Long-Term Operation – Draft Environmental Impact Statement

Appendix G – Water Quality Technical Appendix

July 2024

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Appendix G Water Quality Technical Appendix

G.1 Background Information

This appendix describes surface water quality that could be potentially affected by implementing the alternatives considered in this environmental impact statement. Changes in water quality due to changes in the Central Valley Project (CVP) and State Water Project (SWP) operation may occur in the Trinity River, Sacramento River, Clear Creek, American River, Stanislaus River, San Joaquin River, San Francisco Bay/Sacramento–San Joaquin Delta (Bay-Delta), and the CVP and SWP service area (south to Diamond Valley). Given the limited changes in outflow to the Pacific Ocean, water quality in the nearshore Pacific Ocean is unlikely to be affected by long-term operation of the CVP and SWP, and therefore, this technical appendix will not analyze the nearshore Pacific Ocean. Appendix H, *Water Supply Technical Appendix*, describes changes to surface water bodies and water supplies.

This appendix focuses on constituents of concern that could be affected by changes in CVP and SWP water operations. The *Final California 2020-2022 Integrated Report* (Clean Water Act [CWA] Section 303(d) List/305(b) Report) and other water quality reports identify constituents of concern. This appendix describes constituents' sources, water quality effects, objectives, and guidelines, and plans to improve water quality.

G.1.1 State-Designated Beneficial Uses of Surface Waters in the Study Area

The California Regional Water Quality Control Board (RWQCB) *Basin Plans and Integrated Reports* assessed and described water quality conditions throughout the study area. All waters of the State have specific beneficial uses specified in State or Tribal water quality standards. Each of the nine regional water quality control boards is charged with protecting these uses from pollution and nuisance. The use designations serve as a basis for establishing water quality objections and discharge prohibitions to protect the resource. Beneficial uses are summarized in Table G-1.

Table G-1. State-Designated Beneficial Uses within Project Study Area

Surface Water Body	State-Designated Beneficial Use [a]																								
	MUN	AGR	IND	PRO	GWR	FRSH	NAV	POW	REC-1	REC-2	COMM	WARM	COLD	WILD	RARE	MAR	MIGR	SPWN	SHELL	EST	AQUA	CUL	FFLD	WET	WQE
TRINITY AND LOWER KLAMATH RIVERS																									
Lower Klamath River and Klamath Glen HSA	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 HA	E	E	E	P	E	E	E	P	E	E	E	–	E	E	E	–	E	E	–	–	E&P	–	–	–	–
Lower Trinity River and Surrounding HA [b]	E	E	E	P	E	E	E	E&P	E	E	E	–	E	E	E	–	E	E	P	–	E&P	E [c]	–	–	–
SACRAMENTO RIVER BASIN																									
Shasta Reservoir	E	E	–	–	–	–	–	E	E	E	–	E [e]	E [e]	E	–	–	–	E [f, g]	–	–	–	–	–	–	–
Sacramento River: Shasta Dam to Colusa Basin Drain	E	E	E	–	–	–	E	E	E [d]	E	–	E [e]	E [e]	E	–	–	E [f, g]	E [f, g]	–	–	–	–	–	–	–
Colusa Basin Drain	–	E	–	–	–	–	–	–	E [d]	–	–	E [e]	P [e]	E	–	–	E [g]	E [g]	–	–	–	–	–	–	–
Sacramento River: Colusa Basin Drain to Eye (“I”) Street Bridge	E	E	–	–	–	–	E	–	E [d]	E	–	E [e]	E [e]	E	–	–	E [f, g]	E [f, g]	–	–	–	–	–	–	–
Whiskeytown Reservoir	E	E	–	–	–	–	–	E	E	E	–	E [e]	E [e]	E	–	–	–	E [g]	–	–	–	–	–	–	–
Clear Creek below Whiskeytown Reservoir	E	E	–	–	–	–	–		E [d]	E	–	E [e]	E [e]	E	–	–	E [f]	E [f, g]	–	–	–	–	–	–	–
Feather River below Lake Oroville (Fish Barrier Dam to Sacramento River)	E	E	–	–	–	–	–	–	E [d]	E	–	E [e]	E [e]	E	–	–	E [f, g]	E [f, g]	–	–	–	–	–	–	–

Surface Water Body	State-Designated Beneficial Use [a]																								
	MUN	AGR	IND	PRO	GWR	FRSH	NAV	POW	REC-1	REC-2	COMM	WARM	COLD	WILD	RARE	MAR	MIGR	SPWN	SHELL	EST	AQUA	CUL	FFLD	WET	WQE
American River below Lake Natoma (Folsom Dam to Sacramento River)	E	E	E	–	–	–	–	E	E [d]	E	–	E [e]	E [e]	E	–	–	E [f, g]	E [f, g]	–	–	–	–	–	–	–
Yolo Bypass [h]	–	E	–	–	–	–	–	–	E	E	–	E [e]	P [e]	E	–	–	E [f, g]	E [g]	–	–	–	–	–	–	–
BAY-DELTA																									
Sacramento–San Joaquin Delta [h i, j, k]	E	E	E	E	E	–	E	–	E	E	E	-	-	E	E	–	E [f, g]	E [g]	-	E	–	–	–	–	–
Suisun Bay	–	–	E	E	–	–	E	–	E	E	E	–	–	E	E	–	E	E	–	E	–	–	–	–	–
Carquinez Strait	–	–	E	–	–	–	E	–	E	E	E	–	–	E	E	–	E	E	–	E	-	–	–	–	–
San Pablo Bay	–	–	E	–	–	–	E	–	E	E	E	–	–	E	E	-	E	E	E	E	-	–	–	–	–
San Francisco Bay Central	–	–	E	E	–	–	E	–	E	E	E	–	–	E	E	–	E	E	E	E	–	–	–	–	–
San Francisco Bay Lower	–	–	E	–	–	–	E	–	E	E	E	–	–	E	E	–	E	E	E	E	–	–	–	–	–
San Francisco Bay South	–	–	E	–	–	–	E	–	E	E	E	–	–	E	E	–	E	E	E	E	–	–	–	–	–
SAN JOAQUIN RIVER AND TULARE BASIN																									
San Joaquin River: Friant Dam to Mendota Pool	E	E	–	E	–	–	–	–	E [c]	E	–	E [e]	E [e]	E	–	–	E [f, g]	E [g], P [f]	–	–	–	–	–	–	–
San Joaquin River: Sack Dam to the Mouth of Merced River	P	E	–	E	–	–	–	–	E [c]	E	–	E [e]	–	E	–	–	E [f, g]	E [g], P [f]	–	–	–	–	–	–	–
San Joaquin River: Mouth of Merced River to Vernalis	P	E	–	E	–	–	–	–	E [c]	E	–	E [e]	–	E	–	–	E [f, g]	E [g]	–	–	–	–	–	–	–
New Melones Reservoir	E	E	–	–	–	–	–	E	E	E	–	–	E [e]	E	–	–	–	–	–	–	–	–	–	–	–
Tulloch Reservoir	P	E	–	–	–	–	–	E	E	E	–	E [e]	–	E	–	–	–	–	–	–	–	–	–	–	–

Surface Water Body	State-Designated Beneficial Use [a]																								
	MUN	AGR	IND	PRO	GWR	FRSH	NAV	POW	REC-1	REC-2	COMM	WARM	COLD	WILD	RARE	MAR	MIGR	SPWN	SHELL	EST	AQUA	CUL	FFLD	WET	WQE
Stanislaus River: Goodwin Dam to San Joaquin River	P	E	E	E	–	–	–	E	E[d]	E	–	E[e]	E[f]	E	–	–	E[f]	E[f, g]	–	–	–	–	–	–	–
San Luis Reservoir	E	E	E	–	–	–	–	E	E	E	–	E[e]	–	E	–	–	–	–	–	–	–	–	–	–	–
O’Neill Reservoir	E	E	–	–	–	–	–	–	E	E	–	E[e]	–	–	–	–	–	–	–	–	–	–	–	–	–
California Aqueduct	E	E	E	E	–	–	–	E	E	E	–	–	–	E	–	–	–	–	–	–	–	–	–	–	–
Delta-Mendota Canal	E	E	–	–	–	–	–	–	E	E	–	E[e]	–	E	–	–	–	–	–	–	–	–	–	–	–

Sources: State Water Resources Control Board 2018b; Hoopa Valley Tribal Environmental Protection Agency 2008; Central Valley Regional Water Quality Control Board 2019a; North Coast Regional Water Quality Control Board 2018; San Francisco Bay Regional Water Quality Control Board 2023.

MUN = Municipal & Domestic Supply
AGR = Agricultural Supply
IND = Industrial Service Supply
PRO = Industrial Process Supply
GWR = Groundwater Recharge
FRSH = Freshwater Replenishment
NAV = Navigation
POW = Hydropower Generation
REC-1 = Water Contact Recreation
REC-2 = Non-Contract Water Recreation
COMM = Commercial & Sport Fishing
WARM = Warm Freshwater Habitat
COLD = Cold Freshwater Habitat
WILD = Wildlife Habitat
RARE = Rare, Threatened, or Endangered Species
MAR = Marine Habitat
MIGR = Migration of Aquatic Organisms
SPWN = Spawning, Reproduction, and/or Early Development
SHELL = Shellfish Harvesting
EST = Estuarine Habitat
AQUA = Aquaculture
CUL = Native American Culture
FLD = Flood Water Storage
WET = Wetland Habitat
WQE = Water Quality Enhancement
HSA = Hydrologic Subarea
HA = Hydrologic Area

[a] E = Existing Beneficial Use; P = Potential Beneficial Use

[b] Includes beneficial uses for the Trinity River within the Hoopa Valley Indian Reservation as designated by the *Hoopa Valley Indian Reservation Water Quality Control Plan*, which, in addition to beneficial uses shown, also designates the Lower Trinity River as a Wild and Scenic waterway, providing for scenic, fisheries, wildlife, and recreational purposes.

[c] Not all beneficial uses are present uniformly throughout this waterbody. They have been summarized to reflect beneficial uses present in multiple segments of the waterbody.

[d] Canoeing and rafting included in REC-1 designation.

[e] Resident does not include anadromous. Any Segments with both COLD and WARM beneficial use designations will be considered COLD water bodies for the application of water quality objectives.

[f] Cold water protection for salmon and Steelhead.

[g] Warm water protection for striped bass (*Morone saxatilis*), sturgeon (*Acipenser* spp.), and shad (*Alosa sapidissima* and *Dorosoma petenense*).

[h] Beneficial uses vary throughout the Delta and will be evaluated on a case-by-case basis. COMM is a designated beneficial use for the Sacramento–San Joaquin Delta and Yolo Bypass waterways listed in Appendix 43 of the *Water Quality Control Plan for the Sacramento River and San Joaquin River Basins* (Sacramento–San Joaquin River Basin Plan) and not any tributaries to the listed waterways or portions of the listed waterways outside of the legal Delta boundary unless specifically designated.
[i] Delta beneficial uses are shown as designated by the Sacramento–San Joaquin River Basin Plan, and the *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary*.
[j] Per State Water Board Resolution No. 90-28, Marsh Creek and Marsh Creek Reservoir in Contra Costa County are assigned the following beneficial uses: REC-1 and REC-2 (potential uses), WARM, WILD and RARE. COMM is a designated beneficial use for Marsh Creek and its tributaries listed in Appendix 43 of the Sacramento–San Joaquin River Basin Plan within the legal Delta boundary.
[k] Existing beneficial uses for the Sacramento–San Joaquin Delta identified in the *Water Quality Control Plan (Basin Plan) for the San Francisco Bay Basin* (State Water Quality Control Board 2019) do not include WARM and COLD; however, the *Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board Central Valley Region* (Central Valley Regional Water Quality Control Board 2019a) identifies WARM and COLD as existing beneficial uses for the Sacramento–San Joaquin Delta.

G.1.2 Constituents of Concern

The water quality objectives established to protect the beneficial uses presented in Table G-1 are found in water quality control plans, which define the limits of constituents of concern for protection of each beneficial use. Many of these water quality constituents of concern are prevalent throughout the study area. The origins and prevalence of these pollutants are discussed below.

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

G.1.2.1 Salinity

Salinity, a measure of dissolved salts in water, is a concern in the tidally influenced Delta, as it can affect domestic supply, agriculture, industry, and wildlife (CALFED Bay-Delta Program 2007a). Typical salts found in surface waters include the major cations (i.e., calcium, magnesium, sodium, and potassium) and anions (i.e., sulfate, chloride, fluoride, bromide, bicarbonate, and carbonate). The relative proportion of the anions and cations are different in typical freshwater and seawater, with sodium and chloride dominating seawater salinity. Salinity can be characterized in a variety of ways, including as total dissolved solids (TDS) concentrations, chloride concentrations, and electrical conductivity (EC).

The beneficial uses most affected by salinity levels are municipal, agricultural, and industrial water supply. Related beneficial uses such as commercial and sport fishing and shellfish harvesting can also be affected by salinity levels. Salinity's impacts on the Delta's domestic supply of water include aesthetic, or cosmetic effects, and increasing the need to reduce salinity for municipal and industrial uses by blending, which can lead to a reduction in the quantity of usable water. Salts in drinking water, such as bromide, can increase harmful byproducts formation. Salinity in the Delta affects agriculture by reducing crop yields and salinity in the soil can cause plant stress. Objectives for chloride are intended to protect municipal and industrial uses. Additionally, changes in salinity, including tidally influenced interfaces between fresh water and salt water in the Delta, directly affect aquatic organisms and indirectly affect aquatic and wildlife habitats (warm freshwater habitat, cold freshwater habitat, estuarine habitat).

Some fish and wildlife are also affected by salinity concentrations in the Delta as certain levels of salinity are required during different life stages to survive. One 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 the tidally averaged near-bottom salinity concentration of 2 parts of salt in 1,000 parts of water occurs. The California State Water Resources Control Board (Water Board) established the X2 standard to improve shallow water estuarine habitat in

February through June, and it relates to the extent of salinity movement into the Delta (California Department of Water Resources and Bureau of Reclamation 2016). The location of X2 is important to both aquatic life and water supply beneficial uses.

The primary source of salinity in the Delta is seawater intrusion from the west, which occurs at greater magnitudes when freshwater Delta outflow to San Francisco Bay is low and/or when tidal flows are high. Hydrology and upstream water management operations influence Delta inflows, which in turn influence the balance with the highly saline seawater intrusion. Delta salinity conditions also are affected by inflow quality as well as in-Delta sources such as agricultural returns, natural leaching, and municipal and industrial discharges.

The CVP and SWP are operated to achieve salinity objectives in the Delta, as described in detail in Appendix E, *Draft Alternatives*. As tributaries to the Delta, the Sacramento and San Joaquin Rivers have salinity standards established in the *Water Quality Control Plan for the Sacramento River and San Joaquin River Basins* (Sacramento–San Joaquin River Basin Plan; Central Valley Regional Water Quality Control Board 2019a). The Sacramento River is not listed as impaired by salinity, nor EC or TDS, as related constituents to salinity (State Water Resources Control Board 2022a). However, segments of the San Joaquin River are listed as impaired by salinity, EC, and/or TDS, as described further in Section G.1.8.1, *Constituents of Concern*.

The Water Board Water Right Decision 1641 includes "spring X2" criteria that require CVP and SWP operation to include upstream reservoir releases from February through June to maintain freshwater and estuarine conditions in the western Delta to protect aquatic life. In addition, the 2019 U.S. Fish and Wildlife Service (USFWS) Biological Opinion also includes a proposed additional Delta salinity requirement of a monthly average 2 parts per thousand (ppt) isohaline (X2) at 80 km from the Golden Gate for September and October in wet and above normal water years (U.S. Fish and Wildlife Service 2019).

G.1.2.2 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 from current processes as well as a result of historical deposition. Most of the mercury present in these locations is the result of historical mercury ore mining in the Coast Ranges (via Putah and Cache creeks to the Yolo Bypass) and elemental mercury's extensive use in 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 (Central Valley Regional Water Quality Control Board 2010a). Additional mercury sources include atmospheric deposition from local and distant sources, with minor contributions from discharges from wastewater treatment plants and urban runoff (State Water Resources Control Board 2022b).

Mercury methylation is an important step in the entrance of mercury into food chain (U.S. Environmental Protection Agency 2001a). This transformation can occur in sediment and the water column. Methylmercury is absorbed more quickly by aquatic organisms than inorganic mercury, and it biomagnifies (i.e., the concentration of methylmercury increases in predatory fish as they eat smaller contaminated fish and invertebrates). The measure of acidity (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 methylmercury's bioaccumulation in aquatic organisms. The proportion of an area that is wetlands, the soil type, and erosion can also contribute to the amount of mercury transported from soils to water bodies. These effects can be seen in the variability in bioaccumulated mercury in the Delta.

Contaminated fish consumption is the major pathway for human exposure to methylmercury (U.S. Environmental Protection Agency 2001a). Once consumed, methylmercury is almost completely absorbed into the blood and transported to all tissues. It is also transmitted to the fetus through the placenta. Neurotoxicity from methylmercury can result in mental retardation, cerebral palsy, deafness, blindness, and dysarthria in utero, and in sensory and motor impairments in adults. Studies have also reported cardiovascular and immunological effects from low-dose methylmercury exposure.

In an effort to protect aquatic and human health, the U.S. Environmental Protection Agency (EPA) recommended maximum concentrations "without yielding unacceptable effects" in 2001 for acute exposure, identified as the criteria maximum concentration, and for chronic exposure, identified as the criterion continuous concentration (U.S. Environmental Protection Agency 2001a, 2022a). In 2000, the EPA established current statewide water quality criteria for mercury in the California Toxics Rule (CTR) (U.S. Environmental Protection Agency 2000). Under these requirements, total recoverable mercury for the protection of human health was set as limits for the consumption of water and organisms, as well as the consumption of organisms only, as summarized in Table G-2. Some California RWQCB basin plans also include mercury objectives, as discussed in subsequent sections of this appendix. Where both a CTR criterion and a basin plan objective exist, the more-stringent value applies (State Water Resources Control Board 2006).

Table G-2. Water Quality Criteria for Mercury and Methylmercury (as Total Mercury)

Source	**For Protection of**	**Recommended Criteria**
National: U.S. Environmental Protection Agency	Freshwater Species	CMC = 1.4 µg/L CCC = 0.77 µg/L
	Saltwater Species	CMC = 1.8 µg/L CCC = 0.94 µg/L
	Human Health [a]	0.3 mg/kg [b]
State: California Toxics Rule	Human Health (Consumption of Water + Organism)	0.050 µg/L
	Human Health (Consumption of Organism Only)	0.051 µg/L

Sources: U.S. Environmental Protection Agency 2000, 2001b, 2022a.
µg/L = micrograms per liter; mg/kg = milligrams per kilogram.
CCC = criterion continuous concentration; CMC = criteria maximum concentration
[a] For the consumption of organisms only and based on a total consumption 0.0175 kg fish and shellfish per day
[b] Methylmercury in edible muscle tissue of fish (wet weight)

A review of the mercury human health criteria by the EPA 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 (U.S. Environmental Protection Agency 2001a). The CTR criterion may be implemented as a fish tissue-based objective, or it may be converted into an ambient methylmercury water quality objective, the latter reflecting the EPA's fish consumption rate of 0.0175 kilogram per fish per day, or site-specific consumption rates that more accurately reflect local consumption patterns (U.S. Environmental Protection Agency 2001a). A USFWS evaluation of the EPA methylmercury criterion concluded that the fish tissue-based objective of 0.3 milligram (mg) methylmercury/kg fish would be insufficient to protect three species that may occur in the study area: the California least tern (*Sterna antillarum browni)*, California clapper rail (*Rallus obsoletus*), and bald eagle (*Haliaeetus leucocephalus*) evaluated in the study.

G.1.2.3 Selenium

Selenium is an essential trace element for human and other animal nutrition that occurs naturally in the environment. It is also a constituent of concern in the study area because of its potential effects on water quality and aquatic and terrestrial resources when present in excess, primarily in the San Joaquin Valley and the San Francisco Bay, as well as some locations in Southern California (State Water Resources Control Board 2022a). Elevated selenium concentrations in soil and waterways within the San Joaquin Valley, and to some extent in the San Francisco Bay, are primarily from the 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). Natural processes transport the selenium-enriched soil derived from the eroded rock to the western San Joaquin Valley; irrigation processes mobilize selenium from the soil 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 near Carquinez Strait and San Pablo Bay (Presser and Luoma 2013; State Water Resources Control Board 2022c). The specific water bodies within these areas that may be affected by the project and are impaired by selenium, as specified on California's 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), San Francisco Bay, Delta, Carquinez Strait, San Pablo Bay, and Suisun Bay (State Water Resources Control Board 2022a).

Adverse effects associated with selenium may occur from either a selenium deficiency or excess in the diet (Agency for Toxic Substances and Disease Registry 2003; Ohlendorf 2003); the latter is the primary concern in the case of the impaired water bodies on the CWA Section 303(d) list. Due to the known effects of selenium bioaccumulation from water to aquatic organisms and higher trophic levels in the food chain, the fresh water, estuarine, and wildlife habitat; spawning, reproduction, and 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; Chapman et al. 2009). Consequently, regulatory agencies established exposure criteria to protect the beneficial uses of the water bodies.

The Agency for Toxic Substances and Disease Registry California Office of Environmental Health Hazard Assessment (OEHHA), EPA, Water Board, and California RWQCB determined acceptable selenium exposure levels for humans and water bodies in California. The Agency for Toxic Substances and Disease Registry stated the minimum risk levels for selenium to be ingested over a 1-year period is 0.005 milligrams per kilogram (mg/kg) per day, with an uncertainty factor of three (Agency for Toxic Substances and Disease Registry 2018). The 0.005 mg/kg per day value is also used by the OEHHA to develop guidelines for consuming fish (California Office of Environmental Health Hazard Assessment 2008). The EPA set 50 micrograms per liter (µg/L) as the maximum contaminant level (MCL) for selenium in drinking water and the OEHHA set a more-stringent draft public health goal of 30 µg/L for selenium in drinking water (U.S. Environmental Protection Agency 2009; California Office of Environmental Health Hazard Assessment 2010). The EPA also specified through the CTR that the water quality criteria for aquatic life in all of California's freshwater 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 (U.S. Environmental Protection Agency 2000). 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 (Central Valley Regional Water Quality Control Board 2019a). 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) (U.S. Environmental Protection Agency 2022a).

The EPA, U.S. Department of the Interior, Bureau of Reclamation (Reclamation), Water Board, and California RWQCB created plans to reduce the toxic levels of selenium in California's impaired water bodies. The EPA's Action Plan consists of recommendations to restore water quality and to protect aquatic species in the Bay-Delta, which include strengthening selenium water quality criteria to reduce the long-term exposure of sensitive aquatic and terrestrial species to selenium (U.S. Environmental Protection Agency 2012). 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 Grassland 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 more than 10,000 pounds (lb.) to 22 lb. in 2022 (Bureau of Reclamation 2023). Both the EPA Action Plan and the Grassland Bypass Project reduced selenium levels in waterways to meet water quality objectives. In December 2019, the Central Valley RWQCB released waste discharge requirements for surface water discharges from the Grassland Bypass Project (Central Valley Regional Water Quality Control Board 2019b).

A selenium TMDL was adopted in 2016 for the North San Francisco Bay, which includes a portion of the Delta, Suisun Bay, Carquinez Strait, San Pablo Bay, and the Central Bay. Existing selenium concentrations in the San Francisco Bay water column are below the TMDL target and have been declining since the late 1990s. Therefore, the TMDL does not require load reductions below current levels and the implementation plan's main goal is to prevent increases of selenium concentrations in the North Bay and attain safe levels of selenium in fish, specifically benthic feeders (e.g., Sacramento splittail [*Pogonichthys macrolepidotus*] and white sturgeon [*Acipenser* *transmontanus*]). The TMDL includes a load allocation for the Central Valley watershed (San Francisco Bay Regional Water Quality Control Board 2015). The TMDL does not include the South Bay because it is affected by local and watershed sources not associated with the Delta or refineries (Stewart et al. 2013).

The EPA released the final water quality criteria for the protection of freshwater aquatic life from toxic effects of selenium, shown in Table G-3 (U.S. Environmental Protection Agency 2021). As noted in EPA's *2021 Revision to Aquatic Life Ambient Water Quality Criterion for Freshwater Selenium*, factors that determine selenium bioaccumulation vary among aquatic systems, and site-specific water column criterion may be required at aquatic sites with high selenium bioaccumulation (U.S. Environmental Protection Agency 2021).

Table G-3. Recommended Water Quality Criteria for Selenium

Media Type	**Fish Tissue**		**Water Column** [c]	
Criterion Element	**Egg/Ovary** [a]	**Fish Whole-Body or Muscle** [b]	**Monthly Average Exposure**	**Intermittent Exposure** [d]
Magnitude	15.1 mg/kg	8.5 mg/kg whole-body or 11.3 mg/kg muscle (skinless, boneless fillet)	1.5 µg/L in lentic aquatic systems 3.1 µg/L in lotic aquatic systems	$WQC_{int} = \frac{WQC_{30-day} - C_{bkgrnd}(1 - f_{int})}{f_{int}}$
Duration	Instantaneous measurement [€]	Instantaneous measurement [€]	30 days	Number of days/months with an elevated concentration
Frequency	Not to be exceeded	Not to be exceeded	Not more than once in three years on average	Not more than once in three years on average

Source: U.S. Environmental Protection Agency 2021.
mg/kg = milligrams per kilogram dry weight; µg/L = micrograms per liter.
[a] Overrides any whole-body, muscle, or water column elements when fish egg/vary concentrations are measured.
[b] Overrides any water column element when both fish tissue and water concentrations are measured.
[c] Water column values are based on dissolved total selenium in water.
[d] 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).
[€] 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.

G.1.2.4 Cadmium, Copper, and Zinc

Cadmium, copper, and zinc are constituents of concern primarily in the Sacramento River Region (State Water Resources Control Board 2022a). This impairment results largely from discharges of acid mine drainage from inactive mines in the Upper Sacramento River watershed, specifically from the Iron Mountain Mines site upstream of Keswick Dam and other mines upstream of Shasta Dam (Central Valley Regional Water Quality Control Board 2002a). Because of their industrial and commercial utility, trace metals are also found in urban and agricultural stormwater runoff, landfill and mine leachate, and industrial and municipal wastewater discharges.

Many trace metals are necessary for healthy biological function, where deficiencies in certain trace metals can result in disease. At elevated levels in water, trace metals can be toxic to humans and aquatic life, where the concentration of concern is specific to each metal and each receptor (human or aquatic life). Thus, the beneficial uses of surface waters in the study area most affected by trace metals are aquatic life uses (cold freshwater habitat, warm freshwater habitat, and estuarine habitat), harvesting activities that depend on aquatic life (shellfish harvesting, commercial and sport fishing), and treatment of drinking water supplies (municipal and domestic supply).

To protect aquatic life, the Central Valley RWQCB developed a TMDL program for dissolved cadmium, cooper, and zinc loading into the Upper Sacramento River. Table G-4 lists numeric targets for dissolved cadmium, copper, and zinc.

Table G-4. Numeric Targets for Dissolved Cadmium, Copper, and Zinc

Metal [a]	Acute Numeric Target (µg/L)	Chronic Numeric Target (µg/L)
Cadmium	0.22 [b]	0.22 [b]
Copper	5.6 [b]	4.1 [c]
Zinc	16 [b]	16 [b]

Source: Central Valley Regional Water Quality Control Board 2002a.
µg/L = micrograms per liter.
[a] The proposed numeric targets are hardness dependent; the numbers in this table are based on a hardness of 40 milligrams per liter as calcium carbonate.
[b] The *Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board Central Valley Region* trace element water quality objectives (maximum concentrations) for Sacramento River and its tributaries above State Highway 32 Bridge at Hamilton City.
[c] CTR Criteria for Freshwater Aquatic Life Protection (4-day criterion continuous concentration, not to be exceeded more than once every three-year period) for priority toxic pollutants in the State of California for inland surface waters.

G.1.2.5 Nutrients

Nutrients are a constituent of concern in the Lower Klamath River hydrologic subarea and the Suisun Marsh Wetlands (State Water Resources Control Board 2022a). Nutrients, such as nitrogen and phosphorus, come from natural sources such as rock and soil weathering, nutrient mixing in ocean water currents, animal manure, atmospheric deposition, and nutrient recycling in sediment (National Oceanic and Atmospheric Administration 2018; U.S. Environmental Protection Agency 1998). Anthropogenic sources include fertilizers, detergents, sewage treatment plants, septic systems, combined sewer overflows, and sediment mobilization (U.S. Environmental Protection Agency 1998).

Nutrients are essential to maintaining a healthy aquatic ecosystem. However, nitrogen (N) and phosphorus (P) over-enrichment can contribute to a process known as eutrophication, an excessive growth of macrophytes, phytoplankton, and/or potentially toxic algal blooms. Eutrophication may also lead to a decrease of dissolved oxygen (DO), typically at night, when plants stop producing oxygen through photosynthesis but continue to use oxygen. Low DO levels can kill fish, cause an imbalance of prey and predator species, and result in aquatic resources decline (U.S. Environmental Protection Agency 1998). Severely low DO conditions are referred to as anoxic and may enhance methylmercury production (San Francisco Bay Regional Water Quality Control Board 2012). Over-enrichment can also contribute to cloudy or murky water clarity by increasing the amount of materials (e.g., algae) suspended in the water.

Nutrients can also impact ecosystem dynamics in complex ways that extend beyond eutrophication. Changes in the form of available nutrients (chemical state, oxidized versus reduced, organic versus inorganic, dissolved versus particulate) and the proportion of different nutrients produce effects at multiple scales. For example, the balance of nitrogen and phosphorus (N:P) can affect other metabolic aspects of phytoplankton besides growth, including toxin production, cell membrane thickness, and other chemical constituents (Mitra and Flynn 2005; Flynn et al. 1994; Johansson and Granéli 1999a, 1999b; Granéli and Flynn 2006; Oh et al. 2000; Ha et al. 2009; Harris et al. 2016). Furthermore, biomass of macrophytes can be affected by the N:P ratio (Chorus and Spijkerman 2021).

For decades, researchers have explored the relative use of – or relative preference for – different forms of nitrogen by phytoplankton. Ammonium (NH_4) is generally considered to be the form of nitrogen preferred by phytoplankton because it requires less energy to assimilate than nitrate (NO_3). Research indicates that the form of available nitrogen can affect phytoplankton species composition with some literature suggesting diatoms generally have a preference for nitrate, while dinoflagellates and cyanobacteria generally prefer more chemically reduced forms of nitrogen (ammonium, urea, organic nitrogen) (Berg et al. 2001; Glibert et al. 2004, 2006; Brown 2009). However, more recent research shows certain diatom and chlorophyte species grew significantly faster with ammonium compared with nitrate (Berg et al. 2017). This suggests differences in growth rates among species may have a greater role in phytoplankton species composition than variations in N sources (Berg et al. 2017).

At the ecosystem scale, the total load and balance of nutrient elements can have effects that propagate through the food web, with the potential of transforming ecosystems to new stable states (Sterner and Elser 2002; Peñuelas et al. 2012). Zooplankton feeding rates and egg production have been linked to variation in nutrient content of their food (Kiørboe 1989). Shifts in zooplankton communities from copepods to cladaceran and calanoid copepods to cyclopoid copepods have followed changes in nitrogen to phosphorous ratios (Glibert et al. 2011; Hessen 1997).

G.1.2.6 Dissolved Oxygen

DO is a constituent of concern throughout the study area, primarily in the Lower Klamath River, Delta, Suisun Marsh Wetlands (State Water Resources Control Board 2022a). 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 (U.S. Geological Survey 2018; National Oceanic and Atmospheric Administration 2021a). Levels of DO 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 (National Oceanic and Atmospheric Administration 2021b). Fungus and bacteria use oxygen when decomposing organic matter in water bodies. So, the more organic matter present in a waterbody, the more potential for DO levels to decline.

Adverse effects of low DO are a concern for water quality and aquatic organisms. Low DO impairs growth, immunity, reproduction, and causes asphyxiation and death (North Coast Regional Water Quality Control Board 2018).

To protect aquatic life, the EPA established water quality standards for DO summarized in Table G-5 (U.S. Environmental Protection Agency 1986a). The EPA also established site-specific water quality objectives to protect the beneficial uses of California's water bodies.

Table G-5. Water Quality Criteria for Ambient Dissolved Oxygen Concentration

	Coldwater Criteria (mg/L)		Warmwater Criteria (mg/L)	
	Early Life Stages [a]	Other Life Stages	Early Life Stages [a]	Other Life Stages
30-Day Mean	NA	6.5	NA	5.5
7-Day Mean	9.5 (6.5) [b]	NA	6.0	NA
7-Day Minimum	N/A	5.0	NA	4.0
1-Day Minimum [c, d]	8.0 (5.0) [b]	4.0	5.0	3.0

Source: U.S. Environmental Protection Agency 1986a.
NA = Not Applicable; mg/L = milligrams per liter.
[a] Includes all embryonic and larval stages and all juvenile forms to 30-days following hatching.
[b] These are water column concentrations recommended to achieve the required intergravel DO concentrations shown in parentheses. The 3 mg/L differential is discussed in the criteria document. For species that have early life stages exposed directly to the water column, the figures in parentheses apply.
[c] For highly manipulatable discharge, further restrictions apply.
[d] All minima should be considered as instantaneous concentrations to be always achieved.

G.1.2.7 Pesticides

A pesticide is any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest. Pesticides typically occur in the form of chemicals or biological agents (e.g., viruses or bacteria) and are often formulated for specific pests such as weeds (herbicides), insects (insecticides), and fungi (fungicides). Pesticides may be described in two general categories: current use pesticides and legacy pesticides.

Pesticides are constituents of concern throughout the study area and particularly in the Central Valley. Major legacy pesticides of concern include organophosphate (OP) pesticides, primarily diazinon and chlorpyrifos, and organochlorine (OC) pesticides, mainly dichloro-diphenyl-trichloroethane (DDT) and Group A Pesticides. Current use pesticides include carbamates (e.g., carbofuran), OPs (e.g., diazinon, methyl parathion, malathion), thiocarbamates (e.g., thiobencarb), neonicotinoids (e.g., imidacloprid), and pyrethroids (e.g., permethrin, cypermethrin), a class of synthetic insecticides applied in urban and agricultural areas. The EPA has phased out certain OPs, or their uses, because of their potential toxicity in humans, which has led to their gradual replacement by pyrethroids. The toxicity and fates of these pesticides are described in the following sections. Project-related changes in flow can potentially affect the concentration of pesticides within the area of analysis.

Organophosphate Pesticides

The two most prevalent OP pesticides in the study area are synthetic pesticides, diazinon and chlorpyrifos, which were used extensively in agricultural and residential applications. Former and current uses of diazinon and chlorpyrifos resulted in waterbody contamination throughout the Central Valley, as identified in the CWA Section 303(d) list (State Water Resources Control Board 2022a). The Central Valley RWQCB also identified hot spots of contamination, particularly in the Delta and urban areas of Stockton and Sacramento (Central Valley Regional Water Quality Control Board 2003).

Pesticides are primarily transported into streams and rivers in runoff from agriculture (Central Valley Regional Water Quality Control Board 2011), but they also occur or have occurred in urban nonpoint runoff and stormwater discharges. Treated municipal wastewater can also be a point source. Chlorpyrifos and diazinon, OP pesticides, have been banned from non-agricultural uses since December 2001 and December 2004, respectively. Reported non-agricultural pesticide use of diazinon and chlorpyrifos declined substantially in some counties between 2000 and 2009 (Central Valley Regional Water Quality Control Board 2014). In August 2021, the EPA issued a ban on the use of chlorpyrifos for agricultural uses due to the potential neurodevelopment effects (U.S. Environmental Protection Agency 2022b). 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 United States 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 (U.S. Environmental Protection Agency 2004). Diazinon usage was then prohibited for several agricultural functions in 2007, with only a few remaining agricultural uses permitted, including on some fruit, vegetable, nut and field crops, and as an ear-tag on non-lactating cattle (U.S. Environmental

Protection Agency 2007). The highest continued use of diazinon is on almonds and stone fruits (U.S. Environmental Protection Agency 2004).

The Central Valley RWQCB has also adopted TMDLs for diazinon and chlorpyrifos for CWA Section 303(d)-listed segments of the Sacramento River and San Joaquin River.

Organochlorine Pesticides

OC pesticides are primarily comprised of DDT and Group A Pesticides (Central Valley Regional Water Quality Control Board 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'-dichloro-diphenyl-dichloroethylene (DDE) and o,p'- and p,p'- dichloro-diphenyl-dichloroethane (DDD). Group A Pesticides are the total concentration of the OC pesticides: aldrin, dieldrin, endrin, heptachlor, heptachlor epoxide, chlordane (total), hexachlorocyclohexane (total), and include lindane (gamma-BHC), alpha-BHC, endosulfan (total), and toxaphene. These pesticides have similar chemical properties to DDT and are also persistent in the environment.

The transport of OC pesticides into streams and rivers is primarily from agriculture runoff (Central Valley Regional Water Quality Control Board 2011). Other potential point sources of OC pesticides include storm sewer discharges and historic spills. Nonpoint 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, the erosion and transport of contaminated sediments continue to contribute to detectable levels in stream bed sediment (Central Valley Regional Water Quality Control Board 2010b).

Historically, OC pesticides were used as insecticides, fungicides, and antimicrobial chemicals in residential and agricultural pest control (Central Valley Regional Water Quality Control Board 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, OC pesticides continue to be detected in fish tissue, the water column, and sediment in the Central Valley.

Pyrethroid Pesticides

Pyrethroids (e.g., bifenthrin, permethrin, cypermethrin) are synthetic insecticides used in agriculture and households. The Surface Water Ambient Monitoring Program (SWAMP) studies indicate that the replacement of OP pesticides by pyrethroids resulted in an increased contribution of pyrethroids to ambient water and sediment toxicity (Anderson et al. 2011). In the water column, the water flea *Ceriodaphnia dubia* (*C. dubia*) is sensitive to OP and pyrethroid pesticides while *Hyalella azteca* (*H. azteca*), is highly sensitive to pyrethroids (Weston and Lydy 2010). Pyrethroids are also the major chemical class of concern in urban stormwater, of which bifenthrin is a major concern (Markiewicz et al. 2012).

Fong et al. (2016) suggest that pyrethroid use may have played a role in the pelagic organism decline and urge additional research be conducted. In June 2017, the Central Valley RWQCB adopted the *Proposed Amendments to the Water Quality Control Plan for the Sacramento and San Joaquin River Basins for the Control of Pyrethroid Pesticide Discharges*, establishing measurable pyrethroid concentration goals and a program of implementation to control pyrethroid pesticides (State Water Resources Control Board 2017). On the sediment side, as indicated by *H. azteca*, most of toxicity is attributed to pyrethroids, particularly in urban areas (Markiewicz et al. 2012).

Pyrethroid pesticides are highly hydrophobic and adsorb to surfaces of particulates and settle from the water column onto sediments or are transported while attached to particles. Pyrethroids are, therefore, found in sediments of smaller tributaries to a greater degree than they are found in surface waters of major rivers (Central Valley Regional Water Quality Control Board 2017). Only a small fraction of total pyrethroids is freely dissolved in water where they can cause toxicity to aquatic organisms. Pyrethroids also have a similar mode of toxic action. Consequently, their combined concentrations can cause adverse effects on aquatic life even if each individual pyrethroid concentration is less than levels associated with its individual effects on aquatic life (Central Valley Regional Water Quality Control Board 2017).

A Central Valley Regional Water Quality Control Board (2017) Pyrethroid TMDL and Sacramento–San Joaquin River Basin Plan Amendment is applicable to surface waters in the Central Valley. This TMDL applies to waterbodies that are CWA Section 303(d)-listed as impaired by pyrethroids, and the proposed amendment for the control of pyrethroids in the entirety of the Sacramento River and San Joaquin River basins. It considers a freely dissolved fraction of pyrethroids to account for reduced bioavailability of pyrethroids bound to suspended solids and dissolved organic matter when determining compliance with concentration goals. Additive toxicity is also taken into account by the Central Valley RWQCB's chronic and acute concentration goals where the sum of pyrethroid concentration-to-concentration goal ratios from six pyrethroids (bifenthrin, cyfluthrin, cypermethrin, esfenvalerate, lambda-cyhalothrin, and permethrin) is termed a concentration goal unit (CGU). A chronic or acute CGU of greater than 1 exceeds the chronic or acute pyrethroid trigger, respectively (Central Valley Regional Water Quality Control Board 2017).

Other Pesticides

Recent monitoring programs are routinely detecting multiple pesticides in each water sample from the Bay-Delta. Fong et al. (2016) reported that, "27 pesticides or degradation products were detected in Sacramento River samples, and the average number of pesticides per sample was six. In San Joaquin River samples, 26 pesticides or degradation products were detected, and the average number detected per sample was 9." The effects of chemical mixtures on aquatic organisms are generally unknown but many chemicals may have additive or synergistic effects. Diuron (3-(3,4-dichlorophenyl)-1,1-dimethylurea) was introduced in 1954 and is currently one of the most-used herbicides in California (Central Valley Regional Water Quality Control Board 2012). Analysts identified non-polar organic compounds, especially herbicides, and the herbicide diuron as causes of algal toxicity in the Central Valley. It is an herbicide that inhibits photosynthesis and is used to control annual broadleaf and grassy weeds. In March 2021, the EPA released a revised draft human health risk assessment for diuron, identifying ecological, dietary, and aggregate cancer risks associated with the use of diuron on crops, non-agricultural sites, and residential exterior paint uses. In response to the revised draft human health risk assessment, the EPA released for public comment a proposed interim decision for diuron, proposing to terminate all agricultural and non-agricultural herbicide use in April 2022 (U.S. Environmental Protection Agency 2022c).

G.1.2.8 Polychlorinated Biphenyls

Polychlorinated biphenyls (PCBs), a group of synthetic organic chemicals, is a constituent of concern throughout California including the Sacramento River Region (Sacramento, Feather, and American Rivers), the Delta, Suisun Bay, Carquinez Strait, and San Pablo Bay (State Water Resources Control Board 2022a). PCBs cause harmful environmental effects and pose a risk to human health (Agency for Toxic Substances and Disease Registry 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 and manufactured from 1930 to 1977 primarily to be used 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 (Agency for Toxic Substances and Disease Registry 2000; California Office of Environmental Health Hazard Assessment 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, which increase with the degree of chlorination of new mixtures (California Office of Environmental Health Hazard Assessment 2008). The PCBs 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 the 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 (Agency for Toxic Substances and Disease Registry 2000).

PCBs cannot be distinctly assessed for health effects, as their toxicity is determined by the interactions of individual congeners and the interactions of PCBs with other structurally related chemicals, including those combined with or used in the production of PCBs. However, studies have identified several general health effects of PCB exposure. 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 link oral exposure to cancer and adverse neurological, reproductive, and developmental effects. The International Agency for Research on Cancer listed PCBs as probable human carcinogens, and the OEHHA administratively listed PCBs on the Proposition 65 list of chemicals known to the State of California to cause cancer (California Office of Environmental Health Hazard Assessment 2008).

G.1.3 Trinity and Klamath Rivers

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 operation.

Several water quality requirements affect the Klamath River and Trinity River basins. Beneficial uses and water quality objectives provided by the North Coast RWQCB and the Hoopa Valley Tribal Environmental Protection Agency are described below, as well as relevant TMDLs. The Yurok Tribe's *Water Quality Control Plan for the Yurok 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 EPA, 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 section only discusses the requirements within the Trinity and Lower Klamath River Basins.

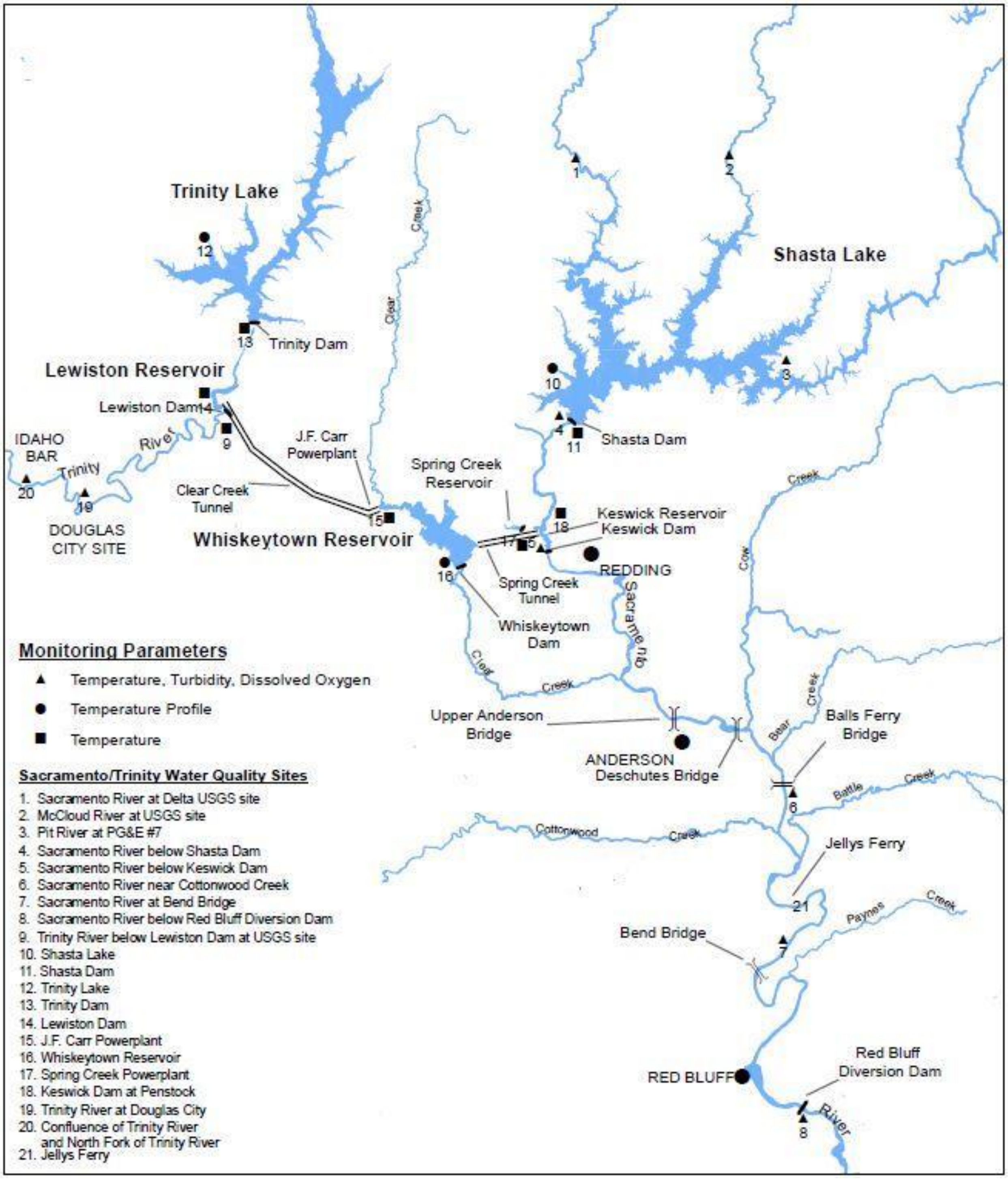
G.1.3.1 Constituents of Concern

The constituents of concern within the Trinity and Lower Klamath rivers that are not currently in compliance with existing water quality standards, for which TMDLs are adopted or are in development, are summarized in Table G-6 and further discussed below. Figure G-1 presents compliance locations for water quality monitoring along the Trinity River.

Table G-6. Constituents of Concern per the Clean Water Act Section 303(d) List in the Trinity and Lower Klamath Rivers

Waterbody	Constituent of Concern	TMDL Status [a]
Trinity Lake (was Claire Engle Lake)	Mercury	Expected: 2019 [a]
Trinity River HU (Lower Trinity HA; Middle HA; South Fork HA; Upper HA; East Fork)	Sedimentation/Siltation,	Approved: 2001
	Temperature [b], Mercury	Expected: 2019 [a]
	Boron	Expected: 2032
	Aluminum	Expected: 2031
Klamath River HU, Lower HA, Klamath Glen HSA	Nutrients, Organic, Enrichment/Low DO, Temperature [b]	Approved: 2010
	Sedimentation/Siltation	Expected: 2025
	Aluminum	Expected: 2031

Source: State Water Resources Control Board 2022a.
DO = dissolved oxygen; HA = hydrologic area; HSA = hydrologic subarea; HU = hydrologic unit; TMDL = total maximum daily load.
[a] The EPA has not approved the TMDL as of July 2023; the expected approval date has passed.
[b] Discussed in Appendix O, *Fish and Aquatic Resources Technical Appendix*.



Source: Bureau of Reclamation 2015.

Figure G-1. Water Quality Compliance Stations along Trinity River and Upper Sacramento River

Mercury

Trinity Lake and the upper hydrologic area of the East Fork Trinity River are two water bodies in the North Coast that are CWA Section 303(d)-listed as impaired by mercury (State Water Resources Control Board 2022a). Mercury in Trinity Lake is attributed to unknown sources (State Water Resources Control Board 2022d). Substantial 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 the EPA's recommended fish tissue residue criteria for human health of 0.3 mg of methylmercury (wet weight) per kg of fish tissue (State Water Resources Control Board 2022d, 2022e, 2022f, 2022g, 2022h, 2022i). This criterion is based on the consumption-weighted rate of 0.0175 kg of total fish and shellfish per day. In samples from fish in Trinity Lake in September 2001 and 2002, 14 out of 57 fish tissue samples exceeded this fish tissue criterion. White catfish (*Ameirus catus*), smallmouth bass (*Micropterus dolomieu*), and Chinook salmon (*Oncorhynchus tshawytscha*) composite fish tissue samples exceeded the criterion.

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

A TMDL was expected to be complete by 2019 to meet the water quality standards in Trinity Lake and the East Fork of Trinity River; however, as of March 2023, the EPA has not completed a TMDL for mercury in Trinity Lake and the East Form of Trinity River. The 2011 North Coast Basin Plan (North Coast Regional Water Quality Control Board 2011) established an approach for calculating effluent limitations.

Metals

The Lower Trinity and Klamath rivers are on the Water Board's CWA Section 303(d) list as impaired by aluminum and the south fork Trinity River is listed as impaired by boron (State Water Resources Control Board 2022a). Metals in the Trinity and Klamath rivers are from an unknown source (State Water Resources Control Board 2022e, 2022g, 2022j).

For protection of waters designated for use as domestic or municipal supply, the North Coast Basin Plan outlines that waters shall not contain concentrations of chemical constituents in excess of the limits specified in the California Code of Regulations, Title 22, Chapter 15, in which the secondary MCL for Aluminum is 0.2 milligrams per liter (mg/L) (North Coast Regional Water Quality Control Board 2018). The North Coast Basin Plan also sets the inland surface water quality objectives for boron as 0.2 mg/L (90% upper limit) and 0.0 mg/L (50% upper limit) (North Coast Regional Water Quality Control Board 2018).

The TMDLs for aluminum and boron are expected to be completed by 2031 and 2032, respectively (State Water Resources Control Board 2022e, 2022g, 2022j).

Nutrients

The Lower Klamath River is on the Water Board's CWA Section 303(d) list as impaired by nutrients (State Water Resources Control Board 2022a). 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 (U.S. Department of the Interior and California Department of Fish and Game 2012).

The Klamath River receives the greatest nutrient loading from the Upper Klamath basin, comprising approximately 40% of its total contaminant load (North Coast Regional Water Quality Control Board 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 Tribal Environmental Protection Agency also designates water quality objectives to address contamination by nutrients, presented in Table G-7.

Table G-7. 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 [a]	–	0.2 mg/L
Total Phosphorus [a]	–	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 [b]	–	< 100,000 cells/mL for recreational water
Cyanobacterial scums	–	There shall be no presence of cyanobacterial scums

Source: Hoopa Valley Tribal Environmental Protection Agency 2020.
µg/L = micrograms per liter; mg chlorophyll a/m^2 = milligrams of chlorophyll a per meter squared;
mg/L = milligrams per liter; pH = measure of acidity; MUN = municipal and domestic supply.
[a] 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.
[b] Includes: Anabaena, Microcystis, Planktothrix, Nostoc, Coelsphaerium, Anabaenopsis, Aphanizomenon, Gloeotrichia, and Oscillatoria.

In addition to the water quality criteria established by the Hoopa Valley Tribal Environmental Protection Agency (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 (U.S. Department of the Interior and California Department of Fish and Game 2012). Nutrient targets include numeric targets for total phosphorus, and total nitrogen (North Coast Regional Water Quality Control Board 2018).

The North Coast RWQCB and other affiliated agencies, including the Water Board, EPA, Reclamation, 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 are implementing the Klamath River nutrient TMDLs (North Coast Regional Water Quality Control Board 2018).

Organic Matter

The Lower Klamath River is on the Water Board's CWA Section 303(d) list as impaired by organic matter (State Water Resources Control Board 2022a).

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 (North Coast Regional Water Quality Control Board 2010). Other sources of organic matter include runoff from agricultural lands (e.g., irrigation tailwater, storm runoff, subsurface drainage, and animal waste), flow regulations/modification, industrial point sources, and municipal point sources (State Water Resources Control Board 2022j).

The North Coast RWQCB established a TMDL for organic matter and other constituents to protect the beneficial uses of the Lower Klamath River, including cold freshwater habitat, in 2010. The TMDL equals 143,019 lb. of carbonaceous biochemical oxygen demand (CBOD) per day from the Klamath River (North Coast Regional Water Quality Control Board 2018). The average organic matter (measured as CBOD) loads from all other Klamath River tributaries are sufficient to meet other related objectives, including DO and biostimulatory substances objectives, in the Klamath River (North Coast Regional Water Quality Control Board 2010). The DO objectives are the primary targets associated with organic matter and nutrients. The North Coast RWQCB also established organic matter allocations for the Klamath River below Salmon River, and the major tributaries to the Klamath, including 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 (North Coast Regional Water Quality Control Board 2018).

Dissolved Oxygen

The Lower Klamath River is on the Water Board's CWA Section 303(d) list as impaired by DO (State Water Resources Control Board 2022a).

Sources that contribute to low DO include sources of organic enrichment, water temperature, and salinity. Other sources that contribute to low DO are runoff from roads and agriculture that can transport nutrients into water bodies and lower DO through biostimulatory effects (North Coast Regional Water Quality Control Board 2010). The over-enrichment and growth of algae and aquatic plants can produce oxygen during the day through photosynthesis, but those same plants can deplete DO 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 (North Coast Regional Water Quality Control Board 2018) and the Hoopa Valley Tribal Environmental Protection Agency (2008) for DO in the Klamath River and its major tributary, the Trinity River (Table G-8 and Table G-9) (North Coast Regional Water Quality Control Board 2011). Site-specific objectives (SSOs) for DO were calculated as part of TMDLs developed by the North Coast RWQCB (2011) and have been incorporated into the North Coast Basin Plan (2018) (Table G-10). For those waters without location-specific DO criteria, DO should not be reduced below minimum levels, shown in Table G-11, at any time to protect beneficial uses.

Table G-8. Water Quality Objectives for Dissolved Oxygen in Trinity and Lower Klamath

	Dissolved Oxygen (ug/L) [a]	
Waterbody	**Minimum**	**50% Lower Limit** [b]
Trinity Lake and Lewiston Reservoir	7,000	10,000
Lower Trinity River	8,000	10,000
Lower Trinity Area Streams	9,000	10,000
Lower Klamath River Area Streams	8,000	10,000

Source: North Coast Regional Water Quality Control Board 2011.
ug/L = micrograms per liter.
[a] Values converted from milligrams per liter (mg/L) to ug/L.
[b] 50% lower limit represents the 50 percentile values of the monthly means for a calendar year. 50% or more of the monthly means must be greater than or equal to the lower limit.

Table G-9. Specific Use Water Quality Criteria for Waters of the Hoopa Valley Indian Reservation

Contaminant	Trinity River	Klamath River
Minimum Water Column DO Concentration	11.0 mg/L	SPWN-designated waters [a]: 11.0 mg/L [b] COLD-designated waters: 8.0 mg/L [b]
Minimum Intergravel DO Concentration	8.0 mg/L	SPWN-designated waters [a]: 8.0 mg/L [b]

Source: Hoopa Valley Tribal Environmental Protection Agency 2020.
mg/L = milligrams per liter; DO = dissolved oxygen; COLD = cold fresh water habitat;
SPWN = spawning, reproduction, and/or early development.
a Whenever spawning occurs, has occurred in the past, or has potential to occur.
b 7-day moving average of the daily minimum DO. If DO standards are not achievable due to natural conditions, the COLD and SPWN standard shall instead be DO concentrations equivalent to 90% saturation under natural receiving water temperatures.

Table G-10. Site-Specific Objectives for Dissolved Oxygen in the Klamath River [a]

Location [b]	Percent DO Saturation Based on Natural Receiving Water Temperatures [c]	Time Period
Downstream of Hoopa-California Boundary to Turwar	85	June 1–August 31
	90	September 1–May 31
Upper and Middle Estuary	80	August 1–August 31
	85	September 1–October 31 and June 1–July 31
	90	November 1–May 31
Lower Estuary	For the protection of EST, the DO 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: North Coast Regional Water Quality Control Board 2018.
DO = dissolved oxygen; EST = estuarine habitat.
[a] States may establish site-specific objectives (SSOs) equal to natural background (U.S. Environmental Protection Agency 1986a; Davies 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 DO objectives are derived from the natural conditions baseline scenario (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 2009). They represent natural DO background conditions due only to non-anthropogenic sources and a natural flow regime.
[b] These objectives apply to the maximum extent allowed by law. To the extent that the State lacks jurisdiction, the DO SSO for the Mainstem Klamath River are extended as a recommendation to the applicable regulatory authority.
[c] Corresponding DO 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 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 the Executive Officer before being used for this purpose.

Table G-11. Water Quality Objectives for Dissolved Oxygen for Specified Beneficial Uses

Beneficial Use Designation	Minimum DO 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 (SPWN-designated waters [a])	11.0 [b]
Klamath River Water Column (COLD-designated waters)	8.0 [b]
Klamath River Inter Gravel (SPWN-designated waters [a])	8.0 [b]

Sources: North Coast Regional Water Quality Control Board 2018; Hoopa Valley Tribal Environmental Protection Agency 2008.
mg/L = milligrams per liter; DO = dissolved oxygen; COLD = cold freshwater habitat; MAR = marine habitat;
SAL = inland saline water habitat; SPWN = spawning, reproduction, and/or early development;
WARM = warm freshwater habitat.
[a] Whenever spawning occurs, has occurred in the past or has potential to occur.
[b] 7-day moving average of the daily minimum DO. If DO standards are not achievable due to natural conditions, the COLD and SPWN standard shall instead be DO concentrations equivalent to 90% saturation under natural receiving water temperatures.

The 2010 *Klamath River TMDLs Addressing Temperature, Dissolved Oxygen, Nutrient, and Microcystin Impairments in California* provides numerical targets for DO and other constituents (North Coast Regional Water Quality Control Board 2010). This TMDL proposed SSOs for DO, which were adopted into the North Coast Basin Plan. The DO objectives are the primary targets associated with nutrient and organic matter, with additional DO-related TMDLs prescribed for total phosphorus, total nitrogen, and organic matter (CBOD) loading. The TMDL also provides numerical targets for benthic algae biomass, suspended algae chlorophyll a, *microcystis aeruginosa*, and microcystin toxin.

Chapter 7 of the Klamath River TMDLs established plans to monitor DO and other constituents in the Klamath River below Trinity River, near Turwar, and the Klamath River Estuary to further protect the beneficial uses of the Trinity and Lower Klamath rivers (North Coast Regional Water Quality Control Board 2010). The TMDL also includes a proposal to revise SSOs for DO in the Klamath River.

Sedimentation and Siltation

The Lower Klamath River and Trinity River are on the Water Board's CWA Section 303(d) list as impaired by sedimentation and siltation (State Water Resources Control Board 2022a). The source of sedimentation and siltation in the Trinity and Klamath rivers is not attributed to CVP operation.

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 resulted in an increased severity and frequency of habitat disturbance (Trinity River Restoration Program and North Coast Regional Water Quality Control Board 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 (North Coast Regional Water Quality Control Board 2008). Future point sources of sedimentation into the Trinity River Basin, including Caltrans facilities and construction sites larger than five acres, must meet discharge requirements pursuant to California's NPDES general permit for construction site runoff (U.S. Environmental Protection Agency 2001c).

The primary adverse impacts of excess sedimentation are those affecting the spawning habitat for anadromous salmonids (Trinity River Restoration Program and North Coast Regional Water Quality Control Board 2009). The main affected beneficial uses include commercial or sport fishing; cold freshwater habitat; the migration of aquatic organisms; spawning, reproduction, and 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 (U.S. Environmental Protection Agency 2001c). The North Coast Basin Plan established water quality objectives for sedimentation and siltation.

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. It also prohibits the placing or disposal of such materials in locations where they can pass into any stream or watercourse in quantities harmful to beneficial uses (North Coast Regional Water Quality Control Board 2018).

The Trinity River TMDL, approved by the EPA in December 2001, addresses sediment loading in the mainstem Trinity River, which exceeds applicable water quality standards (State Water Resources Control Board 2022d, 2022e, 2022f, 2022g, 2022h, 2022i; U.S. Environmental Protection Agency 2001c). The TMDL determined assimilation capacity for sediment loading and provides the percent reduction of managed sediment discharge required for each subarea. These allocations are adequate to protect aquatic habitat and are expected to be evaluated on a ten-year rolling average (U.S. Environmental Protection Agency 2001c).

Lower Klamath River

The Water Board's CWA Section 303(d) list also includes the Klamath River downstream of Weitchpec for contamination from sedimentation and siltation, due to exceedances of the sediment water quality criteria, and long-term sedimentation and siltation influxes (State Water Resources Control Board 2022j).

Major sources of sediment discharge in the Lower Klamath River are ongoing logging and runoff from major storm events. According to reports cited by the Water Board, water quality in runoff from timber harvest in all Lower Klamath watersheds exceed cumulative effect thresholds (State Water Resources Control Board 2022j).

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 (State Water Resources Control Board 2022j). Largely due to timber harvest in all Lower Klamath watersheds, aggradations in salmon spawning reaches are expected to persist for decades (Higgins 2004). 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 (North Coast Regional Water Quality Control Board 2010). The North Coast Basin Plan includes the TMDLs for the region that address sedimentation and siltation (North Coast Regional Water Quality Control Board 2018).

G.1.4 Sacramento River

G.1.4.1 Constituents of Concern

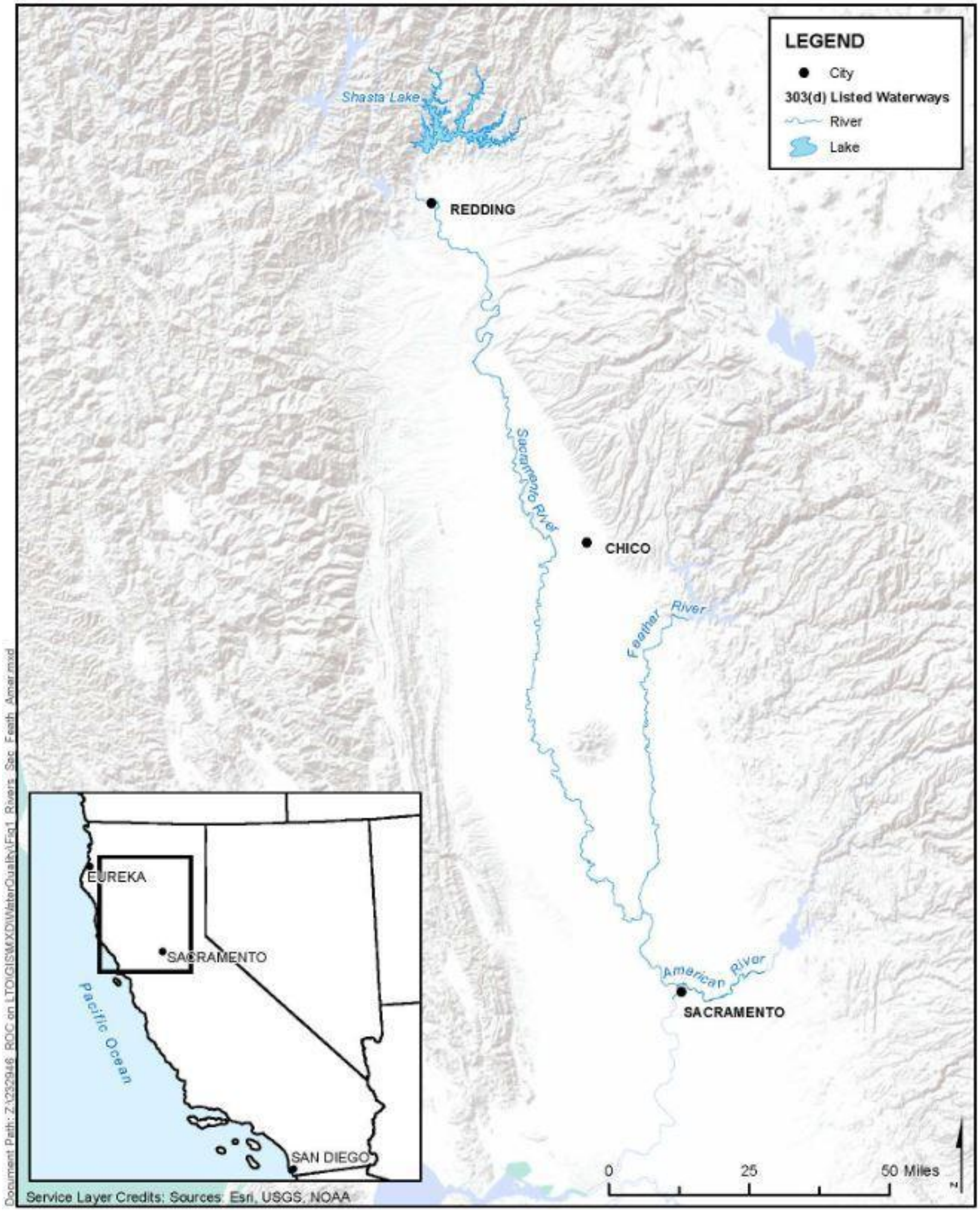
Releases from Shasta Reservoir and diversions from Trinity Lake Water influence water quality in the Upper Sacramento River. Annual and seasonal flows in the Sacramento River watershed are highly variable from year to year. These variations in flow are a source of variability in Sacramento drainage water quality. 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 surrounding urban and agricultural runoff.

The constituents of concern within the Sacramento River that are not currently in compliance with existing water quality standards, and for which TMDLs are adopted or are in development, are summarized in Table G-12 and are discussed further below. Changes to the North Coast Basin Plan addressed past constituents of concern in the Sacramento River, chlorpyrifos and diazinon. In addition, a TMDL addressed cadmium, copper, and zinc in the Sacramento River and is still closely monitored. Figure G-2 presents CWA 303(d)-listed waterways in the Sacramento River Region.

Table G-12. Constituents of Concern per the Clean Water Act Section 303(d) List in the Sacramento River

Waterbody	Constituent of Concern	TMDL Status
Sacramento River from Shasta Reservoir to Verona	Mercury, Cadmium, Copper, Zinc, DDT and Dieldrin (Pesticides), and PCBs	Expected: 2027
	Unknown Toxicity	Expected: 2019 (Keswick Dam to Cottonwood Creek) [a] Expected: 2027 (Cottonwood Creek to Knight's Landing)
	DO	Expected: 2035
	Temperature [b]	Expected: 2033
Sacramento River from Verona to Freeport	Mercury	Expected: 2012 [a]
	DDT (Pesticides) and Unknown Toxicity	Expected: 2027
	Chlordane (Pesticides) and PCBs	Expected: 2021 [a]
	Dieldrin (Pesticides)	Expected: 2022 [a]
	Temperature [b]	Expected: 2033

Source: State Water Resources Control Board 2022a.
DDT = dichloro-diphenyl-trichloroethane; DO = dissolved oxygen; PCB = polychlorinated biphenyl; TMDL = total maximum daily load.
[a] The EPA has not approved the TMDL as of July 2023; the expected approval date has passed.
[b] Discussed in Appendix O.



Source: State Water Resources Control Board 2022a.

Figure G-2. Clean Water Act Section 303(d)-Listed Waterways in the Sacramento River, Feather River, and American River Regions

Sacramento River from Shasta Reservoir to Verona

The CWA Section 303(d)-listed contaminants in this reach of the Sacramento River, which includes the portions of the river from Keswick Dam to Cottonwood Creek, Cottonwood Creek to Red Bluff, and Red Bluff to Knights Landing, are summarized above in Table G-12 and discussed in detail below.

Mercury

Shasta Reservoir and the Sacramento River from Cottonwood Creek to Knights Landing are on the Water Board's CWA Section 303(d) list for mercury contamination (State Water Resources Control Board 2022a). Mercury is not a constituent of concern for the Sacramento River between Keswick Dam and Cottonwood Creek. Mercury in the Sacramento River Basin can be attributed to historic resource extraction (U.S. Geological Survey 2001).

A 2008 CALFED Bay-Delta Program (CALFED) report titled *Methylmercury Concentrations and Loads in the Central Valley and Freshwater Delta*, tabulates methylmercury concentrations in the Sacramento River from Redding (0.3 nanograms per liter [ng/L]) to Freeport (0.11 ng/L) from 2003 to 2006 (Foe et al. 2008). For the 2016 listing, composite fish tissue samples were collected from Shasta Reservoir and the Sacramento River from Cottonwood Creek to Knights Landing. The Water Board deemed the commercial or recreational collection of fish, shellfish, or organisms impaired, since fish tissue exceeded EPA's recommended fish tissue residue criteria for human health of 0.3 mg of methylmercury (wet weight) per kg of fish tissue (State Water Resources Control Board 2022k, 2022l).

The EPA recommended maximum exposure concentrations in an effort to protect the beneficial uses of these water bodies, including the protection of aquatic and human health. In addition, a TMDL is expected to be completed in 2027 to meet the water quality standards in these water bodies (State Water Resources Control Board 2022k, 2022l).

Dissolved Oxygen

Sacramento River (Red Bluff to Knights Landing) is on the Water Board's CWA Section 303(d) list as impaired by DO (State Water Resources Control Board 2022a). The *Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board Central Valley Region* (Central Valley Basin Plan) established a DO objective of 9.0 mg/L[1] from June 1 to August 31 in the Sacramento River from Keswick Dam to Hamilton City (Central Valley Regional Water Quality Control Board 2019a). To protect the beneficial uses of the Sacramento River, including fish spawning and cold freshwater habitat, TMDLs for DO in the Sacramento River from Red Bluff to Knights Landing are expected to be completed in 2035 (State Water Resources Control Board 2022m).

[1] When natural conditions lower DO below this level, the concentrations shall be maintained at or above 95 percent of saturation (Central Valley Regional Water Quality Control Board 2019a).

Cadmium, Copper, and Zinc

Shasta Reservoir where West Squaw Creek enters the lake, Spring Creek (from Iron Mountain Mine to Keswick Reservoir), and Keswick Reservoir downstream of Spring Creek are on the Water Board's CWA Section 303(d) list for impairment by cadmium, copper, and zinc (State Water Resources Control Board 2022a). The Upper Sacramento River from Keswick Dam to Cottonwood Creek was previously on the Section 303(d) list for impairment by cadmium, copper, and zinc, but was delisted after a TMDL completion in 2002 led to the Water Board determining that the water quality standard was met. Acid mine drainage discharged from inactive mines in the Upper Sacramento River watershed, located upstream of Shasta and Keswick dams was the primary cause of the elevated levels (Central Valley Regional Water Quality Control Board 2002a). Abatement projects are underway to clean up many inactive mine sites that discharge high concentrations of metals (Central Valley Regional Water Quality Control Board 2019a).

The *2002 Upper Sacramento River TMDL for Cadmium, Copper and Zinc*, and water quality objectives in the North Coast Basin Plan address cadmium, copper, and zinc contamination in the Sacramento River (Central Valley Regional Water Quality Control Board 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, and thus the water quality objectives focus on individual parameters. Levels of water hardness affect the toxicity of these metals; increased hardness decreases toxicity. Specific levels of water hardness determine the water quality objectives at certain locations (Central Valley Regional Water Quality Control Board 2002a). The TMDL for cadmium, copper, and zinc in Shasta Reservoir and Keswick Reservoir was expected to be complete in 2020; however, as of March 2023, the EPA has not completed the TMDL (State Water Resources Control Board 2022n, 2022o). The TMDL for cadmium, copper, and zinc in Spring Creek is expected to be completed in 2027 (State Water Resources Control Board 2022p).

Pesticides

The Sacramento River from Red Bluff to Knights Landing is on the Water Board's CWA Section 303(d) list as impaired by DDT and the Group A pesticide dieldrin. DDT and dieldrin are legacy pesticides and were discontinued from the early 1970s to the late 1980s.

Although these pesticides were discontinued in the late 1980s, the narrative water quality objective for toxicity, which applies to single or the interactive effect of multiple pesticides or substances and states that *"waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life,"* has not been met (Central Valley Regional Water Quality Control Board 2019a). Fish concentrations of DDT collected in 2005 exceeded the total DDT OEHHA screening value of 21 micrograms per kilogram (µg/kg) by up to five times, which was used as a criterion to evaluate the narrative water quality objective by up to five times. Concentrations of dieldrin also exceeded the OEHHA Evaluation Guideline of 0.46 µg/kg (State Water Resources Control Board 2022m).

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 completed in 2027 (State Water Resources Control Board 2022m).

Although the Sacramento River is not on the Water Board's CWA Section 303(d) list for chlorpyrifos and diazinon contamination, these pesticides are a concern in the Sacramento River because they potentially affect the beneficial uses of Warm and Cold Freshwater Habitat (State Water Resources Control Board 2022m; Central Valley Regional Water Quality Control Board 2007a). Water quality sampling from 1999 to 2006 revealed concentrations of both pesticides at levels of concern in the Sacramento rivers. In addition to runoff of applied pesticides into irrigation and stormwater runoff into the Sacramento rivers, atmospheric transport of diazinon from the Central Valley to the Sierra Nevada Mountains has occurred.

Polychlorinated Biphenyls

The stretch of the Sacramento River from Red Bluff to Knights Landing is on the Water Board's CWA Section 303(d) list as impaired by PCBs (State Water Resources Control Board 2022a). According to the Section 303(d) list /305(b) Report Supporting Information, sources of PCBs in Sacramento River are unknown (State Water Resources Control Board 2022m).

The OEHHA Fish Contaminant Goal (FCG) of total PCBs in fish is 3.6 parts per billion (ppb) (or 3.6 nanograms per gram [ng/g]) (State Water Resources Control Board 2022o). Fish tissue samples collected in August and October 2005 exhibited 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 (*Ictalurus punctatus*) at Colusa, 9.151 ng/g in channel catfish at Grimes, 6.504 ng/g in Sacramento Sucker (*Catostomus occidentalis*) 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 complete in 2027 (State Water Resources Control Board 2022m).

Unknown Toxicity

The Sacramento River from Keswick Dam to Knights Landing is on the Water Board's CWA Section 303(d) list as impaired for unknown toxicity (State Water Resources Control Board 2022a).

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*) and the alga *Pseudokirchneriella subcapitata* (*P. subcapitata*, formerly known as *Selenastrum capricornutum*) (State Water Resources Control Board 2022l, 2022m, 2022q). 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 (Central Valley Regional Water Quality Control Board 2019a). 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 was expected to be completed in 2019; however, no TMDL has been released as of September 2023. The Middle and Lower Sacramento River TMDL is expected to be complete in 2027 (State Water Resources Control Board 2022l, 2022m, 2022q).

A 2012 SWAMP report summarized the occurrences and causes of toxicity in the Central Valley (Markiewicz et al. 2012). The Water Board's SWAMP defines toxicity as a statistically significant adverse impact on standard aquatic test organisms in laboratory exposures. SWAMP testing uses laboratory test organisms as surrogates for aquatic species in the environment to assess the causes of toxicity in California waterways (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, the Sutter Buttes area, and along the eastern valley floor between Chico and Lincoln.

SWAMP studies indicate that replacing OP pesticides by pyrethroids has resulted in an increased contribution of pyrethroids to ambient water and sediment toxicity (Anderson et al. 2011). In sediment, as indicated by *H. azteca*, most of the toxicity is attributed to pyrethroids, particularly in urban areas (Markiewicz et al. 2012). Of the pyrethroid pesticides, bifenthrin is a major concern.

Sacramento River from Verona to Freeport

The CWA Section 303(d)-listed contaminants in this reach of the Sacramento River, which includes the portion of the river from Knight's Landing to the Delta, are summarized above in Table G-12 and discussed in detail below.

Mercury

The Sacramento River from Knights Landing to the Delta is on the Water Board's CWA Section 303(d) list for mercury contamination (State Water Resources Control Board 2022a).

Mercury in this reach of the river is attributed to waterborne inputs from the upper Sacramento, Feather, Yuba, and American Rivers (State Water Resources Control Board 2022r). These major tributaries are also listed as impaired due to mercury. As in the Klamath and Trinity River basins, historical mining has resulted in 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 substantial amounts of mercury-laden sediment, due to the use of mercury to extract gold. These discharges caused alluvial fans to form 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 in the Delta. Over 80% of total mercury flux to the Delta can be attributed to the Sacramento River Basin (Central Valley Regional Water Quality Control Board 2010a). The Central Valley RWQCB (2016) compiled data from 2000 to 2003 and reported an average of 0.10 ng/L in the Sacramento River at Freeport. 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). 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), contribute to the mean methylmercury concentration of 0.11 ng/L at Freeport in the Sacramento River. Table G-13 presents streambed sediment mercury concentrations from the Sacramento River and Delta regions in 1995, sampled as part of the National Water Quality Assessment Program for the Sacramento River Basin (MacCoy and Domagalski 1999). Limited data for mercury in sediment exist, but the existing data exhibits levels of mercury greatly exceeding the average amount of mercury found on the earth's surface, 0.05 micrograms per gram (µg/g). The highest streambed sediment concentrations of mercury were measured downstream from the Sierra Nevada and Coast Ranges. Within the Sacramento River, sites downstream of the Feather River had higher concentrations of mercury than sampled locations upstream of the confluence. The Yuba River, Bear River, Sacramento River at Verona, and the Feather River had the highest reported mercury concentrations, which exceeded the threshold effect concentration (0.18 µg/g), but not the probable effect concentration (1.06 µg/g) reported by MacDonald et al. (2000).

Table G-13. Streambed Sediment Concentrations of Mercury in the Sacramento River and Delta Regions

Waterbody/Site	Concentration (µg/g)
FEATHER RIVER SITES	
Feather River	0.21 [a]
Yuba River	0.37 [a]
Bear River	0.37 [a]
Feather & Sacramento Rivers Downstream of the confluence at Verona	0.24 [a]
SACRAMENTO RIVER SITES	
Bend Bridge	0.16
Freeport	0.14
Cache Creek	0.15
Arcade Creek	0.13
American River	0.16

Source: MacCoy and Domagalski 1999.
µg/g = micrograms per gram.
Note: Reported in bottom material < 63 micron fraction dry weight.
[a] Concentration exceeds the MacDonald et al. (2000) threshold effect concentration (0.18 µg/g dry weight) but not the probable effect concentration (1.06 µg/g dry weight).

The Central Valley RWQCB (2016) made recommendations for the future reduction of mercury contamination 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 Delta Mercury Control Program (Delta Mercury Control Program Mercury Exposure Reduction Program 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 is on the Water Board's CWA Section 303(d) list as impaired by the pesticides chlordane, DDT, and dieldrin from Knights Landing to the Delta (State Water Resources Control Board 2022a). The three pesticides listings were based on the evaluation of fish contaminant data from 2005. Chlordane, DDT, and dieldrin are legacy pesticides discontinued in 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 (State Water Resources Control Board 2022r).

For the Sacramento River from Knights Landing to the Delta, TMDLs were expected to be completed in 2021 for chlordane, in 2022 for dieldrin, and in 2027 for DDT (State Water Resources Control Board 2022q); however, as of March 2023, the EPA has not completed the TMDL for chlordane and dieldrin in the Sacramento River from Knights Landing to the Delta.

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, both exceeding the OEHHA (2008) FCG of 5.6 µg/kg for total chlordane in fish tissue (State Water Resources Control Board 2022r).

Composite samples of carp and channel catfish contained total DDT concentrations of 59.08 µg/kg and 109.09 µg/kg, respectively. These concentrations exceeded the OEHHA (2008) FCG of 21 µg/kg (State Water Resources Control Board 2022r).

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 OEHHA (2008) FCG of 0.46 µg/kg (State Water Resources Control Board 2022r).

Polychlorinated Biphenyls

The Sacramento River from Knights Landing to the Delta is on the Water Board's CWA Section 303(d) list as impaired by PCBs (State Water Resources Control Board 2022a).

According to the Section 303(d) List/305(b) Report Supporting Information, sources of PCBs in this reach of the Sacramento River are unknown (State Water Resources Control Board 2022r).

The Sacramento River from Knights Landing to the Delta was recently listed as contaminated by PCBs. Three of three composite samples analyzed for total PCBs in September 2005 exceeded the OEHHA FCG for total PCBs of 3.6 ppb (or 3.6 ng/g), wet weight. The exceeding concentrations were recorded at 53.34 ng/g in channel catfish, 6.0 ng/g in Sacramento sucker, and 26 in carp (State Water Resources Control Board 2022r).

A TMDL for PCBs in the lower Sacramento River was expected to be completed in 2021 to protect the beneficial uses of the Sacramento River and downstream waterbodies; however, no TMDL has been released as of September 2023 (State Water Resources Control Board 2022r).

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 with laboratory controls violated the narrative toxicity objective of the Sacramento–San Joaquin River Basin Plan. The TMDL for toxicity in this reach of the river is expected to be completed in 2027 (State Water Resources Control Board 2022r).

G.1.5 Clear Creek

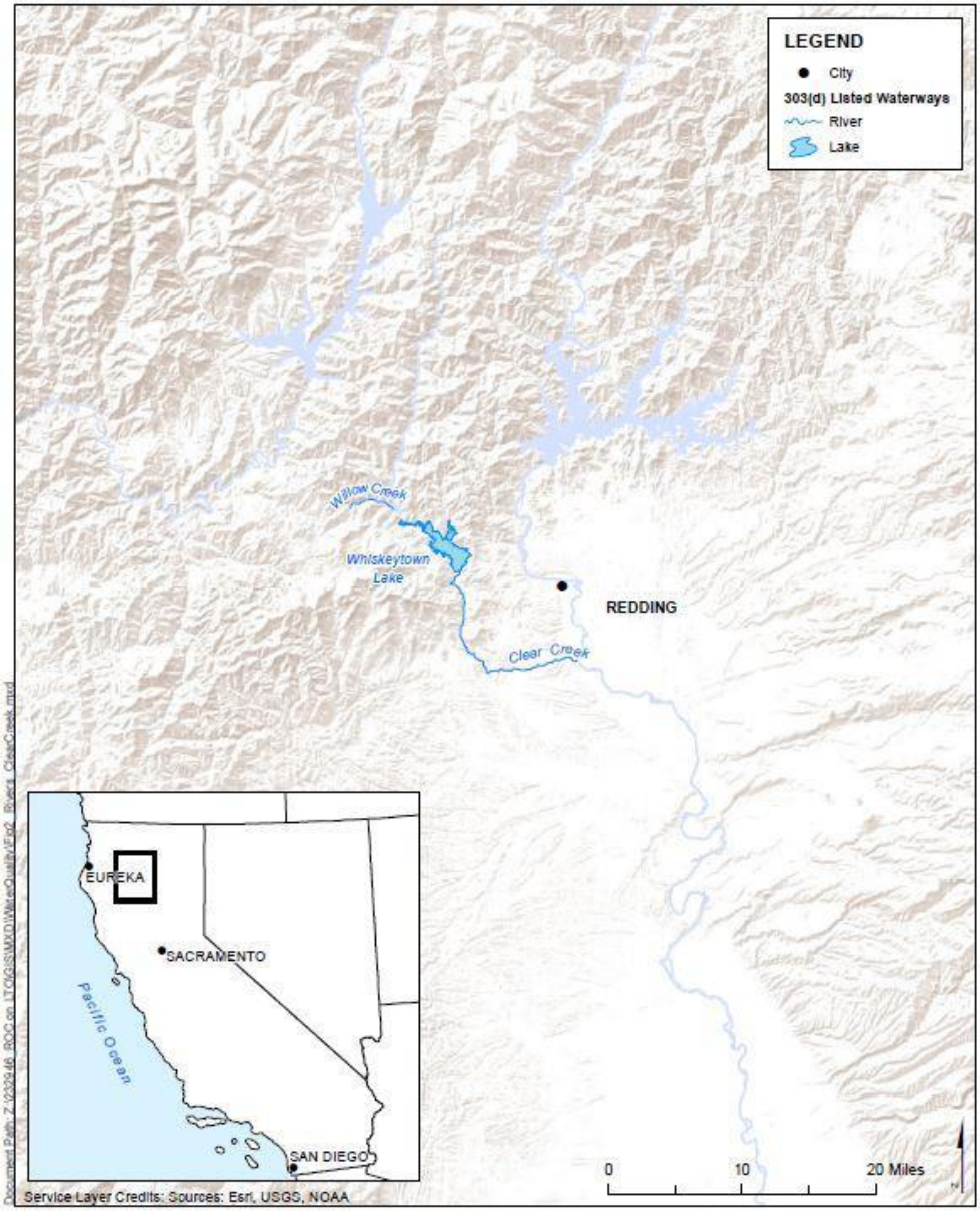
G.1.5.1 Constituents of Concern

The constituents of concern within the Clear Creak Region that are not currently in compliance with existing water quality standards, and for which TMDLs are adopted or are in development, are summarized in Table G-14 and are discussed further below. Figure G-3 presents CWA 303(d)-listed waterways in the Clear Creek Region.

Table G-14. Constituents of Concern per the Clean Water Act Section 303(d) List in the Clear Creek Region

Waterbody	Constituent of Concern	TMDL Status
Willow Creek	Metals (Acid Mine Drainage, Copper, Zinc)	Expected: 2019 [a]
Whiskeytown Lake	Mercury	Expected: 2027
Clear Creek	Mercury	Expected: 2027

Source: State Water Resources Control Board 2022a.
TMDL = total maximum daily load.
[a] The EPA has not approved the TMDL as of July 2023; the expected approval date has passed.



Source: State Water Resources Control Board 2022a.

Figure G-3. Clean Water Act Section 303(d)-Listed Waterways in the Clear Creek Region

Metals

Willow Creek, a Clear Creek tributary just upstream of Whiskeytown Reservoir, is on the Water Board's CWA Section 303(d) list as impaired for metals (acid mine drainage, copper and zinc) (State Water Resources Control Board 2022a). The contamination comes from an abandoned copper mine operated in the early 1900s, however, monitoring data has not shown a substantial impact on Clear Creek from the metal-contaminated Willow Creek drainage (Sacramento River Watershed Program n.d.). Clear Creek (below Whiskeytown Lake, Shasta County) and Whiskeytown Lake (areas near Oak Bottom, Brandy Creek Campgrounds, and Whiskeytown) are not on the Section 303(d) list as impaired by copper or zinc (State Water Resources Control Board 2022a).

Mercury

Clear Creek (below Whiskeytown Lake, Shasta County) and Whiskeytown Lake (areas near Oak Bottom, Brandy Creek Campgrounds, and Whiskeytown) are on the Water Board's CWA Section 303(d) list as impaired by mercury (State Water Resources Control Board 2022a). The major source of this contamination is mercury deposits from in the expansive tailings piles of 1800s dredging gold mining operations (Sacramento River Watershed Program n.d.).

In an effort to meet the water quality standards in Clear Creek and Whiskeytown Lake, a TMDL is expected to be complete by 2027 (State Water Resources Control Board 2022s, 2022t).

G.1.6 American River

G.1.6.1 Constituents of Concern

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. The runoff that flows into Folsom Lake and Lake Natoma, upstream of the lower American River, is generally high quality (Wallace, Roberts, and Todd et al. 2003).

The constituents of concern within the American River that are not currently in compliance with existing water quality standards, and for which TMDLs are adopted or are in development, are summarized in Table G-15 and are discussed further below. Figure G-2 displays the CWA Section 303(d)-listed waterways in the American River region.

Table G-15. Constituents of Concern per the Clean Water Act Section 303(d) List in the American River

Waterbody	Constituent of Concern	TMDL Status
Lower American River	Pesticides and Indicator Bacteria	Expected: 2027
	Temperature [a]	Expected: 2034
	Mercury	Expected: 2010 [b]
	PCBs and Unknown Toxicity	Expected: 2021 [b]
North Fork American River	Mercury	Expected: 2027
South Fork American River	Mercury	Expected: 2021 [b]

Source: State Water Resources Control Board 2022a.
PCB = polychlorinated biphenyl; TMDL = total maximum daily load.
[a] Discussed in Appendix O.
[b] The EPA has not approved the TMDL as of July 2023; the expected approval date has passed.

Mercury

The American River from Nimbus Dam to the confluence with the Sacramento River is on the Water Board's CWA Section 303(d) list as contaminated by mercury, due to exceedances of the OEHHA's guidance tissue levels for mercury (State Water Resources Control Board 2022u). The major source is mercury from historical mining activities that is slowly 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 (Central Valley Regional Water Quality Control Board 2010a). The lower American River is recommended for initial mercury reduction efforts as part of the Delta Estuary Methylmercury TMDL. 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 (State Water Resources Control Board 2022b).

Pesticides

The lower American River is on the Water Board's CWA Section 303 (d) list as impaired by bifenthrin and pyrethroids (State Water Resources Control Board 2022a). The Central Valley Basin Plan states that "no individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses" (Central Valley Regional Water Quality Control Board 2019a). Of the 38 toxicity testing samples, 19 violated the narrative toxicity objective associated with pyrethroid pesticides (State Water Resources Control Board 2022u). Of the seven toxicity testing samples, four violated the narrative toxicity objective associated with bifenthrin pesticides (State Water Resources Control Board 2022u). To protect beneficial uses, a TMDL for bifenthrin and pyrethroids in the lower American River is expected to be complete by 2027 (State Water Resources Control Board 2022u).

Bacteria

The lower American River is on the Water Board's CWA Section 303(d) list as impaired by indicator bacteria (State Water Resources Control Board 2022a). The Water Board has set a bacteria water quality objective of a six-week rolling geometric mean of *Escherichia coli* (*E. coli*) not exceeding 100 colony forming units per 100 mL (State Water Resources Control Board 2018a). *E. coli* samples collected from 2010-2019 in the lower American River exceeded the *E. coli* bacteria objective. A TMDL for indicator bacteria is expected to be complete by 2027 (State Water Resources Control Board 2022u).

Polychlorinated Biphenyls

The lower American River is on the Water Board's CWA Section 303(d) list as impaired by PCBs (State Water Resources Control Board 2022a).

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 (State Water Resources Control Board 2022u). The total PCBs recorded in the white catfish and Sacramento sucker were 3.934 ng/g and 44.094 ng/g. 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 was expected to be completed in 2021 to protect the beneficial uses of the American River and other water bodies downstream; however, no TMDL has been completed as of March 2023 (State Water Resources Control Board 2022u).

Unknown Toxicity

The lower American River is on the Water Board's CWA Section 303(d) list as impaired by unknown toxicity. Samples collected at Discovery Park indicated toxicity for vertebrates and invertebrates, based on survival, growth, and reproduction toxicity tests with *C. dubia* and *P. promelas*. These tests, conducted between 1998 and 2007, exhibited increases in mortality and reductions in growth and reproduction in the test organisms (State Water Resources Control Board 2022u). The TMDL was expected to be completed in 2021; however, no TMDL has been released as of March 2023 (State Water Resources Control Board 2022u).

G.1.7 Stanislaus River

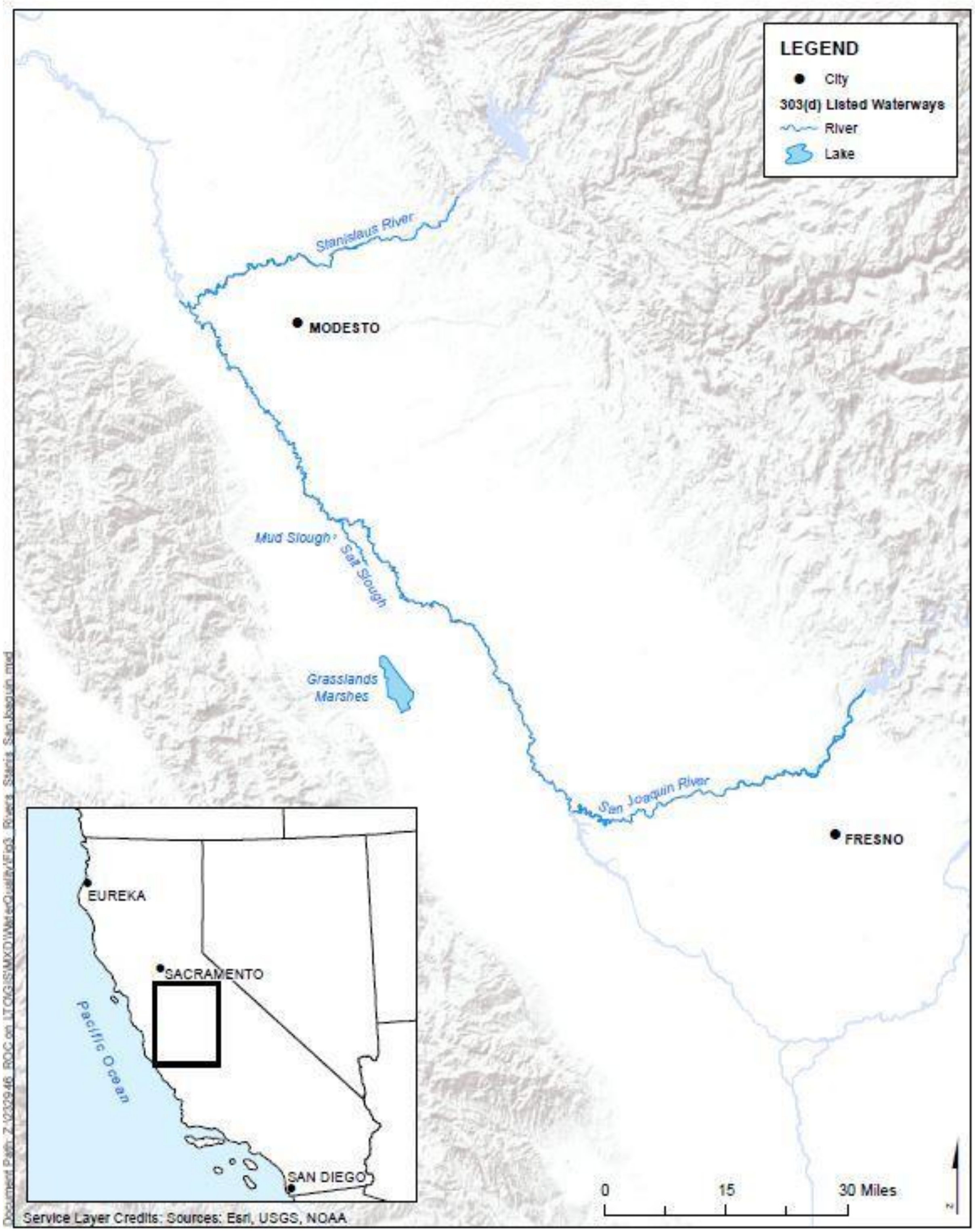
G.1.7.1 Constituents of Concern

The constituents of concern within the Stanislaus River that are not currently in compliance with existing water quality standards, and for which TMDLs are adopted or are in development, are summarized in Table G-16 and are discussed further below. Figure G-4 presents 303(d) listed waterways within the Stanislaus River region.

Table G-16. Constituents of Concern per the Clean Water Act Section 303(d) List in the Stanislaus River

Waterbody	Constituent of Concern	TMDL Status
Lower Stanislaus River	Group A Pesticides	Expected: 2011 [a]
	Mercury	Expected: 2020 [a]
	Temperature [b]	Expected: 2033
	Unknown Toxicity	Expected: 2027

Source: State Water Resources Control Board 2022a.
TMDL = total maximum daily load.
[a] The EPA has not approved the TMDL as of July 2023; the expected approval date has passed.
[b] Discussed in Appendix O.



Source: State Water Resources Control Board 2022a.

Figure G-4. Clean Water Act Section 303(d)-Listed Waterways in the Stanislaus River and San Joaquin River Regions

Mercury

The lower Stanislaus River is on the Water Board's CWA Section 303(d) list as impaired by mercury (State Water Resources Control Board 2022a). Mercury has impaired the beneficial use of the commercial or recreational collection of fish, shellfish, or organisms (State Water Resources Control Board 2022v). The lower Stanislaus River was evaluated prior to 2006, so the evidence for the 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 EPA methylmercury fish tissue criterion (0.3 mg/kg wet weight) for the protection of human health (Shilling 2003).

To protect the beneficial uses of the water bodies mentioned above, including the commercial and recreational collection of fish, shellfish, or organisms, TMDLs were expected to be complete by 2020 to meet the water quality standards in these water bodies; however, no TMDLs have been released as of March 2023 (State Water Resources Control Board 2022v).

Pesticides

The lower Stanislaus River is on the Water Board's CWA Section 303(d) list as impaired by pesticides (Group A Pesticides) (State Water Resources Control Board 2022a). OC pesticides (e.g., Group A Pesticides) are primarily transported to streams and rivers in runoff from agriculture (Central Valley Regional Water Quality Control Board 2011). Sources and descriptions of the listed pesticides are discussed further in Section G.1.2.7, *Pesticides*.

Unknown Toxicity

The lower Stanislaus River is on the Water Board's CWA Section 303(d) list as impaired by unknown toxicity (State Water Resources Control Board 2022a). Samples collected from November 2004 to November 2005 at Caswell Park indicated toxicity for vertebrates and invertebrates, based on survival, growth, and reproduction toxicity tests with P. promelas. (State Water Resources Control Board 2022v). To protect beneficial uses in the lower Stanislaus River, a TMDL is expected to be completed in 2027 (State Water Resources Control Board 2022v).

G.1.8 San Joaquin River

G.1.8.1 Constituents of Concern

Water quality conditions in the San Joaquin River are described for locations that would be influenced by the alternatives, including Stanislaus River near Caswell Park by the confluence with the San Joaquin River, San Joaquin River near Vernalis, and San Joaquin River near Buckley Cove and Stockton.

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, as well as water use and agricultural return flows.

The constituents of concern within the San Joaquin River region that are not currently in compliance with existing water quality standards, and for which TMDLs are adopted or are in development, are summarized in Table G-17 and are discussed further below. Figure G-4, presented above, displays CWA Section 303(d)-listed waterways in the San Joaquin River region.

Table G-17. Constituents of Concern per the Clean Water Act Section 303(d) List in the San Joaquin River Region

Waterbody	Constituent of Concern	TMDL Status
San Joaquin River (Mendota Pool to Bear Creek)	DDT (Pesticides) and Unknown Toxicity	Expected: 2027
	pH	Expected: 2035
	Group A Pesticides	Expected: 2011 [a]
San Joaquin River (Bear Creek to Mud Slough)	Arsenic, DDT (Pesticides), EC, and TDS	Expected: 2027
	Boron, Indicator Bacteria, and Linuron (Pesticides)	Expected: 2035
	Group A Pesticides	Expected: 2011 [a]
	Mercury	Expected: 2012 [a]
	Temperature [b]	Expected: 2034
	Unknown Toxicity	Expected: 2024
San Joaquin River (Mud Slough to Merced River)	Boron, DDT (Pesticides), EC, Indicator Bacteria, and Unknown Toxicity	Expected: 2027
	Chlorpyrifos (Pesticides) and Diazinon (Pesticides)	Approved: 2007
	Group A Pesticides	Expected: 2011 [a]
	Mercury	Expected: 2012 [a]
	Selenium	Approved: 2002
	Temperature [b]	Expected: 2034
San Joaquin River (Merced River to Tuolumne River)	Alpha-BHC (Pesticides), DDE (Pesticides), DDT (Pesticides), EC, Temperature [b], and TDS	Expected: 2027
	Group A Pesticides	Expected: 2011 [a]
	Mercury	Expected: 2012 [a]
	Specific Conductivity	Approved: 2018
	Unknown Toxicity	Expected: 2019 [a]
San Joaquin River (Friant Dam to Mendota Pool)	Invasive Species and pH	Expected: 2027
	Temperature [b]	Expected: 2034
San Joaquin River (Stanislaus River to Delta Boundary)	DDE (Pesticides), DDT (Pesticides), Diuron, and Temperature [b]	Expected: 2027
	Group A Pesticides	Expected: 2011 [a]
	Imidacloprid (Pesticides) and TDS	Expected: 2035
	Mercury	Expected: 2012 [a]
	Toxaphene (Pesticides) and Unknown Toxicity	Expected: 2019 [a]

Waterbody	Constituent of Concern	TMDL Status
San Joaquin River (in Delta Waterways, southern portion)	Temperature [b]	Expected: 2034
San Joaquin River (Tuolumne River to Stanislaus River)	DDT (Pesticides), EC, and Temperature [b]	Expected: 2027
	Group A Pesticides	Expected: 2011 [a]
	Mercury	Expected: 2012 [a]
	Unknown Toxicity	Expected: 2019 [a]
San Joaquin River from Delta Waterways to Stockton Ship Channel	Imidacloprid (Pesticides) and Unknown Toxicity	Expected: 2035
	Temperature [b]	Expected: 2034
Salt Slough (upstream of confluence with San Joaquin River)	EC	Expected: 2019 [a]
	Linuron (Pesticides) and TDS	Expected: 2035
	Mercury and DO	Expected: 2027
	Prometryn (Pesticides)	Expected: 2021 [a]
	Unknown Toxicity	Expected: 2024
Mendota Pool	Mercury and Selenium	Expected: 2027
Panoche Creek (Silver Creek to Belmont Avenue)	Mercury	Expected: 2020 [a]
	Sedimentation/Siltation	Expected: 2007
	Selenium	Expected: 2019 [a]
	Unknown Toxicity	Expected: 2027
Agatha Canal	pH	Expected: 2021 [a]
	Selenium	Approved: 2000
Grasslands Marshes	EC	Expected: 2027
	Selenium	Approved: 2000
Mud Slough, North (downstream of San Luis Drain)	Boron, EC, and Pesticides	Expected: 2019 [a]
	Indicator Bacteria and Linuron (Pesticides)	Expected: 2035
	Selenium	Approved: 2002
	Unknown Toxicity	Expected: 2027

Source: State Water Resources Control Board 2022a.
BHC = benzene hexachloride; DDE = dichloro-diphenyl-dichloroethylene; DDT = dichloro-diphenyl-trichloroethane; DO = dissolved oxygen; EC = electrical conductivity; pH = measure of acidity; TDS = total dissolved solids; TMDL = total maximum daily load.
[a] The EPA has not approved the TMDL as of July 2023; the expected approval date has passed.
[b] Discussed in Appendix O.

Selenium

The San Joaquin River from Mud Slough to Merced River is on the Water Board's CWA list as impaired by selenium (State Water Resources Control Board 2022a). Other water bodies that drain to the San Joaquin River upstream of this reach and are listed as impaired by selenium contamination on the Section 303(d) list include Mendota Pool, Panoche Creek from Silver Creek to Belmont Avenue, Agatha Canal, Grasslands Marshes, and Mud Slough (North, downstream of San Luis Drain) (State Water Resources Control Board 2022a).

The EPA approved TMDLs for selenium 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) (State Water Resources Control Board 2022w 2022x, 2022y, 2022z). A TMDL was expected to be completed for Panoche Creek in 2019; however, no TMDL has been released as of March 2023 (State Water Resources Control Board 2022aa). A TMDL for selenium at Mendota Pool is expected to be completed in 2027 (State Water Resources Control Board 2022ab). Table G-18 presents water quality objectives defined in the Sacramento–San Joaquin River Basin Plan (Central Valley Regional Water Quality Control Board 2019a).

Table G-18. Water Quality Objectives for Selenium in the San Joaquin River Region

Applicable Waterbody	Objective (mg/L)		
	Maximum Concentration	4-Day Average	Monthly Mean
San Joaquin River, mouth of the Merced River to Vernalis	0.012	0.005	–
Mud Slough (north), and the San Joaquin River from Sack Dam to the mouth of Merced River	0.020	0.005	–
Salt Slough and constructed and re-constructed water supply channels in the Grassland watershed [a]	0.020	–	0.002

Source: Central Valley Regional Water Quality Control Board 2019a.
mg/L = milligrams per liter.
[a] Applies to channels identified in Appendix 40 of the Central Valley Basin Plan (Central Valley Regional Water Quality Control Board 2019a).

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 via tributaries such as Mud Slough and Salt Slough (Central Valley Regional Water Quality Control Board 2001). Since implementation of the Grasslands Bypass Project, all discharges of drainage water from the Grassland Drainage Area into wetlands and refuges have been eliminated. From the project's inception in 1996 through 2022, the Grasslands Bypass Project has reduced the load of selenium discharged from the Grassland Drainage Area by 99% (Bureau of Reclamation 2023). In the San Joaquin River at Crows Landing, selenium concentrations decreased from an average of 4.1 µg/L during pre-project conditions (1986 to 1996) to 0.3 µg/L (2018 to 2022) (Bureau of Reclamation 2023). The continued operation of the Grassland Bypass Project is expected to achieve the

Central Valley Basin Plan objectives for the San Joaquin Valley (Bureau of Reclamation and San Luis and Delta-Mendota Water Authority 2009).

The Central Valley RWQCB sampled largemouth bass from the San Joaquin River, lower Sacramento River, and Delta during 1999, 2000, 2005, and 2007 (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 May 2014 EPA draft water quality criteria.

The 2014 Central Valley RWQCB draft discharge requirements aim to meet the water quality objective for the San Joaquin River. In 2010, the Central Valley RWQCB and Water Board approved amendments (Resolution No. 2010-0046) to the Sacramento–San Joaquin River Basin Plan to address selenium control in the San Joaquin River Basin as related to the Grassland Bypass Project, described below (Central Valley Regional Water Quality Control Board 2010c; State Water Resources Control Board 2010).

Other relevant requirements/actions to meet the water quality objectives for the San Joaquin River, in addition to the Central Valley RWQCB draft waste discharge requirements (2010d) include the following:

- The Sacramento–San Joaquin River Basin Plan amendments (Central Valley Regional Water Quality Control Board 2010c; State Water Resources Control Board 2010) 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.
    - 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 Central Valley RWQCB (Central Valley Regional Water Quality Control Board 2024).

Electrical Conductivity, Total Dissolved Solids, and Salinity

The segment of the San Joaquin River from Bear Creek to Mud Slough is placed on the Water Board's CWA Section 303(d) list as impaired by TDS (State Water Resources Control Board 2022a). Out of the 65 water samples that were taken approximately monthly between October 2004 and May 2009, 40 of the samples exceeded the criterion for dissolved solids. A TMDL for this pollutant has been established and is expected to be completed in 2027 (State Water Resources Control Board 2022ac).

Grasslands Marshes, North Mud Slough (downstream of San Luis Drain), and Salt Slough (upstream from confluence with the San Joaquin River) are Central Valley water bodies placed on the Section 303(d) list approved by the EPA in 2010 as impaired by EC (State Water Resources Control Board 2011), and continue to be Section 303(d) listed in the most recent, 2020 update (State Water Resources Control Board 2022a). The segment of the San Joaquin River from Merced River to Tuolumne River is also listed as impaired for specific conductivity, a measure of EC that has been corrected to reflect the measurement temperature (State Water Resources Control Board 2022ad).

Salinity, which is linked to TDS and EC, is a major concern for water quality in the San Joaquin Valley (Central Valley Regional Water Quality Control Board 2019a). The Central Valley RWQCB has adopted a TMDL for the San Joaquin River upstream of Vernalis for salt and boron.

Elevated EC in the Grasslands Marshes, North Mud Slough (downstream of San Luis Dam), Salt Slough (upstream from confluence with the San Joaquin River), and San Joaquin River (all segments from Bear Creek to the Stanislaus River) can be attributed to agriculture (State Water Resources Control Board 2022w, 2022x, 2022z, 2022ac, 2022ad, 2022ae, 2022af). Likewise, high salinity in the San Joaquin River near Vernalis is linked to the discharge of water from agricultural practices (CALFED Bay-Delta Program 2007a). Saline water from agricultural return flow is added to the southern Delta by the San Joaquin River, where 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.

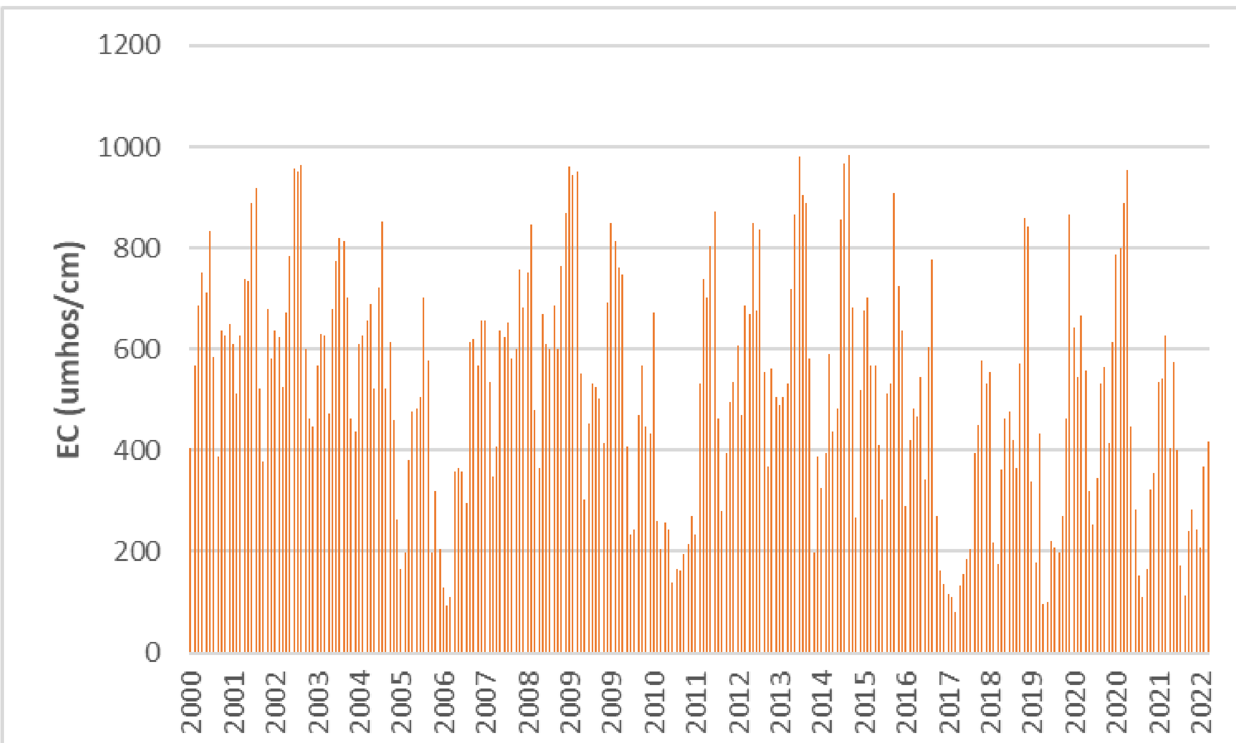
The *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary* (Bay-Delta Plan) establishes water quality objectives to protect the beneficial uses of these water bodies, including agricultural supply, and municipal and domestic supply. The year-round water quality objectives for EC in the San Joaquin River (Airport Way Bridge, Vernalis) is 1.0 millimhos per centimeter (1,000 microsiemens per centimeter) (State Water Resources Control Board 2018b).

The Central Valley RWQCB amended the Sacramento–San Joaquin River Basin Plan (Resolution No. R5-2017-0062) to add EC water quality objectives in the San Joaquin River between the mouth of the Merced River and the Airport Way Bridge near Vernalis. The amendment, which took effect in January 2020, set the EC water quality objective of 1,550 µS/cm, excluding extended dry periods when the objective is 2,470 µS/cm (State Water Resources Control Board 2023).

Several samples from the San Joaquin River (Bear Creek to Vernalis) between October 1995 and February 2007 exceeded the Bay-Delta Plan's water quality objective for EC in the San Joaquin River (State Water Resources Control Board 2022w, 2022x, 2022z, 2022ac, 2022ad, 2022ae, 2022af). Samples were collected from the San Joaquin River at Lander Avenue, Fremont Ford, Patterson Fishing Access, Hills Ferry Bridge, and Crows Landing. Guidelines for evaluating the Grasslands Marshes, North Mud Slough, and Salt Slough are not available because the listing was made prior to 2006.

Figure G-5 shows salinity in the lower San Joaquin River as observed at Vernalis. The record of monthly average EC readings for recent years for the San Joaquin River at Vernalis is shown on 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 Bay-Delta Program 2007a). There is a marked increase in salinity during dry months and dry years at Vernalis, ranging from midwinter lows near 100 micromhos per centimeter (µmhos/cm) up to summer high values near 1,000 µmhos/cm.

A TMDL for Salt Slough and Mud Slough was expected to be completed in 2019; however, no TMDL has been released as of March 2023 (State Water Resources Control Board 2022aa, 2022ad). A TMDL for the San Joaquin River and Grasslands Marshes is expected to be completed in 2027 (State Water Resources Control Board 2022w, 2022x, 2022ac, 2022ad, 2022ae). The Central Valley RWQCB implemented the comprehensive salt management program, known as the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS), to develop salt control strategies for the San Joaquin and the entire Central Valley watershed (Central Valley Regional Water Quality Control Board 2010d, 2011). The San Joaquin River Water Quality Improvement Project is 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.



Source: California Department of Water Resources 2023.

Figure G-5. Monthly Average (Electrical Conductivity) in the San Joaquin River at Vernalis

Mercury

Mercury is a constituent of concern for the San Joaquin River (all segments from Bear Creek to Stanislaus River) and Salt Slough (upstream from confluence with San Joaquin River) (State Water Resources Control Board 2022a). The San Joaquin River from Friant Dam to Bear Creek was not included on the Water Board's CWA Section 303(d) list for mercury contamination.

Mercury in this reach of the San Joaquin River can be attributed to resource extraction. Historically, there were gold mining operations along the major tributaries of the San Joaquin River, including the Merced River, Tuolumne River, Stanislaus River, and Cosumnes River in the San Joaquin River Basin (Central Valley Regional Water Quality Control Board 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) (Central Valley Regional Water Quality Control Board 2010a). This fish tissue concentration exceeds the EPA 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 Delta TMDL specified narrative and more-stringent numeric water quality objectives for the most bioavailable and toxic form of methylmercury. The Delta TMDL (Central Valley Regional Water Quality Control Board 2010a), which is applicable to the Delta, Yolo Bypass, and their waterways, including the reach of the San Joaquin River from Bear Creek to Stanislaus River.

Pesticides

The San Joaquin River (all segments from Mendota Pool to Vernalis) and Salt Slough (upstream from confluence with the San Joaquin River) are on the Water Board's CWA Section 303(d) list as impaired by pesticides (State Water Resources Control Board 2022a). Salt Slough is listed as impaired by linuron and prometryn. The San Joaquin River is listed as impaired by OC pesticides (DDT, DDE, Group A Pesticides, including toxaphene) and alpha.-BHC OP pesticides (chlorpyrifos and diazinon), diuron, linuron, and imidacloprid (State Water Resources Control Board 2022w, 2022ac, 2022ad, 2022ae, 2022af, 2022ag, 2022ah). Impairment listings vary between reaches of the San Joaquin River. Several other small tributaries to the San Joaquin River from the west are also on the Section 303(d) as impaired by pesticides (i.e., North Mud Slough [upstream and downstream of San Luis Drain]) (State Water Resources Control Board 2022a).

Pesticides in North Mud Slough, Salt Slough, and the San Joaquin River are from agriculture runoff, 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 Vernalis), whose sources are unknown (State Water Resources Control Board 2022w, 2022ac, 2022ad, 2022ae, 2022af, 2022ag, 2022ah).

Boron

The lower San Joaquin River upstream of Vernalis is listed as impaired due to elevated concentrations of boron (Central Valley Regional Water Quality Control Board 2002b, 2007b). An amendment to the Sacramento–San Joaquin River Basin Plan for the control of salt and boron discharges into the lower San Joaquin River (Resolution No. R5-2004-0108) (Central Valley Regional Water Quality Control Board 2007c) describes a pending TMDL and establishes waste load allocations to meet boron water quality objectives near Vernalis (at the Airport Way Bridge). A TMDL for boron in the San Joaquin River from Mud Slough to the Merced River and the San Joaquin River from Bear Creek to Mud Slough are expected to be completed by 2027 and 2035, respectively (State Water Resources Control Board 2022w, 2022ac).

Mean salinity in the lower San Joaquin River at Vernalis has doubled since the 1940s, and boron and other trace elements also increased to concentrations that exceed the water quality criteria of 750 µg/L. These criteria were established to protect sensitive crops under long-term irrigation (U.S. Environmental Protection Agency 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's surface and subsurface agricultural discharges (Central Valley Regional Water Quality Control Board 2007c) on soils overlying old marine deposits, and from groundwater (Hoffman 2010; CALFED Bay-Delta Program 2000). Major boron contributions come from Salt and Mud sloughs to the lower river (Central Valley Regional Water Quality Control Board 2002b). Point sources contribute a minimal salt and boron load to the San Joaquin River (Central Valley Regional Water Quality Control Board 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 were 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).

In 2018, the Central Valley RWQCB approved amendments to the Sacramento–San Joaquin River Basin Plan to incorporate a Central Valley-wide Salt and Nitrate Control Program (Central Valley Regional Water Quality Control Board 2018a).

Arsenic

The San Joaquin River from Bear Creek to Mud Slough is on the Water Board's CWA Section 303(d) list as impaired by arsenic (State Water Resources Control Board 2022a). Arsenic can cause adverse dermal, cardiovascular, respiratory, gastrointestinal, and neurological effects, as well as cancer (Agency for Toxic Substances and Disease Registry 2007a). A TMDL addressing impairment due to arsenic is expected to be complete in 2027 to protect the beneficial uses of this reach of the San Joaquin River, including the municipal and domestic supply (State Water Resources Control Board 2022ac).

Dissolved Oxygen

The Salt Slough (upstream from the confluence with the San Joaquin River) is on the Water Board's CWA Section 303(d) list as impaired by DO (State Water Resources Control Board 2022a). To protect the beneficial uses of waters with warm freshwater habitat (WARM), the minimum DO concentration is 5.0 mg/L (Central Valley Regional Water Quality Control Board 2019a). A TMDL addressing impairment due to DO is expected to be complete in 2027 (State Water Resources Control Board 2022ag).

Bacteria

The San Joaquin River (all segments from Bear Creek to Merced River) and North Mud Slough (downstream of San Luis Drain) is on the Water Board's CWA Section 303(d) list as impaired by indicator bacteria (State Water Resources Control Board 2022a).

Invasive Species

The San Joaquin River (Friant Dam to Mendota Pool) is on the Water Board's CWA Section 303(d) list as impaired by invasive species (State Water Resources Control Board 2022a).

A TMDL for invasive species is expected to be completed in 2027. It will aim to meet the narrative water quality objective in the San Joaquin River (Friant Dam to Mendota Pool).

pH

The San Joaquin River (all segments from Friant Dam to Bear Creek) and Agatha Canal are on the Water Board's CWA Section 303(d) list as impaired by pH (State Water Resources Control Board 2022a). The water quality objective for pH outlined in the Sacramento–San Joaquin River Basin Plan states that pH levels shall not be lower than 6.5 or higher than 8.5 (Central Valley Regional Water Quality Control Board 2019a). Samples collected from the San Joaquin River at Sack Dam and Lost Lake County Park and Agatha Canal at Mallard Road exceeded the criterion for pH. A TMDL to address the pH impairment at San Joaquin River (Friant Dam to Mendota Pool) and San Joaquin River (Mendota Pool to Bear Creek) is expected to be completed by 2027 and 2035, respectively. A TMDL for Agatha Canal was expected to be completed by 2021; however, no TMDL has been released as of March 2023.

Unknown Toxicity

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) is on the Water Board's CWA Section 303(d) list as impaired by unknown toxicity (State Water Resources Control Board 2022a). The toxicity impairment at Salt Slough and the San Joaquin River (Bear Creek to Mud Slough) is being addressed through the implementation of the Central Valley Water Board Irrigated Lands Regulatory Program (General Order R5-2014-0002) by the Westside San Joaquin River Watershed Coalition. Prior to the General Order, in 2008, the Coalition developed an active management plan for toxicity, which identified agricultural practices as a significant contributor and requires ongoing monitoring of the water bodies to assess progress at meeting water quality standards. The management plan suggested agricultural management practices to reduce toxicity in surface water, including integrated pest management programs, conversion to high-efficiency irrigation systems, and vegetation management and water management practices. The management plan is required to be updated until water quality criteria are achieved. The expected attainment date is 2024 (State Water Resources Control Board 2022ac, 2022af).

A TMDL to address impairment by toxicity in the San Joaquin River (Merced River to Vernalis) was expected to be completed by 2019; however, no TMDL has been released as of March 2023 (State Water Resources Control Board 2022ad, 2022ae, 2022ag). A TMDL for North Mud Slough and the San Joaquin River from Mud Slough to Merced River, and Mendota Pool to Bear Creek is expected to be completed in 2027 (State Water Resources Control Board 2022w, 2022z, 2022ah).

Sedimentation and Siltation

Panoche Creek, from Silver Creek to Belmont Avenue, is on the Water Board's CWA Section 303(d) list as impaired by sedimentation and siltation (State Water Resources Control Board 2022a). This decision was made prior to 2006 and there has been no new data or information available to reassess this waterbody segment and pollutant. Therefore, the decision to list this waterbody has not changed. A TMDL was established with an expected completion date of 2007; however, as of July 2023, no TMDL has been approved by the EPA (State Water Resources Control Board 2022aa).

G.1.9 Bay-Delta

The "Bay-Delta" region includes the legal Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay.

G.1.9.1 Overview

Primary factors affecting water quality in the Delta, Suisun Marsh, and Suisun Bay include patterns of land use in the upstream watersheds; inter-annual hydrologic variations; operations of the CVP and SWP and flow control gates within the Delta and marsh; and activities and sources of pollutants within and upstream of these water bodies. Point and nonpoint pollutant sources include drainage from inactive and abandoned mines and related debris/sediment from headwaters, industrial and municipal wastewater treatment plant discharges, agricultural return flows, urban storm water runoff, atmospheric deposition, recreational uses, and metabolic waste from wildlife and livestock. Natural erosion, instream sediments, and atmospheric deposition also affect water quality. The magnitude of each source's effect correlates with the relative contribution from each source at a given location and can differ by constituent or with hydrologic and climatic conditions during different times of year, and from year to year.

The San Francisco Bay water quality is similarly affected by upstream land uses; hydrologic variations; pollutant source input from municipal wastewater discharges, agricultural return flows, urban runoff, and mining activities; and recreational uses (Cohen 2000). The northern and central portions of San Francisco Bay are strongly influenced by freshwater Delta inputs, whereas the southern portion of the bay is often dominated by ocean water and is generally isolated from the northern portion (Cohen 2000). Thus, this water quality effects discussion will focus on the northern and central portions of the bay.

G.1.9.2 State-Designated Beneficial Uses

The Delta, Suisun Bay and Marsh, and San Francisco Bay provide water for many state-designated beneficial uses, as shown in Table G-1. The Bay-Delta Plan (State Water Resources Control Board 2018b) designates beneficial uses of the Delta. The Central Valley Basin Plan (Central Valley Regional Water Quality Control Board 2019a) also designates beneficial uses of the Delta within its jurisdiction, which includes the western, northwestern, southern, central, and eastern portions. Additionally, the *Water Quality Control Plan for the San Francisco Bay Region* (San Francisco Bay Region Basin Plan; San Francisco Bay Regional Water Quality Control Board 2023) designates beneficial uses for the western portion of the Delta within its jurisdiction, and for Suisun Marsh, Suisun Bay, and San Francisco Bay.

G.1.9.3 Constituents of Concern

The Section 303(d) list for California identifies the Delta waterways, Suisun Marsh, Suisun Bay, and San Francisco Bay as impaired for many constituents as shown in Table G-19 and Table G-20.

Various sloughs and creeks in the western and eastern Delta are on the Water Board Section 303(d) list of impaired water bodies due to elevated indicator bacteria (State Water Resources Control Board 2022a). Project operations would not affect flows in these waterbodies. Suisun Marsh and Suisun Bay are not on the Water Board Section 303(d) list as impaired due to elevated indicator bacteria. Therefore, pathogens and indicator bacteria are not addressed further in this technical appendix.

Kellogg Creek within the Delta is listed as impaired on the Water Board's Section 303(d) list for pH. Project operations would not affect flow on Kellogg Creek. Surface water pH within the affected environment is controlled primarily by natural factors, such as alkalinity from natural weathering of minerals and carbon dioxide concentrations controlled by algae and bacterial respiration. Therefore, pH is not addressed further in this technical appendix.

The Delta, Suisun Bay, and San Francisco Bay are listed as impaired by invasive species on the Water Board's Section 303(d) list because they have invasive species, with specific sources to these water bodies unknown (State Water Resources Control Board 2022a). Changes in water quality can make conditions more favorable for invasive species (e.g., aquatic vegetation and benthic macroinvertebrates), and invasive species can affect water quality conditions (e.g., turbidity, organic enrichment). However, invasive species are biological parameters and not water quality parameters; thus, invasive species within the Delta, Suisun Bay, and San Francisco Bay are not addressed further within this technical appendix.

The entire Delta is also listed on the Water Board's Section 303(d) list as impaired by unknown toxicity. Aquatic toxicity refers to the mortality of aquatic organisms or sublethal effects (e.g., reduced growth or reproduction) and can be caused by any number of individual constituents of concern, or through additive or synergistic effects attributable to the presence of multiple toxicants. Within the Delta, toxicity is known to occur, but the constituent(s) causing toxicity is unknown (State Water Resources Control Board 2022a). Thus, unknown toxicity within the Delta is not addressed further within this technical appendix.

The central and lower portions of San Francisco Bay are included on the Water Board's Section 303(d) list of impaired water bodies due to trash. The presence of trash is associated with humans discarding unwanted items on land or in surface waters, not CVP and SWP operations. Thus, trash within San Francisco Bay is not addressed further within this technical appendix.

Additional constituents of concern for the Delta that are not included in the Water Board's Section 303(d) list of impaired water bodies include bromide, organic carbon, and nutrients. Bromide is a salinity-related parameter of concern in the Delta because it reacts with ozone, and other municipal water treatment plant disinfectants. These reactions form bromate, bromoform, and other brominated trihalomethane compounds, as well as haloacetic acids, which are regulated disinfection byproducts in drinking water. Organic carbon is also of concern in the Delta because of the potential for disinfection byproducts to form in treated drinking water supplies. The Delta was not included on the Water Board's Section 303(d) list approved as impaired by nutrients, however, nutrients are of interest in the Delta (e.g., Central Valley Regional Water Quality Control Board 2010e) and are the focus of ongoing research. Suisun Marsh is a 303(d) listed waterbody for nutrients (State Water Resources Control Board 2022a).

Table G-19. Clean Water Act Section 303(d) Listed Pollutants and Sources in the Delta, Suisun Bay, and Suisun Marsh

		Delta Region								Specific Delta Waterways																				Suisun	
Pollutant/ Stressor	**Listed Source**	**Central**	**Eastern**	**Export Area**	**Northern**	**Northwestern**	**Southern**	**Stockton DWSC**	**Western**	**Cache Slough**	**Sacramento River**	**Lower Calaveras River**	**Bear Creek**	**Lower Cosumnes River**	**Duck Slough**	**Five Mile Slough**	**French Camp Slough**	**Kellogg Creek**	**Marsh Creek**	**Middle River**	**Lower Mokelumne River**	**Mormon Slough**	**Mosher Slough**	**Old River**	**Pixley Slough**	**Sand Creek**	**Smith Canal**	**Tom Paine Slough**	**Walker Slough**	**Suisun Bay**	**Suisun Marsh**
Arsenic	Source unknown	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benthic Community Effects	Source unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Chlordane	Source unknown	-	-	-	X	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Chloride	Source unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X
Chlorpyrifos	Source unknown, agriculture, urban runoff/storm sewers	X	X	-	X	X	X	X	X	-	-	X	-	-	X	X	X	-	-	-	-	X	-	X	X	X	-	-	-	-	-
Copper	Source unknown	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
DDE/DDT	Source unknown	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	X	-
Diazinon	Source unknown, agriculture, urban runoff/storm sewers	X	X	-	X	X	X	X	X	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-
Dieldrin	Source unknown	-	-	-	X	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	X	-
Dioxin	Source unknown	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Disulfoton	Source unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
EC/salinity	Source unknown	-	-	X	-	X	X	-	X	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	-	X	-	X	-	-	X
Fipronil	Source unknown	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Pollutant/ Stressor	Listed Source	Delta Region								Specific Delta Waterways																				Suisun	
		Central	Eastern	Export Area	Northern	Northwestern	Southern	Stockton DWSC	Western	Cache Slough	Sacramento River	Lower Calaveras River	Bear Creek	Lower Cosumnes River	Duck Slough	Five Mile Slough	French Camp Slough	Kellogg Creek	Marsh Creek	Middle River	Lower Mokelumne River	Mormon Slough	Mosher Slough	Old River	Pixley Slough	Sand Creek	Smith Canal	Tom Paine Slough	Walker Slough	Suisun Bay	Suisun Marsh
Furan compounds	Source unknown	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Group A Pesticides [a]	Source unknown	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indicator bacteria	Source unknown, urban runoff/storm sewers	-	-	-	-	-	-	-	-	-	-	X	X	X	-	X	X	X	X	-	-	X	X	X	X	X	X	-	X	-	-
Invasive species	Source unknown	X	X	X	X	X	X	X	X	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Manganese	Source unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
Mercury	Resource extraction, industrial-domestic wastewater, atmospheric deposition, nonpoint source	X	X	X	X	X	X	X	X	X	-	X	-	X	-	-	-	-	X	X	X	-	X	-	-	-	-	-	-	X	X
Nutrients	Source unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
Organic enrichment/ low DO	Municipal point sources, urban runoff/storm sewers, hydromodification, source unknown	-	-	-	-	-	-	X	-	-	-	X	X	X	-	X	X	-	-	X	-	X	X	X	X	X	X	X	-	-	X

Pollutant/ Stressor	Listed Source	Delta Region								Specific Delta Waterways																				Suisun	
		Central	Eastern	Export Area	Northern	Northwestern	Southern	Stockton DWSC	Western	Cache Slough	Sacramento River	Lower Calaveras River	Bear Creek	Lower Cosumnes River	Duck Slough	Five Mile Slough	French Camp Slough	Kellogg Creek	Marsh Creek	Middle River	Lower Mokelumne River	Mormon Slough	Mosher Slough	Old River	Pixley Slough	Sand Creek	Smith Canal	Tom Paine Slough	Walker Slough	Suisun Bay	Suisun Marsh
PAHs	Source unknown	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PCBs	Source unknown	-	-	-	X	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
pH	Source unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyrethroid Pesticides	Source unknown	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	Source unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-
TDS	Source unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	X
Temperature	Source unknown	-	-	-	-	-	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Toxicity [b]	Source unknown	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	X	X	X	-	X	X	-	-	X	X	-	-	-	-	-
Zinc	Source unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-

Source: State Water Resources Control Board 2022a.

DWSC = deep water ship channel; DDE = dichloro-diphenyl-dichloroethylene; DDT = dichloro-diphenyl-trichloroethane; DO = dissolved oxygen; EC = electrical conductivity; PAH = polycyclic aromatic hydrocarbon; PCB = polychlorinated biphenyl; pH = measure of acidity; TDS = total dissolved solids.

[a] Group A Pesticides include aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, benzene hexachloride (including lindane), endosulfan, and toxaphene.

[b] Toxicity is known to occur, but the constituent(s) causing toxicity is unknown.

Table G-20. Clean Water Act Section 303(d) Listed Pollutants and Sources in the Delta and San Francisco Bay

Pollutant/Stressor	Listed Source	San Francisco Bay					
		Delta	Carquinez Straight	San Pablo Bay	Central	Lower	South
Chlordane	Source unknown	x	x	x	x	x	x
DDT	Source unknown	x	x	x	x	x	x
Dieldrin	Source unknown	x	x	x	x	x	x
Dioxin	Source unknown	x	x	x	x	x	x
Furan compounds	Source unknown	x	x	x	x	x	x
Invasive species	Source unknown	x	x	x	x	x	x
Mercury	Resource extraction, industrial-domestic wastewater, atmospheric deposition, nonpoint source	x	x	x	x	x	x
PCBs	Source unknown	x	x	x	x	x	x
Selenium	Source unknown	x	x	x	x	-	x
Trash	Source unknown	-	-	-	x	x	-

Source: State Water Resources Control Board 2022a.
DDT = dichloro-diphenyl-trichloroethane; PCB = polychlorinated biphenyl.

Salinity

Delta, Suisun Marsh, and Suisun Bay

Salinity in the Delta channels can vary depending on several factors, including surface water hydrology and inflow quality, water project operations, and hydrodynamics. Hydrology and upstream water project operations influence Delta inflows, which in turn influence the balance with the highly saline seawater intrusion. Delta salinity conditions are affected by upstream source water quality that flows into the Delta, as well as in-Delta sources such as agricultural returns, natural leaching, and municipal and industrial discharges. Operation of various Delta gates and barriers, pumping rates of various diversions, and the volume of open water bodies are other key factors influencing Delta hydrodynamics and salinity.

Salinity in Suisun Bay is primarily affected by Delta outflow to the bay and tidal inflows from San Francisco Bay. Salinity within Suisun Marsh is similarly affected by inflows from the Delta, as affected by water project operations, Suisun Bay inflows, and the use of the Suisun Marsh Salinity Control Gates (SMSCG), which are located on Montezuma Slough near Collinsville. The SMSCG are operated periodically from September to May to meet the Bay-Delta Plan objectives and Water Right Decision 1641 requirements. The SMSCG operations restrict the inflow of high-salinity flood-tide water from Grizzly Bay into the marsh but allow freshwater ebb-tide flow from the mouth of the Delta to pass through. The gate operation lowers salinity in Suisun Marsh channels and results in a net movement of water from east to west. When the Delta outflow is low to moderate and the gates are not operating, net movement of water is from west to east, resulting in higher salinity water in Montezuma Slough.

The Bay-Delta Plan (State Water Resources Control Board 2018b) includes numeric salinity-related objectives for the Delta and Suisun Marsh. It includes chloride objectives to protect municipal and industrial water supply beneficial uses. It also includes EC objectives for multiple western, interior, and south Delta compliance locations to protect agricultural supply beneficial uses. The Bay-Delta Plan specifies salinity objectives for fish and wildlife protection: EC objectives for the Delta and Suisun Marsh, a narrative salinity objective for brackish tidal marshes of Suisun Bay, and the X2 standard that regulates the location and number of days of allowable encroachment into the west Delta of salinity exceeding 2 parts per thousand isohaline (2.64 millisiemens per centimeter) (State Water Resources Control Board 2018b). In general, the chloride and EC objectives vary depending on the month and water year type. Compliance with salinity objectives is largely dependent on Delta inflows and outflows. The CVP and SWP are operated to achieve Delta salinity objectives.

Waterways within the Delta and Suisun Marsh have been identified as impaired due to elevated salinity/EC and are included on the Water Board’s Section 303(d) list (State Water Resources Control Board 2022a). The Delta waterways listed as impaired due to elevated EC include southern, western, and northwestern portions, the export area, Old River, Sand Creek, Kellog Creek, and Tom Paine Slough. Tom Paine Slough is also listed as impaired for chloride and Old River is also listed for TDS. Suisun Marsh is listed as impaired due to elevated chloride, EC, and TDS.

The Water Board is in the process of updating flow and water quality objectives in the Bay-Delta Plan. The Water Board adopted the lower San Joaquin River and Southern Delta portion of the Bay-Delta Plan update in December 2018. Updates for the Sacramento River and its tributaries, including Delta eastside streams (Calaveras, Cosumnes, and Mokelumne rivers) are in development (State Water Resources Control Board 2018b).

In addition to EC and chloride, the salinity-related constituent bromide is of concern in Delta waters, even though the Delta is not listed as impaired by bromide. The complex interplay between hydrology, water project operations, bromide sources, and hydrodynamics results in bromide’s presence in Delta waters. The primary source of bromide in the Delta is seawater intrusion. Bromide concentrations also are generally higher in the lower San Joaquin River and Delta island agricultural drainage because of irrigation practices and evaporative concentration that occurs in water diverted from the Delta for irrigated agriculture. Recirculation, or the process of agricultural drainage entering the San Joaquin River and its subsequent and repetitive diversion for agricultural practices, also contributes to elevated bromide concentrations in the San Joaquin River.

There are no federally promulgated or state adopted water quality objectives for bromide in surface waters.

San Francisco Bay

Cohen (2000) characterizes the salinity of the San Francisco Bay Estuary into three broad regions, when considering the bay's biota. The first zone is the Delta, the freshwater region. The second zone is the lower salinity region, which consists of Suisun Bay and extends sometimes into Carquinez Strait and San Pablo Bay, as well as areas along other freshwater inflows, such as the Napa River and Petaluma River on San Pablo Bay, and sloughs and creeks entering the southern portion of the bay. The third zone, the higher salinity region, is the main portions of the South, Central, and San Pablo bays. The freshwater inflows from the Delta flows into the bay near the water surface and gradually mixes in due to its lower density as compared with sea water (Cohen 2000). The Delta inflows also create horizontal salinity gradients, with lower salinity water near the Delta and higher salinity water near the mouth of the bay (Cohen 2000).

The twice daily tidal cycle results in substantial water movement in and out of San Francisco Bay. With each tidal cycle, an average of 1,300,000 acre-feet of seawater moves into and out of San Francisco Bay (Cohen 2000). By comparison, daily freshwater inflow averages about 50,000 acre-feet (Cohen 2000), which is about 4% of the inflow volume of seawater.

The San Francisco Bay Basin Plan water quality objective for salinity requires that controllable water quality factors shall not increase the TDS or salinity of waters of the state in a way that would negatively affect state-designated beneficial uses, particularly fish migration and estuarine habitat (San Francisco Bay Regional Water Quality Control Board 2023).

Mercury

Delta

Legacy mining in the headwaters of the Sacramento River watershed is the primary source of mercury contamination in the Delta and Suisun Bay. At least 80% of the total mercury flux to the Delta can be attributed to the Sacramento River Basin, which is comprised of tributary watersheds to the Sacramento and Yolo Bypass (Central Valley Regional Water Quality Control Board 2010f). An analysis of total mercury loading to the Delta during water years 1984 to 2003 determined that the Sacramento River is the primary tributary source of mercury to the Delta in dry years and the proportion of mercury loading from the Yolo Bypass increases in wet years to the extent that it is comparable to that of the Sacramento River. Cache Creek, and the associated Cache Creek Settling Basin, is also the major source of mercury to the Yolo Bypass where mercury loading mostly occurs via transport of sediment-bound mercury. Therefore, a priority for mercury reduction management strategies is controlling mercury inputs from tributary sources.

Sediment in Cache Creek that is not captured by the Cache Creek Settling Basin is transported into the Yolo Bypass (approximately half of the sediment transported by Cache Creek). Outflow from the Settling Basin (and possibly in other tributaries to the Yolo Bypass) exceeds the CTR mercury criterion of 0.050 μg/L for drinking water; thus, when flows from Cache Creek dominate Yolo Bypass, the bypass also likely exceeds the CTR criterion (Central Valley Regional Water Quality Control Board 2010f). Compounding the issue of mercury contamination in the Yolo Bypass, a U.S. Geological Survey (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 (U.S. Geological Survey 2002). Mine remediation, erosion control in mercury-enriched areas, and removing floodplain sediments containing mercury will reduce mercury loads in Cache Creek (Central Valley Regional Water Quality Control Board 2010f). Regularly excavating the sediment accumulating in the Cache Creek Settling Basin will also reduce mercury entering the Delta.

It has been estimated that the flux of methylmercury from Delta sediments contributes 36% of the waterborne methylmercury load in the Delta annually, based on an analysis of data from water years 2000 to 2003 (Central Valley Regional Water Quality Control Board 2010f). Therefore, the spatial variability of mercury and methylmercury in sediments is an important characteristic of the Delta's current condition for mercury exposure and could be important for determining future mercury risk. The National Water Quality Assessment Program for the Sacramento River Basin sampled streambed sediment mercury concentrations from the Delta in 1995 (MacCoy and Domagalski 1999:13). Sediment mercury concentrations of 0.14 µg/g (dry weight basis in the <63 micron fraction) at Freeport and 0.15 µg/g in Cache Creek were less than the threshold effect concentration (0.18 µg/g) and probable effect concentration (1.06 µg/g) reported by MacDonald et al. (2000:23–24). These reported mercury concentrations in sediment greatly exceeded the average amount of background mercury found on the earth's surface, which is about 0.05 µg/g.

The Central Valley RWQCB initiated the Delta Regional Monitoring Program (RMP) to establish a coordinated system among the many agencies and groups that monitor water quality, flows, and ecological conditions in the Delta. The Delta RMP ensures that all data are collected according to standard practices to produce data of known quality that are synthesized and assessed on a regular basis, with the primary goal of tracking and documenting beneficial use protection and restoration efforts' effectiveness through the comprehensive monitoring of contaminants and contaminant effects in the Delta. The Delta RMP began a methylmercury monitoring program in 2016 to establish baseline concentrations and support long-term trend monitoring as a critical performance measure for mercury control programs. Field workers collected largemouth bass and spotted bass (*Micropterus punctulatus*) from August and September 2016 at six locations distributed across the Delta that coincide with the TMDL subareas (Davis et al. 2018:4). Total mercury in fish tissues (length-normalized to 350 millimeters [mm]) ranged from 0.15 mg/kg wet weight at Little Potato Slough to 0.61 mg/kg wet weight at the Sacramento River at Freeport. Methylmercury concentrations in unfiltered water ranged from 0.021 to 0.22 ng/L among four monitoring events from August 2016 to April 2017. Concentrations of total mercury in unfiltered water ranged from 0.91 to 13 ng/L.

The EPA approved the Delta Estuary Methylmercury TMDL (Central Valley Regional Water Quality Control Board 2010f) in 2011 to protect human health, wildlife, and aquatic life. The TMDL, and associated Basin Plan amendment, establishes methylmercury fish tissue objectives; load allocations for agricultural drainage, atmospheric wet deposition, open water, tributary inputs, wetlands, and nonpoint source dischargers (i.e., municipal separate stormwater systems); and, waste load allocations to point source dischargers (e.g., municipal wastewater dischargers) in the Delta (including Yolo Bypass). The methylmercury objectives protective of human health and wildlife include a goal of not exceeding 0.24 mg/kg wet weight in muscle tissue of trophic level 4 fish (200–500 mm total length) normalized to 350 mm total length. Equivalent objectives are0.08 mg/kg wet weight in muscle tissue of trophic level three fish, (150–500 mm total length) and 0.03 mg methylmercury/kg wet weight in trophic level 2 whole fish less than 50 mm in length.

In conjunction with the mercury and methylmercury load reduction goals of the Delta Methylmercury TMDL, the Central Valley RWQCB developed a Delta Mercury Exposure Reduction Program (Delta Mercury Control Program Mercury Exposure Reduction Program 2012; Sacramento–San Joaquin Delta Conservancy 2019) as a multiple stakeholder effort to promote a better understanding of mercury bioaccumulation in Delta fish and support approaches for reducing human exposure to mercury from fish caught in the Delta.

San Francisco Bay, Suisun Bay, and Suisun Marsh

Delta inputs primarily drive mercury concentrations in northern San Francisco Bay, Suisun Bay, and Suisun Marsh. Methylmercury concentrations in surface waters and sediment are highest in the South Bay because of conditions favoring methylation and historical mercury inputs from the New Almaden Mine. These sources led to higher average total mercury concentrations in striped bass (*Morone saxatilis*) tissues (0.44 mg/kg wet weight) from the San Francisco Bay than any other estuary in the United States (Davis et al. 2014). The San Francisco Bay RMP conducts fish tissue sampling and analysis in the San Francisco Bay every three years to monitor tissue mercury concentrations in fish tissues. Concentrations in several sport fish did not decline from 1994 to 2009 and tissue samples from most species exceeded 0.2 mg/kg wet weight total mercury in fish from San Pablo Bay, Central Bay, and South Bay (Davis et al. 2012). Sampling from shorelines throughout the Bay area in 2008 to 2010 found average total mercury tissue concentrations of Mississippi Silverside (*Menidia beryllina*) exceeded 0.2 mg/kg wet weight in the South Bay and ranged from <0.06 to 0.197 mg/kg wet weight in all areas of the Bay (Greenfield et al. 2013).

The San Francisco Bay Mercury TMDL includes Suisun Bay and describes numeric targets for mercury in fish tissue of 0.03 mg/kg wet weight in whole fish ranging from 3 to 5 centimeters in length for the protection of aquatic organisms and wildlife and 0.2 mg/kg wet weight in trophic level 3 and trophic level 4 fish fillets for the protection of human health. A one-hour average marine surface water objective of 2,100 ng/L total mercury also applies (San Francisco Bay Regional Water Quality Control Board 2006). The San Francisco Bay Mercury TMDL added Suisun Marsh more recently (San Francisco Bay Regional Water Quality Control Board 2018); the Suisun Marsh mercury TMDL was approved by the EPA in 2019.

Selenium

Delta, Suisun Marsh, and Suisun Bay

Inputs from the Sacramento and San Joaquin Rivers drive selenium concentrations in the Delta. Concentrations are higher in the San Joaquin River; however, greater flows in the Sacramento River result in a substantial contribution to the mass loading of selenium to the Delta (Cutter and Cutter 2004; Tetra Tech 2008). Presser and Luoma (2006) projected that loads to the Delta from the Sacramento River were about half of the Grasslands Basin's projected contribution to the San Joaquin River, with subsequent loading to the Delta from the San Joaquin River dependent on flow (Presser and Luoma 2006). Implementation of the Grassland Bypass Project in 1996 led to a 60% decrease in selenium loads to the Delta from the San Joaquin River at Vernalis from the Grassland Drainage Area in comparison to pre-project conditions (Tetra Tech 2008).

Concentrations in the San Joaquin River at Vernalis measured by the USGS (2020) have continued to decline since implementation of the Grasslands Bypass Project between 2000 and 2020 (Figure G-6).

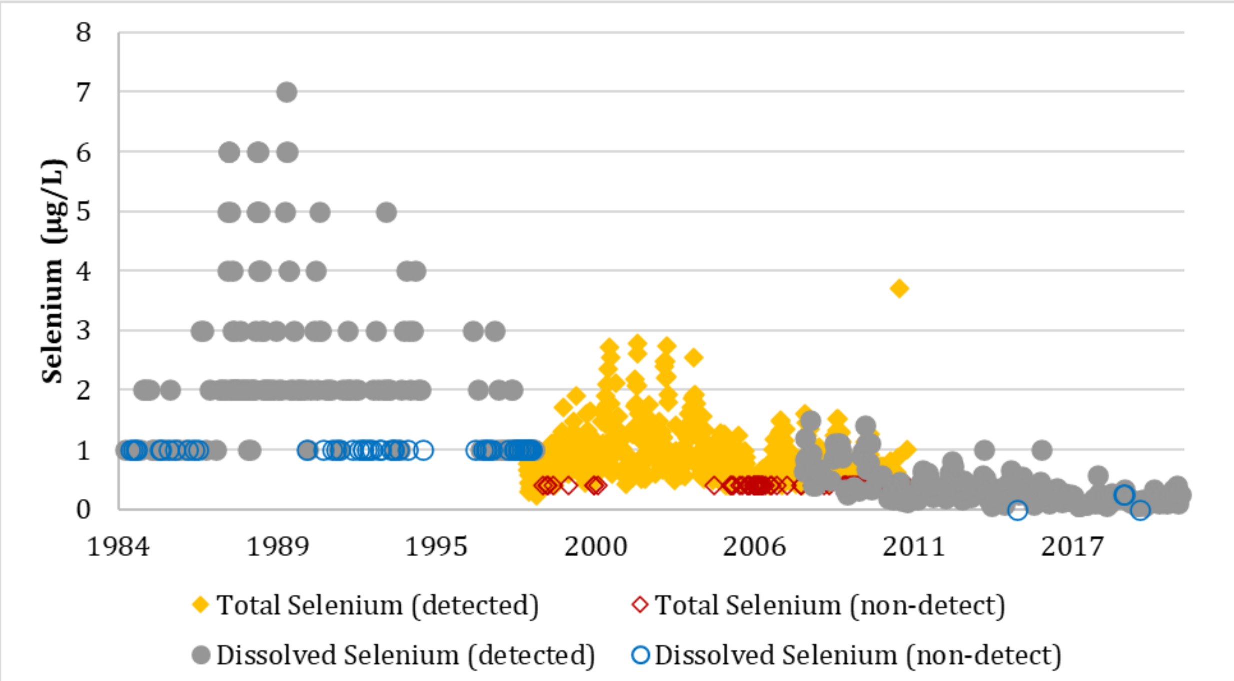


Figure G-6. Measured Selenium Concentrations (total and dissolved in micrograms per liter) in the San Joaquin River at Vernalis

Suisun Bay is on the Water Board's CWA Section 303(d) list as impaired due to elevated concentrations of selenium. However, the list does not identify Suisun Marsh as an impaired waterbody for selenium contamination. The Suisun Bay selenium impairment is attributed to discharge from natural sources, industrial point sources such as oil refineries, and the presence of exotic species, which increase selenium bioaccumulation into the food web (San Francisco Bay Regional Water Quality Control Board 2015). *Corbula* (*Potamocorbula*) *amurensis*, a species of clam and an important food source for sturgeon and certain ducks, bioaccumulates selenium at a high rate (Stewart et al. 2013). The exotic species was first discovered in Suisun Bay in 1986 and was common by 1990 in estuarine waters from San Pablo Bay to Suisun Bay (Cohen 2011).

The EPA developed national recommended chronic aquatic life criteria for selenium, promulgated criteria specific to the San Francisco Bay, Suisun Bay, and Delta, and recently proposed separate selenium criteria for California and the Bay-Delta. In 1992, the EPA promulgated a chronic water quality criterion for selenium applicable to San Francisco Bay, Suisun Bay, and the Delta, expressed as a total recoverable water column concentration of 5 µg/L (58 *Federal Register* 103 [December 22, 1992]). In 2021, the EPA published the current national recommended chronic aquatic life criterion for selenium, which consists of fish tissue (8.5 µg/g dry weight in whole-body; 11.3 µg/g dry weight in muscle, and 15.1 µg/g dry weight in ovaries) and water column concentration thresholds (1.5 µg /L total dissolved selenium in lentic systems and 3.1 g /L total dissolved selenium in lotic systems; U.S. Environmental Protection Agency 2021). The EPA also proposed aquatic life and aquatic-dependent wildlife criteria in 2016 specifically for the Bay-Delta (U.S. Environmental Protection Agency 2016). The proposed Bay-Delta criteria include the same whole-body and muscle criteria for fish as the EPA's national recommended criterion but has lower criteria for water column concentrations to account for greater bioaccumulation of selenium in the tissues of organisms residing in Delta waters. Unlike the national criterion, the proposed Bay-Delta criteria do not include a tissue-based criterion for fish eggs/ovaries but do include a tissue-based criterion for clams. In 2018, the EPA proposed selenium criteria for California that consist of the 2016 national recommended criterion with a bird tissue criterion added, and a performance-based approach to translate the tissue criterion elements into protective water column elements on a site-specific basis instead of specific water column criterion elements. The proposed EPA (2018) criteria for California would not apply to surface waters where site-specific selenium criteria have been adopted or in waters with selenium criteria promulgated in the National Toxics Rule (NTR) (e.g., the lower San Joaquin River, Grasslands watershed, San Francisco Bay, Suisun Bay, and the Delta).

San Francisco Bay

The entire San Francisco Bay is on the Water Board's CWA Section 303(d) list as impaired by selenium. Surface water exports from the Delta, local tributaries, and atmospheric deposition are the primary selenium sources to the northern portion of the bay (San Francisco Bay Regional Water Quality Control Board 2015).

The San Francisco Bay Basin Plan refers to total selenium criteria of 5 µg/L (4-day average) and 20 µg/L (1-hour average) promulgated for all San Francisco Bay/Delta waters in the NTR. The NTR criteria specifically apply to San Francisco Bay upstream to and including Suisun Bay and Delta (San Francisco Bay Regional Water Quality Control Board 2023).

To protect the most susceptible fish, white sturgeon (*Acipenser transmontanus*), from selenium toxicity, a selenium TMDL was adopted in 2016 for the North San Francisco Bay, defined to include a portion of the Delta (i.e., Delta segment), Suisun Bay, Carquinez Strait, San Pablo Bay, North Bay, and the Central Bay (State Water Resources Control Board 2016). The TMDL includes numeric targets for selenium in fish tissue (8.0 µg/g dry weight in whole-body; 11.3 µg/g dry weight in muscle) and the water column (0.5 µg/L dissolved total selenium) (San Francisco Bay Regional Water Quality Control Board 2015). Selenium concentrations in white sturgeon muscle collected from the North Bay from 2015 to 2017 averaged 11.8 µg/g dry weight in 2015, 10.6 µg/g dry weight in 2016, and 7.3 µg/g dry weight in 2017 (Sun et al. 2019). When considered with water year type, data suggests that selenium concentrations in sturgeon tissues were driven more by hydrology than water column concentrations (Sun et al. 2019).

Existing selenium concentrations in the water column are below the TMDL target of 0.5 µg/L and have been declining since the late 1990s. Therefore, the TMDL does not require load reductions below current levels and the implementation plan's main goal is to prevent increases of selenium concentrations in North Bay waters and attain safe levels of selenium in fish, specifically benthic feeders (e.g., Sacramento Splittail [*Pogonichthys macrolepidotus*] and sturgeon). The TMDL includes a load allocation for the Central Valley watershed (4,070 kg/year) and requires monitoring to identify any need for adaptive implementation (San Francisco Bay Regional Water Quality Control Board 2015).

The TMDL does not include the South Bay because it is affected by local and watershed sources not associated with the Delta or refineries, while the primary selenium loading to the North Bay and the Suisun Bay area is from the Delta and oil refineries in the vicinity of Carquinez Strait (Lucas and Stewart 2007; Stewart et al. 2013).

Trace Metals

Trace metals impairments within the assessment area include arsenic in the western Delta, copper in Bear Creek and the lower Mokelumne River, manganese in the Old River, and zinc in the lower Mokelumne River (State Water Resources Control Board 2022a).

Arsenic is a tasteless and odorless semi-metal element highly toxic to humans. Long-term, chronic exposure to arsenic has adverse dermal, cardiovascular, respiratory, gastrointestinal, and neurological effects, and has been linked to cancer of the bladder, lungs, skin, kidneys, nasal passages, liver, and prostate (Agency for Toxic Substances and Disease Registry 2007b). Short-term exposure to high doses of arsenic can cause acute symptoms such as skin damage, circulatory system dysfunction, stomach pain, nausea, and vomiting, diarrhea, numbness in hands and feet, partial paralysis, and blindness. The Section 303(d) impairment listing for arsenic is based on elevated concentrations in *Corbicula* tissue samples collected from 1993–2008 in Bear Creek. A TMDL to protect the state-designated beneficial uses due to arsenic impairment is expected to be completed in 2027 (State Water Resources Control Board 2022a).

Copper occurs in organic and inorganic forms. Organic copper is an essential micronutrient for animals, while exposure to high concentrations of inorganic copper can be toxic (Agency for Toxic Substances and Disease Registry 2004). In humans, short-term exposure to copper can cause nausea and vomiting; long-term exposure can cause liver or kidney damage (Agency for Toxic Substances and Disease Registry 2004). Copper levels in Bay-Delta waters are not sufficiently high to result in health effects on humans, but copper is of concern because low (i.e., at the ppb) levels can be toxic to aquatic life, depending on other ambient water quality conditions (e.g., hardness, organic carbon levels). The Section 303(d) listing for copper for the lower Mokelumne River was based on decisions made prior to 2006 and no additional data was considered for the current listing. In Bear Creek, 4 of 19 surface water samples collected in 2000–2002 exceeded the CTR criteria for copper for the protection of aquatic life (State Water Resources Control Board 2022a). TMDLs to address these water quality impairments were expected to be complete by 2020 for the lower Mokelumne River and 2021 for Bear Creek (State Water Resources Control Board 2022a).

Manganese is a trace element that occurs naturally in many types of rocks and in soil. It is essential for good health, occurs in most foods, and is available in nutritional supplements. It is also used in steel production and other products such as batteries, fertilizer, paints, cosmetics, fireworks, and as a gasoline additive (Agency for Toxic Substances and Disease Registry 2012). The source of manganese in the Old River is not known, but three of 30 samples collected between August 2013 and April 2016 in the Old River, reported as dissolved concentrations, exceeded the 0.05 mg/L water quality objective for the municipal and domestic supply use. A TMDL to protect the state-designated beneficial uses due to manganese in the Old River is expected to be complete by 2035 (State Water Resources Control Board 2022a).

Zinc is an essential micronutrient for plants and animals, but at elevated concentrations in surface water interferes with the metabolism of calcium and iron (Agency for Toxic Substances and Disease Registry 2005). This can lead to osteomalacia (softening of the bone) from deficiency in minerals including calcium and phosphorous. Zinc can also damage fish gills and lead to hypoxia from reduced oxygen exchange. The lower Mokelumne River Section 303(d) listing was based on decisions made prior to 2006 and no additional data was considered, although, zinc concentrations measured in 2002 did not exceed the CTR criteria (State Water Resources Control Board 2022a). A TMDL addressing zinc impairments in the lower Mokelumne River is expected to be complete by 2027 (State Water Resources Control Board 2022a).

Nutrients

Nutrients such as nitrogen and phosphorus originate from natural sources and anthropogenic sources, including point and nonpoint source discharges. Although nutrients are necessary for a healthy ecosystem, the over-enrichment of nitrogen and phosphorus can lead to eutrophication, increased production of blue-green algae, more invasive aquatic macrophytes, and nutrient-related problems in drinking water systems.

Delta, Suisun Marsh, and Suisun Bay

A decline in pelagic fish species in the Delta, known as the pelagic organism decline, including the endangered Delta Smelt (*Hypomesus transpacificus*), may be related to bottom-up effects from nutrients among other drivers (Baxter et al. 2008; Sommer et al. 2007). Nutrients are also affected by flow and other factors (e.g., temperature, turbidity, and invasive species) that are potentially associated with the pelagic organism decline.

Unlike most water bodies where nutrients cause too much primary production, the problem affecting state-designated beneficial uses in parts of the Delta is too little primary production to support fish populations (Hammock et al. 2019 and references within). Despite decades of monitoring and intensive research efforts, the cause for low productivity remains unclear (Hammock et al. 2019). Several hypotheses to explain the low productivity have been proposed. Jassby recognized light as the limiting factor preventing high primary production within the Delta, rather than nutrients (Jassby et al. 2002; Jassby 2008). Dugdale et al. (2007) and Parker et al. (2012) offered another hypothesis, that ammonium (a dominant form of nitrogen in the Delta and Suisun Bay) inhibits the uptake of nitrate, which is more conducive to beneficial algae blooms. Glibert et al. (2011) suggest that the current form and ratio of nutrients (i.e., elevated nitrogen, resulting in a high nitrogen to phosphorus ratio) in the Delta may give preferential advantage to smaller celled and less nutritious primary producers. Alternatively, other factors contributing to little primary production may be caused by invasive clams introduced in the mid-1980s that consume algae, reducing food availability for zooplankton and fish (Lucas and Thompson 2012; Kimmerer et al. 1994) or reduced phosphorus that becomes a limiting factor for primary production (Van Nieuwenhuyse 2007). Grazing by invasive clams (i.e., *Potamocurbula ameurensis*) is the most widely accepted hypothesis for why productivity remains low (Hammock et al. 2019 and references within).

More classical signs of eutrophication are often found in the central and southern Delta near Stockton where nutrient enrichment feeds algal blooms that can cause areas of oxygen depletion. High nutrient concentrations, warm temperatures, and low flow are conditions shown to be conducive to toxic blue-green algae growth (i.e., cyanobacteria) with *Microcystis* blooms becoming more prevalent in the central and southern Delta (Lehman et al. 2008). Studies have shown that many of these *Microcystis* blooms are fueled by ammonium, not nitrate (Lehman et al. 2015, 2017). High nutrient concentrations have also been suggested as facilitating the spread of invasive macrophytes throughout the Delta; however, at this time the exact role of nutrients in driving macrophyte expansion remains unknown (Ta et al. 2017). The rapid expansion of invasive macrophytes despite steady decline in nitrogen and phosphorus concentrations and ratios suggest other factors besides nutrients are contributing to extensive aquatic plant growth in the Delta (Boyer and Sutula 2015).

Municipal discharges into the Delta and its source waters contribute nutrients, though upgrades to treatment processes have resulted in reduced contributions of ammonia and nitrate from these sources. Nitrogen inputs to the Delta from treated wastewater were reduced in spring of 2023 when the EchoWater Resource Recovery Facility (formerly the Sacramento Regional Wastewater Treatment Plant) completed implementing nitrification and denitrification tertiary treatment upgrades to comply with NPDES permit requirements. The Stockton Regional Wastewater Control Facility, which discharges to the San Joaquin River, implemented nitrification in 2007 to reduce ammonium discharged in its treated effluent and is required to reduce nitrate discharges by 2024 to comply with NPDES permit requirements.

Another source of nutrients to the Delta is agricultural return flows. The Central Valley RWQCB Irrigated Lands Regulatory Program aims to prevent agricultural runoff containing nutrients from impairing surface waters. Growers are required to implement management practices to protect surface water, especially in areas where monitoring has identified problems associated with irrigated agriculture. Growers must conduct farm evaluations to determine the effectiveness of farm practices in protecting water quality.

Nutrients and their effects on Delta water quality are a focus of the Delta RMP, as part of its mission is to understand regional water quality conditions and trends, and to inform regulatory and management decisions. The program supports efforts by the USGS to monitor and synthesize existing data to understand how nitrogen and phosphorus from fertilizers and runoff may be affecting Delta waterways. High frequency nutrient monitoring data (about every 15 minutes) is collected in the Delta to examine the relationships between nutrient concentrations, nutrient cycling, and aquatic habitat conditions (Downing et al. 2017). High frequency data collection by the USGS began in 2013 and 11 stations operated throughout the Delta by 2016, measuring temperature, pH, specific conductance, turbidity, DO, nitrate, chlorophyll a, phycocyanin, and dissolved organic matter concentrations (Downing et al. 2017). The spatial and temporal trends in nutrient concentrations and nutrient-related parameters are reasonably well understood (Jabusch et al. 2018a). The data indicates increasing trends for chlorophyll a at the Sacramento and San Joaquin River confluence, Suisun Bay, and Franks Tract. Efforts are ongoing to understand the sources, sinks, and nutrient transformation behind these trends (Novick et al. 2015).

Suisun Marsh is currently listed as impaired due to nutrients (State Water Resources Control Board 2022a). Specific sources of nutrients to Suisun Marsh include agricultural, urban, and livestock grazing drainage through tributaries, the Delta, nutrient exchange with Suisun Bay, atmospheric deposition, and discharge from treated sewage (Tetra Tech and Wetlands and Water

Resources 2013). Concentrations of total ammonia from 2000–2011 in Boynton, Peytonia, Sheldrake, and Chadbourne Sloughs (0–0.4 mg/L), as well as in Suisun Slough (0–0.3 mg/L), exceeded the water quality objective (Tetra Tech and Wetlands and Water Resources 2013). Elevated concentrations of chlorophyll a, in comparison to concentrations at reference sites at Mallard Island, suggest possible impairments by nutrients. Research suggests other possible narrative nutrient criteria impairments caused by excess algal growth in wetlands, elevated organic carbon, and trends in DO and mercury methylation.

The Central Valley RWQCB, California Environmental Protection Agency, and stakeholders developed a *Delta Nutrient Research Plan* (Central Valley Regional Water Quality Control Board 2018b) to determine whether numeric water quality objectives for nutrients are needed to address nutrient-associated water quality concerns in the Delta. The nutrient-associated water quality concerns include harmful algal blooms and associated toxins and nuisance compounds, excess aquatic plant growth, the low abundance of phytoplankton species that support the food web, and low DO in some waterways. The *Delta Nutrient Research Plan* reports that scientific data gaps currently limit the ability to develop nutrient benchmarks, goals, triggers, targets, and water quality objectives. The plan presents a framework and prioritized actions to gather the information necessary to develop protective thresholds and identify management options to reduce nutrient-associated adverse effects.

San Francisco Bay

The San Francisco Bay is recognized as a nutrient-enriched estuary. However, DO concentrations are much higher and phytoplankton biomass is much lower than what would be expected in an estuary with such nutrient enrichment (Novick and Senn 2014; Cloern 1996). The Bay has some of the lowest primary production rates of an estuarine coastal ecosystem in the world (Cloern et al. 2014). Observations in recent years suggest that the Bay's characteristic nutrient enrichment resilience is weakening (San Francisco Estuary Institute 2016). In response to concerns over nutrient enrichment and low phytoplankton growth, the San Francisco Bay RWQCB worked collaboratively with stakeholders to develop the *San Francisco Bay Nutrient Management Strategy* with goals to manage nutrient loads and maintain state-designated beneficial uses within the Bay (San Francisco Estuary Institute 2016).

Large nutrient loads entering the San Pablo Bay from Suisun Bay, which includes Delta outflows, are the dominant source of nutrients to the San Pablo Bay throughout much of the year (Novick and Senn 2014). Therefore, nutrient loads to, and transformations within, the Delta, combined with Delta outflow, affect nutrient concentrations entering San Pablo Bay. The dissolved inorganic nitrogen and dissolved inorganic phosphorus loads from Suisun Bay dominate nutrient inputs throughout much of the year and are drivers of nutrient-dependent processes (e.g., algae growth).

The influence of Delta-derived freshwater flows is muted in the South Bay and Lower South Bay by oceanic flows in and out of the Golden Gate (Senn and Novick 2014). The dominant source of dissolved inorganic nitrogen and dissolved inorganic phosphorus year-round in the lower South Bay, South Bay, and Central Bay is discharge from municipal wastewater treatment plants (Novick and Senn 2014).

Organic Enrichment and Dissolved Oxygen

Delta, Suisun Marsh, and Suisun Bay

Localized incidents of organic enrichment and depressed DO concentrations occur in the eastern, southern, and western Delta, and in Suisun Marsh. Several Delta waterways in the eastern and southern Delta, and Suisun Marsh are included on the Water Board's Section 303(d) list of impaired water bodies due to organic enrichment and low DO.

Notable low DO concentrations occur in the Delta in the Stockton Deep Water Ship Channel, most often during the months of June through October, although low DO conditions have also occurred in the winter months (Central Valley Regional Water Quality Control Board 2005; Schmieder et al. 2008). Historical low DO concentrations are attributed to a combination of low flow and high nutrient loads (U.S. Environmental Protection Agency 2015). DO concentrations increased since the Stockton Deep Water Ship Channel TMDL's adoption in 2007. The duration and magnitude with which DO levels are lower than water quality objectives are smaller than before adoption (U.S. Environmental Protection Agency 2015). Low (e.g., 3 mg/L) DO concentrations of a short duration are considered not harmful to aquatic life (U.S. Environmental Protection Agency 2015). The Port of Stockton operates two aeration facilities located within the deep water ship channel to improve DO concentrations. The Port operates the aerators whenever DO concentrations drop below 5.2 mg/L. However, from August to November, that threshold is raised to 6.2 mg/L to benefit the endangered winter-run Chinook salmon that immigrate through on their way to upstream spawning habitat (Port of Stockton 2019).

Notable low DO conditions also occur in the Suisun Marsh sloughs and are attributed to aquatic plant material and detritus decomposition. Operations and discharges from managed wetlands within the Marsh show a strong effect on DO within the Marsh sloughs (San Francisco Bay Regional Water Quality Control Board 2018). The San Francisco Bay RWQCB adopted a TMDL to address low DO in the Marsh (San Francisco Bay Regional Water Quality Control Board 2018), which was approved by the EPA in July 2019. The TMDL aims to address low DO/organic enrichment (and mercury problems) and evaluate the degree to which nutrients may contribute to DO deficit. The implementation plan is projected to attain the water quality standard within 20 years. DO numeric targets and TMDL for Suisun Marsh are ≥3.8 mg/L as a 1-day average and ≥5.0 mg/L as a 30-day running average (San Francisco Bay Regional Water Quality Control Board 2023).

The Bay-Delta Plan and Central Valley Basin Plan contain numeric DO objectives applicable to the Delta. The Bay-Delta Plan DO objective is 6 mg/L for the protection of state-designated fish and wildlife beneficial uses and applies to the San Joaquin River between Turner Cut and Stockton (State Water Resources Control Board 2018b). The Central Valley Basin Plan DO objectives apply to all Delta waters except for those bodies of water constructed for special purposes and from which fish have been excluded or where the fishery is not important as a beneficial use (Central Valley Regional Water Quality Control Board 2019a). The objectives are: 7.0 mg/L in the Sacramento River (below the I Street Bridge) and in all Delta waters west of the Antioch Bridge; 6.0 mg/L in the San Joaquin River (between Turner Cut and Stockton, 1 September through 30 November); and 5.0 mg/L in all other Delta waters except for those bodies of water constructed for special purposes, and from which fish have been excluded, or where the fishery is not important as a beneficial use.

San Francisco Bay

San Francisco Bay is not listed as impaired due to organic enrichment or DO. As noted in the *San Francisco Bay* subsection under Section G.1.9.3, *Nutrients*, DO concentrations are much higher and phytoplankton biomass is much lower than what would be expected in an estuary with such nutrient enrichment (Novick and Senn 2014).

Minimum DO objectives are described in the San Francisco Bay Basin Plan (San Francisco Bay Regional Water Quality Control Board 2023). The objective is 5 mg/L in tidal waters downstream of Carquinez Bridge. In non-tidal waters upstream of the Carquinez Bridge, the minimum objectives are 7.0 mg/L in cold water habitat and 5 mg/L in warm water habitat.

Legacy Contaminants

Dioxins and Furans

Dioxins and dioxin-like compounds are chemical compounds with similar chemical structures and biotic effects. There are several hundred of these compounds, which can be grouped into three families: chlorinated dibenzo-p-dioxins, chlorinated dibenzofurans, and certain PCBs. PCBs are addressed separately below.

Chlorinated dibenzo-p-dioxins and chlorinated dibenzofurans are created unintentionally, usually through combustion processes. Forest fires and volcanoes can contribute these compounds to the atmosphere, as well as certain human activities (e.g., incineration of municipal solid waste, metal smelting, coal fired power plants, wood burning, and chlorine bleaching of wood pulp).

Dioxin and furan compounds are extremely persistent, and once released into the environment can cycle through various phases including water, sediment, soil, air, and biota. Dioxin and furan compounds bioaccumulate in the tissues of exposed organisms because of their stability, affinity for accumulation in the fats of animals, and slow biodegradation rates. Dioxin and furan compounds can affect state- designated beneficial uses including municipal and domestic (drinking water) supply, commercial and sport fishing, the preservation of rare and endangered species, shellfish harvesting, and warm freshwater, cold fresh water, estuarine, and wildlife habitat.

The Stockton Deep Water Ship Channel is on the Water Board’s Section 303(d) list as impaired due to dioxin and furan compounds. The listing is associated with localized high dioxin and furan concentrations in sediment traced to a wood preserving facility, McCormick and Baxter Creosoting Company, immediately south of Mormon Slough (Hayward et al. 1996). The facility is now a Superfund site and has undergone substantial cleanup efforts. The surface water-sediment remedy (sand cap) and soil remedy (soil excavation, consolidation and capping) are implemented and considered protective of human health and the environment (U.S. Army Corps of Engineers 2018).

The entire San Francisco Bay and Suisun Bay was added to the Water Board’s Section 303(d) list for dioxin and furan compounds in 1999, due to a OEHHA fish consumption advisory issued in San Francisco Bay. The Delta was later added to the Water Board’s Section 303(d) list for dioxin and furan compounds because of the migration of striped bass and sturgeon from the Bay into the Delta. Stormwater runoff is approximately 80% of the dioxins and furans load in the Bay (U.S.

Environmental Protection Agency 2017). Atmospheric deposition is believed to be the primary source because of roughly equivalent concentrations in stormwater runoff around the Bay. Direct atmospheric deposition onto the Bay accounts for approximately 18% of the Bay's dioxins and furans load. The remaining 2% of the load is from wastewater treatment plants and refineries (U.S. Environmental Protection Agency 2017).

Polychlorinated Biphenyls

PCB manufacturing in the United States was discontinued in 1979. Today, PCBs can enter the environment from a variety of sources, including leaking pre-1979 electrical transformers still in use, atmospheric deposition over connected watersheds, and industrial and municipal wastewater discharges. PCBs are extremely stable, and once released to the environment, can cycle through various phases including water, sediment, soil, air, and biota.

Section G.1.2.8, *Polychlorinated Biphenyls*, provides additional background information regarding sources of PCBs in the environment, and associated human health and environmental concerns.

The northern and western Delta, Stockton Deep Water Ship Channel, Suisun Bay, and all segments of San Francisco Bay are listed as impaired due to PCBs, with the source of the impairment unknown (State Water Resources Control Board 2022a). Although research has not quantified sources of PCB loading to the Delta, suspension and transport of contaminated sediments is likely a dominant process. Leatherbarrow et al. (2005) found that PCB concentrations at Mallard Island fluctuated with tide, with highest PCB concentrations associated with flood tide (i.e., Bay water inflow to the Delta). This observation is consistent with their hypothesis that legacy contaminants resuspended from Bay sediments and transported into the west Delta on a flood tide contain higher concentrations of PCBs than riverine suspended sediment being transported from the Delta into the Bay. Furthermore, the mixture of PCBs in riverine suspended sediment is indicative of recent atmospherically deposited PCBs rather than the resuspension of PCBs deposited in the Delta decades earlier.

The narrative water quality objective, which states that controllable water quality factors shall not cause a detrimental increase in toxic substances found in bottom sediments or aquatic life, and the numeric water quality objective of 0.00017 μg/L total PCBs in surface water, are exceeded. There are also elevated concentrations in sport fish. The San Francisco Bay RWQCB (2023) describes an action plan and TMDL approved by the EPA in 2010 for PCBs, including dioxin-like congeners, in the Delta, Suisun Bay, Carquinez Strait, San Pablo Bay, Richardson Bay, and the Central and Lower San Francisco Bay. The TMDL includes a numeric target of 10 μg/kg wet weight in fish tissues to protect human health and aquatic life. Cleanup investigations are ongoing at sources of contamination to the Delta from the legacy contaminants. The implementation plan describes reductions in PCB sources (i.e., storm water runoff and PCB contaminated sites within the Bay), actions to reduce risks to people consuming fish from the Bay, and monitoring PCB concentrations in fish tissues, surface water, and sediments. Actions to reduce PCB concentrations in San Francisco Bay will include dredging and material disposal outside of the Bay, natural attenuation, and outflow through the Golden Gate.

A TMDL for the Stockton Deep Water Ship Channel was expected in 2019 but has not yet been completed.

Polyaromatic Hydrocarbons

Polycyclic aromatic hydrocarbons (PAHs) have limited industrial utility and largely enter the environment by natural means, such as from volcanoes and forest fires, or incidental means related to human activities, such as burning wood, fossil fuel burning, and trash. Particles contaminated with PAHs can eventually settle to the ground throughout a watershed and ultimately enter waterways through stormwater runoff. Hundreds of PAH compounds exist; naphthalene and benzo(a)pyrene are among the common compounds.

PAHs can potentially affect beneficial uses including municipal and domestic drinking water supply, commercial and sport fishing, preserving rare and endangered species, shellfish harvesting, and warm fresh water, cold fresh water, estuarine, and wildlife habitat.

The western Delta is on the Section 303(d) list as impaired due to PAHs (State Water Resources Control Board 2022a). The specific sources of the Delta impairment are unknown (State Water Resources Control Board 2022a); however, sources of PAHs to San Francisco Bay provide insight into possible sources to the Delta. A major source of PAHs to San Francisco Bay water and sediments is petroleum combustion, while minor amounts of PAHs are derived from biomass (wood and grasses) and coal combustion, and from uncombusted petroleum (Oros et al. 2007). Storm water runoff is the primary contributor of PAHs to the Bay, followed by tributary inflow, wastewater treatment plant effluent, atmospheric deposition, and dredged material disposal (Oros et al. 2007).

Pesticides

Delta, Suisun Marsh, and Suisun Bay

The entire Delta region is on the Water Board's CWA Section 303(d) list as impaired by Group A Pesticides, DDE/DDT, chlorpyrifos, and diazinon, with the exception of chlorpyrifos and diazinon in the Delta export area (State Water Resources Control Board 2022a). Pixie Slough is impaired by disulfoton (State Water Resources Control Board 2022a). The north Delta, and the west Delta are impaired by chlordane and dieldrin, while Sand Creek is listed for dieldrin, and Old River is impaired by fipronil. Cache Slough, French Camp Slough, Kellog Creek, Middle River, and the Sacramento River in-Delta waterways are listed as impaired by pyrethroids, and the Sacramento River is also listed as impaired by fipronil. Pesticide impairments in Suisun Bay include chlordane, dieldrin, and DDT (State Water Resources Control Board 2022a).

The Central Valley RWQCB includes a diazinon and chlorpyrifos TMDL for the Delta and a TMDL for pyrethroids in the Sacramento River and San Joaquin River basins (Central Valley Regional Water Quality Control Board 2019a). The TMDL for pyrethroids includes numeric triggers associated with the conditional prohibition of discharges. Pyrethroid discharges exceeding the triggers are prohibited unless the discharger is implementing a management plan to reduce concentrations in their discharges.

Current use pesticide data collected under the Delta RMP reflects pesticide conditions in Delta surface waters. The Delta RMP monitored 154 current use pesticides and toxicity monthly from July 2015–June 2017 at five major inputs to the Delta: the San Joaquin River at Vernalis, the San Joaquin River at Buckley Cove, the Sacramento River at Hood, Mokelumne River at New Hope Road, and Ulatis Creek at Browns Road (De Parsia et al. 2018; Jabusch et al. 2018b). All of the water samples detected pesticides, with mixtures ranging from 2 to 25 pesticides. A total of 54 pesticide compounds were detected: 19 fungicides, 18 herbicides, 9 insecticides, 7 breakdown products, and 1 synergist. The most frequently detected pesticide compounds were the herbicides hexazinone (95% of samples) and diuron (73% of samples) and the fungicides boscalid (93% of samples) and azoxystrobin (75% of samples). Monitoring also found infrequent detection of diazinon (8 of 120 samples) and chlorpyrifos (1 of 120) at five Delta locations. None of these detected concentrations exceeded water quality objectives for diazinon (0.1 µg/L) or chlorpyrifos (0.015 µg/L) either individually or when considering additive toxicity. Likewise, pyrethroids insecticides were infrequently detected (i.e., 8 detects) in 120 monthly surface water samples (De Parsia et al. 2018; De Parsia et al. 2019). Bifenthrin and cyhalothrin were the only pyrethroids detected. Chronic CGUs for pyrethroids were exceeded in 1 of 24 samples from the Sacramento River at Hood collected by the Delta RMP from 2015–2017 (De Parsia et al. 2018; De Parsia et al. 2019) while bifenthrin was detected in only one sample with a CGU greater than 1. The six Delta RMP samples from Ulatis Creek with detected concentrations of bifenthrin also exceeded the chronic CGU trigger. There were no detected pyrethroids in the 24 monthly samples collected by the Delta RMP in the San Joaquin River at Vernalis, the San Joaquin River at Buckley Cove, and the Mokelumne River at New Hope Road.

The Central Valley RWQCB Irrigated Lands Regulatory Program aims to prevent agricultural runoff containing pesticides from impairing surface waters. Growers are required to implement management practices to protect surface water. Growers must conduct farm evaluations to determine the effectiveness of farm practices in protecting water quality.

San Francisco Bay

Section 303(d) listed San Francisco Bay (Central, Lower, and South) and the Delta segment as impaired by the legacy pesticides chlordane, DDT, and dieldrin in 1988. The bioaccumulation of DDT and dieldrin in fish led to the listings. Historical pesticide sources include domestic and commercial uses, and a former DDT and dieldrin manufacture and distribution site adjacent to the Lauritzen Channel, within the Richmond Inner Harbor, where stockpiles led to contamination of Bay sediments (Swartz et al. 1994). The United Heckathorn Superfund Site in Richmond's sediment was remediated in 1990 and the attenuation of these legacy pesticides in sediment and aquatic organism tissues throughout the Bay are currently monitored.

The San Francisco Bay RWQCB (2005) adopted a TMDL for diazinon and pesticide-related toxicity in urban creeks to address beneficial use impairments in all San Francisco Bay Region urban creeks and to reduce pesticide concentrations in the Bay where these urban creeks discharge. Proposed targets are expressed in terms of toxic units and diazinon concentrations.

Organic Carbon

In an aquatic system, organic carbon encompasses a broad range of compounds that fundamentally contain carbon in their structure. Organic carbon may be contributed to the aquatic environment by degraded plant and animal materials, and from anthropogenic sources such as domestic wastewater, urban runoff, and agricultural discharge. Organic carbon is a critical part of the food web and sustains aquatic life in the Delta, Suisun Bay, and San Francisco Bay. However, the presence of organic carbon in Delta waters also is of concern because it is a precursor contributing to disinfection byproduct formation at the drinking water treatment plants that divert water from the Delta.

Sources of organic carbon in the Delta include peat soils, upland, agricultural and urban runoff, wetlands, algae production, and municipal wastewater discharges. Organic carbon is present in all the streams and rivers flowing into the Delta, and the upstream sources supply most of the organic carbon load to the Delta. Between 50% and 90% of the dissolved organic carbon load entering the Delta arrives from river flows (CALFED Bay-Delta Program 2008). Major in-Delta sources include peat islands (5–40%), wetlands (5%–30%), and algae (approximately 5%) (CALFED Bay-Delta Program 2008). Approximately 5% to 50% is lost due to internal recycling (CALFED Bay-Delta Program 2008).

The upstream and internal loads, and their related sources, vary by season (CALFED Bay-Delta Program 2008) where San Joaquin River and Sacramento River inflow concentrations to the Delta exhibit a contrasting relationship. The highest concentrations in the Sacramento River occur in the wet months, whereas in the highest concentrations in the San Joaquin River occur in the dry months (Tetra Tech 2006). The higher dry month San Joaquin River concentrations are attributed to the contribution of agricultural drainage to total flows in the San Joaquin River during the dry season (Tetra Tech 2006). Monthly average total organic carbon concentrations in the Sacramento River at Hood/Greene's Landing range from 2 to 3 mg/L. San Joaquin River monthly average total organic carbon concentrations range from 3 to 4 mg/L at Vernalis (Tetra Tech 2006).

The Delta is an important source of organic carbon to Suisun Bay and the northern portion of San Francisco Bay where it supports microbial production at the base of the food web (CALFED Bay-Delta Program 2008). Jassby et al. (1993) found that, in 1980, 83% of the dissolved organic carbon load in Suisun Bay and 62% of the dissolved organic carbon load in the northern portion of San Francisco Bay was from Delta inflow. Within Suisun Marsh, managed wetlands are the largest direct source of organic carbon to the sloughs. The watersheds surrounding Suisun Marsh also contribute a substantial portion of the organic carbon load via stormwater, followed by tidal marshes and treated wastewater effluent from the Fairfield Suisun Sewer District's wastewater treatment facility (San Francisco Bay Regional Water Quality Control Board 2018).

Most organic carbon in the Delta is in the dissolved form, which is generally less bioavailable to the base of the food web compared with particulate organic carbon or organic carbon derived from primary production (Tetra Tech 2006). Conversely, dissolved organic carbon has the greatest potential to form disinfectant byproducts (e.g., trihalomethanes) in reactions with chlorine as part of wastewater and drinking water treatment.

There are no federal or state numeric surface water quality objectives for organic carbon. There is a state narrative water quality objective, federal drinking water treatment requirements related to total organic carbon levels, and a CALFED goal. The Central Valley Basin Plan (Central Valley Regional Water Quality Control Board 2019a) contains a narrative water quality objective that waters shall not contain chemical constituents, including organic carbon, in concentrations that adversely affect beneficial uses. Under the EPA's Disinfectants and Disinfection Byproducts Rule (63 *Federal Register* 69390), municipal drinking water treatment facilities are required to remove specific percentages of total organic carbon in source waters through enhanced treatment methods, unless the drinking water treatment system can meet alternative criteria. The EPA's action thresholds begin at 2 to 4 mg/L and, depending on source water alkalinity, may require a drinking water utility to employ treatment to achieve as much as a 35% reduction in total organic carbon. Where source water total organic carbon is between 4 and 8 mg/L, a 45% reduction in total organic carbon may be required.

CALFED (2000) established a goal to achieve 3 mg/L as a long-term average for total organic carbon at Delta drinking water intakes. The goal is based on a study prepared by California Urban Water Agencies recommending Delta source water quality targets sufficient to achieving disinfection byproduct criteria in treated drinking water and sufficient to allow continued flexibility in treatment technology. Specifically, the CALFED Drinking Water Program goal aims to achieve either: average concentrations at Clifton Court Forebay and other southern and central Delta drinking water intakes of 3.0 mg/L total organic carbon along with 50 µg/l bromide, or an equivalent level of public health protection using a cost-effective combination of alternative source waters, source control, and treatment technologies (CALFED Bay-Delta Program 2000). In establishing its goal, CALFED assumed more stringent disinfection byproduct criteria for treated drinking water than are currently in place. California Urban Water Agencies (1998) have concluded that source water with total organic carbon between 4 and 7 mg/L is sufficient to meet currently established drinking water criteria for disinfection byproducts, depending on the amount of *Giardia* inactivation required.

Monthly median concentrations of total organic carbon in the San Joaquin River at Vernalis are 3 to 5 mg/L, and 90th percentile concentrations are 7 mg/L or less, except in September and October, when 90th percentile concentrations are 10 mg/L (Tetra Tech 2006). In the Sacramento River at Hood/Greene's Landing, monthly median concentrations range between 1 and 3 mg/L, and monthly average concentrations range from 2 to 3 mg/L, and 90th percentile concentrations are 4 mg/L or less (Tetra Tech 2006).

Cyanobacteria Harmful Algal Blooms

Cyanobacteria (formerly called blue-green algae) are a phylum of bacteria that obtain their energy through photosynthesis. Cyanobacteria harmful algal blooms (CHABs) have the potential to harm human health or aquatic biota. CHABs are a widespread problem in waterbodies worldwide. Although cyanobacteria occur naturally, cultural eutrophication from population growth and associated urban, industrial, and agricultural wastes combined with effects from global climate change have led to the global expansion of CHABs (e.g., Rastogi et al. 2015:1; Glibert 2020:1). Cyanotoxins can cause toxicity to phytoplankton, zooplankton, and fish, and also can affect feeding success or food quality for zooplankton and fish (Ger et al. 2018:2384; Acuña et al. 2012a:1191; Acuña et al. 2012b:1). Cyanotoxins can also adversely affect human health (U.S. Environmental Protection Agency 2023:1-4).

CHABs in fresh and brackish water environments typically contain *Microcystis*, *Dolichospermum*, and *Aphanizomenon*. *Microcystis* is the most common and well-studied cyanobacteria in the Delta and typically comprises a large percentage of the Delta cyanobacteria community. As such, most of the information included in this setting is related to *Microcystis*. *Microcystis* has an annual life cycle characterized by two phases. The first is a benthic phase, during which colonies overwinter in the sediment. In the second planktonic phase, which occurs during the summer and early fall months, *Microcystis* enters the water column and begins to grow. When temperatures reach 19 degrees Celsius (°C) (66.2 degrees Fahrenheit [°F]) active (i.e., sediment mixing) and passive processes (i.e., related to the physiological state of the cells) trigger Microcystis recruitment from the sediment, where the organism is resuspended into the water column (Verspagen et al. 2004:269; Misson and Latour 2012:113; Lehman et al. 2013:141).

There are five primary environmental factors that have been related to the emergence and subsequent growth of *Microcystis* in the water column of Delta waters, which are as follows.

1. Water temperatures greater than 19 °C (66.2 °F).
2. Low flows and channel velocities resulting in low turbulence.
3. Long hydraulic residence times.
4. Water column irradiance and clarity greater than 50 micromoles per square meter per second.
5. Sufficient nutrient availability of nitrogen and phosphorus.

Furthermore, in waterbodies influenced by saltwater, salinity below 10 ppt is more likely to support *Microcystis* growth than salinity above 10 ppt.

The factors listed above have been related to *Microcystis* abundance throughout the Delta (Lehman et al. 2013:141; Berg and Sutula 2015:iii; Preece et al. 2017:33). However, the exact processes and interactions of factors that affect development of *Microcystis* blooms in the Delta are complex. There is growing evidence that blooms vary more with wet and dry water year type conditions than with nutrient availability (Lehman et al. 2022:2). However, *Microcystis* growth in the Delta was found to increase linearly when the percentage of ammonium within the total nitrogen pool increased (Lehman et al. 2015:175; Lehman et al. 2022:2). Recent research identified retention time in the Delta and water temperature as the key environmental correlates with *Microcystis* blooms in the Delta (Lehman et al. 2022:1).

In the Delta, CHABs are primarily comprised of the colonial form of *Microcystis aeruginosa*, but single cells are also present (Baxa et al. 2010:343). Other pelagic cyanobacteria including *Aphanizomenon* spp., *Dolichospermum* spp., *Planktothrix* spp., *Pseudanabaena* spp., and *Oscillatoria* have also been detected in the Delta, although generally to a lesser extent than *M. aeruginosa* (Lehman et al. 2010:229; Spier et al. 2013:8; Mioni et al. 2012:20; Berg and Sutula 2015:35; Kurobe et al. 2018:7; Lehman et al. 2022:8). From August through October 2011, *Aphanizomenon* was identified as the most common cyanobacteria genus in the Delta (Mioni et al. 2012:20); however, the species of *Aphanizomenon* that has been shown to occur in the Delta is typically not toxic (Kudela et al. 2015:196). Since it was first observed in the Delta in 1999, annual *Microcystis* blooms have occurred at varying levels throughout the Delta, with blooms typically beginning in the central and southern Delta and spreading seaward into saline environments (Lehman et al. 2008:199; Lehman et al. 2013:146; Lehman et al. 2022:1; California Water Quality Monitoring Council 2021).

Like other regions where *Microcystis* occurs, a mix of toxigenic and non-toxigenic strains occurs in the Delta and toxicity is variable (Baxa et al. 2010:342, 347). Toxigenic strains and appropriate environmental conditions must be present for cyanotoxins to occur (Marmen et al. 2016:9). Several different secondary metabolites, designated as cyanotoxins, can be produced by cyanobacteria including liver toxins, neurotoxins, and dermatoxins. Production of cyanotoxins associated with CHABs is highly variable and not well understood. Nevertheless, *Microcystis* blooms often produce the liver toxin microcystin (Harke et al. 2016:4) and microcystin is the most frequently documented cyanotoxin in the Delta. Microcystins were first documented in the Delta in 2003 (Lehman et al. 2005:87, 97) and have been detected on numerous occasions since (Lehman et al. 2008:187; 2010:241, 245; 2013:146; 2015:169; 2017:94; 2021:14; Spier et al. 2013:8). In addition to producing cyanotoxins, CHABs can create surface scums that interfere with recreation and cause aesthetic problems, produce taste and odor compounds, and lower oxygen levels within the water column (Sutula and Senn 2017:41). Increased microcystin concentrations are generally associated with higher Microcystis abundances (Lehman et al. 2013:146).

Delta CHAB and cyanotoxin monitoring has generally been inconsistent and incomplete in terms of geographic coverage, which makes it difficult to assess changes over time. Nevertheless, the California Cyanobacteria and Harmful Algal Bloom Network's Harmful Algal Bloom Incident Report Portal and published studies suggest that cyanotoxins are increasing since they were first detected in the Delta.

During the 2014 drought, microcystin concentrations frequently exceeded the World Health Organization provisional drinking water guideline value of 1 µg/L, EPA's 10-day Health Advisories drinking water guidelines of 0.3 µg/L for children under the age of 6 (Lehman et al. 2017:105), and the California Caution Action Trigger of 0.8 µg/L. Since 2014 microcystin concentrations have also exceeded EPA recreational guidelines of 8.0 µg/L and the California Danger Tier II trigger for recreational waters of 20 µg/L a number of times at different locations throughout the southern and central Delta, including in Discovery Bay, at several locations along the San Joaquin River, and at locations along the Stockton waterfront (California Water Quality Monitoring Council 2021). The neurotoxins anatoxin-a and saxitoxin have also been documented in Delta waters, but concentrations have been low (i.e., below the California Warning Tier II trigger for recreational waters of 20 µg/L) (Central Valley Regional Water Quality Control Board 2019c:3; Lehman et al. 2021:1, 8).

Microcystis has been observed in Suisun Marsh, but bloom size has remained very small and does not occur annually (Sommer et al. 2020:18; Hammock et al. 2015:319).

Visible CHABs do not occur regularly in the embayments of the San Francisco Bay or Suisun Bay, likely due to the intolerance of genera like *Microcystis* to elevated salinity. In fact, moving west from Antioch, *Microcystis* abundance decreases substantially, and becomes almost undetectable by Chipps Island (Berg and Sutula 2015:47). However, low levels of microcystins have been detected throughout the San Francisco and Suisun Bays (Peacock et al. 2018:138). The origin of these microcystins is unknown, but the toxin may have come from the Delta, urban runoff, point source, or smaller freshwater inputs (Peacock et al. 2018:145). Saline conditions can stimulate lysing of cells and cease growth of cyanobacteria species such as *Microcystis*. *Microcystis* growth ceases and breakdown of its cellular tissues starts at salinities of 10–12.6 ppt (Tonk et al. 2007; Black et al. 2011:669–674). Although *Microcystis* has been shown to grow for short periods of time in salinities of 35 ppt, the genera typically do not survive for long periods of time in waters with salinity greater than 10 ppt (Preece et al. 2017:33). San Pablo Bay is the only embayment of San Francisco Bay downstream of Suisun Bay that would experience salinities below 10 ppt for any significant duration of the year, although these and lower salinities would only occur under conditions of high Delta outflow, when cool waters and turbulence would prevent CHAB formation.

G.1.10 CVP and SWP Service Areas (south to Diamond Valley)

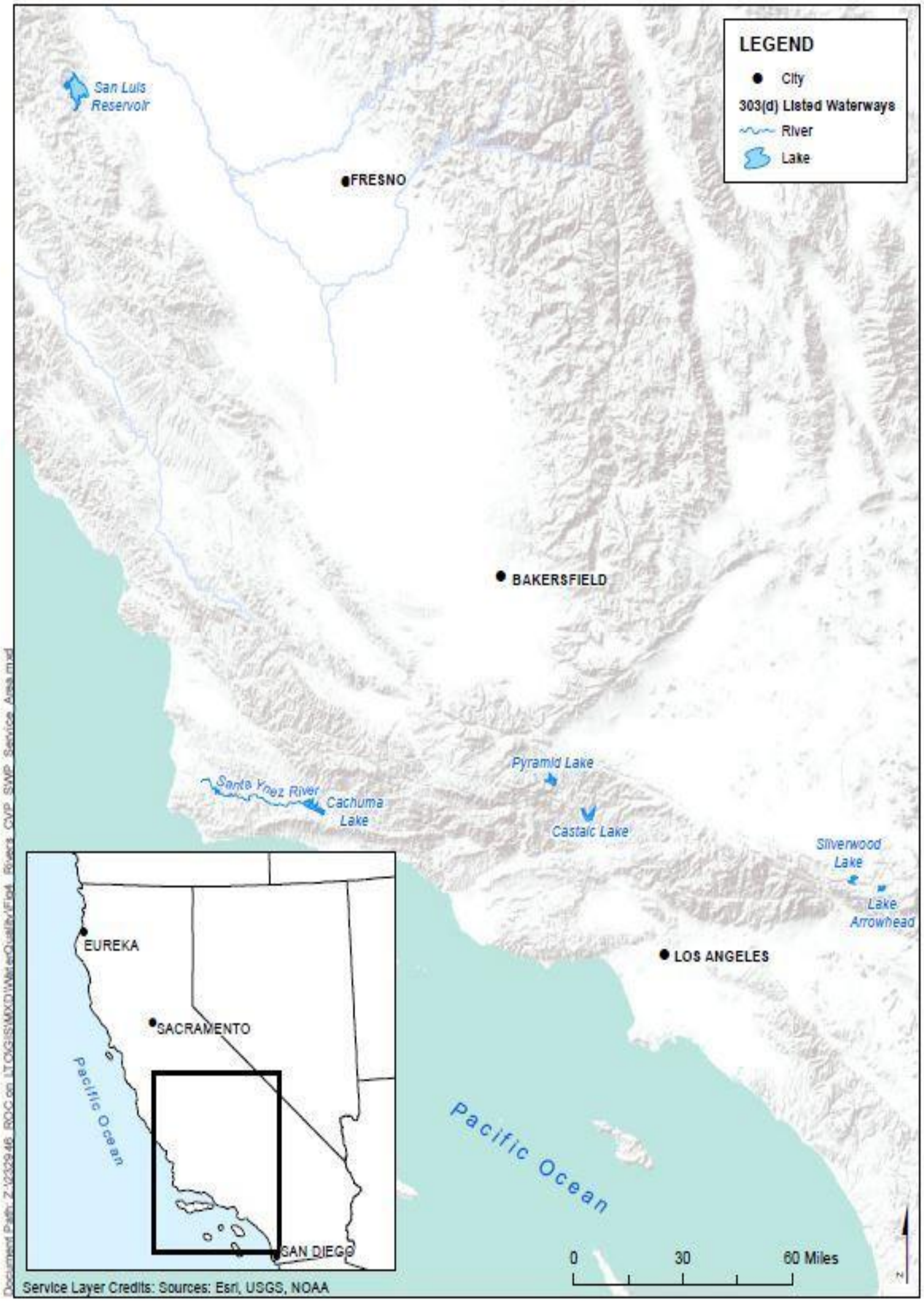
G.1.10.1 Constituents of Concern

The constituents of concern within the CVP and SWP service areas that are not currently in compliance with existing water quality standards, and for which TMDLs are adopted or are in development, are summarized in Constituents of Concern per the Section 303(d) list within CVP and SWP service areas and are discussed further below. Figure G-7 presents 303(d) listed waterways in the CVP and SWP service areas.

Table G-21. Constituents of Concern per the Section 303(d) List in the CVP and SWP Service Areas

Waterbody	Constituent of Concern	TMDL Status
San Luis Reservoir	Pesticides, Mercury, and PCBs	Expected: 2027
	pH	Expected: 2035
Cachuma Lake	Mercury	Expected: 2035
Santa Ynez River (above Lake Cachuma)	Temperature [b] and Turbidity	Expected: 2035
	Unknown Toxicity	Expected: 2023 [a]
Santa Ynez River (Cachuma Lake to below city of Lompoc)	Benthic Community Effects, Molybdenum (Metals), Temperature [b], and Unknown Toxicity	Expected: 2035
	DO	Expected: 2025
	Sedimentation/Siltation, Sodium, and TDS	Expected: 2027
Pyramid Lake	Chlordane (Pesticides), DDT (Pesticides), Dieldrin (Pesticides), and PCBs	Expected: 2027
	Mercury	Expected: 2021 [a]
Castaic Lake	Mercury and PCBs	Expected: 2027
Silverwood Lake	Mercury and PCBs	Expected: 2025
Diamond Valley Lake	Mercury	Expected: 2033 [a]
Lake Arrowhead	Mercury	Expected: 2025

Source: State Water Resources Control Board 2022a.
DDT = dichloro-diphenyl-trichloroethane; DO = dissolved oxygen; PCB = polychlorinated biphenyl; pH = measure of acidity; TDS = total dissolved solids; TMDL = total maximum daily load.
[a] The EPA has not approved the TMDL as of July 2023; the expected approval date has passed.
[b] Discussed in Appendix O.



Source: State Water Resources Control Board 2022a.

Figure G-7. 303(d) Listed Waterways in the CVP and SWP Service Areas

San Luis Reservoir

San Luis Reservoir is an offstream storage facility located along the California Aqueduct downstream of Jones and Banks Pumping Plant and could be potentially affected by CVP and SWP project implementation.

Mercury

San Luis Reservoir is on the Water Board's CWA Section 303(d) list as impaired by mercury (State Water Resources Control Board 2022a). Mercury in San Luis Reservoir is from an unknown source (State Water Resources Control Board 2022ai).

Mercury and enhanced mercury methylation can affect the beneficial uses of San Luis Reservoir. Using 26 largemouth bass tissue samples collected from the San Luis Reservoir in August 2007, an averaged single sample was generated for comparison with the water quality objective. The single sample exceeded the statewide sport fish water quality objective for mercury established in the *Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (State Water Resources Control Board 2017, 2022ai).

TMDLs are expected to be completed by 2027 to meet the water quality standards in San Luis Reservoir to protect the beneficial uses of San Luis Reservoir, including the commercial and recreational collection of fish, shellfish, or other organisms of beneficial use (State Water Resources Control Board 2022ai).

Pesticides

San Luis Reservoir is on the Section 303(d) list as impaired by pesticides (total DDT and chlordane) (State Water Resources Control Board 2022a). OC pesticides (e.g., DDT and chlordane) are primarily transported to streams and rivers in runoff from agriculture. Sources and descriptions of the listed pesticides are discussed in greater detail in Section G.1.2, *Constituents of Concern*.

Polychlorinated Biphenyls

San Luis Reservoir is on the Water Board's CWA Section 303(d) list as impaired by PCBs (State Water Resources Control Board 2022a), based on composite samples of common carp collected from the San Luis Reservoir for PCB congeners and Aroclor mixtures (State Water Resources Control Board 2022ai). The total PCBs recorded ranged from 42 ppb to 133 ppb (Surface Water Ambient Monitoring Program 2009).

pH

San Luis Reservoir is on the Water Board's CWA Section 303(d) list as impaired by pH (State Water Resources Control Board 2022a), due to four of the 35 samples collected from San Luis Reservoir between September 2010 and July 2013 exceed the water quality objective for pH (pH levels shall not be lower than 6.5 or higher than 8.5) (State Water Resources Control Board 2022ai). A TMDL to address the pH impairment at San Luis Reservoir is expected to be completed by 2035 (State Water Resources Control Board 2022ai).

Cachuma Lake

Reclamation in Santa Barbara County owns and operates the Cachuma Lake facility. Mercury is a constituent of concern for Cachuma Lake. The Santa Ynez River flows through Cachuma Lake. The Santa Ynez River (above Lake Cachuma) is on the Water Board's CWA Section 303(d) list as impaired by temperature, turbidity, and toxicity (State Water Resources Control Board 2022a). A TMDL for toxicity is expected to be completed in 2023 and TMDLs for toxicity and temperature are expected to be completed in 2035 (State Water Resources Control Board 2022ak). The Santa Ynez River (Cachuma Lake to below city of Lompoc) is on the Water Board's CWA Section 303(d) list as impaired by benthic community effects, molybdenum (metals), DO, sedimentation/siltation, temperature, sodium, TDS, and toxicity (State Water Resources Control Board 2022a). TMDLs for all constituents of concern in the Santa Ynez River (Cachuma Lake to below city of Lompoc) are expected to be completed between 2023 and 2035 (State Water Resources Control Board 2022ak).

Mercury

Cachuma Lake is on the Water Board's CWA Section 303(d) list as impaired by mercury (State Water Resources Control Board 2022a) from an unknown source (State Water Resources Control Board 2022al).

Mercury and enhanced mercury methylation can affect the beneficial uses of Cachuma Reservoir. In 2009, all five tissue samples from fish collected at one Cachuma Lake location exceeded the criterion for mercury (State Water Resources Control Board 2022al).

To protect the beneficial uses of Cachuma Lake, including the commercial and recreational collection of fish, shellfish, or organisms' beneficial use, a TMDL to address the mercury impairment is expected to be complete by 2035 (State Water Resources Control Board 2022al).

Quail Lake

Section 303(d) does not list Quail Lake, a SWP facility in Los Angeles County as impaired for any constituents of concern (State Water Resources Control Board 2022a).

Pyramid Lake

Pyramid Lake is a SWP facility located in Los Angeles County, upstream of Castaic Lake on the West branch of the California Aqueduct.

Mercury

Section 303(d) does not list Pyramid Lake as impaired by mercury (State Water Resources Control Board 2022a).

Mercury and enhanced mercury methylation can affect the beneficial uses of Pyramid Lake. In 2009, analysts generated 24 sample composites of largemouth bass and brown bullhead (*Ameiurus nebulosus*) from two locations on Pyramid Lake (Surface Water Ambient Monitoring Program 2009). A total of 14 out of 24 samples exceeded the OEHHA fish tissue screening value for human health (State Water Resources Control Board 2022am).

To protect the commercial and recreational collection of fish, shellfish, or organisms beneficial use of Pyramid Lake, TMDLs were set for completion by 2021; however, no TMDL has been released as of March 2023 (State Water Resources Control Board 2022am).

Pesticides

Pyramid Lake is on the Water Board's CWA Section 303(d) list as impaired by chlordane, DDT and the Group A pesticide dieldrin (State Water Resources Control Board 2022a). To protect the beneficial uses of the Pyramid Lake, TMDLs for chlordane, DDT, and dieldrin are expected to be completed in 2027 (State Water Resources Control Board 2022am).

Polychlorinated Biphenyls

Pyramid Lake is on the Water Board's CWA Section 303(d) list as impaired by PCBs (State Water Resources Control Board 2022a). In 2009, composite samples of largemouth bass and brown bullhead from Pyramid Lake at two locations and analyzed them for PCBs concentrations (State Water Resources Control Board 2022am). The average PCB concentrations at Pyramid Lake were among the highest in the state, with 238 ppb in brown bullhead. Pyramid Lake was one of two lakes in the state exceeding the 120 ppb no consumption advisory tissue levels (Surface Water Ambient Monitoring Program 2009).

A TMDL for PCBs in Pyramid Lake is expected to be completed in 2027 to protect beneficial uses (State Water Resources Control Board 2022am).

Castaic Lake

Castaic Lake is a SWP facility located in Los Angeles County at the terminal end of the West Branch of the California Aqueduct.

Mercury

Castaic Lake is on the Water Board's CWA Section 303(d) list as impaired by mercury (State Water Resources Control Board 2022a). TMDLs are set for completion by 2027 (State Water Resources Control Board 2022an).

Twenty-four sample composites were collected from two locations at Castaic Lake generated from largemouth bass (22) and common carp (2). Eight samples exceeded the 0.3 mg/kg OEHHA fish tissue screening value for human health (Surface Water Ambient Monitoring Program 2009).

Polychlorinated Biphenyls

Castaic Lake is on the Water Board's CWA Section 303(d) list as impaired by PCBs (State Water Resources Control Board 2022a). To protect the commercial and recreational collection of fish, shellfish, or organisms beneficial use of Castaic Lake, TMDLs are set for completion by 2027 (State Water Resources Control Board 2022an).

Silverwood Lake

Silverwood Lake is a SWP facility located in San Bernardino County along the East Branch of the California Aqueduct.

Mercury

Silverwood Lake is on the Water Board's CWA Section 303(d) list as impaired by mercury (State Water Resources Control Board 2022a). All 15 samples collected from Silverwood Lake in 2009 exceeded criterion for mercury (State Water Resources Control Board 2022ao). To protect the commercial and recreational collection of fish, shellfish, or organisms beneficial use of Silverwood Lake, TMDLs are set for completion by 2025 (State Water Resources Control Board 2022ao).

Polychlorinated Biphenyls

Silverwood Lake is on the Water Board's CWA Section 303(d) list as impaired by PCBs (State Water Resources Control Board 2022a). In 2018, composite samples from 13 fish species were collected in Silverwood Lake and analyzed for PCBs concentrations. Two of the 13 samples exceeded the water quality standard of 500 ug/Kg maximum total PCB concentration (State Water Resources Control Board 2022ao).

A TMDL for PCBs in Pyramid Lake is expected to be completed in 2025 to protect beneficial uses (State Water Resources Control Board 2022ao).

Crafton Hills Reservoir

Section 303(d) does not list Crafton Hills Reservoir, a SWP facility located in the City of Yucaipa within San Bernardino County, as impaired for any constituents of concern (State Water Resources Control Board 2022a).

Lake Perris

Section 303(d) does not list Lake Perris, a SWP facility located in Riverside County, as impaired for any constituents of concern (State Water Resources Control Board 2022a).

Diamond Valley Lake

Diamond Valley Lake, an offstream storage facility located in Riverside County, is on the Water Board's CWA Section 303(d) list as impaired by mercury (State Water Resources Control Board 2022a). The new decision to list this waterbody was the result of a sample that exceeded the threshold for acceptable fish tissue mercury objectives. 40 fish collected between February and July of the same calendar year were averaged into a single sample, which exceeded the objective. A TMDL for mercury in Diamond Valley Lake is expected to be completed in 2033 (State Water Resources Control Board 2022ap).

Lake Piru

Section 303(d) does not list Lake Piru, an offstream storage facility located in Riverside County, as impaired for any constituents of concern (State Water Resources Control Board 2022a).

Lake Arrowhead

Mercury

Lake Arrowhead is on the Water Board's CWA Section 303(d) list as impaired by mercury (State Water Resources Control Board 2022a). In 2009, 12 out of 15 largemouth bass sample composites from Lake Arrowhead exceeded the OEHHA fish tissue screening value for human health (Surface Water Ambient Monitoring Program 2009; State Water Resources Control Board 2022aq).

To protect the commercial and recreational collection of fish, shellfish, or organisms beneficial use of Lake Arrowhead, TMDLs are set for completion by 2025 (State Water Resources Control Board 2022aq).

G.2 Evaluation of Alternatives

This section describes the technical background for the evaluation of environmental consequences associated with the action alternatives and the No Action Alternative.

G.2.1 Methods and Tools

The impact analysis considers changes in surface water quality conditions related to changes in CVP and SWP operation under the action alternatives as compared with the No Action Alternative. This section details methods and tools used to evaluate those effects. Alternative 2 consists of four phases that could be utilized under its implementation. All four phases are considered in the assessment of Alternative 2 to bracket the range of potential impacts. For all regions except the Bay-Delta, the analysis used changes in flow, as described in Section G.2.1.1, *Changes in Flow*, to investigate potential water quality impacts. Section G.2.1.2, *Bay-Delta Region Specific Methods*, provides a detailed description of the methods used for the Bay-Delta region.

G.2.1.1 Changes in Flow

Changes in CVP and SWP operation will change the flow in rivers within the study area. Flow is used as a surrogate for water quality in this analysis. Flow reductions in rivers could result in increased concentrations of constituents of concern because there would be less water in the waterway to dilute runoff containing those constituents. Constituents of concern are present in study area waterways due to several sources, including urban and agricultural runoff along with legacy drainage from areas that historically had supported mining activities. If the constituent source is downstream from a reservoir, reductions in flow could result in increased constituent of concern concentrations due to reductions in dilution. If the constituent source is located upstream of a reservoir, an increase or decrease in flow due to changes in CVP and SWP operation would not reduce concentrations of constituents of concern.

The surface water quality analysis was conducted using the CalSim II and 3.0 model, as described in Appendix F, *Modeling*. The analysis simulated the operational assumptions of each alternative described in Chapter 3, *Alternatives*.

G.2.1.2 Bay-Delta Region Specific Methods

Section G.1.9, *Bay-Delta*, identifies numerous constituents or constituent categories present in the Delta, Suisun Bay, Suisun Marsh, or San Francisco Bay at levels that currently impair the water bodies' beneficial uses. Constituents of concern include salinity-related constituents (i.e., EC, chloride, and bromide), mercury, selenium, trace metals, nutrients, DO, pathogens, legacy contaminants (e.g., dioxin and furan compounds, PCBs, and PAHs), and pesticides. Thus, the evaluation of the Delta, Suisun Bay, Suisun Marsh, and San Francisco Bay water quality addresses effects on these constituents and constituent categories.

In addition to addressing constituents currently known to impair beneficial uses, other constituents of concern for the Bay-Delta also were evaluated. Organic carbon is of concern because of the drinking water supply drawn from the Delta, and organic carbon's effect on food webs in the Delta, Suisun Bay, and San Francisco Bay. Bromide in Delta waters could also impact drinking water supplies. Nutrients levels in the Delta could potentially induce biostimulation, which can affect drinking water supplies and aquatic life. Nutrient levels are of concern in Suisun Bay, Suisun Marsh, and San Francisco Bay due to potential food web effects.

The project-level evaluation of the project alternatives' effects on surface water quality in the Delta, Suisun Bay, and Suisun Marsh consisted of quantitative and qualitative analyses. Evaluations of the salinity-related parameters EC and chloride were conducted in a quantitative manner, utilizing modeling output from Delta Simulation Model II (DSM2)-Water Quality Module (QUAL). The mercury and selenium evaluations also utilized the DSM2-QUAL modeling output, coupled with bioaccumulation models. Evaluations of the effects of project alternatives on the other constituents of concern was conducted in a qualitative manner, considering the sources, of the constituents of concern and how the alternatives could affect the relative concentrations in Delta inflows and within the Bay-Delta.

The evaluation of each alternative's effect on surface water quality in San Francisco Bay used qualitative analyses and considered qualitative and quantitative analyses for the Delta and Suisun Bay, and Delta outflows as modeled by CalSim 3.0.

The following sections provide additional detail about the evaluation methods for the EC, chloride, bromide, mercury, and selenium evaluations.

Electrical Conductivity, Chloride, and Bromide

The EC evaluation used monthly average EC output from DSM2-QUAL, which was modeled in for water years 1922 through 2021. The analysis summarized percent exceedances of monthly average EC for the 100-year simulation period in tables and plotted by month in exceedance plot format. The EC assessment locations included Bay-Delta Plan compliance locations for agricultural beneficial use protection (State Water Resources Control Board 2018b) and two northern Delta locations, listed below.

- South Fork Mokelumne River at Terminous
- San Joaquin River at Jersey Point
- San Joaquin River at Prisoners Point
- San Joaquin River at San Andreas Landing
- San Joaquin River at Vernalis
- San Joaquin River at Brandt Bridge
- Old River near Middle River
- Old River at Tracy Bridge
- Sacramento River at Emmaton
- Sacramento at Rio Vista
- Sacramento River at Threemile Slough
- Sacramento River at Collinsville
- Montezuma Slough at National Steel
- Montezuma Slough near Beldon Landing
- Chadbourne Slough near Sunrise Duck Club
- Suisun Slough 300 ft south of Volanti Slough
- Banks Pumping Plant
- Jones Pumping Plant

Attachment G.1, *Electrical Conductivity Modeling Results*, presents the EC modeling results.

The analysis generated monthly average chloride and bromide concentrations for the following assessment locations, which are Bay-Delta Plan compliance locations for municipal and industrial beneficial uses protection (State Water Resources Control Board 2018b).

- Contra Costa Pumping Plant #1
- San Joaquin River at Antioch
- Banks Pumping Plant
- Jones Pumping Plant
- Barker Slough at North Bay Aqueduct Intake

Concentrations for Contra Costa Pumping Plant #1 and San Joaquin River at Antioch were calculated from relationships (i.e., regression equations) between EC and chloride, and chloride and bromide. Concentrations for Banks and Jones pumping plants and Barker Slough at North Bay Aqueduct intake were calculated using a mass-balance methodology applied to the DSM2-modeled source water flow fractions. Details regarding the chloride and bromide modeling methodology and modeling results are presented in Attachment G.2, *Chloride Modeling Results*, and Attachment G.3, *Bromide Modeling Results*.

The analysis compared each action alternative's modeled monthly average EC, chloride, and bromide levels to the No Action Alternative in the summary tables and probability exceedance plots provided in Attachments G.1, G.2, and G.3, respectively. The analysis evaluated probability exceedance plots to determine how often the specified EC, chloride, and bromide levels would be exceeded for the alternative as compared with what would occur for the No Action Alternative at the assessment locations. It compared modeled monthly average EC, chloride, and bromide levels for each action alternative to those for the No Action Alternative at various Delta locations for the entire period of record modeled and by water year type.

Methylmercury

The mercury assessment focuses on fish tissue concentrations of methylmercury, to be consistent with the Delta Estuary Methylmercury TMDL, which established waste load allocations and fish tissue objectives expressed as methylmercury. The assessment of the alternatives' effect on Delta methylmercury is based on modeled concentrations at specific Delta locations, as determined from DSM2 output. The analysis used DSM2-QUAL to simulate source water fingerprinting, which identifies the relative contributions of water sources to the volume at the specified Delta location. The analysis input modeled methylmercury concentrations for the entire 100-year modeled period of water years 1922 through 2021 for all water year types (i.e., wet, above normal, below normal, dry, and critical). These data were used to develop estimates of fish tissue concentrations at Delta assessment locations using the Central Valley RWQCB (2010a) TMDL model for the Delta. Attachment G.4, *Methylmercury Modeling Results*, describes the methods for developing the modeled water and fish tissue concentrations in more detail.

The analysis evaluated project alternatives' effects on fish tissue methylmercury concentrations relative to the No Action Alternative at various Delta locations. Modeled concentrations were compared with the water quality objective for methylmercury trophic level 4 fish of 0.24 mg/kg to determine whether the project alternatives would increase the potential for mercury bioaccumulation in fish within the Delta.

In 2017, the Water Board approved *Part 2 of the Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries of California—Tribal and Subsistence Fishing Beneficial Uses and Mercury Provisions*, which established mercury limits to protect the state-designated beneficial uses associated with the consumption of fish by both people and wildlife. However, the mercury water quality objectives do not supersede the Central Valley RWQCB's site-specific numeric mercury water quality objectives established for the Delta (State Water Resources Control Board 2017). Thus, the Water Board water quality objectives were not applied in the methylmercury assessment.

Selenium

The selenium assessment evaluates changes to selenium concentrations in tissues that affect the health of fish, as well as wildlife and humans consuming fish in the Delta, using a suite of modeling tools. The analysis used DSM2-QUAL to simulate source water finger printing to quantify the relative contributions of water sources to the volume at specified Delta locations. The source water fingerprinting values (expressed as a % of each Delta source water) multiplied by source water concentrations determined annual average selenium concentrations in the Delta water column at specified locations. The analysis input modeled selenium concentrations for the entire 100-year modeled period of water years 1922 through 2021 into the bioaccumulation models to estimate bioaccumulation in bird eggs and fish fillets, and to model selenium bioaccumulation in sturgeon (*Acipenseridea*) living in the western Delta. Attachment G.5, *Selenium Modeling results*, describes the methods for modeling water column concentrations and bioaccumulation are described in more detail.

The analysis evaluated project alternatives' effects on fish tissue and bird egg selenium concentrations relative to the No Action Alternative at various Delta locations. Modeled concentrations were compared with tissue-based benchmarks to determine whether the project alternatives would increase the potential for selenium bioaccumulation in bird eggs and fish within the Delta.

Organic Carbon

The EC evaluation used monthly average dissolved organic carbon output from DSM2-QUAL, which was modeled for water years 1922 through 2021. The analysis summarized percent exceedances of monthly average dissolved organic carbon for the 100-year simulation period in tables and plotted by month in exceedance plot format. The analysis generated monthly average concentrations for the following assessment locations, which are Bay-Delta Plan compliance locations for municipal and industrial beneficial uses protection (State Water Resources Control Board 2018b).

- Contra Costa Pumping Plant #1
- San Joaquin River at Antioch
- Banks Pumping Plant
- Jones Pumping Plant
- Barker Slough at North Bay Aqueduct Intake

G.2.2 No Action Alternative

Under the No Action Alternative, Reclamation would continue with the current operation of the CVP, as described in the 2020 Record of Decision and subject to the 2019 Biological Opinions. The 2020 Record of Decision for the CVP and the 2020 Incidental Take Permit for the SWP represent current management direction or intensity pursuant to 43 Code of Federal Regulations § 46.30.

Although the No Action Alternative included habitat restoration projects at a programmatic level, the 2020 Record of Decision did not provide environmental coverage for these projects, and all of the habitat projects considered under the No Action required or will require additional environmental documentation. Thus, ground disturbance for habitat restoration projects did not materialize as a result of implementing the No Action Alternative. For the purpose of the analysis, these habitat restoration projects are considered independent projects that will be considered under cumulative effects.

The No Action Alternative is based on 2040 conditions. Changes that would occur over that time frame without implementation of the action alternatives are not analyzed in this technical appendix. However, the changes to water quality that are assumed to occur by 2040 under the No Action Alternative are summarized in this section.

Conditions in 2040 would be different than existing conditions because of the following factors:

- Climate change and sea-level rise
- General plan development throughout California, including increased water demands in portions of the Sacramento Valley

By the end of September, the surface water elevations at CVP reservoirs generally decline. 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 2040 than in recent historical conditions, potentially. However, as the water is released in the spring, there would be less snowpack to refill the reservoirs. This condition would reduce flow within streams, potentially resulting in less dilution of constituents of concern. These changes in hydrologic conditions would result in a change in concentrations of constituents of concern within CVP and SWP reservoirs.

In the Delta, the greatest effect of the above factors on future water quality would be increases in salinity constituent levels, particularly in the western Delta. Seawater is a primary source of bromide, chloride, and higher EC levels, and anticipated effects of climate change on sea-level rise would be a primary factor in the elevated levels of these constituents. Similarly, climate change–driven effects on water temperature and potentially lower inflows in the summer months would be expected to contribute to more frequent or more extensive cyanobacteria blooms in the Delta. Climate change and associated large flow events could result in higher sediment loading to the Delta, which could affect mercury and trace metals loading. Little change in organic carbon, nutrients, DO, legacy contaminants, pesticides, and selenium, within Delta waters is expected.

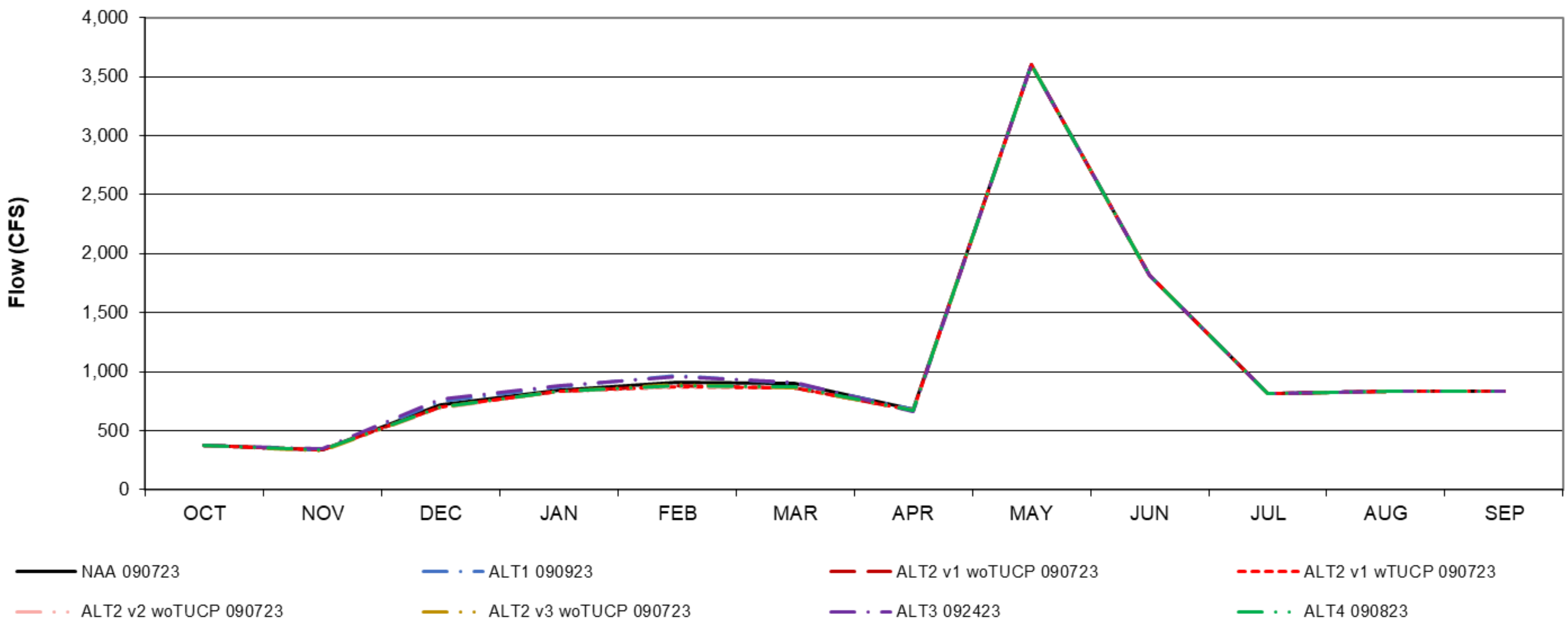
Under the No Action Alternative, land uses in 2040 would occur in accordance with adopted general plans. Development under the general plans could affect water quality, depending on the type and location of development. Infill projects where areas are already developed could increase density but would be done in compliance with applicable local, state, and federal regulations around water quality, as required. Development in non-urbanized areas could convert natural or rural areas to developed areas, resulting in impacts to water quality.The No Action Alternative would also rely upon increased use of Livingston-Stone National Fish Hatchery during droughts to increase production of winter-run Chinook salmon. However, this component requires no physical changes to the facility nor operational changes to water supply, thus would have no adverse effect on water quality.

G.2.3 Alternative 1

G.2.3.1 Potential Changes in Surface Water Quality Conditions

Trinity and Klamath Rivers

Operations in the Trinity River would remain similar to those under the No Action Alternative. The Trinity River Restoration Program Record of Decision controls Trinity River operations, and Reclamation would continue to release flows into the Trinity River as it does under the No Action Alternative. Figure G-8 through Figure G-13 illustrate flow changes for all water year types and alternatives. Figure G-8 demonstrates that changes in long-term average flows under Alternative 1 are not expected to change by more than 6% compared with the No Action Alternative. Flow in the Trinity River under Alternative 1 is expected to increase in February of above normal water years by approximately 24% and decrease by approximately 18% in March of below normal water years when compared with the No Action Alternative. Increasing and decreasing fluctuations in flow under Alternative 1 are expected to a lesser extent in other year types. Because Alternative 1 would have limited changes in flows on the Trinity River, changes in flows would have limited potential to affect water quality. Increases in flow would be considered beneficial based on the improvement of water quality through dilution of constituents of concern. The evaluation does not expect decreases in flow to be a large enough magnitude to affect water quality.



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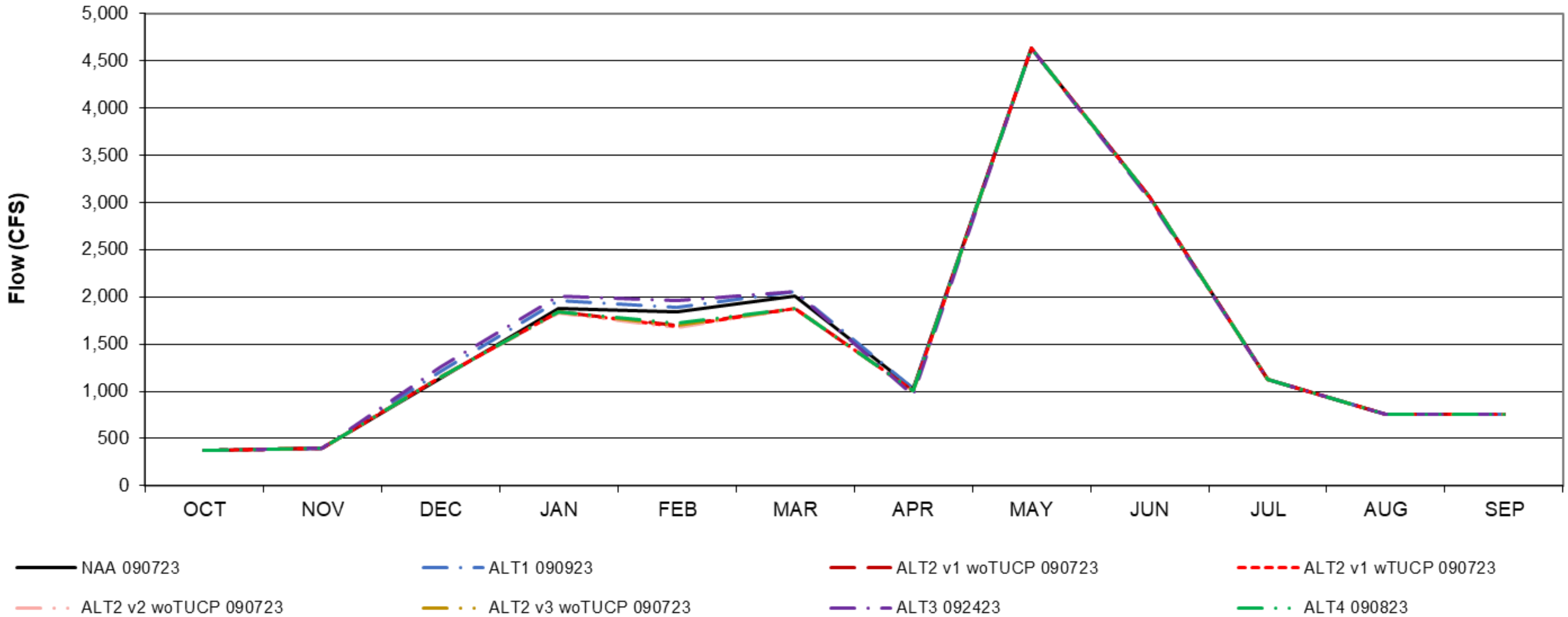
As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-8. Trinity River Flow below Lewiston, Long-Term Average Flow



cfs = cubic feet per second; NAA- No Action Alternative; ALT1 090923 = Alternative 1 (Water Quality Control Plan);
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Figure G-9. Trinity River Flow below Lewiston, Wet Year Average Flow

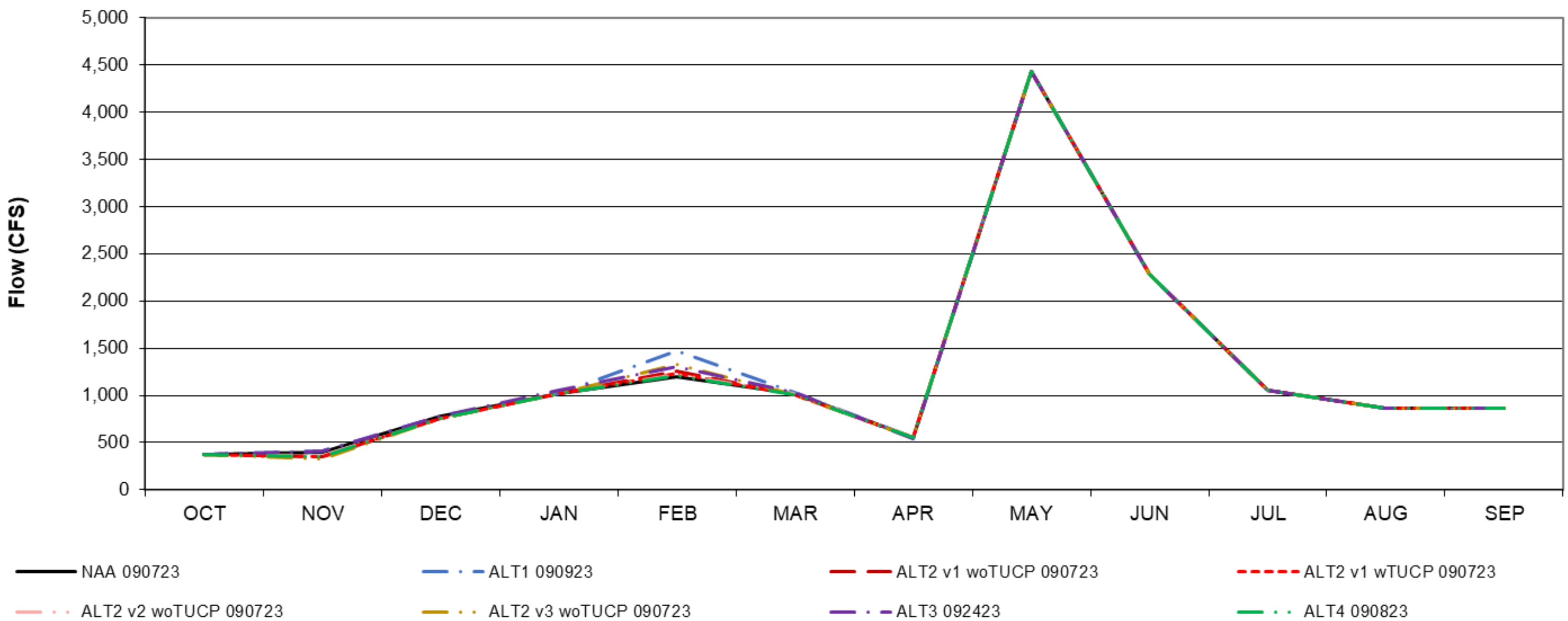

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Figure G-10. Trinity River Flow below Lewiston, Above Normal Year Average Flow

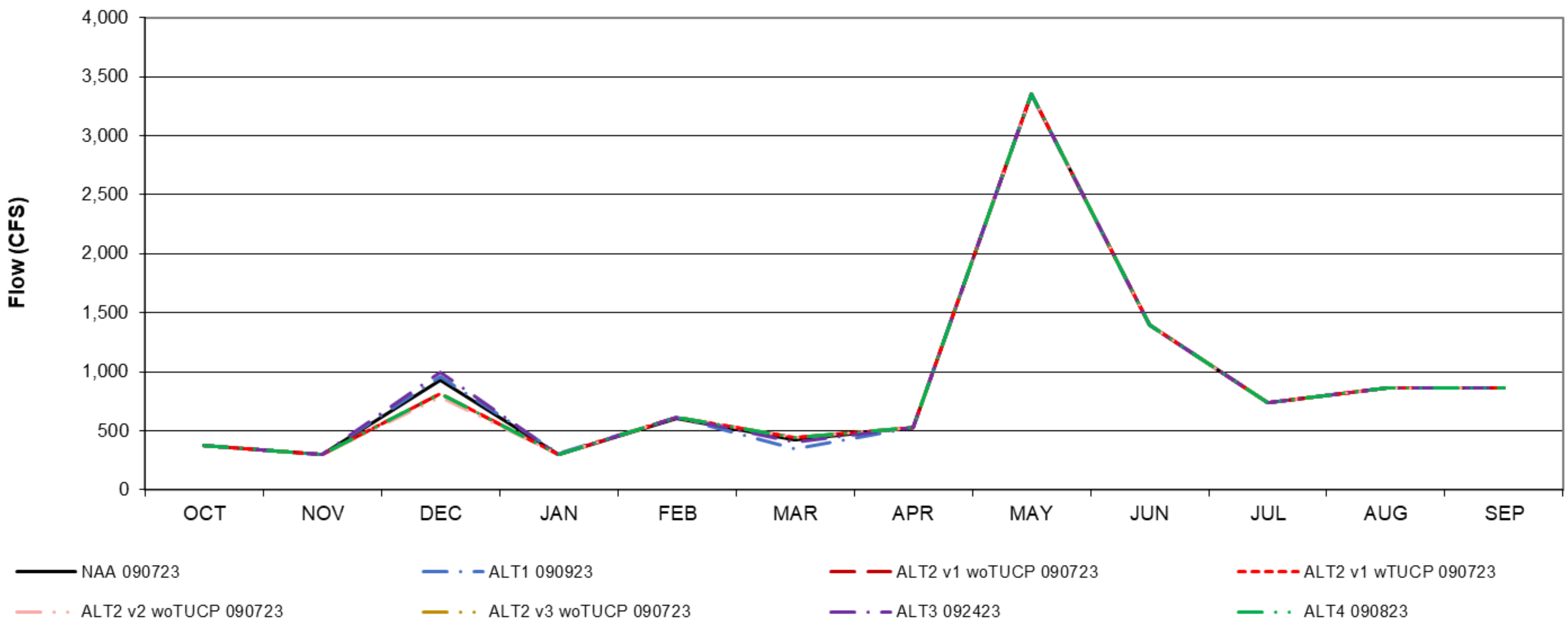

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Figure G-11. Trinity River Flow below Lewiston, Below Normal Year Average Flow

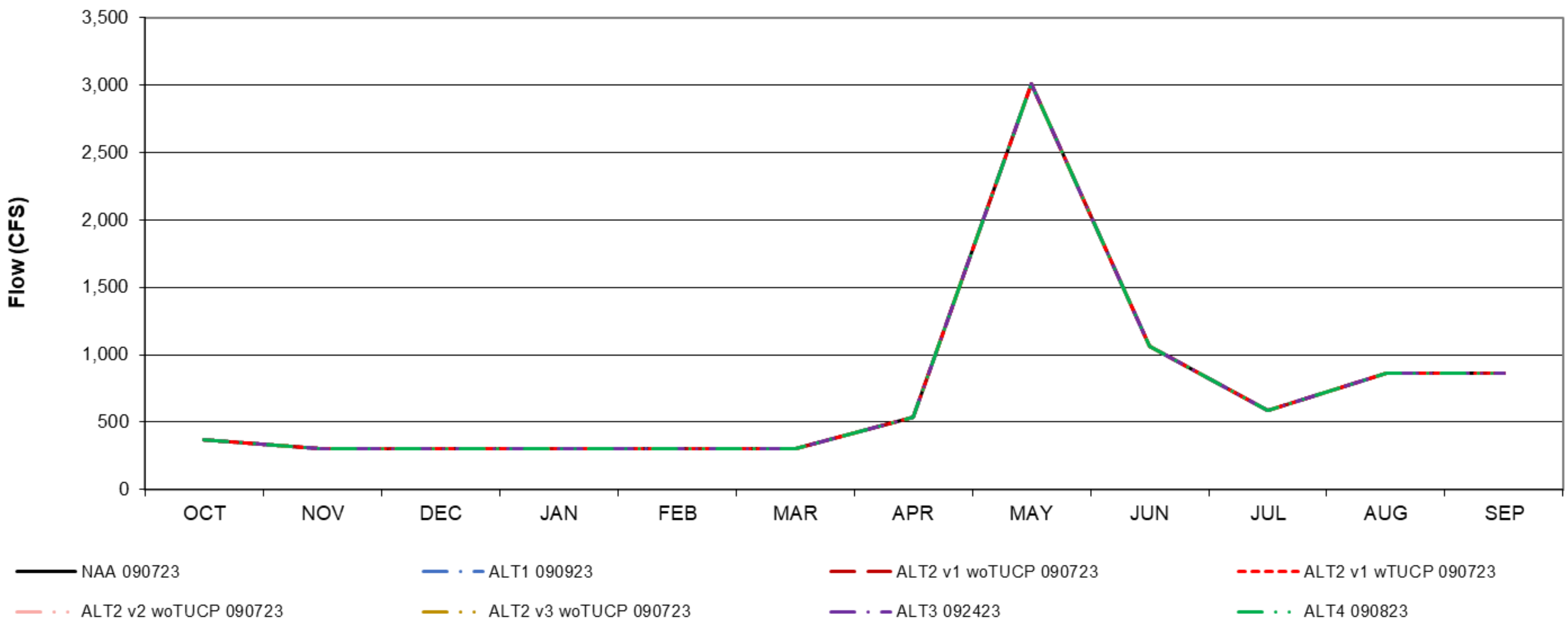

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Figure G-12. Trinity River Flow below Lewiston, Dry Year Average Flow

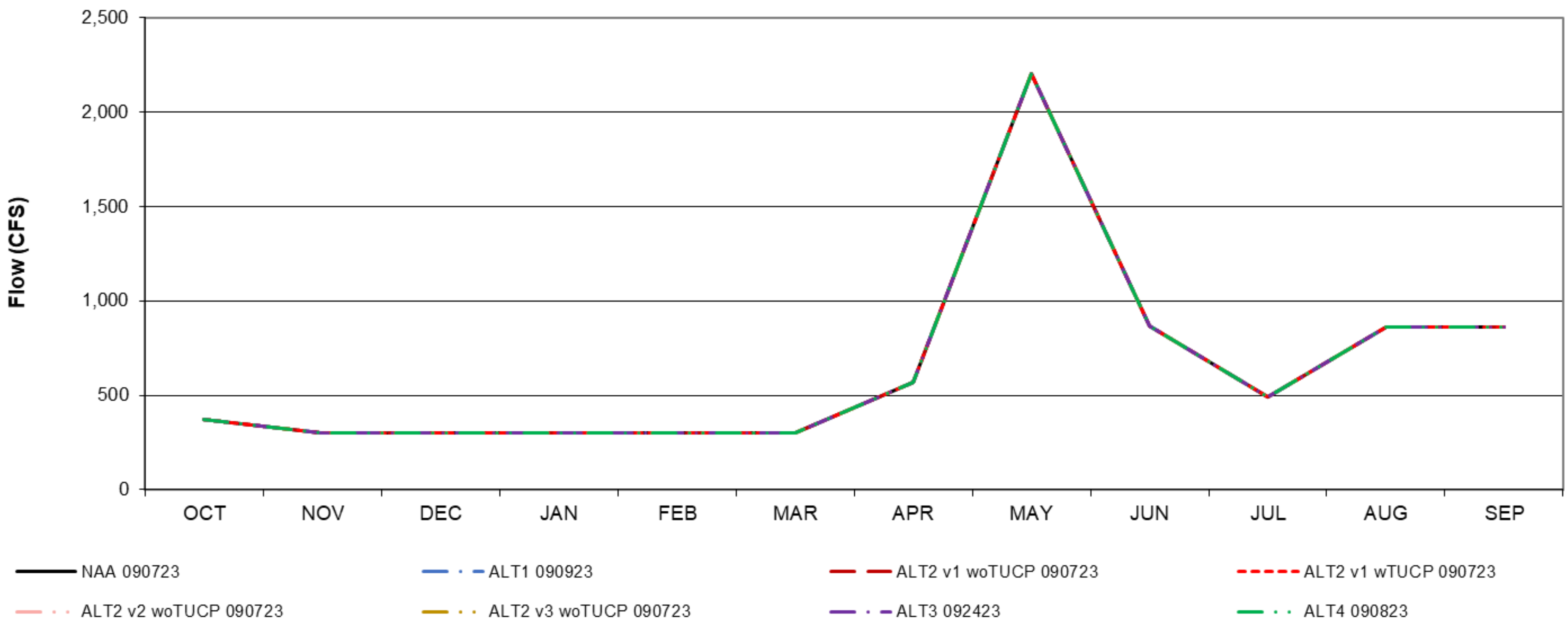

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Figure G-13. Trinity River Flow below Lewiston, Critical Year Average Flow

Sacramento River

Compared with the No Action Alternative, Alternative 1 would cause flow changes in the Sacramento River from changes in coldwater pool management and change in Delta fall requirements. Flow changes could affect water quality in the Sacramento River because flows released from Keswick can dilute concentrations of constituents of concern that enter the river as it flows south. Figure G-14 through Figure G-19 illustrate modeled changes in flow on the Sacramento River downstream of Keswick Reservoir for different year types and alternatives. Under Alternative 1, long-term average flow changes are not expected to deviate substantially from the No Action Alternative (see Figure G-14). The largest changes in flow under Alternative 1 are expected during September and December of above normal water year types (see Figure G-16). The changes in flow come from changes to fall X2 requirements for Delta Smelt compared with the No Action Alternative. Under Alternative 1, reservoir releases would occur at different times, generally resulting in flow decreases during the fall and flow increases during winter and early spring, to regulate temperature management objectives. Substantial decreases in flow are expected only in wet and above normal water year types, when additional water can be placed in storage. A decrease in flow during wet and above normal water year types is not expected to affect water quality due to higher base flows. Trends are similar for other sampling locations along the Sacramento River and can be viewed in Appendix F. While Alternative 1 would create flow changes, including decreases of up to 20%, in the Sacramento River, the flow changes would largely occur during wet and above normal water years when base flow is adequate and decreases in flow are not expected to cause violations of water quality standards. Overall, water quality would not be substantively affected by changes in flow under Alternative 1 and increased frequency of exceedances of water quality thresholds are not expected.

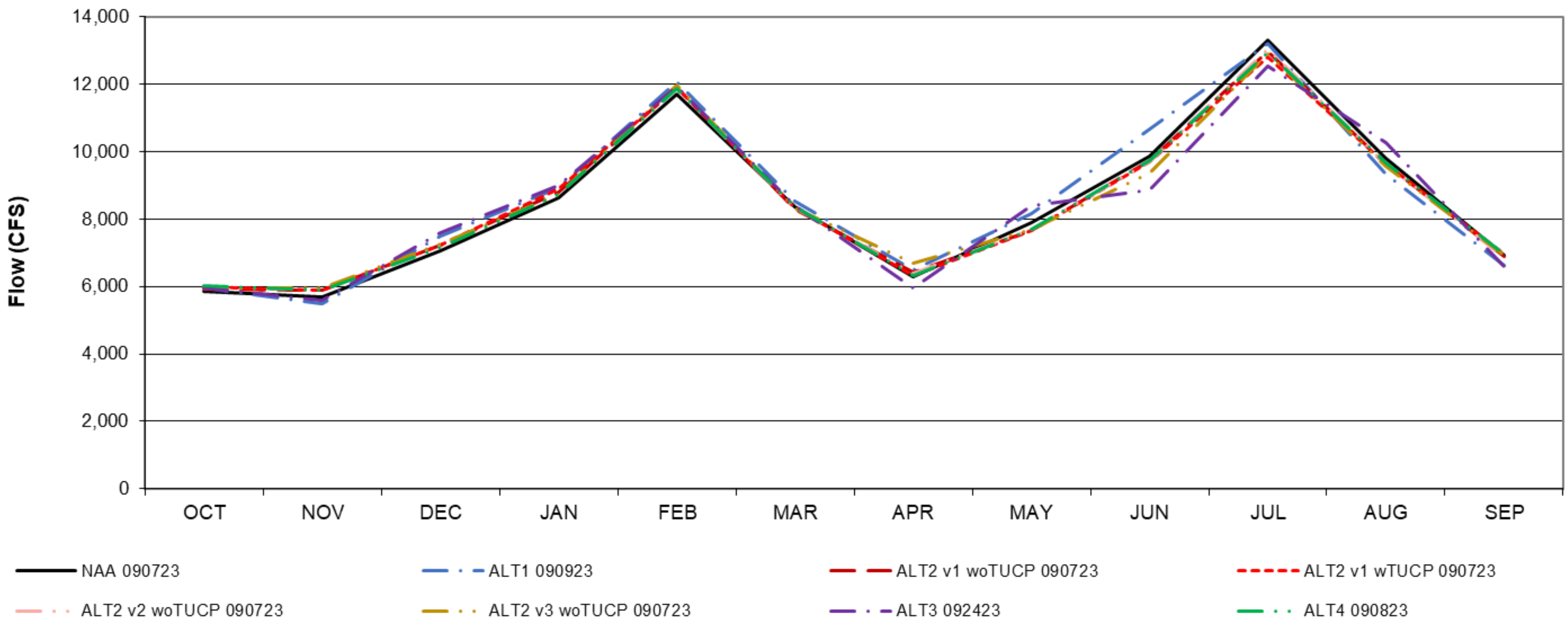

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Figure G-14. Sacramento River Flow downstream of Keswick Reservoir, Long-Term Average Flow

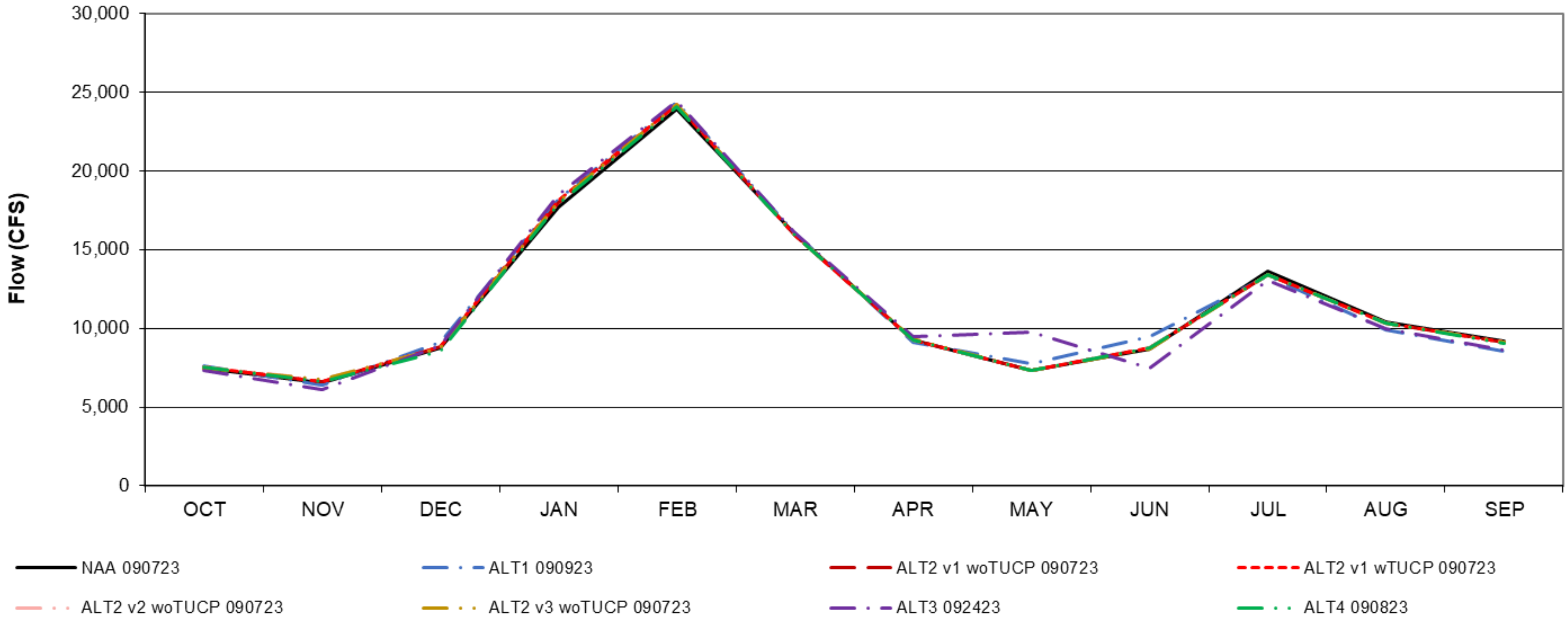

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Figure G-15. Sacramento River Flow downstream of Keswick Reservoir, Wet Year Average Flow

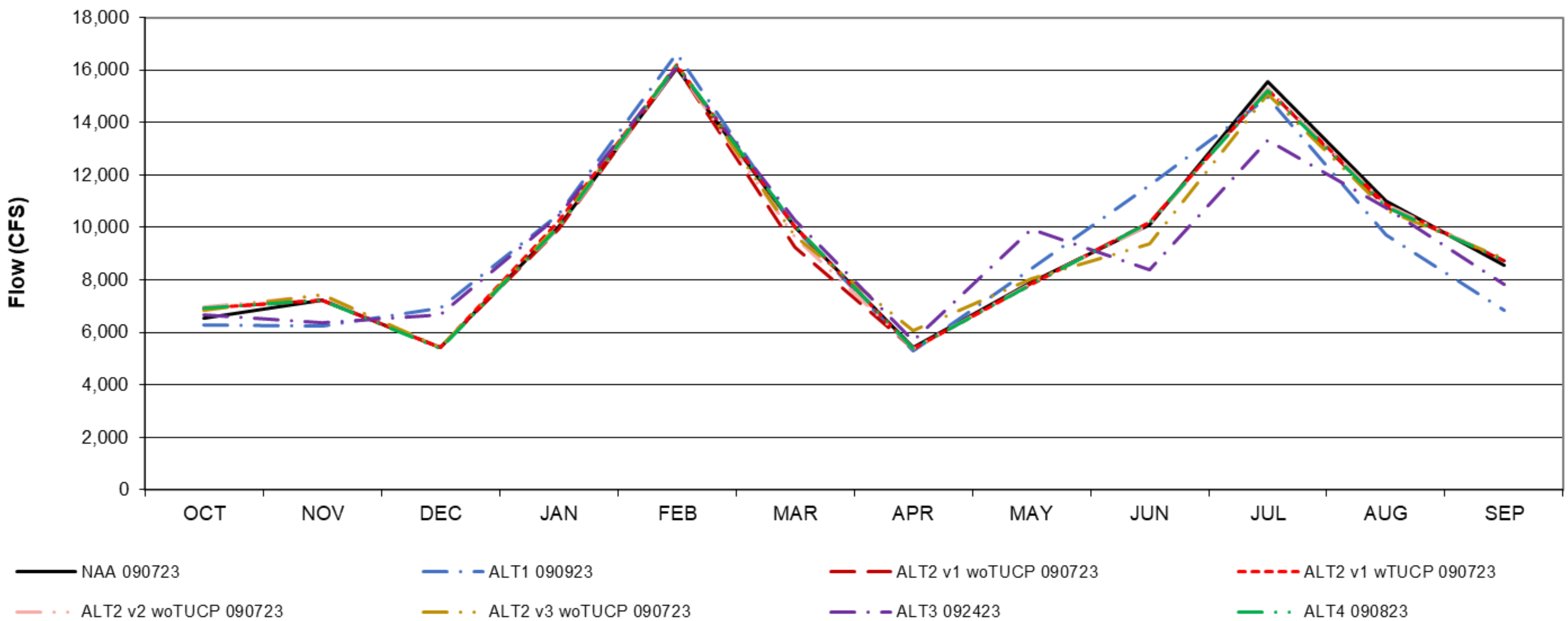

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Figure G-16. Sacramento River Flow downstream of Keswick Reservoir, Above Normal Year Average Flow

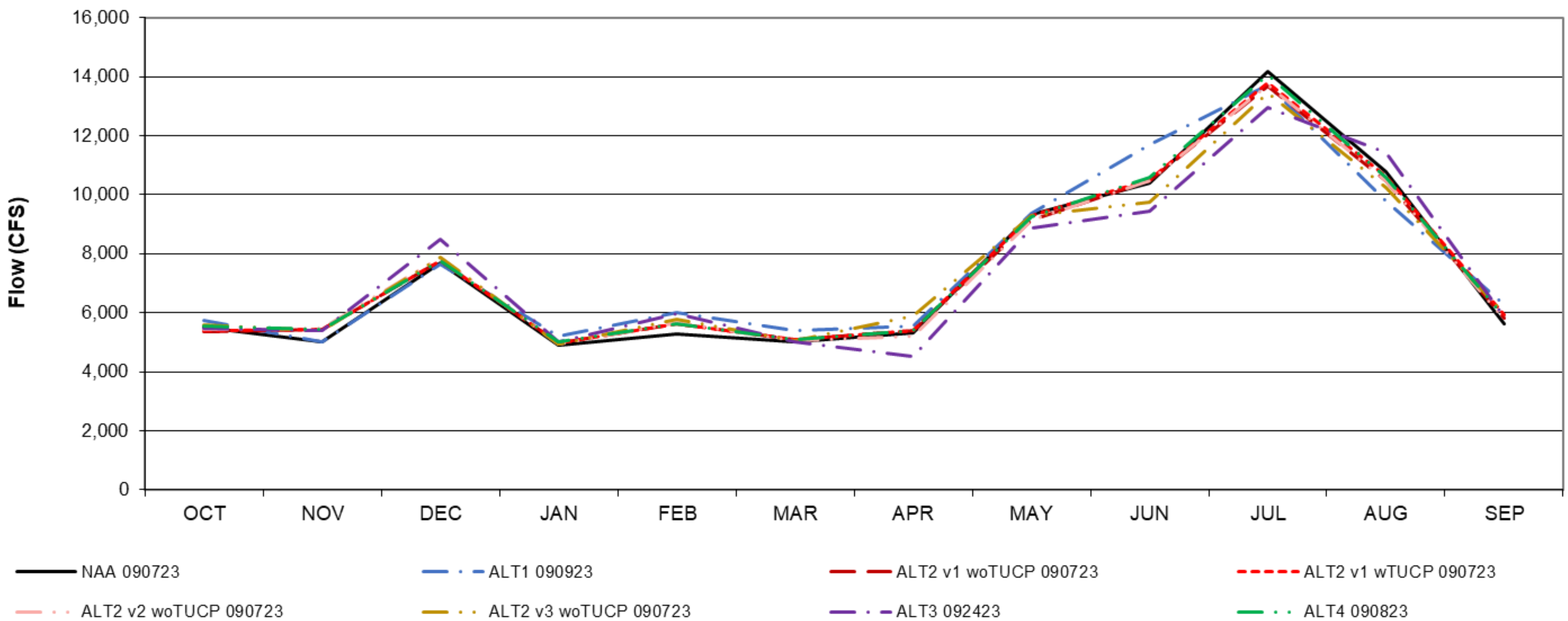

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Figure G-17. Sacramento River Flow downstream of Keswick Reservoir, Below Normal Year Average Flow

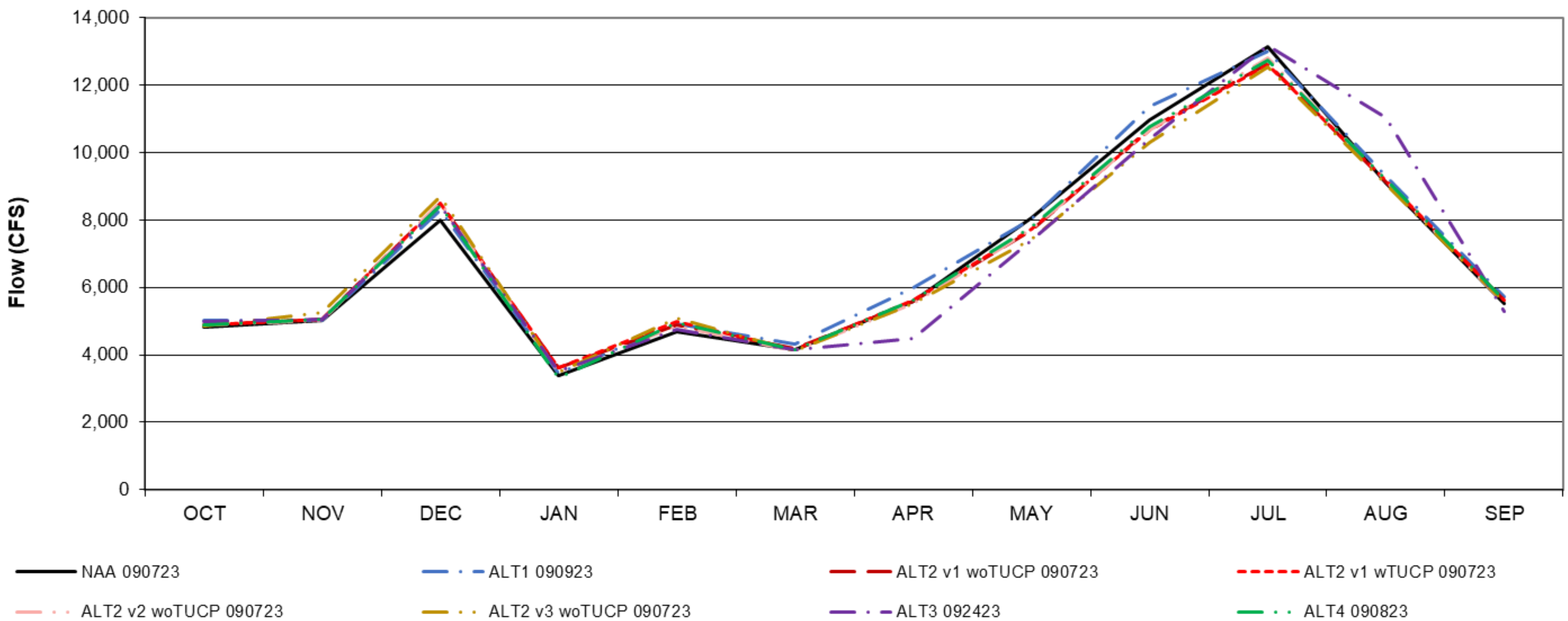

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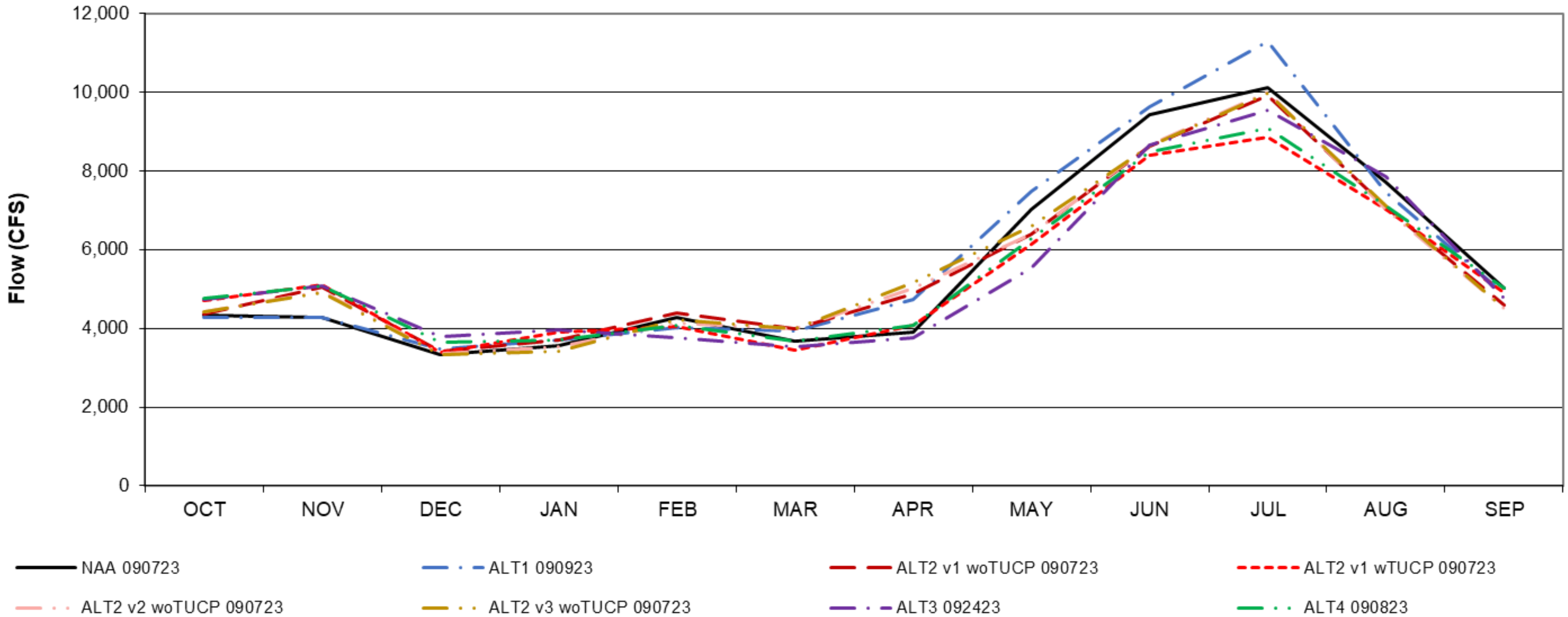
Figure G-18. Sacramento River Flow downstream of Keswick Reservoir, Dry Year Average Flow



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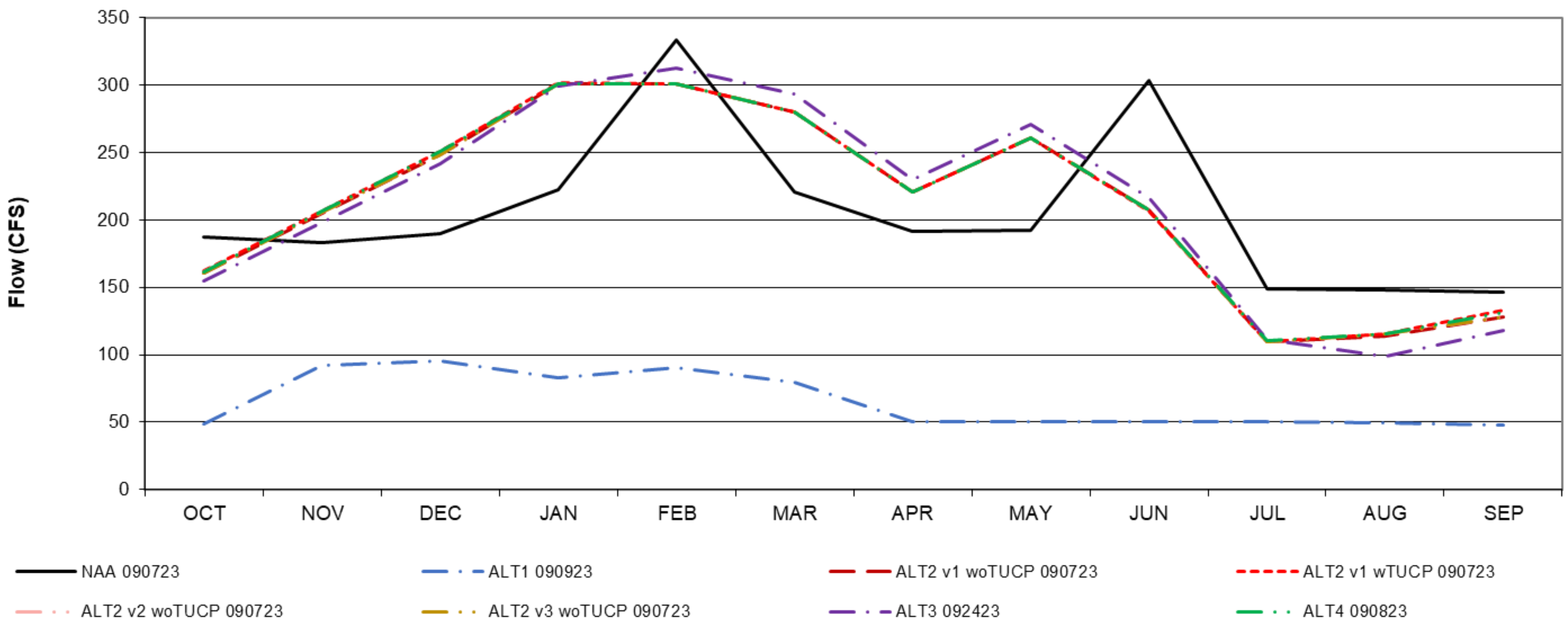
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-19. Sacramento River Flow downstream of Keswick Reservoir, Critical Year Average Flow

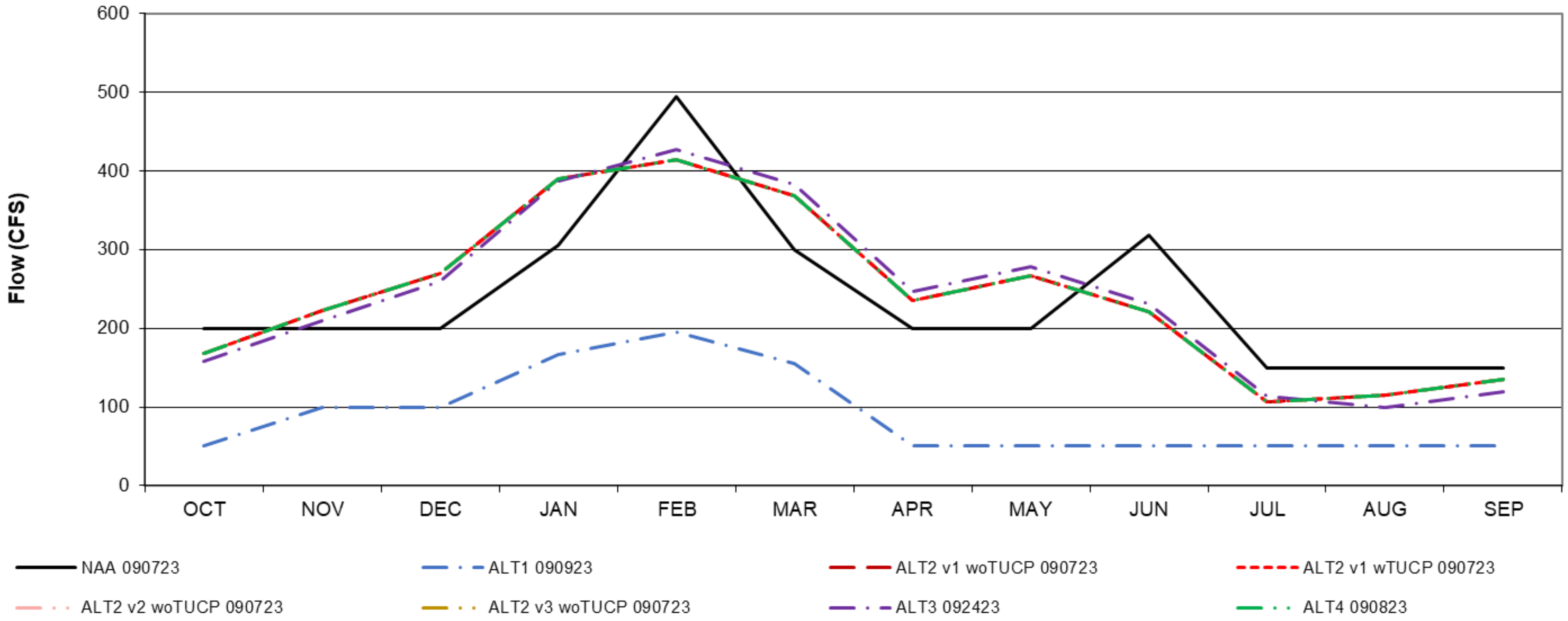
Clear Creek

Flows in Clear Creek under Alternative 1 would decrease compared with the No Action Alternative because Alternative 1 does not include specific winter or spring pulse flows. It is expected that flows in Clear Creek would decrease in all months of all water year types, with a maximum average decrease of approximately 84% in June. Figure G-20 through Figure G-25 illustrate changes in flow under Alternative 1. As mentioned in the *Mercury* subsection under Section G.1.5.1, *Constituents of Concern*, gold mining activity occurred within the Clear Creek watershed between Whiskeytown Lake and the confluence with the Sacramento River during the gold rush era (U.S. Geological Survey 2005), resulting in mercury contamination of Clear Creek and Whiskeytown Lake that currently persist. Reductions in flow due to changes in the operations of CVP and SWP under Alternative 1 could result in less dilution causing increased concentrations of mercury within Clear Creek compared with the No Action Alternative.



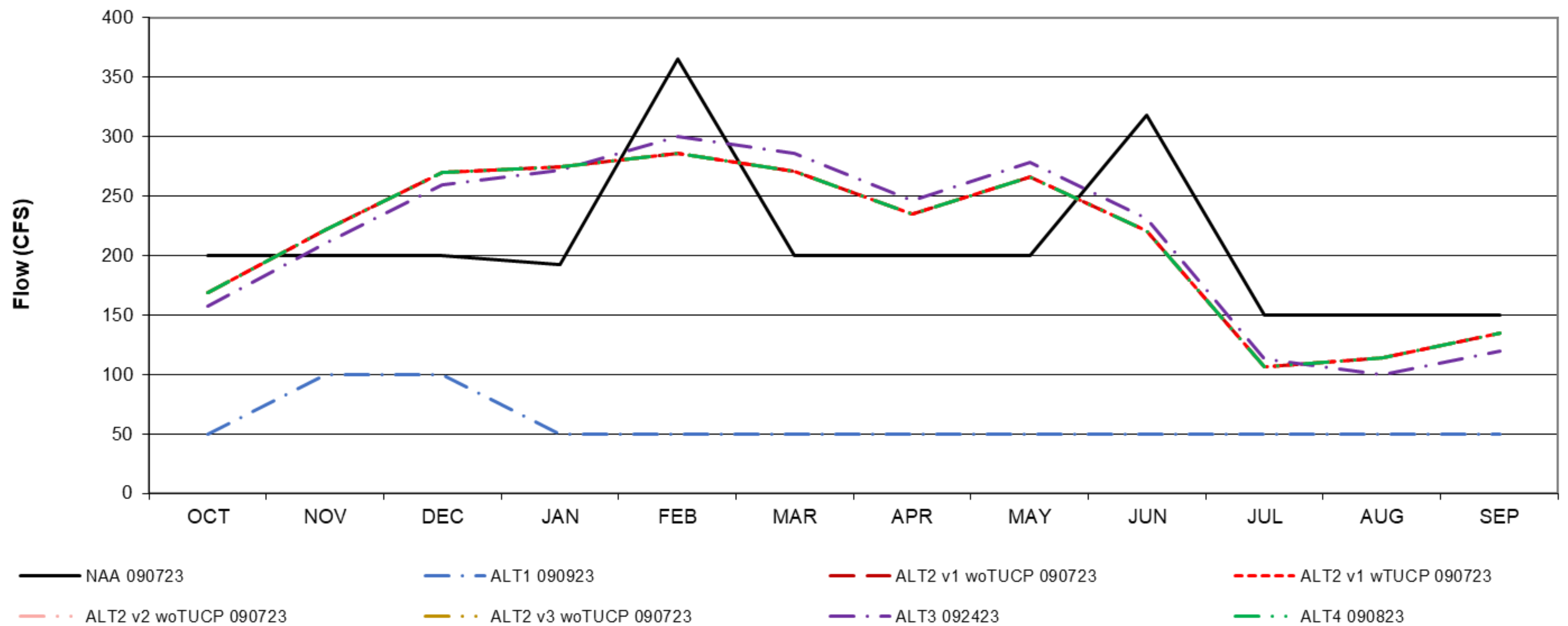
cfs = cubic feet per second;
NAA = No Action Alternative;
ALT1 090923 = Alternative 1 (Water Quality Control Plan);
ALT2 v1 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus without Temporary Urgency Change Petition);
ALT2 v1 wTUCP 090723 = Alternative 2 (Multi-Agency Consensus with Temporary Urgency Change Petition);
ALT2 v2 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = Early Implementation Voluntary Agreements);
ALT2 v3 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = All Voluntary Agreements);
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-20. Clear Creek Flow below Whiskeytown, Long-Term Average Flow



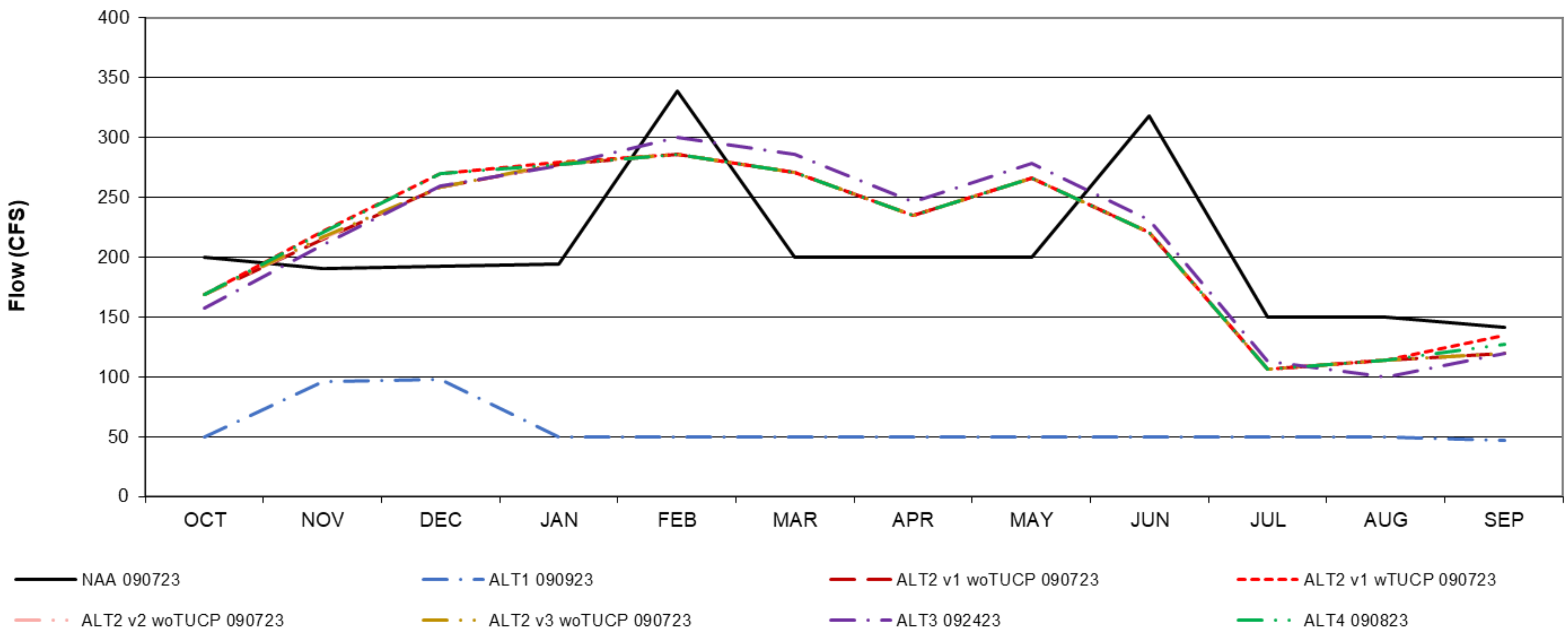
cfs = cubic feet per second;
NAA = No Action Alternative;
ALT1 090923 = Alternative 1 (Water Quality Control Plan);
ALT2 v1 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus without Temporary Urgency Change Petition);
ALT2 v1 wTUCP 090723 = Alternative 2 (Multi-Agency Consensus with Temporary Urgency Change Petition);
ALT2 v2 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = Early Implementation Voluntary Agreements);
ALT2 v3 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = All Voluntary Agreements);
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-21. Clear Creek Flow below Whiskeytown, Wet Year Average Flow



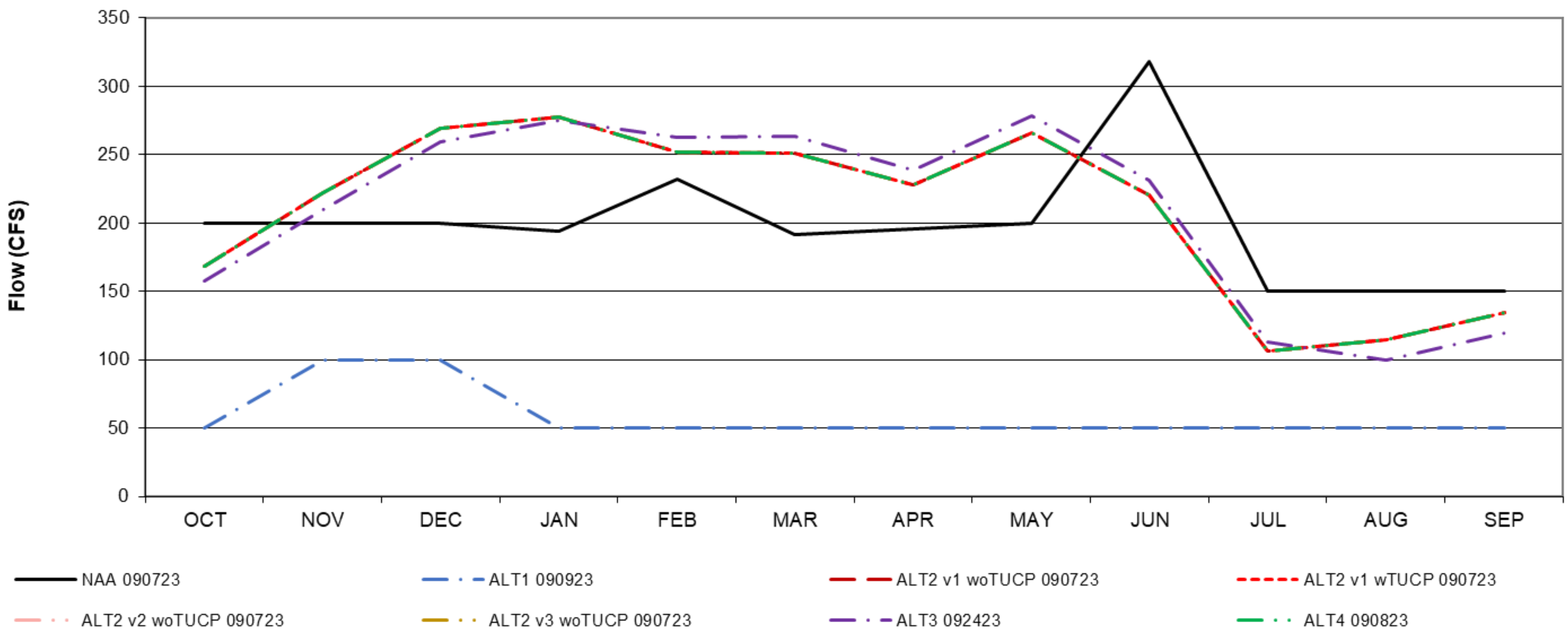
cfs = cubic feet per second;
NAA = No Action Alternative;
ALT1 090923 = Alternative 1 (Water Quality Control Plan);
ALT2 v1 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus without Temporary Urgency Change Petition);
ALT2 v1 wTUCP 090723 = Alternative 2 (Multi-Agency Consensus with Temporary Urgency Change Petition);
ALT2 v2 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = Early Implementation Voluntary Agreements);
ALT2 v3 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = All Voluntary Agreements);
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-22. Clear Creek Flow below Whiskeytown, Above Normal Year Average Flow



cfs = cubic feet per second;
NAA = No Action Alternative;
ALT1 090923 = Alternative 1 (Water Quality Control Plan);
ALT2 v1 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus without Temporary Urgency Change Petition);
ALT2 v1 wTUCP 090723 = Alternative 2 (Multi-Agency Consensus with Temporary Urgency Change Petition);
ALT2 v2 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = Early Implementation Voluntary Agreements);
ALT2 v3 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = All Voluntary Agreements);
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-23. Clear Creek Flow below Whiskeytown, Below Normal Year Average Flow



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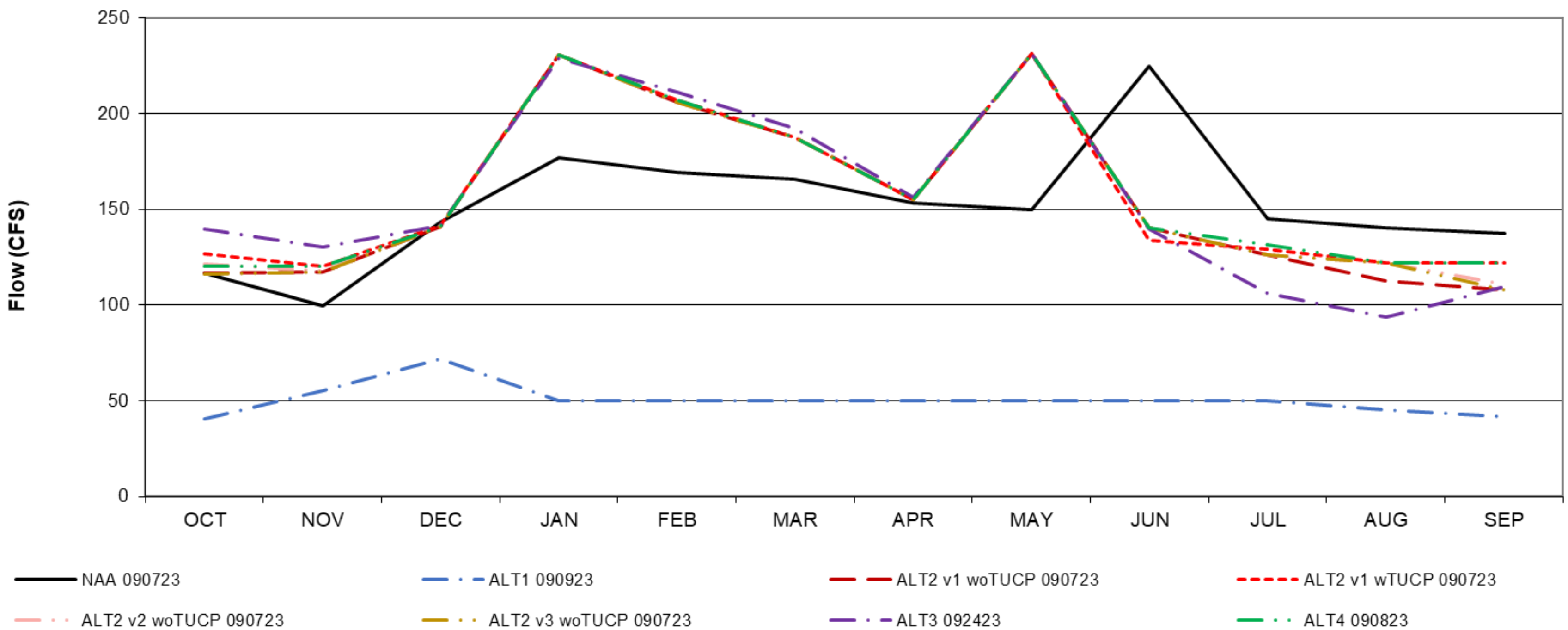
ALT2 v1 wTUCP 090723 = Alternative 2 (Multi-Agency Consensus with Temporary Urgency Change Petition);
ALT2 v2 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = Early Implementation Voluntary Agreements);
ALT2 v3 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = All Voluntary Agreements);
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-24. Clear Creek Flow below Whiskeytown, Dry Year Average Flow

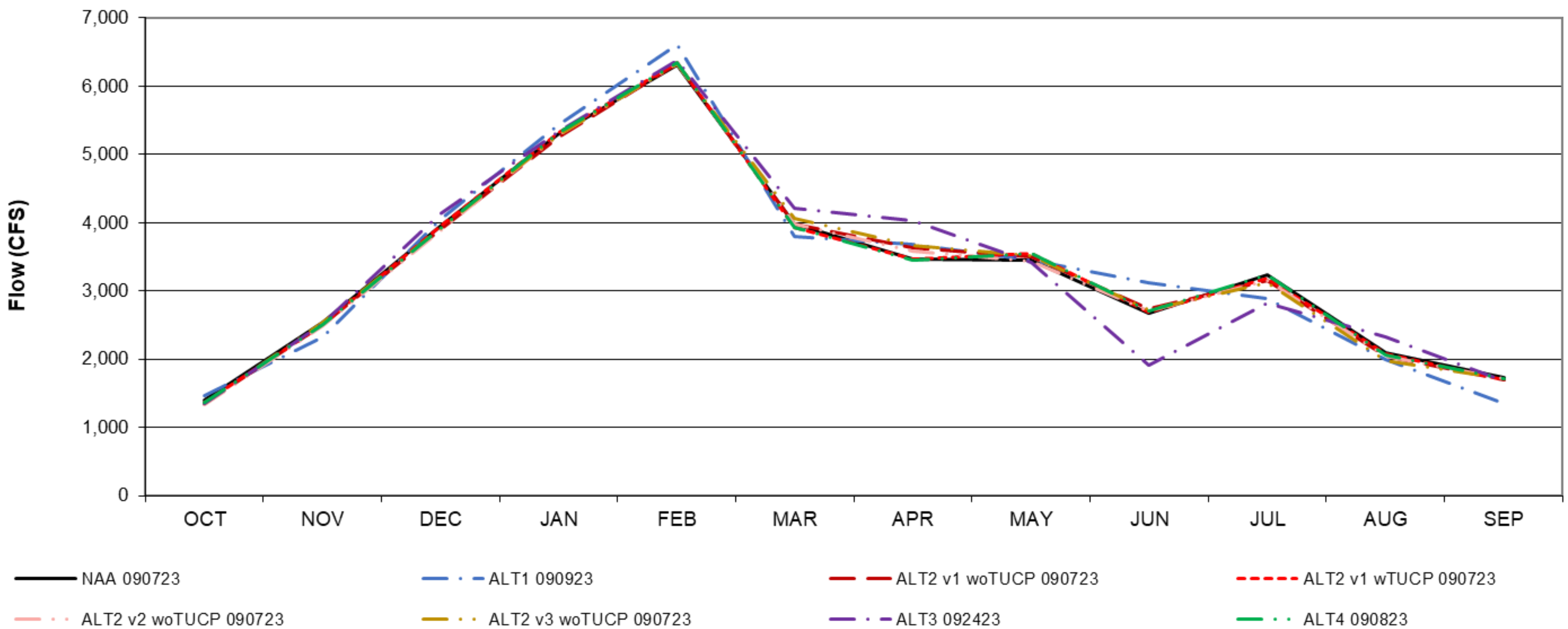


cfs = cubic feet per second;
NAA = No Action Alternative;
ALT1 090923 = Alternative 1 (Water Quality Control Plan);
ALT2 v1 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus without Temporary Urgency Change Petition);
ALT2 v1 wTUCP 090723 = Alternative 2 (Multi-Agency Consensus with Temporary Urgency Change Petition);
ALT2 v2 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = Early Implementation Voluntary Agreements);
ALT2 v3 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = All Voluntary Agreements);
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-25. Clear Creek Flow below Whiskeytown, Critical Year Average Flow

American River

The analysis modeled flows at two locations on the American River: H Street and below Nimbus Dam. Flows under Alternative 1 would differ from those under the No Action Alternative because Alternative 1 does not incorporate spring pulse flows nor redd dewatering adjustments. Based on modeling, the maximum average increase in flows on the American River at H Street would be during April of critical water years, when flows are expected to increase by 149%. The maximum average decrease in flows would be during September of dry water years, when flows are expected to decrease by 57%. Figure G-26 through Figure G-31 illustrate flow changes on the American River at H Street. Changes in flow below Nimbus Dam follow a similar trend but are generally smaller. As mentioned in Section G.1.6, *American River*, there are several constituents of concern within the American River, resulting in contamination in all reaches of the river, which currently persists. Reductions in flow due to changes in the operations of the CVP and SWP under Alternative 1 could result in less dilution causing increased concentrations of constituents of concern within the American River compared with the No Action Alternative.



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ALT2 v1 wTUCP 090723 = Alternative 2 (Multi-Agency Consensus with Temporary Urgency Change Petition);
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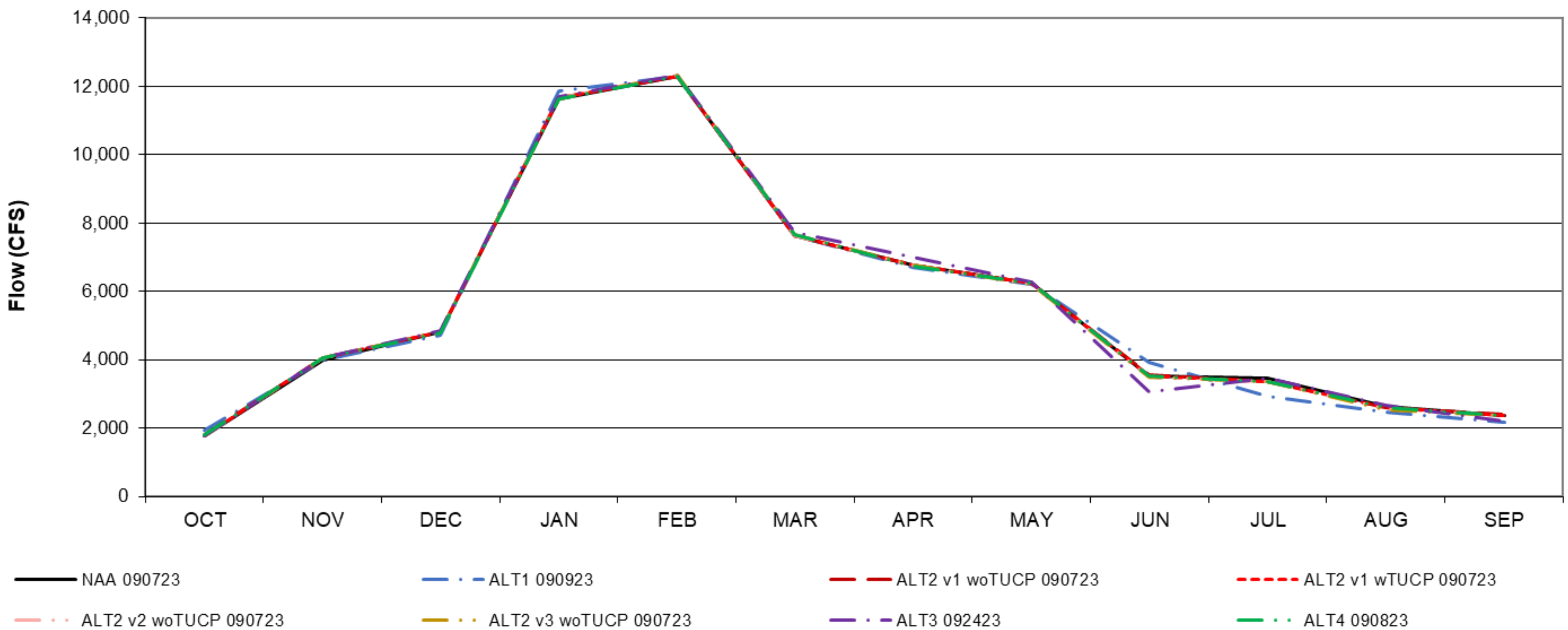
ALT2 v3 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = All Voluntary Agreements);
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-26. American River at H Street, Long-Term Average Flow



cfs = cubic feet per second;
NAA = No Action Alternative;
ALT1 090923 = Alternative 1 (Water Quality Control Plan);
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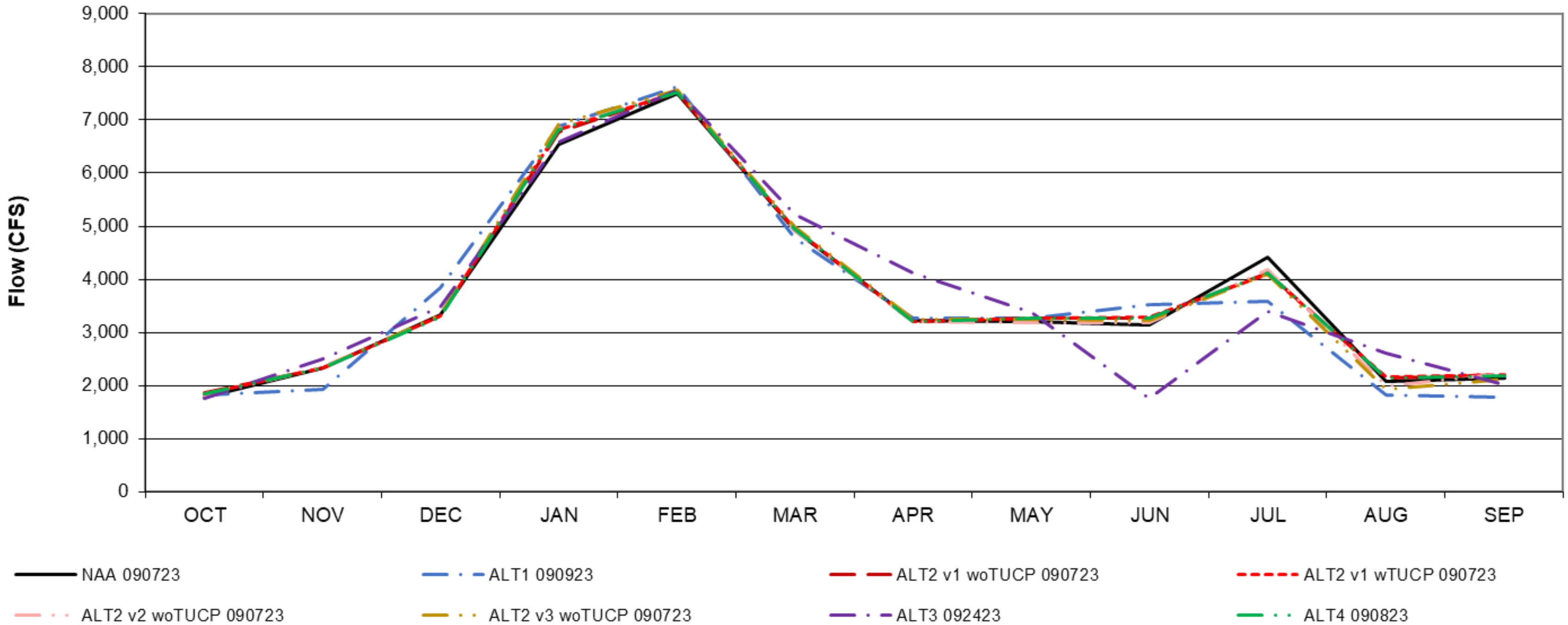
ALT2 v1 wTUCP 090723 = Alternative 2 (Multi-Agency Consensus with Temporary Urgency Change Petition);
ALT2 v2 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = Early Implementation Voluntary Agreements);
ALT2 v3 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = All Voluntary Agreements);
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-27. American River at H Street, Wet Year Average Flow



cfs = cubic feet per second;
NAA = No Action Alternative;
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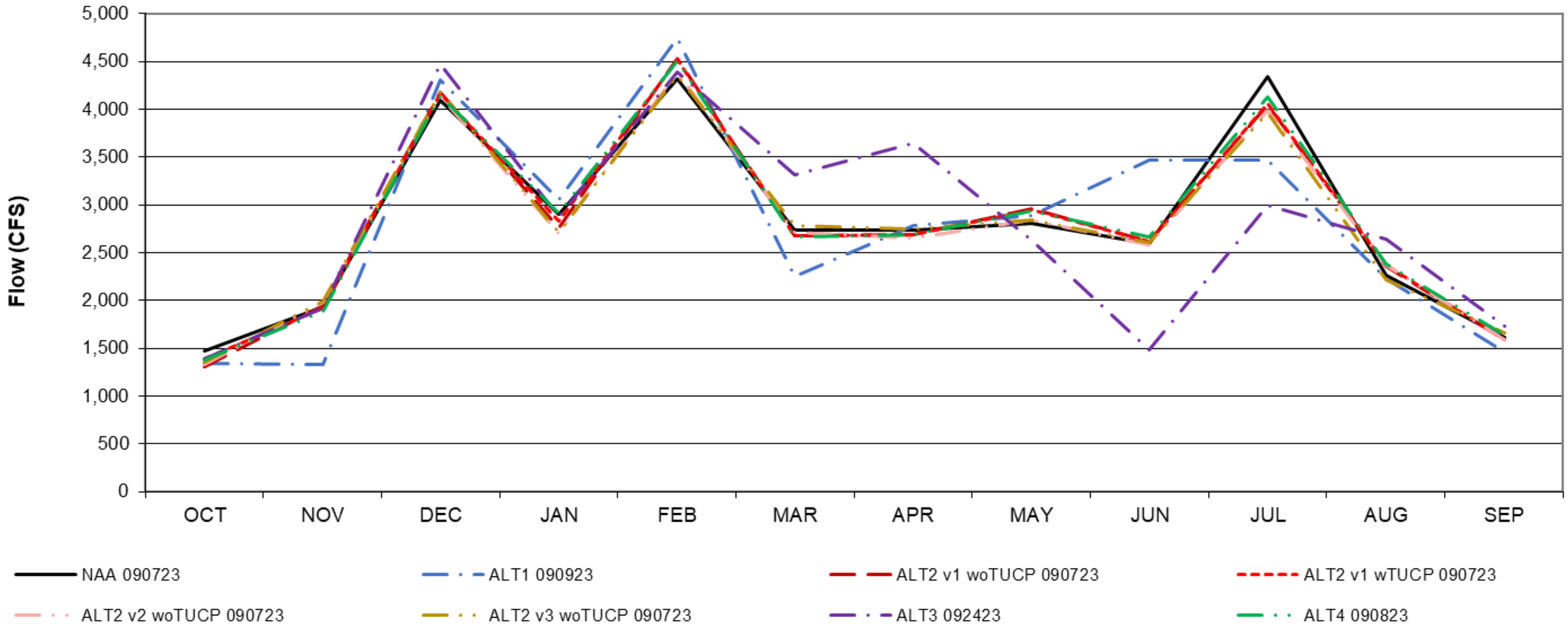
ALT2 v1 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus without Temporary Urgency Change Petition);
ALT2 v1 wTUCP 090723 = Alternative 2 (Multi-Agency Consensus with Temporary Urgency Change Petition);
ALT2 v2 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = Early Implementation Voluntary Agreements);
ALT2 v3 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = All Voluntary Agreements);
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-28. American River at H Street, Above Normal Year Average Flow



cfs = cubic feet per second;
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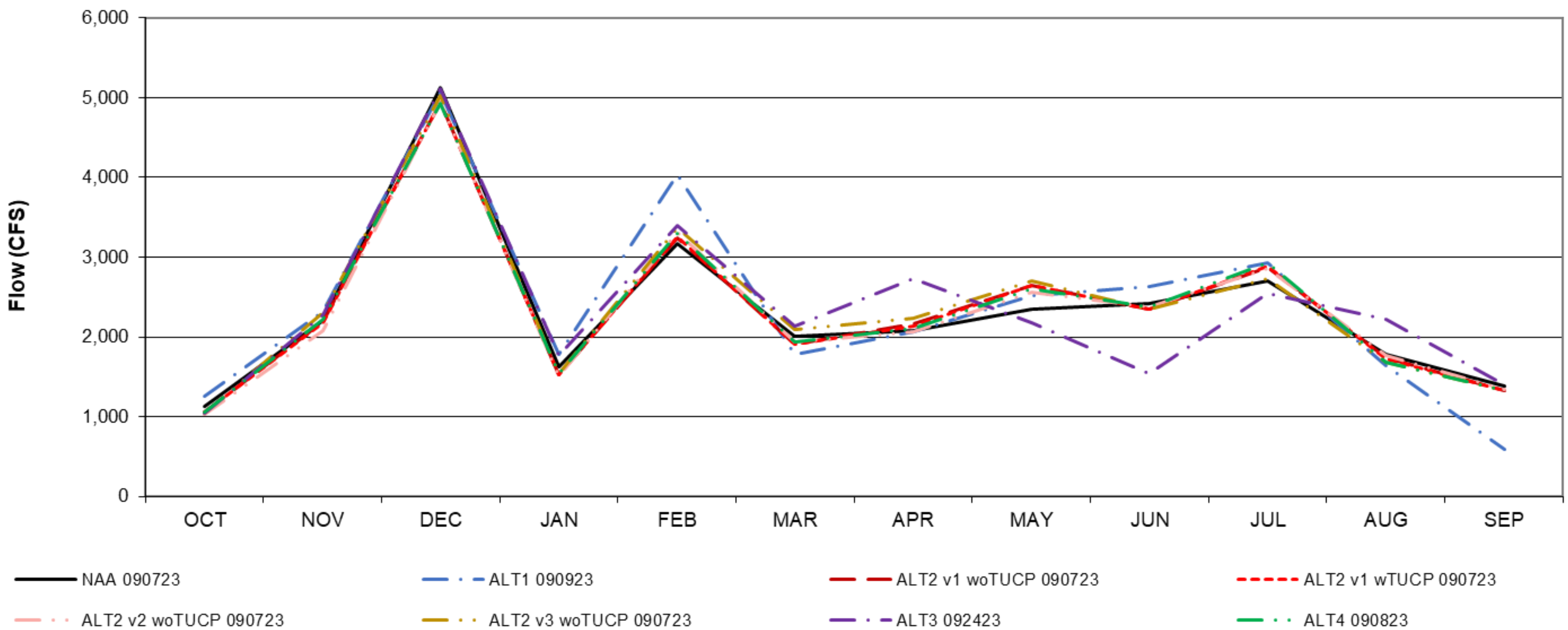
ALT2 v1 wTUCP 090723 = Alternative 2 (Multi-Agency Consensus with Temporary Urgency Change Petition);
ALT2 v2 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = Early Implementation Voluntary Agreements);
ALT2 v3 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = All Voluntary Agreements);
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-29. American River at H Street, Below Normal Year Average Flow



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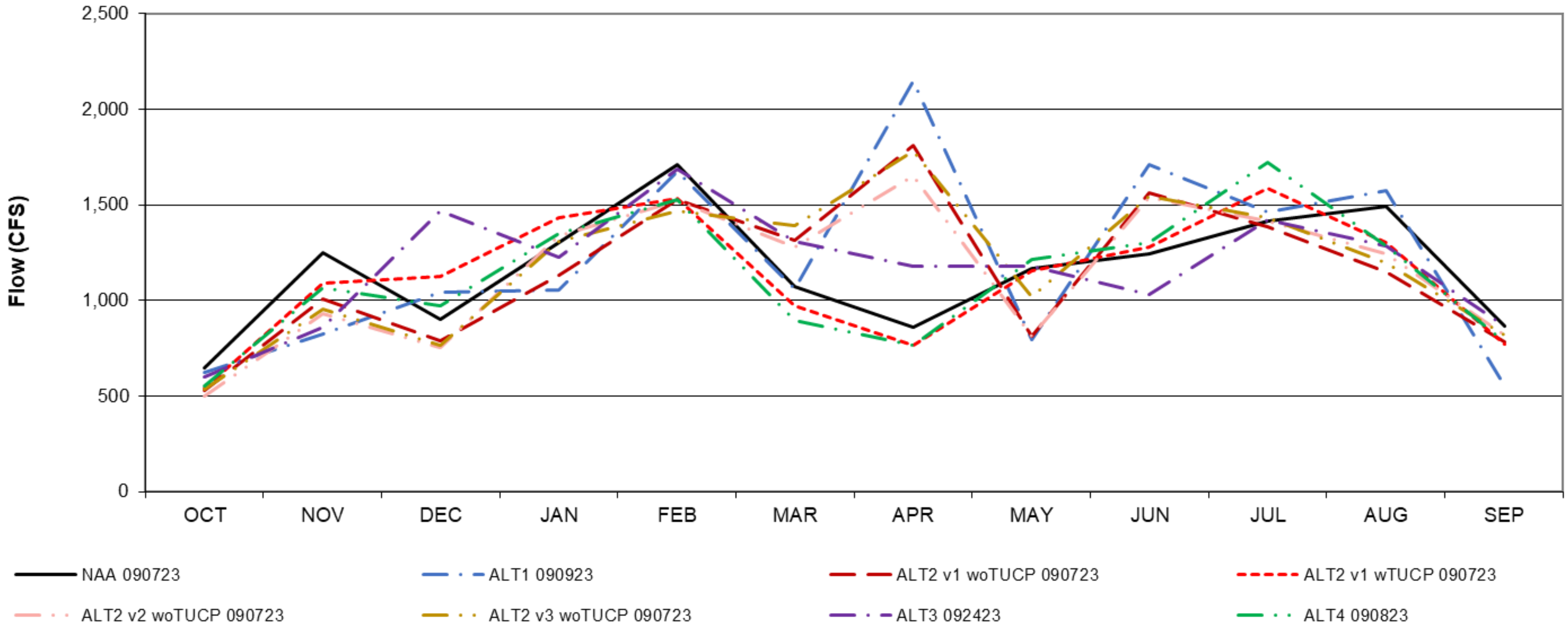
ALT2 v2 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = Early Implementation Voluntary Agreements);
ALT2 v3 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = All Voluntary Agreements);
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-30. American River at H Street, Dry Year Average Flow



cfs = cubic feet per second;
NAA = No Action Alternative;
ALT1 090923 = Alternative 1 (Water Quality Control Plan);
ALT2 v1 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus without Temporary Urgency Change Petition);
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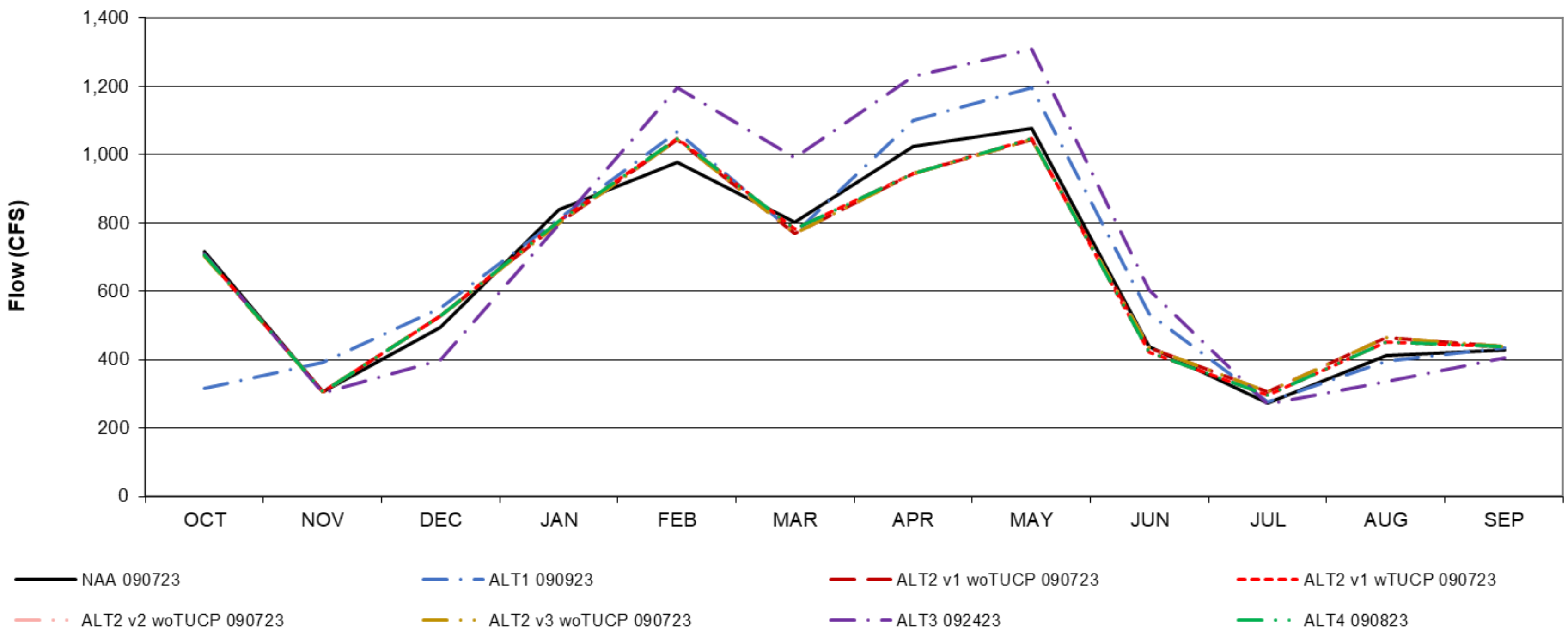
ALT2 v2 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = Early Implementation Voluntary Agreements);
ALT2 v3 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = All Voluntary Agreements);
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-31. American River at H Street, Critical Year Average Flow

Stanislaus River

The analysis modeled flows at two locations on the Stanislaus River: (1) at the mouth of Stanislaus River; and (2) below Goodwin Dam. Alternative 1 would change flows on the Stanislaus River because it would be operated to the 1987 agreement with the California Department of Fish and Wildfire, with Reclamation releasing water from New Melones Reservoir to meet D-1641 salinity and flow objectives at Vernalis. The largest flow decrease would be in October of critical water years and the largest flow increase would be in November of below normal water years under Alternative 1. Stanislaus River flows below Goodwin Dam are expected to have a maximum increase of approximately 74% in November of below normal water years, and a maximum decrease by approximately 77% in October of critical water years. Figure G-32 through Figure G-37 show changes in flow below Goodwin Dam. Changes in flow at the mouth of Stanislaus River follow a similar trend but are generally smaller. As mentioned in Section G.1.7, *Stanislaus River*, there are several constituents of concern within the Stanislaus River, resulting in contamination in all reaches of the river, which currently persists. Reductions in flow due to changes in the operations of CVP and SWP under Alternative 1 could result in less dilution causing increased concentrations of constituents of concern within the Stanislaus River compared with the No Action Alternative.



cfs = cubic feet per second;
NAA = No Action Alternative;
ALT1 090923 = Alternative 1 (Water Quality Control Plan);
ALT2 v1 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus without Temporary Urgency Change Petition);
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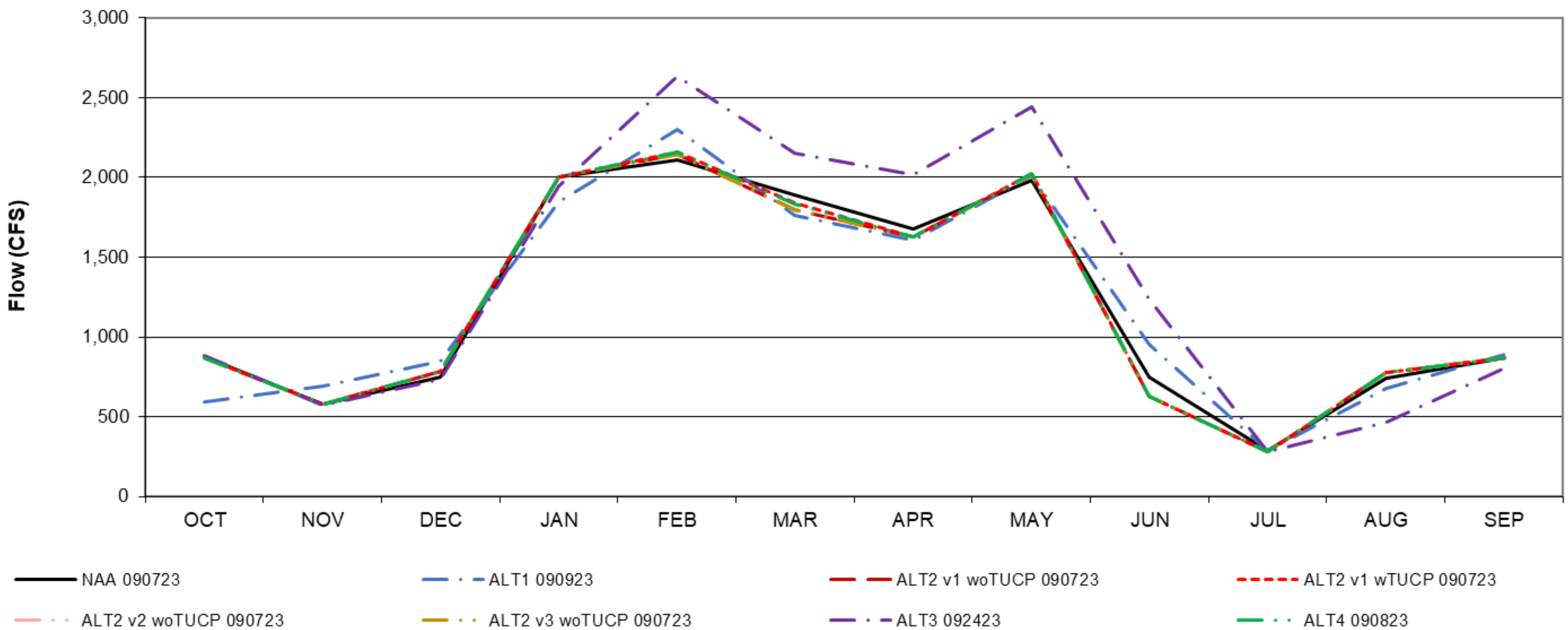
ALT2 v2 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = Early Implementation Voluntary Agreements);
ALT2 v3 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = All Voluntary Agreements);
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-32. Stanislaus River Flow below Goodwin, Long-Term Average Flow



cfs = cubic feet per second;
NAA = No Action Alternative;
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ALT2 v1 wTUCP 090723 = Alternative 2 (Multi-Agency Consensus with Temporary Urgency Change Petition);
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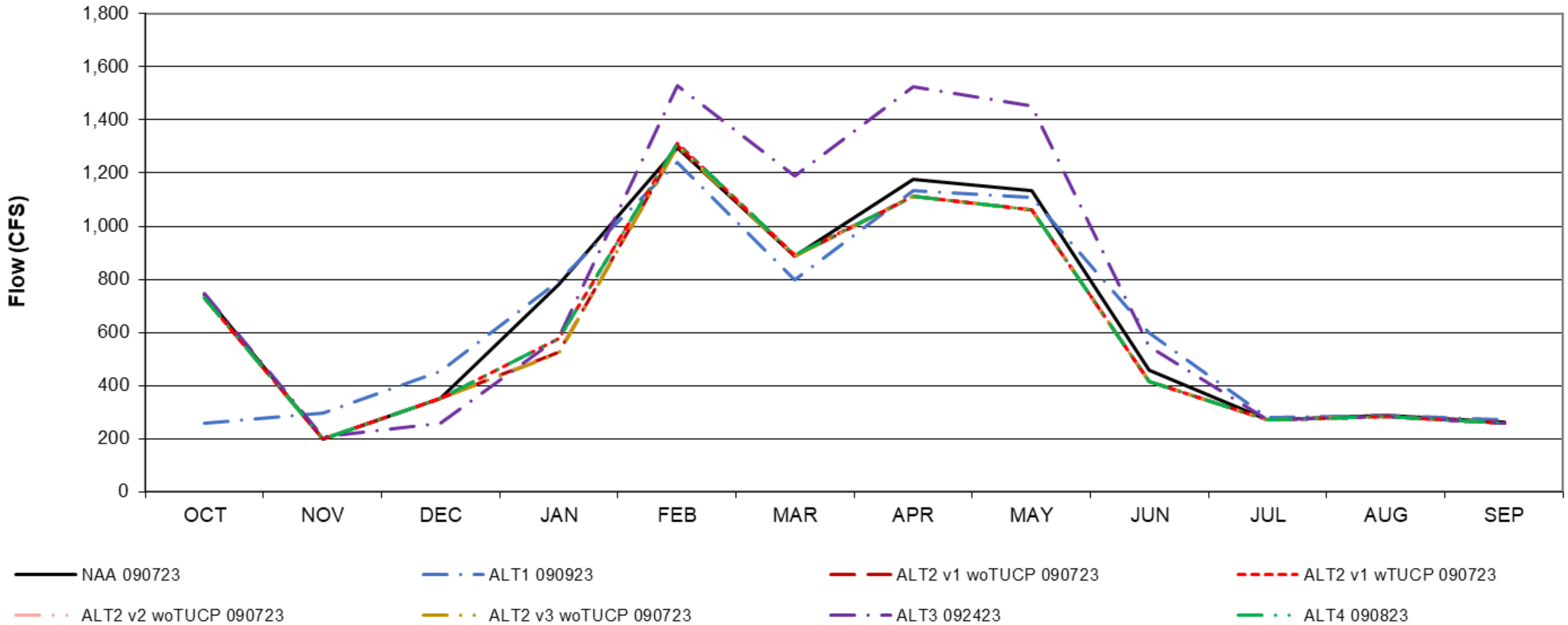
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-33. Stanislaus River Flow below Goodwin, Wet Year Average Flow



cfs = cubic feet per second;
NAA = No Action Alternative;
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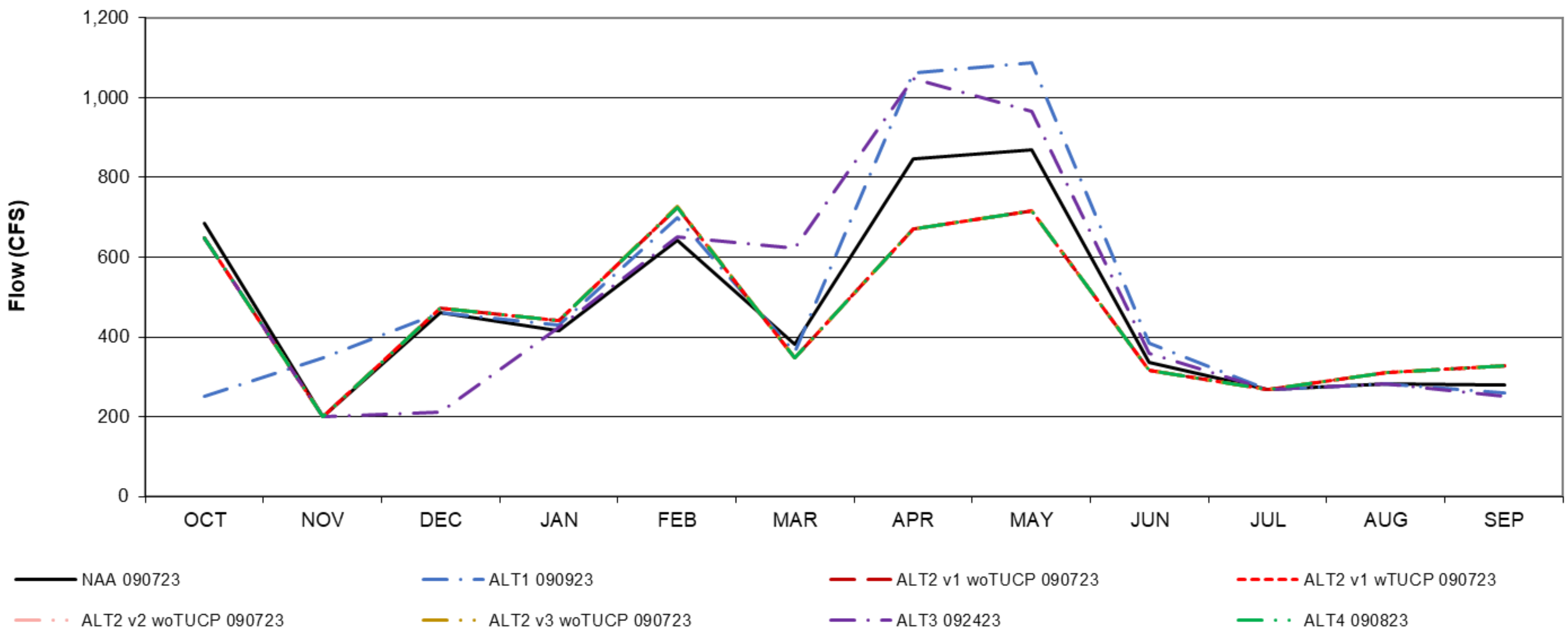
ALT2 v3 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = All Voluntary Agreements);
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-34. Stanislaus River Flow below Goodwin, Above Normal Year Average Flow



cfs = cubic feet per second;
NAA = No Action Alternative;
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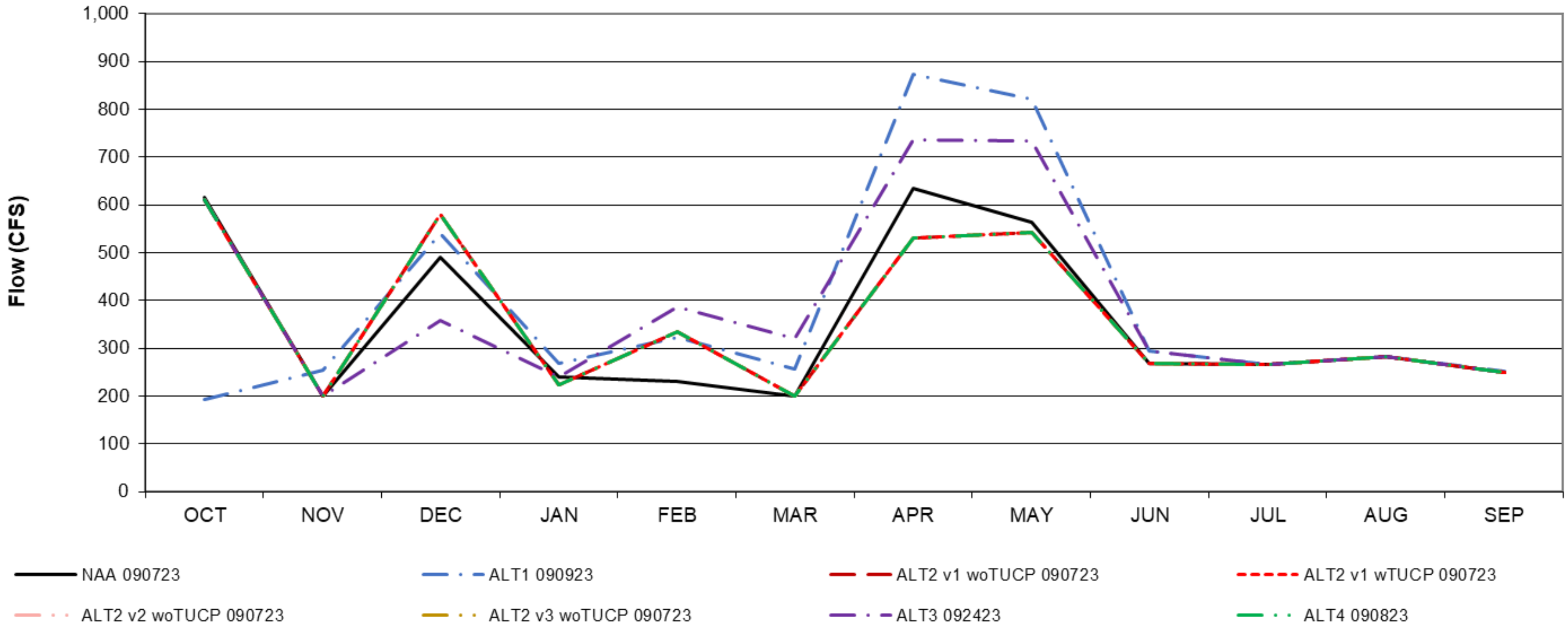
ALT2 v3 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = All Voluntary Agreements);
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-35. Stanislaus River Flow below Goodwin, Below Normal Year Average Flow



cfs = cubic feet per second;
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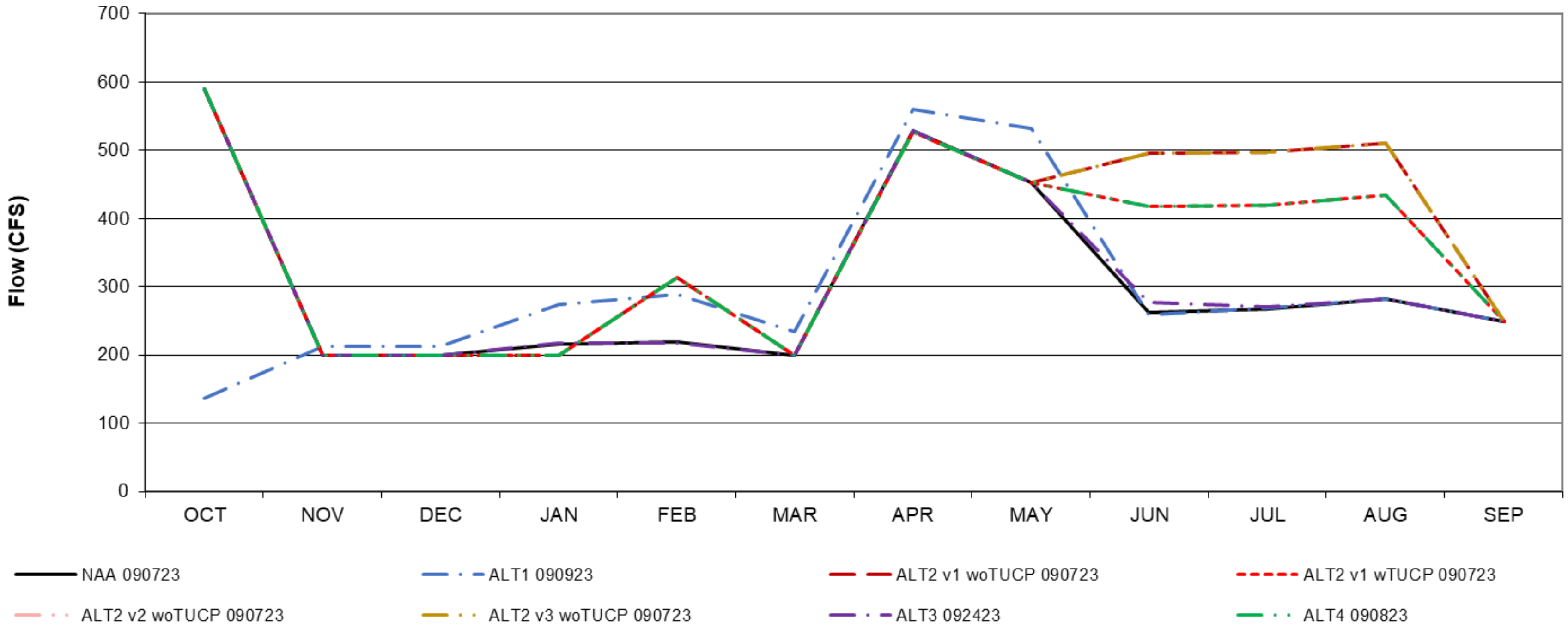
ALT2 v3 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = All Voluntary Agreements);
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-36. Stanislaus River Flow below Goodwin, Dry Year Average Flow



cfs = cubic feet per second;
NAA = No Action Alternative;
ALT1 090923 = Alternative 1 (Water Quality Control Plan);
ALT2 v1 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus without Temporary Urgency Change Petition);
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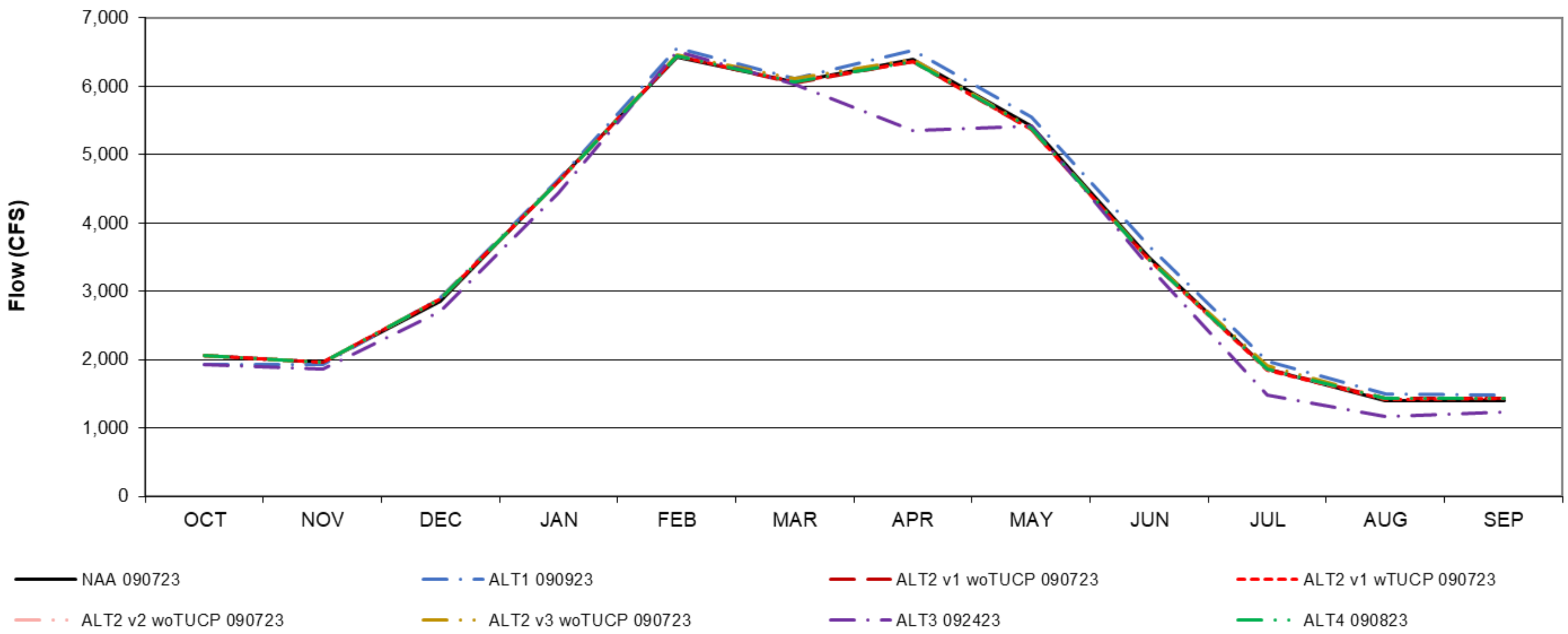
ALT2 v2 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = Early Implementation Voluntary Agreements);
ALT2 v3 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = All Voluntary Agreements);
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-37. Stanislaus River Flow below Goodwin, Critical Year Average Flow

San Joaquin River

The analysis modeled flows at four locations on the San Joaquin River: (1) at Gravelly Ford; (2) below the confluence with the Merced River; (3) below Sack Dam; and (4) at Vernalis. Flow changes at Gravelly Ford, below the confluence with the Merced River, and below Sack Dam would be less than 4%. At Vernalis, Alternative 1 would result in a small decrease in flows for all water year types during October and November. Figure G-38 through Figure G-43 illustrate flow changes at Vernalis. The minimal change in flow under Alternative 1 would not likely result in increased frequency of exceedances of water quality thresholds in the San Joaquin River.



cfs = cubic feet per second;
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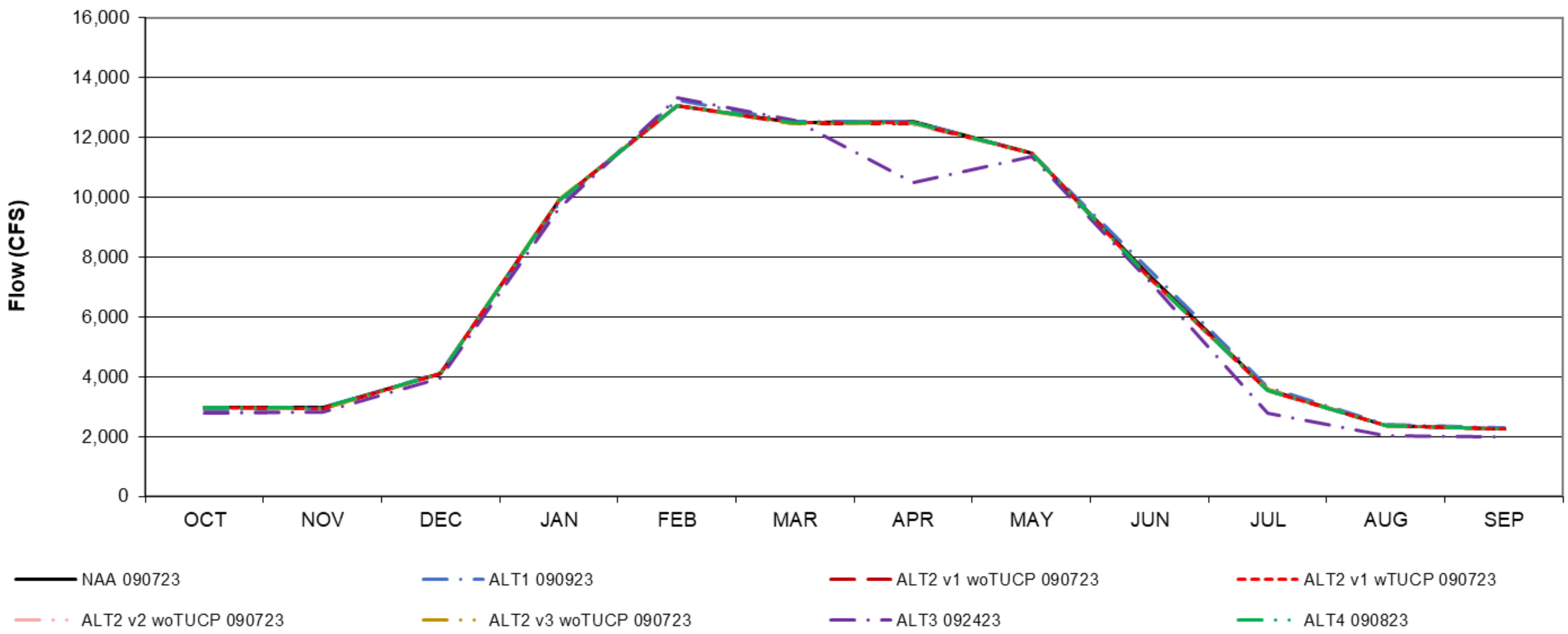
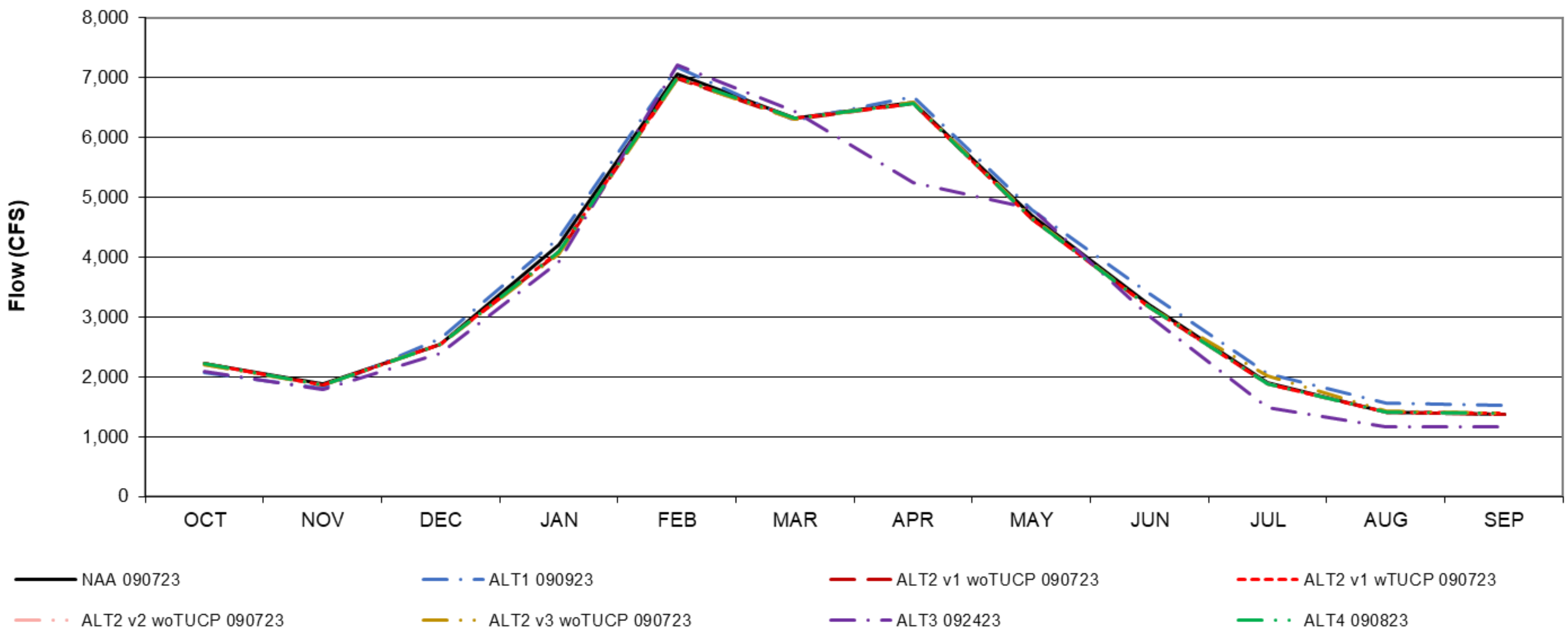
ALT2 v3 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = All Voluntary Agreements);
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-38. San Joaquin River Flow at Vernalis, Long-Term Average Flow



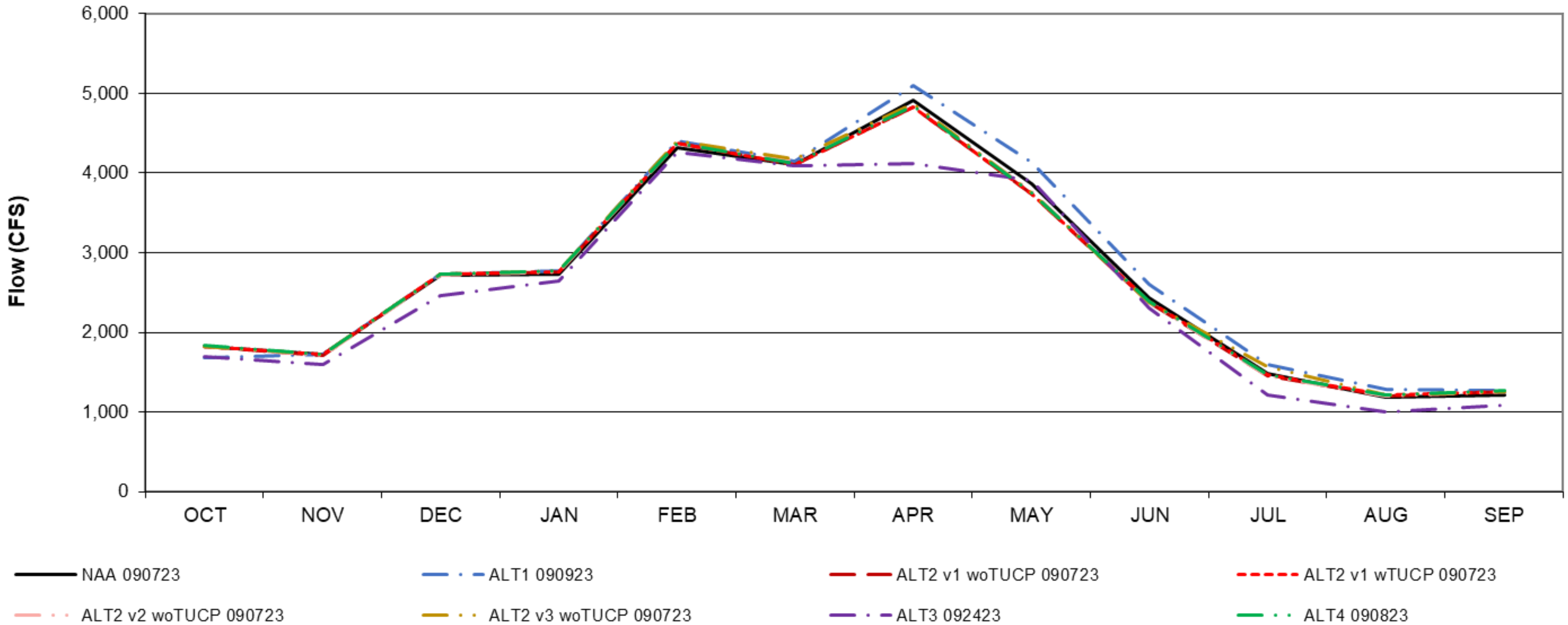
cfs = cubic feet per second;
NAA = No Action Alternative;
ALT1 090923 = Alternative 1 (Water Quality Control Plan);
ALT2 v1 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus without Temporary Urgency Change Petition);
ALT2 v1 wTUCP 090723 = Alternative 2 (Multi-Agency Consensus with Temporary Urgency Change Petition);
ALT2 v2 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = Early Implementation Voluntary Agreements);
ALT2 v3 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = All Voluntary Agreements);
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-39. San Joaquin River Flow at Vernalis, Wet Year Average Flow



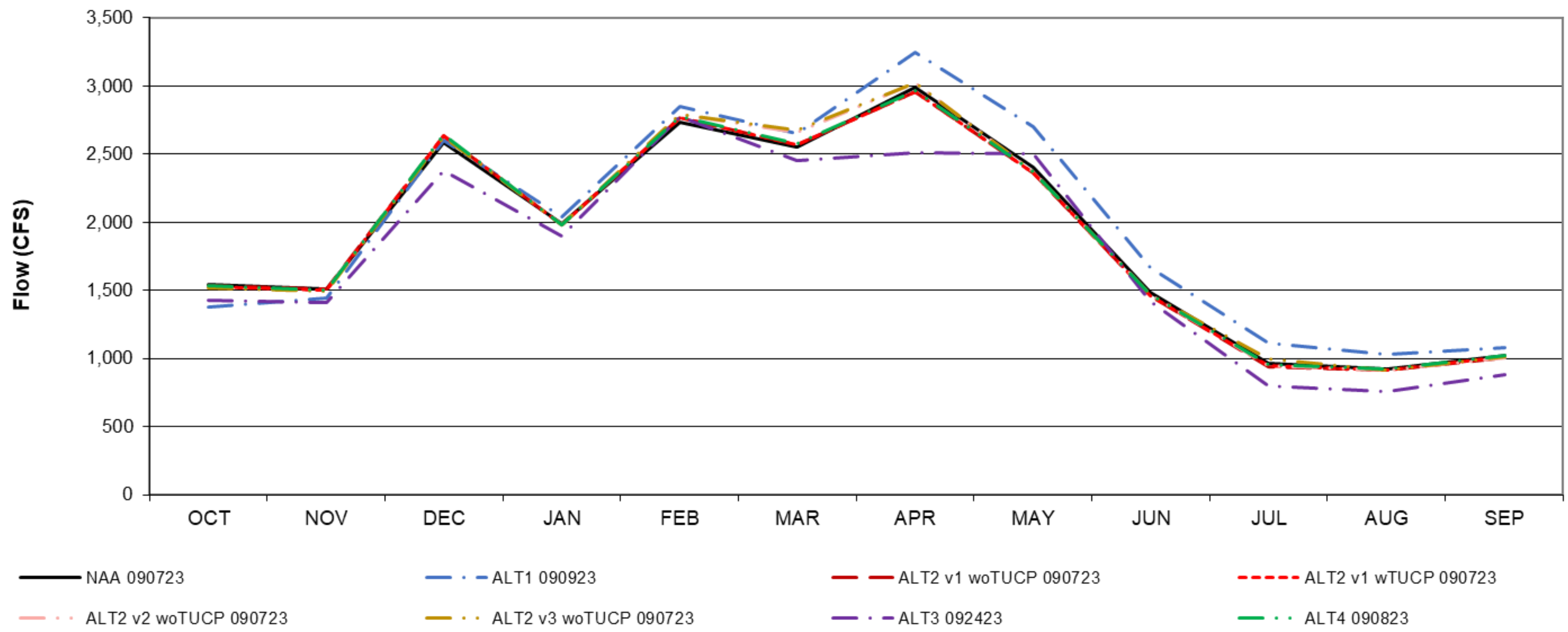
cfs = cubic feet per second;
NAA = No Action Alternative;
ALT1 090923 = Alternative 1 (Water Quality Control Plan);
ALT2 v1 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus without Temporary Urgency Change Petition);
ALT2 v1 wTUCP 090723 = Alternative 2 (Multi-Agency Consensus with Temporary Urgency Change Petition);
ALT2 v2 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = Early Implementation Voluntary Agreements);
ALT2 v3 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = All Voluntary Agreements);
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-40. San Joaquin River Flow at Vernalis, Above Normal Year Average Flow



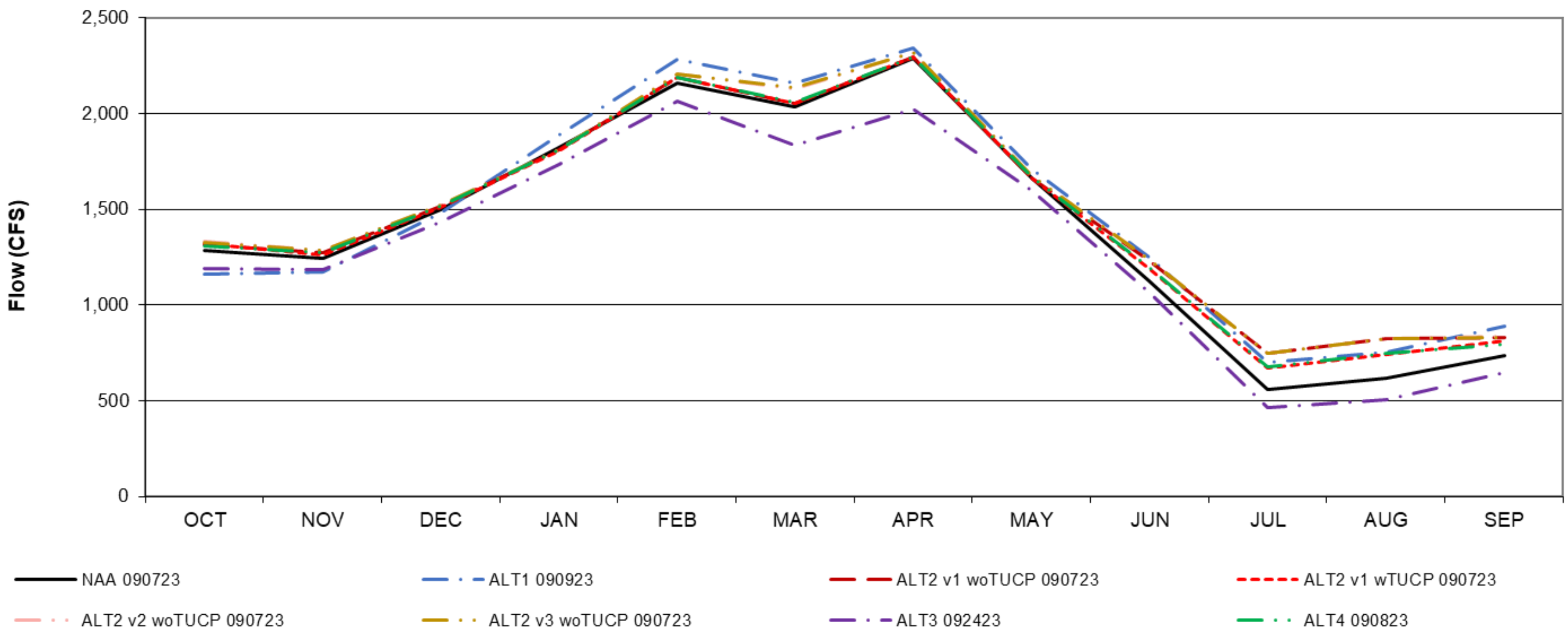
cfs = cubic feet per second;
NAA = No Action Alternative;
ALT1 090923 = Alternative 1 (Water Quality Control Plan);
ALT2 v1 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus without Temporary Urgency Change Petition);
ALT2 v1 wTUCP 090723 = Alternative 2 (Multi-Agency Consensus with Temporary Urgency Change Petition);
ALT2 v2 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = Early Implementation Voluntary Agreements);
ALT2 v3 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = All Voluntary Agreements);
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-41. San Joaquin River Flow at Vernalis, Below Normal Year Average Flow



cfs = cubic feet per second;
NAA = No Action Alternative;
ALT1 090923 = Alternative 1 (Water Quality Control Plan);
ALT2 v1 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus without Temporary Urgency Change Petition);
ALT2 v1 wTUCP 090723 = Alternative 2 (Multi-Agency Consensus with Temporary Urgency Change Petition);
ALT2 v2 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = Early Implementation Voluntary Agreements);
ALT2 v3 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = All Voluntary Agreements);
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-42. San Joaquin River Flow at Vernalis, Dry Year Average Flow



cfs = cubic feet per second;
NAA = No Action Alternative;
ALT1 090923 = Alternative 1 (Water Quality Control Plan);
ALT2 v1 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus without Temporary Urgency Change Petition);
ALT2 v1 wTUCP 090723 = Alternative 2 (Multi-Agency Consensus with Temporary Urgency Change Petition);
ALT2 v2 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = Early Implementation Voluntary Agreements);
ALT2 v3 woTUCP 090723 = Alternative 2 (Multi-Agency Consensus = All Voluntary Agreements);
ALT3 092423 = Alternative 3 (Modified Natural Hydrograph);
ALT4 090823 = Alternative 4 (Risk Informed Operations).
As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (State Water Resources Control Board 2000). These results are displayed with water year–year type sorting. These are draft results and meant for qualitative analysis are subject to revision.

Figure G-43. San Joaquin River Flow at Vernalis, Critical Year Average Flow

Bay-Delta

Alternative 1 would result in some differences in Sacramento River and San Joaquin River inflow rates to the Delta, Delta outflows, and south Delta exports, relative to the No Action Alternative, which could result in changes in the proportion of Delta source waters (i.e., Sacramento River, San Joaquin River, San Francisco Bay, eastside tributaries) at various Delta locations. The water proportion differences may result in water quality differences relative to the No Action Alternative at various Delta locations, Suisun Marsh, and outflow to Suisun Bay and San Francisco Bay. The following sections discuss effects of Alternative 1 on EC, chloride, bromide, methylmercury, selenium, organic carbon, trace metals, nutrients, DO, legacy contaminants, pesticides, and CHABs.

Effects on Electrical Conductivity

<u>Delta</u>

Attachment G.1 provides tables and figures presenting modeled EC levels at the Delta assessment locations for Alternative 1 relative to the No Action Alternative. Table G-22 presents the modeled monthly average EC levels at the Delta assessment locations for Alternative 1 for the 100-year simulation period and the differences from the No Action Alternative.

Modeled monthly average EC levels in the San Joaquin River at Jersey Point, Prisoners Point and San Andreas Landing, and the Sacramento River at Emmaton and Threemile Slough are substantially higher in September, October and November under Alternative 1 relative to the No Action Alternative for the full simulation period (Table G-22). EC levels are substantially higher in October and November of all water year types, and September of wet and above normal years (Attachment G.1, Figures G.1-2-1 through G.1-4-6, G.1-9-1 through G.1-9-6, and G.1-11-1 through G.1-11-6).

Modeled monthly average EC levels in the San Joaquin River at Vernalis and Brandt Bridge, Old River near Middle River and Tracy Bridge, and Sacramento River at Rio Vista are slightly higher in October and November, and similar or lower for the remaining months of the full simulation period under Alternative 1 compared with the No Action Alternative (Table G-22; Figures G.1-5-1 through G.1-8-18 and G.1-10-1 through G.1-10-18).

Modeled monthly average EC levels in the Mokelumne River at Terminous under Alternative 1 are similar to the No Action Alternative (Table G-22; Attachment G.1, Table G.1-1-2, and Figures G.1-1-1 through G.1-1-18).

Modeled monthly average EC levels at the Banks and Jones pumping plants under Alternative 1, relative to the No Action Alternative, are higher in September through December for the full simulation period (Table G-22). EC levels are substantially higher in October and November of all water year types, and September of wet and above normal years (Attachment G.1, Tables G.1-17-2 and G.1-18-2, and Figures G.1-17-1 through G.1-18-6).

While there would be higher monthly average EC levels under Alternative 1 relative to the No Action Alternative, in some months, the CVP and SWP would continue to be operated, in real-time, to meet the Bay-Delta Plan objectives for EC. The objectives are for protecting agricultural, and fish and wildlife beneficial uses. The western Delta EC objectives for the Sacramento River at Emmaton and San Joaquin River at Jersey Point for agricultural beneficial use protection apply from April through June, July, or August, depending on water year type (State Water Resources Control Board 2018b). The San Joaquin River at Jersey Point objective for fish and wildlife protection also applies during April and May (State Water Resources Control Board 2018b). During these months, the monthly average EC levels under Alternative 1 would be similar to the No Action Alternative (Attachment G.1, Figures G.1-2-1 through G.1-2-18, G.1-9-1 through G.1-9-18). The southern Delta EC objectives for the protection of agricultural uses for the San Joaquin River at Vernalis and the export area for Banks and Jones pumping plant apply year-round. Banks and Jones pumping plants would have higher EC levels in the fall, but lower monthly average EC in spring and summer, relative to the No Action Alternative (Table G-22; Attachment G.1, Figures G.1-17-1 through G.1-18-18). Monthly average EC levels at Vernalis under Alternative 1 would be overall similar to the No Action Alternative (Attachment G.1, Figures G.1-5-1 through G.1.-5-18). Based on the modeled differences in EC at the Delta assessment locations, Alternative 2 would not contribute to agricultural or fish and wildlife beneficial use impairments in the Delta relative to the No Action Alternative.

Table G-22. Monthly Average Electrical Conductivity (in micromhos per centimeter) at Delta Assessment Locations for the Full Simulation Period under Alternative 1, and Difference from the No Action Alternative

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
SOUTH FORK MOKELUMNE RIVER AT TERMINOUS												
Full Simulation Period Average	188	198	201	205	216	211	199	191	187	185	186	184
Difference from NAA	0	3	-7	-6	-1	0	-2	-1	-1	0	0	1
SAN JOAQUIN RIVER AT JERSEY POINT												
Full Simulation Period Average	1628	1749	1327	848	472	274	256	303	375	609	1026	1571
Difference from NAA	536	434	187	216	122	13	-20	-39	-50	-64	66	415
SAN JOAQUIN RIVER AT PRISONERS POINT												
Full Simulation Period Average	405	456	454	379	320	260	269	243	226	237	281	364
Difference from NAA	79	91	1	21	21	-10	-12	-15	-11	-11	4	59
SAN JOAQUIN RIVER AT SAN ANDREAS LANDING												
Full Simulation Period Average	453	518	450	359	280	223	220	221	214	233	293	390
Difference from NAA	88	114	-9	33	36	3	-7	-13	-12	-15	4	66
SAN JOAQUIN RIVER AT VERNALIS												
Full Simulation Period Average	640	720	682	622	570	587	441	389	484	567	578	583
Difference from NAA	16	8	0	-2	-3	-3	-7	-9	-8	-7	-5	-3
SAN JOAQUIN RIVER AT BRANDT BRIDGE												
Full Simulation Period Average	636	715	687	629	574	586	450	394	482	565	580	585
Difference from NAA	14	8	2	-1	-2	-3	-7	-9	-8	-5	-4	-3

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
OLD RIVER NEAR MIDDLE RIVER												
Full Simulation Period Average	639	718	687	630	577	590	449	395	485	568	581	586
Difference from NAA	15	8	0	-3	-3	-3	-7	-9	-8	-7	-5	-3
OLD RIVER AT TRACY BRIDGE												
Full Simulation Period Average	631	712	701	653	605	607	468	407	478	531	523	548
Difference from NAA	9	8	0	-3	-4	-3	-8	-9	-4	8	2	0
SACRAMENTO RIVER AT EMMATON												
Full Simulation Period Average	2185	2113	1204	698	310	254	285	419	613	797	1464	2048
Difference from NAA	414	376	265	160	31	3	-73	-73	-137	-124	51	308
SACRAMENTO RIVER AT RIO VISTA												
Full Simulation Period Average	341	352	276	226	193	189	188	195	210	218	272	320
Difference from NAA	39	46	32	16	3	1	-7	-8	-17	-21	-1	28
SACRAMENTO RIVER AT THREEMILE SLOUGH												
Full Simulation Period Average	1053	1034	630	401	235	210	218	267	347	408	705	979
Difference from NAA	187	195	134	75	15	2	-36	-37	-68	-73	13	138
BANKS PUMPING PLANT												
Full Simulation Period Average	552	586	633	542	485	437	414	361	329	329	372	476
Difference from NAA	82	102	14	-22	-14	-36	-18	-20	-19	-9	5	54
JONES PUMPING PLANT												
Full Simulation Period Average	567	613	646	566	509	470	428	370	357	372	407	493
Difference from NAA	65	80	15	-13	-7	-23	-17	-18	-13	-7	5	44

NAA = No Action Alternative.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Suisun Marsh

Attachment G.1 provides tables and figures presenting modeled EC levels at the Suisun Marsh assessment locations for Alternative 1 relative to the No Action Alternative. Table G-23 presents the modeled monthly average EC levels at the Suisun Marsh assessment locations for Alternative 1 for the 100-year simulation period and the differences from the No Action Alternative.

For Suisun Marsh, October through May is the period when Bay-Delta Plan EC objectives for protection of fish and wildlife apply; thus, the discussion of effects of Alternative 1 on EC is focused on changes during these months. The purpose of the EC objectives is to protect habitat for waterfowl favored by hunters in managed wetlands (State Water Resources Control Board 2000:49). Modeled monthly average EC levels are substantially higher in October through January under Alternative 1 relative to the No Action Alternative for the full simulation period and across water year types (Table G-23; Attachment G.1, Figures G.1-12-1 through G.1-16-6).

The Suisun Marsh EC objectives for fish and wildlife beneficial use protection are expressed as a monthly average of daily high tide EC, ranging from 8.0 mmhos/cm for February and March to 19.0 mmhos/cm for October, or demonstration that "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2018b:14). The objectives are implemented through water right actions (D-1641) because the salinity levels are determined by flows and control structure operations (State Water Resources Control Board 2018b:33). Project facilities would be operated to meet Bay-Delta Plan objectives, as implemented through D-1641. Additionally, because marsh management factors also affect beneficial uses, including when wetlands are flooded, soil leaching cycles, how agricultural use of water is managed, and future actions taken with respect to the marsh, higher long-term average EC under Alternative 1 would not necessarily contribute to adverse effects on Suisun Marsh beneficial uses or contribute to additional salinity-related impairment.

Suisun Bay and San Francisco Bay

Alternative 1 would result in lower Delta outflow rates, relative to the No Action Alternative, in all months except June (Appendix F, Attachment 2-2). The differences in Delta EC and outflow could cause the freshwater-seawater salinity gradient within Suisun Bay and the northern portion of San Francisco Bay to be different between Alternative 1 and the No Action Alternative. However, Alternative 1 is not expected to result in substantial changes in overall salinity conditions within Suisun Bay and San Francisco Bay, because seawater is the predominant source of salinity in the bays.

Table G-23. Monthly Average Electrical Conductivity (in millimhos per centimeter) at Suisun Marsh Assessment Locations for the Full Simulation Period under Alternative 1, and Difference from the No Action Alternative

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
SACRAMENTO RIVER AT COLLINSVILLE												
Full Simulation Period Average	8.1	7.7	4.7	2.8	1.1	0.8	1.0	1.8	2.8	4.0	6.2	7.8
Difference from NAA	1.4	0.8	0.6	0.6	0.2	0.0	-0.2	-0.1	-0.4	-0.3	0.2	1.1
MONTEZUMA SLOUGH AT NATIONAL STEEL												
Full Simulation Period Average	11.7	11.3	7.6	4.6	2.2	1.4	1.6	2.6	4.1	5.9	8.5	10.8
Difference from NAA	4.3	3.8	2.8	2.2	1.1	0.4	0.1	0.1	-0.1	0.5	1.2	3.3
MONTEZUMA SLOUGH NEAR BELDON LANDING												
Full Simulation Period Average	15.6	15.0	11.0	7.1	4.1	2.6	2.8	4.0	6.0	8.3	11.2	14.3
Difference from NAA	6.8	6.4	5.0	4.0	2.6	1.0	0.4	0.4	0.2	1.5	2.5	5.1
CHADBOURNE SLOUGH NEAR SUNRISE DUCK CLUB												
Full Simulation Period Average	15.6	15.1	11.9	8.4	5.8	4.5	4.7	5.6	7.2	9.4	12.0	14.6
Difference from NAA	5.5	5.1	4.0	3.3	2.5	1.5	0.9	0.7	0.3	1.1	2.4	4.1
SUISUN SLOUGH 300 FEET SOUTH OF VOLANTI SLOUGH												
Full Simulation Period Average	15.6	15.3	12.3	8.6	5.7	3.9	3.7	4.5	6.2	8.4	10.9	13.9
Difference from NAA	6.1	6.0	4.9	4.0	2.9	1.5	0.8	0.6	0.4	1.1	2.3	4.3

NAA = No Action Alternative.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Effects on Chloride

Attachment G.2 provides tables and figures presenting modeled chloride concentrations at the Delta assessment locations for Alternative 1 relative to the No Action Alternative. Table G-24 presents the modeled monthly average chloride concentrations at the Delta assessment locations for Alternative 1 for the 100-year simulation period and the differences from the No Action Alternative.

Modeled monthly average chloride concentrations in Barker Slough at the North Bay Aqueduct under Alternative 1 are the same as or very similar to those under the No Action Alternative (Table G-24; Attachment G.2, Table G.2-1-2, Figures G.2-1-1 through G.2-1-18).

Modeled monthly average chloride concentrations at Banks and Jones pumping plants are substantially higher in September, October, and November for Alternative 1 compared with the No Action Alternative for the full simulation period (Table G-24; Attachment G.2, Tables G.2-2-2 and G.2-3-2, Figures G.2-2-1 and G.2-3-1). Chloride concentrations are substantially higher in October and November of all water year types, and September of wet and above normal years (Attachment G.2, Tables G.2-2-2 and G.2-3-2, Figures G.2-2-2, G.2-2-3, G.2-3-2, and G.2-3-3).

Modeled monthly average chloride concentrations at Contra Costa Pumping Plant #1 are substantially higher in September, October, and November under Alternative 1 relative to the No Action Alternative for the full simulation period (Table G-24; Attachment G.2, Table G.2-5-2, and Figure G.2-5-1). Chloride concentrations are substantially higher in October and November of all water year types, and September of wet and above normal years (Attachment G.2, Table G.2-5-2, Figures G.2-5-1 through G.2-5-6).

Modeled monthly average chloride concentrations in the San Joaquin River at Antioch are substantially higher in September through February under Alternative 1 relative to the No Action Alternative for the full simulation period (Table G-24; Attachment G.2, Table G.2-4-2, and Figure G.2-4-1). Chloride concentrations are substantially higher in October through December of all water year types, September of wet and above normal years, and January and February of below normal, dry, and critical years (Attachment G.2, Table G.2-4-2, Figures G.2-4-1 through G.2-4-6).

While modeled chloride concentrations under Alternative 1 relative to the No Action Alternative are higher in some months, it is important to note that the CVP and SWP would operate in real-time to meet the Bay-Delta Plan chloride objectives, which aim to protect municipal and industrial beneficial uses. In September through December, when modeled chloride concentrations are higher compared with the No Action Alternative, the maximum mean daily chloride objectives of 250 mg/l would continue to apply at Contra Costa Pumping Plant #1, Banks and Jones pumping plants, and Barker Slough at North Bay Aqueduct. Also, the maximum mean daily chloride objective of 150 mg/l would continue to apply at Contra Costa Pumping Plant #1 for a certain number of days per year, depending on water year type. Thus, Alternative 1 would not contribute to municipal and industrial beneficial uses of Delta waters impairment.

Table G-24. Monthly Average Chloride (in milligrams per liter) at Delta Assessment Locations for the Full Simulation Period under Alternative 1, and Difference from the No Action Alternative

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
BARKER SLOUGH AT NORTH BAY AQUEDUCT												
Full Simulation Period Average	22	23	22	28	31	27	28	19	16	14	15	21
Difference from NAA	0	0	0	1	0	0	1	0	0	0	0	0
BANKS PUMPING PLANT												
Full Simulation Period Average	125	123	112	88	70	56	51	41	43	50	71	117
Difference from NAA	36	32	4	0	-1	-6	-3	-4	-5	-4	2	24
JONES PUMPING PLANT												
Full Simulation Period Average	120	122	110	91	74	62	53	43	47	56	74	112
Difference from NAA	28	25	4	1	1	-4	-3	-3	-3	-3	1	18
SAN JOAQUIN RIVER AT ANTIOCH												
Full Simulation Period Average	1347	1341	830	465	175	81	100	199	324	535	935	1305
Difference from NAA	329	223	127	120	49	5	-27	-29	-60	-55	44	251
CONTRA COSTA WATER DISTRICT PUMPING PLANT #1												
Full Simulation Period Average	152	164	162	107	73	37	33	31	32	41	71	127
Difference from NAA	49	51	16	14	16	1	-5	-8	-6	-7	0	32

NAA = No Action Alternative.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

<u>Suisun Marsh</u>

Suisun Marsh also is not designated for municipal and domestic supply uses, and other salinity-related effects in the marsh are addressed above in the EC discussion.

<u>Suisun Bay and San Francisco Bay</u>

Because Suisun Bay and San Francisco Bay are not designated for municipal and domestic supply use, and seawater is the primary source of chloride in the western Delta, changes in chloride concentrations in the Delta outflow to the bays are not of concern in these water bodies relative to drinking water supplies or other beneficial uses.

Effects on Bromide

Attachment G.3 provides tables and figures presenting modeled bromide concentrations at the Delta assessment locations for Alternative 1 relative to the No Action Alternative. Table G-25 presents the modeled monthly average bromide concentrations at the Delta assessment locations for Alternative 1 for the 100-year simulation period and the differences from the No Action Alternative.

Modeled monthly average bromide concentrations in Barker Slough at the North Bay Aqueduct under Alternative 1 are the same as or similar to those under the No Action Alternative (Table G-25; Attachment G.3, Table G.3-1-2, Figures G.3-1-1 through G.3-1-18).

Modeled monthly average bromide concentrations at Banks and Jones pumping plants are substantially higher in October and November under Alternative 1 relative to the No Action Alternative for the full simulation period (Table G-25; Attachment G.3, Tables G.3-2-2 and G.3-3-2, Figures G.3-2-1 and G.3-3-1). Bromide concentrations are substantially higher in October and November of all water year types, and September of wet and above normal years (Attachment G.3, Tables G.3-2-2 and G.3-3-2, Figures G.3-2-1 through G.3-2-6, and G.3-3-1 through G.3-3-6).

Modeled monthly average bromide concentrations at Contra Costa Pumping Plant #1 are substantially higher in September through February under Alternative 1 relative to the No Action Alternative for the full simulation period (Table G-25; Attachment G.3, Table G.3-5-2, and Figure G.3-5-1). Bromide concentrations are substantially higher in October through December of all water year types, September of wet and above normal years, and January and February of below normal, dry and critical years (Attachment G.3, Table G.3-5-2, Figures G.3-5-1 through G.3-5-6).

Modeled monthly average bromide concentrations in the San Joaquin River at Antioch are substantially higher in September through February under Alternative 1 relative to the No Action Alternative for the full simulation period (Table G-25; Attachment G.3, Table G.3-4-2, and Figure G.3-4-1). Bromide concentrations are substantially higher in October through December of all water year types, September of wet and above normal years, and January and February of below normal, dry and critical years (Attachment G.3, Table G.3-4-2, Figures G.3-4-1 through G.3-4-6).

As explained in Attachment G.3, there are no federal or state adopted water quality criteria for bromide applicable to the Delta. Bromide is a constituent of concern for drinking water treatment due to bromide being a precursor to the formation of bromate, bromoform, trihalomethanes, and other brominated disinfection byproducts when water containing bromide is treated for municipal drinking water supplies. To meet current drinking water regulations for disinfection byproducts, bromide from 100 to 300 µg/l (and total organic carbon from 4 to 7 mg/l) is acceptable to provide users adequate flexibility in their choice of treatment method (Attachment G.3, Section G.3.3, *Applicable Water Quality Objectives*).

Historical monitoring data compiled for the CALFED Water Quality Program Stage 1 Final Assessment shows that bromide concentrations at drinking water intakes can be highly variable. Bromide concentrations at Banks and Jones pumping plants ranged from less than 50 to over 600 µg/l from 1990 to 2006, and at Old River and Rock Slough concentrations ranged from 50 to over 600 µg/l from 1990 to 2006 (CALFED Bay-Delta Program 2007b). Running annual average concentrations of bromide ranged from 89 to 424 µg/l at Banks and Jones pumping plants, and 133 to 190 µg/l at Contra Costa Water District intakes on Old River and Rock Slough (CALFED Bay-Delta Program 2007b). Thus, concentrations of bromide at Delta drinking water intake locations are highly variable and have historically fallen outside of the range of 100 to 300 µg/l.

The potentially higher bromide concentrations under Alternative 1, relative to the No Action Alternative, could result in greater potential for disinfection byproduct formation in drinking water supplies that use Delta source waters, but the degree to which this would occur is uncertain. Treatment plants that use the Delta as a source for drinking water already experience highly variable bromide concentrations and, thus, must implement appropriate treatment technologies to ensure compliance with drinking water regulations for disinfection byproducts. However, the higher bromide concentrations under the Alternative 1, relative to the No Action Alternative, at specific times and locations, are of a magnitude of concern such that they could contribute to drinking water impairments relative to those that would occur under the No Action Alternative.

Table G-25. Monthly Average Bromide (in micrograms per liter) at Delta Assessment Locations for the Full Simulation Period under Alternative 1, and Difference from the No Action Alternative

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
BARKER SLOUGH AT NORTH BAY AQUEDUCT												
Full Simulation Period Average	71	74	85	76	81	94	84	52	47	42	51	56
Difference from NAA	1	1	1	2	1	2	2	0	-1	-1	0	0
BANKS PUMPING PLANT												
Full Simulation Period Average	435	425	393	297	229	197	175	136	145	169	250	392
Difference from NAA	125	111	11	0	-1	-23	-10	-12	-16	-14	7	85
JONES PUMPING PLANT												
Full Simulation Period Average	415	423	389	307	245	219	183	144	162	192	260	377
Difference from NAA	96	88	14	4	3	-15	-10	-11	-12	-12	2	64
SAN JOAQUIN RIVER AT ANTIOCH												
Full Simulation Period Average	4715	4692	2905	1626	613	283	351	697	1135	1874	3273	4567
Difference from NAA	1152	780	446	421	170	17	-94	-101	-211	-192	156	879
CONTRA COSTA WATER DISTRICT PUMPING PLANT #1												
Full Simulation Period Average	532	574	565	373	254	131	116	108	111	145	247	446
Difference from NAA	173	178	56	48	55	4	-19	-27	-19	-25	2	111

NAA = No Action Alternative.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

<u>Suisun Marsh</u>

Suisun Marsh also is not designated for municipal and domestic supply uses, and other salinity-related effects in the marsh are addressed above in the EC discussion.

Suisun Bay and San Francisco Bay

Because Suisun Bay and San Francisco Bay are not designated for municipal and domestic supply use, and seawater is the primary source of bromide in the western Delta, changes in bromide concentrations in the Delta outflow to the bays are not of concern in these water bodies relative to drinking water supplies or other beneficial uses.

Effects on Methylmercury

Delta

Attachment G.4 provides tables and figures presenting modeled total methylmercury concentrations at the Delta assessment locations for Alternative 1 relative to the No Action Alternative. Table G-26 and Table G-27 summarize the modeled average total methylmercury concentrations in water and fish tissues at the Delta assessment locations for Alternative 1 for the 100-year simulation period (1922–2021) and differences from the No Action Alternative.

Modeled long-term average water column concentrations of methylmercury in the Delta under Alternative 1 would be similar to those that would occur under the No Action Alternative at the Delta assessment locations (Table G-26). The range of modeled aqueous methylmercury concentrations for the No Action Alternative and Alternative 1 is the same at all locations for all years (Table G-26; Attachment G.4, Table G.4-6).

Modeled changes in water column concentrations of total methylmercury under Alternative 1 resulted in little to no effect on modeled Delta fish tissue concentrations relative to the No Action Alternative. All modeled fish tissue concentrations exceed the water quality objective of 0.24 mg/kg wet weight in 350 mm largemouth bass fillets under both the No Action Alternative and the Alternative 1 (Table G-27). Concentrations decreased or did not change at all Delta locations except for Montezuma Slough near Beldon Landing and Barker Slough at North Bay Aqueduct, which had minor increases in concentrations (Table G-27; Attachment G.4, Table G.4-21).

Based on the small-modeled changes in total methylmercury concentrations at all Delta assessment locations described above, Alternative 1 would not result in increased Delta methylmercury concentrations that would substantially degrade water quality or cause increased frequency of exceeding water quality objectives.

Table G-26. Modeled Total Methylmercury Concentrations in Water (in nanograms per liter) at Delta Assessment Locations for the Full Simulation Period, Alternative 1 and No Action Alternative

Assessment Location	NAA (ng/L)	Alt1 (ng/L)	Alt1 minus NAA (ng/L)
San Joaquin River at Empire Tract	0.14	0.13	0.00
Turner Cut	0.15	0.15	0.00
San Joaquin River at San Andreas Landing	0.12	0.12	0.00
San Joaquin River at Jersey Point	0.12	0.12	0.00
Victoria Canal	0.14	0.14	0.00
Sacramento River at Emmaton	0.12	0.12	0.00
San Joaquin River at Antioch	0.12	0.12	0.00
Montezuma Slough near Beldon Landing	0.13	0.14	0.01
Barker Slough at North Bay Aqueduct	0.13	0.13	0.00
Contra Costa Water District Pumping Plant #1	0.13	0.12	0.00
Banks Pumping Plant	0.14	0.14	0.00
Jones Pumping Plant	0.15	0.14	0.00

NAA = No Action Alternative; Alt1 = Alternative 1; ng/L = nanograms per liter
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Table G-27. Modeled Total Methylmercury Concentrations in Largemouth Bass Fillets (in milligrams per kilogram wet weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 1 and No Action Alternative

Assessment Location	NAA (mg/kg ww)	Alt1 (mg/kg ww)	Alt1 minus NAA (mg/kg ww)
San Joaquin River at Empire Tract	0.78	0.76	-0.02
Turner Cut	0.96	0.94	-0.02
San Joaquin River at San Andreas Landing	0.61	0.60	-0.01
San Joaquin River at Jersey Point	0.64	0.63	-0.01
Victoria Canal	0.84	0.82	-0.02
Sacramento River at Emmaton	0.60	0.60	0.00
San Joaquin River at Antioch	0.65	0.65	0.00
Montezuma Slough near Beldon Landing	0.73	0.79	0.06
Barker Slough at North Bay Aqueduct	0.74	0.75	0.01
Contra Costa Water District Pumping Plant #1	0.68	0.67	-0.01
Banks Pumping Plant	0.83	0.80	-0.03
Jones Pumping Plant	0.87	0.85	-0.02

NAA = No Action Alternative; Alt1 = Alternative 1; mg/kg ww = milligrams per kilogram wet weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Suisun Marsh

Regularly inundated tidal wetlands that do not fully dry between wetting cycles generate less methylmercury than seasonally flooded wetlands, high-tidal marsh, and agricultural wetlands managed for rice production (Alpers et al. 2008; Alpers et al. 2014). The degree to which methylmercury generation occurs in four Delta tidal wetlands, evaluated as part of methylmercury control studies for the Delta mercury TMDL, found that concentrations did not significantly increase on ebb tides over those entering the wetlands on flood tides (California Department of Water Resources 2020). Thus, tidal wetlands are unlikely to significantly increase methylmercury concentrations in the wetlands themselves and adjacent Delta waters. Likewise, none of the four Delta tidal wetlands studied significantly contributed to net annual methylmercury loads in surrounding waters. Another study of a natural tidal marsh in the western Delta, Browns Island, found it to be a relatively small net source of methylmercury and estimated that existing Delta tidal wetlands contribute only 3% of the external riverine methylmercury loads (Bergamaschi et al. 2011). Studies outside the Delta have also found tidal wetlands to be net sinks for total and methylmercury or only a minor source of methylmercury to nearby surface waters (Mitchell et al. 2012; Turner et al. 2018).

Modeled long-term average water column concentrations of methylmercury in Suisun Marsh for the full simulation period, represented by the Montezuma Slough near Beldon Landing assessment location, are 0.01 ng/L (8%) higher under Alternative 1 relative to the No Action Alternative (Table G-26). Modeled fish tissue concentrations are 0.06 mg/kg ww (8%) higher under Alternative 1 (Table G-27). However, as explained above, methylmercury fate and transport in the environment is complex, and mercury methylation, demethylation, uptake into biota, and degradation can either cause increases or decreases in methylmercury concentrations in water and fish tissue. Based on the small-modeled changes in the water column and fish tissue concentrations of methylmercury and results from studies of tidal wetlands, Alternative 1 would not contribute to measurable water quality degradation with respect to water column methylmercury concentrations or increased methylmercury bioaccumulation in biota in Suisun Marsh as compared with the No Action Alternative.

Suisun Bay and San Francisco Bay

Long-term average methylmercury concentrations in the western Delta under Alternative 1 would be similar to those that would occur under the No Action Alternative (Table G-26). Alternative 1 would also result in lower Delta outflow rates, notably in all months except June (Appendix F, *Modeling*). Thus, Alternative 1 would not contribute to additional water quality degradation with respect to water column methylmercury concentrations or increased methylmercury bioaccumulation in biota in Suisun Bay and San Francisco Bay, as compared with the No Action Alternative.

Effects on Selenium

<u>Delta</u>

Attachment G.5 provides tables and figures presenting modeled selenium concentrations at the Delta assessment locations for Alternative 1 relative to the No Action Alternative. Table G-28 through Table G-34 summarize the modeled average total selenium concentrations in water, fish tissues, and bird tissues at the Delta assessment locations for Alternative 1 for the 100-year simulation period (1922–2021) and differences from the No Action Alternative.

Modeled long-term average water column concentrations of selenium in the Delta under Alternative 1 are similar to the No Action Alternative at all locations for all years (Table G-28; Attachment G.5, Tables G.5-15 and G.5-16). Concentrations do not exceed the 5 µg/L CTR criterion and are similar to those that would occur under the No Action Alternative at the Delta assessment locations (Table G-28). Thus, Alternative 1 would not contribute to additional water quality degradation with respect to selenium, as compared with the No Action Alternative.

Modeled changes in water column concentrations of selenium under Alternative 1 for the full simulation period do not cause an increase in modeled Delta fish or bird tissue concentrations relative to the No Action Alternative. Concentrations in biota at all locations in the Delta under Alternative 1 are similar to those modeled for the No Action Alternative for whole-body fish (Table G-29), fish fillets (Table G-30 and Table G-31), bird eggs [invertebrate diet] (Table G-32), bird eggs [fish diet] (Table G-33). Modeled whole fish selenium concentrations do not exceed the 8.5 mg/kg dry weight water quality criterion (U.S. Environmental Protection Agency 2021). Nor do modeled fish fillet selenium concentrations exceed the 11.3 mg/kg dry weight water quality criterion (U.S. Environmental Protection Agency 2021) or the 2.5 mg/kg ww advisory level for human consumption (California Office of Environmental Health Hazard Assessment 2008). Modeled bird eggs under Alternative 1 and the No Action Alternative do not exceed the 15.1 mg/kg dry weight water quality criterion (U.S. Environmental Protection Agency 2021). Thus, Alternative 1 would not result in increased health risks to wildlife or humans consuming wildlife associated with whole-body fish, bird eggs (invertebrate diet), bird eggs (fish diet), and fish fillets, as compared with the No Action Alternative.

Modeled selenium concentrations in whole-body sturgeon (*Acipenseridae*) in the western Delta under Alternative 1 are similar to or slightly greater than those modeled for the No Action Alternative (Table G-34). Concentrations at all western Delta locations are less than the North Bay TMDL target of 8 mg/kg dry weight in whole fish (San Francisco Bay Regional Water Quality Control Board 2015) for the entire period modeled. Thus, Alternative 1 would not result in measurable increases in health risks to sturgeon, as compared with the No Action Alternative.

Table G-28. Modeled Selenium Concentrations in Water (in nanograms per liter) at Delta Assessment Locations for the Full Simulation Period, Alternative 1 and No Action Alternative

Assessment Location	NAA (µg/L)	Alternative 1 (µg/L)	Alternative 1 minus NAA (µg/L)
San Joaquin River at Empire Tract	0.13	0.12	-0.01
Turner Cut	0.22	0.21	-0.01
San Joaquin River at San Andreas Landing	0.09	0.09	0.00
San Joaquin River at Jersey Point	0.09	0.09	0.00
Victoria Canal	0.15	0.14	-0.01
Sacramento River at Emmaton	0.09	0.09	0.00
San Joaquin River at Antioch	0.10	0.10	0.00
Montezuma Slough near Beldon Landing	0.10	0.10	0.00
Barker Slough at North Bay Aqueduct	0.09	0.09	0.00
Contra Costa Water District Pumping Plant #1	0.11	0.10	0.00
Banks Pumping Plant	0.19	0.17	-0.01
Jones Pumping Plant	0.21	0.20	-0.01

NAA = No Action Alternative; µg/L = micrograms per liter.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Table G-29. Modeled Selenium Concentrations in Whole-Body Fish (in milligram per kilogram dry weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 1 and No Action Alternative

Assessment Location	NAA (mg/kg dw)	Alt1 (mg/kg dw)	Alt1 minus NAA (mg/kg dw)
San Joaquin River at Empire Tract	1.81	1.82	0.01
Turner Cut	1.80	1.81	0.01
San Joaquin River at San Andreas Landing	1.82	1.82	0.00
San Joaquin River at Jersey Point	1.82	1.82	0.00
Victoria Canal	1.81	1.81	0.00
Sacramento River at Emmaton	1.82	1.82	0.00
San Joaquin River at Antioch	1.82	1.82	0.00
Montezuma Slough near Beldon Landing	1.82	1.82	0.00
Barker Slough at North Bay Aqueduct	1.82	1.82	0.00
Contra Costa Water District Pumping Plant #1	1.82	1.82	0.00
Banks Pumping Plant	1.81	1.81	0.00
Jones Pumping Plant	1.81	1.81	0.00

NAA = No Action Alternative; Alt1 = Alternative 1; mg/kg dw = milligram per kilogram dry weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Table G-30. Modeled Selenium Concentrations in Skinless Fish Fillets (in milligram per kilogram dry weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 1 and No Action Alternative

Assessment Location	NAA (mg/kg dw)	Alt1 (mg/kg dw)	Alt1 minus NAA (mg/kg dw)
San Joaquin River at Empire Tract	2.00	2.02	0.02
Turner Cut	1.99	2.00	0.01
San Joaquin River at San Andreas Landing	2.02	2.02	0.00
San Joaquin River at Jersey Point	2.02	2.02	0.00
Victoria Canal	2.00	2.00	0.00
Sacramento River at Emmaton	2.02	2.02	0.00
San Joaquin River at Antioch	2.02	2.02	0.00
Montezuma Slough near Beldon Landing	2.02	2.02	0.00
Barker Slough at North Bay Aqueduct	2.02	2.02	0.00
Contra Costa Water District Pumping Plant #1	2.02	2.02	0.00
Banks Pumping Plant	2.00	2.00	0.00
Jones Pumping Plant	2.00	2.00	0.00

NAA = No Action Alternative; Alt1 = Alternative 1; mg/kg dw = milligram per kilogram dry weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Table G-31. Modeled Selenium Concentrations in Skinless Fish Fillets (in milligram per kilogram wet weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 1 and No Action Alternative

Assessment Location	NAA (mg/kg ww)	Alternative 1 (mg/kg ww)	Alternative 1 minus NAA (mg/kg ww)
San Joaquin River at Empire Tract	0.60	0.61	0.01
Turner Cut	0.60	0.60	0.00
San Joaquin River at San Andreas Landing	0.61	0.61	0.00
San Joaquin River at Jersey Point	0.61	0.61	0.00
Victoria Canal	0.60	0.60	0.00
Sacramento River at Emmaton	0.61	0.61	0.00
San Joaquin River at Antioch	0.61	0.61	0.00
Montezuma Slough near Beldon Landing	0.61	0.61	0.00
Barker Slough at North Bay Aqueduct	0.61	0.61	0.00
Contra Costa Water District Pumping Plant #1	0.61	0.61	0.00
Banks Pumping Plant	0.60	0.60	0.00
Jones Pumping Plant	0.60	0.60	0.00

NAA = No Action Alternative; mg/kg dw = milligram per kilogram wet weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Table G-32. Modeled Selenium Concentrations in Bird Eggs, Invertebrate Diet (in milligram per kilogram dry weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 1 and No Action Alternative

Assessment Location	NAA (mg/kg dw)	Alt1 (mg/kg dw)	Alt1 minus NAA (mg/kg dw)
San Joaquin River at Empire Tract	2.70	2.70	0.00
Turner Cut	2.69	2.69	0.00
San Joaquin River at San Andreas Landing	2.71	2.71	0.00
San Joaquin River at Jersey Point	2.71	2.71	0.00
Victoria Canal	2.70	2.70	0.00
Sacramento River at Emmaton	2.71	2.71	0.00
San Joaquin River at Antioch	2.71	2.71	0.00
Montezuma Slough near Beldon Landing	2.71	2.71	0.00
Barker Slough at North Bay Aqueduct	2.71	2.71	0.00
Contra Costa Water District Pumping Plant #1	2.70	2.71	0.01
Banks Pumping Plant	2.69	2.69	0.00
Jones Pumping Plant	2.69	2.69	0.00

NAA = No Action Alternative; Alt1 = Alternative 1; mg/kg dw = milligram per kilogram dry weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Table G-33. Modeled Selenium Concentrations in Bird Eggs, Fish Diet (in milligram per kilogram dry weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 1 and No Action Alternative

Assessment Location	NAA (mg/kg dw)	Alt1 (mg/kg dw)	Alt1 minus NAA (mg/kg dw)
San Joaquin River at Empire Tract	3.26	3.28	0.02
Turner Cut	3.24	3.26	0.02
San Joaquin River at San Andreas Landing	3.28	3.28	0.00
San Joaquin River at Jersey Point	3.28	3.28	0.00
Victoria Canal	3.26	3.26	0.00
Sacramento River at Emmaton	3.28	3.28	0.00
San Joaquin River at Antioch	3.28	3.28	0.00
Montezuma Slough near Beldon Landing	3.28	3.28	0.00
Barker Slough at North Bay Aqueduct	3.28	3.28	0.00
Contra Costa Water District Pumping Plant #1	3.28	3.28	0.00
Banks Pumping Plant	3.26	3.26	0.00
Jones Pumping Plant	3.26	3.26	0.00

NAA = No Action Alternative; Alt1 = Alternative 1; mg/kg dw = milligram per kilogram dry weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Table G-34. Modeled Selenium Concentrations in Whole Sturgeon (in milligram per kilogram dry weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 1 and No Action Alternative

Assessment Location	NAA (mg/kg dw)	Alt1 (mg/kg dw)	Alt1 minus NAA (mg/kg dw)
Sacramento River at Emmaton	0.72	0.72	0.00
San Joaquin River at Antioch	3.82	3.79	-0.03
Montezuma Slough near Beldon Landing	3.97	4.13	0.16

NAA = No Action Alternative; Alt1 = Alternative 1; mg/kg dw = milligram per kilogram dry weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Suisun Marsh

Modeled long-term average selenium concentrations in Suisun Marsh are represented by the Montezuma Slough near Beldon Landing assessment location. Water column selenium, whole fish, fillets, and bird egg modeled concentrations for the full simulation period at this location do not increase under Alternative 1 relative to the No Action Alternative (Table G-28 through Table G-33) and modeled concentrations in whole sturgeon increase by less than 5% (Table G-34). Thus, Alternative 1 would not contribute to increased water quality degradation with respect to water column selenium concentrations or measurable changes in selenium bioaccumulation in biota in Suisun Marsh as compared with the No Action Alternative.

Suisun Bay and San Francisco Bay

Long-term average water column selenium concentrations in the western Delta under Alternative 1 would be similar to those that would occur under the No Action Alternative (Table G-28) and would not exceed the North Bay TMDL the water column selenium target of 0.5 µg/L (San Francisco Bay Regional Water Quality Control Board 2015). Alternative 1 would also result in lower Delta outflow rates, notably in all months except June (Appendix F). Thus, Alternative 1 would not contribute to additional water quality degradation with respect to water column selenium concentrations or increased selenium bioaccumulation in biota in Suisun Bay and San Francisco Bay, as compared with the No Action Alternative.

Effects on Organic Carbon

Delta

Attachment G.6, *Organic Carbon Modeling Results*, provides tables and figures presenting modeled dissolved organic carbon concentrations at the Delta assessment locations for Alternative 1 relative to the No Action Alternative. Table G-35 presents the modeled monthly average dissolved organic carbon concentrations at the Delta assessment locations for Alternative 1 for the 100-year simulation period and the differences from the No Action Alternative.

Under Alternative 1, monthly average dissolved organic carbon concentrations at Delta assessment locations would be similar to concentrations under the No Action Alternative for both the full simulation period (1922–2021) and the drought period (1987–1991) (Table G-35; Attachment G.6, Tables G.6-1-2, G.6-2-2, G.6-3-2, G.6-4-2, and G.6-5-2, Figures G.6-1-1 through G.6-5-14). Modeled monthly average differences for the full simulation period range from 0.0–0.3 mg/L (Table G-35). Modeled monthly average differences for the drought period also range from 0.0–0.3 mg/L (Attachment G.6, Tables G.6-1-2, G.6-2-2, G.6-3-2, G.6-4-2, and G.6-5-2).

There are no numeric water quality criteria for dissolved organic carbon for the Delta (*Organic Carbon* subsection under Section G.1.9.3, *Constituents of Concern*). Therefore, effects of the alternative on dissolved organic carbon are considered relative to levels currently occurring in the Delta and drinking water treatment technology.

The Stage 1 Disinfectants and Disinfection Byproduct Rule adopted by EPA in 1998, as part of the Safe Drinking Water Act, requires drinking water utilities to reduce total organic carbon concentrations by specified percentages prior to disinfection. EPA's action thresholds related to total organic carbon begin at 2 to 4 mg/L and, depending on source water alkalinity, may require a drinking water utility to employ treatment to achieve as much as a 35% reduction in total organic carbon. These requirements were adopted because organic carbon can react with disinfectants during the water treatment disinfection process to form disinfection byproducts, such as trihalomethane compounds, which pose potential lifetime carcinogenic risks to humans. A California Urban Water Agencies expert panel convened to review Delta water quality and disinfection formation potential found that total organic carbon concentrations ranging from 4 to 7 mg/L would allow continued flexibility in treatment technology necessary to achieve existing drinking water criteria for disinfection byproducts (California Urban Water Agencies 1998:ES-2).

Drinking water treatment plants that utilize Delta source waters are currently designed and operated to meet EPA's 1998 requirements based on the ambient concentrations or organic carbon and seasonal variability that currently exists in the Delta. Substantial increases in ambient dissolved organic carbon concentrations would need to occur with substantial frequency for significant changes in plant design or operations to be triggered. Increases in average dissolved organic carbon concentrations that may occur with Alternative 1 would be of sufficiently small magnitude that modifications to existing drinking water treatment plants to employ additional organic carbon removals would not be necessary.

Based upon the above findings, Alternative 1 would not result in increased Delta dissolved organic carbon concentrations that would substantially degrade water quality or cause increased frequency of exceeding water quality objectives (because none exist) relative to the No Action Alternative.

Table G-35. Monthly Average Dissolved Organic Carbon (in milligrams per liter) at Delta Assessment Locations for the Full Simulation Period under Alternative 1, and Difference from the No Action Alternative

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
BARKER SLOUGH AT NORTH BAY AQUEDUCT												
Full Simulation Period Average	2.3	2.5	2.9	3.2	3.4	3.3	3.1	2.7	2.4	2.2	2.2	2.3
Difference from NAA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BANKS PUMPING PLANT												
Full Simulation Period Average	3.0	3.1	3.8	4.7	5.2	4.8	4.4	4.0	3.7	3.3	3.2	3.1
Difference from NAA	-0.1	0.0	-0.1	-0.2	-0.1	-0.2	0.0	-0.1	-0.1	0.0	0.0	-0.1
JONES PUMPING PLANT												
Full Simulation Period Average	3.1	3.2	3.9	4.8	5.1	4.7	4.3	3.9	3.7	3.4	3.3	3.2
Difference from NAA	-0.1	0.0	-0.1	-0.2	-0.1	-0.2	0.0	-0.1	-0.1	0.0	0.0	0.0
SAN JOAQUIN RIVER AT ANTIOCH												
Full Simulation Period Average	2.3	2.6	3.0	3.4	3.6	3.6	3.4	3.0	2.7	2.4	2.3	2.4
Difference from NAA	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0
CONTRA COSTA WATER DISTRICT PUMPING PLANT #1												
Full Simulation Period Average	2.5	2.8	3.4	4.0	4.7	4.7	4.5	3.8	3.2	2.8	2.7	2.7
Difference from NAA	0.0	0.0	0.0	-0.2	-0.3	-0.3	-0.2	-0.2	-0.1	0.0	0.0	0.0

NAA = No Action Alternative.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Suisun Marsh

In Suisun Marsh, managed wetlands followed by watershed stormwater contributions are the primary sources of organic carbon (*Organic Carbon* subsection under Section G.1.9.3). Furthermore, as described above, concentrations of dissolved organic carbon at the Delta locations would differ minimally from the No Action Alternative. Thus, changes in total organic carbon concentrations in the Delta outflow to Suisun Marsh under Alternative 1, relative to the No Action Alternative, would not contribute to adverse effects on organic enrichment conditions within the marsh.

Suisun Bay and San Francisco Bay

Suisun Bay and San Francisco Bay are not designated for municipal and domestic supply use, thus changes in organic carbon concentrations in the Delta outflow to the bays are not of concern in these water bodies relative to drinking water supplies. However, total organic carbon is an important component of the food web in these water bodies; the Delta provides 68% of the total organic carbon to Suisun Bay and the northern portion of San Francisco Bay (*Organic Carbon* subsection under Section G.1.9.3; Jassby et al. 1993). The Delta also provides the majority of dissolved organic carbon to Suisun Bay and the northern portion of San Francisco Bay, but this is generally less bioavailable to the food web base compared with total organic carbon and/or carbon from primary production (Stepanauskas et al. 2005; Tetra Tech 2006).

Alternative 1 would result in lower Delta outflow rates, relative to the No Action Alternative, in all months except June (Appendix F, *Modeling,* Attachment 2-2). The lower outflow rates could potentially result in reduced total organic carbon and dissolved organic carbon loads to Suisun Bay and San Francisco Bay during those months. A lower dissolved organic carbon load to Suisun and San Francisco Bay would not be expected to adversely affect food webs because dissolved organic carbon is generally less available to the base of the food web compared with particulate organic carbon or carbon from primary production (Tetra Tech 2006). Thus, lower dissolved organic carbon inputs under Alternative 1, relative to the No Action Alternative, would be unlikely to directly affect the food web (Tetra Tech 2006).

Much of the organic carbon transported from the Delta to Suisun Bay and San Francisco Bay is in the form of detritus (Durand 2015). However, total organic carbon contained in freshwater phytoplankton from the Delta represents most of the total organic carbon used in the Suisun and northern San Francisco Bay food webs (Kimmerer 2004). Alterations to the Delta's seasonal flow schedule could change how total organic carbon (e.g., phytoplankton) is transported to Suisun Bay and the San Francisco Bay (Kimmerer 2004). This could potentially reduce food availability to consumers in Suisun Bay and the northern portion of the San Francisco Bay during the months flows are lower under Alternative 1 relative to the No Action Alternative (Jassby and Cloern 2000). However, the relationship between flows and total organic carbon inputs may not be linear. For example, phytoplankton in the Delta may bloom primarily when freshwater flow rates are low and residence times are high (references within Kimmerer 2004). As such, it is difficult to ascertain exactly how foodwebs in Suisun Bay and the northern San Francisco Bay would be affected by the lower Delta outflows and total organic carbon loading under Alternative 1, relative to the No Action Alternative.

Effects on Trace Metals

Trace metals, including aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, silver, and zinc, occur naturally in the river inflows to the Delta. Trace metals concentrations in the Sacramento River and San Joaquin River, the primary inflows that would be affected by Alternative 1, are below applicable water quality objectives/criteria and below impairment levels (State Water Resources Control Board 2022a). Also, in general, concentrations of trace metals within the Delta are at levels that do not cause beneficial use impairments (State Water Resources Control Board 2022a). Trace metals-related impairments in the Delta include arsenic in the western Delta, copper in the portion of Bear Creek in the eastern Delta, copper and zinc in the portion of the lower Mokelumne River within the Delta, and manganese in Old River (Section G.1.9, Table G-19). The Sacramento River and San Joaquin River inflows that would occur under Alternative 1 would not result in additional impairments in the Delta, Suisun Bay and Marsh, or San Francisco Bay, relative to the No Action Alternative, because trace metals conditions within these rivers are less impairment levels, thus applicable water quality objectives.

Effects on Nutrients

The primary nutrients considered in this analysis include ammonium, nitrate, and phosphorus. The two main anthropogenic sources of these nutrients in the Delta are urban point sources (wastewater effluent) and agricultural nonpoint sources (agricultural runoff and return flows of fertilizers mixed in irrigation water). Wastewater discharges are regulated to control ammonia and nitrate discharges via NPDES permits issued by the Central Valley RWQCB. Agricultural nonpoint source discharges are regulated under the Central Valley RWQCB's Irrigated Lands Regulatory Program Waste Discharge Requirements, which mandates nutrient monitoring in the major agricultural reaches, implementing best management practices to reduce nutrient discharges to streams, and controlling fertilizer application and management.

Alternative 1 would result in some differences in Delta inflow rates from the Sacramento River and San Joaquin River, relative to the No Action Alternative, which could create differences in the proportion of Sacramento River and San Joaquin River water at various Delta locations. The analysis anticipates that - resulting difference in nutrient distributions under Alternative 1, relative to the No Action Alternative, would be minimal. Thus, Alternative 1 would not contribute to differences in Delta nutrient concentrations or in nutrient distributions that would substantially degrade water quality or result in adverse effects on beneficial uses relative to the nutrient conditions that would occur under the No Action Alternative.

Because nutrient concentrations in the Delta under Alternative 1 are not expected to be substantially different from those that would occur under the No Action Alternative, Alternative 1 would not cause substantial differences in nutrient concentrations in Delta outflow to Suisun Bay and Marsh, and San Francisco Bay. However, there could be some nutrient loading differences from the Delta to Suisun Bay and Marsh, and San Francisco Bay because of Delta outflow differences. Alternative 1 would result in lower Delta outflow rates relative to the No Action Alternative in some months (Appendix F, Attachment 2-2,). Thus, it is possible that nutrient loading to Suisun Marsh, Suisun Bay, and San Francisco Bay may be slightly lower under Alternative 1 relative to the No Action Alternative, when Delta outflow would be lower.

The evaluation does not expect the potential lower nutrient loading from the Delta to Suisun Bay and Marsh, and San Francisco Bay due to different outflow patterns under Alternative 1, relative to the No Action Alternative, to adversely impact primary productivity in these embayments for several reasons. First, there are numerous drivers of primary productivity throughout Suisun Bay and Marsh, and San Francisco Bay. They include high turbidity (light limitation), strong tidal mixing (breaks down stratification and reduces light availability), and abundant grazing (removes phytoplankton from the water column). These factors, not nutrients, currently limit algal production within the embayments (references within San Francisco Estuary Institute 2016). Thus, minor changes to nutrient loading that may occur under Alternative 1 relative to the No Action Alternative would not result in lower primary productivity rates in these areas. Second, although Suisun Bay and San Francisco Bay have been nutrient enriched for many years, there is evidence that current nutrient levels are starting to cause adverse effects on the phytoplankton community. Observations indicate a shifting phytoplankton community composition away from healthy assemblages toward algal species that form harmful algae blooms (Senn and Novick 2014 and references within). As such, the potential for slightly lower nutrient loadings during certain months of the year due to a change in Delta outflows may be beneficial to Suisun Bay and Marsh, and San Francisco Bay. Finally, the only postulated effect of changes in phosphorus loads to Suisun and San Francisco Bays is related to the influence of nutrient stoichiometry on primary productivity. However, any changes to phosphorus loads under Alternative 1 would be proportional to changes to nitrogen loads, thus the ratios of these two nutrients are expected to change negligibly, if at all. In addition, effects on phytoplankton community composition would likely be small compared with the effects of grazing from introduced clams and zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, potential differences in total nitrogen and phosphorus loading that would occur in Suisun Bay and Marsh, and San Francisco Bay relative to the No Action Alternative, due to differences in Delta outflow are minor. These potential differences in Delta outflow would not result in water quality degradation to a degree which would adversely affect beneficial uses of Suisun Bay and Marsh, or San Francisco Bay.

Effects on Dissolved Oxygen

DO levels in Delta, Suisun Bay and Marsh, and San Francisco Bay waters are primarily affected by water temperature, flow velocities, nutrients (e.g., phosphorus and nitrogen), and the photosynthesis, respiration, and decomposition of aquatic organisms. The sediment oxygen demand of organic material deposited in the low velocity channels also affects DO levels in Delta waters.

The potential for differences in these factors and DO decreases to occur under Alternative 1 relative to the No Action Alternative are addressed below.

- **Water Temperature:** Atmospheric exchange processes primarily drive Delta, Suisun Marsh, and Suisun Bay water temperatures on both short and long timescales (Kimmerer 2004; Wagner et al. 2011; Vroom et al. 2017). Ocean inflow primarily drives northern San Francisco Bay water temperature (Vroom et al. 2017). Thus, the differences in Delta inflows that would occur under Alternative 1, relative to the No Action Alternative, would not result in water temperature differences what would lead to lower DO levels.
- **Channel Velocities:** The relative degree of tidal exchange, flows, and turbulence that contributes to exposure of Delta, Suisun Bay and Marsh, and San Francisco Bay waters to the atmosphere for reaeration would not be substantially different from the No Action Alternative. The water bodies would continue to experience the daily ebb and flood tides that contribute to water movement within the channels, which contributes to the water column's reaeration.
- **Nutrients:** The primary oxygen-demanding nutrient is ammonium. Nutrients can also affect DO by promoting aquatic plants biostimulation. However, as described above, Alternative 1 is not expected to result in changes in nutrient levels within Delta, Suisun Marsh and Bay, and San Francisco Bay waters relative to the No Action Alternative that would encourage additional biostimulation of algae or aquatic plants.
- **Sediment Oxygen Demand:** The differences in Delta inflows that would occur with Alternative 1 relative to the No Action Alternative would not result in higher concentrations of organic material in the Delta, Suisun Bay and Marsh, and San Francisco Bay sediments that would lead to higher oxygen demand.

Some waterways in the eastern, southern, and western Delta as impaired by low oxygen levels (Section G.1.9). A TMDL has been approved for the Stockton Deep Water Ship Channel in the eastern Delta to control the discharge of oxygen-demanding substances, and aerators operated by the Port of Stockton improved DO conditions within the channel (U.S. Environmental Protection Agency 2015). Alternative 1 would not result in changes in Delta inflows relative to the No Action Alternative that would make the impairment worse. Alternative 1 would not make the other DO impairments in the Delta worse relative to the No Action Alternative.

Operations of the managed wetlands and associated discharges cause the current Suisun Marsh DO impairments (Section G.1.9). Therefore, changes in Delta flows into the marsh that could occur under Alternative 1 would not make this impairment worse relative to the No Action Alternative.

Effects on Legacy Contaminants

The Delta is on the Water Board's Section 303(d) list for impaired by dioxin and furan compounds, PCBs, and PAHs (Section G.1.9). Suisun Bay and San Francisco Bay are included on the Section 303(d) list for dioxin and furan compounds, and PCBs. Dioxin and furan compounds, PCBs, and PAHs are identified as "legacy contaminants" because of their persistence in the environment long after use.

River inflows are not the primary sources of dioxin and furan compounds, PCBs, and PAHs in the Delta (Section G.1.9). The Delta's primary source of dioxin and furan compounds and PAHs is from stormwater runoff. The Delta's primary source of PCBs is the suspension and transport of Bay suspended sediment into the western Delta on flood tides. These mechanisms of deposition and transport of dioxins and furans, PCBs, and PAHs are independent of CVP and SWP operation. Thus, changes in river inflows to the Delta due to Alternative 1 implementation would not substantially affect concentrations of dioxin and furan compounds, PCBs, and PAHs in the Delta relative to the No Action Alternative. For these same reasons, concentrations of dioxin and furan compounds, and PCBs Suisun Bay and San Francisco Bay would not be substantially affected by Alternative 1 relative to the No Action Alternative.

Effects on Pesticides

Pesticide concentrations in the Delta, Suisun Bay and Marsh, and San Francisco Bay waters are primarily affected by surface water and stormwater discharges from agricultural and urban land use areas (Central Valley Regional Water Quality Control Board 2006, 2014, 2017). Applications by structural pest control professionals and over-the-counter pesticide use can be among the greatest contributors of pesticides in urban runoff (San Francisco Bay Regional Water Quality Control Board 2005). Pyrethroid insecticide use in urban areas is relatively consistent throughout the year, while agricultural pyrethroid use is highest in the winter (Central Valley Regional Water Quality Control Board 2017). Individual pesticide use and the resulting concentrations in receiving waters can vary seasonally, by source, and depend on weather patterns that influence runoff and river flows.

Differences in the Sacramento River and San Joaquin River inflows to the Delta between Alternative 1 and the No Action Alternative could lead to differing pesticide concentrations within Delta waterways, or in the Delta outflow to Suisun Marsh and Bay, and San Francisco Bay. The difference would depend on the relative presence and concentrations of pesticides in the inflows of these rivers, and the relative contributions from other Delta inflows and in-Delta sources.

Several factors affect the presence of pesticides in Delta inflows. Pesticides must be used in a location with hydrologic connectivity to surface water and in amounts that are not easily diluted in the environment. The pesticide must be transportable, which is largely determined by its individual chemical properties, such as water solubility, vaporization, and soil sorption. The pesticide must be sufficiently stable in the environment, so that residues of the applied pesticide or its degradates, which can also adversely affect beneficial uses, are present during runoff events. If transported to surface waters, enough of the pesticide must be present so that, once diluted by surface water flows, the resulting concentration is a magnitude that can elicit a measurable effect on beneficial uses. Alternatively, pesticides that are transported in the water column can sorb to particles and settle into the sediment, where they can also affect beneficial uses (Central Valley Regional Water Quality Control Board 2017). Factors unrelated to the pesticide are also important, including substrate erosivity, precipitation amount, irrigation and runoff rates, and time elapsed from application to runoff.

Several pesticide control programs and monitoring efforts in the Delta watershed aim to address past pesticide-related impairments and prevent potential future impairments. The Central Valley RWQCB (2006, 2014) adopted TMDLs for diazinon and chlorpyrifos for several Section 303(d)-listed segments of the Sacramento River, San Joaquin River, and Delta, as well as to address impairments related to these pesticides. Likewise, the Central Valley RWQCB (2017) adopted a Basin Plan Amendment for the control of pyrethroids in the entirety of the Sacramento River and San Joaquin River basins. The Central Valley RWQCB's Delta RMP includes a program to describe the status and trends of pesticide concentrations in the Delta, aiming to support future regulatory and management decisions about pesticides control. Monitoring data may indicate the effectiveness of control programs and identify additional pesticides causing toxicity that may need to be the focus of future regulatory actions. The Central Valley RWQCB Irrigated Lands Regulatory Program aims to prevent agricultural runoff containing pesticides from impairing surface waters (Section G.1.9).

Considering the factors described above, Alternative 1 would not result in substantially higher pesticide concentrations in the Delta in a way that would increase the risk of water quality degradation or pesticide-related toxicity to aquatic life, as compared with conditions that would occur under the No Action Alternative. Several primary factors external to CVP and SWP operation affect pesticide presence and concentrations in Delta inflows and throughout the Delta. The Central Valley RWQCB's external regulatory actions to monitor future pesticide presence in the Delta watershed surface waters and adopt TMDLs and water quality objectives, mean that pesticide conditions in the Delta under Alternative 1 and the No Action Alternative would likely be similar. For the same reasons, this evaluation would expect pesticide conditions in Suisun Bay and Marsh, and San Francisco Bay under Alternative 1 to be similar to No Action Alternative conditions.

Effects on CHABs

Although other cyanobacteria species are also frequently detected in the Delta, only Microcystis has been clearly shown to produce cyanotoxins (Otten et al. 2017:3632). Nevertheless, other cyanobacteria species that are routinely detected in the Delta (i.e., *Dolichospermum* spp. and *Aphanizomenon* spp.) were also considered in this assessment. In the cyanobacterial community, *Dolichospermum* and *Aphanizomenon* typically appear in the water column first in late spring/early summer and are then replaced with *Microcystis* spp. as water temperature increases. Although the specific environmental conditions that favor *Aphanizomenon* and *Dolichospermum* blooms differ somewhat from that of *Microcystis*, hence their separation in bloom times each year, the primary environmental factors that trigger *Microcystis* are the same factors that trigger the formation of these and other Delta cyanobacteria species that form CHABs. Consequently, this assessment addresses CHABs in general, with a focus on Microcystis, which causes the most problematic CHABs in the Delta annually.

There are five primary environmental factors that trigger the emergence and subsequent growth of *Microcystis* in the water column.

1. Water temperatures >19°C (66.2°F)
2. Low river inflows and channel velocities resulting in long residence times throughout much of the Delta (i.e., time water remains in the same area)
3. Low flows and channel velocities resulting in low turbulence and mixing
4. Sufficient nutrient availability (nitrogen and phosphorus)
5. Water column irradiance and clarity greater than 50 micromoles per square meter per second (µmoles/m2/s)

The cyanobacteria bloom season in the affected environment is typically June through November, annually, with peak blooms occurring July through September when water temperatures reach their seasonal highs. Cyanobacteria experience their maximum growth rates at relatively high water temperatures. Optimal growth rate for *Microcystis* in the laboratory occurred at 27.5 °C (81.5 °F) (You et al. 2018:26) and some *Microcystis* strains can continue to grow in temperatures of 37 °C (98.6 °F) or higher (Bui et al. 2018:10).

This assessment evaluates how each of the primary factors affecting *Microcystis* and other cyanobacteria listed above would be affected by Alternative 1 and whether changes to these factors from implementing the alternative, and the collective environmental changes, would be of sufficient frequency and magnitude to adversely affect CHABs (i.e., make them occur more frequently and/or be of larger magnitude) within affected environment water bodies compared with CHABs expected to occur in these same water bodies for the No Action Alternative.

Delta

Water Temperature

Atmospheric exchange processes primarily drive Delta water temperature on both short and long timescales (Kimmerer 2004:19; Wagner et al. 2011:12; Vroom et al. 2017:9919–9920). Thus, by the time water released from upstream reservoirs reaches the Delta, it is typically at or close to equilibrium with ambient air temperatures. In addition, Delta water temperatures are also affected by sea water intrusion to the Delta on the tidal cycle. As such, it requires substantial changes in Sacramento River and San Joaquin River flows entering the Delta to have any measurable effect on Delta water temperatures.

On a long-term average basis for the period of record modeled, Alternative 1 has relatively small effects on Delta inflows from the Sacramento and San Joaquin Rivers (Appendix F) during the months June through November, with combined inflows (measured in thousands of acre-feet [TAF]) from these rivers changing 10% or less, relative to the No Action Alternative. This would indicate that, on average, Alternative 1 would have minor, if any, effects on Delta water temperatures relative to the No Action Alternative. Modeling output shows the same finding for each of the five water year types, except for a 15% reduction in combined river flows in September of wet years, a 17% increase in combined flows in June of above normal and below normal years, and a 14–17% increase in June and July of critical years relative to the No Action Alternative. It is a reduction in inflow to the Delta that has some potential to result in higher Delta water temperatures, whereas increases in Delta inflow has some potential for reduced Delta water temperatures. This is because smaller volumes of water heat up more quickly and often to higher levels from ambient heating than do larger volumes of water. Flow effects at the levels described for Alternative 1 would not be expected to increase Delta water temperatures with sufficient frequency or magnitude to cause adverse effects on Delta CHABs (i.e., cause blooms to occur more frequently or be of larger size) relative to CHABs expected to occur in the Delta for the No Action Alternative.

Residence Time

Cyanobacteria tend to be slower growing than diatoms and green algae and thus need long residence times (i.e., water remaining in the same area) to build up their cell numbers at a given location to form blooms. High residence time in any given area of the Delta allows cyanobacteria cells produced there to accumulate versus being flushed downstream from the area under a lower residence time scenario. Whereas water temperature and irradiance most affect growth rates of cyanobacteria, residence time affects the accumulation of cells produced, leading to cells coming together to form colonies and colonies coming together to form mats at the water surface, thereby producing problematic sized blooms. Past Delta studies (Lehman et al. 2013, 2017, 2022) have shown that *Microcystis* blooms are substantially larger during drought years than during wet water years. It is also known that Sacramento River and San Joaquin River flows into the Delta are lowest during drought years and highest during wet years, which affect both residence times throughout the Delta and water temperatures within the Delta (higher water temperatures in drought years and lower water temperatures in wet years). Temperature and residence time are believed to contribute most to the larger cyanobacteria blooms observed in the Delta in drought years versus wetter years (Lehman et al. 2022).

As such, this analysis evaluated the combined Delta inflows for the Sacramento River at Freeport and San Joaquin River at Vernalis (as measured in TAF) as an index of Delta residence time. For example, output for the period of record modeled shows that the combined Delta inflows at these locations is 1,377 TAF in July of wet years versus 672 TAF in critical years – the latter being about half that of the former. When Delta inflows are low, such as in critical years, residence time throughout the Delta is longer compared with when inflows are much higher in wetter years. In looking at combined Sacramento River and San Joaquin River flows described above under water temperature, Alternative 1 would typically have little effect on residence times throughout the Delta relative to the No Action Alternative with the exception of September of wet years (15% reduction). However, wet years generally have the lowest occurrence of CHABs, and September is at the end of the peak growth season for CHABs. Also, Alternative 1 has a modeled 17% increase in combined river flows in June of above normal and below normal years, and a 14–17% increase in June and July of critical years relative to the No Action Alternative. These inflow increases would tend to reduce residence time relative to the No Action Alternative and may do so not only during the peak CHAB period of the year but also in water years where CHAB occurrence is greater compared with wet years. Consequently, Alternative 1 would not result in adverse effects on CHABs in the Delta via its effects on Delta residence time relative to the No Action Alternative.

Turbulence and Mixing

Cyanobacteria, particularly *Microcystis*, prefer a calm, non-turbulent water column versus a flowing, turbulent water column. Turbulence and mixing inhibits the ability of *Microcystis* to control its buoyancy and thus location in the water column. *Microcystis* prefers to be at or near the water surface to form large blooms which shade out other algae deeper in the water column, thereby allowing Microcystis to outcompete other algae for available nutrients and light. Based on the changes in Sacramento River and San Joaquin River flows modeled for Alternative 1 (Appendix F), channel velocities and associated turbulence and mixing in Delta channels would not be expected to change substantially relative to that for the No Action Alternative. Tidal dynamics within the Delta also would not change substantially. Any minor changes in channel velocities and turbulence and mixing in the Delta for Alternative 1 would have negligible, if any, effects on Delta CHABs relative to that which would occur for the No Action Alternative. Consequently, Alternative 1 would not result in adverse effects on CHABs in the Delta via its effects on Delta channel turbulence and mixing relative to the No Action Alternative.

Nutrients

Cyanobacteria need high nutrient levels to form and sustain blooms. The Delta has sufficiently high nutrient levels that nutrients do not limit CHABs in the Delta. Alternative 1 would not result in new or greater nutrient sources to the rivers flowing into the Delta, relative to the No Action Alternative. Because Alternative 1 would not result in new or greater nutrient sources to the rivers flowing into the Delta and nutrients are not a factor that limits CHABs in the Delta, any minor changes in nutrient levels within Delta waters that could occur from changes in inflow would have negligible, if any, effects on both the frequency and magnitude of Delta CHABs relative to that for the No Action Alternative. Consequently, Alternative 1 would not result in adverse effects on CHABs in the Delta via its effects on Delta nutrient levels relative to the No Action Alternative.

Irradiance

Cyanobacteria prefer high water clarity and high irradiance because they are outcompeted by diatoms and green algae under lower light conditions. This is also why many species of cyanobacteria, including *Microcystis* spp., can control their buoyancy and, thus, their location in the water column. *Microcystis* will move to the water surface where it can grow the most rapidly (under high irradiance conditions) and can form colonies and mats that shade out other species of algae living lower in the water column. The minor changes in hydrodynamics within the Delta for Alternative 1 would not be expected to change channel turbidity levels substantially, if at all. Consequently, water clarity and irradiance in Delta channels would not change sufficiently to affect the frequency or magnitude of Delta CHABs relative to that for the No Action Alternative. Consequently, Alternative 1 would not result in adverse effects on CHABs in the Delta via its effects on Delta irradiance levels, relative to the No Action Alternative.

Summary

Alterative 1 is expected to have minor, if any, effect on irradiance, nutrients, water column turbulence and mixing, and temperature within Delta channels, relative to the No Action Alternative. The effects that Alternative 1 may have on residence time within the Delta throughout the June through November bloom season for cyanobacteria would not cause an increase in the frequency or magnitude of Delta CHABs, relative to the No Action Alternative.

Suisun Marsh, Suisun Bay, or San Francisco Bay

In addition to the five primary factors affecting CHABs in the Delta, this assessment also addresses salinity. A salinity of 10 ppt is the threshold generally accepted as the salt tolerance for *Microcystis* (San Francisco Bay Regional Water Quality Control Board 2012:7). Although Suisun Marsh is typically below this salinity level, CHABs are not common in Suisun Marsh (Sommer et al. 2020:18; Hammock et al. 2015:319). The primary source of cyanobacteria in Suisun Marsh is from Delta water that flows into the marsh, which contains cyanobacteria.

The hydrodynamics within Suisun Marsh, Suisun Bay, or San Francisco Bay, which are driven in part by Delta outflow but also substantially by tidal excursions and winds would change little, if at all, for Alternative 1, relative to the No Action Alternative. Therefore, Alternative 1 would not affect hydrodynamic factors such as residence time sufficiently to encourage more frequent or larger cyanobacteria blooms in Suisun Marsh, Suisun Bay, or San Francisco Bay, relative to that which would occur for the No Action Alternative. Also, effects of Alternative 1 on irradiance, nutrients, water column turbulence and mixing, and temperature in Suisun Marsh, Suisun Bay, and San Francisco Bay would be even lesser than its effects on these parameters in the Delta because tidal excursions in these areas would further lessen effects seen in the Delta.

The effects of Alternative 1 on EC, described above under *Effects on Electrical Conductivity*, would not cause waters to decrease in salinity sufficient to supporting CHAB growth, accumulation, or aggregation relative to the No Action Alternative. Consequently, Alternative 1 would not increase the frequency or magnitude of CHABs in Suisun Marsh, Suisun Bay, or San Francisco Bay relative to the No Action Alternative due to changes in salinity.

In summary, Alternative 1 would not affect residence time, water temperature, channel turbulence and mixing, nutrients, water clarity, or salinity at levels that would create conditions more conducive to CHAB formation in Suisun Marsh, Suisun Bay, or San Francisco Bay relative to the No Action Alternative. Small changes in these conditions that may potentially occur under Alternative 1 would not be of sufficient frequency and magnitude to cause CHABs to form more frequently, or grow to larger levels, than would occur for the No Action Alternative.

CVP and SWP Service Areas (south to Diamond Valley)

Alternative 1 would generally result in higher monthly average chloride concentrations in the months of September through January, particularly in wet and above normal water year types, and similar or lower concentrations in the remaining months, as compared with the No Action Alternative. Since this water is delivered to reservoirs for storage in the CVP and SWP reservoirs, reservoir chloride concentrations may increase. While there would be higher chloride concentrations under Alternative 1 in some months, relative to the No Action Alternative, the CVP and SWP would continue to be operated, in real-time, to meet the Bay-Delta Plan objectives for chloride, which aim to protect municipal and industrial beneficial uses. In the months of September through January, when chloride would be higher compared with the No Action Alternative, the maximum mean daily chloride objectives of 250 mg/L would continue to apply at Contra Costa Pumping Plant #1, Banks and Jones pumping plants, and Barker Slough at North Bay Aqueduct (State Water Resources Control Board 2018b). Also, the maximum mean daily chloride objective of 150 mg/L would continue to apply at Contra Costa Pumping Plant #1 or San Joaquin River at Antioch for a certain number of days per year, depending on water year type (State Water Resources Control Board 2018b). Thus, Alternative 1 would not contribute to the impairment of municipal and industrial beneficial uses of the CVP and SWP service area.

G.2.4 Alternative 2

G.2.4.1 Potential Changes in Surface Water Quality Conditions

Trinity and Klamath Rivers

Under all phases of Alternative 2, operations in the Trinity River would remain similar to those under the No Action Alternative. Decreases in flow are expected only in November through April. Figure G-8 through Figure G-13 illustrate flow changes for all water year types. Flow in the Trinity River under Alternative 2 is expected to increase between 3% in March of below normal water years and 11% in February of above normal water years when compared with the No Action Alternative. Trinity River flow is expected to decrease under Alternative 2 between 13% and 18% in November of above normal water years. No fluctuations in flow are expected during May through October of all water year types under all phases of Alternative 2. Because Alternative 2 would have limited changes in flows on the Trinity River, changes in flows would have limited potential to affect water quality. Increases in flow would be considered beneficial based on the improvement of water quality through dilution of constituents of concern. The evaluation does not expect decreases in flow to be a large enough magnitude to affect water quality.

Sacramento River

Changes in flow in the Sacramento River under all phases of Alternative 2 generally increase in winter and early spring and decrease during the summer months. Under Alternative 2, average flows in the Sacramento River below Keswick Dam could decrease between 9% and 13% during some months of critical water years compared with the No Action Alternative. Flow in the Sacramento River is expected to increase between 19% and 33% during certain months of critical water years. Figure G-14 through Figure G-19 illustrate flow changes on the Sacramento River below Keswick Reservoir. Changes in flow at other sampling locations on the Sacramento River would follow a similar trend but are generally smaller. As flow increases are beneficial to water quality because it dilutes constituents of concern, flow decreases are not expected to be large enough to negatively impact water quality and increase the frequency of exceedances of water quality thresholds in the Sacramento River.

Clear Creek

Changes in flow in Clear Creek under all phases of Alternative 2 would generally increase in the winter and spring months and decrease during the summer and fall months as compared with the No Action Alternative. The maximum change in flows is expected to occur during critical water years, when the maximum increase in flows is expected to be approximately 54% and the maximum decrease in flows is expected to be between 38% and 41%. Increases in flow are considered beneficial to water quality because they make more water available to dilute constituents of concern (i.e., mercury). Reductions in flow due to changes in the operations of CVP and SWP under Alternative 2 could result in less dilution causing increased concentrations of mercury within Clear Creek in certain months and year types compared with the No Action Alternative.

Lower American River

Under Alternative 2, the maximum change in flows on the lower American River at H Street is expected to occur during critical water years, when the maximum increase in flows is expected to range from approximately 24% and 110% and the maximum decrease in flows is expected to range from 16% and 30% depending on what phase is implemented. Figure G-26 through Figure G-31 illustrate flow changes on the lower American River at H Street. Changes in flow below Nimbus Dam follow a similar trend but are generally smaller. Reductions in flow, especially during dry and critical years, due to changes in the operations of CVP and SWP under all phases of Alternative 2 could result in less dilution causing increased concentrations of constituents of concern within the American River compared with the No Action Alternative.

Stanislaus River

Alternative 2 would cause flow changes in the Stanislaus River from changes in minimum instream flow requirements, winter instability flows, and fall pulse flows. Across all four phases of Alternative 2, changes in flow in the Stanislaus River below Goodwin Dam would generally decrease in October, January, and March through June, with flows increasing in all other months when compared with the No Action Alternative. The maximum increase in flows is expected to range from 59% and 89% during June of critical water years, and the maximum decrease in flows is expected to range from 26% and 33% during January of above normal water years. Flows at the mouth of the Stanislaus River would follow a similar trend. Flow increases are considered beneficial to water quality because they dilute constituents of concern. While all phases of Alternative 2 would create flow decreases in the Stanislaus River, decreases would largely occur during wet and above normal water years when base flow is adequate and decreases in flow are not expected to cause violations of water quality standards. Overall, increased frequency of exceedances of water quality thresholds are not expected.

San Joaquin River

Under all phase of Alternative 2, the greatest flow change in the San Joaquin River would be at Vernalis, where flows would decrease by a maximum of 3%. Figure G-38 through Figure G-43 show changes in the San Joaquin River at Vernalis. Appendix F presents flow change trends at all sampling locations along the San Joaquin River. As shown, changes in flow at Gravelly Ford, below the confluence with the Merced River, and below Sack Dam follow a similar trend but are generally smaller compared with changes below Sack Dam. The small change in flow under Alternative 2 would not likely result in adverse effects on water quality nor an increase in frequency of exceedances of water quality thresholds in the San Joaquin River.

Bay-Delta

Alternative 2 would result in some differences in Sacramento River and San Joaquin River inflow rates to the Delta, Delta outflows, and south Delta exports, relative to the No Action Alternative, which could result in changes in the proportion of Delta source waters (i.e., Sacramento River, San Joaquin River, San Francisco Bay, eastside tributaries) at various Delta locations. The water proportion differences may result in water quality differences relative to the No Action Alternative at various Delta locations, Suisun Marsh, and outflow to Suisun Bay and San Francisco Bay. The following sections discuss effects of Alternative 2 on EC, chloride, bromide, methylmercury, selenium, organic carbon, trace metals, nutrients, DO, legacy contaminants, pesticides, and CHABs.

Effects on Electrical Conductivity

<u>Delta</u>

Attachment G.1 provides tables and figures presenting modeled EC levels at the Delta assessment locations for Alternative 2 relative to the No Action Alternative. Table G-36 presents the modeled monthly average EC levels at the Delta assessment locations for Alternative 2 for the 100-year simulation period and the differences from the No Action Alternative.

Modeled monthly average EC levels in the San Joaquin River at Jersey Point, Prisoners Point and San Andreas Landing, and the Sacramento River at Emmaton and Threemile Slough are slightly higher in September and October under all phases of Alternative 2 relative to the No Action Alternative for the full simulation period (Table G-36). In all other months, modeled monthly average EC levels are similar to or less than under the No Action Alternative (Table G-36). The lower modeled average EC levels are driven primarily by substantially lower EC in critical years (Attachment G.1, Tables G.1-2-3 through G.1-2-6, G.1-3-3 through G.1-3-6, G.1-4-3 through G.1-4-6, G.1-9-3 through G.1-9-6, and G.1-11-3 through G.1-11-6, and Figures G.1-2-1 through G.1-4-6, G.1-9-1 through G.1-9-6, and G.1-11-1 through G.1-11-6).

Modeled monthly average EC levels in the San Joaquin River at Vernalis and Brandt Bridge, Old River near Middle River and Tracy Bridge, and Sacramento River at Rio Vista are slightly higher in October and November and similar or lower for the remaining months of the full simulation period under all phases of Alternative 2 compared with the No Action Alternative (Table G-36; Attachment G.1, Figures G.1-5-1 through G.1-8-18 and G.1-10-1 through G.1-10-18).

Modeled monthly average EC levels in the Mokelumne River at Terminous under all phases of Alternative 2 are similar to the No Action Alternative (Table G-36; Attachment G.1, Tables G.1-1-3 through G.1-1-6, and Figures G.1-1-1 through G.1-1-18).

Modeled monthly average EC levels at the Banks and Jones pumping plants under all phases of Alternative 2 are similar to the No Action Alternative for the full simulation period (Table G-36; Attachment G.1, Tables G.1-17-3 through G.1-17-6 and G.1-18-3 through G.1-18-6, and Figures G.1-17-1 through G.1-18-6).

The CVP and SWP would continue to be operated, in real-time, to meet the Bay-Delta Plan objectives for EC. The objectives are for protecting agricultural, and fish and wildlife beneficial uses. The western Delta EC objectives for the Sacramento River at Emmaton and San Joaquin River at Jersey Point for agricultural beneficial use protection apply from April through June, July, or August, depending on water year type (State Water Resources Control Board 2018b). The San Joaquin River at Jersey Point objective for fish and wildlife protection also applies during April and May (State Water Resources Control Board 2018b). During these months, the monthly average EC levels under Alternative 2 would be similar to the No Action Alternative (Attachment G.1, Figures G.1-2-1 through G.1-2-18, G.1-9-1 through G.1-9-18). The southern Delta EC objectives for the protection of agricultural uses for the San Joaquin River at Vernalis and the export area for Banks and Jones pumping plant apply year-round. Based on the modeled differences in EC at the Delta assessment locations, Alternative 2 would not contribute to agricultural or fish and wildlife beneficial use impairments in the Delta relative to the No Action Alternative.

Table G-36. Monthly Average Electrical Conductivity (in micromhos per centimeter) at Delta Assessment Locations for the Full Simulation Period under Alternative 2, and Difference from the No Action Alternative

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
SOUTH FORK MOKELUMNE RIVER AT TERMINOUS												
With TUCP Without VA												
Full Simulation Period Average	189	194	207	210	217	211	201	191	188	185	186	183
Difference from NAA	0	0	0	0	0	0	0	-1	0	0	0	0
Without TUCP Without VA												
Full Simulation Period Average	189	194	208	211	217	211	199	191	188	185	186	183
Difference from NAA	0	0	0	0	0	0	-2	-1	0	0	0	0

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Without TUCP Delta VA												
Full Simulation Period Average	189	195	208	211	217	211	200	191	188	185	186	183
Difference from NAA	1	0	0	0	0	0	-2	-1	0	0	0	0
Without TUCP Systemwide VA												
Full Simulation Period Average	188	195	208	211	218	211	198	189	188	185	186	183
Difference from NAA	0	0	0	1	0	0	-3	-2	0	0	0	0
SAN JOAQUIN RIVER AT JERSEY POINT												
With TUCP Without VA												
Full Simulation Period Average	1100	1298	1134	602	336	259	272	341	418	667	979	1177
Difference from NAA	8	-17	-6	-29	-15	-2	-3	-1	-7	-6	20	21
Without TUCP Without VA												
Full Simulation Period Average	1118	1271	1124	617	339	255	252	298	374	609	924	1182
Difference from NAA	25	-44	-16	-15	-12	-6	-23	-44	-51	-64	-35	25
Without TUCP Delta VA												
Full Simulation Period Average	1128	1281	1122	622	352	259	258	301	376	618	947	1197
Difference from NAA	35	-34	-18	-9	1	-2	-18	-41	-49	-55	-12	41
Without TUCP Systemwide VA												
Full Simulation Period Average	1124	1295	1117	618	355	259	253	281	357	612	938	1196
Difference from NAA	31	-20	-22	-14	5	-1	-22	-61	-68	-61	-21	40
SAN JOAQUIN RIVER AT PRISONERS POINT												
With TUCP Without VA												
Full Simulation Period Average	330	363	448	354	296	270	274	249	236	247	280	309
Difference from NAA	3	-1	-4	-5	-3	0	-6	-10	-2	-1	4	4
Without TUCP Without VA												
Full Simulation Period Average	335	362	445	357	298	271	272	241	228	237	270	306
Difference from NAA	8	-2	-7	-2	-1	1	-8	-17	-9	-10	-7	1
Without TUCP Delta VA												
Full Simulation Period Average	337	364	446	357	301	285	290	248	230	239	273	310
Difference from NAA	10	0	-6	-2	2	14	9	-10	-8	-9	-4	5
Without TUCP Systemwide VA												
Full Simulation Period Average	335	365	447	355	302	285	288	245	227	237	271	311
Difference from NAA	8	0	-5	-3	3	15	8	-13	-10	-11	-5	6

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
SAN JOAQUIN RIVER AT SAN ANDREAS LANDING												
With TUCP Without VA												
Full Simulation Period Average	370	400	456	319	240	220	224	230	225	247	292	328
Difference from NAA	5	-4	-3	-7	-5	-1	-3	-4	-2	-1	3	3
Without TUCP Without VA												
Full Simulation Period Average	378	396	452	323	241	219	221	220	215	233	280	327
Difference from NAA	13	-8	-7	-3	-3	-1	-7	-14	-12	-15	-9	2
Without TUCP Delta VA												
Full Simulation Period Average	380	399	454	324	246	223	228	224	216	234	282	332
Difference from NAA	15	-5	-5	-2	1	3	0	-10	-11	-14	-7	7
Without TUCP Systemwide VA												
Full Simulation Period Average	376	401	454	323	247	224	225	219	213	232	280	333
Difference from NAA	11	-3	-5	-3	3	3	-2	-15	-14	-16	-8	8
SAN JOAQUIN RIVER AT VERNALIS												
With TUCP Without VA												
Full Simulation Period Average	624	712	681	625	568	588	450	401	494	574	581	584
Difference from NAA	0	0	-1	1	-4	-2	2	3	2	0	-2	-2
Without TUCP Without VA												
Full Simulation Period Average	624	712	681	626	569	589	450	402	493	573	579	584
Difference from NAA	0	0	-1	1	-4	-1	2	4	2	-1	-3	-2
Without TUCP Delta VA												
Full Simulation Period Average	624	712	681	626	569	589	450	402	493	573	579	584
Difference from NAA	0	0	-1	1	-4	-1	2	4	2	-1	-3	-2
Without TUCP Systemwide VA												
Full Simulation Period Average	624	712	681	626	569	589	450	402	493	573	579	584
Difference from NAA	0	0	-1	1	-4	-1	2	4	2	-1	-3	-2
SAN JOAQUIN RIVER AT BRANDT BRIDGE												
With TUCP Without VA												
Full Simulation Period Average	622	707	685	631	572	587	459	406	492	571	582	586
Difference from NAA	0	0	-1	1	-4	-2	2	3	2	0	-2	-2
Without TUCP Without VA												
Full Simulation Period Average	622	706	685	631	573	588	459	407	492	570	581	586
Difference from NAA	0	0	-1	1	-4	-1	2	4	2	-1	-3	-2

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Without TUCP Delta VA												
Full Simulation Period Average	622	706	685	631	573	588	459	407	492	570	582	586
Difference from NAA	0	0	-1	1	-4	-1	2	4	2	-1	-3	-2
Without TUCP Systemwide VA												
Full Simulation Period Average	622	707	685	631	573	588	459	406	492	570	582	586
Difference from NAA	0	0	-1	1	-4	-1	2	3	2	-1	-3	-2
OLD RIVER NEAR MIDDLE RIVER												
With TUCP Without VA												
Full Simulation Period Average	624	710	686	633	576	591	458	407	495	575	584	587
Difference from NAA	0	0	-1	1	-4	-2	2	3	2	0	-2	-2
Without TUCP Without VA												
Full Simulation Period Average	624	710	686	634	576	592	459	407	494	574	583	587
Difference from NAA	0	0	-1	1	-4	-1	2	3	2	-1	-3	-2
Without TUCP Delta VA												
Full Simulation Period Average	624	710	686	634	576	592	459	407	494	574	583	587
Difference from NAA	0	0	-1	1	-4	-1	2	4	2	-1	-3	-2
Without TUCP Systemwide VA												
Full Simulation Period Average	624	710	686	634	576	592	459	407	494	574	583	587
Difference from NAA	0	0	-1	1	-4	-1	2	3	2	-1	-3	-2
OLD RIVER AT TRACY BRIDGE												
With TUCP Without VA												
Full Simulation Period Average	622	704	700	657	605	608	477	419	482	523	523	550
Difference from NAA	-1	0	-1	1	-4	-2	1	3	0	0	2	2
Without TUCP Without VA												
Full Simulation Period Average	620	704	700	657	605	609	478	420	479	515	511	540
Difference from NAA	-2	0	-1	1	-3	-1	2	3	-4	-8	-10	-8
Without TUCP Delta VA												
Full Simulation Period Average	621	704	700	657	605	609	478	420	480	517	514	541
Difference from NAA	-1	0	-1	1	-3	-1	2	3	-3	-6	-7	-7
Without TUCP Systemwide VA												
Full Simulation Period Average	621	704	700	657	605	609	478	420	479	518	517	542
Difference from NAA	-2	0	-1	1	-3	-1	2	3	-4	-5	-4	-6

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
SACRAMENTO RIVER AT EMMATON												
With TUCP Without VA												
Full Simulation Period Average	1774	1696	940	499	270	252	352	491	750	935	1439	1752
Difference from NAA	2	-40	1	-38	-8	1	-6	0	-1	14	26	13
Without TUCP Without VA												
Full Simulation Period Average	1803	1659	937	530	271	241	278	408	658	808	1368	1771
Difference from NAA	31	-77	-3	-7	-7	-10	-80	-83	-92	-114	-45	32
Without TUCP Delta VA												
Full Simulation Period Average	1803	1662	940	541	291	238	276	407	664	797	1338	1768
Difference from NAA	31	-75	0	3	13	-13	-82	-84	-86	-124	-74	28
Without TUCP Systemwide VA												
Full Simulation Period Average	1794	1684	941	546	295	236	258	359	635	793	1330	1750
Difference from NAA	23	-53	2	9	17	-15	-100	-132	-115	-128	-83	10
SACRAMENTO RIVER AT RIO VISTA												
With TUCP Without VA												
Full Simulation Period Average	302	301	244	207	190	188	195	202	226	239	277	294
Difference from NAA	0	-5	0	-3	-1	0	-1	-1	-1	1	4	1
Without TUCP Without VA												
Full Simulation Period Average	306	296	243	211	190	188	188	194	213	219	266	295
Difference from NAA	4	-10	0	1	-1	-1	-8	-10	-15	-20	-7	2
Without TUCP Delta VA												
Full Simulation Period Average	307	297	245	212	192	188	189	194	213	217	262	295
Difference from NAA	4	-9	1	3	2	-1	-7	-9	-14	-21	-11	2
Without TUCP Systemwide VA												
Full Simulation Period Average	306	303	246	213	193	188	187	191	210	216	261	293
Difference from NAA	3	-4	2	3	2	-1	-9	-13	-17	-22	-13	0
SACRAMENTO RIVER AT THREEMILE SLOUGH												
With TUCP Without VA												
Full Simulation Period Average	866	818	496	310	217	209	250	300	413	487	709	846
Difference from NAA	0	-21	0	-16	-3	0	-4	-4	-2	6	16	5
Without TUCP Without VA												
Full Simulation Period Average	882	798	494	327	218	204	216	261	363	413	667	855
Difference from NAA	16	-41	-2	0	-3	-4	-38	-43	-52	-68	-25	14

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Without TUCP Delta VA												
Full Simulation Period Average	882	800	498	332	227	204	216	262	365	407	650	854
Difference from NAA	16	-39	2	6	7	-4	-37	-42	-49	-74	-43	13
Without TUCP Systemwide VA												
Full Simulation Period Average	878	816	500	336	229	204	210	243	353	405	645	844
Difference from NAA	12	-23	4	9	9	-5	-44	-61	-62	-76	-47	3
BANKS PUMPING PLANT												
With TUCP Without VA												
Full Simulation Period Average	473	484	614	568	499	474	430	371	351	342	373	427
Difference from NAA	3	1	-5	4	1	2	-2	-9	3	3	6	6
Without TUCP Without VA												
Full Simulation Period Average	474	486	611	569	501	478	427	368	343	331	358	416
Difference from NAA	5	2	-8	4	3	6	-5	-13	-5	-8	-9	-5
Without TUCP Delta VA												
Full Simulation Period Average	476	487	612	566	504	511	446	380	347	332	360	420
Difference from NAA	7	4	-7	2	5	38	14	0	-1	-7	-7	-2
Without TUCP Systemwide VA												
Full Simulation Period Average	475	486	612	565	503	512	446	380	343	331	359	419
Difference from NAA	6	3	-7	1	5	39	14	0	-5	-8	-8	-3
JONES PUMPING PLANT												
With TUCP Without VA												
Full Simulation Period Average	504	534	626	582	517	494	443	380	372	381	408	454
Difference from NAA	3	1	-5	3	1	2	-2	-7	2	3	5	5
Without TUCP Without VA												
Full Simulation Period Average	505	536	623	582	518	498	440	377	365	371	394	444
Difference from NAA	4	3	-7	3	2	5	-5	-10	-4	-8	-9	-6
Without TUCP Delta VA												
Full Simulation Period Average	507	537	625	580	520	533	458	388	368	372	396	447
Difference from NAA	5	4	-5	1	4	40	13	1	-1	-7	-7	-3
Without TUCP Systemwide VA												
Full Simulation Period Average	506	536	624	579	520	533	458	388	365	372	395	446
Difference from NAA	5	3	-6	0	4	41	13	1	-4	-7	-8	-4

NAA = No Action Alternative.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Suisun Marsh

Attachment G.1 provides tables and figures presenting modeled EC levels at the Suisun Marsh assessment locations for Alternative 1 relative to the No Action Alternative. Table G-37 presents the modeled monthly average EC levels at the Suisun Marsh assessment locations for Alternative 2 for the 100-year simulation period and the differences from the No Action Alternative.

As discussed for Alternative 1, October through May is the period when Bay-Delta Plan EC objectives for protection of Suisun Marsh fish and wildlife apply; thus, the discussion of effects of Alternative 2 on EC is focused on changes during these months. Modeled monthly average EC levels are in October through May under all phases of Alternative 2 are similar to EC levels under the No Action Alternative for the full simulation period and across water year types (Table G-37; Attachment G.1, Figures G.1-12-1 through G.1-16-6). Therefore, Alternative 2 would not contribute to adverse effects on Suisun Marsh beneficial uses or contribute to additional salinity-related impairment.

Suisun Bay and San Francisco Bay

Alternative 2 would result in Delta outflow rates similar to those under the No Action Alternative (Appendix F). Based on there being less than substantial differences in Delta EC and outflow, Alternative 2 would not result in substantial changes in overall salinity conditions within Suisun Bay and San Francisco Bay, because seawater is the predominant source of salinity in the bays.

Table G-37. Monthly Average Electrical Conductivity (in millimhos per centimeter) at Suisun Marsh Assessment Locations for the Full Simulation Period under Alternative 2, and Difference from the No Action Alternative

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
SACRAMENTO RIVER AT COLLINSVILLE												
With TUCP Without VA												
Full Simulation Period Average	6.7	6.8	4.1	2.0	0.9	0.7	1.2	2.0	3.2	4.3	6.0	6.8
Difference from NAA	0.0	-0.1	0.0	-0.1	-0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.1
Without TUCP Without VA												
Full Simulation Period Average	6.7	6.7	4.1	2.1	0.9	0.7	1.0	1.8	3.0	4.0	5.9	6.8
Difference from NAA	0.1	-0.2	0.0	-0.1	-0.1	-0.1	-0.2	-0.1	-0.2	-0.2	-0.1	0.1
Without TUCP Delta VA												
Full Simulation Period Average	6.7	6.7	4.1	2.1	0.9	0.6	0.9	1.8	3.0	4.0	5.8	6.8
Difference from NAA	0.1	-0.2	0.0	0.0	0.0	-0.1	-0.3	-0.2	-0.2	-0.2	-0.2	0.1
Without TUCP Systemwide VA												
Full Simulation Period Average	6.7	6.7	4.0	2.1	1.0	0.6	0.8	1.5	2.9	4.0	5.8	6.8
Difference from NAA	0.1	-0.1	0.0	0.0	0.0	-0.1	-0.4	-0.4	-0.3	-0.3	-0.2	0.1

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
MONTEZUMA SLOUGH AT NATIONAL STEEL												
With TUCP Without VA												
Full Simulation Period Average	7.1	7.3	4.6	2.2	1.0	0.9	1.6	2.6	4.3	5.5	7.3	7.4
Difference from NAA	-0.3	-0.2	-0.1	-0.2	0.0	0.0	0.0	0.1	0.1	0.1	0.1	-0.2
Without TUCP Without VA												
Full Simulation Period Average	7.1	7.2	4.6	2.4	1.0	0.9	1.4	2.5	4.1	5.2	7.1	7.4
Difference from NAA	-0.3	-0.3	-0.1	-0.1	0.0	0.0	-0.2	0.0	-0.1	-0.1	-0.1	-0.2
Without TUCP Delta VA												
Full Simulation Period Average	7.1	7.2	4.7	2.4	1.1	0.8	1.3	2.4	4.1	5.2	7.1	7.4
Difference from NAA	-0.3	-0.3	-0.1	0.0	0.0	-0.1	-0.3	-0.1	-0.1	-0.2	-0.2	-0.2
Without TUCP Systemwide VA												
Full Simulation Period Average	7.1	7.2	4.7	2.4	1.1	0.8	1.2	2.1	4.0	5.2	7.0	7.4
Difference from NAA	-0.3	-0.3	-0.1	-0.1	0.0	-0.1	-0.4	-0.4	-0.2	-0.2	-0.2	-0.2
MONTEZUMA SLOUGH NEAR BELDON LANDING												
With TUCP Without VA												
Full Simulation Period Average	8.1	8.4	5.8	2.9	1.5	1.5	2.5	3.8	5.9	7.1	8.9	8.6
Difference from NAA	-0.8	-0.3	-0.2	-0.3	0.0	0.0	0.1	0.2	0.1	0.3	0.2	-0.6
Without TUCP Without VA												
Full Simulation Period Average	8.1	8.3	5.8	3.0	1.5	1.5	2.3	3.8	5.8	6.9	8.7	8.6
Difference from NAA	-0.8	-0.4	-0.2	-0.1	0.0	0.0	-0.2	0.2	0.1	0.0	0.0	-0.6
Without TUCP Delta VA												
Full Simulation Period Average	8.1	8.3	5.9	3.1	1.5	1.4	2.1	3.6	5.8	6.9	8.7	8.6
Difference from NAA	-0.8	-0.3	-0.1	0.0	0.0	-0.1	-0.3	0.0	0.0	0.0	-0.1	-0.6
Without TUCP Systemwide VA												
Full Simulation Period Average	8.1	8.3	5.9	3.0	1.6	1.4	2.0	3.3	5.6	6.8	8.6	8.6
Difference from NAA	-0.8	-0.4	-0.1	-0.1	0.0	-0.1	-0.5	-0.3	-0.2	0.0	-0.1	-0.6
CHADBOURNE SLOUGH NEAR SUNRISE DUCK CLUB												
With TUCP Without VA												
Full Simulation Period Average	9.7	9.8	7.8	4.9	3.2	3.0	3.8	5.0	7.1	8.8	10.4	10.4
Difference from NAA	-0.4	-0.2	-0.2	-0.2	-0.1	0.0	0.0	0.2	0.2	0.5	0.8	-0.1
Without TUCP Without VA												
Full Simulation Period Average	9.7	9.8	7.8	5.0	3.3	3.0	3.7	5.0	7.0	8.6	10.2	10.3
Difference from NAA	-0.5	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1	0.1	0.1	0.3	0.6	-0.2

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Without TUCP Delta VA												
Full Simulation Period Average	9.7	9.8	7.9	5.1	3.3	2.9	3.5	4.8	7.0	8.6	10.1	10.3
Difference from NAA	-0.5	-0.2	-0.1	0.0	0.0	-0.1	-0.3	0.0	0.0	0.3	0.5	-0.2
Without TUCP Systemwide VA												
Full Simulation Period Average	9.6	9.7	7.8	5.0	3.3	2.9	3.4	4.5	6.7	8.6	10.1	10.3
Difference from NAA	-0.5	-0.3	-0.1	-0.1	0.0	-0.1	-0.4	-0.4	-0.2	0.2	0.5	-0.2
SUISUN SLOUGH 300 FEET SOUTH OF VOLANTI SLOUGH												
With TUCP Without VA												
Full Simulation Period Average	8.8	8.9	7.2	4.3	2.7	2.3	3.0	4.1	6.0	7.6	9.1	9.4
Difference from NAA	-0.7	-0.3	-0.2	-0.2	-0.1	0.0	0.0	0.2	0.2	0.4	0.5	-0.2
Without TUCP Without VA												
Full Simulation Period Average	8.8	8.9	7.2	4.5	2.8	2.3	2.8	4.0	5.9	7.4	8.9	9.3
Difference from NAA	-0.6	-0.4	-0.2	-0.1	-0.1	0.0	-0.1	0.1	0.1	0.2	0.3	-0.3
Without TUCP Delta VA												
Full Simulation Period Average	8.8	8.9	7.3	4.5	2.8	2.3	2.7	3.9	5.9	7.4	8.9	9.3
Difference from NAA	-0.7	-0.4	-0.1	0.0	0.0	-0.1	-0.3	0.0	0.1	0.1	0.3	-0.3
Without TUCP Systemwide VA												
Full Simulation Period Average	8.8	8.8	7.2	4.5	2.8	2.2	2.6	3.6	5.6	7.3	8.8	9.3
Difference from NAA	-0.7	-0.4	-0.2	-0.1	0.0	-0.1	-0.4	-0.4	-0.2	0.1	0.2	-0.4

NAA = No Action Alternative; TUCP = Temporary Urgency Change Petition; VA = Voluntary Agreement.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Effects on Chloride

Attachment G.2 provides tables and figures presenting modeled chloride concentrations at the Delta assessment locations for Alternative 2 relative to the No Action Alternative. Table G-38 presents the modeled monthly average chloride concentrations at the Delta assessment locations for Alternative 2 for the 100-year simulation period and the differences from the No Action Alternative.

Modeled monthly average chloride concentrations in Barker Slough at the North Bay Aqueduct under all phases of Alternative 2 do not differ from those under the No Action Alternative (Table G-38; Attachment G.2, Tables G.2-1-3 through G.2-1-6, Figures G.2-1-1 through G.2-1-18).

Modeled monthly average chloride concentrations at Banks and Jones pumping plants under all phases of Alternative 2 are similar to concentrations under the No Action Alternative for the full simulation period and all water year types (Table G-38; Attachment G.2, Tables G.2-2-3 through G.2-3-6, Figures G.2-2-1 through G.2-3-18).

Modeled monthly average chloride concentrations at Contra Costa Pumping Plant #1 are similar to or lower than concentrations under the No Action Alternative for the full simulation period and all water year types (Table G-38; Attachment G.2, Table G.2-5-3 through Table G.2-5-6, Figures G.2-5-1 through G.2-5-18).

Modeled monthly average chloride concentrations in the San Joaquin River at Antioch are similar to or substantially lower than concentrations under all phases of Alternative 2 relative to the No Action Alternative for the full simulation period and all water year types (Table G-38; Attachment G.2, Table G.2-4-3 through G.2-4-6, Figures G.2-4-1 through G.2-4-18).

The CVP and SWP would operate in real-time to meet the Bay-Delta Plan chloride objectives, which aim to protect municipal and industrial beneficial uses. In September through December, when modeled chloride concentrations are higher compared with the No Action Alternative, the maximum mean daily chloride objectives of 250 mg/l would continue to apply at Contra Costa Pumping Plant #1, Banks and Jones pumping plants, and Barker Slough at North Bay Aqueduct. Also, the maximum mean daily chloride objective of 150 mg/l would continue to apply at Contra Costa Pumping Plant #1 for a certain number of days per year, depending on water year type. Thus, Alternative 2 would not contribute to impairment of municipal and industrial beneficial uses of Delta waters.

Table G-38. Monthly Average Chloride (in milligrams per liter) at Delta Assessment Locations for the Full Simulation Period under Alternative 2, and Difference from the No Action Alternative

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
BARKER SLOUGH AT NORTH BAY AQUEDUCT												
With TUCP Without VA												
Full Simulation Period Average	21	22	22	27	30	26	27	19	16	14	15	21
Difference from NAA	0	0	0	0	0	0	0	0	0	0	0	0
Without TUCP Without VA												
Full Simulation Period Average	21	22	22	27	30	27	28	19	16	14	15	21
Difference from NAA	0	0	0	0	0	0	0	0	0	0	0	0
Without TUCP Delta VA												
Full Simulation Period Average	21	22	22	27	30	27	28	19	16	14	15	21
Difference from NAA	0	0	0	0	0	0	0	0	0	0	0	0
Without TUCP Systemwide VA												
Full Simulation Period Average	21	22	22	27	30	27	28	19	16	14	15	21
Difference from NAA	0	0	0	0	0	0	0	0	0	0	0	0

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
BANKS PUMPING PLANT												
With TUCP Without VA												
Full Simulation Period Average	90	91	107	88	70	62	54	43	48	53	71	95
Difference from NAA	0	1	-1	0	0	0	0	-1	0	0	1	1
Without TUCP Without VA												
Full Simulation Period Average	91	91	106	89	71	63	53	42	45	49	65	91
Difference from NAA	1	1	-2	0	0	1	-1	-3	-2	-4	-4	-2
Without TUCP Delta VA												
Full Simulation Period Average	92	92	107	88	72	69	56	43	46	50	66	93
Difference from NAA	2	1	-1	0	1	7	2	-1	-2	-4	-3	-1
Without TUCP Systemwide VA												
Full Simulation Period Average	92	92	107	88	72	69	56	43	44	50	65	92
Difference from NAA	2	1	-1	0	1	7	2	-1	-3	-4	-4	-1
JONES PUMPING PLANT												
With TUCP Without VA												
Full Simulation Period Average	92	97	106	90	73	67	56	45	51	59	74	95
Difference from NAA	0	0	-1	0	0	0	0	-1	0	0	1	1
Without TUCP Without VA												
Full Simulation Period Average	93	97	105	90	73	67	55	44	49	56	69	92
Difference from NAA	1	0	-1	0	0	1	-1	-2	-2	-4	-4	-2
Without TUCP Delta VA												
Full Simulation Period Average	94	98	106	89	74	74	58	45	49	56	70	93
Difference from NAA	2	1	0	0	1	7	2	0	-2	-4	-4	-1
Without TUCP Systemwide VA												
Full Simulation Period Average	94	98	105	89	74	74	58	45	48	56	69	93
Difference from NAA	2	1	-1	0	1	8	2	0	-3	-4	-4	-1
SAN JOAQUIN RIVER AT ANTIOCH												
With TUCP Without VA												
Full Simulation Period Average	1023	1099	703	319	116	76	127	239	382	590	897	1069
Difference from NAA	5	-19	0	-25	-11	0	0	11	-2	0	6	16
Without TUCP Without VA												
Full Simulation Period Average	1034	1079	697	332	117	68	95	195	343	542	863	1080
Difference from NAA	16	-38	-6	-13	-9	-8	-33	-33	-41	-48	-27	26

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Without TUCP Delta VA												
Full Simulation Period Average	1038	1082	694	337	127	65	89	191	346	544	868	1082
Difference from NAA	20	-36	-9	-8	1	-12	-38	-37	-39	-46	-23	29
Without TUCP Systemwide VA												
Full Simulation Period Average	1034	1090	691	336	131	64	78	157	327	541	862	1077
Difference from NAA	16	-28	-12	-8	4	-12	-50	-71	-58	-49	-29	24
CONTRA COSTA WATER DISTRICT PUMPING PLANT #1												
With TUCP Without VA												
Full Simulation Period Average	104	113	144	92	55	36	35	35	36	48	72	98
Difference from NAA	2	0	-2	-1	-2	0	-4	-4	-1	-1	2	2
Without TUCP Without VA												
Full Simulation Period Average	107	113	141	93	56	36	34	31	32	42	64	95
Difference from NAA	4	0	-4	0	-1	0	-5	-8	-6	-7	-6	-1
Without TUCP Delta VA												
Full Simulation Period Average	108	114	142	93	58	42	43	34	32	42	66	97
Difference from NAA	5	1	-4	0	1	6	4	-5	-5	-6	-4	1
Without TUCP Systemwide VA												
Full Simulation Period Average	107	114	143	92	58	42	42	33	30	41	65	97
Difference from NAA	5	1	-2	-1	1	6	4	-6	-7	-7	-5	1

NAA = No Action Alternative.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Suisun Marsh

Suisun Marsh also is not designated for municipal and domestic supply uses, and other salinity-related effects in the marsh are addressed above in the EC discussion.

Suisun Bay and San Francisco Bay

Because Suisun Bay and San Francisco Bay are not designated for municipal and domestic supply use, and seawater is the primary source of chloride in the western Delta, changes in chloride concentrations in the Delta outflow to the bays are not of concern in these water bodies relative to drinking water supplies or other beneficial uses.

Effects on Bromide

Delta

Attachment G.3 provides tables and figures presenting modeled bromide concentrations at the Delta assessment locations for Alternative 2 relative to the No Action Alternative. Table G-39 presents the modeled monthly average bromide concentrations at the Delta assessment locations for Alternative 2 for the 100-year simulation period and the differences from the No Action Alternative.

Modeled monthly average bromide concentrations in Barker Slough at the North Bay Aqueduct under all phases of Alternative 2 are similar to those under the No Action Alternative (Table G-39; Attachment G.3, Tables G.3-1-3 through G.3-1-6, Figures G.3-1-1 through G.3-1-18).

Modeled monthly average bromide concentrations at Banks and Jones pumping plants under all phases of Alternative 2 are similar to or lower than concentrations under the No Action Alternative for the full simulation period and all water year types (Table G-39; Attachment G.3, Tables G.3-2-3 through G.3-2-6, G.3-3-3 through G.3-3-6, Figures G.3-2-1 through G.3-3-18).

Modeled monthly average bromide concentrations at Contra Costa Pumping Plant #1 are similar to or lower than concentrations under the No Action Alternative for the full simulation period and all water year types (Table G-39; Attachment G.3, Table G.3-5-3 through G.3-5-6, Figures G.3-5-1 through G.3-5-18).

Modeled monthly average bromide concentrations in the San Joaquin River at Antioch are similar to or substantially lower in all months under all phases of Alternative 2 relative to the No Action Alternative for the full simulation period and all water year types (Table G-39; Attachment G.3, Table G.3-4-3 through G.3-4-6, Figures G.3-4-1 through G.3-4-18).

The overall lower bromide concentrations under Alternative 2 relative to the No Action Alternative would not result in greater potential for disinfection byproduct formation in drinking water supplies that use Delta source waters. The potentially higher bromide concentrations under Alternative 2 in some months could result in greater potential for disinfection byproduct formation in drinking water supplies that use Delta source waters, but the degree to which this would occur is uncertain. Treatment plants that use the Delta as a source for drinking water already experience highly variable bromide concentrations (as described for Alternative 1) and, thus, must implement appropriate treatment technologies to ensure compliance with drinking water regulations for disinfection byproducts. Thus, despite the potential for slightly higher bromide concentrations under the Alternative 2 in some months, it is expected that Alternative 2 would not contribute to drinking water impairments related to bromide relative to the No Action Alternative.

Table G-39. Monthly Average Bromide (in micrograms per liter) at Delta Assessment Locations for the Full Simulation Period under Alternative 2, and Difference from the No Action Alternative

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
BARKER SLOUGH AT NORTH BAY AQUEDUCT												
With TUCP Without VA												
Full Simulation Period Average	69	73	84	74	80	92	83	52	47	43	52	57
Difference from NAA	0	0	0	0	0	0	0	0	0	0	0	0
Without TUCP Without VA												
Full Simulation Period Average	69	73	84	74	80	93	84	52	47	43	51	56
Difference from NAA	0	0	0	0	0	1	1	0	0	0	-1	0
Without TUCP Delta VA												
Full Simulation Period Average	69	73	84	74	80	93	84	52	47	43	51	56
Difference from NAA	-1	0	0	0	0	1	1	0	0	0	-1	0
Without TUCP Systemwide VA												
Full Simulation Period Average	69	73	84	74	80	93	84	51	47	43	51	56
Difference from NAA	-1	0	0	0	0	1	1	0	0	0	-1	0
BANKS PUMPING PLANT												
With TUCP Without VA												
Full Simulation Period Average	312	315	378	297	229	221	183	143	162	182	248	313
Difference from NAA	2	2	-3	0	-1	1	-2	-5	1	-1	5	5
Without TUCP Without VA												
Full Simulation Period Average	314	316	376	298	230	223	181	139	153	168	228	301
Difference from NAA	4	2	-6	1	0	3	-4	-9	-8	-14	-15	-7
Without TUCP Delta VA												
Full Simulation Period Average	318	317	378	296	234	245	193	145	155	170	231	306
Difference from NAA	8	4	-3	-1	4	25	8	-3	-6	-13	-12	-2
Without TUCP Systemwide VA												
Full Simulation Period Average	318	317	377	296	234	245	193	145	150	169	229	306
Difference from NAA	8	4	-5	-2	4	25	8	-3	-11	-14	-14	-2
JONES PUMPING PLANT												
With TUCP Without VA												
Full Simulation Period Average	320	337	373	302	241	235	192	151	175	203	262	317
Difference from NAA	1	2	-2	0	0	1	-1	-4	1	-1	4	3

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Without TUCP Without VA												
Full Simulation Period Average	322	337	372	303	242	237	190	148	166	191	242	305
Difference from NAA	3	2	-3	1	0	3	-3	-7	-7	-14	-16	-8
Without TUCP Delta VA												
Full Simulation Period Average	325	339	375	301	245	260	201	153	168	192	245	310
Difference from NAA	6	4	-1	-1	3	26	8	-1	-6	-12	-13	-3
Without TUCP Systemwide VA												
Full Simulation Period Average	326	339	372	301	245	261	201	153	164	191	244	310
Difference from NAA	7	4	-3	-2	3	27	8	-1	-10	-13	-15	-4
SAN JOAQUIN RIVER AT ANTIOCH												
With TUCP Without VA												
Full Simulation Period Average	3579	3847	2459	1117	405	266	445	837	1338	2065	3139	3743
Difference from NAA	17	-65	-1	-88	-37	0	0	38	-7	-1	22	56
Without TUCP Without VA												
Full Simulation Period Average	3618	3777	2439	1160	410	237	331	682	1201	1896	3021	3779
Difference from NAA	56	-134	-20	-45	-32	-29	-114	-116	-145	-169	-96	91
Without TUCP Delta VA												
Full Simulation Period Average	3632	3787	2429	1179	445	226	311	669	1210	1905	3036	3788
Difference from NAA	70	-125	-30	-26	3	-40	-134	-129	-135	-161	-81	100
Without TUCP Systemwide VA												
Full Simulation Period Average	3618	3815	2419	1177	457	224	272	551	1143	1894	3017	3770
Difference from NAA	56	-97	-41	-29	15	-42	-173	-247	-202	-172	-100	83
CONTRA COSTA WATER DISTRICT PUMPING PLANT #1												
With TUCP Without VA												
Full Simulation Period Average	365	395	503	321	191	126	121	121	128	167	251	342
Difference from NAA	5	0	-7	-4	-7	-1	-14	-14	-3	-3	5	8
Without TUCP Without VA												
Full Simulation Period Average	374	394	495	325	196	127	118	108	111	146	225	331
Difference from NAA	14	-1	-15	0	-3	0	-17	-27	-19	-24	-20	-3
Without TUCP Delta VA												
Full Simulation Period Average	378	398	497	325	202	148	150	119	112	148	230	339
Difference from NAA	18	2	-13	-1	3	21	15	-16	-18	-22	-15	5
Without TUCP Systemwide VA												
Full Simulation Period Average	376	398	501	321	202	148	148	115	106	145	227	338
Difference from NAA	16	2	-9	-4	3	22	14	-21	-25	-25	-18	4

NAA = No Action Alternative. A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Suisun Marsh

Suisun Marsh also is not designated for municipal and domestic supply uses, and other salinity-related effects in the marsh are addressed above in the EC discussion.

Suisun Bay and San Francisco Bay

Because Suisun Bay and San Francisco Bay are not designated for municipal and domestic supply use, and seawater is the primary source of bromide in the western Delta, changes in bromide concentrations in the Delta outflow to the bays are not of concern in these water bodies relative to drinking water supplies or other beneficial uses.

Effects on Methylmercury

Delta

Attachment G.4 provides tables and figures presenting modeled total methylmercury concentrations at the Delta assessment locations for Alternative 2 (i.e., Alternative 2 With TUCP Without VA, Alternative 2 Without TUCP Without VA, Alternative 2 Without TUCP Delta VA, Alternative 2 Without TUCP Systemwide VA) relative to the No Action Alternative. Table G-40 and Table G-41 summarize the modeled average total methylmercury concentrations in water and fish tissues at the Delta assessment locations for Alternative 2 for the 100-year simulation period (1922–2021) and differences from the No Action Alternative.

Modeled long-term average water column concentrations of methylmercury in the Delta under Alternative 2 would be similar to those that would occur under the No Action Alternative at the Delta assessment locations (Table G-40). The range of modeled aqueous methylmercury concentrations for the No Action Alternative and Alternative 2 at all locations for all years. The modeled average aqueous total methylmercury concentrations for Alternative 2 do not change at any assessment location, compared with the No Action Alternative (Table G-40; Attachment G.4, Tables G.4-7 through G.4-14).

Modeled changes in water column concentrations of total methylmercury under the Alternative 2 resulted in little to no effect on modeled Delta fish tissue concentrations relative to the No Action Alternative. All modeled fish tissue concentrations exceed the water quality objective of 0.24 mg/kg ww in 350 mm largemouth bass fillets under both the No Action Alternative and Alternative 2 (Table G-41). Average modeled tissue concentrations differ by no more than 0.01 mg/kg wet weight for all years (Table G-41; Attachment G.4, Tables G.4-22 through G.4-29).

Based on the small-modeled changes in total methylmercury concentrations at all Delta assessment locations described above, Alternative 2 would not result in increased Delta methylmercury concentrations that would substantially degrade water quality or cause increased frequency of exceeding water quality objectives.

Table G-40. Total Methylmercury Concentrations in Water (in nanograms per liter) at Delta Assessment Locations for the Full Simulation Period, Alternative 2 and No Action Alternative

Assessment Location	NAA (ng/L)	Alt2 (ng/L)	Alt2 minus NAA (ng/L)
San Joaquin River at Empire Tract	0.14	0.14	0.00
Turner Cut	0.15	0.15	0.00
San Joaquin River at San Andreas Landing	0.12	0.12	0.00
San Joaquin River at Jersey Point	0.12	0.12	0.00
Victoria Canal	0.14	0.14	0.00
Sacramento River at Emmaton	0.12	0.12	0.00
San Joaquin River at Antioch	0.12	0.12	0.00
Montezuma Slough near Beldon Landing	0.13	0.13	0.00
Barker Slough at North Bay Aqueduct	0.13	0.13	0.00
Contra Costa Water District Pumping Plant #1	0.13	0.13	0.00
Banks Pumping Plant	0.14	0.14	0.00
Jones Pumping Plant	0.15	0.15	0.00

NAA = No Action Alternative; Alt2 = Alternative 2.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.
Al2 consists of: Alt2 With TUCP Without VA, Alt2 Without TUCP Without VA, Alt2 Without TUCP Delta VA, Alt2 Without TUCP Systemwide VA.

Table G-41. Modeled Total Methylmercury Concentrations in largemouth bass Fillets (in milligrams per kilogram wet weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 2 and No Action Alternative

Assessment Location	NAA (mg/kg ww)	Alt2 (mg/kg ww)	Alt2 minus NAA (mg/kg ww)
San Joaquin River at Empire Tract	0.78	0.78	0.00
Turner Cut	0.96	0.96	0.00
San Joaquin River at San Andreas Landing	0.61	0.61	0.00
San Joaquin River at Jersey Point	0.64	0.63 to 0.64	-0.01 to 0.00
Victoria Canal	0.84	0.84 to 0.85	0.00 to 0.01
Sacramento River at Emmaton	0.60	0.60	0.00
San Joaquin River at Antioch	0.65	0.64 to 0.65	-0.01 to 0.00
Montezuma Slough near Beldon Landing	0.73	0.73	0.00
Barker Slough at North Bay Aqueduct	0.74	0.75	0.01
Contra Costa Water District Pumping Plant #1	0.68	0.68 to 0.69	0.00 to 0.01
Banks Pumping Plant	0.83	0.83	0.00
Jones Pumping Plant	0.87	0.87	0.00

NAA = No Action Alternative; Alt2 = Alternative 2; mg/kg ww = milligrams per kilogram wet weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.
Alt2 consists of: Alt2 With TUCP Without VA, Alt2 Without TUCP Without VA, Alt2 Without TUCP Delta VA, Alt2 Without TUCP Systemwide VA.

Suisun Marsh

Modeled long-term average methylmercury concentrations in Suisun Marsh for the full simulation period, represented by the Montezuma Slough near Beldon Landing assessment location, do not increase under Alternative 2 relative to the No Action Alternative (Table G-40 and Table G-41). For this reason, and consistent with the discussion for Alternative 1, Alternative 2 would not contribute to additional water quality degradation with respect to water column methylmercury concentrations or increased methylmercury bioaccumulation in biota in Suisun Marsh as compared with the No Action Alternative.

Suisun Bay and San Francisco Bay

Modeled long-term average methylmercury concentrations in the western Delta under Alternative 2 would not differ from those that would occur under the No Action Alternative (Table G-40). Alternative 2 would also result in Delta outflow rates similar to those under the No Action Alternative (Appendix F). Thus, Alternative 2 would not contribute to measurable water quality degradation with respect to water column methylmercury concentrations or increased methylmercury bioaccumulation in biota in Suisun Bay and San Francisco Bay, as compared with the No Action Alternative.

Effects on Selenium

Delta

Attachment G.5 provides tables and figures presenting modeled selenium concentrations at the Delta assessment locations for Alternative 2 relative to the No Action Alternative. Table G-42 through Table G-48 summarize the modeled average total selenium concentrations in water, fish tissues, and bird tissues at the Delta assessment locations for Alternative 2 for the 100-year simulation period (1922–2021) and differences from the No Action Alternative.

Modeled long-term average water column concentrations of selenium in the Delta under Alternative 2 are similar to the No Action Alternative at all locations for all years (Table G-42; Attachment G.5, Tables G.5-15, G.5-18, G.5-20, G.5-22, and G.5-24). Concentrations do not exceed the 5 µg/L CTR criterion and are similar from those that would occur under the No Action Alternative at the Delta assessment locations (Table G-42). Thus, Alternative 2 would not contribute to measurable water quality degradation with respect to selenium as compared with the No Action Alternative.

Modeled changes in water column concentrations of selenium under Alternative 2 for the full simulation period do not cause an increase in modeled Delta fish or bird tissue concentrations relative to the No Action Alternative. Concentrations in biota at all locations in the Delta under Alternative 2 are similar to those modeled for the No Action Alternative for whole-body fish (Table G-43), fish fillets (Table G-44 and Table G-45), bird eggs [invertebrate diet] (Table G-46), bird eggs [fish diet] (Table G-47). Modeled whole fish selenium concentrations do not exceed the 8.5 mg/kg dry weight water quality criterion (U.S. Environmental Protection Agency 2021).

Nor do modeled fish fillet selenium concentrations exceed the 11.3 mg/kg dry weight water quality criterion (U.S. Environmental Protection Agency 2021) or the 2.5 mg/kg ww advisory level for human consumption (California Office of Environmental Health Hazard Assessment 2008). Modeled bird eggs under Alternative 2 and the No Action Alternative do not exceed the 15.1 mg/kg dry weight water quality criterion (U.S. Environmental Protection Agency 2021). Thus, Alternative 2 would not result in increased health risks to wildlife or humans consuming wildlife associated with whole-body fish, bird eggs (invertebrate diet), bird eggs (fish diet), and fish fillets, as compared with the No Action Alternative.

Modeled selenium concentrations in whole-body sturgeon (*Acipenseridae*) in the western Delta under Alternative 2 are the same or lower than those modeled for the No Action Alternative (Table G-48). Concentrations at all western Delta locations are less than the North Bay TMDL target of 8 mg/kg dry weight in whole fish (San Francisco Bay Regional Water Quality Control Board 2015) for the entire period modeled. Thus, Alternative 2 would not increase health risks to sturgeon, as compared with the No Action Alternative.

Table G-42. Modeled Selenium Concentrations in Water (in nanograms per liter) at Delta Assessment Locations for the Full Simulation Period, Alternative 2 and No Action Alternative

Assessment Location	NAA (µg/L)	Alt2 (µg/L)	Alt2 minus NAA (µg/L)
San Joaquin River at Empire Tract	0.13	0.13	0.00
Turner Cut	0.22	0.23	0.00
San Joaquin River at San Andreas Landing	0.09	0.09	0.00
San Joaquin River at Jersey Point	0.09	0.09	0.00
Victoria Canal	0.15	0.15	0.00
Sacramento River at Emmaton	0.09	0.09	0.00
San Joaquin River at Antioch	0.10	0.10	0.00
Montezuma Slough near Beldon Landing	0.10	0.10	0.00
Barker Slough at North Bay Aqueduct	0.09	0.09	0.00
Contra Costa Water District Pumping Plant #1	0.11	0.11	0.00
Banks Pumping Plant	0.19	0.19	0.00
Jones Pumping Plant	0.21	0.21	0.00

NAA = No Action Alternative; Alt2 = Alternative 2; µg/L = micrograms per liter.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.
Alt2 consists of: Alt2 With TUCP Without VA, Alt2 Without TUCP Without VA, Alt2 Without TUCP Delta VA, Alt2 Without TUCP Systemwide VA.

Table G-43. Modeled Selenium Concentrations in Whole-Body Fish (in milligram per kilogram dry weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 2 and No Action Alternative

Assessment Location	NAA (mg/kg dw)	Alt2 (mg/kg dw)	Alt2 minus NAA (mg/kg dw)
San Joaquin River at Empire Tract	1.81	1.81	0.00
Turner Cut	1.80	1.80	0.00
San Joaquin River at San Andreas Landing	1.82	1.82	0.00
San Joaquin River at Jersey Point	1.82	1.82	0.00
Victoria Canal	1.81	1.81	0.00
Sacramento River at Emmaton	1.82	1.82	0.00
San Joaquin River at Antioch	1.82	1.82	0.00
Montezuma Slough near Beldon Landing	1.82	1.82	0.00
Barker Slough at North Bay Aqueduct	1.82	1.82	0.00
Contra Costa Water District Pumping Plant #1	1.82	1.82	0.00
Banks Pumping Plant	1.81	1.81	0.00
Jones Pumping Plant	1.81	1.81	0.00

NAA = No Action Alternative; Alt2 = Alternative 2; mg/kg dw = milligram per kilogram dry weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.
Alt2 consists of: Alt2 With TUCP Without VA, Alt2 Without TUCP Without VA, Alt2 Without TUCP Delta VA, Alt2 Without TUCP Systemwide VA.

Table G-44. Modeled Selenium Concentrations in Skinless Fish Fillets (in milligram per kilogram dry weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 2 and No Action Alternative

Assessment Location	NAA (mg/kg dw)	Alt2 (mg/kg dw)	Alt2 minus NAA (mg/kg dw)
San Joaquin River at Empire Tract	2.00	2.00	0.00
Turner Cut	1.99	1.99	0.00
San Joaquin River at San Andreas Landing	2.02	2.02	0.00
San Joaquin River at Jersey Point	2.02	2.02	0.00
Victoria Canal	2.00	2.00	0.00
Sacramento River at Emmaton	2.02	2.02	0.00
San Joaquin River at Antioch	2.02	2.02	0.00
Montezuma Slough near Beldon Landing	2.02	2.02	0.00
Barker Slough at North Bay Aqueduct	2.02	2.02	0.00

Assessment Location	NAA (mg/kg dw)	Alt2 (mg/kg dw)	Alt2 minus NAA (mg/kg dw)
Contra Costa Water District Pumping Plant #1	2.02	2.02	0.00
Banks Pumping Plant	2.00	2.00	0.00
Jones Pumping Plant	2.00	2.00	0.00

NAA = No Action Alternative; Alt2 = Alternative 2; mg/kg dw = milligram per kilogram dry weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.
Alt2 consists of: Alt2 With TUCP Without VA, Alt2 Without TUCP Without VA, Alt2 Without TUCP Delta VA, Alt2 Without TUCP Systemwide VA.

Table G-45. Modeled Selenium Concentrations in Skinless Fish Fillets (in milligram per kilogram wet weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 2 and No Action Alternative

Assessment Location	NAA (mg/kg ww)	Alternative 2 (mg/kg ww)	Alternative 2 minus NAA (mg/kg ww)
San Joaquin River at Empire Tract	0.60	0.60	0.00
Turner Cut	0.60	0.60	0.00
San Joaquin River at San Andreas Landing	0.61	0.61	0.00
San Joaquin River at Jersey Point	0.61	0.61	0.00
Victoria Canal	0.60	0.60	0.00
Sacramento River at Emmaton	0.61	0.61	0.00
San Joaquin River at Antioch	0.61	0.61	0.00
Montezuma Slough near Beldon Landing	0.61	0.61	0.00
Barker Slough at North Bay Aqueduct	0.61	0.61	0.00
Contra Costa Water District Pumping Plant #1	0.61	0.61	0.00
Banks Pumping Plant	0.60	0.60	0.00
Jones Pumping Plant	0.60	0.60	0.00

NAA = No Action Alternative; mg/kg dw = milligram per kilogram wet weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.
Al2 consists of: Alt2 With TUCP Without VA, Alt2 Without TUCP Without VA, Alt2 Without TUCP Delta VA, Alt2 Without TUCP Systemwide VA.

Table G-46. Modeled Selenium Concentrations in Bird Eggs, Invertebrate Diet (in milligram per kilogram dry weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 2 and No Action Alternative

Assessment Location	NAA (mg/kg dw)	Alt2 (mg/kg dw)	Alt2 minus NAA (mg/kg dw)
San Joaquin River at Empire Tract	2.70	2.70	0.00
Turner Cut	2.69	2.68	-0.01
San Joaquin River at San Andreas Landing	2.71	2.71	0.00
San Joaquin River at Jersey Point	2.71	2.71	0.00
Victoria Canal	2.70	2.70	0.00
Sacramento River at Emmaton	2.71	2.71	0.00
San Joaquin River at Antioch	2.71	2.71	0.00
Montezuma Slough near Beldon Landing	2.71	2.71	0.00
Barker Slough at North Bay Aqueduct	2.71	2.71	0.00
Contra Costa Water District Pumping Plant #1	2.70	2.70-2.71	0.00 to 0.01
Banks Pumping Plant	2.69	2.69	0.00
Jones Pumping Plant	2.69	2.69	0.00

NAA = No Action Alternative; Alt2 = Alternative 2; mg/kg dw = milligram per kilogram dry weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.
Al2 consists of: Alt2 With TUCP Without VA, Alt2 Without TUCP Without VA, Alt2 Without TUCP Delta VA, Alt2 Without TUCP Systemwide VA.

Table G-47. Modeled Selenium Concentrations in Bird Eggs, Fish Diet (in milligram per kilogram dry weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 2 and No Action Alternative

Assessment Location	NAA (mg/kg dw)	Alt2 (mg/kg dw)	Alt2 minus NAA (mg/kg dw)
San Joaquin River at Empire Tract	3.26	3.26	0.00
Turner Cut	3.24	3.24	0.00
San Joaquin River at San Andreas Landing	3.28	3.28	0.00
San Joaquin River at Jersey Point	3.28	3.28	0.00
Victoria Canal	3.26	3.26	0.00
Sacramento River at Emmaton	3.28	3.28	0.00
San Joaquin River at Antioch	3.28	3.28	0.00
Montezuma Slough near Beldon Landing	3.28	3.28	0.00
Barker Slough at North Bay Aqueduct	3.28	3.28	0.00

Assessment Location	NAA (mg/kg dw)	Alt2 (mg/kg dw)	Alt2 minus NAA (mg/kg dw)
Contra Costa Water District Pumping Plant #1	3.28	3.28	0.00
Banks Pumping Plant	3.26	3.26	0.00
Jones Pumping Plant	3.26	3.26	0.00

NAA = No Action Alternative; Alt2 = Alternative 2; mg/kg dw = milligram per kilogram dry weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.
Alt2 consists of: Alt2 With TUCP Without VA, Alt2 Without TUCP Without VA, Alt2 Without TUCP Delta VA, Alt2 Without TUCP Systemwide VA.

Table G-48. Modeled Selenium Concentrations in Whole Sturgeon (in milligram per kilogram dry weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 2 and No Action Alternative

Assessment Location	NAA (mg/kg dw)	Al2 (mg/kg dw)	Alt2 minus NAA (mg/kg dw)
Sacramento River at Emmaton	0.72	0.72	0.00
San Joaquin River at Antioch	3.82	3.79 to 3.81	-0.03 to -0.01
Montezuma Slough near Beldon Landing	3.97	3.94 to 3.94	-0.03 to -0.02

NAA = No Action Alternative; Alt2 = Alternative 2; mg/kg dw = milligram per kilogram dry weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.
Alt2 consists of: Alt2 With TUCP Without VA, Alt2 Without TUCP Without VA, Alt2 Without TUCP Delta VA, Alt2 Without TUCP Systemwide VA.

Suisun Marsh

Modeled long-term average selenium concentrations in Suisun Marsh are represented by the Montezuma Slough near Beldon Landing assessment location. Water column selenium, whole fish, fillets, bird eggs, and whole sturgeon modeled concentrations for the full simulation period at this location are lower under Alternative 2 relative to the No Action Alternative (Table G-42 through Table G-48). Thus, Alternative 2 would not contribute to increased water quality degradation with respect to water column selenium concentrations or measurable changes in selenium bioaccumulation in biota in Suisun Marsh as compared with the No Action Alternative.

Suisun Bay and San Francisco Bay

Long-term average water column selenium concentrations in the western Delta under Alternative 2 would be similar to those that would occur under the No Action Alternative (Table G-42) and would not exceed the North Bay TMDL the water column selenium target of 0.5 µg/L (San Francisco Bay Regional Water Quality Control Board 2015). Alternative 2 would also result in Delta outflow rates similar to those under the No Action Alternative (Appendix F). Thus, Alternative 2 would not contribute to additional water quality degradation with respect to water column selenium concentrations or increased selenium bioaccumulation in biota in Suisun Bay and San Francisco Bay, as compared with the No Action Alternative.

Effects on Organic Carbon

Delta

Attachment G.6 provides tables and figures presenting modeled dissolved organic carbon concentrations at the Delta assessment locations for Alternative 2 relative to the No Action Alternative. Table G-49 presents the modeled monthly average dissolved organic carbon concentrations at the Delta assessment locations for Alternative 2 for the 100-year simulation period and the differences from the No Action Alternative.

Under Alternative 2, all scenarios, monthly average dissolved organic carbon concentrations at Delta assessment locations would be similar to concentrations under the No Action Alternative for both the full simulation period (1922–2021) and the drought period (1987–1991) (Table G-49; Attachment G.6, Tables G.6-1-3, G.6-1-4, G.6-1-5, G.6-1-6, G.6-2-3, G.6-2-4, G.6-2-5, G.6-2-6, G.6-3-3, G.6-3-4, G.6-3-5, G.6-3-6, G.6-4-3, G.6-4-4, G.6-4-5, G.6-4-6, G.6-5-3, G.6-5-4, G.6-5-5, and G.6-5-6, Figures G.6-1-1 through G.6-5-14). Modeled monthly average differences for the full simulation period range from 0.0–0.2 mg/L (Table G-49). Modeled monthly average differences for the drought period also range from 0.0–0.2 mg/L (Attachment G.6, Tables G.6-1-3, G.6-1-4, G.6-1-5, G.6-1-6, G.6-2-3, G.6-2-4, G.6-2-5, G.6-2-6, G.6-3-3, G.6-3-4, G.6-3-5, G.6-3-6, G.6-4-3, G.6-4-4, G.6-4-5, G.6-4-6, G.6-5-3, G.6-5-4, G.6-5-5, and G.6-5-6,).

As explained for Alternative 1, a California Urban Water Agencies expert panel convened to review Delta water quality and disinfection formation potential found that total organic carbon concentrations ranging from 4 to 7 mg/L would allow continued flexibility in treatment technology necessary to achieve existing drinking water criteria for disinfection byproducts (California Urban Water Agencies 1998:ES-2). Furthermore, drinking water treatment plants that utilize Delta source waters are currently designed and operated to meet existing drinking water criteria for disinfection byproducts based on the ambient concentrations or organic carbon and the seasonal variability that currently exists in the Delta. Therefore, substantial increases in ambient dissolved organic carbon concentrations would need to occur with substantial frequency for significant changes in plant design or operations to be triggered.

Based on the modeling results, any increases in average dissolved organic carbon concentrations that may occur with Alternative 2 in Barker Slough at the North Bay Aqueduct, Banks and Jones pumping plants, the San Joaquin River at Antioch, and at Contra Costa Pumping Plant #1 would be of sufficiently small magnitude that modifications to existing drinking water treatment plants to employ additional organic carbon removals would not be necessary.

Based upon the above findings, Alternative 2 would not result in increased Delta dissolved organic carbon concentrations that would substantially degrade water quality or cause increased frequency of exceeding water quality objectives (because none exist) relative to the No Action Alternative.

Table G-49. Monthly Average Dissolved Organic Carbon (in milligrams per liter) at Delta Assessment Locations for the Full Simulation Period under Alternative 2 and Difference from the No Action Alternative

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
BARKER SLOUGH AT NORTH BAY AQUEDUCT												
With TUCP Without VA												
Full Simulation Period Average	2.3	2.5	2.9	3.2	3.4	3.3	3.1	2.7	2.4	2.2	2.2	2.3
Difference from NAA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Without TUCP Without VA												
Full Simulation Period Average	2.3	2.5	2.9	3.2	3.4	3.3	3.1	2.7	2.4	2.2	2.2	2.3
Difference from NAA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Without TUCP Delta VA												
Full Simulation Period Average	2.3	2.5	2.9	3.2	3.4	3.3	3.1	2.7	2.4	2.2	2.2	2.3
Difference from NAA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Without TUCP Systemwide VA												
Full Simulation Period Average	2.3	2.5	2.9	3.2	3.4	3.3	3.1	2.7	2.4	2.2	2.2	2.3
Difference from NAA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BANKS PUMPING PLANT												
With TUCP Without VA												
Full Simulation Period Average	3.1	3.2	3.9	4.9	5.3	5.0	4.4	4.1	3.8	3.4	3.3	3.2
Difference from NAA	0.0	0.0	0.0	0.0	0.0	0.0	0.1	-0.1	0.0	0.0	0.1	0.0
Without TUCP Without VA												
Full Simulation Period Average	3.0	3.2	3.9	4.9	5.3	5.0	4.5	4.0	3.8	3.3	3.2	3.2
Difference from NAA	0.0	0.0	0.0	0.0	0.0	0.0	0.1	-0.1	0.0	0.0	0.0	0.0
Without TUCP Delta VA												
Full Simulation Period Average	3.0	3.2	3.9	4.9	5.3	5.0	4.5	4.1	3.8	3.3	3.2	3.1
Difference from NAA	0.0	0.0	0.0	0.0	0.0	0.0	0.1	-0.1	0.0	0.0	0.0	0.0
Without TUCP Systemwide VA												
Full Simulation Period Average	3.0	3.2	3.9	4.9	5.3	5.0	4.5	4.1	3.8	3.3	3.1	3.1
Difference from NAA	0.0	0.0	0.0	0.0	0.0	0.0	0.1	-0.1	0.0	0.0	-0.1	0.0
JONES PUMPING PLANT												
With TUCP Without VA												
Full Simulation Period Average	3.2	3.3	3.9	5.0	5.2	4.9	4.3	3.9	3.7	3.4	3.3	3.3
Difference from NAA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.1	0.0
Without TUCP Without VA												
Full Simulation Period Average	3.2	3.2	3.9	5.0	5.2	4.9	4.3	3.9	3.7	3.4	3.3	3.3

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Difference from NAA	0.0	0.0	0.0	0.0	0.0	0.0	0.1	-0.1	0.0	0.0	0.0	0.0
Without TUCP Delta VA												
Full Simulation Period Average	3.1	3.2	3.9	5.0	5.2	4.8	4.3	4.0	3.7	3.4	3.2	3.2
Difference from NAA	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Without TUCP Systemwide VA												
Full Simulation Period Average	3.1	3.3	3.9	5.0	5.2	4.8	4.3	3.9	3.7	3.4	3.2	3.2
Difference from NAA	0.0	0.0	0.0	0.0	0.0	0.0	0.1	-0.1	0.0	0.0	-0.1	0.0
SAN JOAQUIN RIVER AT ANTIOCH												
With TUCP Without VA												
Full Simulation Period Average	2.3	2.6	3.0	3.4	3.7	3.7	3.4	3.0	2.7	2.4	2.4	2.4
Difference from NAA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0
Without TUCP Without VA												
Full Simulation Period Average	2.3	2.6	3.0	3.4	3.7	3.7	3.4	3.0	2.7	2.4	2.3	2.4
Difference from NAA	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0
Without TUCP Delta VA												
Full Simulation Period Average	2.3	2.6	3.0	3.4	3.7	3.7	3.5	3.0	2.7	2.4	2.3	2.4
Difference from NAA	0.0	0.0	0.0	0.0	0.0	0.1	0.0	-0.1	0.0	0.0	0.0	0.0
Without TUCP Systemwide VA												
Full Simulation Period Average	2.3	2.6	3.0	3.4	3.7	3.7	3.4	3.0	2.7	2.4	2.3	2.4
Difference from NAA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0
CONTRA COSTA WATER DISTRICT PUMPING PLANT #1												
With TUCP Without VA												
Full Simulation Period Average	2.6	2.9	3.4	4.3	5.1	4.9	4.5	3.9	3.3	2.9	2.8	2.8
Difference from NAA	0.0	0.0	0.0	0.0	0.1	-0.1	-0.2	-0.2	0.0	0.0	0.1	0.0
Without TUCP Without VA												
Full Simulation Period Average	2.6	2.8	3.4	4.3	5.1	4.9	4.5	3.8	3.3	2.8	2.7	2.7
Difference from NAA	0.0	0.0	0.0	0.0	0.1	-0.1	-0.2	-0.2	-0.1	0.0	0.0	0.0
Without TUCP Delta VA												
Full Simulation Period Average	2.6	2.8	3.4	4.3	5.1	5.1	4.7	3.9	3.3	2.8	2.7	2.7
Difference from NAA	0.0	0.0	0.0	0.0	0.1	0.2	0.0	-0.2	0.0	0.0	0.0	0.0
Without TUCP Systemwide VA												
Full Simulation Period Average	2.6	2.8	3.4	4.3	5.1	5.1	4.7	3.9	3.3	2.8	2.7	2.7
Difference from NAA	0.0	0.0	0.0	0.0	0.1	0.2	-0.1	-0.2	0.0	0.0	0.0	0.0

NAA = No Action Alternative.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Suisun Marsh

For the same reasons described for Alternative 1, Alternative 2 would not result in differences in organic carbon concentrations in Suisun Marsh that would contribute to adverse effects on organic enrichment conditions within the marsh.

Suisun Bay and San Francisco Bay

Alternative 2 would result in Delta outflow rates similar to those under the No Action Alternative (Appendix F). For the reasons described for Alternative 1, differences in organic carbon loading to Suisun Bay and San Francisco Bay that may occur under Alternative 2 would not be expected to contribute to adverse effects on the food web in the bays.

Effects on Trace Metals

For the same reasons described for Alternative 1, Alternative 2 would not affect existing Delta impairments related to trace metals and would not result in additional trace metals-related impairments in the Delta, Suisun Bay and Marsh, or San Francisco Bay relative to the No Action Alternative.

Effects on Nutrients

For the same reasons described for Alternative 1, Alternative 2 would not contribute to different Delta nutrient concentrations or nutrient distributions that would result in adverse effects on beneficial uses or substantially degrade the water quality relative to nutrient conditions that would occur under the No Action Alternative. Furthermore, potential differences in total nitrogen and phosphorus loading that would occur in Delta outflow to Suisun Bay and Marsh, and San Francisco Bay, relative to the No Action Alternative, are not expected to result in water quality degradation with regard to nutrients that would result in adverse effects on beneficial uses or the further impairment of Suisun Bay and Marsh, or San Francisco Bay.

Effects on Dissolved Oxygen

For the same reasons described for Alternative 1, Alternative 2 would not substantially affect DO concentrations in the Delta, Suisun Bay and Marsh, or San Francisco Bay, or make existing DO impairments in the Delta and Suisun Marsh worse relative to the No Action Alternative.

Effects on Legacy Contaminants

For the same reasons described for Alternative 1, Alternative 2 would not substantially affect levels of legacy contaminants (e.g., dioxin and furan compounds, PCBs, and PAHs) in the Delta, Suisun Bay and Marsh, or San Francisco Bay relative to the No Action Alternative.

Effects on Pesticides

For the same reasons described for Alternative 1, Alternative 2 would not substantially affect pesticide concentrations in the Delta, Suisun Bay and Marsh, or San Francisco Bay relative to the No Action Alternative.

Effects on CHABs

All phases of Alternative 2 would result in similar changes to Sacramento River and San Joaquin River flows entering the Delta compared with Alternative 1. For the same reasons discussed under Alternative 1, Alternative 2 would result in similar effects on Delta residence time, water temperature, channel turbulence and mixing, nutrients, and water clarity compared with Alternative 1. Consequently, Alternative 2 would not adversely affect CHABs in the Delta, Suisun Marsh, Suisun Bay, or San Francisco Bay.

CVP and SWP Service Areas (south to Diamond Valley)

Alternative 2 would generally result in higher monthly average chloride concentrations in late fall and early spring in all water year types, and similar or lower concentrations in the remaining months, as compared with the No Action Alternative. It should be noted that under Alternative 2 Without TUCP Delta VA, average chloride concentrations would increase substantially on the San Joaquin River at Antioch in all water year types. Since this water is delivered to reservoirs for storage in CVP and SWP reservoirs, chloride concentrations in these reservoirs may increase. While there would be higher chloride concentrations under Alternative 2 relative to the No Action Alternative in some months, the CVP and SWP would continue operation, in real-time, to meet the Bay-Delta Plan objectives for chloride, which aim to protect municipal and industrial beneficial uses. In March through July, when chloride would be higher compared with the No Action Alternative, the maximum mean daily chloride objectives of 250 mg/L would continue to apply at Contra Costa Pumping Plant #1, Banks and Jones pumping plants, and Barker Slough at North Bay Aqueduct (State Water Resources Control Board 2018b). Also, the maximum mean daily chloride objective of 150 mg/L would continue to apply at Contra Costa Pumping Plant #1 or San Joaquin River at Antioch for a certain number of days per year, depending on water year type (State Water Resources Control Board 2018b). Thus, Alternative 2 would not contribute to municipal and industrial beneficial uses CVP and SWP service area impairment.

G.2.5 Alternative 3

G.2.5.1 Potential Changes in Surface Water Quality Conditions

Trinity and Klamath Rivers

Operations in the Trinity River under Alternative 3 would remain like those under the No Action Alternative. The maximum average increase in flows is modeled during December of wet year types, when flows are expected to increase by approximately 10% and the maximum average decrease in flows is modeled during April of wet year types, when flows are expected to decrease by approximately 8%. Figure G-8 through Figure G-13 illustrate flow changes. Increases in flow would be considered beneficial based on the improvement of water quality through dilution of constituents of concern. The evaluation does not expect decreases in flow to be a large enough magnitude to affect water quality.

Sacramento River

Compared with the No Action Alternative, flow in the Sacramento River under Alternative 3 generally increases in late winter and early spring and decreases during the summer months. Under Alternative 3, average flows could decrease a maximum of approximately 21% in May of critical water years when compared with the No Action Alternative. The maximum average increase in flows on the Sacramento River would be during May of wet water years, when flows are expected to increase by 33%. Increases in flow are considered beneficial to water quality because they make more water available to dilute constituents of concern. Reductions in flow due to changes in the operations of CVP and SWP under Alternative 3 could result in less dilution causing increased concentrations of constituents of concern within the Sacramento River in certain months and year types compared with the No Action Alternative.

The decrease in flow would occur during wet water year types. Increases in flow are also expected under Alternative 3 during some months, especially during dry and critical water years. Figure G-14 through Figure G-19 illustrate flow changes on the Sacramento River below Keswick Reservoir. As flow increases are beneficial to water quality because it dilutes constituents of concern, flow decreases are not expected to be large enough to negatively impact water quality and increase the frequency of exceedances of water quality thresholds in the Sacramento River.

Clear Creek

Changes in flow in Clear Creek under Alternative 3 would generally increase in the winter and spring months and decrease during the summer and fall months as compared with the No Action Alternative. The maximum change in flows is expected to occur during critical water years, when the maximum increase in flows is expected to be approximately 54% and the maximum decrease in flows is expected to be approximately 38%. Increases in flow are considered beneficial to water quality because they make more water available to dilute constituents of concern (i.e., mercury). Reductions in flow due to changes in the operations of CVP and SWP under Alternative 3 could result in less dilution causing increased concentrations of mercury within Clear Creek in certain months and year types compared with the No Action Alternative.

Lower American River

Alternative 3 would bypass 55% of unimpaired inflows to Folsom Reservoir from December through May, which may shift the timing of releases from Folsom Reservoir. The largest flow decreases would be in June of above normal water years and the largest flow increases would be in December of critical water years. Flow changes would be similar for both locations on the lower American River. Lower American River flows at H Street and below Nimbus Dam would have a maximum increase of approximately 62% and a maximum decrease of approximately 44%. Figure G-26 through Figure G-31 present monthly changes in American River flow at H Street for all water year types under Alternative 3 compared with the No Action Alternative. Flow increases are beneficial to water quality because they dilute constituents of concern, and flow decreases, expected when conditions are wet or above normal, have a minor impact on water quality. Frequency increases of exceedances of water quality standards in the American River are not expected.

Stanislaus River

The largest flow decrease would be in December of below normal water years and the largest flow increase would be in February of dry water years under Alternative 3. Stanislaus River flows below Goodwin Dam would have a maximum increase of approximately 68% and a maximum decrease of approximately 54%. Figure G-32 through Figure G-37 present monthly changes in Stanislaus River flow below Goodwin Dam for all water year types under Alternative 3 compared with the No Action Alternative. Changes in flow at the mouth of Stanislaus River follow a similar trend but are generally smaller. At times when flow increases, water quality could improve as more water is available to dilute constituent (i.e., pesticide) runoff in the Stanislaus River. Flow decreases during spring and summer months of all water year types could cause water quality degradation because less water would be available to dilute pesticide concentrations.

San Joaquin River

The greatest flow change in the San Joaquin River would be at Vernalis, where flows would decrease by a maximum of 22%. Figure G-38 through Figure G-43 show changes in the San Joaquin River at Vernalis. The change in flow under Alternative 3 would not likely result in adverse effects on water quality nor an increase in frequency of exceedances of water quality thresholds in the San Joaquin River.

Bay-Delta

Alternative 3 would result in some differences in Sacramento River and San Joaquin River inflow rates to the Delta, Delta outflows, and south Delta exports, relative to the No Action Alternative, which could result in changes in the proportion of Delta source waters (i.e., Sacramento River, San Joaquin River, San Francisco Bay, eastside tributaries) at various Delta locations. The water proportion differences may result in water quality differences relative to the No Action Alternative at various Delta locations, Suisun Marsh, and outflow to Suisun Bay and San Francisco Bay. The following sections discuss effects of Alternative 3 on EC, chloride, bromide, methylmercury, selenium, organic carbon, trace metals, nutrients, DO, legacy contaminants, pesticides, and CHABs.

Effects on Electrical Conductivity

<u>Delta</u>

Attachment G.1 provides tables and figures presenting modeled EC levels at the Delta assessment locations for Alternative 3 relative to the No Action Alternative. Table G-50 presents the modeled monthly average EC levels at the Delta assessment locations for Alternative 3 for the 100-year simulation period and the differences from the No Action Alternative.

Modeled monthly average EC levels for the San Joaquin River at Jersey Point and the Sacramento River at Emmaton and Threemile Slough are substantially lower in all months under Alternative 3 relative to the No Action Alternative for the full simulation period (Table G-50; Attachment G.1, Tables G.1-2-7, G.1-9-7, and G.1-11-7, and Figures G.1-2-1 through G.1-2-18, G.1-9-1 through G.1-9-18, and G.1-11-1 through G.1-11-18). Modeled monthly average EC levels for the San Joaquin River at San Andreas Landing and Sacramento River at Rio Vista are similar or lower for all months compared with the No Action Alternative to a lesser degree (Table

G-50; Attachment G.1, Tables G.1-4-7 and G.1-10-7, and Figures G.1-4-1 through G.1-4-18 and G.1-10-1 through G.1-10-18).

The difference between modeled monthly average EC levels for Alternative 3 compared with the No Action Alternative are variable for the San Joaquin River at Prisoners Point, Vernalis and Brandt Bridge, and Old River near Middle River (Table G-50). For these locations, modeled monthly average EC levels are slightly higher in July through January and somewhat lower in February through June (Table G-50; Attachment G.1, Tables G.1-3-7, G.1-5-7, G.1-6-7, and G.1-7-7, and Figures G.1-3-1 through G.1-3-18, and G.1-5-1 through G.1-7-18).

For Old River at Tracy Bridge, modeled monthly average EC levels are less than those under the No Action Alternative in February through October (Table G-50; Attachment G.1, Table G.1-8-7, and Figures G.1-8-1 through G.1-8-18). Modeled monthly average EC levels are slightly higher in November through January (Table G-50; Attachment G.1, Table G.1-8-7, and Figures G.1-8-1 through G.1-8-18).

Modeled monthly average EC levels in the Mokelumne River at Terminous under Alternative 3 are similar to the No Action Alternative (Table G-50; Attachment G.1, Table G.1-1-7, and Figures G.1-1-1 through G.1-1-18).

Modeled monthly average EC levels at the Banks and Jones pumping plants for Alternative 3 lower than for the No Action Alternative in August through January of the full simulation period (Table G-50; Attachment G.1, Tables G.1-17-7 and G.1-18-7, and Figures G.1-17-1 through G.1-18-6). Modeled monthly average EC levels are similar to or slightly higher than for the No Action Alternative in February through July of the full simulation period (Table G-50; Attachment G.1, Tables G.1-17-7 and G.1-18-7, and Figures G.1-17-1 through G.1-18-6). Higher EC levels in February through July were modeled to occur across all water year types (Attachment G.1, Tables G.1-17-7 and G.1-18-7).

The CVP and SWP would continue to be operated, in real-time, to meet the Bay-Delta Plan objectives for EC. The objectives are for protecting agricultural, and fish and wildlife beneficial uses. The western Delta EC objectives for the Sacramento River at Emmaton and San Joaquin River at Jersey Point for agricultural beneficial use protection apply from April through June, July, or August, depending on water year type (State Water Resources Control Board 2018b). The San Joaquin River at Jersey Point objective for fish and wildlife protection also applies during April and May (State Water Resources Control Board 2018b). During these months, the monthly average EC levels under Alternative 3 would be similar to the No Action Alternative (Attachment G.1, Figures G.1-2-1 through G.1-2-18, G.1-9-1 through G.1-9-18). The southern Delta EC objectives for the protection of agricultural uses for the San Joaquin River at Vernalis and the export area for Banks and Jones pumping plant apply year-round. Based on the modeled differences in EC at the Delta assessment locations, Alternative 3 would not contribute to agricultural or fish and wildlife beneficial use impairments in the Delta relative to the No Action Alternative.

Table G-50. Monthly Average Electrical Conductivity (in micromhos per centimeter) at Delta Assessment Locations for the Full Simulation Period under Alternative 3, and Difference from the No Action Alternative

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
SOUTH FORK MOKELUMNE RIVER AT TERMINOUS												
Full Simulation Period Average	189	196	207	210	217	211	200	193	190	187	187	183
Difference from NAA	0	1	0	0	0	0	-1	1	2	2	1	0
SAN JOAQUIN RIVER AT JERSEY POINT												
Full Simulation Period Average	811	1009	652	363	267	249	260	289	323	404	429	557
Difference from NAA	-282	-306	-488	-268	-84	-12	-16	-53	-102	-269	-530	-599
SAN JOAQUIN RIVER AT PRISONERS POINT												
Full Simulation Period Average	279	335	342	300	291	288	292	273	247	235	227	228
Difference from NAA	-47	-30	-110	-59	-7	18	11	14	10	-13	-50	-77
SAN JOAQUIN RIVER AT SAN ANDREAS LANDING												
Full Simulation Period Average	302	354	316	249	224	223	229	232	221	217	216	228
Difference from NAA	-64	-50	-143	-77	-20	2	1	-2	-6	-31	-72	-96
SAN JOAQUIN RIVER AT VERNALIS												
Full Simulation Period Average	629	716	687	629	559	568	430	387	483	576	592	593
Difference from NAA	5	4	5	4	-13	-21	-18	-11	-8	3	9	7
SAN JOAQUIN RIVER AT BRANDT BRIDGE												
Full Simulation Period Average	627	710	691	634	564	568	440	392	481	574	594	595
Difference from NAA	5	4	5	4	-13	-21	-18	-11	-9	3	10	8
OLD RIVER NEAR MIDDLE RIVER												
Full Simulation Period Average	629	714	693	637	567	572	440	393	485	577	596	597
Difference from NAA	5	4	6	5	-13	-21	-17	-11	-8	3	10	8
OLD RIVER AT TRACY BRIDGE												
Full Simulation Period Average	616	704	707	662	598	590	463	406	469	474	433	462
Difference from NAA	-6	0	7	6	-10	-19	-13	-10	-13	-49	-88	-86
SACRAMENTO RIVER AT EMMATON												
Full Simulation Period Average	1439	1499	688	340	231	223	281	379	607	800	885	1118
Difference from NAA	-333	-237	-252	-198	-48	-28	-77	-113	-143	-121	-528	-621
SACRAMENTO RIVER AT RIO VISTA												
Full Simulation Period Average	267	287	222	193	187	187	190	195	212	216	217	234
Difference from NAA	-36	-19	-22	-17	-3	-2	-6	-8	-15	-22	-56	-59

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
SACRAMENTO RIVER AT THREEMILE SLOUGH												
Full Simulation Period Average	699	742	389	242	202	200	224	260	348	407	436	543
Difference from NAA	-166	-96	-107	-85	-19	-9	-30	-44	-67	-74	-256	-298
BANKS PUMPING PLANT												
Full Simulation Period Average	407	476	593	544	504	502	454	402	419	385	346	327
Difference from NAA	-62	-7	-26	-20	6	29	22	22	72	46	-21	-95
BANKS PUMPING PLANT												
Full Simulation Period Average	444	518	615	566	525	520	465	407	429	402	367	356
Difference from NAA	-58	-16	-16	-12	9	27	20	20	59	23	-36	-93

NAA = No Action Alternative.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Suisun Marsh

Attachment G.1 provides tables and figures presenting modeled EC levels at the Suisun Marsh assessment locations for Alternative 3 relative to the No Action Alternative. Table G-51 presents the modeled monthly average EC levels at the Suisun Marsh assessment locations for Alternative 3 for the 100-year simulation period and the differences from the No Action Alternative.

October through May is the period when Bay-Delta Plan EC objectives for protection of Suisun Marsh fish and wildlife apply; thus, the discussion of effects of Alternative 3 on EC is focused on changes during these months. Modeled monthly average EC levels are in October through May under Alternative 3 are less than EC levels under the No Action Alternative for the full simulation period and across water year types (Table G-51; Attachment G.1, Figures G.1-12-1 through G.1-16-6). Therefore, Alternative 3 would not contribute to adverse effects on Suisun Marsh beneficial uses or contribute to additional salinity-related impairment.

Suisun Bay and San Francisco Bay

Alternative 3 would result in higher Delta outflow rates, relative to the No Action Alternative, in all months except June (Appendix F). The differences in Delta EC and outflow could cause the freshwater-seawater salinity gradient within Suisun Bay and the northern portion of San Francisco Bay to be different between Alternative 3 and the No Action Alternative. However, Alternative 3 is not expected to result in substantial changes in overall salinity conditions within Suisun Bay and San Francisco Bay, because seawater is the predominant source of salinity in the bays.

Table G-51. Monthly Average Electrical Conductivity (in millimhos per centimeter) at Suisun Marsh Assessment Locations for the Full Simulation Period under Alternative 3, and Difference from the No Action Alternative

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
SACRAMENTO RIVER AT COLLINSVILLE												
Full Simulation Period Average	5.8	5.8	2.8	1.3	0.6	0.5	0.8	1.4	2.7	3.9	4.3	5.0
Difference from NAA	-0.9	-1.0	-1.3	-0.9	-0.3	-0.2	-0.4	-0.6	-0.5	-0.4	-1.7	-1.8
MONTEZUMA SLOUGH AT NATIONAL STEEL												
Full Simulation Period Average	6.3	6.4	3.4	1.7	0.8	0.7	1.1	1.9	3.6	5.2	5.8	6.0
Difference from NAA	-1.1	-1.1	-1.3	-0.7	-0.2	-0.2	-0.5	-0.6	-0.6	-0.1	-1.4	-1.6
MONTEZUMA SLOUGH NEAR BELDON LANDING												
Full Simulation Period Average	7.5	7.6	4.7	2.6	1.4	1.3	1.9	2.8	5.0	7.1	7.9	7.8
Difference from NAA	-1.3	-1.0	-1.3	-0.5	-0.1	-0.3	-0.6	-0.8	-0.8	0.2	-0.8	-1.4
CHADBOURNE SLOUGH NEAR SUNRISE DUCK CLUB												
Full Simulation Period Average	9.3	9.0	6.6	4.2	2.9	2.6	3.1	3.9	6.1	8.5	9.4	9.6
Difference from NAA	-0.9	-1.0	-1.4	-0.9	-0.5	-0.4	-0.7	-0.9	-0.8	0.2	-0.2	-1.0
SUISUN SLOUGH 300 FEET SOUTH OF VOLANTI SLOUGH												
Full Simulation Period Average	8.4	8.3	6.1	3.8	2.5	2.0	2.4	3.1	5.0	7.4	8.3	8.5
Difference from NAA	-1.1	-1.0	-1.3	-0.7	-0.3	-0.3	-0.6	-0.8	-0.8	0.1	-0.3	-1.1

NAA = No Action Alternative.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Effects on Chloride

Attachment G.2 provides tables and figures presenting modeled chloride concentrations at the Delta assessment locations for Alternative 3 relative to the No Action Alternative. Table G-52 presents the modeled monthly average chloride concentrations at the Delta assessment locations for Alternative 3 for the 100-year simulation period and the differences from the No Action Alternative.

Modeled monthly average chloride concentrations in Barker Slough at the North Bay Aqueduct under Alternative 3 are similar to those under the No Action Alternative (Table G-52; Attachment G.2, Table G.2-1-7, Figures G.2-1-1 through G.2-1-18).

Modeled monthly average chloride concentrations at Banks and Jones pumping plants under Alternative 3 are similar to or lower than concentrations under the No Action Alternative for the full simulation period and all water year types (Table G-52; Attachment G.2, Tables G.2-2-7 and G.2-3-7, Figures G.2-2-1 through G.2-3-18).

Modeled monthly average chloride concentrations at Contra Costa Pumping Plant #1 are somewhat higher in March through May and lower in July through February under Alternative 3 relative to the No Action Alternative for the full simulation period and all water year types (Table G-52; Attachment G.2, Table G.2-5-7, and Figures G.2-5-1 through G.2-5-18).

Modeled monthly average chloride concentrations in the San Joaquin River at Antioch are substantially lower in all months under Alternative 3 relative to the No Action Alternative for the full simulation period and all water year types (Table G-52; Attachment G.2, Table G.2-4-7, and Figures G.2-4-1 through G.2-4-18).

It is important to note that the CVP and SWP would operate in real-time to meet the Bay-Delta Plan chloride objectives, which aim to protect municipal and industrial beneficial uses. In September through December, the maximum mean daily chloride objectives of 250 mg/l would continue to apply at Contra Costa Pumping Plant #1, Banks and Jones pumping plants, and Barker Slough at North Bay Aqueduct. Also, the maximum mean daily chloride objective of 150 mg/l would continue to apply at Contra Costa Pumping Plant #1 for a certain number of days per year, depending on water year type. Thus, Alternative 3 would not contribute to municipal and industrial beneficial uses of Delta waters impairment.

Table G-52. Monthly Average Chloride (in milligrams per liter) at Delta Assessment Locations for the Full Simulation Period under Alternative 3, and Difference from the No Action Alternative

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
BARKER SLOUGH AT NORTH BAY AQUEDUCT												
Full Simulation Period Average	22	23	23	29	32	28	29	20	16	14	15	22
Difference from NAA	0	0	1	2	2	2	2	1	0	0	0	0
BANKS PUMPING PLANT												
Full Simulation Period Average	67	84	87	77	70	67	58	49	58	57	50	52
Difference from NAA	-23	-7	-21	-11	0	5	4	5	11	3	-19	-42
JONES PUMPING PLANT												
Full Simulation Period Average	72	89	90	81	74	71	59	51	60	59	54	56
Difference from NAA	-20	-8	-17	-9	0	5	3	5	9	-1	-20	-38
SAN JOAQUIN RIVER AT ANTIOCH												
Full Simulation Period Average	824	894	429	164	65	49	78	145	276	437	496	637
Difference from NAA	-194	-223	-273	-180	-61	-27	-49	-83	-108	-153	-395	-417
CONTRA COSTA WATER DISTRICT PUMPING PLANT #1												
Full Simulation Period Average	62	91	99	61	48	49	58	55	40	36	35	38
Difference from NAA	-41	-22	-47	-31	-9	13	19	16	3	-13	-35	-58

NAA = No Action Alternative.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Suisun Marsh

Suisun Marsh also is not designated for municipal and domestic supply uses, and other salinity-related effects in the marsh are addressed above in the EC discussion.

Suisun Bay and San Francisco Bay

Because Suisun Bay and San Francisco Bay are not designated for municipal and domestic supply use, and seawater is the primary source of chloride in the western Delta, changes in chloride concentrations in the Delta outflow to the bays are not of concern in these water bodies relative to drinking water supplies or other beneficial uses.

Effects on Bromide

Attachment G.3 provides tables and figures presenting modeled bromide concentrations at the Delta assessment locations for Alternative 3 relative to the No Action Alternative. Table G-53 presents the modeled monthly average bromide concentrations at the Delta assessment locations for Alternative 3 for the 100-year simulation period and the differences from the No Action Alternative.

Modeled monthly average bromide concentrations in Barker Slough at the North Bay Aqueduct under Alternative 3 are similar to those under the No Action Alternative (Table G-53; Attachment G.3, Table G.3-1-7, Figures G.3-1-1 through G.3-1-18).

Modeled monthly average chloride concentrations at Banks and Jones pumping plants under Alternative 3 are similar to or lower than concentrations under the No Action Alternative for the full simulation period and all water year types (Table G-53; Attachment G.3, Tables G.3-2-7 and G.3-3-7, Figures G.3-2-1 through G.3-3-18).

Modeled monthly average chloride concentrations at Contra Costa Pumping Plant #1 are somewhat higher in March through May and lower in July through February under Alternative 3 relative to the No Action Alternative for the full simulation period and all water year types (Table G-53; Attachment G.3, Table G.3-5-7, Figures G.3-5-1 through G.3-5-18).

Modeled monthly average chloride concentrations in the San Joaquin River at Antioch are substantially lower in all months under Alternative 3 relative to the No Action Alternative for the full simulation period and all water year types (Table G-53; Attachment G.3, Table G.3-4-7, Figures G.3-4-1 through G.3-4-18).

The overall lower bromide concentrations under Alternative 3 relative to the No Action Alternative would not result in greater potential for disinfection byproduct formation in drinking water supplies that use Delta source waters. The potentially higher bromide concentrations under Alternative 3 in some months could result in greater potential for disinfection byproduct formation in drinking water supplies that use Delta source waters. However, the degree to which this would occur is uncertain and bromide concentrations in all months and Delta locations that increase under Alternative 3, relative to the No Action Alternative, are below the 300 mg/L drinking water regulations for disinfection byproducts. Treatment plants that use the Delta as a source for drinking water already experience highly variable bromide concentrations (as described for Alternative 1) and, thus, must implement appropriate treatment technologies to ensure compliance with drinking water regulations for disinfection byproducts. Thus, despite the potential for somewhat higher bromide concentrations under the Alternative 3 in some months, Alternative 3 would not contribute to drinking water impairments related to bromide relative to those that would occur under the No Action Alternative.

Table G-53. Monthly Average Bromide (in micrograms per liter) at Delta Assessment Locations for the Full Simulation Period under Alternative 3, and Difference from the No Action Alternative

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
BARKER SLOUGH AT NORTH BAY AQUEDUCT												
Full Simulation Period Average	71	75	87	79	85	100	89	54	48	45	53	57
Difference from NAA	1	1	3	5	4	8	6	2	1	1	1	1
BANKS PUMPING PLANT												
Full Simulation Period Average	231	289	310	257	230	238	200	170	200	194	180	161
Difference from NAA	-79	-24	-71	-40	0	18	15	22	39	11	-63	-147
JONES PUMPING PLANT												
Full Simulation Period Average	249	309	320	271	244	252	205	175	206	203	192	178
Difference from NAA	-70	-26	-56	-31	2	17	12	20	33	-2	-67	-136
SAN JOAQUIN RIVER AT ANTIOCH												
Full Simulation Period Average	2884	3130	1503	575	228	172	272	507	966	1531	1735	2230
Difference from NAA	-678	-782	-956	-630	-214	-94	-173	-291	-380	-535	-1382	-1458
CONTRA COSTA WATER DISTRICT PUMPING PLANT #1												
Full Simulation Period Average	218	319	345	215	167	173	202	191	141	125	122	133
Difference from NAA	-142	-76	-165	-110	-31	46	67	56	11	-45	-124	-201

NAA = No Action Alternative.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Suisun Marsh

Suisun Marsh is not designated for municipal and domestic supply uses, and other salinity-related effects in the marsh are addressed above in the EC discussion.

Suisun Bay and San Francisco Bay

Because Suisun Bay and San Francisco Bay are not designated for municipal and domestic supply use, and seawater is the primary source of bromide in the western Delta, changes in bromide concentrations in the Delta outflow to the bays are not of concern in these water bodies relative to drinking water supplies or other beneficial uses.

Effects on Methylmercury

Delta

Attachment G.4 provides tables and figures presenting modeled total methylmercury concentrations at the Delta assessment locations for Alternative 3 relative to the No Action Alternative. Table G-54 and Table G-55 summarize the modeled average total methylmercury concentrations in water and fish tissues at the Delta assessment locations for Alternative 3 for the 100-year simulation period (1922–2021) and differences from the No Action Alternative.

Modeled long-term average water column concentrations of methylmercury in the Delta under Alternative 3 would be similar to those under the No Action Alternative at the Delta assessment locations (Table G-54). The modeled average aqueous total methylmercury concentrations for Alternative 3 do not differ from the No Action Alternative except for increases of 0.01 ng/L at Victoria Canal, Contra Costa Water District Pumping Plant #1, Banks Pumping Plant, and Jones Pumping Plant (Table G-54; Attachment G.4, Table G.4-16).

Modeled changes in water column concentrations of total methylmercury under Alternative 3 could have a measurable effect on Delta fish tissue concentrations relative to the No Action Alternative. All modeled fish tissue concentrations exceed the water quality objective of 0.24 mg/kg ww in 350 mm largemouth bass fillets under both the No Action Alternative and the Alternative 3 (Table G-55). Average concentrations for all years increased at all Delta locations by 0.01 to 0.08 mg/kg wet weight relative to the No Action Alternative (Table G-55; Attachment G.4, Table G.4-31), which indicates a substantial increase in the potential for methylmercury bioaccumulation in fish tissue.

Based on the modeled changes in total methylmercury concentrations at all Delta assessment locations described above, Alternative 3 may result in increased Delta methylmercury concentrations that could substantially degrade water quality or cause increased frequency of exceeding water quality objectives.

Table G-54. Modeled Total Methylmercury Concentrations in Water (in nanograms per liter) and Largemouth Bass Fillets (in milligrams per kilogram wet weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 3 and No Action Alternative

Assessment Location	**NAA (ng/L)**	**Alt3 (ng/L)**	**Alt3 minus NAA (ng/L)**
San Joaquin River at Empire Tract	0.14	0.14	0.00
Turner Cut	0.15	0.16	0.00
San Joaquin River at San Andreas Landing	0.12	0.12	0.00
San Joaquin River at Jersey Point	0.12	0.12	0.00
Victoria Canal	0.14	0.15	0.01
Sacramento River at Emmaton	0.12	0.12	0.00
San Joaquin River at Antioch	0.12	0.12	0.00
Montezuma Slough near Beldon Landing	0.13	0.13	0.00

Assessment Location	NAA (ng/L)	Alt3 (ng/L)	Alt3 minus NAA (ng/L)
Barker Slough at North Bay Aqueduct	0.13	0.13	0.00
Contra Costa Water District Pumping Plant #1	0.13	0.13	0.01
Banks Pumping Plant	0.14	0.15	0.01
Jones Pumping Plant	0.15	0.15	0.01

NAA = No Action Alternative; Alt3 = Alternative 3; ng/L = nanograms per liter.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Table G-55. Modeled Total Methylmercury Concentrations in Water (in nanograms per liter) and Largemouth Bass Fillets (in milligrams per kilogram wet weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 3 and No Action Alternative

Assessment Location	NAA (mg/kg ww)	Alt3 (mg/kg ww)	Alt3 minus NAA (mg/kg ww)
San Joaquin River at Empire Tract	0.78	0.82	0.04
Turner Cut	0.96	1.00	0.04
San Joaquin River at San Andreas Landing	0.61	0.63	0.02
San Joaquin River at Jersey Point	0.64	0.66	0.02
Victoria Canal	0.84	0.92	0.08
Sacramento River at Emmaton	0.60	0.61	0.01
San Joaquin River at Antioch	0.65	0.66	0.01
Montezuma Slough near Beldon Landing	0.73	0.74	0.01
Barker Slough at North Bay Aqueduct	0.74	0.75	0.01
Contra Costa Water District Pumping Plant #1	0.68	0.75	0.07
Banks Pumping Plant	0.83	0.90	0.07
Jones Pumping Plant	0.87	0.92	0.05

NAA = No Action Alternative; Alt3 = Alternative 3; mg/kg ww = milligrams per kilogram wet weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Suisun Marsh

Modeled long-term average water column concentrations of methylmercury in Suisun Marsh for the full simulation period, represented by the Montezuma Slough near Beldon Landing assessment location, would not increase under Alternative 3 relative to the No Action Alternative (Table G-54). Modeled fish tissue concentrations are 0.01 mg/kg ww (1%) higher under Alternative 1 (Table G-55). For this reason, and consistent with the discussion for Alternative 1, Alternative 3 would not contribute to additional water quality degradation with respect to water column methylmercury concentrations or increased methylmercury bioaccumulation in biota in Suisun Marsh as compared with the No Action Alternative.

Suisun Bay and San Francisco Bay

Alternative 3 would result in higher Delta outflow rates relative to the No Action Alternative in all months except June (Appendix F). The higher outflow rates could potentially result in increased methylmercury loads to Suisun Bay and San Francisco Bay. Thus, differences in methylmercury loading to Suisun Bay and San Francisco Bay that may occur under Alternative 3 could contribute to measurable water quality degradation with respect to water column methylmercury concentrations or increased bioaccumulation in biota in Suisun Bay and San Francisco Bay, as compared with the No Action Alternative.

Effects on Selenium

Delta

Attachment G.5 provides tables and figures presenting modeled selenium concentrations at the Delta assessment locations for Alternative 3 relative to the No Action Alternative. Table G-56 through Table G-62 summarize the modeled average total selenium concentrations in water, fish tissues, and bird tissues at the Delta assessment locations for Alternative 3 for the 100-year simulation period (1922–2021) and differences from the No Action Alternative.

Modeled long-term average water column concentrations of selenium in the Delta under Alternative 3 are similar to the No Action Alternative at all locations for all years (Table G-56; Attachment G.5, Table G.5-15, and Table G.5-26). Concentrations do not exceed the 5 µg/L CTR criterion and the same or greater than would occur under the No Action Alternative at the Delta assessment locations (Table G-56). Thus, Alternative 3 would not contribute to measurable water quality degradation with respect to selenium as compared with the No Action Alternative.

Modeled changes in water column concentrations of selenium under Alternative 3 for the full simulation period do not cause an increase in modeled Delta fish or bird tissue concentrations relative to the No Action Alternative. Concentrations in biota at all locations in the Delta under Alternative 3 are the same or lower than those modeled for the No Action Alternative for whole-body fish (Table G-57), fish fillets (Table G-58 and Table G-59), bird eggs [invertebrate diet] (Table G-60), bird eggs [fish diet] (Table G-61). Modeled whole fish selenium concentrations do not exceed the 8.5 mg/kg dry weight water quality criterion (U.S. Environmental Protection Agency 2021). Nor do modeled fish fillet selenium concentrations exceed the 11.3 mg/kg dry weight water quality criterion (U.S. Environmental Protection Agency 2021) or the 2.5 mg/kg ww advisory level for human consumption (California Office of Environmental Health Hazard Assessment 2008). Modeled bird eggs under Alternative 3 and the No Action Alternative do not exceed the 15.1 mg/kg dry weight water quality criterion (U.S. Environmental Protection Agency 2021). Thus, Alternative 3 would not result in increased health risks to wildlife or humans consuming wildlife associated with whole-body fish, bird eggs (invertebrate diet), bird eggs (fish diet), and fish fillets, as compared with the No Action Alternative.

Modeled selenium concentrations in whole-body sturgeon (*Acipenseridae*) in the western Delta under Alternative 3 are similar to or slightly greater than those modeled for the No Action Alternative (Table G-62). Concentrations at all western Delta locations are less than the North Bay TMDL target of 8 mg/kg dry weight in whole fish (San Francisco Bay Regional Water Quality Control Board 2015) for the entire period modeled. Thus, Alternative 3 would not result in measurable increases in health risks to sturgeon, as compared with the No Action Alternative.

Table G-56. Modeled Selenium Concentrations in Water (in micrograms per liter) at Delta Assessment Locations for the Full Simulation Period, Alternative 3 and No Action Alternative

Assessment Location	NAA (μg/L)	Alt3 (μg/L)	Alt3 minus NAA (μg/L)
San Joaquin River at Empire Tract	0.13	0.15	0.02
Turner Cut	0.22	0.24	0.02
San Joaquin River at San Andreas Landing	0.09	0.09	0.00
San Joaquin River at Jersey Point	0.09	0.10	0.01
Victoria Canal	0.15	0.17	0.02
Sacramento River at Emmaton	0.09	0.09	0.00
San Joaquin River at Antioch	0.10	0.10	0.00
Montezuma Slough near Beldon Landing	0.10	0.10	0.00
Barker Slough at North Bay Aqueduct	0.09	0.09	0.00
Contra Costa Water District Pumping Plant #1	0.11	0.13	0.02
Banks Pumping Plant	0.19	0.22	0.03
Jones Pumping Plant	0.21	0.24	0.03

NAA = No Action Alternative; Alt3 = Alternative 3; μg/L = micrograms per liter.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Table G-57. Modeled Selenium Concentrations in Whole-Body Fish (in milligram per kilogram dry weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 3 and No Action Alternative

Assessment Location	NAA (mg/kg dw)	Alt3 (mg/kg dw)	Alt3 minus NAA (mg/kg dw)
San Joaquin River at Empire Tract	1.81	1.81	0.00
Turner Cut	1.80	1.80	0.00
San Joaquin River at San Andreas Landing	1.82	1.82	0.00
San Joaquin River at Jersey Point	1.82	1.82	0.00
Victoria Canal	1.81	1.81	0.00
Sacramento River at Emmaton	1.82	1.82	0.00
San Joaquin River at Antioch	1.82	1.82	0.00
Montezuma Slough near Beldon Landing	1.82	1.82	0.00
Barker Slough at North Bay Aqueduct	1.82	1.82	0.00
Contra Costa Water District Pumping Plant #1	1.82	1.81	-0.01
Banks Pumping Plant	1.81	1.81	0.00
Jones Pumping Plant	1.81	1.80	-0.01

NAA = No Action Alternative; Alt3 = Alternative 3; mg/kg dw = milligram per kilogram dry weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Table G-58. Modeled Selenium Concentrations in Skinless Fish Fillets (in milligram per kilogram dry weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 3 and No Action Alternative

Assessment Location	NAA (mg/kg dw)	Alt3 (mg/kg dw)	Alt3 minus NAA (mg/kg dw)
San Joaquin River at Empire Tract	2.00	2.00	0.00
Turner Cut	1.99	1.99	0.00
San Joaquin River at San Andreas Landing	2.02	2.02	0.00
San Joaquin River at Jersey Point	2.02	2.02	0.00
Victoria Canal	2.00	2.00	0.00
Sacramento River at Emmaton	2.02	2.02	0.00
San Joaquin River at Antioch	2.02	2.02	0.00
Montezuma Slough near Beldon Landing	2.02	2.02	0.00
Barker Slough at North Bay Aqueduct	2.02	2.02	0.00
Contra Costa Water District Pumping Plant #1	2.02	2.00	-0.02
Banks Pumping Plant	2.00	2.00	0.00
Jones Pumping Plant	2.00	1.99	-0.01

NAA = No Action Alternative; Alt3 = Alternative 3; mg/kg dw = milligram per kilogram dry weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Table G-59. Modeled Selenium Concentrations in Skinless Fish Fillets (in milligram per kilogram wet weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 3 and No Action Alternative

Assessment Location	NAA (mg/kg ww)	Alt3 (mg/kg ww)	Alt3 minus NAA (mg/kg ww)
San Joaquin River at Empire Tract	0.60	0.60	0.00
Turner Cut	0.60	0.60	0.00
San Joaquin River at San Andreas Landing	0.61	0.61	0.00
San Joaquin River at Jersey Point	0.61	0.61	0.00
Victoria Canal	0.60	0.60	0.00
Sacramento River at Emmaton	0.61	0.61	0.00
San Joaquin River at Antioch	0.61	0.61	0.00
Montezuma Slough near Beldon Landing	0.61	0.61	0.00
Barker Slough at North Bay Aqueduct	0.61	0.61	0.00
Contra Costa Water District Pumping Plant #1	0.61	0.60	-0.01
Banks Pumping Plant	0.60	0.60	0.00
Jones Pumping Plant	0.60	0.60	0.00

NAA = No Action Alternative; Alt3 = Alternative 3; mg/kg dw = milligram per kilogram wet weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Table G-60. Modeled Selenium Concentrations in Bird Eggs, Invertebrate Diet (in milligram per kilogram dry weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 3 and No Action Alternative

Assessment Location	NAA (mg/kg dw)	Alt3 (mg/kg dw)	Alt3 minus NAA (mg/kg dw)
San Joaquin River at Empire Tract	2.70	2.70	0.00
Turner Cut	2.69	2.68	-0.01
San Joaquin River at San Andreas Landing	2.71	2.71	0.00
San Joaquin River at Jersey Point	2.71	2.71	0.00
Victoria Canal	2.70	2.69	-0.01
Sacramento River at Emmaton	2.71	2.71	0.00
San Joaquin River at Antioch	2.71	2.71	0.00
Montezuma Slough near Beldon Landing	2.71	2.71	0.00
Barker Slough at North Bay Aqueduct	2.71	2.71	0.00
Contra Costa Water District Pumping Plant #1	2.70	2.70	0.00
Banks Pumping Plant	2.69	2.69	0.00
Jones Pumping Plant	2.69	2.68	-0.01

NAA = No Action Alternative; Alt3 = Alternative 3; mg/kg dw = milligram per kilogram dry weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Table G-61. Modeled Selenium Concentrations in Bird Eggs, Fish Diet (in milligram per kilogram dry weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 3 and No Action Alternative

Assessment Location	NAA (mg/kg dw)	Alt3 (mg/kg dw)	Alt3 minus NAA (mg/kg dw)
San Joaquin River at Empire Tract	3.26	3.26	0.00
Turner Cut	3.24	3.24	0.00
San Joaquin River at San Andreas Landing	3.28	3.28	0.00
San Joaquin River at Jersey Point	3.28	3.28	0.00
Victoria Canal	3.26	3.26	0.00
Sacramento River at Emmaton	3.28	3.28	0.00
San Joaquin River at Antioch	3.28	3.28	0.00
Montezuma Slough near Beldon Landing	3.28	3.28	0.00
Barker Slough at North Bay Aqueduct	3.28	3.28	0.00
Contra Costa Water District Pumping Plant #1	3.28	3.26	-0.02
Banks Pumping Plant	3.26	3.26	0.00
Jones Pumping Plant	3.26	3.24	-0.02

NAA = No Action Alternative; Alt3 = Alternative 3; mg/kg dw = milligram per kilogram dry weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Table G-62. Modeled Selenium Concentrations in Whole Sturgeon (in milligram per kilogram dry weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 3 and No Action Alternative

Assessment Location	NAA (mg/kg dw)	Alt3 (mg/kg dw)	Alt3 minus NAA (mg/kg dw)
Sacramento River at Emmaton	0.72	0.74	0.02
San Joaquin River at Antioch	3.82	3.99	0.17
Montezuma Slough near Beldon Landing	3.97	4.03	0.06

NAA = No Action Alternative; Alt3 = Alternative 3; mg/kg dw = milligram per kilogram dry weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Suisun Marsh

Modeled long-term average selenium concentrations in Suisun Marsh are represented by the Montezuma Slough near Beldon Landing assessment location. Water column selenium, whole fish, fillets, and bird egg modeled concentrations for the full simulation period at this location do not increase under Alternative 3, relative to the No Action Alternative (Table G-56 through Table G-61), and modeled concentrations in whole sturgeon increase by less than 5% (Table G-62). Thus, Alternative 3 would not contribute to increased water quality degradation with respect to water column selenium concentrations or measurable changes in selenium bioaccumulation in biota in Suisun Marsh as compared with the No Action Alternative.

Suisun Bay and San Francisco Bay

Long-term average water column selenium concentrations in the western Delta under Alternative 3 would be the same as those that would occur under the No Action Alternative (Table G-56) and would not exceed the North Bay TMDL the water column selenium target of 0.5 µg/L (San Francisco Bay Regional Water Quality Control Board 2015). Alternative 3 would also result in higher Delta outflow rates relative to the No Action Alternative, in all months except June (Appendix F). However, because water concentrations do not increase, Alternative 3 would not contribute to additional water quality degradation with respect to water column selenium concentrations or increased selenium bioaccumulation in biota in Suisun Bay and San Francisco Bay, as compared with the No Action Alternative.

Effects on Organic Carbon

Delta

Attachment G.6 provides tables and figures presenting modeled dissolved organic carbon concentrations at the Delta assessment locations for Alternative 3 relative to the No Action Alternative. Table G-63 presents the modeled monthly average dissolved organic carbon concentrations at the Delta assessment locations for Alternative 3 for the 100-year simulation period and the differences from the No Action Alternative.

Under Alternative 3, monthly average dissolved organic carbon concentrations at Delta assessment locations would be similar to, less than, or greater than concentrations under the No Action Alternative for both the full simulation period (1922–2021) and the drought period (1987–1991), depending on month and location (Table G-63; Attachment G.6, Tables G.6-1-7, G.6-2-7, G.6-3-7, G.6-4-7, and G.6-5-7, Figures G.6-1-1 through G.6-5-14).

In Barker Slough at the North Bay Aqueduct, modeled monthly average dissolved organic carbon concentrations under Alternative 3 are similar to those under the No Action Alternative for all months of the full simulation period (Table G-63; Attachment G.6, Table G.6-1-7). At Banks and Jones pumping plants, modeled monthly average dissolved organic carbon concentrations are 0.1–0.7 mg/L higher in June through January and 0.2–0.3 mg/L lower in February, April, and May (Table G-63; Attachment G.6, Tables G.6-2-7 and G.6-3-7). In the San Joaquin River at Antioch, modeled monthly average dissolved organic carbon concentrations are 0.1–0.3 mg/L higher than the No Action Alternative in December through September, and similar to the No Action Alternative in October and November (Table G-63; Attachment G.6, Table G.6-4-7).

The greatest increases in dissolved organic carbon concentrations at the Delta assessment locations were modeled to occur at Contra Costa Pumping Plant #1 (Table G-63). Modeled monthly average dissolved organic carbon concentrations are 0.1–0.6 mg/L higher under for the full simulation period, depending on month (Table G-63; Attachment G.6, Table G.6-5-7). The greatest increases were modeled to occur in April, May, and June of the drought period (Attachment G.6, Table G.6-5-7, Figures G.6-5-2, G.6-5-7, G.6-5-8).

As explained for Alternative 1, a California Urban Water Agencies expert panel convened to review Delta water quality and disinfection formation potential found that total organic carbon concentrations ranging from 4 to 7 mg/L would allow continued flexibility in treatment technology necessary to achieve existing drinking water criteria for disinfection byproducts (California Urban Water Agencies 1998:ES-2). Furthermore, drinking water treatment plants that utilize Delta source waters are currently designed and operated to meet existing drinking water criteria for disinfection byproducts based on the ambient concentrations or organic carbon and the seasonal variability that currently exists in the Delta. Therefore, substantial increases in ambient dissolved organic carbon concentrations would need to occur with substantial frequency for significant changes in plant design or operations to be triggered.

Based on the modeling results, any increases in average dissolved organic carbon concentrations that may occur with Alternative 3 in Barker Slough at the North Bay Aqueduct, Banks and Jones pumping plants, and the San Joaquin River at Antioch would be of sufficiently small magnitude that modifications to existing drinking water treatment plants to employ additional organic carbon removals would not be necessary. The increases in dissolved organic carbon concentrations at Contra Costa Pumping Plant #1 are more substantial, but still may not rise to the level of requiring additional organic carbon removal given the existing range of total organic carbon concentrations in the Delta.

Based upon the above findings, Alternative 3 would not result in increased Delta dissolved organic carbon concentrations that would substantially degrade water quality or cause increased frequency of exceeding water quality objectives (because none exist) relative to the No Action Alternative.

Table G-63. Monthly Average Dissolved Organic Carbon (in milligrams per liter) at Delta Assessment Locations for the Full Simulation Period under Alternative 3, and Difference from the No Action Alternative

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
BARKER SLOUGH AT NORTH BAY AQUEDUCT												
Full Simulation Period Average	2.3	2.5	2.9	3.1	3.3	3.3	3.1	2.7	2.4	2.3	2.3	2.3
Difference from NAA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BANKS PUMPING PLANT												
Full Simulation Period Average	3.2	3.3	4.1	5.0	5.1	5.0	4.1	3.8	4.3	4.0	3.7	3.4
Difference from NAA	0.1	0.2	0.2	0.1	-0.2	0.1	-0.3	-0.3	0.5	0.7	0.5	0.2
JONES PUMPING PLANT												
Full Simulation Period Average	3.2	3.4	4.1	5.1	5.0	4.9	4.0	3.7	4.2	4.0	3.7	3.4
Difference from NAA	0.1	0.1	0.2	0.1	-0.2	0.0	-0.2	-0.3	0.4	0.6	0.4	0.2
SAN JOAQUIN RIVER AT ANTIOCH												
Full Simulation Period Average	2.3	2.6	3.1	3.6	3.9	3.8	3.6	3.3	3.0	2.7	2.6	2.5
Difference from NAA	0.0	0.0	0.1	0.1	0.2	0.2	0.1	0.2	0.2	0.3	0.2	0.1
CONTRA COSTA WATER DISTRICT PUMPING PLANT #1												
Full Simulation Period Average	2.6	2.9	3.7	4.6	5.5	5.3	5.1	4.6	3.9	3.4	3.1	2.9
Difference from NAA	0.1	0.1	0.2	0.3	0.5	0.3	0.4	0.6	0.6	0.5	0.4	0.2

NAA = No Action Alternative.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Suisun Marsh

For the same reasons described for Alternative 1, Alternative 3 would not result in differences in organic carbon concentrations in Suisun Marsh that would contribute to adverse effects on organic enrichment conditions within the marsh.

Suisun Bay and San Francisco Bay

Alternative 3 would result in higher Delta outflow rates, relative to the No Action Alternative, in all months except June (Appendix F). The higher outflow rates could potentially result in increased total organic carbon and dissolved organic carbon loads to Suisun Bay and San Francisco Bay. For the reasons described for Alternative 1, the differences in organic carbon loading to Suisun Bay and San Francisco Bay under Alternative 3 would not be expected to contribute to adverse effects on the food web in the bays.

Effects on Trace Metals

For the same reasons described for Alternative 1, Alternative 3 would not affect existing Delta impairments related to trace metals and would not result in additional trace metals-related impairments in the Delta, Suisun Bay and Marsh, or San Francisco Bay relative to the No Action Alternative.

Effects on Nutrients

For the same reasons described for Alternative 1, Alternative 3 would not contribute to different Delta nutrient concentrations or nutrient distributions that would result in adverse effects on beneficial uses or substantially degrade the water quality, relative to nutrient conditions that would occur under the No Action Alternative. Furthermore, any potential differences in total nitrogen and phosphorus loading that would occur in Delta outflow to Suisun Bay and Marsh, and San Francisco Bay, relative to the No Action Alternative, are not expected to result in water quality degradation with regard to nutrients that would result in adverse effects on beneficial uses or the further impairment of Suisun Bay and Marsh, or San Francisco Bay.

Effects on Dissolved Oxygen

For the same reasons described for Alternative 1, Alternative 3 would not substantially affect DO concentrations in the Delta, Suisun Bay and Marsh, or San Francisco Bay, or make existing DO impairments in the Delta and Suisun Marsh worse relative to the No Action Alternative.

Effects on Legacy Contaminants

For the same reasons described for Alternative 1, Alternative 3 would not substantially affect levels of legacy contaminants (e.g., dioxin and furan compounds, PCBs, and PAHs) in the Delta, Suisun Bay and Marsh, or San Francisco Bay relative to the No Action Alternative.

Effects on Pesticides

For the same reasons described for Alternative 1, Alternative 3 would not substantially affect pesticide concentrations in the Delta, Suisun Bay and Marsh, or San Francisco Bay relative to the No Action Alternative.

Effects on CHABs

<u>Delta</u>

Alternative 3 would result in substantial reductions in Sacramento River flows at Freeport and San Joaquin River flows at Vernalis entering the Delta relative to the No Action Alternative. For the full period of record modeled, Alternative 3 would have an average reduction of combined Sacramento River and San Joaquin River flows of 10%–28% during the months June through September, with the 28% flow reduction occurring in July. Average combined river flows in October and November are relatively similar to those for the No Action Alternative. (Table G-64).

Table G-64. Percent Difference in Flow in the Sacramento River at Freeport, the San Joaquin River at Vernalis, and for the Combined Flow of these Rivers for Alternative 3 Relative to Flows for the No Project Alternative for the Period of Record Modeled

Month	Sacramento River Flow Change (%)	San Joaquin River Flow Change (%)	Combined River Flow Change (%)
June	-21	-4	-18
July	-29	-20	-28
August	-16	-16	-16
September	-10	-13	-10
October	-4	-7	-5
November	-2	-5	-2

Source: CalSim 3.0 modeling output.

Substantially lower Delta inflows, relative to the No Action Alternative, for the months June through September also occur for Alternative 3 in wet years (16%–30%) and above normal years (16%–43%). In below normal years, average combined river flows for Alternative 3 would be 25% lower in June, 40% lower in July, and 18% lower in August, and 0–6% lower in the months September through November, relative to the No Action Alternative. In dry water years, average combined river flows for Alternative 3 would be 19% lower in June, 20% lower in July, 16% higher in August, and only 1% different in the months September through November, relative to the No Action Alternative. In critical years, combined river flows would increase by 11% in June and July, increase by 15% in August, and be reduced 3%–6% September through November, relative to the No Action Alternative.

The substantial flow reductions that would occur for Alternative 3, relative to the No Action Alternative, for the months June and July in all but critical water years types; June through August for wet, above normal, and below normal years; and in June and July of dry years would be expected to increase residence time throughout many locations within the Delta. This effect of reduced flows entering the Delta and increased residence times within the Delta could also cause increased Delta water temperatures at some Delta locations in some months of the June through September period. The substantial reductions in flows entering the Delta from the Sacramento River and San Joaquin River may also result in reduced turbulence and mixing of water in the channels within the Delta, relative to that for the No Action Alternative. This would create a calmer water column favored by cyanobacteria. With regard to nutrients and water clarity and associated irradiance, Alternative 3 would result in minimal changes relative to the No Action Alternative.

Alternative 3 would result in substantial reductions in Sacramento River flows entering the Delta at Freeport and San Joaquin River flows entering the Delta at Vernalis. The expected effect would be a substantial increase in residence time at many Delta locations with a likely less substantial, but still important, effect on increasing Delta water temperatures. The increase in water temperatures would be expected to make CHABs worse in the Delta. CHABs could occur more frequently and reach larger magnitudes due to increased Delta residence times, increased Delta water temperatures, and reduced Delta channel turbulence and mixing. Based on these findings, Alternative 3 would result in an adverse effect to Delta CHABs.

Suisun Marsh, Suisun Bay, or San Francisco Bay

Because Alternative 3 is expected to make CHABs worse in the Delta, greater volumes of cyanobacteria cells would be expected to flow from the Delta into Suisun Marsh, relative to the No Action Alternative. Also, salinity is typically sufficiently low within the eastern portion of the marsh to allow CHABs to form. Consequently, Alternative 3 could adversely affect CHABs in Suisun Marsh. However, because of higher salinity levels in Suisun Bay and San Fransico Bay that typically prevent *Microcystis* and other cyanobacteria common to the Delta from producing problematic blooms in these water bodies, Alternative 3 is not expected to adversely affect CHABs in Suisun Bay or San Fransico Bay.

CVP and SWP Service Areas (south to Diamond Valley)

Alternative 3 would generally result in higher monthly average chloride concentrations, particularly in the months of March through July in all water year types. Since this water is delivered to reservoirs for storage in CVP and SWP reservoirs, chloride concentrations in these reservoirs may increase. While there would be higher chloride concentrations under Alternative 3 relative to the No Action Alternative, the CVP and SWP would continue real-time operation in some months to meet the Bay-Delta Plan objectives for chloride. In March through July, when chloride would be higher than the No Action Alternative, the maximum mean daily chloride objectives of 250 mg/L would continue to apply at Contra Costa Pumping Plant #1, Banks and Jones pumping plants, and Barker Slough at North Bay Aqueduct (State Water Resources Control Board 2018b). Also, the maximum mean daily chloride objective of 150 mg/L would continue to apply at Contra Costa Pumping Plant #1 or San Joaquin River at Antioch for a certain number of days per year, depending on water year type (State Water Resources Control Board 2018b). Thus, Alternative 3 would not contribute to impairment of municipal and industrial beneficial uses in the CVP and SWP service area.

G.2.6 Alternative 4

G.2.6.1 Potential Changes in Surface Water Quality Conditions

Trinity and Klamath Rivers

Operations in the Trinity River under Alternative 4 would remain similar to those under the No Action Alternative. The maximum average increase in flows is modeled during March of below normal water year types, when flows are expected to increase by approximately 4%. The maximum average decrease in flows is modeled during December of below normal water year types, when flows are expected to decrease by approximately 12%. Figure G-8 through Figure G-13 illustrate flow changes. Increases in flow would be considered beneficial based on the improvement of water quality through dilution of constituents of concern. The evaluation does not expect decreases in flow to be a large enough magnitude to affect water quality.

Sacramento River

Changes in flow under Alternative 4 compared with the No Action Alternative in the Sacramento River would be similar to those seen under Alternatives 1-3, with increases in late winter and early spring and decreases during the summer months. Under Alternative 4, average flows could decrease a maximum of 11% during May of critical water years and increase a maximum of 18% during November of critical water years when compared with the No Action Alternative. Figure G-14 through Figure G-19 illustrate flow changes. Flow increases are beneficial to water quality because they dilute constituents of concern. Flow decreases would be relatively small and expected to not negatively affect water quality or increase the frequency of water quality thresholds exceedances in the Sacramento River.

Clear Creek

Under all water year types, flows in Clear Creek are expected to increase in the winter and spring under Alternative 4. The maximum change in flows is expected to occur during critical water years, when the maximum average change in flows is expected to increase by approximately 54% and the maximum decrease in flows is expected to be approximately 38%. Figures G.2-37 through G.2-42 illustrate changes in flow under Alternative 4. The analysis considers flow increases beneficial to water quality because they make more water available to dilute constituents of concern (i.e., mercury). Reductions in flow due to changes in the operations of CVP and SWP under Alternative 4 could result in less dilution causing increased concentrations of mercury within Clear Creek in certain months and year types compared with the No Action Alternative.

Lower American River

Lower American River flows under Alternative 4 would vary slightly from those under the No Action Alternative because the American River would be operated the same as the No Action Alternative other than the operation of a new Automated Temperature Selection Procedure. Based on modeling, the maximum average increase in flows on the American River at H Street would be during July of critical water years, when flows are expected to increase by 22%. The maximum average decrease in flows would be during March of critical water years, when flows are expected to decrease by 16%. Figure G-26 through Figure G-31 illustrate flow changes on the American River at H Street. Changes in flow below Nimbus Dam follow a similar trend but are generally smaller. Reductions in flow due to changes in the operations of CVP and SWP under Alternative 4 could result in less dilution causing increased concentrations of constituents of concern within the lower American River compared with the No Action Alternative.

Stanislaus River

Changes in flow under Alternative 4 would be similar to those seen under Alternative 2 because Alternative 4 includes the same minimum instream flow requirements, winter instability flows, and fall pulse flows. Stanislaus River flows below Goodwin Dam are expected to have a maximum increase of approximately 59% during June of critical water years and a maximum decrease by approximately 26% during January of above normal water years compared with the No Action Alternative. Figure G-32 through Figure G-37 show changes in flow below Goodwin Dam. Changes in flow at the mouth of Stanislaus River follow a similar trend but are generally smaller. While the evaluation considers a decrease in flows harmful to water quality because it reduces the dilution of constituents of concern, changes in flows are small enough and at times of year that they would not be expected to result in more water quality thresholds exceedances in Stanislaus River.

San Joaquin River

The greatest flow change in the San Joaquin River would be below Sack Dam, where flows would decrease by a maximum of 4%. Appendix F presents flow change trends at all sampling locations along the San Joaquin River, including changes in the San Joaquin River below Sack Dam. As shown, changes in flow at Vernalis, at Gravelly Ford, and below the confluence with the Merced River follow a similar trend but are generally smaller compared with changes below Sack Dam. The small change in flow under Alternative 4 would not likely result in adverse effects on water quality nor an increase in frequency of exceedances of water quality thresholds in the San Joaquin River.

Bay-Delta

Alternative 4 would result in some differences in Sacramento and San Joaquin Rivers inflow rates to the Delta, Delta outflows, and south Delta exports, relative to the No Action Alternative. These differences could result in changes in the proportion of Delta source waters (i.e., Sacramento River, San Joaquin River, San Francisco Bay, eastside tributaries) at various Delta locations. The water proportion differences may result in water quality differences relative to the No Action Alternative at various Delta locations, Suisun Marsh, and outflow to Suisun Bay and San Francisco Bay. The following sections discuss effects of Alternative 4 on EC, chloride, bromide, methylmercury, selenium, organic carbon, trace metals, nutrients, DO, legacy contaminants, pesticides, and CHABs.

Effects on Electrical Conductivity

<u>Delta</u>

Attachment G.1 provides tables and figures presenting modeled EC levels at the Delta assessment locations for Alternative 4 relative to the No Action Alternative. Table G-65 presents the modeled monthly average EC levels at the Delta assessment locations for Alternative 4 for the 100-year simulation period and the differences from the No Action Alternative.

Modeled monthly average EC levels at all Delta assessment locations for Alternative 4 are similar to the No Action Alternative for the full simulation period (Table G-65; Attachment G.1, Tables G.1-1-8, G.1-2-8, G.1-3-8, G.1-4-8, G.1-5-8, G.1-6-8, G.1-7-8, G.1-8-8, G.1-9-8, G.1-10-8, and G.1-11-8, and Figures G.1-1-1 through G.1-11-18).

Modeled monthly average EC levels at the Banks and Jones pumping plants for Alternative 3 are also similar to the No Action Alternative for the full simulation period (Table G-65; Attachment G.1, Tables G.1-17-8 and G.1-18-8, and Figures G.1-17-1 through G.1-18-6).

In real time, the CVP and SWP would continue to be operated to meet the Bay-Delta Plan objectives for EC. The objectives are for protecting agricultural, and fish and wildlife beneficial uses. The western Delta EC objectives for the Sacramento River at Emmaton and San Joaquin River at Jersey Point for agricultural beneficial use protection apply from April through June, July, or August, depending on water year type (State Water Resources Control Board 2018b). The San Joaquin River at Jersey Point objective for fish and wildlife protection also applies during April and May (State Water Resources Control Board 2018b). During these months, the monthly average EC levels under Alternative 3 would be similar to the No Action Alternative (Attachment G.1, Figures G.1-2-1 through G.1-2-18, G.1-9-1 through G.1-9-18). The southern Delta EC objectives for the protection of agricultural uses for the San Joaquin River at Vernalis and the export area for Banks and Jones pumping plant apply year-round. Based on the modeled differences in EC at the Delta assessment locations, Alternative 3 would not contribute to agricultural or fish and wildlife beneficial use impairments in the Delta relative to the No Action Alternative.

Table G-65. Monthly Average Electrical Conductivity (in micromhos per centimeter) at Delta Assessment Locations for the Full Simulation Period under Alternative 4, and Difference from the No Action Alternative

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
SOUTH FORK MOKELUMNE RIVER AT TERMINOUS												
Full Simulation Period Average	188	194	207	210	217	211	201	191	188	185	186	183
Difference from NAA	0	-1	0	0	0	0	-1	-1	0	0	0	0
SAN JOAQUIN RIVER AT JERSEY POINT												
Full Simulation Period Average	1114	1309	1073	597	356	265	274	339	419	667	976	1178
Difference from NAA	21	-5	-67	-34	5	4	-1	-3	-6	-6	17	21
SAN JOAQUIN RIVER AT PRISONERS POINT												
Full Simulation Period Average	330	364	433	348	296	269	274	248	236	247	280	309
Difference from NAA	4	0	-19	-10	-3	-1	-7	-10	-2	-1	4	4
SAN JOAQUIN RIVER AT SAN ANDREAS LANDING												
Full Simulation Period Average	370	402	438	314	245	221	225	229	226	247	292	328
Difference from NAA	5	-3	-21	-12	0	0	-3	-5	-1	-1	4	4
SAN JOAQUIN RIVER AT VERNALIS												
Full Simulation Period Average	624	712	681	625	568	588	450	401	494	574	580	584
Difference from NAA	0	0	-1	1	-4	-2	2	3	2	0	-2	-2
SAN JOAQUIN RIVER AT BRANDT BRIDGE												
Full Simulation Period Average	622	707	685	631	572	587	459	406	492	571	582	586
Difference from NAA	0	0	0	1	-4	-2	2	3	2	0	-2	-2
OLD RIVER NEAR MIDDLE RIVER												
Full Simulation Period Average	624	710	686	633	576	591	458	407	495	575	584	587
Difference from NAA	0	0	-1	1	-4	-2	2	3	2	0	-2	-2
OLD RIVER AT TRACY BRIDGE												
Full Simulation Period Average	622	705	700	657	604	607	477	419	482	524	523	550
Difference from NAA	0	1	-1	1	-4	-2	1	3	0	1	2	2

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
SACRAMENTO RIVER AT EMMATON												
Full Simulation Period Average	1796	1711	908	510	288	259	355	489	756	924	1426	1745
Difference from NAA	24	-25	-32	-27	9	8	-3	-2	6	3	13	6
SACRAMENTO RIVER AT RIO VISTA												
Full Simulation Period Average	304	302	240	207	191	189	195	202	228	238	277	293
Difference from NAA	2	-4	-4	-3	1	1	-1	-2	1	0	4	1
SACRAMENTO RIVER AT THREEMILE SLOUGH												
Full Simulation Period Average	877	825	480	313	225	212	251	299	418	483	705	843
Difference from NAA	11	-14	-16	-14	4	3	-3	-5	3	2	12	2
BANKS PUMPING PLANT												
Full Simulation Period Average	473	486	612	559	485	468	429	371	349	341	372	428
Difference from NAA	3	3	-7	-6	-13	-5	-3	-9	1	2	5	6
BANKS PUMPING PLANT												
Full Simulation Period Average	504	536	623	574	506	489	443	380	371	381	407	455
Difference from NAA	3	3	-7	-5	-10	-3	-2	-7	1	2	5	5

NAA = No Action Alternative.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Suisun Marsh

Attachment G.1 provides tables and figures presenting modeled EC levels at the Suisun Marsh assessment locations for Alternative 1 relative to the No Action Alternative. Table G-66 presents the modeled monthly average EC levels at the Suisun Marsh assessment locations for Alternative 4 for the 100-year simulation period and the differences from the No Action Alternative.

As discussed for Alternative 1, October through May is the period when Bay-Delta Plan EC objectives for protection of Suisun Marsh fish and wildlife apply; thus, the discussion of effects of Alternative 4 on EC is focused on changes during these months. Modeled monthly average EC levels are in October through May under Alternative 4 are similar to EC levels under the No Action Alternative for the full simulation period and across water year types (Table G-66; Attachment G.1, Figures G.1-12-1 through G.1-16-6). Therefore, Alternative 4 would not contribute to adverse effects on Suisun Marsh beneficial uses or contribute to additional salinity-related impairment.

Suisun Bay and San Francisco Bay

Alternative 4 would result in Delta outflow rates similar to those under the No Action Alternative (Appendix F). Differences in Delta EC and outflow could cause the freshwater-seawater salinity gradient within Suisun Bay and the northern portion of San Francisco Bay to be different between Alternative 4 and the No Action Alternative. However, Alternative 4 is not expected to result in substantial changes in overall salinity conditions within Suisun Bay and San Francisco Bay, because seawater is the predominant source of salinity in the bays.

Table G-66. Monthly Average Electrical Conductivity (in millimhos per centimeter) at Suisun Marsh Assessment Locations for the Full Simulation Period under Alternative 4, and Difference from the No Action Alternative

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
SACRAMENTO RIVER AT COLLINSVILLE												
Full Simulation Period Average	6.7	6.8	4.0	2.1	1.0	0.8	1.2	2.0	3.2	4.2	5.9	6.8
Difference from NAA	0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
MONTEZUMA SLOUGH AT NATIONAL STEEL												
Full Simulation Period Average	7.1	7.3	4.5	2.4	1.1	1.0	1.6	2.6	4.3	5.6	7.6	7.4
Difference from NAA	-0.3	-0.2	-0.2	0.0	0.0	0.0	0.0	0.1	0.1	0.3	0.4	-0.2
MONTEZUMA SLOUGH NEAR BELDON LANDING												
Full Simulation Period Average	8.1	8.3	5.6	3.1	1.6	1.6	2.5	3.8	6.0	7.5	9.6	8.6
Difference from NAA	-0.7	-0.3	-0.3	0.0	0.1	0.0	0.1	0.2	0.2	0.6	0.8	-0.6
CHADBOURNE SLOUGH NEAR SUNRISE DUCK CLUB												
Full Simulation Period Average	9.7	9.8	7.7	5.0	3.3	3.1	3.8	5.0	7.1	9.0	10.7	10.6
Difference from NAA	-0.4	-0.2	-0.3	-0.1	0.0	0.0	0.0	0.2	0.2	0.7	1.1	0.1
SUISUN SLOUGH 300 FEET SOUTH OF VOLANTI SLOUGH												
Full Simulation Period Average	8.9	8.9	7.1	4.5	2.8	2.4	3.0	4.1	6.0	7.8	9.6	9.6
Difference from NAA	-0.6	-0.3	-0.3	-0.1	0.0	0.0	0.0	0.2	0.2	0.6	1.0	0.0

NAA = No Action Alternative.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Effects on Chloride

Attachment G.2 provides tables and figures presenting modeled chloride concentrations at the Delta assessment locations for Alternative 4 relative to the No Action Alternative. Table G-67 presents the modeled monthly average chloride concentrations at the Delta assessment locations for Alternative 4 for the 100-year simulation period and the differences from the No Action Alternative.

Modeled monthly average chloride concentrations in Barker Slough at the North Bay Aqueduct under Alternative 4 are similar to those under the No Action Alternative (Table G-67; Attachment G.2, Table G.2-1-8, Figures G.2-1-1 through G.2-1-18).

Modeled monthly average chloride concentrations at Banks and Jones pumping plants under Alternative 4 are similar to concentrations under the No Action Alternative for the full simulation period and all water year types (Table G-67; Attachment G.2, Tables G.2-2-8 and G.2-3-8, Figures G.2-2-1 through G.2-3-18).

Modeled monthly average chloride concentrations at Contra Costa Pumping Plant #1 are similar to or lower than concentrations under Alternative 4 relative to the No Action Alternative for the full simulation period and all water year types (Table G-67; Attachment G.2, Table G.2-5-8, and Figures G.2-5-1 through G.2-5-18).

Modeled monthly average chloride concentrations in the San Joaquin River at Antioch are similar to concentrations under Alternative 4 relative to the No Action Alternative for the full simulation period and all water year types (Table G-67; Attachment G.2, Table G.2-4-8, and Figures G.2-4-1 through G.2-4-18).

The CVP and SWP would operate in real-time to meet the Bay-Delta Plan chloride objectives, which aim to protect municipal and industrial beneficial uses. In September through December, when modeled chloride concentrations are higher compared with the No Action Alternative, the maximum mean daily chloride objectives of 250 mg/l would continue to apply at Contra Costa Pumping Plant #1, Banks and Jones pumping plants, and Barker Slough at North Bay Aqueduct. Also, the maximum mean daily chloride objective of 150 mg/l would continue to apply at Contra Costa Pumping Plant #1 for a certain number of days per year, depending on water year type. Thus, Alternative 4 would not contribute to municipal and industrial beneficial uses of Delta waters impairment.

Table G-67. Monthly Average Chloride (in milligrams per liter) at Delta Assessment Locations for the Full Simulation Period under Alternative 4, and Difference from the No Action Alternative

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
BARKER SLOUGH AT NORTH BAY AQUEDUCT												
Full Simulation Period Average	22	23	22	28	31	27	28	19	16	14	15	21
Difference from NAA	0	0	0	1	0	0	1	0	0	0	0	0
BANKS PUMPING PLANT												
Full Simulation Period Average	91	92	104	87	68	61	54	43	47	53	70	95
Difference from NAA	1	1	-4	-2	-2	-1	0	-1	0	0	1	2
JONES PUMPING PLANT												
Full Simulation Period Average	93	98	103	88	72	66	56	45	51	59	74	96
Difference from NAA	1	1	-3	-2	-2	-1	0	-1	0	0	1	1
SAN JOAQUIN RIVER AT ANTIOCH												
Full Simulation Period Average	1034	1109	673	325	133	82	129	238	383	584	888	1067
Difference from NAA	16	-9	-30	-20	6	5	2	10	-1	-6	-2	13
CONTRA COSTA WATER DISTRICT PUMPING PLANT #1												
Full Simulation Period Average	105	114	139	87	55	36	34	35	36	48	71	98
Difference from NAA	2	1	-7	-6	-2	0	-4	-4	-1	-1	1	2

NAA = No Action Alternative.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Suisun Marsh

Suisun Marsh also is not designated for municipal and domestic supply uses, and other salinity-related effects in the marsh are addressed above in the EC discussion.

Suisun Bay and San Francisco Bay

Because Suisun Bay and San Francisco Bay are not designated for municipal and domestic supply use, and seawater is the primary source of chloride in the western Delta, changes in chloride concentrations in the Delta outflow to the bays are not of concern in these water bodies relative to drinking water supplies or other beneficial uses.

Effects on Bromide

Attachment G.3 provides tables and figures presenting modeled bromide concentrations at the Delta assessment locations for Alternative 4 relative to the No Action Alternative. Table G-68 presents the modeled monthly average bromide concentrations at the Delta assessment locations for Alternative 4 for the 100-year simulation period and the differences from the No Action Alternative.

Modeled monthly average bromide concentrations in Barker Slough at the North Bay Aqueduct under Alternative 4 are similar to those under the No Action Alternative (Table G-68; Attachment G.3, Table G.3-1-8, Figures G.3-1-1 through G.3-1-18).

Modeled monthly average bromide concentrations at Banks and Jones pumping plants under Alternative 4 are similar to or lower than concentrations under the No Action Alternative for the full simulation period and all water year types (Table G-68; Attachment G.3, Tables G.3-2-8 and G.3-3-8, Figures G.3-2-1 through G.3-3-18).

Modeled monthly average bromide concentrations at Contra Costa Pumping Plant #1 are similar to or lower under Alternative 4 relative to the No Action Alternative for the full simulation period and all water year types (Table G-68; Attachment G.3, Table G.3-5-8, Figures G.3-5-1 through G.3-5-18).

Modeled monthly average bromide concentrations in the San Joaquin River at Antioch are substantially lower in all months under Alternative 4 relative to the No Action Alternative for the full simulation period and all water year types (Table G-68; Attachment G.3, Table G.3-4-8, Figures G.3-4-1 through G.3-4-18).

The overall lower bromide concentrations under Alternative 4 relative to the No Action Alternative would not result in greater potential for disinfection byproduct formation in drinking water supplies that use Delta source waters. The potentially higher bromide concentrations under Alternative 4 in some months could result in greater potential for disinfection byproduct formation in drinking water supplies that use Delta source waters, but the degree to which this would occur is uncertain. Treatment plants that use the Delta as a source for drinking water already experience highly variable bromide concentrations (as described for Alternative 1) and, thus, must implement appropriate treatment technologies to ensure compliance with drinking water regulations for disinfection byproducts. Thus, despite the potential for slightly higher bromide concentrations under the Alternative 4 in some months, Alternative 4 would not contribute to drinking water impairments related to bromide relative to those that would occur under the No Action Alternative.

Table G-68. Monthly Average Bromide (in micrograms per liter) at Delta Assessment Locations for the Full Simulation Period under Alternative 4, and Difference from the No Action Alternative

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
BARKER SLOUGH AT NORTH BAY AQUEDUCT												
Full Simulation Period Average	70	73	84	74	80	92	83	52	47	43	52	57
Difference from NAA	0	0	0	0	0	0	0	0	0	0	0	0
BANKS PUMPING PLANT												
Full Simulation Period Average	314	317	368	290	223	217	183	144	161	181	248	314
Difference from NAA	4	4	-14	-7	-7	-3	-2	-5	-1	-1	4	6
JONES PUMPING PLANT												
Full Simulation Period Average	322	338	364	296	236	232	192	151	173	203	261	318
Difference from NAA	3	3	-12	-6	-6	-2	-1	-3	-1	-1	3	5
SAN JOAQUIN RIVER AT ANTIOCH												
Full Simulation Period Average	3619	3881	2356	1136	464	285	451	832	1342	2044	3109	3734
Difference from NAA	57	-31	-104	-69	22	19	6	34	-4	-22	-8	47
CONTRA COSTA WATER DISTRICT PUMPING PLANT #1												
Full Simulation Period Average	367	399	486	303	192	127	121	121	127	168	250	343
Difference from NAA	7	4	-23	-22	-7	0	-14	-14	-3	-2	5	8

NAA = No Action Alternative.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Suisun Marsh

Suisun Marsh is not designated for municipal and domestic supply uses, and other salinity-related effects in the marsh are addressed above in the EC discussion.

Suisun Bay and San Francisco Bay

Because Suisun Bay and San Francisco Bay are not designated for municipal and domestic supply use, and seawater is the primary source of bromide in the western Delta, changes in bromide concentrations in the Delta outflow to the bays are not of concern in these water bodies relative to drinking water supplies or other beneficial uses.

Effects on Methylmercury

Delta

Attachment G.4 provides tables and figures presenting modeled total methylmercury concentrations at the Delta assessment locations for Alternative 4 relative to the No Action Alternative. Table G-69 and Table G-70 summarize the modeled average total methylmercury concentrations in water and fish tissues at the Delta assessment locations for Alternative 4 for the 100-year simulation period (1922–2021) and differences from the No Action Alternative.

Modeled long-term average water column concentrations of methylmercury in the Delta under Alternative 4 would be similar to those that would occur under the No Action Alternative at the Delta assessment locations (Table G-69). The range of modeled aqueous methylmercury concentrations for the No Action Alternative and Alternative 4 is the same at all locations for all years (Table G-69; Attachment G.4, Table G.4-18).

Modeled changes in water column concentrations of total methylmercury under Alternative 4 resulted in little to no effect on Delta fish tissue concentrations relative to the No Action Alternative. All modeled fish tissue concentrations exceed the water quality objective of 0.24 mg/kg ww in 350 mm largemouth bass fillets under both the No Action Alternative and Alternative 4 (Table G-70). Average modeled tissue concentrations did not increase under Alternative 4 at any Delta assessment location except for an increase of 0.01 mg/kg wet weight at Barker Slough at North Bay Aqueduct (Table G-70; Attachment G.4, Table G.4-33).

Based on the small-modeled changes in modeled total methylmercury concentrations at all Delta assessment locations described above, Alternative 4 would not result in increased Delta methylmercury concentrations that would substantially degrade water quality or cause increased frequency of exceeding water quality objectives.

Table G-69. Modeled Total Methylmercury Concentrations in Water (in nanograms per liter) at Delta Assessment Locations for the Full Simulation Period, Alternative 4 and No Action Alternative

Assessment Location	NAA (ng/L)	Alt4 (ng/L)	Alt4 minus NAA (ng/L)
San Joaquin River at Empire Tract	0.14	0.14	0.00
Turner Cut	0.15	0.15	0.00
San Joaquin River at San Andreas Landing	0.12	0.12	0.00
San Joaquin River at Jersey Point	0.12	0.12	0.00
Victoria Canal	0.14	0.14	0.00
Sacramento River at Emmaton	0.12	0.12	0.00
San Joaquin River at Antioch	0.12	0.12	0.00
Montezuma Slough near Beldon Landing	0.13	0.13	0.00
Barker Slough at North Bay Aqueduct	0.13	0.13	0.00
Contra Costa Water District Pumping Plant #1	0.13	0.13	0.00
Banks Pumping Plant	0.14	0.14	0.00
Jones Pumping Plant	0.15	0.15	0.00

NAA = No Action Alternative; Alt4 = Alternative 4; ng/L = nanograms per liter.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Table G-70. Modeled Total Methylmercury Concentrations in Largemouth Bass Fillets (in milligrams per kilogram wet weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 4 and No Action Alternative

Assessment Location	NAA (mg/kg ww)	Alt (mg/kg ww)	Alt4 minus NAA (mg/kg ww)
San Joaquin River at Empire Tract	0.78	0.78	0.00
Turner Cut	0.96	0.96	0.00
San Joaquin River at San Andreas Landing	0.61	0.61	0.00
San Joaquin River at Jersey Point	0.64	0.63	-0.01
Victoria Canal	0.84	0.84	0.00
Sacramento River at Emmaton	0.60	0.60	0.00
San Joaquin River at Antioch	0.65	0.65	0.00
Montezuma Slough near Beldon Landing	0.73	0.73	0.00
Barker Slough at North Bay Aqueduct	0.74	0.75	0.01
Contra Costa Water District Pumping Plant #1	0.68	0.68	0.00
Banks Pumping Plant	0.83	0.83	0.00
Jones Pumping Plant	0.87	0.87	0.00

NAA = No Action Alternative; Alt4 = Alternative 4; mg/kg ww = milligrams per kilogram wet weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Suisun Marsh

Modeled long-term average methylmercury concentrations in Suisun Marsh for the full simulation period, represented by the Montezuma Slough near Beldon Landing assessment location, do not increase under Alternative 4 relative to the No Action Alternative (Table G-69 and Table G-70). For this reason, and consistent with the discussion for Alternative 1, Alternative 4 would not contribute to additional water quality degradation with respect to water column methylmercury concentrations or increased methylmercury bioaccumulation in biota in Suisun Marsh as compared with the No Action Alternative.

Suisun Bay and San Francisco Bay

Modeled long-term average methylmercury concentrations in the western Delta under Alternative 4 would not differ to those that would occur under the No Action Alternative (Table G-69). Alternative 4 would also result in Delta outflow rates similar to those under the No Action Alternative (Appendix F). Thus, Alternative 4 would not contribute to water quality degradation with respect to water column methylmercury concentrations or increased methylmercury bioaccumulation in biota in Suisun Bay and San Francisco Bay, as compared with the No Action Alternative.

Effects on Selenium

Delta

Attachment G.5 provides tables and figures presenting modeled selenium concentrations at the Delta assessment locations for Alternative 4 relative to the No Action Alternative. Table G-71 through Table G-77 summarize the modeled average total selenium concentrations in water, fish tissues, and bird tissues at the Delta assessment locations for Alternative 4 for the 100-year simulation period (1922–2021) and differences from the No Action Alternative.

Modeled long-term average water column concentrations of selenium in the Delta under Alternative 4 are similar to the No Action Alternative at all locations for all years (Table G-71; Attachment G.5, Table G.5-15 and G.5-28). Concentrations do not exceed the 5 µg/L CTR criterion and are similar from those that would occur under the No Action Alternative at the Delta assessment locations (Table G-71). Thus, Alternative 4 would not contribute to measurable water quality degradation with respect to selenium as compared with the No Action Alternative.

Modeled changes in water column concentrations of selenium under Alternative 4 for the full simulation period do not cause an increase in modeled Delta fish or bird tissue concentrations relative to the No Action Alternative. Concentrations in biota at all locations in the Delta under Alternative 4 are similar to those modeled for the No Action Alternative for whole-body fish (Table G-72), fish fillets (Table G-73 and Table G-74), bird eggs [invertebrate diet] (Table G-75), bird eggs [fish diet] (Table G-76). Modeled whole fish selenium concentrations do not exceed the 8.5 mg/kg dry weight water quality criterion (U.S. Environmental Protection Agency 2021). Nor do modeled fish fillet selenium concentrations exceed the 11.3 mg/kg dry weight water quality criterion (U.S. Environmental Protection Agency 2021) or the 2.5 mg/kg ww advisory level for human consumption (California Office of Environmental Health Hazard Assessment 2008). Modeled bird eggs under Alternative 4 and the No Action Alternative do not exceed the 15.1 mg/kg dry weight water quality criterion (U.S. Environmental Protection Agency 2021). Thus, Alternative 4 would not result in increased health risks to wildlife or humans consuming wildlife associated with whole-body fish, bird eggs (invertebrate diet), bird eggs (fish diet), and fish fillets, as compared with the No Action Alternative.

Modeled selenium concentrations in whole-body sturgeon (*Acipenseridae*) in the western Delta under Alternative 4 are the same or lower than those modeled for the No Action Alternative (Table G-77). Concentrations at all western Delta locations are less than the North Bay TMDL target of 8 mg/kg dry weight in whole fish (San Francisco Bay Regional Water Quality Control Board 2015) for the entire period modeled. Thus, Alternative 4 would not increase health risks to sturgeon, as compared with the No Action Alternative.

Table G-71. Modeled Selenium Concentrations in Water (in nanograms per liter) at Delta Assessment Locations for the Full Simulation Period, Alternative 4 and No Action Alternative

Assessment Location	NAA (µg/L)	Alt4 (µg/L)	Alt4 minus NAA (µg/L)
San Joaquin River at Empire Tract	0.13	0.13	0.00
Turner Cut	0.22	0.23	0.00
San Joaquin River at San Andreas Landing	0.09	0.09	0.00
San Joaquin River at Jersey Point	0.09	0.09	0.00
Victoria Canal	0.15	0.15	0.00
Sacramento River at Emmaton	0.09	0.09	0.00
San Joaquin River at Antioch	0.10	0.10	0.00
Montezuma Slough near Beldon Landing	0.10	0.10	0.00
Barker Slough at North Bay Aqueduct	0.09	0.09	0.00
Contra Costa Water District Pumping Plant #1	0.11	0.11	0.00
Banks Pumping Plant	0.19	0.19	0.00
Jones Pumping Plant	0.21	0.21	0.00

NAA = No Action Alternative; Alt4 = Alternative 4; µg/L = micrograms per liter.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Table G-72. Modeled Selenium Concentrations in Whole-Body Fish (in milligram per kilogram dry weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 4 and No Action Alternative

Assessment Location	NAA (mg/kg dw)	Alt4 (mg/kg dw)	Alt4 minus NAA (mg/kg dw)
San Joaquin River at Empire Tract	1.81	1.81	-0.01
Turner Cut	1.80	1.80	-0.01
San Joaquin River at San Andreas Landing	1.82	1.82	0.00
San Joaquin River at Jersey Point	1.82	1.82	0.00
Victoria Canal	1.81	1.81	0.00
Sacramento River at Emmaton	1.82	1.82	0.00
San Joaquin River at Antioch	1.82	1.82	0.00
Montezuma Slough near Beldon Landing	1.82	1.82	0.00
Barker Slough at North Bay Aqueduct	1.82	1.82	0.00
Contra Costa Water District Pumping Plant #1	1.82	1.82	0.00
Banks Pumping Plant	1.81	1.81	0.00
Jones Pumping Plant	1.81	1.81	0.00

NAA = No Action Alternative; Alt4 = Alternative 4; mg/kg dw = milligram per kilogram dry weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Table G-73. Modeled Selenium Concentrations in Skinless Fish Fillets (in milligram per kilogram dry weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 4 and No Action Alternative

Assessment Location	NAA (mg/kg dw)	Alt4 (mg/kg dw)	Alt4 minus NAA (mg/kg dw)
San Joaquin River at Empire Tract	2.00	2.00	0.00
Turner Cut	1.99	1.99	0.00
San Joaquin River at San Andreas Landing	2.02	2.02	0.00
San Joaquin River at Jersey Point	2.02	2.02	0.00
Victoria Canal	2.00	2.00	0.00
Sacramento River at Emmaton	2.02	2.02	0.00
San Joaquin River at Antioch	2.02	2.02	0.00
Montezuma Slough near Beldon Landing	2.02	2.02	0.00
Barker Slough at North Bay Aqueduct	2.02	2.02	0.00
Contra Costa Water District Pumping Plant #1	2.02	2.02	0.00
Banks Pumping Plant	2.00	2.00	0.00
Jones Pumping Plant	2.00	2.00	0.00

NAA = No Action Alternative; Alt4 = Alternative 4; mg/kg dw = milligram per kilogram dry weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Table G-74. Modeled Selenium Concentrations in Skinless Fish Fillets (in milligram per kilogram wet weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 4 and No Action Alternative

Assessment Location	NAA (mg/kg ww)	Alt4 (mg/kg ww)	Al4 minus NAA (mg/kg ww)
San Joaquin River at Empire Tract	0.60	0.60	0.00
Turner Cut	0.60	0.60	-0.01
San Joaquin River at San Andreas Landing	0.61	0.61	0.00
San Joaquin River at Jersey Point	0.61	0.61	0.00
Victoria Canal	0.60	0.60	0.00
Sacramento River at Emmaton	0.61	0.61	0.00
San Joaquin River at Antioch	0.61	0.61	0.00
Montezuma Slough near Beldon Landing	0.61	0.61	0.00
Barker Slough at North Bay Aqueduct	0.61	0.61	0.00
Contra Costa Water District Pumping Plant #1	0.61	0.61	0.01
Banks Pumping Plant	0.60	0.60	0.00
Jones Pumping Plant	0.60	0.60	0.00

NAA = No Action Alternative; Alt4 = Alternative 4; mg/kg dw = milligram per kilogram wet weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Table G-75. Modeled Selenium Concentrations in Bird Eggs, Invertebrate Diet (in milligram per kilogram dry weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 4 and No Action Alternative

Assessment Location	NAA (mg/kg dw)	Alt4 (mg/kg dw)	Alt4 minus NAA (mg/kg dw)
San Joaquin River at Empire Tract	2.70	2.70	0.00
Turner Cut	2.69	2.68	-0.01
San Joaquin River at San Andreas Landing	2.71	2.71	0.00
San Joaquin River at Jersey Point	2.71	2.71	0.00
Victoria Canal	2.70	2.70	0.00
Sacramento River at Emmaton	2.71	2.71	0.00
San Joaquin River at Antioch	2.71	2.71	0.00
Montezuma Slough near Beldon Landing	2.71	2.71	0.00
Barker Slough at North Bay Aqueduct	2.71	2.71	0.00
Contra Costa Water District Pumping Plant #1	2.70	2.71	0.01
Banks Pumping Plant	2.69	2.69	0.00
Jones Pumping Plant	2.69	2.69	0.00

NAA = No Action Alternative; Alt4 = Alternative 4; mg/kg dw = milligram per kilogram dry weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Table G-76. Modeled Selenium Concentrations in Bird Eggs, Fish Diet (in milligram per kilogram dry weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 4 and No Action Alternative

Assessment Location	NAA (mg/kg dw)	Alt4 (mg/kg dw)	Alt4 minus NAA (mg/kg dw)
San Joaquin River at Empire Tract	3.26	3.26	0.00
Turner Cut	3.24	3.24	0.00
San Joaquin River at San Andreas Landing	3.28	3.28	0.00
San Joaquin River at Jersey Point	3.28	3.28	0.00
Victoria Canal	3.26	3.26	0.00
Sacramento River at Emmaton	3.28	3.28	0.00
San Joaquin River at Antioch	3.28	3.28	0.00
Montezuma Slough near Beldon Landing	3.28	3.28	0.00
Barker Slough at North Bay Aqueduct	3.28	3.28	0.00
Contra Costa Water District Pumping Plant #1	3.28	3.28	0.00
Banks Pumping Plant	3.26	3.26	0.00
Jones Pumping Plant	3.26	3.26	0.00

NAA = No Action Alternative; Alt4 = Alternative 4; mg/kg dw = milligram per kilogram dry weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Table G-77. Modeled Selenium Concentrations in Whole Sturgeon (in milligram per kilogram dry weight) at Delta Assessment Locations for the Full Simulation Period, Alternative 4 and No Action Alternative

Assessment Location	NAA (mg/kg dw)	Al4 (mg/kg dw)	Alt4 minus NAA (mg/kg dw)
Sacramento River at Emmaton	0.72	0.72	0.00
San Joaquin River at Antioch	3.82	3.79	-0.03
Montezuma Slough near Beldon Landing	3.97	3.95	-0.02

NAA = No Action Alternative; Alt4 = Alternative 4; mg/kg dw = milligram per kilogram dry weight.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Suisun Marsh

Modeled long-term average selenium concentrations in Suisun Marsh are represented by the Montezuma Slough near Beldon Landing assessment location. Water column selenium, whole fish, fillets, bird eggs, and whole sturgeon modeled concentrations for the full simulation period at this location are similar or lower under Alternative 4 relative to the No Action Alternative (Table G-71 through Table G-77). Thus, Alternative 4 would not contribute to increased water quality degradation with respect to water column selenium concentrations or measurable changes in selenium bioaccumulation in biota in Suisun Marsh as compared with the No Action Alternative.

Suisun Bay and San Francisco Bay

Long-term average water column selenium concentrations in the western Delta under Alternative 4 would be similar to those that would occur under the No Action Alternative (Table G-71) and would not exceed the North Bay TMDL the water column selenium target of 0.5 µg/L (San Francisco Bay Regional Water Quality Control Board 2015). Alternative 4 would also result in Delta outflow rates similar to those under the No Action Alternative (Appendix F). Thus, Alternative 4 would not contribute to additional water quality degradation with respect to water column selenium concentrations or increased selenium bioaccumulation in biota in Suisun Bay and San Francisco Bay, as compared with the No Action Alternative.

Effects on Organic Carbon

Delta

Attachment G.6 provides tables and figures presenting modeled dissolved organic carbon concentrations at the Delta assessment locations for Alternative 4 relative to the No Action Alternative. Table G-78 presents the modeled monthly average dissolved organic carbon concentrations at the Delta assessment locations for Alternative 4 for the 100-year simulation period and the differences from the No Action Alternative.

Under Alternative 4, monthly average dissolved organic carbon concentrations at Delta assessment locations would be similar to concentrations under the No Action Alternative for both the full simulation period (1922–2021) and the drought period (1987–1991) (Table G-78;

Attachment G.6, Tables G.6-1-8, G.6-2-8, G.6-3-8, G.6-4-8, and G.6-5-8, Figures G.6-1-1 through G.6-5-14). Modeled monthly average differences for the full simulation period range from 0.0–0.2 mg/L (Table G-78). Modeled monthly average differences for the drought period also range from 0.0–0.2 mg/L (Attachment G.6, Tables G.6-1-2, G.6-2-2, G.6-3-2, G.6-4-2, and G.6-5-2).

A California Urban Water Agencies expert panel convened to review Delta water quality and disinfection formation potential found that total organic carbon concentrations ranging from 4 to 7 mg/L would allow continued flexibility in treatment technology necessary to achieve existing drinking water criteria for disinfection byproducts (California Urban Water Agencies 1998:ES-2). Furthermore, drinking water treatment plants that utilize Delta source waters are currently designed and operated to meet existing drinking water criteria for disinfection byproducts based on the ambient concentrations or organic carbon and the seasonal variability that currently exists in the Delta. Therefore, substantial increases in ambient dissolved organic carbon concentrations would need to occur with substantial frequency for significant changes in plant design or operations to be triggered.

Based on the modeling results, increases in average dissolved organic carbon concentrations that may occur with Alternative 4 in Barker Slough at the North Bay Aqueduct, Banks and Jones pumping plants, the San Joaquin River at Antioch, and at Contra Costa Pumping Plant #1 would be of sufficiently small magnitude that modifications to existing drinking water treatment plants to employ additional organic carbon removals would not be necessary.

Based upon the above findings, Alternative 4 would not result in increased Delta dissolved organic carbon concentrations that would substantially degrade water quality or cause increased frequency of exceeding water quality objectives (because none exist) relative to the No Action Alternative.

Table G-78. Monthly Average Dissolved Organic Carbon (in milligrams per liter) at Delta Assessment Locations for the Full Simulation Period under Alternative 4, and Difference from the No Action Alternative

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
BARKER SLOUGH AT NORTH BAY AQUEDUCT												
Full Simulation Period Average	2.3	2.5	2.9	3.2	3.4	3.3	3.1	2.7	2.4	2.2	2.2	2.3
Difference from NAA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BANKS PUMPING PLANT												
Full Simulation Period Average	3.1	3.2	3.9	4.9	5.3	4.9	4.4	4.0	3.8	3.4	3.3	3.2
Difference from NAA	0.0	0.0	0.0	0.0	0.0	0.0	0.1	-0.1	0.0	0.1	0.1	0.0
JONES PUMPING PLANT												
Full Simulation Period Average	3.2	3.2	3.9	4.9	5.2	4.8	4.3	3.9	3.7	3.5	3.3	3.3
Difference from NAA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.1	0.0

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
SAN JOAQUIN RIVER AT ANTIOCH												
Full Simulation Period Average	2.3	2.6	3.0	3.4	3.6	3.6	3.4	3.0	2.7	2.4	2.4	2.4
Difference from NAA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0
CONTRA COSTA WATER DISTRICT PUMPING PLANT #1												
Full Simulation Period Average	2.6	2.8	3.4	4.3	5.1	4.9	4.5	3.9	3.3	2.9	2.8	2.8
Difference from NAA	0.0	0.0	0.0	0.0	0.1	-0.1	-0.2	-0.2	0.0	0.0	0.1	0.0

NAA = No Action Alternative.
A positive difference denotes an increase from the NAA, and a negative difference indicates a decrease from the NAA.

Suisun Marsh

For the same reasons described for Alternative 1, Alternative 4 would not result in differences in organic carbon concentrations in Suisun Marsh that would contribute to adverse effects on organic enrichment conditions within the marsh.

Suisun Bay and San Francisco Bay

Alternative 4 would result in Delta outflow rates similar to those under the No Action Alternative (Appendix F). For the reasons described for Alternative 1, differences in organic carbon loading to Suisun Bay and San Francisco Bay that may occur under Alternative 4 would not be expected to contribute to adverse effects on the food web in the bays.

Effects on Trace Metals

For the same reasons described for Alternative 1, Alternative 4 would not affect existing Delta impairments related to trace metals and would not result in additional trace metals-related impairments in the Delta, Suisun Bay and Marsh, or San Francisco Bay relative to the No Action Alternative.

Effects on Nutrients

For the same reasons described for Alternative 1, Alternative 4 would not contribute to different Delta nutrient concentrations or nutrient distributions that would result in adverse effects on beneficial uses or substantially degrade the water quality, relative to nutrient conditions that would occur under the No Action Alternative. Furthermore, any potential differences in total nitrogen and phosphorus loading that would occur in Delta outflow to Suisun Bay and Marsh, and San Francisco Bay, relative to the No Action Alternative, are not expected to result in water quality degradation with regard to nutrients that would result in adverse effects on beneficial uses or the further impairment of Suisun Bay and Marsh, or San Francisco Bay.

Effects on Dissolved Oxygen

For the same reasons described for Alternative 1, Alternative 4 would not substantially affect DO concentrations in the Delta, Suisun Bay and Marsh, or San Francisco Bay, or make existing DO impairments in the Delta and Suisun Marsh worse relative to the No Action Alternative.

Effects on Legacy Contaminants

For the same reasons described for Alternative 1, Alternative 4 would not substantially affect levels of legacy contaminants (e.g., dioxin and furan compounds, PCBs, and PAHs) in the Delta, Suisun Bay and Marsh, or San Francisco Bay relative to the No Action Alternative.

Effects on Pesticides

For the same reasons described for Alternative 1, Alternative 4 would not substantially affect pesticide concentrations in the Delta, Suisun Bay and Marsh, or San Francisco Bay relative to the No Action Alternative.

Effects on CHABs

Alternative 4 would result in minimal (0%–4%) reductions to Sacramento River flows at Freeport and San Joaquin River flows at Vernalis entering the Delta, relative to the No Action Alternative, for the entire period of record modeled and for each water year type. For the same reasons discussed under Alternative 1, Alternative 4 would result in negligible, if any, effects on Delta residence time, water temperature, channel turbulence and mixing, nutrients, and water clarity, relative to the No Action Alternative. Consequently, Alternative 4 would not adversely affect CHABs in the Delta, Suisun Marsh, Suisun Bay, or San Francisco Bay.

CVP and SWP Service Areas (south to Diamond Valley)

Alternative 4 would generally result in higher monthly average chloride concentrations from August through November, and similar or lower concentrations in the remaining months, as compared with the No Action Alternative. Since this water is delivered to reservoirs for storage in the CVP and SWP reservoirs, reservoir chloride concentrations may increase. However, in some months, the CVP and SWP would continue to be operated in real-time to meet the Bay-Delta Plan objectives for chloride, which aim to protect municipal and industrial beneficial uses. In September through January, when chloride would be higher compared with the No Action Alternative, the maximum mean daily chloride objectives of 250 mg/L would continue to apply at Contra Costa Pumping Plant #1, Banks and Jones pumping plants, and Barker Slough at North Bay Aqueduct (State Water Resources Control Board 2018b). Also, the maximum mean daily chloride objective of 150 mg/L would continue to apply at Contra Costa Pumping Plant #1 or San Joaquin River at Antioch for a certain number of days per year, depending on water year type (State Water Resources Control Board 2018b). Thus, Alternative 4 would not impair municipal and industrial beneficial uses of the CVP and SWP service area.

G.2.7 Mitigation Measures

Following is a description of mitigation measures identified for water quality resources per alternative. These mitigation measures include avoidance and minimization measures that are part of each alternative and, where appropriate, additional mitigation to lessen impacts of the alternatives.

G.2.7.1 Avoidance and Minimization Measures

Alternative 1

- **State Water Resources Control Board: Bay Delta Water Quality Control Plan:** Reclamation will implement the State Water Resources Control Board (State Water Board) Water Quality Control Plan. The Water Quality Control Plan covers the Bay-Delta Estuary and tributary watersheds. A water quality control plan consists of: (1) beneficial uses to be protected; (2) water quality objectives for the reasonable protection of beneficial uses; and (3) a program of implementation for achieving the water quality objectives. This plan provides reasonable protection for the Estuary's beneficial uses that require control of salinity and constituents of concern.
- **Water Temperature Management:** Relevant to water quality because high water temperature in combination with increased nutrient runoff can decrease DO, all these factors support the growth harmful cyanobacterial.
    - Reclamation would operate the Temperature Control Device on Shasta Dam, consistent with Water Rights Order (WRO) 90-5, to target 56°F at the most downstream location feasible, up to Red Bluff Diversion Dam, from May 15 through October 30 each year.
    - Reclamation would target Whiskeytown Dam releases to not exceed the mean daily temperatures at Igo gauge of:
        - 61°F from June 1 through August 15.
        - 60°F from August 16 through September 15.
        - 56°F from Sept 15 through Nov 15.
- **Minimum Instream Flows:** Relevant to water quality because minimum instream flows are necessary to help preserve desired water quality parameters prescribed by D-1641.
    - Reclamation will operate to the minimum flows set forth in WRO 90-5 for the Sacramento River. The minimum flows set forth are as follows:
        - March 1 through August 31 – minimum flows of 2,300 cfs
        - September 1 through the end of February – minimum flows of 3,250 cfs

      In addition, the agreement contains a schedule providing for flow reductions in critical dry years.
    - Reclamation would operate to the 1987 Stipulation with the California Department of Fish and Wildlife for the Stanislaus River.

Alternative 2

- **Adult Migration and Holding Water Temperature Objectives:** Relevant to water quality because it will influence the management of water temperatures, which is a component of water quality.

Under a circumstance where conditions may cause water temperatures to rise to concerning levels prior to the final Temperature Management Plan (TMP), Reclamation will begin water temperature management as early as March 1 to target water temperatures of 58.0° F daily average at the Sacramento River above the Clear Creek Gage (CCR). Reclamation is a higher priority on maintaining storage for drought protection. The strategy is framed around a framework adapted from the multi-year drought sequence experienced in Victoria, Australia (Mount et al. 2016, "Victorian Objectives") that establishes different objectives depending on hydrologic conditions and identifies actions that can be taken for fishery management and drought protection.

- **Pulse Flows:** Relevant to Clear Creek water quality because it will result in higher flows, which may increase dilution capability is a beneficial component of water quality.

  Except in years with significant uncontrolled spill, Reclamation will release up to 10,000 acre-feet from Whiskeytown Dam for channel maintenance, spring attraction flows, and to meet other physical and biological objectives. In critical years, Reclamation will release up to 5,000 acre-feet. Reclamation, through the Clear Creek Technical Team, will develop pulse flow schedules, which include measures (e.g., nighttime down ramping, slow down ramping rates, coordination with natural precipitation events) to mitigate for potential risks (e.g., potential juvenile fish stranding).

- **Water Temperature Management:** Relevant to water quality because it will influence the management of water temperatures in Clear Creek to the targets shown in Chapter 3, Table 3-12, which is a component of water quality. Reclamation will target Whiskeytown Dam releases to not exceed the mean daily temperatures at Igo gauge:

  - 61°F from June 1 through August 15.
  - 60°F from August 16 through September 15.
  - 56°F from September 16 through November 15.

  Reclamation may not be able to meet these water temperatures and will operate Whiskeytown Dam as close to these water temperatures as practicable.

- **Delta Smelt Adult Entrainment Protection Action (Turbidity Bridge):** Relevant to water quality because it will influence turbidity, which is a component of Delta water quality. If after a "First Flush" Action or after December 20, whichever occurs first, daily average turbidity remains or becomes elevated to 12 Formazin Nephelometric Units (FNU) or higher at each of three turbidity sensors in the OMR corridor creating a continuous bridge of turbidity from the lower San Joaquin River to the CVP and SWP export facilities, Reclamation and the California Department of Water Resources (DWR) will manage exports to achieve a five-day average OMR flow that is no more negative than -3,500 cfs until the daily average turbidity in at least one of the three turbidity sensors is less than 12 FNU for two consecutive days, thereby indicating a break in the continuous Turbidity Bridge.

- **Spring Delta Outflow:** Relevant to water quality because this measure will enhance Delta outflows in the Spring, which is a component of Delta water quality. Reclamation and DWR will take actions intended to supplement Delta outflow per the terms of the voluntary agreements (VAs). Reclamation and DWR will operate consistent with the VAs approved by the Water Board and executed agreements by VA Parties.

Actions that will support the additional Delta outflow include: (1) Reclamation and DWR south of Delta export modifications; (2) Reclamation reoperating upstream reservoirs to advance and allow for scheduling of water made available by contractors in CVP watersheds; and (3) passing Delta inflow from water made available by VA Parties. **Error! Reference source not found.**Volumes are reflected in the Memorandum of U nderstanding signed by VA parties in March 2022.

- **Delta Smelt Summer and Fall Habitat:** Relevant to water quality because it will enhance Delta outflows to maintain the location of X2, which addresses salt intrusion in the Delta. Maintain a 30-day average X2 ≤80 km for September through October in above normal and wet years.

  Under Alternative 2, DWR will operate the SMSCG in summer and fall (June through October) for 60 days using a seven-day tidal -seven-day open operation (7-7) schedule to maximize the number of days that Belden's Landing three-day average salinity is equal to, or less than, 4 practical salinity units. In dry years following below normal years, DWR will operate SMSCG for 30 days using 7-7 operation to maximize the number of days Belden's Landing three-day salinity is equal to, or less than 6 practical salinity units.

Alternative 3

- **Water Temperature Management Sacramento:** Relevant to water quality because this measure will influence the management of water temperatures, which is a component of water quality. Reclamation would develop an annual temperature management plan, consistent with WRO 90-5. The TMP will be reviewed and approved by the National Marine Fisheries Service on or before April 15, and will be approved before Reclamation releases water from Shasta Dam for delivery to or diversion by any contractor.
- **Winter and Spring Pulses and Delta Outflow Sacramento River:** Relevant to water quality because this measure will enhance Delta outflows, increasing the dilution capability in the Delta. Alternative 3 bypasses 55% of unimpaired inflow to Shasta Reservoir from December through May to achieve the monthly Delta Outflow criteria in Table E.6-1, as described in Section E.6.1.2, *Winter and Spring Pulses Delta Outflow* (Appendix E). If the monthly Delta Outflow criteria in Table E.6-1 is met, then releases from Shasta Reservoir that month may be reduced to 45% of unimpaired inflows from December to May.
- **Minimum Instream Flows Stanislaus River:** Relevant to water quality because this measure will contribute to meeting minimum flows at Vernalis as a component of Delta water quality. The 2018 Bay-Delta Water Quality Control Plan states that the Lower San Joaquin River water quality objectives provide for reasonable protection of fish and wildlife beneficial uses. This measure requires reservoir releases to meet 40% of unimpaired inflow on a 7-day running average to the confluence with the San Joaquin in February through June. In the months of February through June, Reclamation also would make releases from New Melones as necessary to contribute its share (29%) of meeting the 1,000 cfs minimum flow at Vernalis required in the Bay-Delta Water Quality Control Plan.

Alternative 4

- **Water Temperature Management:** Relevant to water quality to fisheries because this will influence the management of water temperatures. Reclamation, through governance, would prepare a TMP consistent with requirements in WRO 90-5 and update the plan throughout the water temperature management season to improve water temperature conditions in the Sacramento River on or after June 16.

- **Fall and Winter Instream Flows:** Relevant to Sacramento River water quality because it will result in higher flows, which is a beneficial component of water quality by augmenting the dilution capacity of the Sacramento River.

Table G-79. Keswick Dam December through February Default Release Schedule determined by EOS Storage

Keswick Release (cfs)	Shasta EOS Storage (MAF)
3,250	<2.4
4,000	≥2.4
4,500	≥2.8
5,000	≥3.2

EOS = end-of-September; cfs = cubic feet per second; MAF = million acre-feet.

G.2.7.2 Additional Mitigation Measures

Alternatives 1-4

Mitigation Measure WQ-1: Develop a water quality mitigation and monitoring program

A program shall be developed and implemented to reduce, minimize, or eliminate increases in water quality constituents. The program will develop a monitoring plan, including frequent sampling and reporting, particularly for existing constituents of concern. Reclamation will coordinate with the implementation of current TMDLs to share monitoring information and contribute to the efforts to reduce constituents of concern. Efforts could include water quality (through the water column), soil, and fish and invertebrate tissue monitoring.

G.2.8 Summary of Impacts

Table G-80 includes a summary of impacts, the magnitude and direction of those impacts, and potential mitigation measures to consider.

Table G-80. Impact Summary

Impact	Alternative	Magnitude and Direction of Impacts [a]	Potential Mitigation Measures
Potential Changes In Water Quality	No Action	Flows and water quality levels would remain as under existing conditions in upstream rivers and the CVP/SWP service area. [b]	-
	Alternative 1	Flow reductions in Clear Creek (maximum of 84% in June under long-term average flows), the American River (maximum of 57% in September under dry water years), and the Stanislaus River (maximum decrease of 77% in October of critical water years) could result in water quality degradation. Flow reductions in the Trinity and Klamath Rivers (maximum decrease of 18% in March of below normal water years), Sacramento River (maximum decrease of 20% in September of above normal years), and the San Joaquin River (maximum decrease of 11% in October of dry years) are not expected to be at a level that would result in water quality degradation. Flow increases in the Trinity and Klamath Rivers (maximum of 24% in February of above normal water years), the Sacramento River (maximum increase of 28% in December of above normal years), the American River (maximum increase of 149% in April of critical years), Stanislaus River (maximum increase of 74% in November of below normal water years), and the San Joaquin River (maximum increase of 26% in July of critical water years) would be considered beneficial. Although monthly average chloride concentrations in CVP and SWP reservoirs storing water diverted from the Delta is expected to increase, the CVP and SWP operation would continue to meet Bay-Delta Plan water quality objectives.	Mitigation Measure WQ-1
	Alternative 2	Flow reductions in Clear Creek (maximum decrease of 41% in June of critical water years) and the American River (maximum decrease of 30% in May of critical water years) could result in water quality degradation. Flow reductions in the Trinity and Klamath rivers (maximum decrease of 18% in November of above normal water years), the Sacramento River (maximum decrease of 13% during several months of critical water years), the Stanislaus River (maximum decrease of 33% in January of above normal water years), and San Joaquin River (maximum decrease of 3% in January of above normal water years) are not expected to be at a level that would result in water quality degradation.	Mitigation Measure WQ-1

Impact	Alternative	Magnitude and Direction of Impacts [a]	Potential Mitigation Measures
		Flow increases in the Trinity and Klamath rivers (maximum increase of 11% in February of above normal water years), Sacramento River (maximum increase of 33% in certain months of critical water years), Clear Creek (maximum increase of 54% in May of critical water years), the American River (maximum increase of 110% in April of critical water years), the Stanislaus River (maximum increase of 89% in June of critical water years), and the San Joaquin River (maximum increase of 34% in July and August of critical water years) would be considered beneficial. Although monthly average chloride concentrations in CVP and SWP reservoirs storing water diverted from the Delta is expected to increase, the CVP and SWP would continue to be operated to meet Bay-Delta Plan water quality objectives.	
	Alternative 3	Flow reductions in Sacramento River (maximum decrease of 21% on May of critical water years), Clear Creek (maximum decrease of 38% in June of critical water years), and Stanislaus River (maximum decrease of 54% in December of below normal water years) could result in water quality degradation. Flow reductions in the Trinity and Klamath rivers (maximum decrease of 8% in April of wet water years), American River (maximum decrease of 44% in June of above normal water years when flows are relatively high), and San Joaquin River (maximum decrease of 22% in July of above normal water years when flows are relatively high) are not expected to be at a level that would result in water quality degradation. Flow increases in the Trinity and Klamath rivers (maximum increase of 10% in December of wet water years), Sacramento River (maximum increase of 33% in May of wet water years), Clear Creek (maximum increase of 54% in May of critical water years), the American River (maximum increase of 62% in December of critical water years), the Stanislaus River (maximum increase of 68% in February of dry water years), and the San Joaquin River (maximum increase of 4% in May of dry water years) would be considered beneficial. Although monthly average chloride concentrations in CVP and SWP reservoirs storing water diverted from the Delta is expected to increase, the CVP and SWP would continue to be operated to meet Bay-Delta Plan water quality objectives.	Mitigation Measure WQ-1

Impact	Alternative	Magnitude and Direction of Impacts [a]	Potential Mitigation Measures
	Alternative 4	Flow reductions in Clear Creek (maximum of 38% in June of critical water years) and the American River (maximum of 16% in March of critical water years) could result in water quality degradation. Flow reductions in the Trinity and Klamath rivers (maximum decrease of 12% in December of below normal water years), Sacramento River (maximum decrease of 11% in May of critical water years), Stanislaus River (maximum decrease 26% in January of above normal water years when flows are relatively high), and San Joaquin River (maximum decrease of 4% in May of below normal water years) are not expected to be at a level that would result in water quality degradation. Flow increases in the Trinity and Klamath rivers (maximum increase of 4% in March of below normal water years), Sacramento River (maximum increase of 18% in November of critical water years), Clear Creek (maximum increase of 54% in May of critical water years), the American River (maximum increase of 22% in July of critical water years), the Stanislaus River (maximum increase of 59% in June of critical water years), and the San Joaquin River (maximum increase of 3% in August of critical water years) would be considered beneficial. Although monthly average chloride concentrations in CVP and SWP reservoirs storing water diverted from the Delta is expected to increase, the CVP and SWP would continue to be operated to meet Bay-Delta Plan water quality objectives.	Mitigation Measure WQ-1
Bay-Delta Region: Potential Changes in EC	No Action	EC levels in the Delta could be higher due to climate change-related factors, but would not be affected by CVP operations, which would remain the same as existing conditions. [b]	-
	Alternative 1	Modeled monthly average EC levels are substantially higher in the San Joaquin River at Jersey Point, Prisoners Point and San Andreas Landing, and the Sacramento River at Emmaton and Threemile Slough are substantially higher in September, October, and November compared with the No Action Alternative. Higher EC in Suisun Marsh in these months. No substantial differences in Suisun Bay or San Francisco Bay. The CVP and SWP would operate in real-time to meet the Bay-Delta Plan EC objectives, which aim to protect beneficial uses.	Mitigation Measure WQ-1

Impact	Alternative	Magnitude and Direction of Impacts [a]	Potential Mitigation Measures
	Alternative 2	Modeled monthly average EC levels at Delta and Suisun Marsh assessment locations are similar to the No Action Alternative. No substantial differences in Suisun Bay or San Francisco Bay. The CVP and SWP would operate in real-time to meet the Bay-Delta Plan EC objectives, which aim to protect beneficial uses. Thus, this alternative would not contribute to beneficial use impairments of Delta waters.	Mitigation Measure WQ-1
	Alternative 3	Modeled monthly average EC levels at Delta and Suisun Marsh assessment locations are similar to the No Action Alternative. No substantial differences in Suisun Bay or San Francisco Bay. The CVP and SWP would operate in real-time to meet the Bay-Delta Plan EC objectives, which aim to protect beneficial uses.	Mitigation Measure WQ-1
	Alternative 4	Modeled monthly average EC levels at Delta and Suisun Marsh assessment locations are similar to the No Action Alternative. No substantial differences in Suisun Bay or San Francisco Bay. The CVP and SWP would operate in real-time to meet the Bay-Delta Plan EC objectives, which aim to protect beneficial uses. Thus, this alternative would not contribute to beneficial use impairments of Delta waters.	Mitigation Measure WQ-1
Bay-Delta Region: Potential Changes in Chloride	No Action	Chloride concentrations in the Delta could be higher due to climate change-related factors, but would not be affected by CVP operations, which would remain the same as existing conditions. [b]	-
	Alternative 1	Modeled monthly average chloride concentrations are substantially higher at some Delta assessment locations in certain months compared with the No Action Alternative. The CVP and SWP would operate in real-time to meet the Bay-Delta Plan chloride objectives, which aim to protect municipal and industrial beneficial uses.	Mitigation Measure WQ-1
	Alternative 2	Modeled monthly average chloride concentrations at Delta assessment locations are similar to the No Action Alternative. Thus, Alternative 2 would not contribute to municipal and beneficial use impairments of Delta waters. The CVP and SWP would operate in real-time to meet the Bay-Delta Plan chloride objectives, which aim to protect municipal and industrial beneficial uses.	Mitigation Measure WQ-1
	Alternative 3	Modeled monthly average chloride concentrations at Delta assessment locations are similar or somewhat lower compared with the No Action Alternative during most months. Modeled chloride concentrations at the Contra Costa Pumping Plant #1 are higher in March through May.	Mitigation Measure WQ-1

Impact	Alternative	Magnitude and Direction of Impacts [a]	Potential Mitigation Measures
		The CVP and SWP would operate in real-time to meet the Bay-Delta Plan chloride objectives, which aim to protect municipal and industrial beneficial uses.	
	Alternative 4	Modeled monthly average chloride concentrations at Delta assessment locations are similar to the No Action Alternative. The CVP and SWP would operate in real-time to meet the Bay-Delta Plan chloride objectives, which aim to protect municipal and industrial beneficial uses.	Mitigation Measure WQ-1
Bay-Delta Region: Potential Changes in Bromide	No Action Alternative	Bromide concentrations in the Delta could be higher due to climate change-related factors, but would not be affected by CVP operations, which would remain the same as existing conditions.[b]	-
	Alternative 1	Modeled monthly average bromide concentrations would be substantially higher at some Delta assessment locations in certain months compared with the No Action Alternative. This could result in greater potential for disinfection byproduct formation in drinking water supplies that use Delta source waters, but the degree to which this would occur is uncertain. The higher bromide concentrations in some months at Delta locations are of a magnitude of concern such that they could contribute to drinking water impairments relative to those that would occur under the No Action Alternative.	Mitigation Measure WQ-1
	Alternative 2	Modeled monthly average bromide concentrations at Delta assessment locations are similar or lower compared with the No Action Alternative. Thus, the alternative would not contribute to drinking water impairments related to bromide.	Mitigation Measure WQ-1
	Alternative 3	Modeled monthly average bromide concentrations at Delta assessment locations are similar or somewhat higher compared with the No Action Alternative. However, Delta locations that increase, relative to the No Action Alternative, are below the 300 mg/L goal for disinfection byproducts.	Mitigation Measure WQ-1
	Alternative 4	Modeled monthly average bromide concentrations at Delta assessment locations are similar or lower compared with the No Action Alternative.	Mitigation Measure WQ-1

Impact	Alternative	Magnitude and Direction of Impacts [a]	Potential Mitigation Measures
Bay-Delta Region: Potential Changes in Methylmercury	No Action Alternative	Methylmercury concentrations in the Delta could be higher due to climate change-related factors, but would not be affected by CVP operations, which would remain the same as existing conditions.[b]	-
	Alternative 1	Water column methylmercury concentrations and methylmercury bioaccumulation in biota the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay would not be substantially affected, and existing impairments would not be made worse relative to the No Action Alternative.	-
	Alternative 2	Water column methylmercury concentrations and methylmercury bioaccumulation in biota the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay would not be substantially affected, and existing impairments would not be made worse relative to the No Action Alternative	-
	Alternative 3	Water column methylmercury concentrations and methylmercury bioaccumulation in biota Suisun Marsh would not be substantially affected and existing impairments would not be made worse, relative to the No Action Alternative. However, water column methylmercury concentrations and methylmercury bioaccumulation in biota the Delta, Suisun Bay, and San Francisco Bay may be affected, and existing impairments could be made worse relative to the No Action Alternative.	Mitigation Measure WQ-1
	Alternative 4	Water column methylmercury concentrations and methylmercury bioaccumulation in biota the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay would not be substantially affected, and existing impairments would not be made worse relative to the No Action Alternative	-
Bay-Delta Region: Potential Changes in Selenium	No Action Alternative	Selenium concentrations in the Delta are expected to be similar in the future, and would not be affected by CVP operations, which would remain the same as existing conditions.[b]	-
	Alternative 1	Levels of selenium in the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay would not be substantially affected and would not result in increased water quality degradation or health risks to wildlife or humans consuming wildlife relative to the No Action Alternative.	-
	Alternative 2	Levels of selenium in the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay would not be substantially affected and would not result in increased water quality degradation or health risks to wildlife or humans consuming wildlife relative to the No Action Alternative.	-

Impact	Alternative	Magnitude and Direction of Impacts [a]	Potential Mitigation Measures
	Alternative 3	Levels of selenium in the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay would not be substantially affected and would not result in increased water quality degradation or health risks to wildlife or humans consuming wildlife relative to the No Action Alternative.	-
	Alternative 4	Levels of selenium in the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay would not be substantially affected and would not result in increased water quality degradation or health risks to wildlife or humans consuming wildlife relative to the No Action Alternative.	-
Delta, Suisun Bay and Marsh, and San Francisco Bay: Potential Changes in Organic Carbon	No Action Alternative	Organic carbon concentrations in the Delta are expected to be similar in the future, and would not be affected by CVP operations, which would remain the same as existing conditions.[b]	-
	Alternative 1	No substantial changes in total organic carbon concentrations in the Delta or Suisun Marsh; could result in lower organic carbon loading to Suisun Bay and San Francisco Bay.	-
	Alternative 2	No substantial changes in total organic carbon concentrations in the Delta or Suisun Marsh; similar organic carbon loading to Suisun Bay and San Francisco Bay.	-
	Alternative 3	No substantial changes in total organic carbon concentrations in the Delta or Suisun Marsh, except at Contra Costa Pumping Plant #1, where modeled average concentrations are up to 0.6 mg/L higher, depending on month; potentially higher organic carbon loading to Suisun Bay and San Francisco Bay.	Mitigation Measure WQ-1
	Alternative 4	No substantial changes in total organic carbon concentrations in the Delta or Suisun Marsh; similar organic carbon loading to Suisun Bay and San Francisco Bay.	-
Bay-Delta Region: Potential Changes in Trace Metals	No Action Alternative	Trace metals concentrations in the Delta could be higher due to climate change-related factors, but would not be affected by CVP operations, which would remain the same as existing conditions.[b]	-
	Alternative 1	Existing trace metals impairments would not be affected and no contributions to additional impairments would occur, relative to the No Action Alternative.	-
	Alternative 2	Existing trace metals impairments would not be affected and no contributions to additional impairments would occur, relative to the No Action Alternative.	-

Impact	Alternative	Magnitude and Direction of Impacts [a]	Potential Mitigation Measures
	Alternative 3	Existing trace metals impairments would not be affected and no contributions to additional impairments would occur, relative to the No Action Alternative.	-
	Alternative 4	Existing trace metals impairments would not be affected and no contributions to additional impairments would occur, relative to the No Action Alternative.	-
Bay-Delta Region: Potential Changes in Nutrients	No Action Alternative	Nutrient concentrations in the Delta are expected to be similar in the future, and would not be affected by CVP operations, which would remain the same as existing conditions.[b]	-
	Alternative 1	Nutrients levels and distributions would not be substantially different from No Action Alternative conditions in the Delta; potentially lower nutrient loading to Suisun Marsh, Suisun Bay, and San Francisco Bay.	-
	Alternative 2	Nutrients levels and distributions would not be substantially different from No Action Alternative conditions in the Delta; similar nutrient loading to Suisun Marsh, Suisun Bay, and San Francisco Bay.	-
	Alternative 3	Nutrients levels and distributions would not be substantially different from No Action Alternative conditions in the Delta; potentially higher nutrient loading to Suisun Marsh, Suisun Bay, and San Francisco Bay.	-
	Alternative 4	Nutrients levels and distributions would not be substantially different from No Action Alternative conditions in the Delta; similar nutrient loading to Suisun Marsh, Suisun Bay, and San Francisco Bay.	-
Bay-Delta Region: Potential Changes in Dissolved Oxygen	No Action Alternative	DO concentrations in the Delta are expected to be similar in the future, and would not be affected by CVP operations, which would remain the same as existing conditions.[b]	-
	Alternative 1	DO levels in the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay would not be affected and existing impairments would not be made worse, relative to No Action Alternative conditions.	-
	Alternative 2	DO levels in the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay would not be affected and existing impairments would not be made worse, relative to No Action Alternative conditions.	-
	Alternative 3	DO levels in the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay would not be affected and existing impairments would not be made worse, relative to No Action Alternative conditions.	-

Impact	Alternative	Magnitude and Direction of Impacts [a]	Potential Mitigation Measures
	Alternative 4	DO levels in the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay would not be affected and existing impairments would not be made worse, relative to No Action Alternative conditions.	-
Delta, Suisun Bay and Marsh, and San Francisco Bay: Potential Changes in Legacy Contaminants	No Action Alternative	Concentrations of legacy contaminants in the Delta are expected to be similar in the future, and would not be affected by CVP operations, which would remain the same as existing conditions.[b]	-
	Alternative 1	Levels of legacy contaminants (dioxin and furan compounds, PCBs, and PAHs) in the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay would not be substantially affected, relative to the No Action Alternative.	-
	Alternative 2	Levels of legacy contaminants (dioxin and furan compounds, PCBs, and PAHs) in the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay would not be substantially affected, relative to the No Action Alternative.	-
	Alternative 3	Levels of legacy contaminants (dioxin and furan compounds, PCBs, and PAHs) in the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay would not be substantially affected, relative to the No Action Alternative.	-
	Alternative 4	Levels of legacy contaminants (dioxin and furan compounds, PCBs, and PAHs) in the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay would not be substantially affected, relative to the No Action Alternative.	-
Delta, Suisun Bay and Marsh, and San Francisco Bay: Potential Changes in Pesticides	No Action Alternative	Pesticide concentrations in the Delta are expected to be similar in the future, and would not be affected by CVP operations, which would remain the same as existing conditions.[b]	-
	Alternative 1	No substantial increased risk of higher pesticide concentrations or pesticide-related toxicity in the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay, relative to the No Action Alternative.	-
	Alternative 2	No substantial increased risk of higher pesticide concentrations or pesticide-related toxicity in the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay, relative to the No Action Alternative.	-
	Alternative 3	No substantial increased risk of higher pesticide concentrations or pesticide-related toxicity in the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay, relative to the No Action Alternative.	-

Impact	Alternative	Magnitude and Direction of Impacts [a]	Potential Mitigation Measures
	Alternative 4	No substantial increased risk of higher pesticide concentrations or pesticide-related toxicity in the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay, relative to the No Action Alternative.	-
Delta, Suisun Bay and Marsh, and San Francisco Bay: Potential Changes in CHABs	No Action Alternative	CHABs in the Delta could be more frequent due to climate change-related factors, but would not be affected by CVP operations, which would remain the same as existing conditions.[b]	-
	Alternative 1	No substantial increased risk of increased CHABs in the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay relative to the No Action Alternative.	-
	Alternative 2	No substantial increased risk of increased CHABs in the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay relative to the No Action Alternative.	-
	Alternative 3	Potential increased risk of CHABs in the Delta and Suisun Marsh; no increased risk of CHABs in Suisun Bay and San Francisco Bay relative to the No Action Alternative.	-
	Alternative 4	No substantial increased risk of increased CHABs in the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay relative to the No Action Alternative.	-

DO = dissolved oxygen; CHAB = cyanobacteria harmful algal bloom.

[a] For the evaluation of alternatives, operation of the action alternatives are compared with the No Action Alternative.

[b] Under the No Action Alternative, Reclamation would operate the CVP consistent with the 2020 Record of Decision implementing the Proposed Action consulted upon for the 2019 Biological Opinions and the reasonable and prudent measures in the incidental take statements. DWR would operate the SWP consistent with the 2020 Record of Decision and the 2020 Incidental Take Permit for the SWP. Reclamation and DWR would operate consistent with authorizing legislation, water rights, contracts, and agreements as described by common components. The evaluation under the No Action Alternative is compared with existing conditions.

G.2.9 Cumulative Impacts

Past, present, and reasonably foreseeable projects, described in Appendix Y, *Cumulative Impacts Technical Appendix*, may have cumulative effects on water quality, to the extent that they could affect reservoirs that store CVP water, tributaries, and agricultural land.

Past and present actions contribute to the existing condition of the affected environment in the project area while reasonably foreseeable actions are those that are likely to occur in the future that are not speculative. Past, present, and reasonably foreseeable projects include actions to develop water storage capacity, water conveyance infrastructure, water recycling capacity, the reoperation of existing water supply infrastructure, including surface water reservoirs and conveyance infrastructure, and habitat restoration actions. The projects identified in Appendix Y that have the most potential to contribute to cumulative impact on water quality are:

- Pacheco Reservoir/San Luis Low Point Improvement Project
- Contra Costa Canal Replacement Project
- Alternative Intake Project
- Davis-Woodland Water Supply Project
- Eastern San Joaquin Integrated Conjunctive Use Program
- Suisun Marsh Habitat Management, Preservation, and Restoration Plan
- South Delta Temporary Barriers Project
- San Francisco Bay- Delta Action Plan
- Prospect Island Tidal Habitat Restoration Project
- Bradmoor Island Habitat Restoration
- Lookout Slough Habitat Restoration
- Chipps Island Habitat Restoration
- Klamath River Renewal Project
- Sites Reservoir
- Bay-Delta Water Quality Control Plan Update
- Los Vaqueros Reservoir Expansion Project

The No Action Alternative would continue with the current operation of the CVP and may result in changes to water quality of reservoirs that store CVP water, tributaries, and agricultural land. These changes may potentially contribute to cumulative impacts and were described and considered in the 2020 Record of Decision.

Alternative 1 would negatively affect water quality in Clear Creek, the American River, and the Stanislaus River by reducing flows in most water year types. This flow reduction could result in less dilution, causing increased constituents of concern concentrations within Clear Creek, the American River, and the Stanislaus River compared with current conditions. Flow reductions could lead to an increase in the frequency of exceedances of water quality standards and negatively impact assigned beneficial uses. Alternative 1's contribution to water quality degradation would be anticipated to be minimal. When combined with water quality impacts from past, present, and reasonably foreseeable projects, Alternative 1 could contribute to the cumulative impacts of water quality.

Alternatives 2, 3, and 4 would have similar or less impact compared with Alternative 1. Alternatives 2 and 4 would negatively affect water quality in the American River and Alternative 3 would negatively affect water quality in the Sacramento and Stanislaus Rivers. Alternatives 2, 3, and 4 would not generate substantial contributions to cumulative water quality conditions in the Trinity River, Feather River, and San Joaquin River areas. When considered in combination with the projects identified in Appendix Y, Alternatives 2, 3, and 4 are not expected to contribute to the cumulative impacts on water quality.

Specific to the CVP and SWP service area, all action alternatives would result in high chloride concentrations during some months. However, the CVP/SWP would continue operation, in real-time, to meet the Bay-Delta Water Quality Control Plan objectives for chloride, which aim to protect municipal and industrial beneficial uses. Thus, all action alternatives would not generate substantial contributions to cumulative water quality conditions as it pertains to chloride concentrations in the CVP and SWP service area.

Specific to the Bay-Delta region, the action alternatives would have negligible, if any, effects on selenium, organic carbon, trace metals, nutrients, DO, legacy contaminants (i.e., dioxin and furan compounds, PCBs, and PAHs), or pesticides. Thus, the action alternatives would not have an effect on the future cumulative conditions of these constituents and constituent groups. However, the action alternatives could have some effect on EC, chloride, bromide, methylmercury, selenium, organic carbon, and CHABs in the Delta, Suisun Marsh, Suisun Bay, and/or San Francisco Bay.

G.2.9.1 Salinity-Related Parameters: EC, Chloride, and Bromide

The western, northwestern, southern, and export area portions of the Delta are on the Water Board's CWA Section 303(d) list as impaired due to elevated EC/salinity. Suisun Marsh is listed as impaired due to salinity and chloride (State Water Resources Control Board 2022a). Bromide is not specifically identified as a constituent contributing to impairment, but is also a salinity-related parameter, so is addressed with EC and chloride. Climate change is anticipated to cause an increase in EC/chloride/salinity in the western and southern due to sea-level rise, which would contribute to cumulative conditions for EC and chloride, and potentially bromide, in the western Delta.

Several regulatory programs aim to address salinity in the Central Valley and have the potential to reduce salt loads to the Bay-Delta region. The Central Valley RWQCB has adopted a Salt and Nitrate Control Program Basin Plan Amendment to manage salt and nitrate discharges within the Central Valley region. Furthermore, the Central Valley RWQCB includes requirements in municipal wastewater treatment plant NPDES permits to control salinity discharges to surface waters. While implementing additional controls should reduce salinity in discharges, the EC and chloride would contribute to the cumulative condition, primarily because of sea-level rise and how that affects EC in the western and southern Delta, and Suisun Marsh. There are also likely to be contributions of bromide to the cumulative condition, depending on the extent to which sea-level rise results in higher bromide concentrations at drinking water treatment plant intakes in the Delta.

All action alternatives would not contribute to additional effects on Delta EC, chloride, and bromide, and Suisun Marsh salinity/chloride. The CVP and SWP would continue to be operated in real-time to meet the Bay-Delta Plan objectives for EC, which aim to protect agricultural and fish and wildlife beneficial uses, and chloride for the protection of municipal and industrial supply uses. Although there could be some level of water quality degradation for EC and chloride under these alternatives, relative to the No Action Alternative, operations to meet the Bay-Delta Water Quality Control Plan objectives would ensure that beneficial uses would remain protected with regard to EC and chloride levels. While there are no objectives specifically for bromide, bromide concentrations are related to EC and chloride, and thus, all action alternatives would not be expected to contribute to additional effects on beneficial uses because of the operations to meet Bay-Delta Water Quality Control Plan objectives.

G.2.9.2 Methylmercury

Numerous regulatory efforts are implemented or under development to control and reduce mercury loading to the Bay-Delta region, including TMDLs, increased restrictions on point source discharges such as municipal wastewater treatment plants, greater restrictions on suction dredging in Delta tributary watersheds, and continued cleanup actions on mine drainage in the upper watersheds. A key challenge surrounds the pool of mercury deposited in Delta sediments, which cannot be readily or rapidly reduced, despite efforts to reduce future loads in Delta tributaries, and serves as a source for continued methylation and Delta biota methylmercury bioaccumulation. Consequently, methylmercury levels in Bay-Delta waters would contribute to the cumulative condition.

Based on the water and fish tissue modeling performed for the analysis, methylmercury concentrations in water and fish tissue are not expected to be substantially affected by Alternatives 1, 2, and 4; Alternative 3 may make existing impairments worse. Increased methylmercury bioaccumulation under Alternative 3 could contribute to the cumulative condition for methylmercury in the Bay-Delta region.

G.2.9.3 CHABs

Future climate change will result in reduced Delta inflows annually during June through November, which may result in longer residence times in some areas of the Delta. Delta inflows are also expected to be warmer in the future as less water enters the Delta from the upper watersheds due to a lower snowpack and precipitation increasingly falling as rain.

Climate change combined with warmer Delta inflows is expected to cause an increase in average Delta water temperatures during the summer and early fall months. High water temperatures, particularly those above 25°C (77°F), give cyanobacteria a competitive advantage over other algae. As such, *Microcystis* and other cyanobacteria typically produce more biovolume and cell abundance (i.e., have greater production) at elevated water temperatures. Increased water temperatures could lead to earlier attainment of the water temperature threshold of 19°C required to initiate *Microcystis* bloom in the Delta and thus earlier occurrences of *Microcystis* blooms. Warmer water temperatures could also increase bloom duration and magnitude.

Past research within the Delta has shown that increased residence time and higher water temperatures are the two most important drivers of past and present problem-level CHABs in the Delta. Because water temperatures and possibly residence times in some portions of the Delta could be expected to increase in the future due primarily to sea-level rise and climate change, which will favor CHABs, *Microcystis* (and thus microcystin concentrations) and other species that form CHABs are expected to contribute to the cumulative condition in the Delta.

Alternatives 1, 2, and 4 would not substantially alter Delta water temperatures or residence times relative to the No Action Alternative; Alternative 3 may make temperature and/or residence time conditions worse because it would result in substantial reductions in Sacramento River flows entering the Delta at Freeport and San Joaquin River flows entering the Delta at Vernalis. Alternative 3 could contribute to the cumulative condition for CHABs.

G.3 References

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