs in 2011 (GBPOC 2013). Both the USEPA Action Plan and the Grasslands Bypass Project reduce selenium levels in waterways to meet the water quality objective targeted for December 2019. The CVRWQCB released a draft waste discharge requirement in May 2014 that suggests a performance goal of 15 µg/l (monthly mean) and water quality objective of 5 µg/l (4-day average) for Mud Slough (north) and the San Joaquin River (CVRWQCB 2014a). This water quality objective for a 4-day average selenium concentration is consistent with the TMDL for the lower San Joaquin River (CVRWQCB 2001). The USEPA also released draft water quality criteria for the protection of freshwater aquatic life from toxic effects of selenium, shown in Table 6.4 (USEPA 2014b).

Table 6.4 Draft Water Quality Criteria for Selenium

Media Type	Fish Tissue	–	Water Column[3]	–
Criterion Element	Egg/Ovary[1]	Fish Whole-Body or Muscle[2]	Monthly Average Exposure	Intermittent Exposure[4]
Magnitude	15.2 mg/kg	8.1 mg/kg whole body or 11.8 mg/kg muscle (skinless, boneless filet)	1.3 µg/l in lentic aquatic systems 4.8 µg/l in lotic aquatic systems	$WQC_{int} = \frac{WQC_{30-day} - C_{bkgrnd}(1 - f_{int})}{f_{int}}$
Duration	Instantaneous measurement[5]	Instantaneous measurement[5]	30 days	Number of days/month with an elevated concentration

Source: USEPA 2014b

1. Overrides any whole-body, muscle, or water column elements when fish egg/vary concentrations are measured.

2. Overrides any water column element when both fish tissue and water concentrations are measured,

3. Water column values are based on dissolved total selenium in water

4. Where $WQC_{30\text{-}day}$ is the water column monthly element, for either a lentic or lotic system, as appropriate. C_{bkgrnd} is the average background selenium concentration, and f_{int} is the fraction of any 30-day period during which elevated selenium concentrations occur, with f_{int} assigned a value ≥0.033 (corresponding to 1 day).

5. Instantaneous measurement. Fish tissue data provide point measurements that reflect integrative accumulation of selenium over time and space in the fish at a given site. Selenium concentrations in fish tissue are expected to change only gradually over time in response to environmental fluctuations.

6.3.1.5 Nutrients

Nutrients are a constituent of concern in the lower Klamath River hydrologic area (Klamath Glen HSA) and the Suisun Marsh Wetlands (SWRCB 2011a) (Klamath Glen HSA; SWRCB 2011a). Nutrients, such as nitrogen and phosphorus, come from natural sources such as weathering of rocks and soil, and from the ocean when nutrients are mixed in the water current, as well as animal manure, atmospheric deposition, and nutrient recycling in sediment (NOAA 2014; USEPA 1998). Anthropogenic sources include fertilizers, detergents, sewage treatment plants, septic systems, combined sewer overflows, and sediment mobilization (USEPA 1998).

Nutrients are essential to maintaining a healthy water system. However, over enrichment of nitrogen and phosphorus can contribute to a process known as eutrophication where there is an excessive growth of macrophytes, phytoplankton, or potentially toxic algal blooms. Eutrophication may also lead to a decrease of dissolved oxygen, typically at night, when plants stop producing oxygen through photosynthesis but continue to use oxygen. Low dissolved oxygen levels can kill fish, cause an imbalance of prey and predator species, and result in a decline in aquatic resources (USEPA 1998). Severely low dissolved oxygen conditions are referred to as anoxic and may enhance methylmercury production (SFB RWQCB

2012a). Over enrichment can also contribute to cloudy or murky water clarity by increasing the amount of materials (i.e., algae) suspended in the water.

6.3.1.6 Dissolved Oxygen

Dissolved oxygen is a constituent of concern in the project area primarily in the lower Klamath River, Sacramento-San Joaquin River Delta, and Suisun Marsh Wetlands (SWRCB 2011a). Oxygen in water comes primarily from the atmosphere through diffusion at the water surface, as well as from groundwater discharge into streams and when plants undergo photosynthesis releasing oxygen in exchange for carbon dioxide (USGS 2014; NOAA 2008a). Levels of dissolved oxygen vary with several factors including season, time of day, water temperature, salinity, and organic matter. The season and time of day dictate photosynthesis processes, which require sunlight. Increases in water temperature and salinity reduce the solubility of oxygen (NOAA 2008b). Fungus and the bacteria use oxygen when decomposing organic matter in water bodies. So, the more organic matter present in a water body, the more potential for dissolved oxygen levels to decline.

Adverse effects of low dissolved oxygen are a concern for water quality and aquatic organisms. Low dissolved oxygen impairs growth, immunity, reproduction, habitat through avoidance, and causes asphyxiation and death (NCRWQCB 2011).

To protect aquatic life, USEPA has established water quality standards for dissolved oxygen (USEPA 1986a). However, to protect the beneficial uses of California’s water bodies (Table 6.2), including warm and cold freshwater habitats in both tidal and non-tidal waters, site-specific water quality objectives were established.

Future plans to maintain a healthy level of dissolved oxygen in water bodies are also site-specific, such as plans for the San Joaquin River and the Stockton Deep Water Ship Channel (CVRWQCB 2011).

6.3.1.7 Pesticides

Pesticides are constituents of concern throughout the study area and particularly in the Central Valley. Major pesticides of concern include organophosphate (OP) pesticides – primarily diazinon and chlorpyrifos, and organochlorine (OC) pesticides – mainly Dichloro-Diphenyl-Trichloroethane (DDT) and Group A compounds. The toxicity and fates of these pesticides are described in the following sections.

6.3.1.7.1 Organophosphate Pesticides

The two most prevalent OP pesticides in the study area are man-made pesticides, diazinon and chlorpyrifos, which have been used extensively in agricultural and residential applications. Former and current uses of diazinon and chlorpyrifos have resulted in the contamination of water bodies throughout the Central Valley, as identified on the 303(d) list (SWRCB 2011a). The CVRWQCB has also identified hot spots of contamination, particularly in the Delta and in urban areas of Stockton and Sacramento (CVRWQCB 2003).

Pesticides are primarily transported into streams and rivers in runoff from agriculture (CVRWQCB 2011) but also occur or have occurred in urban non-point runoff and stormwater discharges. Treated municipal wastewater can also be a point source. However, OP pesticides, diazinon and chlorpyrifos, have been banned from non-agricultural uses since December 31st, 2004 and December, 2001, respectively. Reported non-agricultural pesticide use of diazinon and chlorpyrifos declined substantially in some counties between 2000 and 2009 (CVRWQCB 2014b). However, the reduction of OP pesticide use has resulted in the increasing use of pyrethroids and carbamates as alternative pesticides in urban and agricultural areas.

Diazinon was one of the most common insecticides in the U.S. for household lawn and garden pest control, indoor residential crack and crevice treatments and pet collars until all residential uses of diazinon were phased out, between 2002 and 2004 (USEPA 2004). Diazinon usage was then prohibited for several agricultural uses in 2007, with only a few remaining agricultural uses permitted, including uses on some fruit, vegetable, nut and field crops, and as an ear-tag on non-lactating cattle (USEPA 2007). The highest continued use of diazinon is on almonds and stone fruits (USEPA 2004).

6.3.1.7.2 Organochlorine Pesticides

Organochlorine (OC) pesticides are mainly comprised of Dichloro-Diphenyl-Trichloroethane (DDT) and Group A Pesticides (CVRWQCB 2010b). DDT is a persistent chemical that binds tightly to soil and sediment, and breaks down slowly in the environment. It degrades to the isomers o,p'- and p,p'- DDT; o,p'- and p,p'-Dicholoro-Diphenyl-Dichloroethylene (DDE) and o,p'- and p,p'-Dichloro-Diphenyl-Dichloroethane (DDD). Group A Pesticides are made up of the total concentration of the OC pesticides: aldrin, dieldrin, endrin, heptachlor, heptachlor epoxide, chlordane (total), hexachlorocyclohexane (total) including Lindane (gamma-BHC), alpha-BHC, endosulfan (total), and toxaphene. These pesticides have similar chemical properties to DDT and are also persistent in the environment.

Transport of OC pesticides into streams and rivers is primarily from agriculture runoff (CVRWQCB 2011). Other potential point sources of OC pesticides include storm sewer discharges and historic spills. Non-point sources can include areas of previous residential applications, open space and channel erosion, and some background sources through wet and dry atmospheric deposition. Most OC pesticides were previously deposited on terrestrial soils, thus erosion and transport of contaminated sediments continue to contribute to detectable levels in stream bed sediment (CVRWQCB 2010b).

OC pesticides have historically been used as insecticides, fungicides and antimicrobial chemicals in residential and agricultural pest control (CVRWQCB 2010b). Most were banned in the mid-1970s, and fish tissue concentrations declined rapidly since the ban through the mid-1980s (Greenfield et al., 2004);

however, they continue to be detected in fish tissue, the water column, and sediment in the Central Valley.

6.3.1.7.3 Other Pesticides

Diuron (3-(3,4-dichlorophenyl)-1,1-dimethylurea or DCMU) was introduced in 1954 and is currently is one of the most-used herbicides in California (CVRWQCB 2012b). It is an herbicide that inhibits photosynthesis and is targeted on controlling annual broadleaf and grassy weeds. EPA has not developed a WQC specific to Diuron but a TMDL in development will include the development of WQO for Diuron in the Central Valley.

6.3.1.7.4 General Pesticide Regulations

In addition to the existing water quality objectives and FCGs for pesticides in the study area, a Basin Plan Amendment for the Sacramento and San Joaquin River watersheds and the Delta is in progress to address those pesticides which currently impact or could potentially impact aquatic life uses in surface waters. The Basin Plan Amendment will include the establishment of numeric water quality objectives for these selected pesticides. By addressing a greater grouping of pesticides than those included in the current Section 303(d) impaired water body list, the Basin Plan Amendment will help prevent the increased use of those pesticides not included on the 303(d) list (CVRWQCB 2006a).

6.3.1.8 Polychlorinated Biphenyls (PCBs)

Polychlorinated biphenyls, a group of synthetic organic chemicals, is a constituent of concern throughout California including the Sacramento River region (Sacramento River, Feather River, and American River), the Sacramento-San Joaquin River Delta, Suisun Bay, Carquinez Strait, and San Pablo Bay (SWRCB 2011a). PCBs cause harmful environmental effects and also pose a risk to human health (ATSDR 2000).

PCBs are mixtures of a variety of individual chlorinated biphenyl components, known as congeners. In the United States, many of these mixtures were sold under the trade name Aroclor, manufactured from 1930 to 1977 primarily for use as coolants and lubricants in transformers, capacitors, and other electrical equipment. Although manufacture was banned in 1979, PCBs continue to cause environmental degradation because they are environmentally persistent, easily redistributed between air, water and soil, and tend to accumulate and biomagnify in the food chain (ATSDR 2000, OEHHA 2008).

The “weathering” of PCBs is a process by which the composition of Aroclor mixtures undergo differential partitioning, degradation, and biotransformation. This results in differential environmental persistence and bioaccumulation of the mixtures, where these increase with the degree of chlorination of new mixtures. (OEHHA 2008). The biphenyls with more chlorine atoms tend to be heavier and remain close to the source of contamination, whereas those with fewer chlorine atoms are easily transported in the atmosphere. Atmospheric deposition is the primary source of PCBs to surface waters, although redissolution of sediment-bound PCBs also contributes to surface water contamination. PCBs leave the water column through sorption to suspended solids, volatilization from water surfaces, and concentration in plants and animals (ATSDR 2000).

PCBs cannot be distinctly assessed for health effects, as their toxicity is determined by the interactions of individual congeners and by the interactions of PCBs with other structurally related chemicals, including those combined with or used in the production of PCBs. However, several general health effects of PCB exposure have been identified. When PCBs are absorbed, they are distributed throughout the body and accumulate in lipid-rich tissues, including the liver, skin tissue, and breast milk. They can also be transferred across the placenta to the fetus. Studies have linked oral exposure to cancer and to adverse neurological, reproductive, and developmental effects. The International Agency for Research on Cancer has thus listed PCBs as probable human carcinogens, and OEHHA has administratively listed PCBs on the Proposition 65 list of chemicals known to the State of California to cause cancer (OEHHA 2008).

6.3.2 Trinity River Region

The Trinity River Region includes the area in Trinity County along the Trinity River from Trinity Lake to the confluence with the Klamath River; and in Humboldt and Del Norte counties along the Klamath River from the confluence with the Trinity River to the Pacific Ocean.

This water quality analysis includes Trinity Lake, Lewiston Lake, Trinity River downstream of Lewiston Dam, and the Klamath River from its confluence with the Trinity River to the Pacific Ocean. The analysis does not include Trinity River upstream of Trinity Lake, the South Fork of the Trinity River, or the Klamath River upstream of Trinity River, because these areas are not affected by changes in CVP operations.

Several water quality requirements affect the Klamath River and Trinity River basins. Beneficial uses and water quality objectives provided by the NCRWQCB and the Hoopa Valley Tribal Environmental Protection Agency (Hoopa Valley TEPA) are described below, as well as relevant TMDLs. The Yurok Tribe Basin Plan for the Yurok Indian Reservation and the Resighini Rancheria Tribal Water Quality Ordinance also regulate portions of the Trinity and Klamath Rivers that flow into and through the reservations; however, because they have not yet been approved by the USEPA, their objectives are not described in detail here. Oregon water quality requirements also affect the water quality of the Klamath River which originates in Oregon. However, this chapter only discusses the requirements within the Trinity and lower Klamath River Basins.

6.3.2.1 Beneficial Uses

Beneficial uses for all water bodies in the study area are determined by the NCRWQCB and the Hoopa Valley TEPA (Table 6.2). In addition to the beneficial uses listed in the Trinity and Klamath River basins, the North Coast Basin Plan notes that recreational use (i.e., water contact recreation [REC-1] and non-contact water recreation [REC-2]) occurs in all hydrologic units of the Klamath River Basin, with Trinity River being one of the rivers receiving the largest levels of recreational use (NCRWQCB 2011). Fish and wildlife reside in virtually all of the surface waters within the North Coast Region (NCRWQCB 2011). These species include several that are designated as rare, threatened and endangered. Trinity Dam also provides the beneficial use of hydroelectric power (i.e., POW).

6.3.2.2 Constituents of Concern

The constituents of concern that are currently not in compliance with existing water quality standards and for which TMDLs are adopted or are in development are summarized in Table 6.1 and discussed below.

6.3.2.2.1 Water Temperature

The majority of the Trinity and Klamath Rivers are not listed on the 303(d) list approved by the USEPA in 2010 as impaired by water temperature. However, the hydrologic area of the South Fork Trinity River and the lower hydrologic area of the Klamath River (Klamath Glen HSA) are listed for elevated water temperatures adversely affecting the cold freshwater habitat (SWRCB 2011c-h).

The Trinity River and lower Klamath River watersheds must maintain water temperatures to protect and support resident and seasonal fish species habitats. The North Coast Basin Plan designates narrative and numeric water temperature objectives applicable to surface waters in the Trinity River and the lower Klamath River basins. Other objectives and criteria specific to each region are specified below.

Trinity River

The South Fork Trinity River flows from its headwaters to the confluence with the mainstem of the Trinity River. It then flows into the lower Klamath River and out to the Pacific Ocean. Elevated water temperatures in the South Fork Trinity River can be attributed to the loss of shade trees due to habitat modification, range grazing-riparian, removal of riparian vegetation, streambank modification/destabilization, and water diversions (SWRCB 2011d). This reach supports steelhead, Chinook Salmon, and Coho Salmon (below Grouse Creek) (USDAFS 2014). The mainstem of the Trinity River also supports steelhead, Coho Salmon, and Chinook Salmon.

Water temperature objectives, summarized in Table 6.5, were set forth in the North Coast Basin Plan specifically applicable to the Trinity River, from Lewiston Dam to Douglas City and to the confluence with the North Fork Trinity River. These criteria are reach dependent, and vary seasonally. They were specifically developed to enhance the productivity of Trinity River Fish Hatchery, specifically for salmon and steelhead trout populations (NCRWQCB 2011).

Table 6.5 Water Quality Objectives for Temperature in the Trinity River

Period	Daily Average Temperature Not to Exceed	Trinity River Reach
July 1 – September 14	60° F	Lewiston Dam to Douglas City Bridge
September 15 – October 1	56° F	Lewiston Dam to Douglas City Bridge
October 1 – December 31	56° F	Lewiston Dam to confluence of North Fork Trinity River

Source: NCRWQCB 2011

Hoopa Valley Indian Reservation

Natural causes of temperature exceedances, such as unusually excessive ambient air temperatures coupled with flows, intended to protect aquatic habitat specified in the Trinity River Flow Evaluation report (TRFE), as well as naturally low stream flows, streamside shade, and solar radiation, among others, will not be considered to violate the water quality objectives stated in the Hoopa Valley Indian Reservation Basin Plan.

Temperature objectives for the Trinity River as it passes through the Hoopa Valley Reservation vary seasonally and are precipitation dependent (Table 6.6).

The water quality objectives are based on temperature-flow relationships that maintain TRFE flow regimes and protect adult salmonids holding and spawning. The objectives are also consistent with the temperature standards specified in the NCRWQCB Basin Plan (Hoopa Valley TEPA 2008).

Table 6.6 Trinity River Temperature Criteria for the Hoopa Valley Indian Reservation

Dates	Running 7-Day Average Temperature not to Exceed[1,2]	
	Extremely Wet, Wet and Normal Water Years	Dry and Critically Dry Water Years
May 23 – June 4	59º F	62.6º F
June 5 – July 9	62.6º F	68º F
July 10 – September 14	72.0º F	74.0º F[3]
September 15 – October 31	66.0º F	66.0º F
November 1 – May 22	55.4º F	59.0º F

Source: Adapted from Hoopa Valley TEPA 2008

1. Temperature standards will be monitored at the Weitchpec temperature monitoring station operated and maintained by Reclamation.

2. Temperature standard violations will be determined if more than ten percent of seven-day running averages exceed the standard, to be determined by the number of days exceeded for that seasonal period (i.e., for June 16 – September 14, a 91 day period, ten percent exceedance will equate to nine days).

3. For the seasonal period of June 16 – September 14, temperatures on the mainstem Trinity River at the Weitchpec gauging station were used to determine running seven-day averages.

The Hoopa Valley TEPA established a goal of attaining a temperature of 21º C (69.8º F) during the July 10 – September 14 period within five years of the adoption of these standards (Hoopa Valley TEPA 2008). If monitoring reveals that temperatures continue to increase, the Hoopa Valley TEPA will employ adaptive management strategies until temperatures begin to decrease

In addition to the seasonal water temperature criteria, the Hoopa Valley TEPA has established varying criteria for each life stage of salmonids (Table 6.7).

Table 6.7 Tributary Temperature Criteria for the Hoopa Valley Indian Reservation

	Maximum Weekly Average Temperature (MWAT)[1,2]		
Dates	**Extremely Wet, Wet and Normal Water Years**	**Dry and Critically Dry Water Years**	**Applicable Salmonid Life Stage(s)[3]**
May 23 – June 4	55.4º F	57.2º F	Adult holding; coho incubation and emergence; spawning; smoltification
June 5 – Jul 9	60.8º F	62.6º F	Adult holding; peak temperatures timeframe according to Hoopa Tribal data
July 10 – September 14	64.4º F	68.0º F	Adult holding
September 15 – October 31	57.2º F	60.8º F	Adult holding; spawning
November 1 – May 22	50.0º F	53.6º F	Adult incubation and emergence (including coho); smoltification; spawning

Source: Adapted from Hoopa Valley TEPA 2008

1: The MWAT is defined as the highest 7-day moving average of equally spaced water temperature measurements for a given time period. In this application, the time period is the duration of the existing salmonids life stage. For the MWAT objective, temperatures may not exceed the numeric objective for every 7-day period during the given life stage.

2: Applicable where a given species and life stage time period exist, and when and where the species and life stage time period existed historically, and have the potential to exist again.

3: Adult migration and juvenile rearing are considered all year life stages.

Water temperature data for Trinity River between 2001 and 2012 show seasonal trends and the warming effect of ambient conditions at the downstream location (Table 6.8 and Figure 6.1). Compliance locations for water quality monitoring along the Trinity River are shown in Figure 6.2.

Table 6.8 Monthly Average of Water Temperatures Recorded at Trinity River Compliance Locations

WY	WYT	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Douglas City													
2001	D	51.9	46.6	44.2	42.0	43.2	47.5	50.7	54.4	55.5	58.5	57.0	54.2
2002	D	51.0	47.7	42.7	43.1	43.8	46.6	52.5	49.4	56.1	58.9	56.2	54.4
2003	AN	49.8	46.5	44.6	44.9	44.8	48.0	48.8	50.4	52.8	57.0	56.6	52.7
2004	BN	51.2	46.6	43.7	41.5	43.7	47.5	51.4	50.3	51.4	54.7	56.4	53.0
2005	AN	50.9	47.4	42.9	42.8	45.3	48.2	50.8	49.9	52.2	57.9	59.5	54.7
2006	W	51.5	47.4	43.9	45.5	44.4	44.2	47.5	48.4	49.3	54.9	NA	NA
2007	D	NA	NA	43.0	39.8	43.1	48.4	52.5	47.9	55.8	58.7	57.2	54.1
2008	C	50.3	46.9	41.8	39.8	41.2	46.4	50.0	48.6	50.8	53.4	58.0	55.3
2009	D	51.4	49.3	43.5	43.0	43.4	46.8	51.7	50.9	56.6	60.5	58.1	55.9
2010	BN	51.2	47.5	42.2	44.3	45.2	46.8	48.4	48.4	52.3	57.3	58.5	55.1
2011	W	51.4	46.7	44.4	42.3	42.6	45.2	48.8	47.7	50.4	54.4	57.6	53.9
2012	BN	50.5	45.5	41.2	40.2	43.5	45.2	48.9	49.3	50.9	55.2	55.6	52.4
WY	**WYT**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
North Fork Trinity near Helena													
2001	D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2002	D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2003	AN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2004	BN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2005	AN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	64.5	58.2
2006	W	53.4	47.8	44.0	45.7	44.8	44.9	48.3	49.6	51.4	59.0	NA	NA
2007	D	NA	NA	42.5	39.6	43.5	48.9	53.2	49.3	59.8	65.4	63.0	58.3
2008	C	52.5	48.3	42.0	40.6	42.3	46.6	50.1	50.1	53.2	56.7	62.8	59.2
2009	D	53.3	49.6	43.0	42.5	43.4	47.0	51.8	52.6	59.7	66.0	62.9	60.0
2010	BN	53.4	47.7	41.9	44.8	45.9	47.1	48.4	49.4	53.7	60.9	63.3	59.0
2011	W	53.9	47.1	45.1	43.1	43.0	45.2	45.5	NA	NA	NA	NA	NA
2012	BN	52.8	46.4	40.9	39.9	43.8	45.1	49.1	50.6	53.3	59.3	60.3	55.9
WY	**WYT**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Weitchpec													
2001	D	57.9	48.2	44.8	41.9	43.5	48.8	52.1	60.9	65.8	73.8	72.1	67.0
2002	D	59.3	51.2	46.0	44.7	45.8	47.4	53.9	55.9	66.1	73.6	71.1	67.2
2003	AN	57.5	49.1	46.7	49.3	50.8	54.2	54.8	58.6	69.5	70.2	71.3	64.6
2004	BN	59.7	50.4	46.3	45.3	46.8	53.5	58.7	56.6	62.3	70.4	72.1	64.4
2005	AN	58.6	49.9	45.0	44.3	46.7	50.0	51.5	54.6	59.5	69.8	73.0	64.9
2006	W	58.8	50.6	46.4	48.8	47.5	47.8	50.2	53.8	57.1	65.2	NA	NA
2007	D	NA	NA	47.9	44.9	48.3	52	56.2	56.3	66.6	73.2	72.6	NA
2008	C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2009	D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

WY	WYT	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2010	BN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2011	W	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2012	BN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Source: DWR 2014a,b,c

Temperatures in the Trinity River within the Reservation boundary will be monitored based on water-year type as established by the TRFE and determined by the Bureau of Reclamation.

Activities that increase water temperatures must comply with Tribal and Federal anti-degradation policies. The responsible party must not increase water temperatures, even if caused by their actions coupled with natural factors (Hoopa Valley TEPA 2008). In some streams, the numeric objectives may not be attainable due to site specific limitations. If this is the case, and provided that the stream has been restored to its full site potential; and the salmonid population is at a level consistent with the National Marine Fisheries Service (NMFS) concept of a ‘Viable Salmonid Population’(McElhany et al. 2000), then the Hoopa Valley TEPA may consider site specific objectives.

6.3.2.2.2 Mercury

Trinity Lake and the upper hydrologic area of the East Fork Trinity River are two water bodies in the North Coast that were placed on the Section 303(d) list, approved by USEPA in 2010 (SWRCB 2011a), as impaired due to mercury. Mercury in Trinity Lake can be attributed to atmospheric deposition, natural sources, resource extractions, and other unknown sources (SWRCB 2011b). Significant mercury contamination is likely due to historical gold and mercury mining activities along the East Fork Trinity River at the inactive Altoona Mercury Mine (May et al. 2004).

The commercial or recreational collection of fish, shellfish, or organisms was deemed impaired since fish tissue exceeded USEPA’s recommended Fish Tissue Residue Criteria for human health of 0.3 mg of methylmercury (wet weight) per kg of fish tissue (SWRCB 2011b-g). This criterion is based on the consumption-weighted rate of 0.0175 kg of total fish and shellfish per day. Fourteen out of fifty seven fish tissue samples from fish in the North and the East Fork of the lake in September 2001 and 2002 exceeded this fish tissue criterion. Composite fish tissue samples that exceeded the criterion were from White Catfish, Smallmouth Bass, and Chinook Salmon.

For the protection of marine aquatic life, water quality objectives for mercury were set for discharges within the area specified in the North Coast Region Water Quality Control Board Basin Plan as follows (NCRWQCB 2011).

- Six-Month Median: 0.04 µg/l
- Daily Maximum: 0.16 µg/l
- Instantaneous Maximum: 0.4 µg/l (conservative estimate for chronic toxicity)

In an effort to meet the water quality standards in Trinity Lake and the East Fork of Trinity River, a TMDL is expected to be complete in 2019. An approach for calculating effluent limitations was established in the NCRWQCB Basin Plan (NCRWQCB 2011).

6.3.2.2.3 Nutrients

The lower Klamath River was placed on the 303(d) list approved by the USEPA in 2010 for being impaired by nutrients (SWRCB 2011a). Nutrient levels in the Klamath Estuary may cease to be a limiting factor and can promote levels of algal growth that cause a nuisance or adversely affect beneficial uses when excess growth is not consumed by animals or exported by flows (DOI and DFG 2012).

The Klamath River receives the greatest nutrient loading from the Upper Klamath basin, comprising approximately 40 percent of its total contaminant load (NCRWQCB 2010). Tributaries to the Klamath River are the greatest contributors of the remaining nutrient loads, with the Trinity River contributing the most.

The Hoopa Valley TEPA also designates water quality objectives to address contamination by nutrients (Table 6.9).

Table 6.9 Specific Use Water Quality Criteria for Waters of the Hoopa Valley Indian Reservation

Contaminant	Trinity River	Klamath River
Maximum Annual Periphyton Biomass	–	150 mg chlorophyll *a*/m^2 of streambed area
pH	MUN-designated waters: 5.0 – 9.0 All other designated uses: 7.0 – 8.5	7.0 – 8.5
Total Nitrogen[1]	–	0.2 mg/l
Total Phosphorus[1]		0.035 mg/l
Microcystis aeruginosa cell density	–	< 5,000 cells/mL for drinking water < 40,000 cells/mL for recreational water
Microcystin toxin concentration		< 1 µg/l total microcystins for drinking water < 8 µg/l total microcystins for recreational water
Total potentially toxigenic blue-green algal species[2]		< 100,000 cells/mL for recreational water
Cyanobacterial scums		There shall be no presence of cyanobacterial scums

Source: Hoopa Valley TEPA 2008

1: There should be at least two samples per 30-day period. If total nitrogen and total phosphorus standards are not achievable due to natural conditions, then the standards shall instead be the natural conditions for total nitrogen and total phosphorus. Through consultation, the ongoing TMDL process for the Klamath River is expected to further define these natural conditions.

2: Includes: Anabaena, Microcystis, Planktothrix, Nostoc, Coelsphaerium, Anabaenopsis, Aphanizomenon, Gloeotrichia, and Oscillatoria.

In addition to the water quality criteria established by the Hoopa Valley TEPA (2008), the 2010 *Klamath River TMDLs Addressing Temperature, Dissolved Oxygen, Nutrient, and Microcystin Impairments in California* provides TMDLs for nutrients which address elevated pH levels (DOI and DFG 2012). Nutrient targets include numeric targets for total phosphorus (TP), total nitrogen (TN) (NCRWQCB 2010).

The Klamath River nutrient TMDLs are in the process of being implemented by the NCRWQCB and other affiliated agencies, including the SWRCB, the USEPA, Reclamation, the USFWS, the Oregon Department of Environmental Quality, responsible for implementation of the Klamath TMDLs in Oregon, and other state, federal, and private agencies with operations that affect the Klamath River (NCRWQCB 2010).

6.3.2.2.4 Organic Matter

The lower Klamath River was placed on the 303(d) list approved by the USEPA in 2010 for impairment due to organic enrichment (SWRCB 2011a).

The Klamath River has several natural sources of organic matter. The river originates from the Upper Klamath Lake, which is a naturally shallow, eutrophic lake, with high levels of organic matter (algae), including nitrogen fixing blue-green algae (NCRWQCB 2010). Other sources of organic matter include runoff from agricultural lands (i.e., irrigation tailwater, storm runoff, subsurface drainage, and animal waste), flow regulations/modification, industrial point sources, and municipal point sources (SWRCB 2011).

To protect the beneficial uses of the lower Klamath River, including cold freshwater habitat, a TMDL was established in 2010 for organic matter and other constituents. The TMDL equals 143,019 pounds of Carbonaceous Biochemical Oxygen Demand (CBOD) per day from the Klamath River (NCRWQCB 2011h). The average organic matter (measured as CBOD) loads from all other Klamath River tributaries are sufficient to meet other related objectives, including dissolved oxygen and biostimulatory substances objectives, in the Klamath River (NCRWQCB 2010). The dissolved oxygen objectives are the primary targets associated with organic matter as well as nutrients. Organic matter allocations were also established for the Klamath River below Salmon River, and the major tributaries to the Klamath, including Trinity River. The seasonal monthly mean organic matter concentration allocations for the Trinity River.

Implementation actions and other objectives were established to ensure the TMDL is met to protect the beneficial uses of the Klamath River and other water bodies downstream. The North Coast Basin Plan states that a water quality study will be completed to identify actions for monitoring, evaluating, and implementing any necessary actions to address organic matter loading so that the TMDL will be met (NCRWQCB 2011).

6.3.2.2.5 Dissolved Oxygen

The lower Klamath River was placed on the 303(d) list approved by the USEPA in 2010 for low dissolved oxygen (SWRCB 2011a).

Sources that contribute to low dissolved oxygen include sources of organic enrichment, specified in the previous section, the season, time of day, water temperature, and salinity, explained further in Section 6.3.2.6. Other sources that contribute to low dissolved oxygen are runoff from roads and agriculture that can transport nutrients into water bodies and lower dissolved oxygen through biostimulatory effects (NCRWQCB 2010). Over enrichment and growth of algae and aquatic plants can produce oxygen during the day through photosynthesis but those same plants can deplete dissolved oxygen at night.

To protect the beneficial uses of the lower Klamath River, including the cold freshwater habitat, water quality objectives were established in the North Coast Basin Plan (2010) and the Hoopa Valley TEPA (2008) for dissolved oxygen in the Klamath River and its major tributary, the Trinity River (Table 6.10 and Table 6.11) (NCRWQCB 2011). Site Specific Objectives (SSOs) for dissolved oxygen were calculated as part of TMDLs developed by the NCRWQCB (2011), and have been incorporated into the North Coast Basin Plan (2011) (Table 6.12). For those waters without location-specific dissolved oxygen criteria, dissolved oxygen shall not be reduced below minimum levels, shown in Table 6.13, at any time to protect beneficial uses.

Table 6.10 Water Quality Objectives for Dissolved Oxygen in Trinity and Lower Klamath

Water body	Dissolved Oxygen (mg/l)	
	Minimum	50% Lower Limit[1]
Trinity Lake and Lewiston Reservoir	7.0	10.0
Lower Trinity River	8.0	10.0
Lower Trinity Area Streams	9.0	10.0
Lower Klamath River Area Streams	8.0	10.0

Source: NCRWQCB 2011

1: 50 percent lower limit represents the 50 percentile values of the monthly means for a calendar year. 50 percent or more of the monthly means must be greater than or equal to the lower limit.

Table 6.11 Specific Use Water Quality Criteria for Waters of the Hoopa Valley Indian Reservation

Contaminant	Trinity River	Klamath River
Minimum Water Column Dissolved Oxygen Concentration	11.0 mg/l	SPWN-designated waters[1]: 11.0 mg/l[2] COLD-designated waters: 8.0 mg/l[2]
Minimum Inter-gravel Dissolved Oxygen Concentration	8.0 mg/l	SPWN-designated waters[1]: 8.0 mg/l[2]

Source: Hoopa Valley TEPA 2008

1: Whenever spawning occurs, has occurred in the past or has potential to occur.

2: 7-day moving average of the daily minimum DO. If dissolved oxygen standards are not achievable due to natural conditions, the COLD and SPWN standard shall instead be dissolved oxygen concentrations equivalent to 90 percent saturation under natural receiving water temperatures.

Table 6.12 Site Specific Objectives for Dissolved Oxygen in the Klamath River[1]

Location[2]	Percent Dissolved Oxygen Saturation Based On Natural Receiving Water Temperatures[3]	Time Period
Downstream of Hoopa-California Boundary to Turwar	85%	June 1 through August 31
	90%	September 1 through May 31
Upper and Middle Estuary	80%	August 1 through August 31
	85%	September 1 through October 31 and June 1 through July 31
	90%	November 1 through May 31
Lower Estuary	For the protection of estuarine habitat (EST), the dissolved oxygen content of the Lower Klamath estuary shall not be depressed to levels adversely affecting beneficial uses as a result of controllable water quality factors.	

Source: NCRWQCB 2011

1: States may establish site specific objectives equal to natural background (USEPA 1986a. Ambient Water Quality Criteria for Dissolved Oxygen, EPA 440/5-86-033; USEPA Memo from Tudor T. Davies, Director of Office of Science and Technology, USEPA Washington, D.C. dated November 5, 1997). For aquatic life uses, where the natural background condition for a specific parameter is documented, by definition that condition is sufficient to support the level of aquatic life expected to occur naturally at the site absent any interference by humans (Davies 1997). These dissolved oxygen objectives are derived from the T1BSR run of the Klamath TMDL model and described in Tetra Tech, December 23, 2009 Modeling Scenarios: Klamath River Model for TMDL Development (Tetra Tech and WR and TMDL Center 2009). They represent natural dissolved oxygen background conditions due only to non-anthropogenic sources and a natural flow regime.

2: These objectives apply to the maximum extent allowed by law. To the extent that the State lacks jurisdiction, the Site Specific Dissolved Oxygen Objectives for the Mainstem Klamath River are extended as a recommendation to the applicable regulatory authority.

3: Corresponding dissolved oxygen concentrations are calculated as daily minima, based on site-specific barometric pressure, site-specific salinity, and natural receiving water temperatures as estimated by the T1BSR run of the Klamath TMDL model and described in Tetra Tech, December 23, 2009 (Tetra Tech and WR and TMDL Center 2009). Modeling Scenarios: Klamath River Model for TMDL Development. The estimates of natural receiving water temperatures used in these calculations may be updated as new data or method(s) become available. After opportunity for public comment, any update or improvements to the estimate of natural receiving water temperature must be reviewed and approved by Executive Officer before being used for this purpose.

Table 6.13 Water Quality Objectives for Dissolved Oxygen for Specified Beneficial Uses

Beneficial Use Designation	Minimum Dissolved Oxygen Limit (mg/l)
WARM, MAR, or SAL	5.0
COLD	6.0
SPWN	7.0
SPWN – during critical spawning and egg incubation periods	9.0
Klamath River Water Column[1]	
SPWN-designated waters[2]:	11.0 mg/l[3]
COLD-designated waters:	8.0 mg/l[3]
Klamath River Inter Gravel[1] SPWN-designated waters[2]:	8.0 mg/l[3]

Source: NCRWQCB 2011

1 Hoopa Valley TEPA (2008)

2: Whenever spawning occurs, has occurred in the past or has potential to occur.

3: 7-day moving average of the daily minimum DO. If dissolved oxygen standards are not achievable due to natural conditions, the COLD and SPWN standard shall instead be dissolved oxygen concentrations equivalent to 90 percent saturation under natural receiving water temperatures.

The 2010 *Klamath River TMDLs Addressing Temperature, Dissolved Oxygen, Nutrient, and Microcystin Impairments in California* provide numerical targets for dissolved oxygen and other constituents (NCRWQCB 2010). Site specific objectives for dissolved oxygen were proposed in this TMDL and adopted into the North Coast Basin Plan (Table 6.29). The dissolved oxygen objectives are the primary targets associated with nutrient and organic matter. with additional dissolved oxygen-related TMDLs prescribed for total phosphorus (TP), total nitrogen (TN) and organic matter (CBOD) loading, and numerical targets provided for benthic algae biomass, suspended algae chlorophyll-a, *microcystis aeruginosa*, and microcystin toxin discussed in their corresponding sections.

Plans to monitor dissolved oxygen and other constituents in the Klamath River below Trinity River, near Turwar, and the Klamath River Estuary were established in Chapter 7 of the Klamath River TMDLs to further protect the beneficial uses of the Trinity and lower Klamath Rivers (NCRWQCB 2010). The TMDL also includes a proposal to revise SSOs for dissolved oxygen in the Klamath River.

6.3.2.2.6 Sedimentation and Siltation

Sedimentation and siltation are not caused by operation of the CVP. However, the lower Klamath River and Trinity River were placed on the 303(d) list approved in 2010 as impaired by sedimentation and siltation (SWRCB 2011a).

Trinity River

Disturbance of sediment and silt is a natural part of stream ecosystems, which can contribute to fluctuating salmonid populations in response to fine sediment embedded in spawning gravels. However, human activities have resulted in an increased severity and frequency of habitat disturbance (TRRP and NCRWQCB 2009). In the Mainstem Trinity River, sediment loading can be attributed to runoff from areas of active or past mining, timber harvest, and road-related activities. Natural sources, such as landsliding, bank erosion, and soil creep, contribute the greatest sediment loads each year (NCRWQCB 2008). Future point sources of sedimentation into the Trinity River Basin may include CalTrans facilities and construction sites larger than five acres that discharge pursuant to California's NPDES general permit for construction site runoff (USEPA 2001f).

The primary adverse impacts of excess sedimentation are those affecting the spawning habitat for anadromous salmonids (TRRP and NCRWQCB 2009). The main affected beneficial uses include commercial or sport fishing, cold fresh water habitat, migration of aquatic organisms, spawning, reproduction, and/or early development; and rare, threatened and endangered species. Recreation in the Trinity River Basin, such as boating, fishing, camping, swimming, sightseeing, and hiking, is also potentially affected because sedimentation can affect the water clarity and water quality, for activities such as swimming (USEPA 2001f). Water quality objectives for sedimentation and siltation were established in the North Coast Basin Plan.

Turbidity criteria for all waters within the Hoopa Valley Indian Reservation are also under development (Hoopa Valley TEPA 2008).

In addition to these water quality objectives, the North Coast Basin Plan also prohibits the discharge of soil, silt, bark, sawdust, or other organic and earthen material from any logging, construction, or associated activity into any stream or watercourse in quantities harmful to beneficial uses, and the placing or disposal of such materials in locations where they can pass into any stream or watercourse in quantities harmful to beneficial uses (NCRWQCB 2011).

Sediment loading in the mainstem Trinity River exceeds applicable water quality standards, and is being addressed by the Trinity River TMDL for sediment, approved by the USEPA in December 2001 (SWRCB 2011b-g, USEPA 2001f). Assimilation capacity for sediment loading was determined for this TMDL and the percent reduction of managed sediment discharge required to meet the TMDL is provided for each subarea. These allocations are adequate to protect aquatic habitat, and are expected to be evaluated on a ten year rolling basis (USEPA 2001f).

Lower Klamath River

The Klamath River downstream of Weitchpec has also been included on the 303(d) list for contamination from sedimentation and siltation, due to exceedances of the sediment water quality criteria, and long-term sedimentation and siltation influxes (SWRCB 2011h).

Major sources of sediment discharge in the lower Klamath River are from ongoing logging and runoff from major storm events. According to reports cited by the SWRCB, water quality in runoff from timber harvest in all lower Klamath watersheds exceed cumulative effect thresholds (SWRCB 2011h).

The *Long Range Plan for the Klamath River Basin Fishery Conservation Area Restoration Program* (1986 to 2006) emphasizes sedimentation in the lower Klamath Basin, and notes that the sediment is creating problems with fish passage and stream bed stability (Klamath River Basin Fisheries Task Force 1991). The near extinction of the eulachon indicated problems with sediment supply, size and bed load movement, and that aggradations in salmon spawning reaches are expected to persist for decades (SWRCB 2011h). Increased sediment loads also result from the widening of stream channels, through processes like bank erosion, and with the related reduction of riparian shade can contribute to elevated stream temperatures (NCRWQCB 2010). The North Coast Basin Plan includes the TMDLs for the region, which include those that address sedimentation and siltation (NCRWQCB 2011).

6.3.3 Central Valley Region

6.3.3.1 Sacramento Valley

Major watersheds within the Sacramento Valley that could be affected by CVP and SWP operations include the Sacramento River, Feather River, and the lower American River watersheds.

This water quality analysis section focuses on Shasta Lake, Keswick Reservoir, Whiskeytown Lake, Spring Creek and Clear Creek; the Sacramento River from Shasta Lake to the Delta (near Freeport); the Feather River below Lake Oroville; American River below Lake Natoma; and Yolo Bypass.

Beneficial uses for the Sacramento Valley, as defined in the Central Valley Basin Plan, are summarized in Table 6.2. The constituents of concern that are currently not in compliance with existing water quality standards and for which TMDLs are adopted or are in development in this region are summarized in Table 6.1.

6.3.3.1.1 Sacramento River from Shasta Lake to Verona

Water quality in the upper Sacramento River is influenced by releases from Shasta Lake and diversions from Trinity Lake. Annual and seasonal flows in the Sacramento River watershed are highly variable from year to year, as described in Chapter 5, Surface Water Resources and Water Supplies. These variations in flow are a source of variability in water quality in the Sacramento drainage.

The water quality constituents that are currently not in compliance with existing water quality standards and for which TMDLs are adopted or are in development in this region are: mercury, PCBs, unknown toxicity and multiple pesticides. Chlorpyrifos and diazinon have been addressed by changes to the Basin Plan, cadmium, copper, zinc have been addressed by a TMDL, and temperature is also closely monitored.

Water Temperature

The Sacramento River was not placed on the 303(d) list approved by the USEPA in 2010 as impaired by water temperature (SWRCB 2011a). However, water bodies in the Upper Sacramento River watershed support the beneficial uses of both warm and cold fresh water habitat, which require that the water bodies maintain water temperatures suitable for multiple fish species (CVRWQCB 2011). Water quality objectives have been established by the SWRCB for Sacramento River, as summarized in Table 6.14 and Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. Compliance locations in the upper Sacramento River basin are shown in Figure 6.2. Performance measures to meet temperature requirements are included in the 2009 NMFS BO, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations.

Table 6.14 Water Quality Objectives for Temperature in the Sacramento River

Applicable Water Bodies	Objective
Sacramento River from Keswick Dam to Hamilton City	> 56º F
Sacramento River from Hamilton City to the I Street Bridge (during periods when temperature increases will be detrimental to the fishery)	> 68º F

Source: CVRWQCB 2011

Table 6.15 and Figure 6.3 depict monthly water temperature data at selected compliance locations in the Sacramento River between 2001 and 2012.

Table 6.15 Monthly Average of Water Temperatures Recorded at Sacramento River Compliance Locations in °F

WY	WYT	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Balls Ferry													
2001	D	55.0	53.2	51.4	47.9	47.0	51.5	52.5	52.9	53.6	54.5	54.3	55.3
2002	D	56.1	54.3	50.0	49.4	48.8	50.5	53.9	53.7	53.7	54.4	54.4	54.0
2003	AN	54.4	54.2	50.0	49.6	49.3	51.7	53.2	53.3	53.5	53.6	54.9	55.4
2004	BN	54.7	52.6	50.2	48.3	47.6	50.9	52.5	53.0	53.7	54.5	54.6	56.7
2005	AN	56.5	54.9	50.6	48.8	50.0	52.1	54.1	54.2	53.5	54.0	55.4	55.6
2006	W	56.2	54.5	50.5	ND	47.8	47.7	49.7	52.7	52.8	53.6	53.8	53.5
2007	D	53.4	52.4	49.7	47.7	48.4	52.0	54.0	52.9	53.8	55.2	55.1	55.7
2008	C	55.9	55.3	50.1	45.7	46.8	49.8	50.9	52.9	55.6	56.0	56.4	57.0
2009	D	58.1	55.8	50.1	47.5	47.8	50.6	51.6	53.8	55.0	56.0	56.0	56.5
2010	BN	56.5	55.1	49.4	48.3	49.6	50.9	52.5	54.0	53.5	53.9	54.2	54.2
2011	W	54.0	51.3	51.2	49.2	48.0	48.8	51.8	54.1	53.6	53.6	54.3	54.0
2012	BN	53.1	51.2	49.6	48.4	48.6	49.6	53.6	54.5	53.4	53.6	54.0	54.1
WY	**WYT**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Jelly's Ferry													
2001	D	55.5	52.9	51.1	47.5	47.0	52.3	53.6	54.5	54.7	55.6	55.6	56.3
2002	D	56.7	54.4	49.1	47.9	48.6	51.0	55.4	55.1	55.1	55.6	55.5	55.1
2003	AN	54.9	54.1	50.3	50.0	49.0	52.4	53.4	54.5	55.4	55.0	56.0	56.6
2004	BN	55.3	52.5	50.0	47.9	48.1	52.0	54.0	54.7	55.1	55.5	55.8	57.5

WY	WYT	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2005	AN	56.8	54.6	50.2	48.4	50.3	52.8	55.3	55.6	55.3	55.6	56.7	56.5
2006	W	56.5	54.3	49.9	49.1	48.3	47.9	50.7	54.6	54.8	55.1	55.0	54.6
2007	D	54.2	52.6	49.0	47.1	48.7	52.8	55.0	54.2	54.9	56.0	56.0	56.6
2008	C	56.3	55.4	49.6	45.4	47.0	50.5	52.2	54.5	56.6	56.9	57.3	58.0
2009	D	58.0	55.8	49.8	47.4	47.9	51.2	53.3	55.7	56.4	57.1	57.0	57.8
2010	BN	57.1	54.9	48.9	48.0	49.7	51.7	53.3	55.2	55.4	55.6	55.3	55.2
2011	W	54.6	51.3	50.9	48.9	47.8	48.7	52.2	55.3	55.2	55.0	55.4	55.2
2012	BN	53.7	51.2	49.1	48.1	48.8	49.9	54.4	56.0	54.8	54.6	55.1	55.3
WY	**WYT**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Bend Bridge													
2001	D	55.7	52.8	50.8	47.3	47.0	52.6	54.1	55.0	55.1	56.0	56.0	56.8
2002	D	56.9	54.4	49.0	48.1	48.9	51.2	55.8	55.6	55.6	56.0	56.2	55.6
2003	AN	55.1	53.9	50.2	50.0	49.0	52.6	53.8	54.7	55.9	55.4	56.7	57.0
2004	BN	55.5	52.3	49.4	48.0	48.2	52.2	54.2	55.5	55.6	56.1	56.2	57.9
2005	AN	57.0	54.4	50.0	48.3	50.4	53.1	55.7	55.9	55.5	56.0	57.2	56.9
2006	W	56.6	54.2	50.0	49.2	48.4	48.0	50.7	54.9	55.1	55.6	55.4	54.9
2007	D	54.4	52.3	49.1	46.9	48.8	52.9	55.1	54.9	55.5	56.6	56.6	57.0
2008	C	56.4	55.1	49.3	45.6	47.1	51.0	52.6	55.0	57.4	57.5	57.9	58.5
2009	D	57.4	55.8	49.4	47.3	48.1	52.0	53.6	56.1	56.9	57.7	57.2	58.0
2010	BN	57.0	54.8	48.6	47.9	49.6	51.6	53.3	55.4	55.5	56.2	56.2	55.8
2011	W	54.4	51.0	50.7	49.0	48.0	49.0	52.5	55.7	55.6	55.8	56.2	55.6
2012	BN	53.9	51.3	48.8	47.9	48.9	49.9	54.8	56.5	55.4	55.1	55.5	55.8

Source: Reclamation 2013b

Mercury

The USEPA approved a new decision to place Shasta Lake, Whiskeytown Lake, Clear Creek, and the Sacramento River from Cottonwood Creek to Red Bluff, on the Section 303(d) list in 2010 for mercury contamination (SWRCB 2011a). The Sacramento River from Red Bluff to Knights Landing has been on the 303(d) list for mercury prior to the final decision in 2010. Mercury is not a constituent of concern for the Sacramento River between Shasta Dam and the Cottonwood Creek.

Mercury in the Sacramento River Basin can be attributed to resource extraction as described in Section 6.3.2 (SWRCB 2011i-l). Significant gold mining activity took place within the Whiskeytown watershed, lands inundated by Whiskeytown Reservoir, in the Clear Creek watershed between Whiskeytown Reservoir, the confluence with the Sacramento River, and within the Sacramento River watershed.

A 2008 CALFED report tabulates methylmercury concentrations in the Sacramento River from Redding (0.3ng/l) to Freeport (0.11 ng/l) from 2003 to 2006 (Foe et al. 2008). For the 2010 listing, composite fish tissue samples were collected from Shasta Lake, Whiskeytown Lake, Clear Creek, and the Sacramento River from Cottonwood Creek to Knights Landing. The commercial or recreational collection of fish, shellfish, or organisms were deemed impaired since fish tissue exceeded USEPA's recommended Fish Tissue Residue Criteria for human health of 0.3 mg of methylmercury (wet weight) per kg of fish tissue (SWRCB 2011i-l).

In an effort to protect the beneficial uses of these water bodies, including the protection of aquatic and human health, USEPA has recommended maximum exposure concentrations. In addition, a TMDL is expected to be complete in 2021 to meet the water quality standards in these water bodies (SWRCB 2011i-l).

Cadmium, Copper, and Zinc

Shasta Lake where West Squaw Creek enters the lake, Spring Creek (from Iron Mountain Mine to Keswick Reservoir), and Keswick Reservoir downstream of Spring Creek were placed on the 303(d) list approved by the USEPA in 2010 for impairment by cadmium, copper, and zinc (SWRCB 2011a). The Upper Sacramento River from Keswick Dam to Cottonwood Creek was previously listed on the 303(d) list for impairment by cadmium, copper, and zinc but was delisted after a TMDL was completed in 2002 and the SWRCB determined the water quality standard was met. The elevated levels were primarily the result of acid mine drainage discharged from inactive mines in the upper Sacramento River watershed, located upstream of Shasta and Keswick dams (CVRWQCB 2002a). There are projects underway to clean up many inactive mine sites that discharge high concentrations of metals (CVRWQCB 2011).

Cadmium, copper and zinc contamination in the Sacramento River have been addressed by the *2002 Upper Sacramento River TMDL for Cadmium, Copper and Zinc*, and by water quality objectives in the Basin Plan (CVRWQCB 2002a). Although cadmium, copper, and zinc are generally found as mixtures in surface water, the mixtures tend to be antagonistic – less toxic than when found as individual components – thus the water quality objectives focus on individual parameters. Levels of water hardness affect the toxicity of these metals, where increased hardness decreases toxicity. Thus the water quality objectives at certain locations are determined using specific levels of water hardness (CVRWQCB 2002a). The TMDL for cadmium, copper, and zinc in Shasta Lake, Spring Creek, and Keswick Reservoir is expected to be completed in 2020 (SWRCB 2011i,m,n).

Pesticides

The Sacramento River from Red Bluff to Knights Landing was placed on the 303(d) list approved by the USEPA in 2010 as impaired by DDT and the Group A pesticide dieldrin. The Sacramento River from Knights Landing to the Delta was also placed on the 303(d) list as impaired by chlordane, DDT, and dieldrin (SWRCB 2011a). Chlordane, DDT, and dieldrin are legacy pesticides and were discontinued from the early 1970s to the late 1980s.

Although these pesticides have been discontinued since the late 1980's, the narrative water quality objective for toxicity, which applies to single or the interactive effect of multiple pesticides or substances, not being met, which states that “All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life”. Fish concentrations of DDT collected in 2005 exceeded the Total DDT OEHHA screening value of 21 µg/kg by up to five times, which was used as a criterion to evaluate the narrative water quality objective. Concentrations of dieldrin were also found to exceed the OEHHA Evaluation Guideline of 0.46 µg/kg (SWRCB 2011o).

To protect the beneficial uses of the Sacramento River and other water bodies downstream, including the impaired commercial or recreational collection of fish, shellfish, or organisms, TMDLs for DDT and dieldrin in the Sacramento River from Red Bluff to Knights Landing are expected to be complete in 2021 (SWRCB 2011o). For the Sacramento River from Knights Landing to the Delta, TMDLs are expected to be complete in 2021 for DDT and chlordane, and in 2022 for dieldrin.

Although the Sacramento River was not placed on the 303(d) list approved by the USEPA in 2010 for chlorpyrifos and diazinon contamination, these pesticides have also been of concern in the Sacramento River (SWRCB 2011o, CVRWQCB 2007a). Water quality sampling from 1999 to 2006 revealed concentrations of both pesticides at levels of concern in the Sacramento and Feather Rivers. In addition to runoff of applied pesticides into irrigation and storm water runoff into the Sacramento and Feather Rivers, atmospheric transport of diazinon from the Central Valley to the Sierra Nevada Mountains has been noted to occur. Of particular concern were the beneficial uses of Warm and Cold Fresh water Habitat.

PCBs

The reach of the Sacramento River from Red Bluff to Knights Landing was placed on the 303(d) list approved by the USEPA in 2010 as impaired by PCBs (SWRCB 2011a). According to the *Final California 2010 Integrated Report* (303(d)/305(b) Report) Supporting Information, sources of PCBs in Sacramento River are unknown (SWRCB 2011o). PCBs, a group of synthetic organic chemicals, were manufactured in from 1930 to 1977 and were banned in 1979. However, these organic pollutants persistent in the environment (ATSDR 2000).

The OEHHA Fish Contaminant Goal of total PCBs in fish is 3.6 ppb (or 3.6 ng/g) (SWRCB 2011o). Fish tissue samples collected in August and October 2005 exhibited significant exceedances. Six composite samples were analyzed for 48 individual PCB congeners and four Aroclor mixtures, with the four exceedances reported as 102.499 ng/g in channel catfish at Colusa, 9.151 ng/g in channel catfish at Grimes, 6.504 ng/g in Sacramento sucker at Colusa, and 5.767 ng/g in Sacramento sucker at Woodson Bridge.

To protect the beneficial uses of the Sacramento River, including the impaired beneficial use of commercial and sport fishing, a TMDL is expected to be completed in 2021 (SWRCB 2011o).

Unknown Toxicity

The Sacramento River from Keswick Reservoir to Knights Landing was placed on the 303(d) list as impaired for unknown toxicity (SWRCB 2011a).

Results of survival, growth, and reproductive toxicity tests performed from 1998 to 2007 showed an increase in mortality and a reduction in growth and reproduction in *C. dubia*, the Fathead Minnow *Pimephales promelas* (*P. promelas*) and the alga *Pseudokirchneriella subcapitata* (*P. subcapitata*, formerly known as *Selenastrum capricornutum*) (SWRCB 2011l,o-q). Observations violated the narrative toxicity objective found in the Sacramento – San Joaquin River Basin Plan, which states that all waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, or aquatic life (CVRWQCB 2011). This objective applies regardless of whether the toxicity is caused by a single substance or the interactive effect of multiple substances. Further research is being conducted on the causes of toxicity in the Sacramento River. The TMDL for unknown toxicity in the Upper Sacramento River is expected to be completed in 2019 (SWRCB 2011l,o-q).

A 2012 SWAMP report summarized the occurrences and causes of toxicity in the Central Valley (Markiewicz et al.2012). The SWRCB's Surface Water Ambient Monitoring Program (SWAMP) defines toxicity as a statistically significant adverse impact on standard aquatic test organisms in laboratory exposures. In order to assess the causes of toxicity in California waterways, SWAMP testing uses laboratory test organisms as surrogates for aquatic species in the environment (Anderson et al.2011).

Sediment toxicity was noted to be higher in urban areas including Sacramento, Yuba City, Redding, and Antioch, while sediments from agricultural areas were generally non-toxic (Markiewicz et al.2012). Moderate water toxicity was observed throughout the agricultural and urban-agricultural areas in the upper Sacramento watershed, including in the Colusa Basin, in the vicinity of the Sutter Buttes, and along the eastern valley floor between Chico and Lincoln.

SWAMP studies indicate that the replacement of organophosphate pesticides by pyrethroids has resulted in an increased contribution of pyrethroids to ambient water and sediment toxicity (Anderson et al. 2011). With regard to sediment, as indicated by H. azteca, the majority of toxicity has been attributed to pyrethroids, particularly in urban areas (Markiewicz et al. 2012). Of the pyrethroid pesticides, bifenthrin is of major concern.

6.3.3.1.2 Sacramento River from Verona to Freeport

The water quality of the lower Sacramento River is influenced by the upstream sources discussed above as well as by inflows from the American River and from surrounding urban and agricultural runoff. The major water quality constituents of concern are described below. Water temperature is not a major concern in this lower reach of the Sacramento River because the vitality of aquatic species in this reach are not dependent on temperature.

Mercury

The Sacramento River from Verona to Freeport is on the 303(d) list approved by USEPA in 2010 for mercury contamination (SWRCB 2011a).

Mercury in this reach of the river can be attributed to waterborne inputs from the upper Sacramento River, Feather River, Yuba River, and American River (SWRCB 2011q). These major tributaries are also listed as impaired due to mercury. As in the Klamath and Trinity River basins, historic mining has resulted in significant mercury contamination in the Sacramento River Basin.

Flows from the Yuba River are an important source of mercury loading to the lower Sacramento River. Tailings discharged from gold mines in the Sierra Nevada mountains during the nineteenth century contained significant amounts of mercury-laden sediment, due to the use of mercury to extract gold. These discharges caused the formation of anthropogenic alluvial fans at the base of the Sierra Nevada, most notably the Yuba Fan. Singer et al. (2013) predicted that mercury-laden sediment from the original fan deposit will continue to be transported to the Sacramento River for the next 10,000 years.

The Sacramento River is a key source of mercury contamination into the Sacramento – San Joaquin River Delta. Over 80 percent of total mercury flux to the Delta can be attributed to the Sacramento River Basin (CVRWQCB 2010a). The CVRWQCB (2010a) compiled data from 2000 to 2003 and reported an average of 0.10 ng/l in the Sacramento River at Freeport. Similarly, CALFED reported that the Sacramento River at Freeport contributed an average of 0.11 ng/l of methylmercury to the Delta from 2003 to 2006 (Foe et al. 2008).

Water samples were collected from the lower Sacramento River and its tributaries from March 2003 to June 2006 (Foe et al. 2008). For comparison, concentrations in samples from the upper Sacramento River from Redding to Colusa were lower, ranging from 0.03 to 0.10 ng/l. Major tributaries to the lower Sacramento River, including the Feather River (0.05 ng/l), American River (0.06 ng/l), Colusa Basin Drain (0.21 ng/l), and Yuba River (0.05 ng/l), contributed to the mean methylmercury concentration of 0.11 ng/l at Freeport in the Sacramento River.

The commercial or recreational collection of fish, shellfish, or organisms were deemed impaired prior to the current 303(d) list approved in 2010 (SWRCB 2011q). However, no new data were available to be assessed for this updated listing.

Table 6.16 presents streambed sediment mercury concentrations from the Sacramento River and Delta regions in 1995, sampled as part of the National Water Quality Assessment (NWQA) Program for the Sacramento River Basin (MacCoy and Domagalski 1999). Limited data for mercury in sediment exist; however, these data exhibit levels of mercury greatly exceeding the average amount of mercury found on the earth’s surface, of about 0.05 µg/g. The highest streambed sediment concentrations of mercury were measured downstream from the Sierra Nevada and Coast Ranges. Within the Sacramento River, those sites downstream of the Feather River had higher concentrations of mercury than sampled locations upstream of this confluence. The highest reported mercury concentrations were from the Yuba River, Bear River, Sacramento River at Verona, and the Feather River which exceeded the threshold effect concentration (0.18 µg/g), but not the probably effect concentration (1.06 µg/g) reported by MacDonald et al. (2000).

Table 6.15 Streambed sediment concentrations of mercury in the Sacramento River and Delta regions

Water body/Site	Concentration
Feather River sites	
Feather River	0.21 µg/g
Yuba River	0.37 µg/g
Bear River	0.37 µg/g
Feather & Sacramento Rivers Downstream of the confluence at Verona	0.24 µg/g
Sacramento River sites	
Bend Bridge	0.16 µg/g
Freeport	0.14 µg/g
Cache Creek	0.15 µg/g
Arcade Creek	0.13 µg/g
American River	0.16 µg/g

Source: MacCoy and Domagalski 1999

Reported in bottom material <63 micron fraction dry weight.

* Concentration exceeds the MacDonald et al. (2000) threshold effect concentration (0.18 µg/g dry weight) but not the probably effect concentration (1.06 µg/g dry weight).

In an effort to protect the beneficial uses of the Sacramento River, including the impaired commercial and recreational collection of fish, shellfish, or organisms, the CVRWQCB (2011) made recommendations for the future reduction of mercury contamination. Additionally, the Delta Mercury Control Program (MERP 2012) provides potential load allocations for mercury pertaining to the Sacramento River and the Yolo Bypass, while the Cache Creek Watershed Mercury Program provides load allocations for Cache Creek, Bear Creek, Sulphur Creek, and Harley Gulch.

Pesticides

The Sacramento River was placed on the 303(d) list approved by the USEPA in 2010 as impaired by the pesticides chlordane, DDT, and dieldrin from Knights Landing to the Delta. These three pesticides listings were based on the evaluation of fish contaminant data from 2005. Chlordane, DDT, and dieldrin are legacy pesticides that were discontinued from the early 1970s to the late 1980s. However, samples collected in the Sacramento River at the Veterans Bridge in September 2005 revealed elevated pesticide concentrations (SWRCB 2011q).

A composite sample of carp and a composite sample of channel catfish had total chlordane concentrations of 6.72 µg/kg and 10.20 µg/kg, respectively, both exceeding OEHHAs (2008) FCG of 5.6 µg/kg for total chlordane in fish tissue (SWRCB 2011q).

Composite samples of carp and Channel Catfish contained total DDT concentrations of 59. µg/kg and 109. µg/kg, respectively. These concentrations exceeded the OEHHAs (2008) FCG of 21 µg/kg (SWRCB 2011q).

Composite samples of carp and Channel Catfish contained total dieldrin concentrations of 0.98 µg/kg and 1.49 µg/kg, respectively, These concentrations both exceeded the OEHHAs (2008) FCG of 0.46 µg/kg (SWRCB 2011q).

PCBs

The Sacramento River from Knights Landing to the Delta was placed on the 303(d) list approved by the USEPA in 2010 as impaired by PCBs (SWRCB 2011a).

According to the Final California 2010 Integrated Report (303(d)/305(b) Report) Supporting Information, sources of PCBs in this reach of the Sacramento River are unknown (SWRCB 2011q).

The Sacramento River from Knights Landing to the Delta has also been newly listed as contaminated by PCBs. Three of three composite samples analyzed for total PCBs in September 2005 exceeded the OEHHA Fish Contaminant Goal for total PCBs of 3.6 ppb (or 3.6 ng/g), wet weight. The exceeding concentrations were recorded at 53 ng/g in channel catfish, 6.0 ng/g in Sacramento sucker, and 26 in carp (SWRCB 2011q).

A TMDL for PCBs in the Sacramento River from Knights Landing to the Delta is expected to be completed in 2021 to protect the beneficial uses of the Sacramento River and downstream waterbodies (SWRCB 2011q).

Dissolved Oxygen

The Sacramento River was not placed on the 303(d) list approved by the USEPA in 2010 for low dissolved oxygen (SWRCB 2011a).

Salinity, Electrical Conductivity, and Total Dissolved Solids

The Sacramento River was not placed on the 303(d) list approved by the USEPA in 2010 as impaired by salinity (SWRCB 2011a).

Selenium

Water bodies in the Sacramento River Basin were not listed on the 303(d) list as impaired by selenium. Waterborne selenium concentrations in the Sacramento River near Verona are relatively low compared to concentrations in the San Joaquin River Basin. However, the much larger flow that the Sacramento River contributes to the Delta, in comparison to the San Joaquin River, results in a substantial contribution to the mass loading of selenium to the Delta from the Sacramento River (Cutter and Cutter 2004; SWRCB 2008a). Loads to the Delta from the Sacramento River were projected to be about half of what the Grasslands basin was projected to contribute to the San Joaquin River, with subsequent loading to the Delta from the San Joaquin River dependent on flow (Presser and Luoma 2006).

Data for selenium in fish from the Sacramento River are limited, but Largemouth Bass were sampled in 1999, 2000, 2005, and 2007 from the lower Sacramento River, San Joaquin River, and Delta by the CVRWQCB. The fillet data and whole-body selenium concentrations, estimated using an equation from Saiki et al. (1991), were used to evaluate potential human and wildlife health risks (Foe 2010). Selenium concentrations in fillets and whole bodies of the bass from the Sacramento River at Veterans Bridge were well below the draft criteria released in May 2014 (11.8 mg/kg for fillets and 8.1 mg/kg for whole body) (USEPA 2014b).

Unknown Toxicity

The Sacramento River from Knights Landing to the Delta is listed as impaired by toxicity due to the results of survival, growth and reproductive toxicity tests performed in 2006 and 2007. Observations of increased mortality and reduction in growth and reproduction in *C. dubia* and *P. promelas* compared to laboratory controls violated the narrative toxicity objective of the Basin Plan. The TMDL for toxicity in this reach of the river is expected to be completed in 2019 (SWRCB 2011q).

6.3.3.1.3 Colusa Basin Drain

The Colusa Basin Drain receives inflow from local creeks and discharge and runoff from the Colusa agricultural basin. Under conditions of low water levels, it drains by gravity into the Sacramento River at Knights Landing; however, when the water levels at Knights Landing are too high for this gravity flow to occur, discharge from the Colusa Basin Drain is routed directly to the Yolo Bypass through the Ridge Cut canal (USGS 2002). During the non-storm season, flows from the Colusa Basin Drain can contribute over ten percent of Sacramento River flows at Verona when there are floods in the Colusa Basin, high irrigation discharges, and/or low Sacramento River flows (Colusa Basin Drain Steering Committee 2005).

Beneficial uses designated for the Colusa Basin Drain include agricultural irrigation and stock watering, water contact recreation, and warm and cold water habitat, migration and spawning for aquatic biota (CVRWQCB 2011). In spite of the many uses of the waterway, the Colusa Basin Drain is listed as impaired for numerous contaminants. Water quality constituents of concern impact both local beneficial uses and the water quality of receiving waterways, including the Sacramento River and the Yolo Bypass. Suspended solids, agricultural chemicals, heavy metals and organic matter are often present in concentrations that exceed those in the Sacramento, Feather, and American Rivers (Colusa Basin Drain Steering Committee 2005, SWRCB 2011r, USGS 2002)

Mercury

The Colusa Basin Drain listed on the 303(d) list for contamination by mercury due to multiple exceedances of the USEPA Fish Tissue Residue Criterion for methylmercury in fish of 0.3 mg/kg (or 0.3 ppm) for the protection of human health (SWRCB 2011r). Samples exceeding the criterion included two of seven samples collected at the County Road 99E bridge crossing between 1997 and

2002 (one carp composite sample with a concentration of 0.41 ppm and one white catfish composite sample with concentration of 0.30 ppm) and one of ten samples collected in the Colusa Basin Drain at Abel Road between 1980 and 1988 (one brown bullhead composite sample with concentration of 0.58 ppm).

The Delta mercury TMDL reported average concentrations of methylmercury in the Colusa Basin Drain was reported to be 0.214 ng/l between 2000 and 2003. The Colusa Basin Drain contributed 3.3 percent of total mercury inputs to the Sacramento Basin between 1984 and 2003 (CVRWQCB 2010a).   A TMDL for the Colusa Basin Drain is expected to be completed in 2021 (SWRCB 2011r).

Pesticides

The Colusa Basin Drain is listed as contaminated by the organophosphate pesticides azinphos-methyl (Guthion), diazinon, DDT and malathion. Azinphos-methyl and malathion have been included on the 303(d) list since 2006; thus, supporting information for their listing is not readily available. However, diazinon has been listed due to samples collected between 1996 and 2000 and again in 2004 exceeding the DFG acute criterion of 0.16 µg/l one hour average. Samples collected in 2004 also exceeded the four day average criterion of 0.10 µg/l. Diazinon was addressed by a 2008 basin plan amendment but has not been removed from the 303(d) list (SWRCB 2011r).

Two of two samples assessed for DDT in the Colusa Basin Drain in 2005 greatly exceeded the OEHHA 2008 FCG for DDT, of 21 µg/kg of total DDT in fish tissue. Concentrations of 44.009 µg/kg and 65.903 µg/kg were recorded in composite samples of white catfish and carp, respectively. The TMDL for DDT is expected to be completed in 2021 (SWRCB 2011r).

The organochlorine pesticide dieldrin, and the Group A pesticides generally, are included on the 303(d) list for the Colusa Basin Drain (SWRCB 2011r). The Group A pesticides have been listed since 2006, thus supporting information is not readily available. Dieldrin is listed due to two of two samples collected in August 2005 exceeding the OEHHA FCGs for dieldrin, of 0.46 µg/kg dieldrin in fish tissue. One composite sample of white catfish recorded a concentration of 0.7 µg/kg and one composite sample of carp recorded a value of 1.14 µg/kg. Contamination by organochlorine pesticides in the Colusa Basin Drain will be addressed by the Central Valley Organochlorine Pesticide TMDL and Basin Plan Amendment.

The carbamate pesticide carbofuran is also included on the 303(d) list for the Colusa Basin Drain. It has been listed since 2006; thus, supporting information not readily available. A TMDL is expected by 2021 (SWRCB 2011r).

Dissolved Oxygen

The Colusa Basin Drain was placed on the 303(d) list approved by the USEPA in 2010 for low dissolved oxygen (SWRCB 2011a). According to the Final California 2010 Integrated Report (303(d)/305(b) Report) Supporting Information, sources of contributing to the dissolved oxygen impairment in the Colusa Basin Drain are unknown (SWRCB 2011r).

Samples collected from the Colusa Basin Drain (at Maxwell Road, above Knights Landing, at Highway 162, and at "Colusa Basin Drain #5") between September 2004 and October 2006 and were tested for dissolved oxygen (SWRCB 2011r). Thirty of the 73 samples exceeded the general number water quality objectives for COLD and SPWN beneficial uses. Five of the samples exceeded the water quality objective for WARM beneficial uses.

Other Constituents of Concern

The Colusa Basin Drain is also listed as contaminated by *E. coli*, low dissolved oxygen, and unknown toxicity (SWRCB 2011r). Knights Landing Ridge Cut is listed as contaminated by boron, low dissolved oxygen, and salinity. A USGS study of Yolo Bypass water quality in 2000 also reported that significant concentrations of ammonium and dissolved organic carbon in the Yolo Bypass were correlated with high concentrations in the Colusa Basin Drain, and that the Colusa Basin Drain was a major discharger of sulfate to the Yolo Bypass (USGS 2002)

6.3.3.1.4 Feather River from Lake Oroville to the Confluence with the Sacramento River

Water quality constituents of concern in the Lower Feather River have the potential to affect several supported beneficial uses, including municipal and agricultural water supply, contact and non-contact water recreation, and fish habitat and migration uses, for cold and warm water. The 303(d) listed contaminants in this reach of the Feather River.

Water Temperature

The Lower Feather River (downstream of Lake Oroville) is not listed on the 303(d) list as impaired by water temperature (SWRCB 2011a). However, water temperature in the lower Feather River is crucial to maintaining fresh water habitat for both warm and cold fresh water fish species in downstream habitats (DWR 2007). The SWP operates Lake Oroville and the Thermalito Reservoir Complex to meet temperature objectives established through a 1983 agreement with California Department of Fish and Wildlife and biological opinions issued by NMFS, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations. Releases from Lake Oroville determine initial river temperatures. Water is released at different depths through shutters at the intake structures (DWR 2007). Although Lake Oroville releases determine water temperatures initially, atmospheric conditions modify downstream river temperatures. Water temperatures vary seasonally and spatially between the low flow channel (LFC) and high flow channel (HFC) of the Lower Feather River downstream of the fish barrier dam. The LFC is the reach of the river between the Fish Barrier Dam and the confluence with the Thermalito Afterbay Outlet and it is managed to protect cold water fish species. The HFC is the downstream reach of the river, from the Thermalito Afterbay Outlet to the confluence with the Sacramento River.

Warmer temperatures in the LFC start to appear in March, reaching maximum temperatures in July and early August ranging from 61° F upstream of the Feather

River Fish Hatchery to 69º F upstream of the Thermalito Afterbay Outlet (DWR 2007a). Cooling of the LFC begins in September, with a minimum temperature of approximately 45º F occurring in February. At the Feather River Fish Hatchery, water temperatures are generally compliant with the 1983 Agreement. Temperatures from 2002 to 2004 were in compliance 95 percent of the time, exceeding requirements for 23 days during an extended warm period in fall 2002, and dropping below requirements for 13 days during the warm summer months. Water temperatures at Robinson Riffle are almost always met when the fish hatchery temperatures are met. Agricultural temperature requests cannot always be satisfied due to the requirements of the fish species and the fluctuating meteorological conditions.

Temperatures in the HFC are influenced by releases from the Thermalito Afterbay and flow contributions from Honcut Creek, the Yuba River, and the Bear River from April through October (DWR 2007). Except for during high flows from the Thermalito Afterbay (occurring frequently in July and August), releases in the warm season generally raise the water temperature. Honcut and Bear River inflows tend to increase downstream temperatures as well, while flows from the Yuba River tend to cool downstream temperatures during the warmer months.

Warming water temperatures appear in the HFC starting in March, with maximum temperatures occurring in July and August, ranging from 71 to 77º F (DWR 2007). In late august, the HFC begins to cool, reaching minimum temperatures of 44 to 45º F by January or February.

In addition to effects on fish species, agriculture is potentially affected by changes in water temperature, because the temperatures of irrigation water can affect crop growth (DWR 2007). In the Feather River Basin, this is particularly an issue for rice production. Water contact recreation can also be affected by water temperatures, as flows in the LFC are managed for cold water species and thus may be too cold for some water-contact recreation.

Mercury

The Lower Feather River is included on the 303(d) list for mercury contamination (SWRCB 2011a). The listing was made before the 2006 Integrated Report; thus, the evidence of water quality exceedance is not readily available. It has been noted, however, that the Feather River has relatively large mercury loadings and high mercury concentrations in suspended sediment, contributing significantly to mercury loading to the Delta. The Feather River transports much of the mercury to the Sacramento River that was released in the Sierra Nevada Mountains during gold mining operations (CVRWQCB 2010a).

FERC relicensing studies indicate that mercury consistently exceeds USEPA guidelines in most fish species and locations, and that biomagnification appears to have caused elevated mercury levels in fish (DWR 2007). A beneficial effect of Lake Oroville is the capture of contaminated sediments, preventing their further transport downstream.

In the Sacramento – San Joaquin Delta Estuary TMDL for methylmercury, the CVRWQCB (2010a) recommends that the Feather River be targeted for mercury reduction during initial efforts focusing on the watersheds that export the largest volumes of highly mercury-contaminated sediment to the Delta.

Pesticides

The Feather River below Lake Oroville is listed as contaminated for chlorpyrifos. Samples collected during storm events at the Feather River near Nicolaus in 2004 exceeded the California DFG Hazard Assessment Criteria of 25 ng/l over a one hour average. The TMDL for chlorpyrifos in the Feather River is expected to be completed in 2019 (SWRCB 2011t).

Group A Pesticides have also been detected in exceedance of water quality criteria (SWRCB 2011t). Data collected for organochlorine pesticide contamination in the Feather River between 2000 and 2009 as part of the NPDES permit program did not indicate exceedances of CTR criteria, but did show detections in all samples in the water column. Channel catfish tissue samples from the Feather River at Highway 99 between 1978 and 2008 exhibited high concentrations of DDT and dieldrin. These water quality and fish tissue data were presented as part of supplemental documents in the process to develop a basin plan amendment to address organochlorine pesticides in Central Valley water bodies. This basin plan amendment is currently in development and will include organochlorine pesticides in the Feather River (CVRWQCB 2010c).

PCBs

The Lower Feather River was placed on the 303(d) list approved by the USEPA in 2010 as impaired by PCBs (SWRCB 2011a).

According to the *Final California 2010 Integrated Report* (303(d)/305(b) Report) Supporting Information, sources of PCBs in the Feather River are unknown (SWRCB 2011t). However, The Draft Environmental Impact Report for the FERC relicensing notes that PCBs have been detected in all fish and crayfish species from all sampled water bodies. Aroclors were also detected in at least some fish in all water bodies, as well as in crayfish in the Feather River downstream from the State Route 70 bridge (DWR 2007). PCBs have been released into the Feather River watershed from several activities. Two events in the 1980s resulted in PCB contamination in the watershed: oil containing PCBs was applied to a dirt road and entered the Ponderosa Reservoir in surface runoff, and PCBs contaminated soil and water at Belden Forebay due to a landslide which damaged powerhouses. Some remediation was performed in response to these events.

The same narrative water quality objective and evaluation criteria of 3.6 ng/g that was used as guidance to place the Sacramento River on the 303(d) list was also used to evaluate the Feather River. Composite samples of Largemouth Bass and crayfish collected in 2002 and 2003 showed high exceedances of the FCG. Upstream of the Thermalito Afterbay Outlet, a composite sample of Largemouth Bass had a concentration of 15.6 ng/g total PCBs, wet weight. Downstream of the outlet, the concentration of total PCBs in two composite samples of Largemouth Bass were 11.2 and 15.0 ng/g. Downstream of the Highway 70 Bridge, the concentration of total PCBs in a composite sample of crayfish was 56 ng/g (SWRCB 2011t)

An additional study performed in 2003 and 2004 also revealed high exceedances of the OEHHA FCG for PCBs. Concentrations of total PCBs in composite samples of hardhead and pikeminnow were 26 ng/g and 31 ng/g wet weight, respectively. All samples were analyzed for 48 individual PCB congeners and two Aroclor mixtures (SWRCB 2011t)

A TMDL for PCBs in the Lower Feather River is expected to be completed in 2021 to protect the beneficial uses of the Feather River and other water bodies downstream (SWRCB 2011t).

Other Constituents of Concern

The Lower Feather River is listed as impaired by unknown toxicity due to significant exceedances of the toxicity criteria outlined by the CVRWQCB (SWRCB 2011t, CVRWQCB 2011). Water samples were tested with *C. dubia, P. promelas*, and *P. subcapitata* for survival, growth and/or reproductive toxicity between 1998 and 2007. Of 212 samples tested with *C. dubia* for survival and/or reproductive toxicity, 85 exceeded the narrative toxicity objective. Of 34 samples tested with *P. promelas* for survival and/or growth toxicity, seven exceeded the objective. Of 23 samples tested with *P. subcapitata*, none exceeded the objective. Samples in violation of the toxicity objective were collected in the Feather River at Nicolaus; in the Thermalito Diversion Pool; downstream from the Feather River Hatchery; upstream and downstream from the Thermalito Afterbay Outlet; downstream from the Sewage Commission Oroville Region (SCOR) Outlet; and downstream from the FERC Project 2100 project boundary.

6.3.3.1.5 American River below Lake Natoma

The lower American River flows for 23 miles from Nimbus Dam to its confluence with the Sacramento River. Water quality in this reach of the river is influenced by releases from upstream reservoirs, including Lake Natoma and Folsom Lake. In general, the runoff that flows into Folsom Reservoir and Lake Natoma, upstream of the lower American River, is of high quality (Wallace, Roberts, and Todd et al. 2003). Water quality parameters measured in Folsom Reservoir, upstream of the lower American River, include pH, turbidity, dissolved oxygen (DO), total organic carbon (TOC), nutrients (nitrogen and phosphorus), electrical conductivity, total dissolved solids (TDS), and fecal coliform.

Water Temperature

The lower American River is not listed on the 303(d) list as impaired by water temperature (SWRCB 2011a). The lower American River supports warm and cold fresh water habitat beneficial uses, as well as migration and spawning uses. In particular, in-stream rearing of juvenile steelhead requires certain water temperatures which are targeted through water temperature objectives (CVRWQCB 2011, NMFS 2009).

The CVP operates Folsom Lake to meet temperature objectives, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations.

Mercury

The American River from Nimbus Dam to the confluence with the Sacramento River was listed on the 303(d) list for mercury contamination in 2010, due to exceedances of OEHHA's guidance tissue levels for mercury (SWRCB 2011u). The major source of mercury to the lower American River is mercury lost during historic mining activities that is now distributed downstream.

The American River contributes mercury to the Sacramento River, and thus the Delta, due to its relatively large mercury loadings and high mercury concentrations in suspended sediment (CVRWQCB 2010a). Like the Feather River, the lower American River is recommended for initial mercury reduction efforts as part of the Sacramento – San Joaquin Delta Estuary TMDL for Methylmercury. In addition to load allocations recommended as part of the Delta TMDL for methylmercury, mercury contamination in the American River and its reservoirs will be addressed as part of the statewide water quality control program for mercury (SWRCB 2014a).

PCBs

The lower American River was placed on the 303(d) list approved by the USEPA in 2010 as impaired by PCBs (SWRCB 2011a).

Composite samples of white catfish and Sacramento sucker collected in the American River at Discovery Park were analyzed for 48 individual PCB congeners and three Aroclor mixtures (SWRCB 2011u). The total PCBs recorded in the White Catfish and Sacramento Sucker were 3.934 ng/g and 44.094 ng/g, respectively. An additional Sacramento Sucker composite sample collected at Nimbus Dam did not exceed the OEHHA goal.

A TMDL for PCBs in the lower American River is expected to be completed in 2021 to protect the beneficial uses of the American River and other water bodies downstream (SWRCB 2011u).

Unknown Toxicity

The lower American River is listed as impaired by unknown toxicity. Toxicity has been indicated for vertebrates and invertebrates from samples collected at Discovery Park, using survival, growth, and reproduction toxicity tests with *C. dubia* and *P. promelas*. These tests, conducted between 1998 and 2007, exhibited significant increases in mortality and reductions in growth and reproduction in the test organisms (SWRCB 2011u). The TMDL is expected to be completed in 2021 (SWRCB 2011u).

6.3.3.1.6 Yolo Bypass

The Yolo Bypass supports a variety of beneficial uses, including agricultural supply, recreational uses, and spawning, migration and habitat use. The Yolo Bypass is used for agriculture in times of low flow, and discharges to the San

Francisco Bay-Delta contribute to drinking water supplies. The Yolo Bypass also supports seasonal fish and bird populations when it is inundated, and resident fish species in its perennial channel. Water quality in the Yolo Bypass is of great importance because of the in-Bypass water uses and its effects on receiving waters downstream (CVRWQCB 2011, Sommer et al. 2001)

Mercury

The Yolo Bypass contributes a significant amount of methylmercury and total mercury to the Delta. While the Sacramento River is the primary tributary source of mercury to the Delta in dry years, mercury loading from the Yolo Bypass increases in wet years and is comparable to that of the Sacramento River. Although only two thirds of the Yolo Bypass floodplain lie within the legal Delta, the entire floodplain was evaluated as part of the Sacramento – San Joaquin Delta Estuary TMDL for Methylmercury (Delta Methylmercury TMDL) (CVRWQCB 2010a). Compounding the issue of mercury contamination in the Yolo Bypass, the USGS study noted that the Bypass has conditions conducive to the production of methylmercury, including stagnant waters and marshes with an abundance of sulfate and organic carbon (USGS 2002).

A major source of mercury to the Yolo Bypass is Cache Creek. Mercury mine wastes have contributed relatively large mercury loading and high mercury concentrations in suspended sediment, making this area a priority for mercury reduction as part of the Delta Methylmercury TMDL (CVRWQCB 2010a). Elevated methylmercury concentrations in the Colusa Basin Drain are also a concern (USGS 2002).

The Cache Creek Settling Basin (CCSB) captures sediment and mercury transported by Cache Creek; however, any sediment that is not captured is transported to the Yolo Bypass (approximately half of the sediment transported by Cache Creek). The CTR mercury criterion of 0.050 µg/l for drinking water is exceeded in outflow from the CCSB (and possibly in other tributaries to Yolo Bypass), thus it is anticipated that when the Yolo Bypass is dominated by flows from Cache Creek, it also exceeds the CTR criterion (CVRWQCB 2010a).

The Delta Methylmercury TMDL recommends reducing mercury loads entering the CCSB, and regularly excavating the sediment accumulating in the CCSB, in order to increase its effectiveness and prevent its filling and thus cessation of sediment and mercury deposition. Additional reductions in mercury loading to Cache Creek will be achieved through the existing mercury TMDL in the watershed, which includes measures for mine remediation, erosion control in mercury-enriched areas, and the removal of floodplain sediments containing mercury (CVRWQCB 2010a).

In addition to efforts targeting mercury loading reductions in Cache Creek, the TMDL includes methylmercury and total mercury load and waste load allocations for agricultural drainage, tributary inputs and NDPES facilities in the Yolo Bypass to enable reductions in mercury contamination in water and fish (CVRWQCB 2010a).

Agricultural Runoff

The City of Woodland developed a water quality management plan for the Yolo Bypass which included water quality testing to identify pollutants of concern. Water quality was monitored within the Yolo Bypass and in its major tributaries, at the locations where they enter the Bypass. The study indicated that the highest concentrations of several contaminants were found in tributaries receiving predominantly agricultural discharge: the Willow Slough Bypass; Knights Landing Ridge Cut, which drains the Colusa Basin Drain; and for some contaminants, the Z Drain (City of Woodland 2005). Although the Yolo Basin is not included as a water body on the 303(d) list, the Tule Canal is listed as contaminated by several of these agricultural by-products, including boron, salinity, E. coli and fecal coliform. These contaminants will be addressed by TMDLs expected to be completed in 2021 (SWRCB 2011w).

Pesticides are of major concern in the agricultural drains tributary to the Yolo Bypass. DDE, a degradation product of the organochlorine pesticide DDT, was detected in the water column in agricultural drains and in Putah Creek sediment. The organophosphate pesticide chlorpyrifos was detected in excess of the concurrent DFG criterion of 0.009 µg/l in four samples, while diazinon was not reported in excess of its criterion. The carbamate pesticides diuron and methomyl were detected, but did not exceed their applicable criteria. Pyrethroids were not monitored, but were noted to be of increasing concern in the Yolo Bypass as in the rest of the Central Valley (City of Woodland 2005).

6.3.3.2 San Joaquin Valley

Water quality conditions in the San Joaquin River are described for locations that would be influenced by implementation of Alternatives 1 through 5, including Stanislaus River near Caswell Park in the vicinity of the confluence with the San Joaquin River; San Joaquin River near Vernalis, and San Joaquin River near Buckley Cove and Stockton

6.3.3.2.1 San Joaquin River

Water quality concerns in the San Joaquin River near Vernalis are primarily salinity, boron, and selenium which are influenced by low flows due to upstream diversions and water use and agricultural return flows.

Water Temperature

The reach of the San Joaquin River from Merced River to Stanislaus River was placed on the Section 303(d) list per the partial approval by USEPA in 2010 and the final approval in 2011 (SWRCB 2011a).

According to the *Final California 2010 Integrated Report* (303(d) list/305(b) Report) Supporting Information, water temperature concerns in San Joaquin River from Merced River to Stanislaus River are attributed to unknown sources (SWRCB 2011x,y). However, declines in fish populations, particularly salmon and steelhead trout, have been linked to increases in water temperatures and suggestions have been made that the population declines may be a result of watershed changes from the construction of dams, water diversions, mining, and harvest (NMFS 2009).

USEPA (2011) evaluated salmonid migration and spawning temperatures to assess the water quality of the San Joaquin River. Recommended water temperature criteria for salmon and steelhead trout life stages are presented in Table 6.16. San Joaquin River temperatures from the Merced River to the Stanislaus River in 1996-2007 exceeded USEPA's recommendations, thus impairing the cold freshwater habitat.

Table 6.16 San Joaquin River Maximum Temperature Criteria and Recommended Uses for Summer

Applicable to:	Criteria:
Chinook Salmon Adult Migration	64 °F
Chinook Salmon Spawning	55 °F
Chinook Salmon Smoltification and Juvenile Rearing	61 °F
Steelhead Trout Summer Rearing	64 °F

Source: SWRCB 2011x,y; USEPA 2003

TMDLs for the lower reaches in the San Joaquin River (Merced to Tuolumne and Tuolumne to Stanislaus) are expected to be complete in 2021 in an effort to further protect the beneficial uses of this water body (SWRCB 2011).

Selenium

San Joaquin River from Mud Slough to Merced River was placed on the Section 303(d) list in 2010 for selenium contamination per the list approved by USEPA (SWRCB 2011a). Other water bodies that drain to the San Joaquin River upstream of this reach and are listed as impaired by selenium contamination on the 303(d) list include Mendota Pool, Panoche Creek from Silver Creek to Belmont Avenue, Agatha Canal, Grasslands Marshes, Mud Slough (North, downstream of San Luis Drain), and Salt Slough (upstream from confluence with San Joaquin River).

TMDLs for selenium were approved by the USEPA for the San Joaquin River (Mud Slough to Merced River) (in 2002), Grasslands Marshes (in 2000), Agatha Canal (in 2000), and Mud Slough (north, downstream of San Luis Drain) (in 2002) (SWRCB 2011z-ac). A TMDL is expected to be complete for Panoche Creek in 2019 and another for Mendota Pool in 2021. Water quality objectives defined in the Basin Plan for the Sacramento River basin and the San Joaquin River basin are shown in Table 6.17 (CVRWQCB 2011).

Table 6.17 Water Quality Objectives for Selenium in the San Joaquin River Region, mg/l

Objective	Applies to:
0.012 (maximum concentration)	San Joaquin River, mouth of the Merced River to Vernalis
0.005 (4-day average)	–
0.020 (maximum concentration)	Mud Slough (north), and the San Joaquin River from Sack Dam to the mouth of Merced River
0.005 (4-day average)	–
0.020 (maximum concentration)	Salt Slough and constructed and re-constructed water supply channels in the Grassland watershed*
0.002 (monthly mean)	–

Source: CVRWQCB 2011

*Applies to channels identified in Appendix 40 of the CVRWQCB (2011) Basin Plan

The drainage area for the Grasslands Bypass Project is a major but decreasing source of selenium to the San Joaquin River. Selenium from subsurface agricultural drainage waters originating in the Drainage Area was historically transported through the Grassland Marshes through tributaries such as Mud Slough and Salt Slough (CVRWQCB 2001). Efforts to decrease the selenium loading to the San Joaquin River include the Grassland Bypass Project, discussed in more detail below, which has decreased selenium loading by an average of 55 percent from the Grasslands Drainage Area in comparison to pre-Grassland Bypass Project conditions (1986-1996 to 1997-2011) (GBPOC 2013). In the San Joaquin River below the Merced River, selenium concentrations decreased from an average of 4.1 µg/l during pre-project conditions (1986 to 1996) to 2 µg/l (1997 to 2011). The continued operation of the Grassland Bypass Project is expected to achieve the CVRWQCB Basin Plan objectives for the San Joaquin Valley (Reclamation & SLDMWA 2009).

Largemouth Bass were sampled during 1999, 2000, 2005, and 2007 from the San Joaquin River, lower Sacramento River, and Delta by the CVRWQCB (Foe 2010). The samples were analyzed as fillets to evaluate potential human health risks, and whole-body selenium concentrations were estimated using an equation from Saiki et al. (1991) to evaluate risks to wildlife. The data do not exceed the draft water quality criteria released by the USEPA in May 2014.

The draft discharge requirements released by the CVRWQCB in 2014 were created in an effort to meet the water quality objective for the San Joaquin River. In 2010, the CVRWQCB and SWRCB approved amendments (Resolution 2010-0046) to the Basin Plan for the Sacramento River and San Joaquin River Basins to address selenium control in the San Joaquin River basin as related to the Grassland Bypass Project (which is described below) (CVRWQCB 2010g, SWRCB 2010b).

Other relevant requirements/actions to meet the water quality objectives for the San Joaquin River, in addition to release of the draft waste discharge requirements by the CVRWQCB (2010g), include the following:

- The Basin Plan amendments (CVRWQCB 2010g, SWRCB 2010b) modify the compliance time schedule for discharges regulated under waste discharge requirements to meet the selenium objective or comply with a prohibition of discharge of agricultural subsurface drainage to Mud Slough (north), a tributary to the San Joaquin River, in Merced County. For Mud Slough (north) and the San Joaquin River from the Mud Slough confluence to the mouth of the Merced River:
    - The interim performance goal is 15 µg/l (monthly mean) by December 31, 2015 (adds to Table 6.46), and
    - The water quality objective to be achieved by December 31, 2019, is 5 µg/l (4-day average).

An extensive water quality and biological monitoring program was implemented in conjunction with the Grassland Bypass Project, and reports are issued periodically through the San Francisco Estuary Institute (e.g., SFEI 2011).

Electrical Conductivity and Salinity

Grasslands Marshes, North Mud Slough (downstream of San Luis Dam), Salt Slough (upstream from confluence with San Joaquin River), and San Joaquin River (Bear Creek to Vernalis) are water bodies in the Central Valley that were placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by electrical conductivity (SWRCB 2011a). Salinity, which is linked to electrical conductivity, is a major concern for water quality in the San Joaquin Valley (CVRWQCB 2011). The RWQCB has adopted a TMDL for the San Joaquin River upstream of Vernalis for salt and boron.

Elevated electrical conductivity in Grasslands Marshes, North Mud Slough (downstream of San Luis Dam), Salt Slough (upstream from confluence with San Joaquin River), and San Joaquin River (Bear Creek to Vernalis) can be attributed to agriculture (SWRCB 2011x-aa,ac-af). Likewise, high salinity in the San Joaquin River near Vernalis has been linked to the discharge of water from agricultural practices (CALFED 2007). Saline water from agricultural return flow is added to the southern Delta by the San Joaquin River whereupon a portion is pumped by the export pumps back to the farms that eventually drain back to the river, exacerbating the problem of salinity control and salt buildup in the San Joaquin Valley.

To protect the beneficial uses of these water bodies, including agricultural supply, and municipal and domestic supply, particularly for San Joaquin River from Bear Creek to Mud Slough, water quality objectives were established in the SWRCB (2006a) Basin Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Table 6.18).

Table 6.18 SWRCB Water quality objectives for electrical conductivity in the San Joaquin River (Airport Way Bridge, Vernalis)

Time Period	Water Quality Objective[1]
April 1 to August 31	0.7 mmhos (700 µS/cm)
September 1 to March 31	1.0 mmhos (1000 µS/cm)

Source: SWRCB 2006a

[1] Maximum 30-day running average of mean daily

Several samples from San Joaquin River (Bear Creek to Vernalis) between October 1995 and February 2007 exceeded the SWRCB Basin Plan's water quality objective for electrical conductivity in the San Joaquin River (SWRCB 2011 x-aa,ac-af). Samples were collected from San Joaquin River at Lander Avenue, Fremont Ford, Patterson Fishing Access, Hills Ferry Bridge, and Crows Landing. Guidelines for evaluating Grasslands Marshes, North Mud Slough, and Salt Slough are not available because the listing was made prior to 2006.

The record of monthly average EC readings for recent years for the San Joaquin River at Vernalis is shown in Figure 6.4. Salinity in the lower San Joaquin River as observed at Vernalis often exceeds the water quality objective for individual records during summer months. The highest salt concentrations emanate from Mud and Salt sloughs, while less saline water provides dilution from the Merced River (CALFED 2007). Note the marked increase in salinity during dry months and dry years at Vernalis, ranging from midwinter lows near 100 µmhos/cm up to summer high values near 1000 µmhos/cm.

A TMDL is expected to be completed in 2019, with the exception of San Joaquin River from Tuolumne to Stanislaus River which is expected to be completed in 2021 (SWRCB 2011 x-aa,ac-af). In addition, the Board has implemented the comprehensive salt management program, known as CV-SALTS (Central Valley Salinity Alternatives for Long Term Sustainability), to develop salt control strategies for the San Joaquin and the entire Central Valley watershed (CVRWQCB 2011, 2010h). The San Joaquin River Water Quality Improvement Program (SJRIP) was designed to address issues of chronically saline water, reuse, treatment options, and the development of salt-tolerant crops for this area of the valley, as part of the Grasslands Bypass Project.

Mercury

Mercury is a constituent of concern for the San Joaquin River from Bear Creek to the Delta boundary, and was placed on the 303(d) list in 2010 (SWRCB 2011a). San Joaquin River from Friant Dam to Bear Creek was not included on the 303(d) list for mercury contamination.

Mercury in this reach of the San Joaquin can be attributed to resource extraction. Significant gold mining took place along the major tributaries of the San Joaquin River, including Merced River, Tuolumne River, Stanislaus River, and Cosumnes River in the San Joaquin River basin (CVRWQCB 2010a).

Mercury and enhanced mercury methylation can affect the beneficial uses of the San Joaquin River and receiving waters downstream. At the Delta boundary in Vernalis, the waterborne methylmercury concentration in the San Joaquin River, from 2003 to 2006 ranged from 0.10-0.75 ng/l with an average of 0.19 ng/l (Foe et al. 2008). The average fish tissue mercury concentration in Largemouth Bass from Vernalis in 2000 was 0.68 mg/kg (wet weight) (CVRWQCB 2010a). This fish tissue concentration exceeds the USEPA wet weight methylmercury fish tissue criterion (0.3 mg/kg) for the protection of human health.

To further protect the health of humans and wildlife, the Sacramento-San Joaquin Delta TMDL specified narrative and more stringent numeric water quality objectives for the more bioavailable and more toxic form methylmercury (CVRWQCB 2011). The TMDL for the Sacramento-San Joaquin Delta (CVRWQCB 2010a), which is applicable to the Delta, Yolo Bypass, and their waterways, includes the reach of the San Joaquin River from Bear Creek to the Delta boundary.

Pesticides

The San Joaquin River (all segments from Mendota Pool to Vernalis), North Mud Slough (downstream of San Luis Drain), and Salt Slough (upstream from confluence with San Joaquin River) were placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by pesticides (SWRCB 2011a). North Mud Slough is listed as impaired by “pesticides”; Salt Slough by chlorpyrifos and prometryn, and San Joaquin River by OP pesticides (chlorpyrifos and diazinon), OC pesticides (DDT, DDE, Group A Pesticides, including toxaphene), alpha.-BHC, and diuron. Impairment listings are vary between reaches of the San Joaquin River. Several other small tributaries to the San Joaquin River from the west are also 303(d) listed as impaired by pesticides (i.e., Mud Slough North (upstream and downstream of San Luis drain).

Pesticides in North Mud Slough, Salt Slough, and the San Joaquin River can be attributed to runoff from agriculture, with the exception of the alpha-BHC in the San Joaquin River (from Merced to Tuolumne) and toxaphene in the San Joaquin River (from Stanislaus to the Vernalis) whose sources are unknown (SWRCB 2011x-z,ac-ag).

Boron

The lower San Joaquin River upstream of Vernalis is listed as impaired due to elevated concentrations of boron (CVRWQCB 2002b, 2007c). A draft Amendment to the Basin Plan for the Sacramento River and San Joaquin River Basins for the control of Salt and Boron discharges into the lower San Joaquin River (resolution R5-2004-0108) (CVRWQCB 2007c) describes a pending TMDL and establishes Waste Load Allocations to meet boron water quality objectives near Vernalis (at the Airport Way Bridge).

Mean salinity in the lower San Joaquin River at Vernalis has doubled since the 1940s while boron and other trace elements have also increased to concentrations that exceed the water quality criteria of 750 µg/l. These criteria were established to be protective of sensitive crops under long-term irrigation (USEPA 1986b).

Water quality improves in the San Joaquin River downstream of confluences with the Merced, Tuolumne, and Stanislaus rivers.

Most of the boron load to the Delta comes from the lower San Joaquin River as a result of surface and subsurface agricultural discharges (CVRWQCB 2007c) on soils overlying old marine deposits and from groundwater (Hoffman 2010h, CALFED 2000). Major boron contributions come from Salt and Mud sloughs to the lower river (CVRWQCB 2002b). Point sources contribute very little of the salt and boron loads to the San Joaquin River (CVRWQCB 2007c).

Boron concentrations in surface water from two surface water sources in the lower San Joaquin River are variable, and range from 100 to over 1000 µg/l (Hoffman 2010). Effluent from subsurface drains in the New Jerusalem Drainage District have also been reported up to 4200 µg/l (Hoffman 2010). These concentrations at times exceed the water quality criteria and thresholds for sensitive crops (i.e., bean tolerance threshold is 750 to 1000 µg/l).

The collaborative effort by stakeholders and regulators is developing comprehensive management programs that will lead to attainment of water-quality objectives for salinity and boron. This program, CV-SALTS, is scheduled to be completed by 2016 and may lead to a basin plan amendment that will support the protection of beneficial uses.

Arsenic

The San Joaquin River from Bear Creek to Mud Slough was placed on the 303(d) list approved by the USEPA in 2010 for impairment by arsenic (SWRCB 2011a). Arsenic can cause adverse dermal, cardiovascular, respiratory, gastrointestinal, and neurological effects, and can cause cancer (ATSDR 2007).A TMDL addressing impairment due to arsenic is expected to be complete in 2021to protect the beneficial uses of this reach of the San Joaquin River, including the municipal and domestic supply (SWRCB 2011ae).

Bacteria

San Joaquin River (Bear Creek to Merced River; Stanislaus River to Delta Boundary) and Salt Slough (upstream from confluence with San Joaquin River) is a water body in the Central Valley that were placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by *E. coli* (SWRCB 2011a).

Invasive Species

San Joaquin River (Friant Dam to Mendota Pool) is a water body in the Central Valley that was placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by invasive species (SWRCB 2011a).

A TMDL for invasive species is expected to be complete in 2019 in an effort to meet the narrative water quality objective in San Joaquin River (Friant Dam to Mendota Pool).

6.3.3.2.2 Stanislaus River

Water Temperature

The lower Stanislaus River was placed on the 303(d) list per the partial approval by USEPA in 2010 and the final approval in 2011 (SWRCB 2011a). The Stanislaus River supports warm and cold fresh water habitat for aquatic species such as steelhead.

According to the *Final California 2010 Integrated Report* (303(d) list/305(b) Report) Supporting Information, water temperature concerns are attributed to unknown sources (SWRCB 2011). Future climate conditions that are warmer or drier or both will further restrict the extent of suitable habitat for steelhead (NMFS 2009).

USEPA recommended water temperature criteria for different salmon and steelhead trout life stages. Data from 1991 to 2007 exceeded USEPA's and thus impairing the cold freshwater habitat. The 2009 NMFS BO also includes temperature objectives for the Stanislaus River, as described in Appendix 3A, No Action Alternative: Central Valley Project and State Water Project Operations.

Mercury

Lower Stanislaus River is a water body in the Central Valley that was placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by mercury (SWRCB 2011a).

Mercury has impaired the beneficial use of the commercial or recreational collection of fish shellfish or organisms (SWRCB 2011aj-al). The lower Stanislaus River was evaluated prior to 2006, so the evidence for list is not readily available. However, the total methylmercury concentration in the Stanislaus River at Caswell State Park from 2003 to 2006 was 0.12 ng/l (Foe et al. 2008). Concentrations of methylmercury in Largemouth Bass, carp, Channel Catfish, and White Catfish tissue samples from the Stanislaus River between 1999 and 2000 exceeded the USEPA methylmercury fish tissue criterion (0.3 mg/kg wet weight) for the protection of human health (Shilling 2003).

In an effort to protect the beneficial uses of these water bodies mentioned above, and including the commercial and recreational collection of fish, shellfish, or organisms beneficial use, TMDLs are expected to be complete between 2019 to 2021to meet the water quality standards in these water bodies (CVRWQCB 2011).

Pesticides

Lower Stanislaus River was placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by pesticides (chlorpyrifos, diazinon, Group A Pesticides) (SWRCB 2011a). OP pesticides (e.g., diazinon and chlorpyrifos) and OC pesticides (e.g., Group A Pesticides) are primarily transported to streams and rivers in runoff from agriculture (CVRWQCB 2011). Sources and descriptions of the listed pesticides are discussed further in Section 6.3.2.7.

Other Constituents of Concern

Lower Stanislaus River was placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by unknown toxicity (SWRCB 2011a).

To protect the beneficial uses of Lower Stanislaus River, a narrative water quality objective, which addresses *E. coli*, was established in the CVRWQCB (2011) Basin Plan. T

A TMDL is expected to be complete in 2021 in an effort to meet the water quality standards in the lower Stanislaus River.

6.3.3.3 Sacramento-San Joaquin River Delta

Water quality conditions in the Sacramento and San Joaquin River in the Delta are described in this subsection to protect the beneficial uses summarized in Table 6.2. The constituents of concern that are currently not in compliance with existing water quality standards and for which TMDLs are adopted or are in development in this region are summarized in Table 6.1.

6.3.3.3.1 Salinity

Delta waterways were placed on the Section 303(d) List approved by the USEPA in 2010 as impaired by electrical conductivity (SWRCB 2011a). Electrical conductivity is linked to salinity and salinity is of particular concern in the tidally-influenced Delta (CVRWQCB 2011, CALFED 2007).

Electrical conductivity in Delta waterways (export area, northwestern portion, southern portion, western portion) can be attributed to runoff from agricultural practices (SWRCB 2011at-aw). Salinity in the Delta can vary significantly depending on several factors including hydrology, water operations, and Delta hydrodynamics (Jassby et al. 1995). Hydrology and upstream water operations influence the Delta inflows, which influences the balance with the high saline seawater intrusion. Various upstream watershed sources determine the quality of the Delta inflows, in addition to the in-Delta sources such as agricultural returns, natural leaching, municipal and industrial discharges influence the Delta salinity conditions. Operation of various Delta gates and barriers, pumping rates of various diversions and volume of the open water bodies are the other key factors that influence the Delta hydrodynamics and the salinity transport in the Delta.

Water quality objectives for electrical conductivity were established in the SWRCB (2006a) Basin Plan to protect the beneficial uses of these Delta waterways, including agricultural supply. Objectives are specific to the western Delta, interior Delta, southern Delta and export area, as well as for inflows and outflows to the delta from other water bodies. Compliance locations in the Delta are shown in Figure 6.5.

The patterns of EC and salinity in the Delta over time and space follow predictable patterns, under the strong influence of higher saline water from the San Joaquin and less saline water from the Sacramento and Eastside streams in an ever-changing balance with tidal influence upstream from Suisun Bay and the losses from south Delta pumping. The record of monthly average EC readings for recent years at five sites throughout the Delta show the pattern of increasing average EC in the western Delta, as shown in Figures 6.6 through 6.8. The highest salinity occurs in the late summer months when the flows from the Sacramento and San Joaquin rivers are the lowest; and sea water intrusion occurs. The lower Sacramento River at Collinsville experiences strong tidal influence during dry periods (EC above 8000 µmhos/cm) but is flushed with fresh water during winter flows. Historical salinity discharged from the CVP Jones Pumping Plant into the Delta Mendota Canal is summarized in Figure 6.9.

Salinity objectives for the southern Delta are now under review by the SWRCB (SWRCB 2008b).

6.3.3.3.2 Mercury

Mercury is a constituent of concern for the Sacramento-San Joaquin River Delta, which was placed on the 303(d) list in 2010 (SWRCB 2011a). In 2008, the San Francisco Bay Mercury TMDL was approved by the USEPA and the implementation plan is expected to attain the water quality standard 20 years after the approval (SFB RWQCB 2006). In 2010, the RWQCB approved amendments to the Basin Plan for the Sacramento River and San Joaquin River Basins to include the Sacramento-San Joaquin Delta Methylmercury TMDL (CVRWQCB 2011). The TMDL was created to control methylmercury and total mercury in the Sacramento-San Joaquin River Delta Estuary, which is applicable to the Delta, Yolo Bypass, and their waterways (CVRWQCB 2010a). The waterways include the major tributaries to the Delta, the Sacramento River, eastside streams, and the San Joaquin River. Fish tissue and waterborne mercury concentration data for these water bodies are summarized in Tables 6.19 and 6.20.

Table 6.19 Fish and Waterborne Methylmercury (as Total Mercury) Concentrations by Delta Subarea

	Delta Subarea[1]				
	Sacramento River	**Mokelumne River**	**Central Delta**	**San Joaquin River**	**West Delta**
Fish (Sampled in September/October 2000) (mg/kg wet weight)					
Standardized 350-mm Largemouth Bass[2]	0.72	1.04	0.19	0.68	0.31
Water (Sampled between March and October 2000) (ng/l)					
Average	0.120	0.140	0.055	0.147	0.087
Median	0.086	0.142	0.032	0.144	0.053
Water (Sampled between March 2000 and April 2004) (ng/l)					
Annual Average	0.108	0.166	0.060	0.160	0.083
Annual Median	0.101	0.161	0.051	0.165	0.061
Cool Season[3] Average	0.137	0.221	0.087	0.172	0.106
Cool Season[3] Median	0.138	0.246	0.077	0.175	0.095
Warm Season[3] Average	0.094	0.146	0.050	0.156	0.075
Warm Season[3] Median	0.089	0.146	0.040	0.162	0.055

Source: Adapted from CVRWQCB 2010a.

1: Location of each water and fish collection site provided on Figure 5.1 of the 2008 Draft Staff Report for the Sacramento-San Joaquin Delta Estuary TMDL for Methylmercury (CVRWQCB 2010a).

2: See CVRWQCB 2010a for the method used to calculate standard 350-mm Largemouth Bass mercury concentrations.

3: For this analysis, “cool season” is defined as November through February and “warm season” is defined as March through October.

Table 6.20 Historical Methylmercury Concentrations in the Five Delta Source Waters for the Period 2000-2008

Source Water	Sacramento River		San Joaquin River		San Francisco Bay		East Side Tributaries		Agriculture in the Delta	
	Total[2]	Dissolved[3]	Total[2]	Dissolved[3]	Total[2]	Dissolved[3]	Total[2]	Dissolved[3]	Total[2]	Dissolved[3]
Mean[1] (ng/L)	0.10	0.05	0.15	0.03	0.032	-	0.22	0.08	0.51	-
Minimum (ng/L)	0.06	0.02	0.09	0.01	-	-	0.02	0.02	0.02	-
Maximum (ng/L)	0.16	0.12	0.26	0.08	-	-	0.32	0.41	5.44	-
75th Percentile (ng/L)	0.13	0.08	0.18	0.06	-	-	0.2	0.15	0.53	-
99th Percentile (ng/L)	0.16	0.12	0.26	0.08	-	-	0.31	0.39	4.81	-
Data Source	CEDEN 2014 (Irrigated Lands Regulatory Program)		Central Valley Water Board 2010a		SFEI 2014b	-	Central Valley Water Board 2010a		Heim et al. 2009	-
Station(s)	Sacramento River at Freeport		San Joaquin River at Vernalis		Suisun Bay		Mokelumne and Calaveras Rivers		Delta locations	
Date Range	12/2006-08/2007		2000-2001; 2003-2004	2000-2002	2008	-	2000-2001; 2003-2004	2000-2002	10/2005-03/2008	-
ND Replaced with RL	No		Not Applicable	Yes	-		Yes		Not Applicable	
Data Omitted	No		None		-		None		None	
No. of Data Points	8	8	49	25	-	-	27	9	183	-

Source: Adapted from Reclamation et al. 2013.

1: Geometric mean.

2: Total recoverable concentration of analyte.

3: Dissolved concentration of analyte.

For the protection of the beneficial uses of the Sacramento – San Joaquin Delta, water quality objectives were specified in the San Francisco Bay Mercury TMDL (Table 6.21) and the Sacramento-San Joaquin Delta Methylmercury TMDL (Table 6.22).

Table 6.21 Water Quality Objectives for Total Mercury in the Delta within the San Francisco Bay Region[1]

For the protection of human health	0.2 mg/kg wet weight mercury in fish tissue[2]
For the protection of aquatic organisms and wildlife	0.03 mg Hg/kg in fish[3]
1-hour average	2.1 µg/l, in water

Source: SFB RWQCB 2013

1 Water quality objectives are applicable to Sacramento/San Joaquin River Delta (within the San Francisco Bay region as specified in the SFB RWQCB Basin Plan, 2013), Suisun Bay, Carquinez Strait, and San Pablo Bay.

2 measured in the edible portion of trophic level 3 and trophic level 4 fish

3 measured in whole fish 3-5 cm in length

Table 6.22 Water Quality Objectives for total mercury in the Delta within the Central Valley

	Wet Weight Methylmercury Concentration of Fish Tissue (mg/kg wet weight)	
Water body	**Trophic Level 3 Fish**	**Trophic Level 4 Fish**
Cache Creek, North Fork Cache Creek, and Bear Creek	0.12	0.23
Harley Gulch	0.05[1]	–
Sacramento-San Joaquin Delta[2] and Yolo Bypass	0.08[3], 0.03[4]	0.24[3], 0.03[4]

Source: CVRWQCB 2011

1: Applies to whole fish of trophic levels 2 and 3.

2: Applies to the 146 Sacramento-San Joaquin Delta and Yolo Bypass waterways listed in Appendix 43 of the Basin Plan for the Sacramento River and San Joaquin River Basins.

3: Applies to fish of total length 150-500 mm.

4: Applies to whole fish less than 50 mm in length.

Methylation processes in the Delta are enhanced by environmental characteristics such as the source of inorganic mercury, nutrient enrichment, dissolved oxygen in the water column, sediment organic content and grain size, water residence time and sediment accumulation, periodic drying and wetting, and fish species and age structure (Alpers et al. 2008). The mercury-laden sediment that accumulates in the Delta as a result of waterborne loading is subject to methylation (Heim et al. 2007). Waterborne methylmercury in the Delta may be a more significant factor to bioaccumulation in fish than mercury-laden sediment that is subject to methylation (Melwani et al. 2009). Another factor affecting bioaccumulation in fish may be dissolved organic carbon (DOC). Laboratory studies have shown mercury uptake is much higher in water with lower DOC (as might be expected from the tributaries versus the interior Delta) (Pickhardt et al. 2006).

Mercury exposure and methylation can affect the beneficial uses of the Sacramento-San Joaquin Delta, and receiving waters downstream such as the Suisun Bay, Carquinez Strait, San Pablo Bay, and San Francisco Bay. To protect the beneficial uses of the water body a narrative water quality objective was specified, in addition to numeric water quality objectives, stating that surface waters are to "…be maintained free of toxic substances in concentrations that are toxic to or that produce detrimental physiological responses to human, plant, animal, and aquatic life" (CVRWQCB 2011).

In an effort to meet the water quality objectives, the CVRWQCB plans to continue monitoring metals in the Delta and control mass emissions from inactive or abandoned mines and other significant sources (CVRWQCB 2011). The ongoing interest in controlling mercury in fish in the Delta has spawned the Mercury Exposure Reduction Program (MERP), developed by the CVRWQCB, with the goal of pooling the resources of mercury dischargers to develop reduction programs and a better understanding of mercury bioaccumulation in Delta fish (MERP 2012). The MERP is designed to build on previous CALFED efforts. MERP was included as part of an amendment to the Sacramento River and San Joaquin River Basins Basin Plan in 2011 (CVRWQCB 2011), and is applicable to people eating one meal of trophic level 3 or 4 fish per week (32 g/day) from the Delta and Yolo Bypass, as well as their waterways. The two-phase program was put into effect October 20, 2011 and will be complete in 2030. Phase 1 consists of implementing programs to minimize pollution, implementing interim mass limits for point sources, and controlling potentially methylated sediment-bound mercury in the Delta and Yolo Bypass. Phase 1 also includes developing a program to control mercury in tributaries upstream. Plans for Phase 2 include implementing control programs and monitoring compliance. In addition to the Delta Control Mercury Program, the CVRWQCB designated load and waste load allocations for point sources within and to the Delta as specified in the Basin Plan.

6.3.3.3.3 Selenium

Selenium is a constituent of concern for the Sacramento-San Joaquin River Delta and the Delta was placed on the 303(d) list in 2010 (SWRCB 2011a). Selenium criteria were promulgated for all San Francisco Bay and Delta waters in the NTR (SFB RWQCB 2011a). Although the entire San Francisco Bay is listed as impaired by selenium, the TMDL for the San Francisco Bay focuses on the North San Francisco Bay (North Bay, defined to include a portion of the Delta, Suisun Bay, Carquinez Strait, San Pablo Bay, and the Central Bay) because sources there are substantially different from sources in the South San Francisco Bay (South Bay) (Lucas and Stewart 2007). The NTR criteria specifically apply to San Francisco Bay upstream to and including Suisun Bay and the Delta. The NTR values are 5.0 µg/l (4-day average) and 20 µg/l (1-hour average).

Selenium concentrations in whole-body fish and in bird eggs are most useful for evaluating risks to fish and bird wildlife receptors (Skorupa and Ohlendorf 1991; DOI 1998; Ohlendorf 2003). Analyses of dietary items (such as benthic [sediment-associated] or water-column invertebrates) can be used for evaluating risks through dietary exposure, although with less certainty than when using concentrations measured in fish or wildlife receptors. The USEPA (2014b) released draft water quality criteria for public comment in May 2014 for selenium in fish tissue; they include 15.2 mg/kg in egg/ovary, 8.1 mg/kg whole body, or 11.8 mg/kg muscle (skinless, boneless fillet).

A large number of fish tissue samples were collected from the Sacramento and San Joaquin River watersheds and the Delta between 2000 and 2007 (Foe 2010). As part of the Strategic Workplan for Activities in the San Francisco Bay/Sacramento–San Joaquin Delta Estuary (SWRCB 2008a), archived Largemouth Bass samples were analyzed for selenium to investigate possible sources of selenium being bioaccumulated in bass in the Delta and whether selenium concentrations in bass were above recommended criteria for the protection of human and wildlife health (Foe 2010). Results of this study are the most relevant biota data from the Delta, and they are summarized in Table 6.23 to compare to tissue guidelines.

Table 6.23 Selenium Concentrations in Largemouth Bass

Site	Number of Samples	Selenium Concentrations in Fish Fillets (mg/kg, wet weight)			Selenium Concentrations in Whole-Body Fish (mg/kg, dry weight)			Years
		Min.	Max.	Mean	Min.	Max.	Mean	–
Sacramento River at Veterans Bridge	3	0.40	0.81	0.56	1.7	2.9	2.2	2005
Sacramento River at River Mile 44[a]	9	0.27	0.72	0.46	1.2	2.7	1.9	2000, 2005, 2007
Sacramento River near Rio Vista	9	0.30	0.80	0.44	1.3	3.2	1.9	2000, 2005, 2007
San Joaquin River at Freemont Ford	3	0.35	0.46	0.48	1.46	2.44	1.9	2005
San Joaquin River at Vernalis	8	0.15	0.63	0.40	0.77	2.5	1.7	2000, 2005, 2007
Old River near Tracy	3	0.45	0.69	0.55	2.0	2.9	2.4	2005
San Joaquin River at Potato Slough	9	0.22	0.89	0.38	1.1	3.5	1.6	2000, 2005, 2007
Middle River at Bullfrog	6	0.37	0.58	0.47	1.6	2.3	2.0	2005, 2007
Franks Tract	8	0.15	0.70	0.37	0.79	3.0	1.7	2000, 2005, 2007
Big Break	9	0.15	0.82	0.38	0.81	3.1	1.6	2000, 2005, 2007
Discovery Bay	3	0.32	0.41	0.37	1.5	1.7	1.6	2005
Whiskey Slough	2	0.35	0.47	0.41	1.6	1.9	1.7	2005

Source: Foe 2010

Notes: Means are geometric means.

Max. = maximum, mg/kg = milligrams per kilogram, Min. = minimum.

a. Near Clarksburg.

Average selenium concentrations varied slightly in Largemouth Bass caught in the Sacramento River between Veterans Bridge and Rio Vista in 2005, as well as on the San Joaquin River between Fremont Ford and Vernalis (Foe 2010). These concentrations also varied slightly among years (2000, 2005, and 2007) in the Sacramento River at Rio Vista and in the San Joaquin River at Vernalis. The lack of a significant difference in bioavailable selenium between the two river systems was unexpected because the San Joaquin River is considered a significant source of selenium to the Delta. Selenium concentrations in the Largemouth Bass were compared to criteria recommended for the protection of human health (based on fillets; 2 mg/kg, wet weight) and fish and wildlife health (based on whole-body fish; concern threshold of 4–9 mg/kg, dry weight) (Foe 2010). Geometric means and maximum concentrations (Table 6.23) did not exceed the draft criteria.

Sporadic sampling of selenium has been conducted at a few locations in the Delta. Five major sources, shown in Table 6.24, are Sacramento River, Yolo Bypass, Eastside Delta Tributaries, San Joaquin River, and Martinez/Suisun Bay. Total selenium concentrations in Sacramento and San Joaquin river surface waters just upstream of Mallard Island (near the western limit of the Delta [Regional Monitoring Program stations BG20 and BG30, respectively]) are considered more representative of generalized Delta concentrations than of the individual rivers (SWRCB 2008a). Total and dissolved selenium concentrations were somewhat lower at those locations during low flow in a dry year (<0.1 µg/l in August 2001) than during high flow (>0.1 µg/l in February 2001) (SWRCB 2008a). Cutter and Cutter (2004) reported similar flow-related patterns for those locations. The maximum selenium concentration found in the Delta was 2 µg/l at an Old/Middle River location in the south subarea of the Delta. Except for that location, the available data show geometric mean concentrations well below 1 µg/l.

Table 6.24 Selenium Concentrations in Water at Inflow Sources to the Delta

Source Water[1]	Sacramento River	San Joaquin River	San Francisco Bay	East Side Tributaries[3]	Agriculture in the Delta
Mean[2] (ng/L)	0.10	0.54	0.09	0.1	0.11
Minimum (ng/L)	0.04	0.07	0.03	0.1	0.11
Maximum (ng/L)	0.23	1.50	0.45	0.1	0.11
75th Percentile (ng/L)	0.11	0.76	0.12	0.1	0.11
99th Percentile (ng/L)	0.23	1.50	0.44	0.1	0.11
Data Source	USGS Website 2014b	USGS Website 2014c	SFEI 2014b	None	Lucas and Stewart 2007
Station(s)	Sacramento River at Freeport	San Joaquin River at Vernalis	Central-West; San Joaquin River Near Mallard Island	None	Mildred Island, Center
Date Range	11/2007-07/2014	11/2007-08/2014	02/2000-08/2013	None	2000, 2003-2004
ND Replaced with RL	Not Applicable	Not Applicable	Yes	Not Applicable	No
Data Omitted	None	None	-	Not Applicable	No
No. of Data Points	88	93	14	None	1

Sources: Adapted from Reclamation et al. 2013; U.S. Geological Survey 2014b,c; San Francisco Estuary Institute 2014b; Lucas and Stewart 2007

1: Dissolved selenium concentration.

2: Geometric mean.

3: Dissolved selenium concentration in Mokelumne, Calaveras, and Cosumnes Rivers is assumed to be 0.1 µg/L because of lack of available data and lack of sources that would be expected to result in concentrations greater than 0.1 µg/L

In efforts to address the selenium in the Delta and water bodies downstream, the SFB RWQCB is conducting a new TMDL project to address selenium toxicity in the North Bay (SFB RWQCB 2011, 2013). The North Bay selenium TMDL will identify and characterize selenium sources to the North Bay and the processes that control the uptake of selenium by fish and wildlife. The TMDL will quantify selenium loads, develop and assign waste load and load allocations among sources, and include an implementation plan designed to achieve the TMDL and protect beneficial uses.

USEPA's Action Plan for Water Quality Challenges in the San Francisco Bay/Sacramento-San Joaquin Estuary (USEPA 2012a) identifies selenium as one of seven priority items for action. The plan indicated that USEPA will draft new site-specific numeric selenium criteria by December 2012 to protect aquatic and terrestrial species dependent on the aquatic habitats of the Bay Delta Estuary. More stringent selenium water quality criteria will require actions that decrease allowable concentrations of selenium in surface waters of the Bay Delta Estuary and may set allowable levels of selenium in the tissue of fish and wildlife. Following the development of the Bay Delta selenium criteria, USEPA plans to develop site-specific criteria for other parts of California, including the San Joaquin Valley watershed (USEPA 2012a). USEPA also is engaged in other efforts to minimize selenium discharges to the San Joaquin River and the Bay Delta Estuary, including the Grasslands Bypass Project and the North San Francisco Bay TMDL.

6.3.3.3.4 PCBs

The Sacramento-San Joaquin River Delta was placed on the 303(d) list approved by the USEPA in 2010 as impaired by PCBs (SWRCB 2011a). A TMDL for PCBs in the Sacramento River from Knights Landing to the Delta is expected to be completed in 2021 to protect the beneficial uses of the Sacramento River and other water bodies downstream (SWRCB 2011ax).

6.3.3.3.5 Pesticides

Sacramento-San Joaquin River Delta (central, eastern, northern, northwestern, southern, western portions, the export area, and the Stockton Ship Channel) were placed on the Section 303(d) List approved by the USEPA in 2010 as impaired by pesticides (chlorpyrifos, DDT, Diazinon, Group A Pesticides, Chlordane, Dieldrin, Dioxin, and Furan and Dioxin compounds) (SWRCB 2011a).

Samples were collected from Sacramento River at Rio Vista, near Hood along the Sacramento/Yolo County line, San Joaquin River at Highway 4 and Antioch, 1 1/2 miles upstream from the Mossdale launch ramp, and other locations north portion of the Delta waterways (SWRCB 2011at-bb).

In an effort to meet the water quality standards in Sacramento-San Joaquin River Delta, TMDLs expected to be complete in 2019 with the exception of the TMDL for chlorpyrifos and diazinon. A TMDL, Delta Diazinon and Chlorpyrifos Project, approved in 2007.

6.3.3.3.6 Nutrients

The Sacramento-San Joaquin River Delta was not placed on the 303(d) list approved by USEPA in 2010 as impaired by nutrients (SWRCB 2011a). However, nutrients are a cause of concern in the Delta (e.g., CVRWQCB 2010j) and have been the subject of discussion. A decline in pelagic fish species in the Delta, known as the pelagic organism decline (POD),including the endangered California Delta smelt, may be related to bottom-up effects from nutrients among other drivers (Baxter et. al. 2010; Sommer et al. 2007). However, unlike most waterbodies where nutrients cause too much primary production the problem affecting beneficial uses parts of the Delta is too little primary production to support fish populations. Nutrient effects are also dependent on flow and other factors (e.g., temperature, turbidity, and invasive species) that are potentially associated with the POD. Specific hypotheses for an association between nutrients and the POD are that ammonium (a dominant form or nitrogen in the Delta and Suisun Bay, inhibits the uptake of nitrate which is a better fuel for algae blooms (Dugdale et al. 2007) and that changes in nutrient forms and rations have caused a shift in the food web (Glibert et al. 2011). Alternatively, causes of the POD may be related to reduced phosphorus that has become a limiting factor for primary production (Van Nieuwenhuyse 2007) or that invasive clam consumption of algae have made this food source unavailable to zooplankton and fish since their introduction in the mid-1980s (Lucas and Thompson 2012; Kimmerer et al. 1994).

The Delta is a major source of anthropogenic ammonium loading to the Suisun Bay, which exchanges nutrients with Suisun Marsh, an estuarine habitat impaired by nutrients (Senn et al. 2014, Tetra Tech Inc. and WWR 2013). Primary sources of nutrients are erosion, agricultural runoff, urban runoff, and treated effluent. The Sacramento Regional Wastewater Treatment Plant (SRWTP) is largest major point source of ammonium in the Delta, contributing 90 percent of ammonium in the river from 1986 to 2005 (Jassby 2008). Nitrogen inputs to the Delta will change as SRWTPs current NPDES permit (NO. CA0077682) includes effluent limits for nitrogen that require the addition of nitrification and denitrification treatment by 2020. Another source of ammonium loading has already changed as the Stockton Regional Wastewater Control Facility, which discharges to the San Joaquin River, had discharged ammonia prior to implementing nitrification and denitrification treatment in 2007 (SWRCB 2012b).

Nutrients, primarily nitrogen and phosphorous, may trigger excessive growth of algae or toxic blue-green cyanobacteria. However, within the Delta, it is generally recognized that nutrients are too high in concentration to be limiting (as compared to light, for example) (Jassby et al. 2002). The secondary effects of nutrient enrichment and oxygen depletion are most often found in the central and southern Delta near Stockton rather than the Sacramento River.

6.3.3.3.7 Dissolved Oxygen

The Stockton Ship Channel in the Delta waterways was placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by dissolved oxygen (SWRCB 2011a).

Low dissolved oxygen is of concern in the central and southern Delta because of enhanced treated effluent loading from Stockton, agricultural runoff, and reduced flushing of dead-end channels. Middle River, Old River, and the Stockton Deep Water Ship Channel are listed as impaired due to dissolved oxygen depletion, with dissolved oxygen concentrations criteria set at 6 mg/L minimum for the San Joaquin River between Turner Cut and Stockton between September 1 and November 30 (SWRCB 2011a, SWRCB 2006a). Loading from the Stockton

Regional Wastewater Control Facility had the greatest affect in reducing DO, with hydrologic flushing (as related to upstream river flows, upstream discharges of materials that increase biological oxygen demand), geometrical cross-sections of the channels, temperature, and phytoplankton being less important (Jassby and Niewenhuyse 2005). Following recent upgrades to the Stockton Regional Wastewater Control Facility in 2006, less oxygen demand constituents have been discharged into the channels.

A TMDL addressing impairment due to dissolved oxygen was approved by the USEPA in 2007 to meet the water quality standards in the Stockton Ship Channel.

6.3.3.3.8 Organics and Pathogens

The Stockton Ship Channel in the Delta waterways was placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by organic enrichment and pathogens (SWRCB 2011a).

The Delta as a source of drinking water is impaired through the presence of disinfection byproducts from treated wastewater effluent and the interactions with bromide and dissolved organic carbon, which may produce potentially harmful disinfection byproducts such as the carcinogenic trihalomethanes and haloacetic acid (Healey et al. 2008). Bromide and organic carbon are natural chemical constituents of the estuarine ecosystem but their exacerbation through discharges, agriculture drainage, or water management, combined with the addition of disinfectants. Changes to flow or use patterns or discharges to the Delta must be examined for their potential effects to concentrations of these byproduct compounds.

Pathogens are another potential concern impairing the Delta for drinking water use. Giardia and Cryptosporidium are common protozoans found in urban runoff and sometimes found to be in exceedance of drinking water standards in the Delta (SWRCB 2007). A TMDL addressing impairment due to pathogens was approved by the USEPA in 2008 to meet the water quality standards in the Stockton Ship Channel.

6.3.3.3.9 Invasive Species

Sacramento-San Joaquin River Delta (central, eastern, northern, northwestern, southern, western portions, the export area, and the Stockton Ship Channel) were placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by invasive species (SWRCB 2011a).

A TMDL addressing impairment due to invasive species is expected to be complete in 2019 in an effort to meet the water quality standards in Sacramento-San Joaquin River Delta (central, eastern, northern, northwestern, southern, western portions, the export area, and the Stockton Ship Channel).

6.3.3.3.10 Unknown Toxicity

Sacramento-San Joaquin River Delta (central, eastern, northern, northwestern, southern, western portions, the export area, and the Stockton Ship Channel) were placed on the Section 303(d) list approved by the USEPA in 2010 as impaired by unknown toxicity (SWRCB 2011a).

A TMDL is expected to be complete in 2019 to protect the beneficial uses of Sacramento-San Joaquin River Delta and its waterways, including impaired warm fresh water habitat.

6.3.3.4 Suisun Bay and Suisun Marsh

Suisun Bay and Suisun Marsh are located in transition zones between upstream fresh water inputs and tidal saline flux from San Francisco Bay. Beneficial uses of these areas are summarized in Table 6.2. Constituents of concern are summarized in Table 6.1.

Historically, the chlorophyll maxima were found to coincide with the mixing (entrapment) zone but recent alterations by invasive species of benthic grazing clams has greatly altered the Suisun Bay food web and these historical patterns (Kimmerer 2004; Jassby et al. 2002). Although turbidity remains high and limiting to primary productivity in Suisun Bay, there has been a long term trend toward increased water clarity. Suisun Bay has low retention time, lower salinity (average of 5.8 ppt), lower nutrients, and higher particulate matter and light attenuation (Cloern and Jassby 2012).

6.3.3.4.1 Salinity

The Suisun Marsh Wetlands was placed on the 303(d) list approved by the USEPA in 2010 for impairment by salinity. The wetlands are also impaired by TDS and chlorides (SWRCB 2011a).

In an effort to protect the beneficial uses, including estuarine habitat, narrative and numeric objectives were specified by the SWRCB in Decision 1641.

The salinity objective in Suisun Bay, X2, which is the location, as measured in kilometers upstream from the Golden gate bridge, of the 2 ppt isohaline (2.64 mS/cm) was established as part of the Basin Plan of 1995 (SWRCB 1995). X2 is a constantly fluctuating position in the continuum between upstream, Delta fresh water (salinity less than 2 ppt) and San Francisco Bay tidal influence, downstream (salinity greater than 2 ppt).

6.3.3.4.2 Mercury

Mercury is a constituent of concern for Suisun Bay and Suisun Marsh, which were placed on the 303(d) list in 2010 (SWRCB 2011a). For the Suisun Bay, a TMDL was specified in the San Francisco Bay Mercury TMDL (SFB RWQCB 2013), which was approved by the USEPA in February 2008 and the implementation plan is expected to attain the water quality standard 20 years after the approval. For the Suisun Marsh, a TMDL was specified in the Sacramento-San Joaquin Delta Methylmercury TMDL (CVRWQCB 2010a) and was completed in September 2012 (SFB RWQCB 2012a).

Water quality objectives for Suisun Bay are specified in the San Francisco Bay Mercury TMDL (SFB RWQCB 2013). Suisun Marsh standards as specified in

Suisun Marsh TMDL, are shown in Table 6.25 (SFB RWQCB 2012a). There are future plans to adopt the Suisun Bay standards for the Suisun Marsh as well as implementation plans to improve the water quality in Suisun Marsh.

Table 6.25 Water Quality Objectives for Total Mercury in Suisun Marsh

For the Protection of Marine and Freshwater Aquatic Life	4-day average (adverse effects from acute toxicity[1])	0.25 µg/l
	1-hour average (adverse effects from chronic toxicity)	2.1 µg/l

Source: SFB RWQCB 2012a

1 Applicable to marine aquatic life, where salinity is greater than 10 parts per thousand. The same objectives apply to freshwater aquatic life because the marine objective is more stringent.

6.3.3.4.3 Selenium

Although the Suisun Marsh Wetlands is not identified as an impaired water body for selenium contamination on the 303(d) list in 2010, selenium is identified as a cause for impairment for the adjacent water body, Suisun Bay (SWRCB 2011a).

The impairment of Suisun Bay by selenium can be attributed to exotic species as well as discharge from industrial point sources and natural sources (SWRCB 2011bd). *Corbula (Potamocorbula) amurensis*, a species of clam that is an important food source for sturgeon and certain ducks, is a bioaccumulator for selenium (Beckon and Maurer 2008). This exotic species was first discovered in Suisun Bay in 1986 and became very common by 1990 from San Pablo Bay through Suisun Bay (Cohen 2011). Industrial point sources, such as oil refineries, discharge waste containing selenium to the Suisun Bay (SFB RWQCB 2011).

To best protect the most susceptible fish, white sturgeon, from selenium toxicity, a TMDL for Selenium in the North San Francisco Bay, defined to include also a portion of the Delta, Suisun Bay, Carquinez Strait, San Pablo Bay, and the Central Bay, is being completed and a Preliminary Project Report was released in 2011 (SFB RWQCB 2011). A range of concentrations for selenium in fish tissue from 6.0 to 8.1 µg/g dry weight was proposed as a numeric target. This range is based on the minimal effects of selenium in whole-body freshwater fish and the 10 percent effect level concentration.

6.3.3.4.4 Nutrients

Suisun Marsh is a water body in the San Francisco Bay that was placed on the Section 303(d) list approved by USEPA in 2010 as impaired by nutrients (SWRCB 2011a).

According to the Final California 2010 Integrated Report (303(d) list/305(b) Report) Supporting Information, nutrients in Suisun Marsh can be attributed to flow regulation/modification, and urban runoff/storm sewers (SWRCB 2011bc). More specific sources of nutrients to Suisun Marsh include agricultural, urban, and livestock grazing drainage through tributaries, the Sacramento River and San Joaquin River through the Sacramento-San Joaquin River Delta, nutrient exchange with Suisun Bay, atmospheric deposition, and discharge from the

Fairfield Suisun Sewer District wastewater treatment plant (Tetra Tech Inc. and WWR 2013).

Concentrations of ammonia from 2000-2011, in the receiving waters from Boynton, Peytonia, Sheldrake and Chadbourne Sloughs (0-0.4 mg/l), as well as in Suisun Slough (0-0.3mg/l) exceeded the maximum water quality objective concentration for ammonia (Tetra Tech Inc. and WWR 2013). Elevated concentrations of chlorophyll-a, in comparison to concentrations at reference sites at Mallard, suggest possible impairments by nutrients. Other possible impairments of the narrative criteria by nutrients were suggested as a result of excess algal growth in wetlands and elevated organic carbon and impacts on dissolved oxygen and mercury methylation.

6.3.3.4.5 Dissolved Oxygen

Suisun Marsh Wetlands were placed on the 303(d) list approved by the USEPA in 2010 for impairment by dissolved oxygen (SWRCB 2011a). Dissolved oxygen can alter the well-being of the estuarine habitat, fish spawning, warm freshwater habitat, wildlife habitat (SFB RWQCB 2013).

Flow regulation and modification, as well as urban runoff and storm sewers dictate the dissolved oxygen levels in the marsh (SWRCB 2011bc). Specific oxygen demanding sources that cause low dissolved oxygen levels are "grazed open areas, nutrient-enriched wastewater discharge from Fairfield-Suisun Sewer District, wastes from boats in Suisun City marina, and tidal marshes," in addition to tides, delta outflow, agricultural drainage from surrounding watersheds and urban areas, and managed wetlands (Tetra Tech, Inc. and WWR 2013). Slough size, and hydrology also influenced the low dissolved oxygen conditions in Suisun Marsh Wetlands (Siegel et al. 2010).

Dissolved oxygen exceedances of water quality objectives between 2000 and 2011 in Suisun Slough, Montezuma Slough, and Goodyear Slough are presented in Table 6.26 (Tetra Tech, Inc. and WWR 2013).

Table 6.26 Percentage of Observations Exceeding Water Quality Objectives for Dissolved Oxygen

Location	WQO Exceedances	
	7 mg/l	< 80% Saturation[1]
Suisun Slough	10 – 40%	2%
Montezuma Slough	< 10%	60 – 68%
Goodyear, Peytonia, and Boynton Sloughs	> 50%	73 – 94%[2]

Source: Tetra Tech, Inc. and WWR 2013

1 3-month median above 80 percent dissolved oxygen saturation

2 Lower Goodyear Slough exceeded the 3-month media above 80 percent dissolved oxygen saturation 48.1 percent of the time

To further protect the beneficial uses of the Suisun Marsh Wetlands from low dissolved oxygen concentrations, water quality objectives more representative of natural conditions are currently being developed (Tetra Tech, Inc. and WWR 2013). A TMDL for Suisun Creek, a tributary of Suisun Marsh Wetlands that is impaired by low dissolved oxygen, is expected to be complete in 2021 (SWRCB 2011bc).

6.3.3.4.6 Organics

Suisun Marsh was placed on the 303(d) list approved by USEPA in 2010 for organic enrichment (SWRCB 2011a). Organic enrichment enhances microbial production and activity, such as the methylation of mercury, and the decomposition of organic matter can causes low dissolved oxygen levels (Tetra Tech, Inc. and WWR 2013).

6.3.3.4.7 Pesticides

Suisun Bay, and other water bodies in the San Francisco Bay area including Carquinez Strait and San Pablo Bay were placed on the Section 303(d) list for pesticides (chlordane, DDT, dieldrin) contamination per the list approved by USEPA in 2010 (SWRCB 2011a). However, according to the 2013 Regional Monitoring Program Report, pesticides (chlordane, DDT, and dieldrin) in the estuary are being considered for delisting (SFEI 2013).

A TMDL for the Diazinon and Pesticide-related Toxicity in Urban Creeks was added as an amendment to the Basin Plan and was approved by the USEPA in 2007 (SWRCB 2014c; SFB RWQCB 2005).

6.3.3.4.8 PCBs

Suisun Bay, and several other water bodies within San Francisco Bay area including Carquinez Strait and San Pablo Bay, were placed on the Section 303(d) list for the contamination of PCBs per the list approved by USEPA in 2010 (SWRCB 2011a). The following is applicable to all water bodies specified in the San Francisco Bay PCBs TMDL, including Suisun Bay, Carquinez Strait, and San Pablo Bay (SFB RWQCB 2013).

A TMDL was approved by the USEPA in 2010. The TMDL allows 10 kilograms of PCBs to be discharged to San Francisco Bay per year (SFB RWQCB 2013). It is projected that this load allocation will be achieved in 20 years with implementation of plans and actions for external and internal sources, such as municipal and industrial dischargers, as stated in the San Francisco Bay TMDL.

6.3.3.4.9 Other Constituents of Concern

Suisun Bay was placed on the Section 303(d) list for invasive species contamination per the list approved by USEPA in 2010 (SWRCB 2011a).

Invasive species in Suisun Bay can be attributed to ballast water, fresh or salt water placed on a ship for stability (SWRCB 2011bd). *Corbula (Potamocorbula) amurensis*, a native clam of southern China estuaries, was discovered in Suisun Bay in 1986 and was introduced to San Pablo Bay shortly after (USFWS and

NSGCP 1995). This species of clam is important as a food source for sturgeon, diving ducks, etc. and consequently a bioaccumulator of selenium (USFWS 2008). Other species introduced to the Suisun Bay are reported in the *Nonindigenous Aquatic Species in a United States Estuary: A Case Study of the Biological Invasions of the San Francisco Bay and Delta* (USFWS and NSGCP 1995).

Invasive species can affect the beneficial uses of Suisun Bay, Table 6.2, including estuarine habitat. For the protection of marine aquatic life, a TMDL is expected to be complete in 2019.

Other contaminants in the Suisun Bay include furan compounds and dioxin compounds. These contaminants were placed on Section 303(d) list per the list approved by USEPA in 2010 (SWRCB 2011bd).

6.4 Impact Analysis

This section describes the potential mechanisms and analytical methods for change in surface water quality; results of the impact analysis; potential mitigation measures; and cumulative effects.

6.4.1 Potential Mechanisms for Change and Analytical Methods

As described in Chapter 4, Approach to Environmental Analysis, the impact analysis considers changes in surface water quality conditions related to changes in CVP and SWP operations under the alternatives as compared to the No Action Alternative and Second Basis of Comparison.

Changes in CVP and SWP operations under the alternatives as compared to the No Action Alternative and Second Basis of Comparison could result in changes to surface water quality due to changes in river flows and surface water deliveries. Based on the discussion above, the following water quality changes are further analyzed in the Evaluation of Alternatives section.

As described in Section 6.3 Affected Environment, there are numerous constituents of concern that have been identified in the study area. These components are not all critical in each region and may not be all affected by changes in CVP and SWP operations considered in the alternatives of this EIS. The groups of constituents that could be affected by implementation of the alternatives has been identified through consideration of constituents of concern described in Section 6.3, Affected Environment, and the anticipated implementation of TMDLs by 2030. These constituents were grouped into major categories, as shown in Table 6.27. The constituents that already have approved TMDLs in certain regions are not further analyzed for those regions, as it is expected that the TMDL will be implemented by 2030. A complete list of TMDLs and the anticipated completion dates is provided in Table 6.1.

Table 6.27 List of Surface Water Quality Constituents Considered for this Analysis

Constituent/Parameter Group	Individual Constituents/Parameters
Water Temperature	Water Temperature
Salinity Indicators	EC, TDS, Chloride, Bromide, Delta X2
Nutrients	Nitrate, phosphorus
Mercury	Mercury, methylmercury
Selenium	Selenium
Dissolved Oxygen	Dissolved Oxygen
Other Constituents	Pesticides, PCBs, DOC/TOC, Boron, Trace Metals, Pathogens, TSS, Turbidity, Unknown Toxicity

Each constituent group is further discussed below, to determine whether changes would occur due to implementation of the alternatives.

6.4.1.1 Changes in Water Temperature

Changes in CVP and SWP operations would change water temperatures in rivers downstream of CVP and SWP reservoirs. Changes in water temperatures are presented in Appendix 6B, Surface Water Temperature Modeling. However, the effects of change in temperature are related to the changes on aquatic habitat. Therefore, analysis of changes in temperature is presented in Chapter 9, Fish and Aquatic Resources.

6.4.1.2 Changes in Salinity

Changes in salinity due to changes in CVP and SWP operations would be focused in the Delta. Salinity indicators generally considered in this analysis include electrical conductivity, total dissolved solids, chloride, bromide, and X2.

The DSM2, a one-dimensional hydrodynamic and water quality simulation model, is used to evaluate changes in salinity (as represented by EC) in the Delta and at the CVP/SWP export locations. CalSim II outputs are used to evaluate changes in location of X2 in the Delta.

6.4.1.3 Changes in Mercury/Methylmercury Concentrations

Changes in CVP and SWP operations under the alternatives could affect mercury concentrations in the Delta and Suisun Marsh. The changes in CVP and SWP operations would not affect mercury concentrations in the tributaries to the Sacramento and San Joaquin rivers.

A modeling framework is used to evaluate changes in methylmercury concentrations in the Delta reaches and qualitatively estimate mercury concentration changes at the San Luis Reservoir and O’Neill Forebay.

The methylmercury impacts analysis uses CalSim II, DSM2, and the Central Valley Regional Water Quality Control Board Total Maximum Daily Load model (RWQCB model) to assess and quantify effects of the alternatives on the long-term operations and the environment, as described in Appendix 6C, Methylmercury Model Documentation.

The QUAL module of DSM2 is used to simulate source water finger printing which allows determining the relative contributions of water sources to the volume at any specified location. DSM2 water quality and volumetric fingerprinting results are used to assess changes in concentration of methylmercury in Delta waters. CalSim II, DSM2 (water), and the RWQCB model (fish tissue) are used in sequence to estimate the effects of CVP and SWP operations on water and fish tissue quality in the Delta.

6.4.1.4 Changes in Selenium Concentrations

Changes in CVP and SWP operations under the alternatives could affect selenium concentrations in the San Joaquin River, Delta, and Suisun Marsh. Selenium also is of a concern in the Southern California Region that use water supplies from the Colorado River.

A suite of modeling tools is used to evaluate changes in selenium concentrations in the Delta reaches and in the San Francisco Bay, based on the western Delta model outputs. The selenium impacts analysis uses CalSim II, DSM2, and Delta-specific selenium bioaccumulation modeling to assess and quantify effects of the alternatives on the long-term operations and the environment. Appendix 6D, Selenium Model Documentation, provides information about the development and calibration of a Delta-wide bioaccumulation model for selenium in fish, use of outputs from that model to estimate bioaccumulation in bird eggs and fish fillets and modeling of selenium bioaccumulation in sturgeon living in the western Delta using inputs from other models. Modeling assumptions for the selenium analysis are also provided in that appendix.

The selenium impact analysis focuses on evaluation of changes to selenium concentrations in tissues that affect the health of fish as well as wildlife and humans consuming fish in the Delta.

CalSim II, DSM2, and bioaccumulation modeling are used in sequence to estimate the effects of CVP and SWP operations on water quality relative to selenium in the Delta. The DSM2-QUAL module simulates one-dimensional source tracking in the Delta. Results from DSM2 are multiplied by source concentrations to determine annual average waterborne selenium concentrations in the Delta for all year types. Output from the DSM2-QUAL model (expressed as percent inflow from different sources) is used in combination with the available measured waterborne selenium concentrations to model concentrations of selenium at locations throughout the Delta. These modeled waterborne selenium concentrations are used in the relationship model to estimate bioaccumulation of selenium in whole-body fish and in bird eggs.

6.4.1.5 Changes in Nutrient Concentrations

Nutrients generally considered in this analysis include nitrate and phosphorus. The two main anthropogenic sources of these constituents are urban point sources (wastewater effluent), and agricultural non-point sources (agricultural runoff and return flows of fertilizers mixed in irrigation water). By 2030, wastewater treatment plants that discharge into the Sacramento and San Joaquin rivers watersheds and the Delta that are currently implementing nutrient removal projects will complete those projects. Agricultural non-point source discharges are regulated under the Long-Term Irrigated Lands Regulatory Program (ILRP) Waste Discharge Requirements, which mandate monitoring of nutrients in the major agricultural reaches and the implementation of Best Management Practices to reduce nutrient discharges to streams, by also controlling fertilizer application and management. Nutrient loadings would be managed through regulatory processes by 2030 and that nutrient conditions would be similar under the No Action Alternative, Alternatives 1 through 5, and the Second Basis of Comparison. Therefore, changes in nutrients are not evaluated in this EIS.

6.4.1.6 Changes in Dissolved Oxygen Concentrations

Dissolved oxygen has been found to be a parameter of concern primarily in the lower Klamath River, Sacramento-San Joaquin River Delta, and the Suisun Marsh. By 2030, it is anticipated that TMDLs would be implemented to address the dissolved oxygen issues. It is anticipated that dissolved oxygen conditions would be similar under the No Action Alternative, Alternatives 1 through 5, and the Second Basis of Comparison. Therefore, changes in dissolved oxygen are not evaluated in this EIS.

6.4.1.7 Changes in Other Constituents

Conditions for other water quality constituents are expected to be similar under the No Action Alternative, Alternatives 1 through 5, and the Second Basis of Comparison because critical factors that affect the sources, transport mechanisms or chemical transformations are not expected to be affected by changes in CVP and SWP operations. Therefore, changes in the other constituents are not analyzed in this EIS.

6.4.1.8 Effects Related to Water Transfers

Historically water transfer programs have been developed on an annual basis. The demand for water transfers is dependent upon the availability of water supplies to meet water demands. Water transfer transactions have increased over time as CVP and SWP water supply availability has decreased, especially during drier water years.

Parties seeking water transfers generally acquire water from sellers who have available surface water who can make the water available through releasing previously stored water, pump groundwater instead of using surface water (groundwater substitution); idle crops; or substitute crops that uses less water in order to reduce normal consumptive use of surface water.

Water transfers using CVP and SWP Delta pumping plants and south of Delta canals generally occur when there is unused capacity in these facilities. These conditions generally occur drier water year types when the flows from upstream reservoirs plus unregulated flows are adequate to meet the Sacramento Valley water demands and the CVP and SWP export allocations. In non-wet years, the

CVP and SWP water allocations would be less than full contract amounts; therefore, capacity may be available in the CVP and SWP conveyance facilities to move water from other sources.

Projecting future water quality conditions related to water transfer activities is difficult because specific water transfer actions required to make the water available, convey the water, and/or use the water would change each year due to changing hydrological conditions, CVP and SWP water availability, specific local agency operations, and local cropping patterns. Reclamation recently prepared a long-term regional water transfer environmental document which evaluated potential changes in conditions related to water transfer actions (Reclamation 2014c). Results from this analysis were used to inform the impact assessment of potential effects of water transfers under the alternatives as compared to the No Action Alternative and the Second Basis of Comparison.

6.4.2 Conditions in Year 2030 without Implementation of Alternatives 1 through 5

This EIS includes two bases of comparison, as described in Chapter 3, Description of Alternatives: the No Action Alternative and the Second Basis of Comparison. Both of these bases are evaluated at 2030 conditions. Changes that would occur over the next 15 years without implementation of the alternatives are not analyzed in this EIS. However, the changes to water quality that are assumed to occur by 2030 under the No Action Alternative and the Second Basis of Comparison are summarized in this section. Many of the changed conditions would occur in the same manner under both the No Action Alternative and the Second Basis of Comparison.

6.4.2.1 Common Changes in Conditions under the No Action Alternative and Second Basis of Comparison

Conditions in 2030 would be different than existing conditions due to:

- Climate change and sea level rise
- General plan development throughout California, including increased water demands in portions of Sacramento Valley
- Implementation of reasonable and foreseeable water resources management projects to provide water supplies

6.4.2.1.1 Effects due to Climate Change and Sea Level Rise

It is anticipated that climate change would result in more short-duration high-rainfall events and less snowpack in the winter and early spring months. The reservoirs would be full more frequently by the end of April or May by 2030 than in recent historical conditions. However, as the water is released in the spring, there would be less snowpack to refill the reservoirs. This condition would reduce reservoir storage and available water supplies, including water supplies released to maintain freshwater conditions in the western Delta and at the CVP and SWP Delta intakes. Ambient temperatures are also expected to increase. Therefore, water temperatures in the CVP and SWP reservoirs and in the rivers downstream of the reservoirs are expected to increase by 2030 under the No Action Alternative as compared to recent historical conditions.

6.4.2.1.2 Effects due to Reasonable and Foreseeable Projects and Programs

Under the No Action Alternative and the Second Basis of Comparison, land uses in 2030 would occur in accordance with adopted general plans. Development under the general plans would change water quality, especially near municipal areas.

The No Action Alternative and the Second Basis of Comparison assumes completion of water resources management and environmental restoration projects that would have occurred without implementation of Alternatives 1 through 5, including regional and local recycling projects, surface water and groundwater storage projects, conveyance improvement projects, and desalination projects, as described in Chapter 3, Description of Alternatives. The No Action Alternative and the Second Basis of Comparison also assumes implementation of actions included in the 2008 U.S. Fish and Wildlife Service (USFWS) Biological Opinion (BO) and 2009 National Marine Fisheries Service (NMFS) BO that would have been implemented without the BOs by 2030, as described in Chapter 3, Description of Alternatives. These projects would include several projects that could affect surface water quality in beneficial and adverse manners, including restoration of more than 10,000 acres of intertidal and associated subtidal wetlands in Suisun Marsh and Cache Slough; and at least 17,000 to 20,000 acres of seasonal floodplain restoration in Yolo Bypass.

The reasonable and foreseeable projects also would include issuance and implementation of TMDL programs and other programs to improve water quality, including those that address salinity, mercury, and selenium.

Potential Changes in Salinity Indicators

In the Central Valley, changes in salinity under the No Action Alternative and the Second Basis of Comparison as compared to recent historical conditions are anticipated primarily to occur in the Delta. The salinity in the Delta is anticipated to increase with projected sea level rise; and therefore, the region of the Delta influenced by daily tidal fluctuations will increase, and the increased tidal mixing may result in salt transport further upstream. The average water depth in the Delta will increase, allowing for increased gravitational circulation and upstream transport of salinity further into the Delta. The increased salinity potentially will decrease the flexibility to meet regulatory requirements at compliance locations, municipal and industrial water intakes, and export facilities.

Potential Changes in Mercury Concentrations

In the Central Valley, mercury concentrations in the Sacramento River watershed would be similar under the No Action Alternative and the Second Basis of Comparison as compared to recent historical conditions. Programs would be implemented to reduce the source of mercury into water bodies by 2030; however, the results of those programs are not anticipated to change mercury concentrations prior to 2030.

Changes in mercury in the Yolo Bypass are also anticipated under the No Action Alternative and the Second Basis of Comparison as floodplain restoration is implemented as compared to recent historical conditions.

Under the No Action Alternative and the Second Basis of Comparison, it is anticipated that mercury concentrations in fish tissue within the Delta will be either similar or greater than recent historical conditions. Phase 1 of the Delta Mercury Program mandated by the CVRWQCB is currently being completed to protect people eating one meal per week of larger fish from the Delta, including Largemouth Bass. This program also would reduce wildlife exposure to excess mercury. Phase 1 is focused on studies and pilot projects to develop and evaluate management practices to control methylmercury from mercury sources in the Delta and Yolo Bypass; and to reduce total mercury loading to the San Francisco Bay. Following completion of Phase 1 in 2019, Phase 2 will be implemented through 2030. Phase 2 will focus on methylmercury control programs and reduction programs for total inorganic mercury. Due to the extent of these studies, it is not anticipated that changes in methylmercury or total mercury concentrations in fish tissue would be reduced by 2030 under the No Action Alternative and the Second Basis of Comparison as compared to recent historical conditions.

Potential Changes in Selenium Concentrations

Selenium is a constituent of concern in the San Joaquin Valley and the Delta, and TMDLs have been adopted for the San Joaquin River from Mud Slough to Merced River, Grasslands Marshes, Agatha Canal, and Mud Slough. It is assumed that water quality concerns for selenium in those reaches will be addressed before 2030. TMDLs are anticipated prior to 2030 for Panoche Creek and Mendota Pool. However, it is assumed that these TMDLs for water quality issues related to selenium may not be fully implemented by 2030.

It is expected that a TMDL also may be developed separately for the Delta. To increase the database for evaluation of constituents of concern in the Delta, a large number of fish tissue samples were collected from the Sacramento and San Joaquin River watersheds and the Delta between 2000 and 2007 for selenium analysis. As part of the Strategic Workplan for Activities in the San Francisco Bay/Sacramento–San Joaquin Delta Estuary (State Water Resources Control Board 2008b), archived Largemouth Bass samples were analyzed for selenium to determine the primary source of the selenium being bioaccumulated in bass in the Delta and whether selenium concentrations in bass were above recommended criteria for the protection of human and wildlife health (Foe 2010). There were no differences in selenium concentrations in Largemouth Bass caught in the Sacramento River at Rio Vista and in the San Joaquin River at Vernalis in 2000, 2005, and 2007. However, because the TMDL is not yet under development, it is assumed that it would not be in place by 2030 under the No Action Alternative and the Second Basis of Comparison.

6.4.3 Evaluation of Alternatives

Alternatives 1 through 5 have been compared to the No Action Alternative; and the No Action Alternative and Alternatives 1 through 5 have been compared to the Second Basis of Comparison.

During review of the numerical modeling analyses used in this EIS, an error was determined in the CalSim II model assumptions related to the Stanislaus River operations for the Second Basis of Comparison, Alternative 1, and Alternative 4 model runs. Appendix 5C includes a comparison of the CalSim II model run results presented in this chapter and CalSim II model run results with the error corrected. Appendix 5C also includes a discussion of changes in the comparison of groundwater conditions for the following alternative analyses.

- No Action Alternative compared to the Second Basis of Comparison
- Alternative 1 compared to the No Action Alternative
- Alternative 3 compared to the Second Basis of Comparison
- Alternative 5 compared to the Second Basis of Comparison.

6.4.3.1 No Action Alternative

The No Action Alternative is compared to the Second Basis of Comparison.

6.4.3.1.1 Potential Changes in Salinity Indicators

Salinity in the Sacramento River at Emmaton would be lower in September through January, higher in June, and similar in all other months over long-term average conditions under the No Action Alternative as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.2.4.

Salinity in the San Joaquin River at Vernalis would be lower in April and October, and higher in all other months under the No Action Alternative as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.15.4.

Salinity in the San Joaquin River at Jersey Point would be lower in September through January, higher in June, and similar in all other months, for long-term average conditions under the No Action Alternative as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.3.4.

Salinity in the western Delta at Port Chicago, Chipps Island, and Collinsville would be substantially lower in September through January, moderately lower February through May, higher in June, and similar in all other months, for long-term average conditions under the No Action Alternative as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.6.4, 6E.4.4, and 6E.2.4.

Salinity at the CVP Contra Costa Canal and Jones pumping plants and the SWP Banks Pumping Plant intakes in the Delta would be lower in September through January, and higher in all other months for long-term average conditions under the No Action Alternative as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Tables 6.E.11.4, 6E.7.4, and 6E.8.4. Salinity at the Contra Costa Water District Old River and Middle River intakes also would be lower in September through January, and higher in all other months for long-term average conditions under the No Action Alternative as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Tables 6E.12.4 and 6E.13.4. Changes in salinity at the intakes would influence the salinity in water delivered in the San Joaquin Valley which could influence salinity in water bodies that receive agricultural return flows from CVP and SWP water users. Chloride and bromide concentrations at the intakes are expected to change in a similar manner to other salinity indicators.

Another indication of salinity is the measurement of X2. X2 decreases with increases in Delta outflow as freshwater from the Central Valley flows towards San Francisco Bay. Under the No Action Alternative, Delta outflow would increase and X2 would move towards the west as compared to the Second Basis of Comparison, as shown in in Appendix 6E, Table C-16-4. X2 distances would be lower in September through May, and similar in all other months in long-term average conditions under the No Action Alternative as compared to the Second Basis of Comparison.

6.4.3.1.2 Potential Changes in Mercury Concentrations

Changes in mercury from the rivers results in changes in mercury concentrations in fish used for human consumption in the Delta, including Largemouth Bass, as summarized in Tables 6.28 and 6.29 for long-term average conditions and dry and critical dry years, respectively. All values exceed the threshold of 0.24 milligram/kilogram wet weight (mg/kg ww) for mercury.

Table 6.28 Changes in Mercury Concentrations 350-millimeter Largemouth Bass over the Long-term Average Conditions under the No Action Alternative as Compared to the Second Basis of Comparison

Delta Location	No Action Alternative (mg/kg ww)	Second Basis of Comparison (mg/kg ww)	Changes
San Joaquin River at Stockton	1.00	0.99	0.1%
San Joaquin River at Turner Cut	0.89	0.87	3%
San Joaquin River at San Andreas Landing	0.59	0.58	3%
San Joaquin River at Jersey Point	0.57	0.54	5%
Victoria Canal	0.85	0.82	4%
Sacramento River at Emmaton	0.50	0.49	2%
San Joaquin River at Antioch	0.50	0.47	7%
Montezuma Slough at Hunter Cut and Beldon’s Landing (Suisun Marsh)	0.35	0.32	7%
SWP Barker Slough Pumping Plant Intake	0.56	0.56	1%
CVP Contra Costa Pumping Plant Intake	0.73	0.68	6%
SWP Banks Pumping Plant Intake	0.79	0.75	5%
CVP Jones Pumping Plant Intake	0.83	0.79	3%

Notes:

Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical dry years values calculated using 1987-1991 results from DSM2 model.

Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

mg/kg – milligram/kilogram; ww – wet weight

Table 6.29 Changes in Mercury Concentrations 350-millimeter Largemouth Bass in Dry and Critical Dry Years under the No Action Alternative as Compared to the Second Basis of Comparison

Delta Location	No Action Alternative (mg/kg ww)	Second Basis of Comparison (mg/kg ww)	Changes
San Joaquin River at Stockton	1.06	1.06	0.3%
San Joaquin River at Turner Cut	0.84	0.81	4%
San Joaquin River at San Andreas Landing	0.54	0.53	3%
San Joaquin River at Jersey Point	0.52	0.50	4%
Victoria Canal	0.82	0.76	7%
Sacramento River at Emmaton	0.48	0.47	2%
San Joaquin River at Antioch	0.43	0.41	5%
Montezuma Slough at Hunter Cut and Beldon’s Landing (Suisun Marsh)	0.28	0.26	5%
SWP Barker Slough Pumping Plant Intake	0.59	0.57	2%
CVP Contra Costa Pumping Plant Intake	0.67	0.62	8%
SWP Banks Pumping Plant Intake	0.75	0.69	8%
CVP Jones Pumping Plant Intake	0.82	0.77	7%

Notes:

Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical dry years values calculated using 1987-1991 results from DSM2 model.

Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

mg/kg – milligram/kilogram; ww – wet weight

6.4.3.1.3 Potential Changes in Selenium Concentrations

It is anticipated that the selenium loadings would be similar under the No Action Alternative and the Second Basis of Comparison; and that selenium concentrations in the San Joaquin River also would be similar.

Selenium in the water column at various locations in the Delta under No Action Alternative and the Second Basis of Comparison are shown in Appendix 6D, Selenium Model Documentation. Selenium in the water column at the three western Delta locations under No Action Alternative would be identical to conditions under the Second Basis of Comparison, as shown in Appendix 6D, Table 6D.16. Selenium in the water column would be below the NTR criterion of 5 µg/L for the San Francisco Bay. Similarly, they would be below the draft USEPA (2014b) criterion for lentic aquatic systems (1.3 µg/L).

In the western Delta and at the Barker Slough Pumping Plant intake, the selenium would be similar (within 5 percent change) under the No Action Alternative and the Second Basis of Comparison.

Selenium at the Contra Costa Pumping Plant intake would be similar under the No Action Alternative and Second Basis of Comparison, as shown in Table 6D.9 of Appendix 6D. Selenium at the Jones and Banks pumping plant intakes under No Action Alternative would be slightly higher than Second Basis of Comparison, as shown in Appendix 6D, Table 6D.9.

Estimated selenium concentration in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) at all locations in the Delta under the No Action Alternative would be similar as under the Second Basis of Comparison, as shown in Appendix 6D, Table 6D.10. As shown in Appendix 6D, Table 6D.13, Exceedance Quotients (EQs) computed with respect to the applicable benchmarks show that selenium concentrations in biota under the No Action Alternative would be below the thresholds identified for ecological risk.

For sturgeon in the western Delta, modeling also suggests that whole-body concentrations would be similar under the No Action Alternative and the Second Basis of Comparison (Appendix 6D, Table 6D.17), and the EQs would be similar (Appendix 6D, Table 6D.18). Low Toxicity Threshold EQs for selenium concentrations in sturgeon in the western Delta would remain under 1.0 for long-term average conditions, and slightly exceed 1.0 (indicating a higher probability for adverse effects) for drought years at the three western Delta locations under both No Action Alternative and Second Basis of Comparison (Table 6D.18 of Appendix 6D). Estimated EQs for High Toxicity Threshold at all locations are less than 1.0 under all hydrologic conditions.

6.4.3.1.4 Effects Related to Cross Delta Water Transfers

Potential effects to water quality could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c). Potential effects to water quality were identified as:

- Potential for sediment and other constituents to be transported from crop idled lands into adjacent water bodies.
- Groundwater substitution to make transfer water available would introduce contaminants from the groundwater into surface waters.
- Water transfer practices could change reservoir storage or stream flow patterns in a manner that would affect water quality, including upstream temperatures and Delta water quality.
- Use of transferred water could increase drainage flows in the purchaser's service areas.

The analysis indicated that these potential impacts would not be substantial because the amount of land subject to crop changes in the seller's and purchaser's service areas would be within the historical range of irrigated lands and crop idled lands. The groundwater substitution practices would be implemented with monitoring and mitigation programs to avoid long-term adverse impacts, including impacts to water quality. The water transfers would not be allowed to occur if the program harmed other water users or the environment, including changes to water quality in the rivers or the Delta. Therefore, water quality conditions would be similar with and without the water transfers.

Under the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second Basis of Comparison, water could be transferred throughout the year without an annual volumetric limit. Overall, the potential for cross Delta water transfers would be less under the No Action Alternative than under the Second Basis of Comparison.

6.4.3.2 Alternative 1

As described in Chapter 3, Description of Alternatives, Alternative 1 is identical to the Second Basis of Comparison. As described in Chapter 4, Approach to Environmental Analysis, Alternative 1 as compared to the No Action Alternative and the Second Basis of Comparison. However, because water quality factors under Alternative 1 are identical to water quality factors under the Second Basis of Comparison; Alternative 1 is only compared to the No Action Alternative.

6.4.3.2.1 Alternative 1 Compared to the No Action Alternative

Potential Changes in Salinity Indicators

Salinity in the Sacramento River at Emmaton would be higher in September through January, lower in June, and similar in all other months over long-term average conditions under Alternative 1 as compared to the No Action Alternative, as summarized in Appendix 6E, Table 6E.2.1.

Salinity in the San Joaquin River at Vernalis would be higher in April and October, lower in May through June, lower in November through February and similar in March and July through September and higher in all other months under

Alternative 1 as compared to the No Action Alternative, as summarized in Appendix 6E, Table 6E.15.1.

Salinity in the San Joaquin River at Jersey Point would be higher in September through January, lower in June, and similar in all other months, for long-term average conditions under Alternative 1 as compared to the No Action Alternative, as summarized in Appendix 6E, Table 6E.3.1.

Salinity in the Delta at Port Chicago, Chipps Island, and Collinsville would be higher in September through January, moderately higher February through May, lower in June, and similar in all other months, for long-term average conditions under Alternative 1 as compared to the No Action Alternative, as summarized in Appendix 6E, Tables 6E.6.1, 6E.4.1, and 6E.2.1.

Salinity at the CVP Contra Costa Canal and Jones pumping plants and the SWP Banks Pumping Plant intakes in the Delta would be higher in September through January, and lower in all other months for long-term average conditions under Alternative 1 as compared to the No Action Alternative, as summarized in Appendix 6E, Tables 6E.11.1, 6E.7.1, and 6E.8.1. Salinity at the Contra Costa Water District Old River and Middle River intakes also would be higher in September through January, and lower in all other months, for long-term average conditions under Alternative 1 as compared to the No Action Alternative, as summarized in Appendix 6E, Tables 6E.12.1 and 6E.13.1. Changes in salinity at the intakes would influence the salinity in water delivered in the San Joaquin Valley which could influence salinity in water bodies that receive agricultural return flows from CVP and SWP water users. Chloride and bromide concentrations at the intakes are expected to change in a similar manner to other salinity indicators.

X2 decreases with increases in Delta outflow as freshwater from the Central Valley flows towards San Francisco Bay. Under Alternative 1, Delta outflow would decrease and X2 would move towards the east as compared to the No Action Alternative, as shown in in Appendix 6E, Table C-16.1. X2 distances would be higher in September through May, and similar in all other months in long-term average conditions under Alternative 1 as compared to the No Action Alternative.

Potential Changes in Mercury Concentrations

Changes in mercury from the rivers results in changes in mercury concentrations in fish used for human consumption in the Delta, including Largemouth Bass, as summarized in Tables 6.30 and 6.31 for long-term average conditions and dry and critical dry years, respectively. All values exceed the threshold of 0.24 milligram/kilogram wet weight (mg/kg ww) for mercury.

Table 6.30 Changes in Mercury Concentrations 350-millimeter Largemouth Bass over the Long-term Average Conditions under Alternative 1 as Compared to the No Action Alternative

Delta Location	Alternative 1 (mg/kg ww)	No Action Alternative (mg/kg ww)	Changes
San Joaquin River at Stockton	0.99	1.00	0%
San Joaquin River at Turner Cut	0.87	0.89	-3%
San Joaquin River at San Andreas Landing	0.58	0.59	-3%
San Joaquin River at Jersey Point	0.54	0.57	-4%
Victoria Canal	0.82	0.85	-4%
Sacramento River at Emmaton	0.49	0.50	-2%
San Joaquin River at Antioch	0.47	0.50	-6%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.32	0.35	-6%
SWP Barker Slough Pumping Plant Intake	0.56	0.56	0%
CVP Contra Costa Pumping Plant Intake	0.68	0.73	-6%
SWP Banks Pumping Plant Intake	0.75	0.79	-5%
CVP Jones Pumping Plant Intake	0.79	0.83	-4%

Notes:

Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical dry years values calculated using 1987-1991 results from DSM2 model.

Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

mg/kg – milligram/kilogram; ww – wet weight

Table 6.31 Changes in Mercury Concentrations 350-millimeter Largemouth Bass in Dry and Critical Dry Years under the Alternative 1 as Compared to the No Action Alternative

Delta Location	Alternative 1 (mg/kg ww)	No Action Alternative (mg/kg ww)	Changes
San Joaquin River at Stockton	1.06	1.06	0%
San Joaquin River at Turner Cut	0.81	0.84	-4%
San Joaquin River at San Andreas Landing	0.53	0.54	-3%
San Joaquin River at Jersey Point	0.50	0.52	-4%
Victoria Canal	0.76	0.82	-6%
Sacramento River at Emmaton	0.47	0.48	-2%
San Joaquin River at Antioch	0.41	0.43	-5%
Montezuma Slough at Hunter Cut and Beldon’s Landing (Suisun Marsh)	0.26	0.28	-5%
SWP Barker Slough Pumping Plant Intake	0.57	0.59	-2%
CVP Contra Costa Pumping Plant Intake	0.62	0.67	-7%
SWP Banks Pumping Plant Intake	0.69	0.75	-8%
CVP Jones Pumping Plant Intake	0.77	0.82	-6%

Notes:

Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical dry years values calculated using 1987-1991 results from DSM2 model.

Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

mg/kg – milligram/kilogram; ww – wet weight

Potential Changes in Selenium Concentrations

It is anticipated that the selenium loadings would be similar under Alternative 1 as compared to the No Action Alternative; and that selenium concentrations in the San Joaquin River also would be similar.

Selenium in the water column at various locations in the Delta under Alternative 1 as compared to the No Action Alternative are shown in Appendix 6D, Selenium Model Documentation. Selenium in the water column at the three western Delta locations under Alternative 1 would be identical to conditions under the No Action Alternative, as shown in Appendix 6D, Table 6D.16. Selenium in the water column would be below the NTR criterion of 5 µg/L for the San Francisco Bay. Similarly, they would be below the draft USEPA (2014b) criterion for lentic aquatic systems (1.3 µg/L).

In the western Delta and at the Barker Slough Pumping Plant intake, selenium in the water column would be similar under Alternative 1 as compared to the No Action Alternative.

Selenium at the Contra Costa Pumping Plant intake would be similar under Alternative 1 as compared to the No Action Alternative, as shown in Table 6D.9 of Appendix 6D. Selenium at the Jones and Banks pumping plant intakes under Alternative 1 would be lower than under the No Action Alternative, as shown in Appendix 6D, Table 6D.9.

Estimated selenium concentration in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) at all locations in the Delta under Alternative 1 would be similar as under the No Action Alternative, as shown in Appendix 6D, Table 6D.10. As shown in Appendix 6D, Table 6D.13, EQs computed with respect to the applicable benchmarks show that selenium concentrations in biota under Alternative 1 would be below the thresholds identified for ecological risk.

For sturgeon in the western Delta, modeling also suggests that whole-body concentrations would be similar under Alternative 1 and the No Action Alternative (Appendix 6D, Table 6D.17), and the EQs would be similar (Appendix 6D, Table 6D.18). Low Toxicity Threshold EQs for selenium concentrations in sturgeon in the western Delta would remain under 1.0 for long-term average conditions, and slightly exceed 1.0 (indicating a higher probability for adverse effects) for drought years at the three western Delta locations under Alternative 1 and the No Action Alternative (Table 6D.18 of Appendix 6D). Estimated EQs for High Toxicity Threshold at all locations are less than 1.0 under all hydrologic conditions.

Effects Related to Cross Delta Water Transfers

Potential effects to water quality could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 1 and the No Action Alternative, and that impacts on water quality would not be substantial in the seller's service area due to implementation requirements of the transfer programs.

Under Alternative 1, water could be transferred throughout the year without an annual volumetric limit. Under the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be increased under Alternative 1 as compared to the No Action Alternative.

6.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison

Alternative 1 is identical to the Second Basis of Comparison.

6.4.3.3 Alternative 2

The CVP and SWP operations under Alternative 2 are identical to the CVP and SWP operations under the No Action Alternative; therefore, Alternative 2 is only compared to the Second Basis of Comparison.

6.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison

The CVP and SWP operations under Alternative 2 are identical to the CVP and SWP operations under the No Action Alternative. Therefore, changes to surface water quality under Alternatives 2 as compared to the Second Basis of Comparison would be the same as the impacts described in Section 6.4.3.1, No Action Alternative.

6.4.3.4 Alternative 3

As described in Chapter 3, Description of Alternatives, CVP and SWP operations under Alternative 3 are similar to the Second Basis of Comparison and Alternative 1 with modified Old and Middle River flow criteria. As described in Chapter 4, Approach to Environmental Analysis, Alternative 3 is compared to the No Action Alternative and the Second Basis of Comparison.

6.4.3.4.1 Alternative 3 Compared to the No Action Alternative

Potential Changes in Salinity Indicators

Salinity in the Sacramento River at Emmaton would be higher in September through January, lower in June, and similar in all other months over long-term average conditions under Alternative 3 as compared to the No Action Alternative, as summarized in Appendix 6E, Table 6E.2.2.

Salinity in the San Joaquin River at Vernalis would be higher in February through July and in October, lower in November through December, and similar in other months under Alternative 3 as compared to the No Action Alternative, as summarized in Appendix 6E, Table 6E.15.2.

Salinity in the San Joaquin River at Jersey Point would be higher in September through January, lower in June, and similar in all other months, for long-term average conditions under Alternative 3 as compared to the No Action Alternative, as summarized in Appendix 6E, Table 6E.3.2.

Salinity in the Delta at Port Chicago, Chipps Island, and Collinsville would be higher in September through December, moderately higher January and April, and similar in all other months, for long-term average conditions under Alternative 3 as compared to the No Action Alternative, as summarized in Appendix 6E, Tables 6E.6.2, 6E.4.2, and 6E.2.2.

Salinity at the CVP Jones Pumping Plant and the SWP Banks Pumping Plant intakes in the Delta would be higher in September through January, and lower or similar in all other months for long-term average conditions under Alternative 3 as compared to the No Action Alternative, as summarized in Appendix 6E, Table 6E.7.2 and Table 6E.8.2. Salinity at the CVP Contra Costa Canal Pumping Plant and at the Contra Costa Water District Old River and Middle River intakes would be higher in September through January, lower in February through June, and similar in July and August for long-term average conditions under Alternative 3 as compared to the No Action Alternative, as summarized in Appendix 6E, Tables 6E.11.2, 6E.12.2, and 6E.13.2. Changes in salinity at the intakes would influence the salinity in water delivered in the San Joaquin Valley which could influence salinity in water bodies that receive agricultural return flows from CVP and SWP water users. Chloride and bromide concentrations at the intakes are expected to change in a similar manner to other salinity indicators.

X2 decreases with increases in Delta outflow as freshwater from the Central Valley flows towards San Francisco Bay. Under Alternative 3, Delta outflow would decrease and X2 would move towards the east as compared to the No Action Alternative, as shown in in Appendix 6E, Table C-16.2. X2 distances would be higher in September through December and in April and May, and similar in all other months in long-term average conditions under Alternative 3 as compared to the No Action Alternative.

Potential Changes in Mercury Concentrations

Changes in mercury from the rivers results in changes in mercury concentrations in fish used for human consumption in the Delta, including Largemouth Bass, as summarized in Tables 6.32 and 6.33 for long-term average conditions and dry and critical dry years, respectively. All values exceed the threshold of 0.24 milligram/kilogram wet weight (mg/kg ww) for mercury.

Table 6.32 Changes in Mercury Concentrations 350-millimeter Largemouth Bass over the Long-term Average Conditions under Alternative 3 as Compared to the No Action Alternative

Delta Location	Alternative 3 (mg/kg ww)	No Action Alternative (mg/kg ww)	Changes
San Joaquin River at Stockton	1.00	1.00	1%
San Joaquin River at Turner Cut	0,88	0.89	-2%
San Joaquin River at San Andreas Landing	0.58	0.59	-3%
San Joaquin River at Jersey Point	0.55	0.57	-4%
Victoria Canal	0.83	0.85	-2%
Sacramento River at Emmaton	0.49	0.50	-2%
San Joaquin River at Antioch	0.48	0.50	-6%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.33	0.35	-6%
SWP Barker Slough Pumping Plant Intake	0.56	0.56	0%
CVP Contra Costa Pumping Plant Intake	0.69	0.73	-5%
SWP Banks Pumping Plant Intake	0.77	0.79	-3%
CVP Jones Pumping Plant Intake	0.81	0.83	-3%

Notes:

Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical dry years values calculated using 1987-1991 results from DSM2 model.

Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

mg/kg – milligram/kilogram; ww – wet weight

Table 6.33 Changes in Mercury Concentrations 350-millimeter Largemouth Bass in Dry and Critical Dry Years under the Alternative 3 as Compared to the No Action Alternative

Delta Location	Alternative 3 (mg/kg ww)	No Action Alternative (mg/kg ww)	Changes
San Joaquin River at Stockton	1.07	1.06	1%
San Joaquin River at Turner Cut	0.82	0.84	-3%
San Joaquin River at San Andreas Landing	0.53	0.54	-2%
San Joaquin River at Jersey Point	0.51	0.52	-2%
Victoria Canal	0.79	0.82	-3%
Sacramento River at Emmaton	0.47	0.48	-1%
San Joaquin River at Antioch	0.42	0.43	-3%
Montezuma Slough at Hunter Cut and Beldon’s Landing (Suisun Marsh)	0.27	0.28	-3%
SWP Barker Slough Pumping Plant Intake	0.58	0.59	-1%
CVP Contra Costa Pumping Plant Intake	0.64	0.67	-4%
SWP Banks Pumping Plant Intake	0.72	0.75	-4%
CVP Jones Pumping Plant Intake	0.80	0.82	-3%

Notes:

Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical dry years values calculated using 1987-1991 results from DSM2 model.

Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

mg/kg – milligram/kilogram; ww – wet weight

Potential Changes in Selenium Concentrations

It is anticipated that the selenium loadings would be similar under Alternative 3 as compared to the No Action Alternative; and that selenium concentrations in the San Joaquin River also would be similar.

Selenium in the water column at various locations in the Delta under Alternative 3 as compared to the No Action Alternative are shown in Appendix 6D, Selenium Model Documentation. Selenium in the water column at the three western Delta locations under Alternative 3 would be similar to conditions under the No Action Alternative, as shown in Appendix 6D, Table 6D.9. Selenium in the water column would be below the NTR criterion of 5 µg/L for the San Francisco Bay. Similarly, they would be below the draft USEPA (2014b) criterion for lentic aquatic systems (1.3 µg/L).

In the western Delta and at the Barker Slough Pumping Plant intake, selenium in the water column would be similar under Alternative 3 as compared to the No Action Alternative.

Selenium at the Contra Costa Pumping Plant intake would be similar under Alternative 3 as compared to the No Action Alternative, as shown in Table 6D.9 of Appendix 6D. Selenium at the Jones and Banks pumping plant intakes under Alternative 3 would be lower than under the No Action Alternative, as shown in Appendix 6D, Table 6D.9.

Estimated selenium concentration in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) at all locations in the Delta under Alternative 3 would be similar as under the No Action Alternative, as shown in Appendix 6D, Table 6D.10. As shown in Appendix 6D, Table 6D.14, EQs computed with respect to the applicable benchmarks show that selenium concentrations in biota under Alternative 3 would be below the thresholds identified for ecological risk.

For sturgeon in the western Delta, modeling also suggests that whole-body concentrations would be similar under Alternative 3 and the No Action Alternative (Appendix 6D, Table 6D.17), and the EQs would be similar (Appendix 6D, Table 6D.18). Low Toxicity Threshold EQs for selenium concentrations in sturgeon in the western Delta would remain under 1.0 for long-term average conditions, and slightly exceed 1.0 (indicating a higher probability for adverse effects) for drought years at the three western Delta locations under Alternative 3 and the No Action Alternative (Table 6D.18 of Appendix 6D). Estimated EQs for High Toxicity Threshold at all locations are less than 1.0 under all hydrologic conditions.

Effects Related to Cross Delta Water Transfers

Potential effects to water quality could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 3 and the No Action Alternative, and that impacts on water quality would not be substantial in the seller's service area due to implementation requirements of the transfer programs.

Under Alternative 3, water could be transferred throughout the year without an annual volumetric limit. Under the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be increased under Alternative 3 as compared to the No Action Alternative.

6.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison

Potential Changes in Salinity Indicators

Salinity in the Sacramento River at Emmaton would be higher in October through November and June, lower in December through March and July through September, and similar in April and May over long-term average conditions under Alternative 3 as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.2.5.

Salinity in the San Joaquin River at Vernalis would be higher in November through March and May through June, and similar in all other months under Alternative 3 as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.15.5.

Salinity in the San Joaquin River at Jersey Point would be higher in October through November and June through August, lower in December through March and September, and similar in April and May for long-term average conditions under Alternative 3 as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.3.5.

Salinity in the western Delta at Port Chicago, Chipps Island, and Collinsville would be lower in December through April and July through September, higher in May and June, and similar in all other months, for long-term average conditions under Alternative 3 as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Tables 6E.6.5, 6E.4.5, and 6E.2.5.

Salinity at the CVP Contra Costa Canal intake would be lower in December through February, as summarized in Appendix 6E, Table 6E.11.5. Salinity at Jones Pumping Plant and the SWP Banks Pumping Plant intakes in the Delta would be higher in January through May, lower in June, and similar in all other months for long-term average conditions under Alternative 3 as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.7.5 and Table 6E.8.5. Salinity at the Contra Costa Water District Old River and Middle River intakes also would be higher in January through April, lower in May and June, and similar in all other months, for long-term average conditions under Alternative 3 as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Tables 6E.12.5 and 6E.13.5. Changes in salinity at the intakes would influence the salinity in water delivered in the San Joaquin Valley which could influence salinity in water bodies that receive agricultural return flows from CVP and SWP water users.

X2 decreases with increases in Delta outflow as freshwater from the Central Valley flows towards San Francisco Bay. Under Alternative 3, Delta outflow generally would increase and X2 would move towards the west as compared to the Second Basis of Comparison, as shown in in Appendix 6E, Table 6E16-5. X2 distances would be lower (towards the west) in December through April and July through September, higher in May and June (towards the east), and similar in all other months in long-term average conditions under Alternative 3 as compared to the Second Basis of Comparison.

Potential Changes in Mercury Concentrations

Changes in flows in the rivers results in similar changes erosional inputs and resuspension of both inorganic and methylmercury fractions. Changes in mercury from the rivers results in changes in mercury concentrations in fish used for human consumption in the Delta, including Largemouth Bass, as summarized in Tables 6.34 and 6.35 for long-term average conditions and dry and critical dry years, respectively. All values exceed the threshold of 0.24 milligram/kilogram wet weight (mg/kg ww) for mercury.

Table 6.34 Changes in Mercury Concentrations 350-millimeter Largemouth Bass over the Long-term Average Conditions under Alternative 3 as Compared to the Second Basis of Comparison

Delta Location	Alternative 3 (mg/kg ww)	Second Basis of Comparison (mg/kg ww)	Changes
San Joaquin River at Stockton	1.00	0.99	1%
San Joaquin River at Turner Cut	0,88	0.87	1%
San Joaquin River at San Andreas Landing	0.58	0.58	0%
San Joaquin River at Jersey Point	0.55	0.54	1%
Victoria Canal	0.83	0.82	2%
Sacramento River at Emmaton	0.49	0.49	0%
San Joaquin River at Antioch	0.48	0.47	1%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.33	0.32	1%
SWP Barker Slough Pumping Plant Intake	0.56	0.56	0%
CVP Contra Costa Pumping Plant Intake	0.69	0.68	1%
SWP Banks Pumping Plant Intake	0.77	0.75	2%
CVP Jones Pumping Plant Intake	0.81	0.79	2%

Notes:

Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical dry years values calculated using 1987-1991 results from DSM2 model.

Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

mg/kg – milligram/kilogram; ww – wet weight

Table 6.35 Changes in Mercury Concentrations 350-millimeter Largemouth Bass in Dry and Critical Dry Years under Alternative 3 as Compared to the Second Basis of Comparison

Delta Location	Alternative 3 (mg/kg ww)	Second Basis of Comparison (mg/kg ww)	Changes
San Joaquin River at Stockton	1.07	1.06	1%
San Joaquin River at Turner Cut	0.82	0.81	1%
San Joaquin River at San Andreas Landing	0.53	0.53	1%
San Joaquin River at Jersey Point	0.51	0.50	2%
Victoria Canal	0.79	0.76	3%
Sacramento River at Emmaton	0.47	0.47	0%
San Joaquin River at Antioch	0.42	0.41	2%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.27	0.26	2%
SWP Barker Slough Pumping Plant Intake	0.58	0.57	2%
CVP Contra Costa Pumping Plant Intake	0.64	0.62	4%
SWP Banks Pumping Plant Intake	0.72	0.69	4%
CVP Jones Pumping Plant Intake	0.80	0.77	4%

Notes:

Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical dry years values calculated using 1987-1991 results from DSM2 model.

Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

mg/kg – milligram/kilogram; ww – wet weight

Potential Changes in Selenium Concentrations

It is anticipated that the selenium loadings would be similar under Alternative 3 and the Second Basis of Comparison; and that selenium concentrations in the San Joaquin River also would be similar.

Selenium in the water column at various locations in the Delta under Alternative 3 and the Second Basis of Comparison are shown in Appendix 6D, Selenium Model Documentation. Selenium in the water column at the three western Delta locations under Alternative 3 would be identical to conditions under the Second Basis of Comparison, as shown in Appendix 6D, Table 6D.16. Selenium in the water column would be below the NTR criterion of 5 µg/L for the San Francisco Bay. Similarly, they would be below the draft USEPA (2014b) criterion for lentic aquatic systems (1.3 µg/L).

In the western Delta and at the Barker Slough Pumping Plant intake, the selenium would be similar under Alternative 3 and the Second Basis of Comparison.

Selenium at the Contra Costa Pumping Plant and Banks Pumping Plant intakes would be similar under Alternative 3 and Second Basis of Comparison, as shown in Appendix 6D, Table 6D.9. Selenium at the Jones Pumping Plant intake under Alternative 3 would be slightly higher than Second Basis of Comparison, as shown in Appendix 6D, Table 6D.9.

Estimated selenium concentration in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) at all locations in the Delta under Alternative 3 would be similar as under the Second Basis of Comparison, as shown in Appendix 6D, Table 6D.11. As shown in Appendix 6D, Table 6D.14, EQs computed with respect to the applicable benchmarks show that selenium concentrations in biota under Alternative 3 would be below the thresholds identified for ecological risk.

For sturgeon in the western Delta, modeling also suggests that whole-body concentrations would be similar under Alternative 3 and the Second Basis of Comparison (Appendix 6D, Table 6D.17), and the EQs would be similar (Appendix 6D, Table 6D.18). Low Toxicity Threshold EQs for selenium concentrations in sturgeon in the western Delta would remain under 1.0 for long-term average conditions, and slightly exceed 1.0 (indicating a higher probability for adverse effects) for drought years at the three western Delta locations under both Alternative 3 and Second Basis of Comparison (Table 6D.18 of Appendix 6D). Estimated EQs for High Toxicity Threshold at all locations are less than 1.0 under all hydrologic conditions.

Effects Related to Cross Delta Water Transfers

Potential effects to water quality could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under

Alternative 3 and the Second Basis of Comparison, and that impacts on water quality would not be substantial in the seller's service area due to implementation requirements of the transfer programs.

Under Alternative 3 and the Second Basis of Comparison, water could be transferred throughout the year without an annual volumetric limit. Overall, the potential for cross Delta water transfers would be similar under Alternative 3 and the Second Basis of Comparison.

6.4.3.5 Alternative 4

Water quality under Alternative 4 would be identical to the conditions under the Second Basis of Comparison; therefore, Alternative 4 is only compared to the No Action Alternative.

6.4.3.5.1 Alternative 4 Compared to the No Action Alternative

The CVP and SWP operations under Alternative 4 are identical to the CVP and SWP operations under the Second Basis of Comparison and Alternative 1. Therefore, changes in water quality under Alternative 4 as compared to the No Action Alternative would be the same as the impacts described in Section 12.4.3.2.1, Alternative 1 Compared to the No Action Alternative.

6.4.3.6 Alternative 5

As described in Chapter 3, Description of Alternatives, CVP and SWP operations under Alternative 5 are similar to the No Action Alternative with modified Old and Middle River flow criteria and New Melones Reservoir operations. As described in Chapter 4, Approach to Environmental Analysis, Alternative 5 is compared to the No Action Alternative and the Second Basis of Comparison.

6.4.3.6.1 Alternative 5 Compared to the No Action Alternative

Potential Changes in Salinity Indicators

Salinity in the Sacramento River at Emmaton would be lower in May through September, and similar in all other months over long-term average conditions under Alternative 5 as compared to the No Action Alternative, as summarized in Appendix 6E, Table 6E.2.3.

Salinity in the San Joaquin River at Vernalis would be lower in April and May, and similar in all other months under Alternative 5 as compared to the No Action Alternative, as summarized in Appendix 6E, Table 6E.15.3.

Salinity in the San Joaquin River at Jersey Point would be lower in December through February, higher in June through August, and similar in all other months, for long-term average conditions under Alternative 5 as compared to the No Action Alternative, as summarized in Appendix 6E, Table 6E.3.3.

Salinity in the Delta at Port Chicago, Chipps Island, and Collinsville would be lower in April through June, and similar in all other months, for long-term average conditions under Alternative 5 as compared to the No Action Alternative, as summarized in Appendix 6E, Tables 6E.6.3, 6E.4.3, and 6E.2.3.

Salinity at the Jones pumping plants and the SWP Banks Pumping Plant intakes in the Delta would be lower in May and slightly higher in June through September, and similar in all other months for long-term average conditions under Alternative 5 as compared to the No Action Alternative, as summarized in Appendix 6E, Table 6E.7.3 and Table 6E.8.3. Salinity at the CVP Contra Costa Canal intake and at the Contra Costa Water District Old River and Middle River intakes also would be higher in April through September, and similar in all other months, for long-term average conditions under Alternative 5 as compared to the No Action Alternative, as summarized in Appendix 6E, Tables 6E.11.3, 6E.12.3, and 6E.13.3. Changes in salinity at the intakes would influence the salinity in water delivered in the San Joaquin Valley which could influence salinity in water bodies that receive agricultural return flows from CVP and SWP water users. Chloride and bromide concentrations at the intakes are expected to change in a similar manner to other salinity indicators.

X2 decreases with increases in Delta outflow as freshwater from the Central Valley flows towards San Francisco Bay. Under Alternative 5, Delta outflow would increase and X2 would move towards the west as compared to the No Action Alternative, as shown in in Appendix 6E, Table C-16.3. X2 distances would be lower (towards the west) in April and May, and similar in all other months in long-term average conditions under Alternative 5 as compared to the No Action Alternative.

Potential Changes in Mercury Concentrations

Changes in flows in the rivers result in similar changes in erosional inputs and resuspension of both inorganic and methylmercury fractions. Changes in mercury from the rivers results in changes in mercury concentrations in fish used for human consumption in the Delta, including Largemouth Bass, as summarized in Tables 6.36 and 6.37 for long-term average conditions and dry and critical dry years, respectively. All values exceed the threshold of 0.24 milligram/kilogram wet weight (mg/kg ww) for mercury.

Table 6.36 Changes in Mercury Concentrations 350-millimeter Largemouth Bass over the Long-term Average Conditions under Alternative 5 as Compared to the No Action Alternative

Delta Location	Alternative 5 (mg/kg ww)	No Action Alternative (mg/kg ww)	Changes
San Joaquin River at Stockton	1.00	1.00	0%
San Joaquin River at Turner Cut	0.89	0.89	0%
San Joaquin River at San Andreas Landing	0.55	0.59	1%
San Joaquin River at Jersey Point	0.57	0.57	1%
Victoria Canal	0.85	0.85	0%
Sacramento River at Emmaton	0.50	0.50	0%
San Joaquin River at Antioch	0.51	0.50	1%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.35	0.35	1%
SWP Barker Slough Pumping Plant Intake	0.56	0.56	0%
CVP Contra Costa Pumping Plant Intake	0.74	0.73	2%
SWP Banks Pumping Plant Intake	0.79	0.79	0%
CVP Jones Pumping Plant Intake	0.83	0.83	0%

Notes:

Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical dry years values calculated using 1987-1991 results from DSM2 model.

Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

mg/kg – milligram/kilogram; ww – wet weight

Table 6.37 Changes in Mercury Concentrations 350-millimeter Largemouth Bass in Dry and Critical Dry Years under the Alternative 5 as Compared to the No Action Alternative

Delta Location	Alternative 5 (mg/kg ww)	No Action Alternative (mg/kg ww)	Changes
San Joaquin River at Stockton	1.05	1.06	0%
San Joaquin River at Turner Cut	0.85	0.84	1%
San Joaquin River at San Andreas Landing	0.55	0.54	2%
San Joaquin River at Jersey Point	0.53	0.52	2%
Victoria Canal	0.82	0.82	0%
Sacramento River at Emmaton	0.49	0.48	1%
San Joaquin River at Antioch	0.44	0.43	2%
Montezuma Slough at Hunter Cut and Beldon’s Landing (Suisun Marsh)	0.28	0.28	0%
SWP Barker Slough Pumping Plant Intake	0.58	0.59	0%
CVP Contra Costa Pumping Plant Intake	0.70	0.67	5%
SWP Banks Pumping Plant Intake	0.74	0.75	-1%
CVP Jones Pumping Plant Intake	0.82	0.82	1%

Notes:

Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical dry years values calculated using 1987-1991 results from DSM2 model.

Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

mg/kg – milligram/kilogram; ww – wet weight

Potential Changes in Selenium Concentrations

It is anticipated that the selenium loadings would be similar under Alternative 5 as compared to the No Action Alternative; and that selenium concentrations in the San Joaquin River also would be similar.

Selenium in the water column at various locations in the Delta under Alternative 5 as compared to the No Action Alternative are shown in Appendix 6D, Selenium Model Documentation. Selenium in the water column at the three western Delta locations under Alternative 5 would be similar to conditions under the No Action Alternative, as shown in Appendix 6D, Table 6D.16. Selenium in the water column would be below the NTR criterion of 5 µg/L for the San Francisco Bay. Similarly, they would be below the draft USEPA (2014b) criterion for lentic aquatic systems (1.3 µg/L).

In the western Delta and at the Barker Slough Pumping Plant intake, selenium in the water column would be similar under Alternative 5 as compared to the No Action Alternative.

Selenium at the Contra Costa Pumping Plant and Banks Pumping Plant intakes would be higher under Alternative 5 as compared to the No Action Alternative, as shown in Table 6D.9 of Appendix 6D. Selenium at the Jones Pumping Plant intake under Alternative 5 would be similar to conditions under the No Action Alternative, as shown in Appendix 6D, Table 6D.9.

Estimated selenium concentration in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) at all locations in the Delta under Alternative 5 would be similar as under the No Action Alternative, as shown in Appendix 6D, Table 6D.12. As shown in Appendix 6D, Table 6D.15, Exceedance Quotients (EQs) computed with respect to the applicable benchmarks show that selenium concentrations in biota under Alternative 5 would be below the thresholds identified for ecological risk.

For sturgeon in the western Delta, modeling also suggests that whole-body concentrations would be higher under Alternative 5 and the No Action Alternative (Appendix 6D, Table 6D.17), and the EQs would be similar (Appendix 6D, Table 6D.18). Low Toxicity Threshold EQs for selenium concentrations in sturgeon in the western Delta would remain under 1.0 for long-term average conditions, and slightly exceed 1.0 (indicating a higher probability for adverse effects) for drought years at the three western Delta locations under Alternative 5 and the No Action Alternative (Table 6D.18 of Appendix 6D). Estimated EQs for High Toxicity Threshold at all locations are less than 1.0 under all hydrologic conditions.

Effects Related to Cross Delta Water Transfers

Potential effects to water quality could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under

Alternative 5 and the No Action Alternative, and that impacts on water quality would not be substantial in the seller's service area due to implementation requirements of the transfer programs.

Under Alternative 5 and the No Action Alternative, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be similar under Alternative 5 and the No Action Alternative.

6.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison

Potential Changes in Salinity Indicators

Salinity in the Sacramento River at Emmaton would be lower in September through January, higher in June, and similar in all other months over long-term average conditions under Alternative 5 as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.2.6.

Salinity in the San Joaquin River at Vernalis would be lower in April through May and October, higher in November through March, and similar in all other months under Alternative 5 as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.15.6.

Salinity in the San Joaquin River at Jersey Point would be lower in September through January, higher in July and August, and similar in all other months for long-term average conditions under Alternative 5 as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.3.6.

Salinity in the western Delta at Port Chicago, Chipps Island, and Collinsville would be lower in all months for long-term average conditions under Alternative 5 as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Tables 6E.6.6, 6E.4.6, and 6E.2.6.

Salinity at Jones Pumping Plant and the SWP Banks Pumping Plant intakes in the Delta would be lower in September through January, and higher in all other months for long-term average conditions under Alternative 5 as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Table 6E.7.6 and Table 6E.8.6. Salinity at the CVP Contra Costa Canal intake and the Contra Costa Water District Old River and Middle River intakes also would be lower in September through January and higher in February through August for long-term average conditions under Alternative 5 as compared to the Second Basis of Comparison, as summarized in Appendix 6E, Tables 6E.11.6, 6E.12.6, and 6E.13.6. Changes in salinity at the intakes would influence the salinity in water delivered in the San Joaquin Valley which could influence salinity in water bodies that receive agricultural return flows from CVP and SWP water users.

X2 decreases with increases in Delta outflow as freshwater from the Central Valley flows towards San Francisco Bay. Under Alternative 5, Delta outflow generally would increase and X2 would move towards the west, especially in September through May, as compared to the Second Basis of Comparison, as shown in in Appendix 6E, Table 6E16-6.

Potential Changes in Mercury Concentrations

Changes in mercury from the rivers results in changes in mercury concentrations in fish used for human consumption in the Delta, including Largemouth Bass, as summarized in Tables 6.38 and 6.39 for long-term average conditions and dry and critical dry years, respectively. All values exceed the threshold of 0.24 milligram/kilogram wet weight (mg/kg ww) for mercury.

Table 6.38 Changes in Mercury Concentrations 350-millimeter Largemouth Bass over the Long-term Average Conditions under Alternative 5 as Compared to the Second Basis of Comparison

Delta Location	Alternative 5 (mg/kg ww)	Second Basis of Comparison (mg/kg ww)	Changes
San Joaquin River at Stockton	1.00	0.99	0%
San Joaquin River at Turner Cut	0.89	0.87	3%
San Joaquin River at San Andreas Landing	0.55	0.58	4%
San Joaquin River at Jersey Point	0.57	0.54	5%
Victoria Canal	0.85	0.82	4%
Sacramento River at Emmaton	0.50	0.49	3%
San Joaquin River at Antioch	0.51	0.47	7%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.35	0.32	7%
SWP Barker Slough Pumping Plant Intake	0.56	0.56	1%
CVP Contra Costa Pumping Plant Intake	0.74	0.68	8%
SWP Banks Pumping Plant Intake	0.79	0.75	5%
CVP Jones Pumping Plant Intake	0.83	0.79	5%

Notes:

Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical dry years values calculated using 1987-1991 results from DSM2 model.

Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

mg/kg – milligram/kilogram; ww – wet weight

Table 6.39 Changes in Mercury Concentrations 350-millimeter Largemouth Bass in Dry and Critical Dry Years under Alternative 5 as Compared to the Second Basis of Comparison

Delta Location	Alternative 5 (mg/kg ww)	Second Basis of Comparison (mg/kg ww)	Changes
San Joaquin River at Stockton	1.05	1.06	0%
San Joaquin River at Turner Cut	0.85	0.81	4%
San Joaquin River at San Andreas Landing	0.55	0.53	4%
San Joaquin River at Jersey Point	0.53	0.50	5%
Victoria Canal	0.82	0.76	7%
Sacramento River at Emmaton	0.49	0.47	3%
San Joaquin River at Antioch	0.44	0.41	7%
Montezuma Slough at Hunter Cut and Beldon's Landing (Suisun Marsh)	0.28	0.26	7%
SWP Barker Slough Pumping Plant Intake	0.58	0.57	2%
CVP Contra Costa Pumping Plant Intake	0.70	0.62	13%
SWP Banks Pumping Plant Intake	0.74	0.69	7%
CVP Jones Pumping Plant Intake	0.82	0.77	7%

Notes:

Long-term values calculated using 1976-1991 results from DSM2 model. Dry and critical dry years values calculated using 1987-1991 results from DSM2 model.

Concentrations greater than 0.24 mg/kg ww Hg exceed CVRWQCB threshold

mg/kg – milligram/kilogram; ww – wet weight

Potential Changes in Selenium Concentrations

It is anticipated that the selenium loadings would be similar under Alternative 5 and the Second Basis of Comparison; and that selenium concentrations in the San Joaquin River also would be similar.

In the Delta, selenium concentrations are related to the movement of flows from the San Joaquin River and the accumulation in certain areas of the Delta due to tidal flow patterns.

Selenium in the water column at various locations in the Delta under Alternative 5 and the Second Basis of Comparison are shown in Appendix 6D, Selenium Model Documentation. Selenium in the water column at the three western Delta locations under Alternative 5 would be similar to conditions under the Second Basis of Comparison, as shown in Appendix 6D, Table 6D.16. Selenium in the water column would be below the NTR criterion of 5 µg/L for the San Francisco Bay. Similarly, they would be below the draft USEPA (2014b) criterion for lentic aquatic systems (1.3 µg/L).

In the western Delta and at the Barker Slough Pumping Plant intake, the selenium would be similar under Alternative 5 and the Second Basis of Comparison. There would be small increases in selenium along the Sacramento River at Emmaton under Alternative 5 as compared to the Second Basis of Comparison.

Selenium at the Contra Costa Pumping Plant, Jones Pumping Plant, and Banks Pumping Plant intakes would be higher under Alternative 5 and Second Basis of Comparison, as shown in Appendix 6D, Table 6D.9.

Estimated selenium concentration in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) at all locations in the Delta under Alternative 5 would be similar as under the Second Basis of Comparison, as shown in Appendix 6D, Table 6D.12. As shown in Appendix 6D, Table 6D.13, EQs computed with respect to the applicable benchmarks show that selenium concentrations in biota under Alternative 5 would be below the thresholds identified for ecological risk.

For sturgeon in the western Delta, modeling also suggests that whole-body concentrations would be higher under Alternative 5 and the Second Basis of Comparison (Appendix 6D, Table 6D.17), and the EQs would be similar (Appendix 6D, Table 6D.18). Low Toxicity Threshold EQs for selenium concentrations in sturgeon in the western Delta would remain under 1.0 for long-term average conditions, and slightly exceed 1.0 (indicating a higher probability for adverse effects) for drought years at the three western Delta locations under both Alternative 5 and Second Basis of Comparison (Table 6D.18 of Appendix 6D). Estimated EQs for High Toxicity Threshold at all locations are less than 1.0 under all hydrologic conditions.

Effects Related to Cross Delta Water Transfers

Potential effects to water quality could be similar to those identified in a recent environmental analysis conducted by Reclamation for long-term water transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described above under the No Action Alternative compared to the Second Basis of Comparison. For the purposes of this EIS, it is anticipated that similar conditions would occur during implementation of cross Delta water transfers under Alternative 5 and the Second Basis of Comparison, and that impacts on water quality would not be substantial in the seller's service area due to implementation requirements of the transfer programs.

Under Alternative 5, the timing of cross Delta water transfers would be limited to July through September and include annual volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second Basis of Comparison, water could be transferred throughout the year without an annual volumetric limit. Overall, the potential for cross Delta water transfers would be reduced under Alternative 5 as compared to the Second Basis of Comparison.

6.4.3.7 Summary of Environmental Consequences

The results of the environmental consequences of implementation of Alternatives 1 through 5 as compared to the No Action Alternative and the Second Basis of Comparison are presented in Tables 6.40 and 6.41.

Table 6.40 Comparison of Alternatives 1 through 5 to No Action Alternative

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	Salinity increases near Emmaton in June (5 to 41 percent depending upon water year type); decreases in July through March (5 to 79 percent); and is similar in April and May. Salinity increases near CVP and SWP, Contra Costa Water District, and Antioch (5 to over 47 percent) in February through August; and is similar or decreases (5 to over 39 percent) in September through January. Salinity decreases near Port Chicago in September through May (5 to 33 percent); and is similar in June through August. Similar mercury concentrations in Largemouth Bass in the most of the Delta; and a 6 percent decrease near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough over the long-term conditions. Similar selenium concentrations in whole body fish, bird eggs, and fish fillets.	Coordination of CVP and SWP operations between Reclamation, DWR, USFWS, and NMFS to reduce salinity near the CVP, SWP, Contra Costa Water District, and Antioch intakes and near Emmaton.
Alternative 2	No effects on public health issues.	None needed
Alternative 3	Salinity decreases near Emmaton in September through January (5 to 68 percent); and is similar in February through August. Salinity increases CVP and SWP, Contra Costa Water District, and Antioch intakes (5 to over 50 percent) in February through June; and is similar or decreases (5 to over 30 percent) in July through January. Salinity decreases near Port Chicago in September through June (5 to 34 percent); and is similar in July and August. Similar mercury concentrations in Largemouth Bass in the most of the Delta; and a 6 percent decrease near San Joaquin River at Antioch and Montezuma Slough over the long-term conditions. Similar selenium concentrations in whole body fish, bird eggs, and fish fillets.	Coordination of CVP and SWP operations between Reclamation, DWR, USFWS, and NMFS to reduce salinity near the CVP, SWP, Contra Costa Water District, and Antioch intakes.
Alternative 4	Same effects as described for Alternative 1 compared to the No Action Alternative.	None needed
Alternative 5	Salinity near Emmaton is similar in all months. Salinity decreases near the CVP and SWP, Contra Costa Water District, and Antioch intakes (5 to over 29 percent) in April through June; and is similar in July through February. Salinity near Port Chicago is similar in all months. Similar mercury concentrations in Largemouth Bass throughout the Delta. Similar selenium concentrations in whole body fish, bird eggs, and fish fillets.	None needed

Table 6.41 Comparison of No Action Alternative and Alternatives 1 through 5 to Second Basis of Comparison

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	Salinity increases near Emmaton in July through March (5 to 125 percent depending upon water year type); decreases in June (5 to 29 percent); and is similar in April and May. Salinity increases near the CVP and SWP, Contra Costa Water District, and Antioch intakes (5 to over 65 percent) in September through January; and is similar or decreases (5 to over 30 percent) in spring and summer months. Salinity increases near Port Chicago in January through March (5 to 50 percent); and is similar in June through August. Similar mercury concentrations in Largemouth Bass in the most of the Delta; and a 7 percent increase near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough over the long-term conditions. Similar selenium concentrations in whole body fish, bird eggs, and fish fillets.	Not considered for this comparison.
Alternative 1	No effects on public health issues.	Not considered for this comparison.
Alternative 2	Same effects as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.
Alternative 3	Salinity increases near Emmaton in January through March and July through September (5 to 32 percent); decreases in June (5 to 26 percent); and is similar in October through December, April, and May. Salinity decreases near Jones and Banks Pumping Plants in January through May (5 to 18 percent); and is similar in remaining months. Salinity increases near the Contra Costa Water District and Antioch intakes (5 to 30 percent) in January and February; and is similar or decreases (5 to over 10 percent) in remaining months. Salinity increases near Port Chicago in January through March (5 to 34 percent); and is similar in April through December. Similar mercury concentrations in Largemouth Bass throughout the Delta. Similar selenium concentrations in whole body fish, bird eggs, and fish fillets.	Not considered for this comparison.
Alternative 4	No effects on public health issues.	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 5	Salinity increases near Emmaton in July through May (5 to 124 percent depending upon water year type); and decreases in June (5 to 29 percent). Salinity increases near the CVP and SWP, Contra Costa Water District, and Antioch intakes (5 to over 60 percent) in September through January or February; and decreases (5 to over 30 percent) in remaining months. Salinity increases near Port Chicago in September through May (5 to 50 percent); and is similar in June through August. Similar mercury concentrations in Largemouth Bass in the most of the Delta; and a 7 percent increase near Rock Slough, San Joaquin River at Antioch, and Montezuma Slough over the long-term conditions. Similar selenium concentrations in whole body fish, bird eggs, and fish fillets.	Not considered for this comparison.

6.4.3.8 Potential Mitigation Measures

Changes in CVP and SWP operations under Alternatives 1 through 5 as compared to the No Action Alternative would result in adverse changes in water quality, especially related to salinity. Potential mitigation measures that could be considered to reduce the adverse impacts include:

- Coordination of CVP and SWP operations between Reclamation, DWR, USFWS, and NMFS to reduce salinity near the CVP, SWP, Contra Costa Water District, and Antioch intakes and near Emmaton under Alternative 1.
- Coordination of CVP and SWP operations between Reclamation, DWR, USFWS, and NMFS to reduce salinity near the CVP, SWP, Contra Costa Water District, and Antioch intakes under Alternative 3.

6.4.3.9 Cumulative Effects Analysis

As described in Chapter 3, the cumulative effects analysis considers projects, programs, and policies that are not speculative; and are based upon known or reasonably foreseeable long-range plans, regulations, operating agreements, or other information that establishes them as reasonably foreseeable.

The No Action Alternative, Alternatives 1 through 5, and Second Basis of Comparison include climate change and sea level rise, implementation of general plans, and completion of ongoing projects and programs (see Chapter 3, Description of Alternatives). The effects of these items were analyzed quantitatively and qualitatively, as described in the Impact Analysis of this chapter. The discussion below focuses on the qualitative effects of the alternatives and other past, present, and reasonably foreseeable future projects identified for consideration of cumulative effects (see Chapter 3, Description of Alternatives).

6.4.3.9.1 No Action Alternative and Alternatives 1 through 5

Continued coordinated long-term operation of the CVP and SWP under the No Action Alternative would result in reduced CVP and SWP water supply availability as compared to recent conditions due to climate change and sea level rise by 2030. These conditions are included in the analysis presented above.

Future water resource management projects considered in cumulative effects analysis could increase water supply availability, as described in Chapter 5, Surface Water Resources and Water Supplies; and improve water quality conditions for beneficial uses in the Delta and portions of the San Francisco Bay Area, Central Coast, and Southern California regions that use CVP and SWP water.

There also are several ongoing programs that could result in reductions in CVP and SWP water supply availability due to changes in flow patterns in the Sacramento and San Joaquin rivers watersheds and the Delta that could reduce availability of CVP and SWP water deliveries as well as local and regional water supplies, as described in Chapter 5, Surface Water Resources and Water Supplies. These programs could improve Delta water quality to meet beneficial uses. However, these programs could reduce available surface water supplies as compared to projected water supplies which could result in degradation of water quality conditions at reservoirs in San Francisco Bay Area, Central Coast, and Southern California.

There would be adverse water quality impacts associated with implementation of the alternatives as compared to the No Action Alternative. Therefore, Alternatives 1 and 3 would contribute cumulative impacts to water quality, specifically associated with:

- Increased salinity near the CVP, SWP, Contra Costa Water District, and Antioch intakes and near Emmaton under Alternative 1.
- Increased salinity near the CVP, SWP, Contra Costa Water District, and Antioch intakes under Alternative 3.

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Chapter 6

Surface Water Quality Figures

The following figures are included in Chapter 6, Surface Water Quality.

- 6.1 Monthly Average of Water Temperatures Recorded at Trinity River Compliance Locations (2001-2012)
- 6.2 Water Quality Compliance Stations Along Trinity River and Upper Sacramento River
- 6.3 Monthly Average of Water Temperatures Recorded at Sacramento River Compliance Locations (2001-2012)
- 6.4 Monthly Average Specific Conductance in San Joaquin River at Vernalis (Reclamation 2013e)
- 6.5 Water Quality Compliance Stations in the Delta
- 6.6 Monthly Average Specific Conductance in Sacramento River at Collinsville (Reclamation 2013e)
- 6.7 Monthly Average Specific Conductance in Sacramento River at Emmaton (Reclamation 2013e)
- 6.8 Monthly Average Specific Conductance in Sacramento River at Rio Vista (Reclamation 2013e)
- 6.9 Monthly Average Specific Conductance in Delta Mendota Canal Intake (Reclamation 2013e)

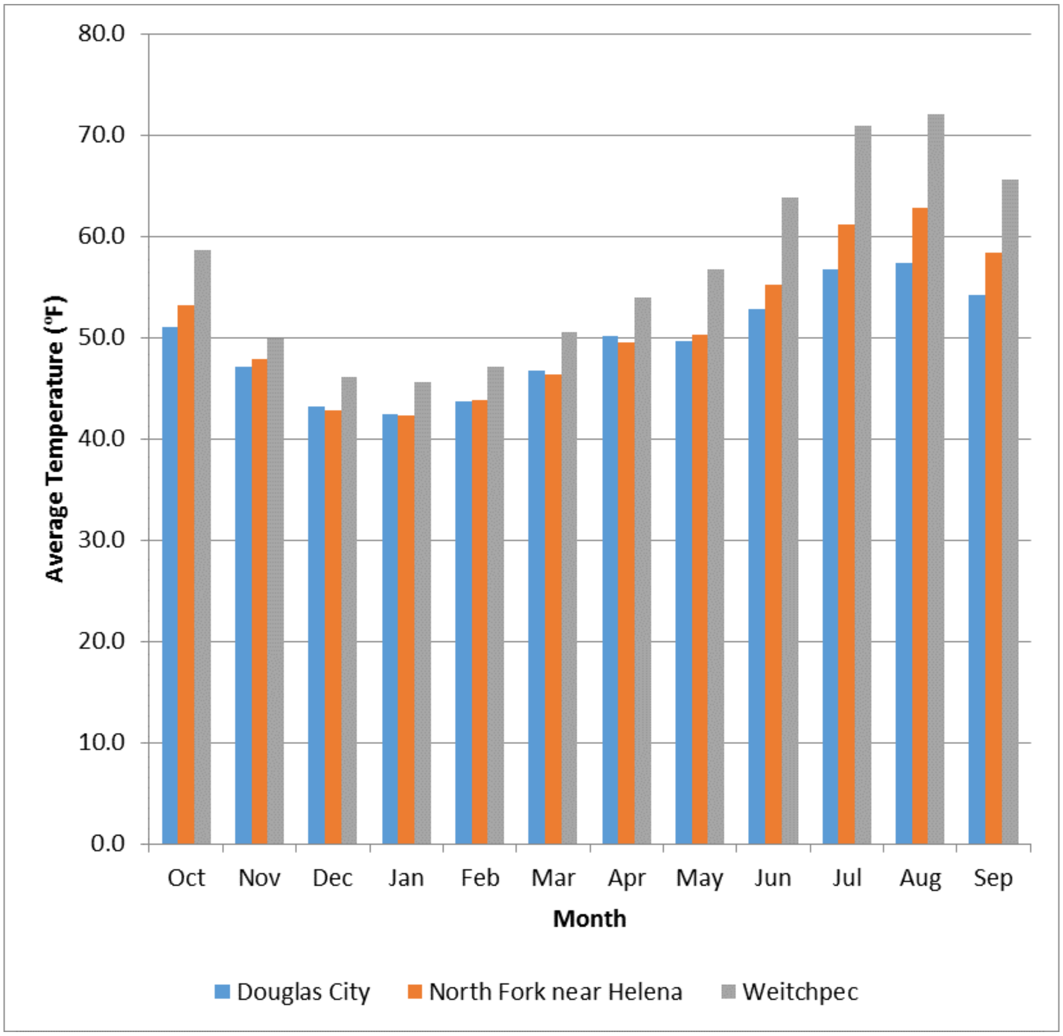
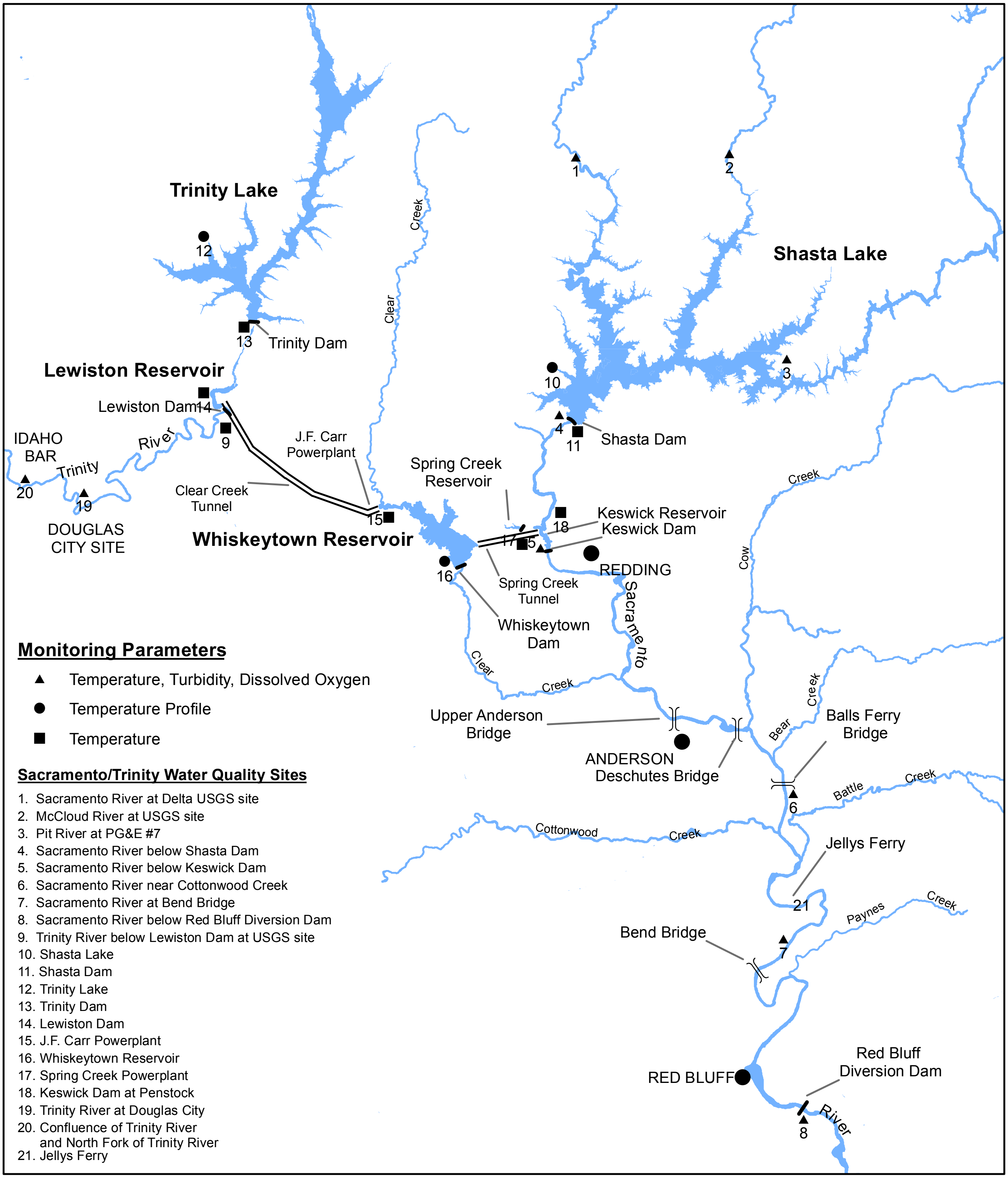


Figure 6.1 Monthly Average of Water Temperatures Recorded at Trinity River Compliance Locations (2001-2012)



Monitoring Parameters

▲ Temperature, Turbidity, Dissolved Oxygen

● Temperature Profile

■ Temperature

Sacramento/Trinity Water Quality Sites

1. Sacramento River at Delta USGS site
2. McCloud River at USGS site
3. Pit River at PG&E #7
4. Sacramento River below Shasta Dam
5. Sacramento River below Keswick Dam
6. Sacramento River near Cottonwood Creek
7. Sacramento River at Bend Bridge
8. Sacramento River below Red Bluff Diversion Dam
9. Trinity River below Lewiston Dam at USGS site
10. Shasta Lake
11. Shasta Dam
12. Trinity Lake
13. Trinity Dam
14. Lewiston Dam
15. J.F. Carr Powerplant
16. Whiskeytown Reservoir
17. Spring Creek Powerplant
18. Keswick Dam at Penstock
19. Trinity River at Douglas City
20. Confluence of Trinity River and North Fork of Trinity River
21. Jellys Ferry

Figure 6.2 Water Quality Compliance Stations Along Trinity River and Upper Sacramento River

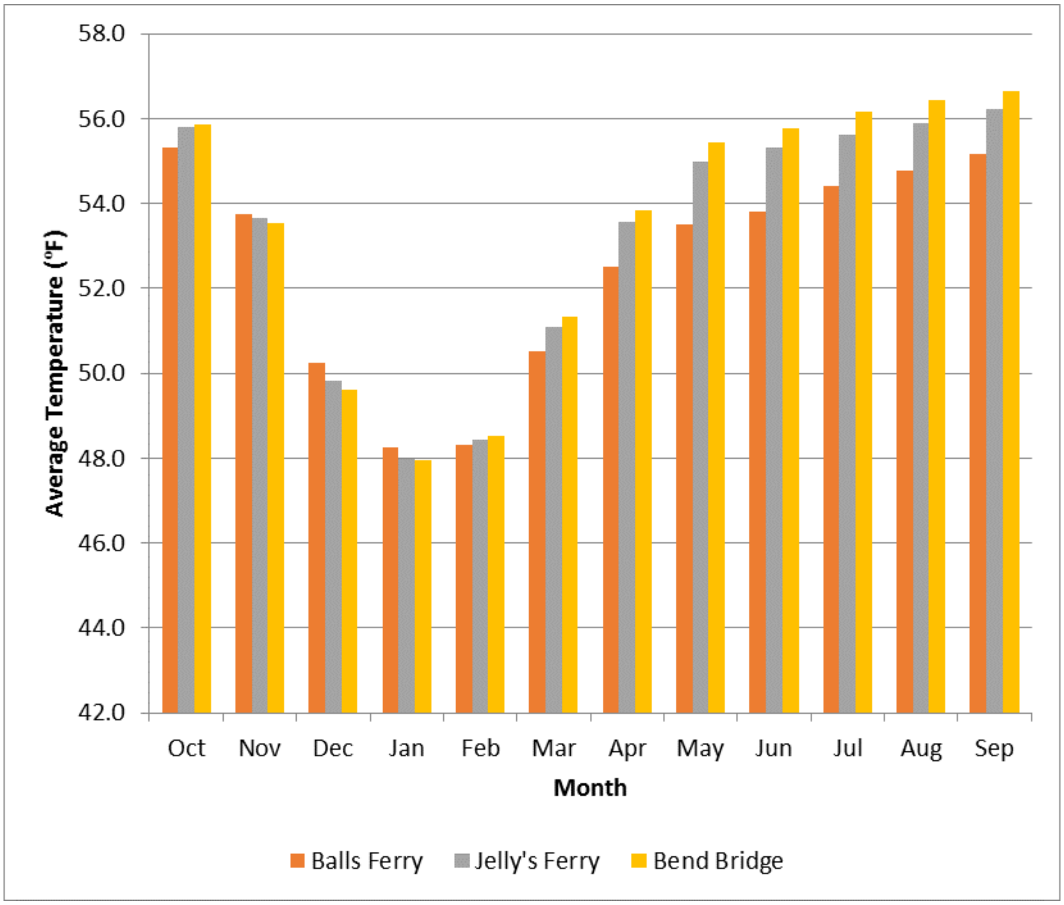


Figure 6.3 Monthly Average of Water Temperatures Recorded at Sacramento River Compliance Locations (2001-2012)

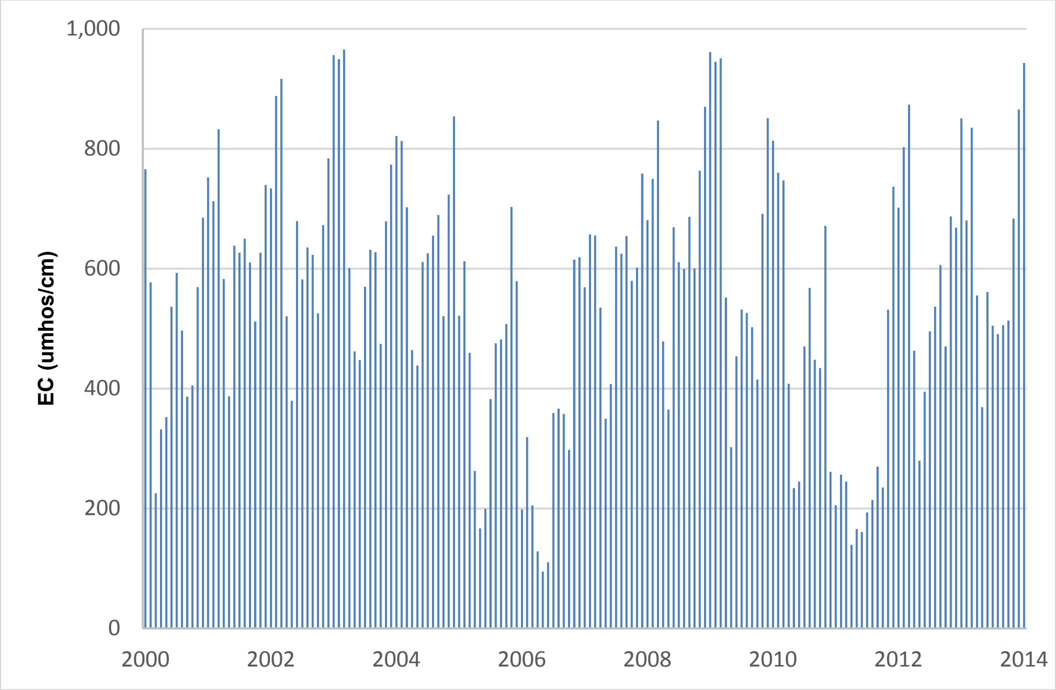


Figure 6.4 Monthly Average Specific Conductance in San Joaquin River at Vernalis (Reclamation 2013e)

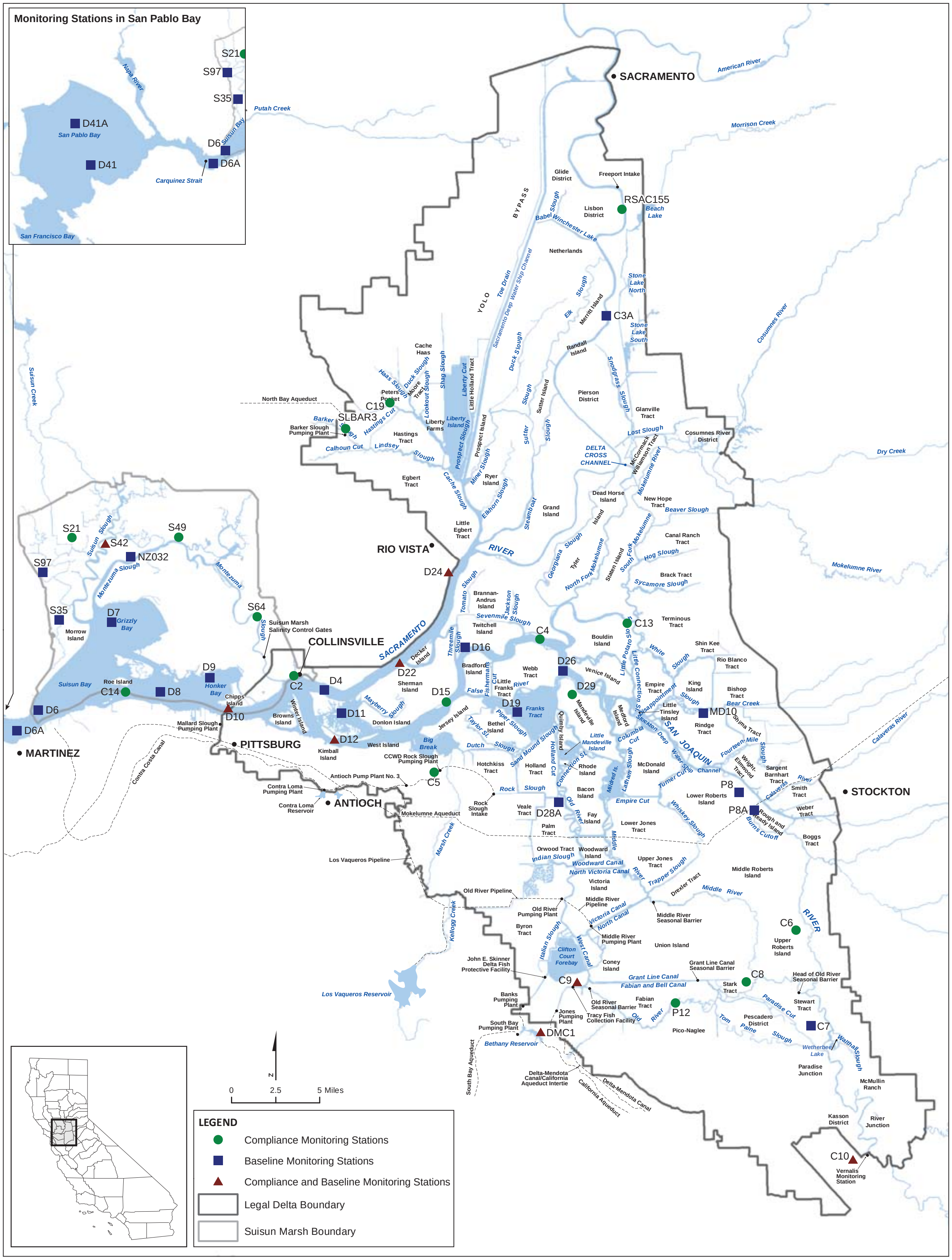


Figure 6.5 Water Quality Compliance Stations in the Delta

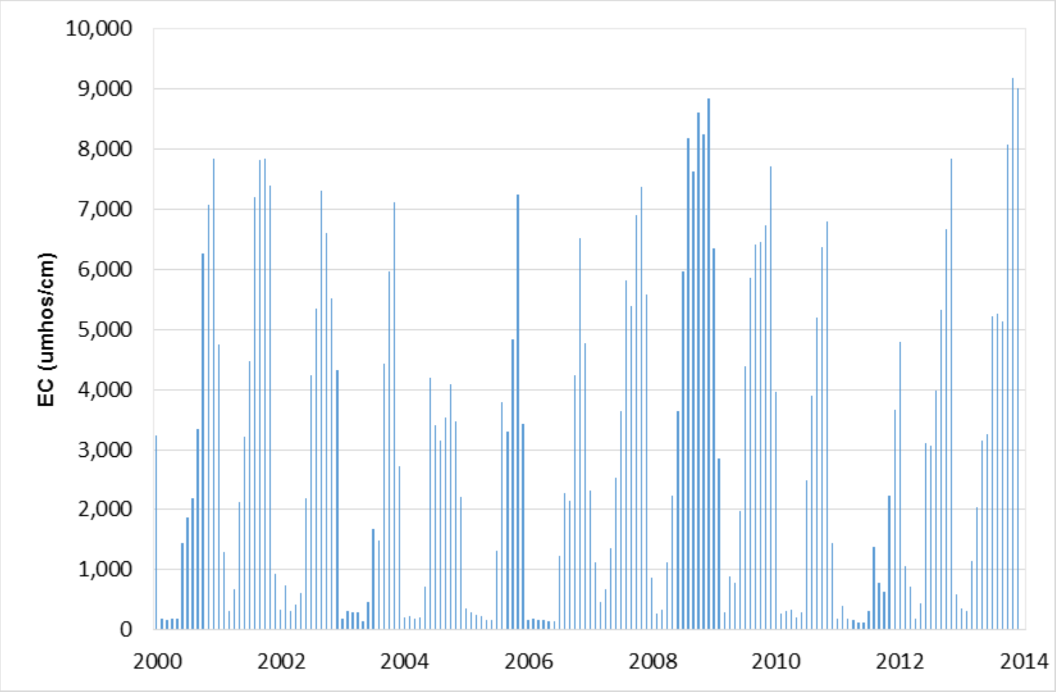


Figure 6.6 Monthly Average Specific Conductance in Sacramento River at Collinsville (Reclamation 2013e)

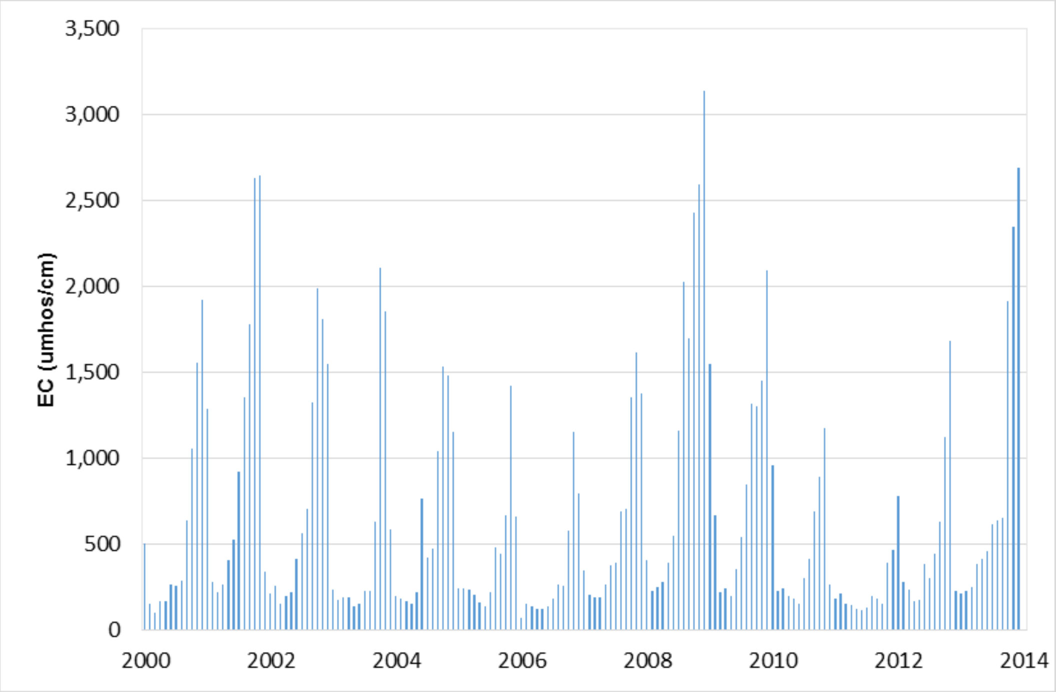


Figure 6.7 Monthly Average Specific Conductance in Sacramento River at Emmaton (Reclamation 2013e)

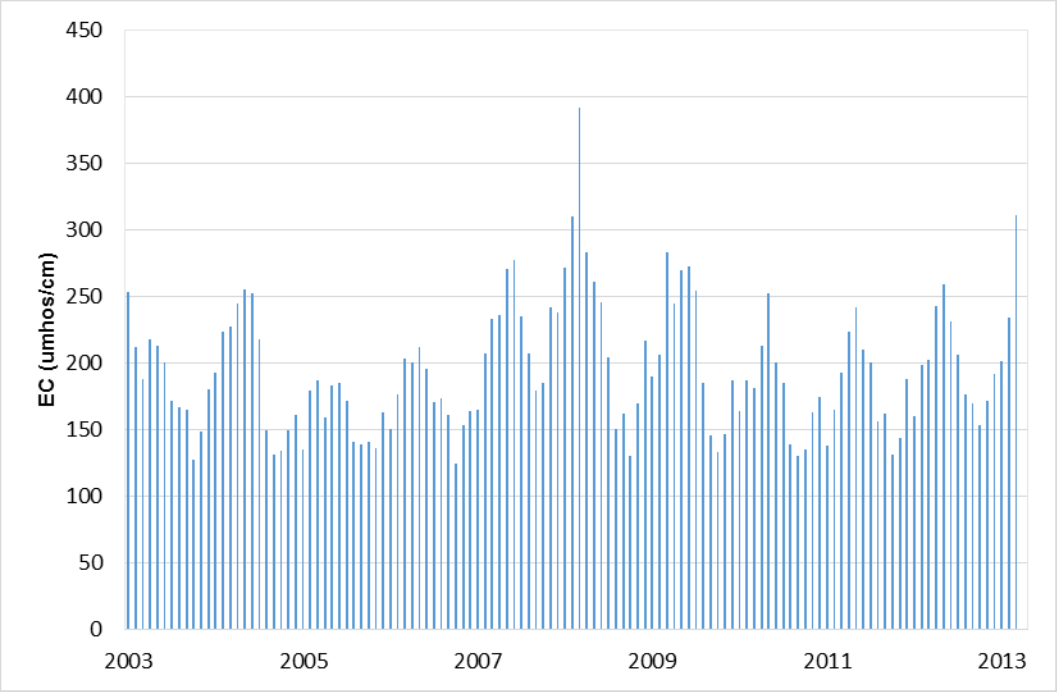


Figure 6.8 Monthly Average Specific Conductance in Sacramento River at Rio Vista (Reclamation 2013e)

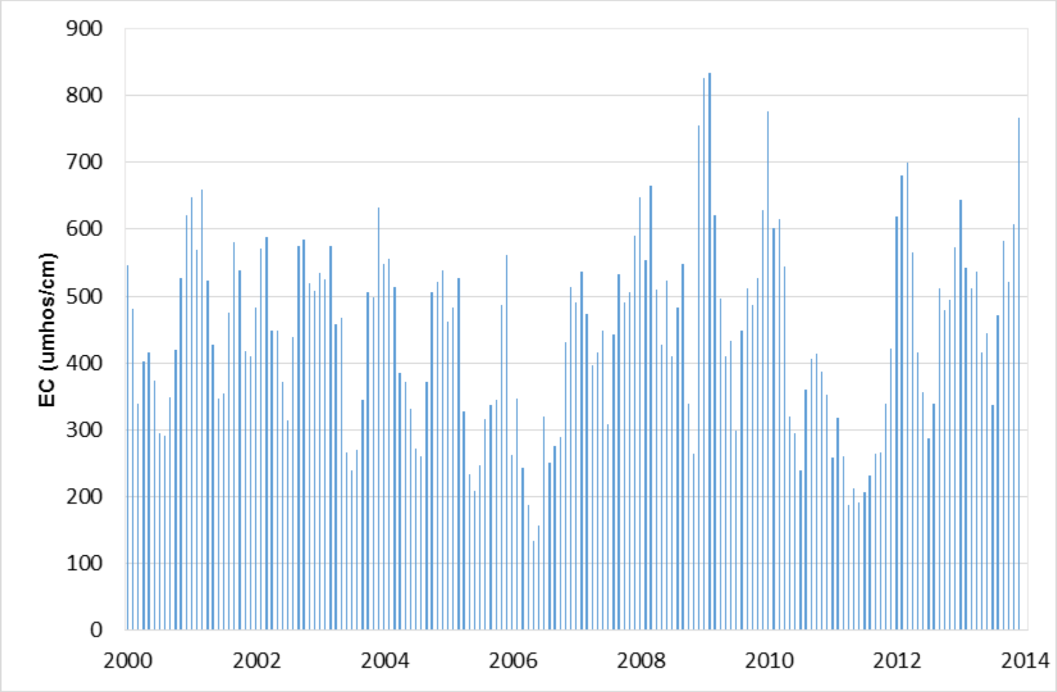


Figure 6.9 Monthly Average Specific Conductance at Delta Mendota Canal Intake (Reclamation 2013e)